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Monitoring of Heavy Metal Concentration in Ground Water of Pisangan Tehsil of Ajmer District, Rajasthan, India

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Abstract

In the present investigation the heavy metal concentration such as Iron, Zinc, Lead, Cadmium, Nickel and Aluminium in the ground water samples of the study areas caused by natural and anthropogenic activities are studied.

Keywords: Ground Water, Heavy Metals, Monsoon,Analysis, Rain Water Harvesting.

Introduction

The rapidly Increasing human activities have modified the global cycle of heavy metals, non metals and metalloids. Heavy metals are a group of elements that occur in natural system in minute concentration and when present in sufficient quantities, are toxic to living organisms. The behavior of trace metals in groundwater is complicated and is related to source of group water and the bio-geochemical process in elemental conditions (WHO, 1993). For normal functioning of the human body, some metals are essential, where as others are non essential.(Shiv Shankaran,M.A. 1997). Most of the metals are important for the growth, development and health of living organisms.(Duan, A, 1993)

Objective of The Study

Ground water system in the state of Rajasthan has become extremely vulnerable to the overuse and water quality degradation. Since the volume of ground water in storage varies both in space and time in accordance with the hydrometeorological and hydrogeological domain conditions together with the external stress loaded on it as per the ground water requirements of various sectors like agriculture, drinking water needs and industrial uses, therefore the net impact imparted on the ground water system need to be studied closely and critically by analysing the behavioural pattern of the different heavy metal concentrations of ground water of study area.

Study Area

Pisangan is a Tehsil in Ajmer District of Rajasthan State India. Pisangan Tehsil Head Quarters is Pisangan Town. It belongs to Ajmer Division. It is located 20 KM towards south from District Headquaters Ajmer. 167 KM from state capital Jaipur towards east. It is in the 438 m elevation (altitude). Ajmer is located in centre of Rajasthan. Ajmer is a 12^{th} biggest district of Rajasthan with area of 8,480 square kms.

Physiography

Ajmer district is located in between $25^{0}58^{'}$ north latitudes and $73^{0}54^{'}$; and $75^{0}22^{'}$ East longitudes. As a whole, the region has dry and wet land, plains and rocky areas. Ajmer is divided into six sub division, nine tehsil, eight panchayat samities 706 villages and 1391 other habitations. Its total population is 21,81,670 as per year 2001 census.

Geology

Ajmer district has a geographical area of 8480 square kms . The north western part is covered with sand dunes and rest of area is generally flat. Hydro geologically, the major part of the region is occupied by crystalline rocks comprising of caleschist, amphibolites /calc-gneiss and biotite Schist (all Precamb, rian); sand and alluvium of younger age are other important formations (GSI, 1977).

Rainfall

The mean annual rainfall of the district is below 500 mm whereas normal rainfall is lower than average. Almost 95%of the total annual rainfall is received during the south west monsoon, which enters the district in the last week of June and withdraws in the middle of September.

Review of Literature

The sampling, preservation, digestion and preparations and the analysis of heavy metals in water samples are made as prescribed by standard methods of APHA 1998 using Atomic Absorption Spectrophotometer (Perkin Elmer -403). The water levels reflect the cumulative effect on ground water regime as a consequence of natural recharge - discharge conditions and artificial draft. Where the draft exceeds the recharge, its manifestation is reflected in the decline of water level. (Central Ground water Board year book 2014-15). The world main source of ions in the naturally occurring drinking water derived from deep tube-wells, containing minerals which commonly contain 3 to 5 ppm fluoride in ground water and sometimes natural thermal spring bring it to 10 to 15 ppm fluoride in complex with heavy metals by Madhavan and V. Subramanian (2016). The contamination of under ground waters depends on the availability and solubility of the parent materials with which this water are in contact (WHO) 2016.

Concepts and Hypothesis

The other factors affecting the ground water are pH, alkalinity and heavy metal ions present in water. High pH of water favours the dissolution of more heavy metal ions in water. However, at acidic pH fluoride and other heavy metal ions tends to complexes with the heavy metal present in water. Naturally occurring heavy metal ions in ground water are a result of the dissolution of ions containing rock minerals by water due to artificially high ionic soil levels can occur through contamination by application of phosphate fertilizers, sewage sludge, or pesticides.

Research Design / Materials and Methods

The assessment of heavy metal concentration in ground water of study area was carried out for three seasons (Monsoon, Post monsoon and Pre monsoon) in the year 2017-18. The 20 water samples are selected from identified tube wells in the study areas and samples were collected in pre cleaned black coloured car buoys of 2litres capacity with necessary precautions. The sampling, preservation, digestion and preparations and the analysis of heavy metals in water samples are made as prescribed by standard methods of APHA 1998 using Atomic Absorption Spectrophotometer (Perkin Elmer -403)

Table-1 Heavy Metals Recorded in the Study Sites during the Year 2017-18

S.No	Location	Location Heavy Metals (mg/l)					
		Fe	Pb	Zn	Ni	Al	Cd
1.	Rampura Dabla	4.01	0.006	0.351	0.002	0.36	0.002
2.	Leeri	5.42	0.005	0.358	0.003	0.023	BDL
3.	Mangaliyawas	2.02	0.003	BDL	BDL	0.25	BDL
4.	Jethana	2.01	0.003	BDL	BDL	0.022	0.002
5.	Kadel	1.01	BDL	0.002	BDL	0.021	BDL
6.	Daurai	2.01	BDL	0.102	BDL	BDL	BDL
7.	Derathoo	3.00	BDL	BDL	0.050	BDL	0.002
8.	Doomara	1.02	0.001	0.063	0.001	0.03	0.02
9.	Gola	1.08	0.006	0.231	0.001	0.20	BDL
10.	Hatoondi	2.01	0.001	0.340	0.002	0.14	BDL
11.	Jharwasa	1.06	BDL	0.301	0.001	BDL	BDL
12.	Kalesara	1.08	0.002	BDL	0.001	0.10	BDL
13.	Kesharpura	1.09	0.003	BDL	0.001	BDL	BDL
14.	Lamana	3.06	BDL	BDL	BDL	0.19	BDL
15.	Makrera	3.01	0.005	BDL	BDL	0.20	BDL
16.	Miyapur	3.02	0.002	BDL	0.001	BDL	BDL
17.	Nand	2.05	0.003	BDL	0.002	0.18	BDL
18.	Nyara	2.02	BDL	BDL	0.003	BDL	BDL
19.	Peesangan	3.03	0.002	BDL	0.021	0.120	0.001
20.	Tilora	4.01	0.001	BDL	0.062	BDL	0.002

Note: BDL- below detectable level

Table 2

Drinking Water Quality Standards (BIS 2014-15)

Parameter	BIS 2014-15	
	P(mg/l)	E(mg/l)
Iron	0.3	1.0
Zinc	5	15
Cadmium	0.01	0.01
Lead	0.05	0.05
Nickel	___	0.02
Aluminium	0.03	0.2

Note: P=Permissible limit; E=Excessive limit.

Results and Discussions

The finding of the present investigation are summarized in table – 1 and was also been compared with drinking water standards (table-2) which provides the comprehensive picture of the heavy metals characteristics of ground water in the study area.

Iron (Fe)

It is the fourth most abundant element by mass in the earth's crust. In water, it occurs mainly in the ferrous and ferric state. Iron in surface water generally present in ferric state. It is an essential and non-conservative trace element found in significant concentration in drinking water because of its

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abundance in the earth's crust. Usually iron occurring in the ground water is in the form of ferric hydroxide, in concentration less than 0.5 mg/l. The shortage of iron causes a disease called "anemia" and prolonged consumption of drinking water with high concentration of iron may lead to liver disease called as haemosiderosis (Rajgopal, 1984)

ZINC (Zn)

Zinc is one of the important trace elements that play a vital role in the physiological and metabolic process of many organisms. Nevertheless, at higher concentration, Zinc can be toxic to the organisms. It plays an important role in protein synthesis. Zinc is a metal which shows fairly low concentration in surface water, which is due to its restricted mobility from the place of rock weathering or from the natural sources (BIS,2014). The permissible limit of zinc in water is 0.5 mg/l.

In the present study, the concentration of zinc ranged between a minimum of BDL and a maximum of 0.358 mg/l. The values of zinc are showed within the limit of drinking water standard.

Cadmium (Cd)

it is not an essential non-beneficial element known to have a toxic potential. The concentration of cadmium in lithosphere is low. It normally ranges from $1x10^{-4}$ to $2x10^{-4}$mg/l. the main sources of cadmium are industrial activities as the metal widely used in electroplating, pigments, plastic, stabilizes and battery industries. Cadmium is highly toxic and responsible for several cases of poisoning through food. Small quantities of cadmium cause adverse changes in the arteries of human kidney. It replaces zinc biochemically and causes high blood pressures, kidney damage etc. It interferes with enzymes and causes a painful disease called Itai-Itai. Cadmium concentrations in ground water of the study area are below the detectable level. Nevertheless, cadmium in low concentration is quite toxic to human health (Mohan, R.N, Chopra, 1998).

Lead (Pb)

It is an undesirable trace metal less abundantly found in earth's crust. Lead is also found in soil, vegetation, animals and food. It is a serious cumulative body poison. Lead inhibits several key enzymes involved in the overall process of haemo-synthesis where by metabolic intermediate accumulates (Verma, N.K., Jain, O.P.,1995). The study revealed that the concentration of lead is below the detectable level in most of the borewell samples. However the concentration of lead observed is within the safe limit of BIS (2014).

Nickel (Ni)

It occurs in natural water as divalent cation with pH range between5-9. Nickel is a natural element of the earth's crust, therefore, small amounts are found in food, water, soil and air. Nickel occurs naturally in the environment at low levels. Nickel is used for nickel alloys, electroplating, machinery parts, stainless-steel, spark plugs and also as catalysts. Nickel is found in ambient air at very low levels as a result of releases from oil and coal combustion, nickel metal refining, sewage sludge incineration and other sources. Nickel in general, is associated with basic and ultra basic rocks. Nickel dermatitis, consisting of itching of the fingers, hands and forearms, it is the most common effect in humans from chronic skin contact with nickel. However nickel concentration in ground water of the study area is below the detectable level.

Aluminium (Al)

The concentration of Aluminium in the groundwater of the study area is below the detectable level in most of the bore well samples. However, the concentration of Aluminium, wherever recorded is well within the limits of drinking water standards prescribed by BIS and WHO. Cumulative effect is reported to cause dementia.

Findings And Conclusion

In the present investigation, the heavy metal concentration such as Iron, Zinc, Lead, Cadmium, Nickel and Aluminium are well within the permissible limits prescribed by BIS standards. However, the concentrations of Cadmium and Nickel in the groundwater samples of the study area were found to be below detectable level. Iron concentration in the village Leeri is a little towards the higher level.

Suggestion

Firstly Regular physico-chemical analysis of water at source must be carried out to determine or check quality of drinking water source. Hence a good knowledge of the chemical qualities of raw water is necessary so as to guide its suitability for use. Secondly there is a need for an appropriate water policy and institutional arrangements for coordination in the management of water resources for both livelihood security and drought mitigation. Water quality monitoring and surveillance system should be given top priority, low awareness regarding the importance of water quality at all levels is a mojor constraint. Rural people specially the lactating mothers should be motivated to use heavy metal free and fluoride safe water.Domestic Roof Top Rain Water Harvesting System (RRHS) provides a viable solution to bridge the gap between demand and supply of water in such areas, especially during periods of water scarcity, RRHS is applicable.

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