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Iron a Specific Heavy Metal Concentration in the Ground Water of Tiptur Town and Its Surrounding Areas, Tumkur District, Karnataka, India

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ABSTRACT

The generation of solid waste has become an increasing environmental and public health problem everywhere in the world, particularly in the developing countries. The problem of inadequate solid waste management is a major environmental challenge all over the world and Tiptur town is no exception. The problem has become compounded due to technical, financial and institutional constraints and landfill sites have further contributed to environmental degradation. The present study was to investigate the heavy metal contamination of ground water sources in and around Tiptur Town. Heavy metals like Fe^{++}, Cd, Zn, Mn, Cr, Pb and Hg estimated to analyze ground water pollution load with respect to human health concern,since Tipturians depend on ground water for drinking purpose. In the present investigation observed result showed that iron concentration varied between a minimum of 0.03 mg/l to a maximum of 2.9 mg/l. Other trace metals Zn, Mn and Cr were within the permissible limit and Pb, Hg and Cd were below detectable level.

Introduction

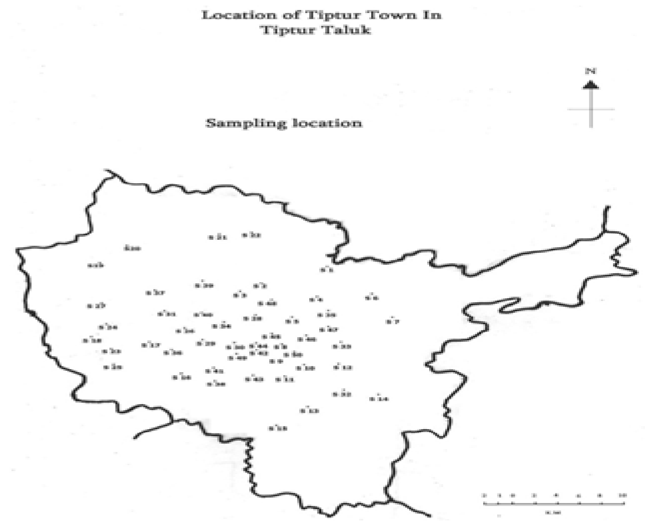
The generation of solid waste has become an increasing environmental and public health problem everywhere in the world, particularly in the developing countries. The problem of inadequate solid waste management is a major environmental challenge all over the world and Tiptur town is no exception. The problem has become compounded due to technical, financial and institutional constraints and landfill sites have further contributed to environmental degradation.

Land fills have been identified as the major threats to ground water resources. Areas near land fills have a greater possibility of ground water contamination because of the potential pollution source of leachate originating from the nearby site (Nixon *et al*., 1997; Aldecy de Almeida *et al*., 2008). Contamination of ground water resource poses a substantial risk to local resources user and the natural environment. Heavy metals designate a group of elements that occur in natural system in minute concentration and when present in sufficient quantities are toxic to living organisms (Verma *et al*., 1995). The behavior of trace metals in ground water is complicated and is related to geochemical process. In elemental condition, some metals are essential for normal functioning of the human body, while others are non essential (Shivashankaran *et al*., 1997). Most of the metals are important for growth, development and health of living organisms (Duan and Kofi, 1993).

The objective of the present study was to investigate the heavy metal contamination of ground water around landfill sites, domestic sewage and unscientific waste disposal near ground water sources in and around Tiptur area keeping human health concern.

Study Area

Karnataka state is situated in the southern peninsular India. Tiptur taluk is about 75 Kms from Tumkur district and covers an area of about 758.5 Sq.Km. The average temperature ranges from 11°C in winter and 38°C during summer. Average rainfall of Tiptur town is 503 mm and its geographical area is 76,510 ha.



Methodology

In the present study, 50 bore well water samples from Tiptur and its surrounding villages were collected during summer (February - May), rainy (June - September) and winter (October - January) seasons for the period of two years (February 2009 - January 2011), for the analysis of physico-chemical and bacteriological parameters.

Analysis of trace metal: Heavy metals or trace metals, which are non degradable, persist for longer duration, even for several years (Walker *et al*., 1996). The trace elements such as iron, mercury, lead, zinc, manganese, chromium and cadmium were analyzed using atomic absorption spectrophotometer (AAS). Heavy metals and their discharge into aquatic ecosystem have increased greatly in recent years.

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Result and discussion

Iron is the fourth most abundant element by mass in the earth's crust. Usually iron occurs in ferrous and ferric state in surface water. In ground water, it occurs as ferric hydroxide. Heavy metals are found in drinking water because of abundance in the earth's crust. Iron deficiency causes a disease called anemia. Long term use of high concentration causes a liver disease called as haemo siderosis.

In the present study, the concentration of iron varied from a minimum of 0.27 mg/l to a maximum of 2.3 mg/l during summer 2009-10 (Table-1, 2). In rainy season (2009-10), it varied from a minimum of 0.03 mg/l to a maximum of 2.9 mg/l (Table-3, 4) and in winter season iron varied from a minimum of 0.5 mg/l to a maximum of 2 mg/l during 2009-11 (Table-5, 6). Iron concentration showed an increasing trend in pre monsoon and monsoon season than in winter season. Increase in iron concentration may be due to unscientific and improper management and disposal of domestic wastes near the sites of water resources. Iron may be acquired in solution by ground water coming into contact with iron objects such as well casings, delivery pipes, etc. Most of the tube wells yield iron-rich water on pumping after prolonged idle periods.

In the present study, it was also noted that iron concentration in S_3, S_{16}, S_{23} and S_{24} was above BIS limits in summer of 2009-10 (Table-1, 2). 60% of samples during summer were found to exhibit an increasing trend and also exceeded the BIS (1998) limits of 1 mg/l and 40% of the samples were within the limit. Chronic intake may lead to diseases and health hazards.

Cadmium

The main sources of cadmium are industrial activities as the metal is widely used in electroplating pigments, plastic stabilizers and batteries. It is a non essential toxic element found in low concentration in lithosphere usually at a concentration of 0.0001 to 0.0002 mg/kg. Cadmium is highly toxic and responsible for several cases of poisoning through food. It affects the human kidneys, replaces zinc biochemically and causes high blood pressure.

Effect of cadmium on environment, is that, it is toxicologically similar to zinc. It is an essential micro nutrient for plants, animals and human beings. Cadmium is bio persistent and once absorbed by an organism remains resident for many years although it is eventually excreted (EPA, 1999).

In the present investigation, cadmium was below detectable level in all the sampling locations during the period of study (Table-1 to 6).

Zinc :Zinc is one of the important element that plays a vital role in the physiological and metabolic process of many organisms. At high concentration, zinc can be toxic to the organism. It plays an important role in protein synthesis. Zinc is a metal which shows fairly low concentration in surface water due to its restricted mobility from the place of rock weathering or from the natural sources (BIS, 1998).

In the present study, zinc varied from a minimum of 0.01mg/l to a maximum of 2.72 mg/l in summer season (Table-1, 2), in rainy season the values ranged from a minimum of 0.02 mg/l to a maximum of 3.36mg/l (Table-3, 4). In winter, it fluctuated from a minimum of 0.05mg/l to a maximum of 3.9 mg/l (Table-5, 6). The study also reveals that the values were found within the permissible limit of BIS (1998).

Chromium :It occurs in nature as chrome iron ore ($FeOCr_2O_3$) and accumulates in lungs affecting the central nervous system (USEPA, 2008). Generally, natural concentration of chromium in water ranges from 0.01 to 0.05 mg/l, except the regions with substantial chromium deposits. It is essential to plants and animals as a micro nutrient in less concentration (Zayed *et al*., 1998).

In the present findings, chromium was found in S_7 and S_{35} sampling locations at a concentration of 0.21 to 0.25 mg/l during summer 2009 (Table-1, 2) and in rainy season, it varied between 0.1 to 0.15 mg/l (Table-3, 4). In winter, it was below detectable level (Table-5, 6). The study revealed that 96% of the sampling locations showed chromium concentration below detectable level.

Manganese :Manganese like iron is also a naturally derived metallic pollutant. Soils and rocks quite commonly contain manganese bearing minerals. Fertilizers and fuel oils act as significant sources of manganese in certain areas. Excessive concentration of manganese may exist in ground water contaminated with oil field brine (WHO, 2004).

Most natural waters contain manganese in concentration of 0.02 mg/l or less. At high p^H, it tends to precipitate due to conversion into oxidized form. Deeper strata of lakes and reservoirs have comparatively higher quantities of manganese than the in surface strata. Water can also be enriched with manganese by acid drainage.

Manganese does not appear to have any toxicological significance in drinking water. Upper limit for manganese in drinking water is 0.05 mg/l. Concentration above 0.5 mg/l imparts metallic taste in both water and food (Verma *et al*., 1995). Excess intake in human beings causes deterioration of central nervous system.

In the present study, manganese varied from a minimum of 0.002 mg/l to a maximum of 0.352 mg/l in summer (Table-2, 3). In rainy season, it varied between a minimum of 0.002 mg/l to a maximum of 0.35 mg/l (Table-2, 4).

In winter, it ranged between a minimum of 0.02 mg/l to a maximum of 0.6 mg/l (S_{26}) (Table-5, 6). In the present observation, it was revealed that the concentration of manganese was well within the BIS (1998) limits, except in one sampling location, $S_{26,}$ which exceeded the limit (0.58-0.6 mg/l) in winter season (Table-5, 6).

Lead: Lead is an undesirable metal, less abundantly found in the earth's crust. It is also found in soil, vegetation, animals and food and is a serious cumulative body poison. Lead inhibits several key enzymes involved in the overall process of haemosynthesis whereby metabolic intermediates accumulate (Akoteyon *et al*., 2011).

In the present study, the concentration of lead was below detectable level in all the sampling locations (Table-1, 6).

Mercury: Mercury occurs in deposits throughout the world, mostly as cinnabar (Mecuric sulfide). A pure form mercuric sulfide is obtained by reaction of mercury with sulfur. It is highly toxic and enters through ingestion, inhalation and intake through seafood.

It is usually deposited in atmosphere by industrial emissions, volcanic eruptions, gold mining and power plants. Recent atmospheric contamination is elevated upto 0.069 micro-gm/m^3. It may pollute even ground water through precipitation. Mercury containing insecticides and fungicides cause toxicity. Commonly, mercury is not present in ground water.

It is found in water due to disposal of industrial waste. In humans, mercury may cause headache, abdominal pain and diarrhoea (Kamaruddin Samuding *et al*., 2009). In the present findings, mercury was below detectable level in all locations during the study period (Table-1 to 6)

Table 1. Trace metals concentration in the ground water of study area during summer season, 2009

Sample No.	Fe	Cd	Mn	Hg	Zn	Pb	Cr
S1	0.27	BDL	BDL	BDL	0.01	BDL	BDL
S2	0.37	BDL	BDL	BDL	BDL	BDL	BDL
S3	0.48	BDL	BDL	BDL	0.07	BDL	BDL
S4	0.51	DBL	BDL	BDL	0.17	BDL	BDL
S5	0.37	BDL	BDL	BDL	0.1	BDL	BDL
S6	0.43	BDL	BDL	BDL	0.02	BDL	BDL
S7	0.53	BDL	BDL	BDL	0.24	BDL	0.22
S8	0.6	BDL	BDL	BDL	0.01	BDL	BDL
S9	0.51	BDL	0.082	BDL	2.15	BDL	BDL
S10	0.86	BDL	BDL	BDL	0.02	BDL	BDL
S11	0.75	BDL	BDL	BDL	0.124	BDL	BDL
S12	0.9	BDL	BDL	BDL	0.31	BDL	BDL
S13	1.22	BDL	0.15	BDL	0.412	BDL	BDL
S14	0.61	BDL	0.01	BDL	0.O41	BDL	BDL
S15	0.58	BDL	BDL	BDL	0.002	BDL	BDL
S16	1.07	BDL	BDL	BDL	0.04	BDL	BDL
S17	0.77	BDL	BDL	BDL	0.17	BDL	BDL
S18	0.9	BDL	0.042	BDL	1.22	BDL	BDL
S19	1	BDL	BDL	BDL	0.93	BDL	BDL
S20	0.84	BDL	0.07	BDL	2.15	BDL	BDL
S21	0.37	BDL	0.352	BDL	0.63	BDL	BDL
S22	0.91	BDL	BDL	BDL	0.45	BDL	BDL
S23	1.8	BDL	BDL	BDL	1.06	BDL	BDL
S24	2.1	BDL	0.057	BDL	1.31	BDL	BDL
S25	1	BDL	BDL	BDL	0.164	BDL	BDL
S26	1.02	BDL	0.32	BDL	0.38	BDL	BDL
S27	1	BDL	0.162	BDL	0.191	BDL	BDL
S28	0.51	BDL	0.004	BDL	1.27	BDL	BDL
S29	0.62	BDL	BDL	BDL	0.87	BDL	BDL
S30	0.8	BDL	0.002	BDL	0.602	BDL	BDL
S31	0.78	BDL	BDL	BDL	0.031	BDL	BDL
S32	2.3	BDL	0.04	BDL	1.241	BDL	BDL
S33	0.42	BDL	BDL	BDL	0.01	BDL	BDL
S34	0.54	BDL	BDL	BDL	0.061	BDL	BDL
S35	0.47	BDL	0.062	BDL	0.54	BDL	0.22
S36	0.81	BDL	0.011	BDL	0.123	BDL	BDL
S37	0.49	BDL	0.002	BDL	2.72	BDL	BDL
S38	0.6	BDL	BDL	BDL	0.01	BDL	BDL
S39	0.54	BDL	0.02	BDL	0.275	BDL	BDL
S40	0.46	BDL	0.004	BDL	0.232	BDL	BDL
S41	0.31	BDL	BDL	BDL	0.42	BDL	BDL
S42	0.46	BDL	BDL	BDL	0.25	BDL	BDL
S43	0.51	BDL	BDL	BDL	0.43	BDL	BDL
S44	0.51	BDL	BDL	BDL	0.01	BDL	BDL
S45	0.43	BDL	BDL	BDL	0.04	BDL	BDL
S46	0.6	BDL	BDL	BDL	BDL	BDL	BDL
S47	0.34	BDL	BDL	BDL	0.13	BDL	BDL
S48	0.45	BDL	0.003	BDL	0.171	BDL	BDL
S49	0.38	BDL	BDL	BDL	0.01	BDL	BDL
S50	0.37	BDL	BDL	BDL	0.01	BDL	BDL

Note: All parameters are in mg/l

Table 2. Trace metals concentration in the ground water of study area during summer season, 2010

Sample No.	Fe	Cd	Mn	Hg	Zn	Pb	Cr
S1	1.2	BDL	BDL	BDL	0.01	BDL	BDL
S2	1.94	BDL	BDL	BDL	BDL	BDL	BDL
S3	1.09	BDL	BDL	BDL	0.073	BDL	BDL
S4	1.14	DBL	BDL	BDL	0.17	BDL	BDL
S5	1.32	BDL	BDL	BDL	0.1	BDL	BDL
S6	1.10	BDL	BDL	BDL	0.03	BDL	BDL
S7	1.8	BDL	BDL	BDL	0.27	BDL	0.22
S8	1.41	BDL	BDL	BDL	0.01	BDL	BDL
S9	1.28	BDL	0.082	BDL	2.15	BDL	BDL
S10	0.9	BDL	BDL	BDL	0.02	BDL	BDL
S11	2	BDL	BDL	BDL	0.126	BDL	BDL

S12	1.04	BDL	BDL	BDL	0.31	BDL	BDL
S13	1.08	BDL	0.15	BDL	0.414	BDL	BDL
S14	1.08	BDL	0.01	BDL	0.043	BDL	BDL
S15	1.04	BDL	BDL	BDL	0.002	BDL	BDL
S16	1.01	BDL	BDL	BDL	0.04	BDL	BDL
S17	0.91	BDL	BDL	BDL	0.17	BDL	BDL
S18	1.08	BDL	0.042	BDL	1.22	BDL	BDL
S19	1.12	BDL	BDL	BDL	0.93	BDL	BDL
S20	1.04	BDL	0.07	BDL	2.15	BDL	BDL
S21	1.2	BDL	0.352	BDL	0.63	BDL	BDL
S22	0.67	BDL	BDL	BDL	0.45	BDL	BDL
S23	0.84	BDL	BDL	BDL	1.08	BDL	BDL
S24	1.0218	BDL	0.057	BDL	1.31	BDL	BDL
S25	0.68	BDL	BDL	BDL	0.168	BDL	BDL
S26	1.14	BDL	0.32	BDL	0.38	BDL	BDL
S27	1.2	BDL	0.162	BDL	0.194	BDL	BDL
S28	0.91	BDL	0.004	BDL	1.27	BDL	BDL
S29	0.98	BDL	BDL	BDL	0.87	BDL	BDL
S30	1.16	BDL	0.002	BDL	0.604	BDL	BDL
S31	1.08	BDL	BDL	BDL	0.037	BDL	BDL
S32	0.5	BDL	0.04	BDL	1.241	BDL	BDL
S33	1.0	BDL	BDL	BDL	0.01	BDL	BDL
S34	1.07	BDL	BDL	BDL	0.063	BDL	BDL
S35	0.72	BDL	0.062	BDL	0.54	BDL	0.22
S36	1.09	BDL	0.011	BDL	0.123	BDL	BDL
S37	0.68	BDL	0.002	BDL	2.7	BDL	BDL
S38	1.01	BDL	BDL	BDL	0.01	BDL	BDL
S39	0.98	BDL	0.02	BDL	0.284	BDL	BDL
S40	0.78	BDL	0.004	BDL	0.236	BDL	BDL
S41	0.66	BDL	BDL	BDL	0.42	BDL	BDL
S42	0.54	BDL	BDL	BDL	0.25	BDL	BDL
S43	0.56	BDL	BDL	BDL	0.43	BDL	BDL
S44	0.6	BDL	BDL	BDL	0.01	BDL	BDL
S45	0.5	BDL	BDL	BDL	0.04	BDL	BDL
S46	0.54	BDL	BDL	BDL	BDL	BDL	BDL
S47	0.48	BDL	BDL	BDL	0.13	BDL	BDL
S48	1.04	BDL	0.003	BDL	0.173	BDL	BDL
S49	0.87	BDL	BDL	BDL	0.01	BDL	BDL
S50	0.71	BDL	BDL	BDL	0.01	BDL	BDL

Note: All parameters are in mg/l

Table 3. Trace metals concentration in the ground water of study area during rainy season, 2009

Sample No.	Fe	Cd	Mn	Hg	Zn	Pb	Cr
S1	0.24	BDL	BDL	BDL	0.5	BDL	BDL
S2	0.35	BDL	BDL	BDL	BDL	BDL	BDL
S3	0.45	BDL	BDL	BDL	BDL	BDL	BDL
S4	0.62	DBL	BDL	BDL	0.6	BDL	BDL
S5	0.48	BDL	BDL	BDL	0.28	BDL	BDL
S6	0.5	BDL	BDL	BDL	0.13	BDL	BDL
S7	0.77	BDL	BDL	BDL	3	BDL	0.22
S8	0.75	BDL	BDL	BDL	0.02	BDL	BDL
S9	0.84	BDL	0.082	BDL	2.07	BDL	BDL
S10	0.54	BDL	BDL	BDL	0.022	BDL	BDL
S11	0.71	BDL	BDL	BDL	0.22	BDL	BDL
S12	0.89	BDL	BDL	BDL	1.06	BDL	BDL
S13	1.3	BDL	0.15	BDL	0.46	BDL	BDL
S14	0.77	BDL	0.01	BDL	3.3	BDL	BDL
S15	0.52	BDL	BDL	BDL	0.46	BDL	BDL
S16	0.99	BDL	BDL	BDL	BDL	BDL	BDL
S17	1	BDL	BDL	BDL	0.45	BDL	BDL
S18	0.91	BDL	0.042	BDL	1.41	BDL	BDL
S19	0.89	BDL	BDL	BDL	0.88	BDL	BDL
S20	0.89	BDL	0.07	BDL	2.32	BDL	BDL
S21	0.52	BDL	0.352	BDL	0.7	BDL	BDL
S22	1.1	BDL	BDL	BDL	0.79	BDL	BDL
S23	1.7	BDL	BDL	BDL	2.34	BDL	BDL
S24	1.24	BDL	0.057	BDL	1.62	BDL	BDL

S25	1.01	BDL	BDL	BDL	1.17	BDL	BDL
S26	1.1	BDL	0.32	BDL	0.63	BDL	BDL
S27	1	BDL	0.162	BDL	0.27	BDL	BDL
S28	0.6	BDL	0.004	BDL	1.7	BDL	BDL
S29	0.59	BDL	BDL	BDL	0.8	BDL	BDL
S30	0.84	BDL	0.002	BDL	1.9	BDL	BDL
S31	0.8	BDL	BDL	BDL	0.63	BDL	BDL
S32	1.49	BDL	0.04	BDL	1.08	BDL	BDL
S33	0.49	BDL	BDL	BDL	0.86	BDL	BDL
S34	0.51	BDL	BDL	BDL	2.24	BDL	BDL
S35	0.5	BDL	0.062	BDL	0.14	BDL	0.22
S36	0.85	BDL	0.011	BDL	0.82	BDL	BDL
S37	0.87	BDL	0.002	BDL	2.8	BDL	BDL
S38	0.8	BDL	BDL	BDL	0.1	BDL	BDL
S39	0.6	BDL	0.02	BDL	0.3	BDL	BDL
S40	0.5	BDL	0.004	BDL	0.2	BDL	BDL
S41	0.48	BDL	BDL	BDL	0.31	BDL	BDL
S42	0.54	BDL	BDL	BDL	0.25	BDL	BDL
S43	0.74	BDL	BDL	BDL	0.5	BDL	BDL
S44	0.61	BDL	BDL	BDL	0.02	BDL	BDL
S45	0.51	BDL	BDL	BDL	0.05	BDL	BDL
S46	0.78	BDL	BDL	BDL	BDL	BDL	BDL
S47	0.7	BDL	BDL	BDL	0.15	BDL	BDL
S48	0.72	BDL	0.003	BDL	0.16	BDL	BDL
S49	0.9	BDL	BDL	BDL	0.02	BDL	BDL
S50	0.8	BDL	BDL	BDL	0.015	BDL	BDL

Note: All parameters are in mg/l

Table 4. Trace metal concentration in the ground water of study area during rainy season, 2010

Sample No.	Fe	Cd	Mn	Hg	Zn	Pb	Cr
S1	0.27	BDL	0.17	BDL	0.61	BDL	BDL
S2	0.49	BDL	0.35	BDL	BDL	BDL	BDL
S3	0.08	BDL	0.08	BDL	BDL	BDL	BDL
S4	2	BDL	0.11	BDL	0.65	BDL	BDL
S5	0.05	BDL	0.14	BDL	0.28	BDL	BDL
S6	0.14	BDL	0.03	BDL	0.13	BDL	BDL
S7	2.5	BDL	0.48	BDL	3.0	BDL	0.15
S8	0.9	BDL	BDL	BDL	0.02	BDL	BDL
S9	2.6	BDL	0.076	BDL	2.07	BDL	BDL
S10	1	BDL	BDL	BDL	0.025	BDL	BDL
S11	0.17	BDL	BDL	BDL	0.22	BDL	BDL
S12	0.53	BDL	BDL	BDL	1.04	BDL	BDL
S13	0.1	BDL	0.15	BDL	0.46	BDL	BDL
S14	1.4	BDL	0.05	BDL	3.3	BDL	BDL
S15	0.52	BDL	BDL	BDL	0.46	BDL	BDL
S16	2.2	BDL	0.09	BDL	BDL	BDL	BDL
S17	0.56	BDL	BDL	BDL	0.49	BDL	BDL
S18	0.82	BDL	0.04	BDL	1.41	BDL	BDL
S19	0.9	BDL	BDL	BDL	0.98	BDL	BDL
S20	2.5	BDL	0.06	BDL	2.32	BDL	BDL
S21	0.6	BDL	0.25	BDL	0.7	BDL	BDL
S22	1.07	BDL	0.02	BDL	0.79	BDL	BDL
S23	1.85	BDL	0.04	BDL	2.34	BDL	BDL
S24	2.8	BDL	BDL	BDL	1.82	BDL	BDL
S25	0.64	BDL	BDL	BDL	1.17	BDL	BDL
S26	2.5	BDL	0.6	BDL	0.63	BDL	BDL
S27	0.28	BDL	BDL	BDL	0.27	BDL	BDL
S28	0.16	BDL	BDL	BDL	1.9	BDL	BDL
S29	1	BDL	BDL	BDL	0.9	BDL	BDL
S30	2.9	BDL	BDL	BDL	1.9	BDL	BDL
S31	0.08	BDL	BDL	BDL	0.63	BDL	BDL
S32	2.2	BDL	0.03	BDL	1.08	BDL	BDL
S33	0.68	BDL	0.04	BDL	0.86	BDL	BDL
S34	0.17	BDL	BDL	BDL	2.54	BDL	BDL
S35	0.03	BDL	0.03	BDL	0.14	BDL	0.1
S36	0.14	BDL	BDL	BDL	0.82	BDL	BDL
S37	0.9	BDL	BDL	BDL	2.8	BDL	BDL

S38	0.03	BDL	BDL	BDL	0.1	BDL	BDL
S39	0.7	BDL	0.01	BDL	0.3	BDL	BDL
S40	0.6	BDL	0.002	BDL	0.28	BDL	BDL
S41	0.04	BDL	0.005	BDL	0.31	BDL	BDL
S42	0.6	BDL	BDL	BDL	0.28	BDL	BDL
S43	0.8	BDL	BDL	BDL	0.5	BDL	BDL
S44	0.7	BDL	BDL	BDL	0.02	BDL	BDL
S45	0.6	BDL	BDL	BDL	0.05	BDL	BDL
S46	0.8	BDL	BDL	BDL	BDL	BDL	BDL
S47	0.7	BDL	BDL	BDL	0.15	BDL	BDL
S48	0.68	BDL	0.005	BDL	0.18	BDL	BDL
S49	0.8	BDL	BDL	BDL	0.02	BDL	BDL
S50	0.7	BDL	BDL	BDL	0.015	BDL	BDL

Note: All parameters are in mg/l

Table 5. Trace metal concentration in the ground water of study area during winter season, 2009-10

Sample No.	Fe	Cd	Mn	Hg	Zn	Pb	Cr
S1	1.2	BDL	BDL	BDL	0.81	BDL	BDL
S2	1.5	BDL	BDL	BDL	BDL	BDL	BDL
S3	0.8	BDL	BDL	BDL	BDL	BDL	BDL
S4	1.1	DBL	BDL	BDL	0.9	BDL	BDL
S5	0.74	BDL	BDL	BDL	0.48	BDL	BDL
S6	2	BDL	BDL	BDL	0.2	BDL	BDL
S7	1.1	BDL	BDL	BDL	3.5	BDL	0.22
S8	1.1	BDL	BDL	BDL	0.08	BDL	BDL
S9	1.2	BDL	0.082	BDL	2.5	BDL	BDL
S10	1.6	BDL	BDL	BDL	0.04	BDL	BDL
S11	0.5	BDL	BDL	BDL	0.28	BDL	BDL
S12	2	BDL	BDL	BDL	1.15	BDL	BDL
S13	1.1	BDL	0.15	BDL	0.46	BDL	BDL
S14	1.89	BDL	0.01	BDL	3.8	BDL	BDL
S15	0.67	BDL	BDL	BDL	0.6	BDL	BDL
S16	1.04	BDL	BDL	BDL	BDL	BDL	BDL
S17	1.08	BDL	BDL	BDL	0.59	BDL	BDL
S18	1.18	BDL	0.042	BDL	1.6	BDL	BDL
S19	0.91	BDL	BDL	BDL	1.2	BDL	BDL
S20	1.1	BDL	0.07	BDL	2.55	BDL	BDL
S21	0.98	BDL	0.352	BDL	1	BDL	BDL
S22	1	BDL	BDL	BDL	1.3	BDL	BDL
S23	1.14	BDL	BDL	BDL	2.5	BDL	BDL
S24	1.24	BDL	0.057	BDL	2.1	BDL	BDL
S25	1.01	BDL	BDL	BDL	1.4	BDL	BDL
S26	1.1	BDL	0.32	BDL	0.85	BDL	BDL
S27	1.20	BDL	0.162	BDL	0.5	BDL	BDL
S28	0.80	BDL	0.004	BDL	2.2	BDL	BDL
S29	0.94	BDL	BDL	BDL	0.9	BDL	BDL
S30	0.91	BDL	0.002	BDL	2.3	BDL	BDL
S31	0.8	BDL	BDL	BDL	0.84	BDL	BDL
S32	1.4	BDL	0.04	BDL	1.2	BDL	BDL
S33	0.99	BDL	BDL	BDL	0.99	BDL	BDL
S34	0.74	BDL	BDL	BDL	2.6	BDL	BDL
S35	0.69	BDL	0.062	BDL	0.4	BDL	0.22
S36	0.8	BDL	0.011	BDL	1.1	BDL	BDL
S37	0.71	BDL	0.002	BDL	3.2	BDL	BDL
S38	1.08	BDL	BDL	BDL	0.2	BDL	BDL
S39	1.08	BDL	0.02	BDL	0.3	BDL	BDL
S40	0.84	BDL	0.004	BDL	0.28	BDL	BDL
S41	0.61	BDL	BDL	BDL	0.31	BDL	BDL
S42	0.7	BDL	BDL	BDL	0.28	BDL	BDL
S43	0.66	BDL	BDL	BDL	0.6	BDL	BDL
S44	0.56	BDL	BDL	BDL	0.05	BDL	BDL
S45	0.6	BDL	BDL	BDL	0.07	BDL	BDL
S46	0.71	BDL	BDL	BDL	BDL	BDL	BDL
S47	0.68	BDL	BDL	BDL	0.18	BDL	BDL
S48	0.69	BDL	0.003	BDL	0.2	BDL	BDL
S49	0.8	BDL	BDL	BDL	0.05	BDL	BDL
S50	0.74	BDL	BDL	BDL	0.02	BDL	BDL

Note: All parameters are in mg/l

Table 6. Trace metal concentration in the ground water of study area during winter season, 2010-11

Sample No.	Fe	Cd	Mn	Hg	Zn	Pb	Cr
S1	1.01	BDL	BDL	BDL	0.9	BDL	BDL
S2	1.09	BDL	BDL	BDL	BDL	BDL	BDL
S3	0.94	BDL	BDL	BDL	BDL	BDL	BDL
S4	1.2	DBL	BDL	BDL	1.0	BDL	BDL
S5	1.02	BDL	BDL	BDL	0.58	BDL	BDL
S6	1.1	BDL	BDL	BDL	0.28	BDL	BDL
S7	2	BDL	BDL	BDL	3.9	BDL	0.22
S8	0.98	BDL	BDL	BDL	0.1	BDL	BDL
S9	1.2	BDL	0.082	BDL	2.8	BDL	BDL
S10	1.98	BDL	BDL	BDL	0.05	BDL	BDL
S11	0.8	BDL	BDL	BDL	0.3	BDL	BDL
S12	1.04	BDL	BDL	BDL	1.2	BDL	BDL
S13	1	BDL	0.15	BDL	0.5	BDL	BDL
S14	1.1	BDL	0.01	BDL	3.9	BDL	BDL
S15	1.22	BDL	BDL	BDL	0.7	BDL	BDL
S16	1.02	BDL	BDL	BDL	BDL	BDL	BDL
S17	0.97	BDL	BDL	BDL	0.65	BDL	BDL
S18	1.02	BDL	0.042	BDL	1.9	BDL	BDL
S19	1.08	BDL	BDL	BDL	1.5	BDL	BDL
S20	0.85	BDL	0.07	BDL	2.7	BDL	BDL
S21	1.38	BDL	0.352	BDL	1.2	BDL	BDL
S22	1.02	BDL	BDL	BDL	1.4	BDL	BDL
S23	0.8	BDL	BDL	BDL	2.8	BDL	BDL
S24	1.04	BDL	0.057	BDL	2.4	BDL	BDL
S25	11.02	BDL	BDL	BDL	1.4	BDL	BDL
S26	1.04	BDL	0.32	BDL	0.89	BDL	BDL
S27	1.6	BDL	0.162	BDL	0.58	BDL	BDL
S28	0.8	BDL	0.004	BDL	2.25	BDL	BDL
S29	1	BDL	BDL	BDL	0.95	BDL	BDL
S30	0.8	BDL	0.002	BDL	2.5	BDL	BDL
S31	0.66	BDL	BDL	BDL	0.89	BDL	BDL
S32	1	BDL	0.04	BDL	1.26	BDL	BDL
S33	1.1	BDL	BDL	BDL	1.1	BDL	BDL
S34	1.2	BDL	BDL	BDL	2.8	BDL	BDL
S35	0.8	BDL	0.062	BDL	0.4	BDL	0.22
S36	0.99	BDL	0.011	BDL	1.4	BDL	BDL
S37	0.88	BDL	0.002	BDL	3.5	BDL	BDL
S38	1.2	BDL	BDL	BDL	0.28	BDL	BDL
S39	1.2	BDL	0.02	BDL	0.35	BDL	BDL
S40	0.99	BDL	0.004	BDL	0.3	BDL	BDL
S41	1.02	BDL	BDL	BDL	0.35	BDL	BDL
S42	0.9	BDL	BDL	BDL	0.3	BDL	BDL
S43	0.7	BDL	BDL	BDL	0.6	BDL	BDL
S44	0.65	BDL	BDL	BDL	0.08	BDL	BDL
S45	0.89	BDL	BDL	BDL	0.07	BDL	BDL
S46	0.6	BDL	BDL	BDL	BDL	BDL	BDL
S47	0.7	BDL	BDL	BDL	0.2	BDL	BDL
S48	1.4	BDL	0.003	BDL	0.2	BDL	BDL
S49	0.87	BDL	BDL	BDL	0.08	BDL	BDL
S50	0.9	BDL	BDL	BDL	0.05	BDL	BDL

Note: All parameters are in mg/l

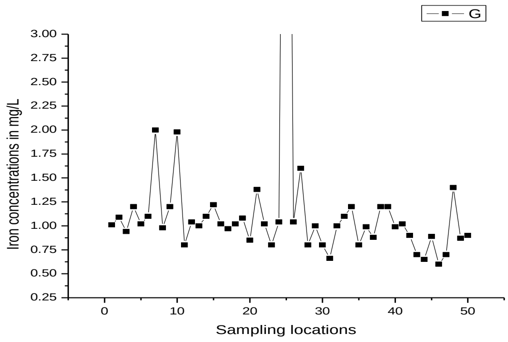

Figure 1. showing iron concentration in during period of study

Conclusion

In the present investigation, certain trace metals like Fe, Cd, Mn, Hg, Zn, Pb and Cr were studied. The observed result showed that iron concentration varied between a minimum of 0.03 mg/l to a maximum of 2.9 mg/l. It was also observed that 8% of the samples exceeded the limit of BIS and 20-40% were approaching the maximum value, but rest of the sampling locations were within the limit. Other trace metals Zn, Mn and Cr were within the permissible limit and Pb, Hg and Cd were below detectable level. It is advised to control and to monitor pollution load by municipality for portability.

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