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Heavy metals concentration Assessment in Ground water and General public Health aspects around Granite mining sites of Laxman pura, U.P., Jhansi, India

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Abstract

Ground water analyzed in granite mining sites at Jhansi to check the current status of heavy metal ions and their sources. Samples of groundwater where collected from various mining sites as well as from residential sites for analysis. In study areas near by 30 crushers were running. The location is situated at 10 km north-east of Jhansi city. Three samples were collected from each mining and residential areas at various distances. Pb, Zn, Cu, Mn, Ni, and Cd, heavy metal concentrations have been analyzed in groundwater. The results shows all the parameters are more or less within permissible limits of WHO.

Keywords: Heavy metal concentration, Ground water, *Laxman pura*, Jhansi.

Introduction

We are largely depends on ground water for domestic, irrigation and industrial requirements, there for it should be good quality along with its aesthetic value in the scenic environment. Water is directly related to human beings and in arid or semi arid regions it's become more precious. In arid or semi-arid environment where surface water is limited, the groundwater is often affected by environmental component. The main sources by which leach contaminants can go into groundwater are leach pad liners, subsequent leaching to groundwater, leakage or spills from storage ponds, storm water run-on/off uncontrolled leaching from heaps and dumps following closer[1].

The earth crust contains heavy metals which are natural components in which some heavy metals are vital micro nutrients for living beings, at higher concentrations micro nutrients becomes poisonous for living organism. The most toxic forms of these metals in their ionic species are the most stable oxidation states e.g. Cd^{2+} and Pb^{2+} and in which, they react with the body's bio-molecules to form very stable biotoxic compounds which are complicated to separate[2].

Petroleum by-products or pesticides are those contaminants which are not so much persistent then heavy metals in the environment generally. They can become mobile in soils depending on soil pH and their speciation. So a fraction of the total mass can leach to aquifer or can become bio-available to living organisms[3]. There are various sources of heavy metal poisoning such as drinking-water contamination, the change in mobility of heavy metals in aquifers with intrusion of organic pollutants are being studied in more details in recent years and the diffusion phenomenon of contaminants through soil layers[4].

The objective of the current work is to discuss the concentration of heavy metals in ground water of granite mining area and the health aspects due to its increased level.

Materials and Methods

Study Area: Jhansi is situated at 25.4333 N 78.5833 E. It has an average elevation of 284 meters (935 feet). Jhansi is situated in the plateau of central India which is mostly rocky area with so many minerals underneath. The city has a natural slope in the north as it lies on the south western border of the vast Tarai plains of Uttar Pradesh. The elevation rises on the south. The land is appropriate for citrus species fruits. Crops comprise pulses, peas, wheat, and oilseeds. The region relies a great deal on Monsoon rains for irrigation purposes. Under an ambitious canal project (Rajghat canal), the government is constructing a network of canals for irrigation in Jhansi and Lalitpur and some area of Madhya Pradesh.

Laxman Pura is a small village in Gursarai Tehsil in Jhansi District in Uttar Pradesh State. Its geographical coordinates are 25° 24' 0" North, 78° 40' 0" East. It has an average elevation of 678 feet Gursarai, Bamaur, Moth, Panwari, are the nearby Towns to Laxman Pura. Laxman Pura is reachable by Moth Railway Station, Erich Road Railway Station, Parauna Railway Station, Nankhas Railway Station. Its main Village Panchayat is Lathwara Panchayat .It has a population of about 721 persons living in around 139 households. The below map show the Jhansi district and sampling site.

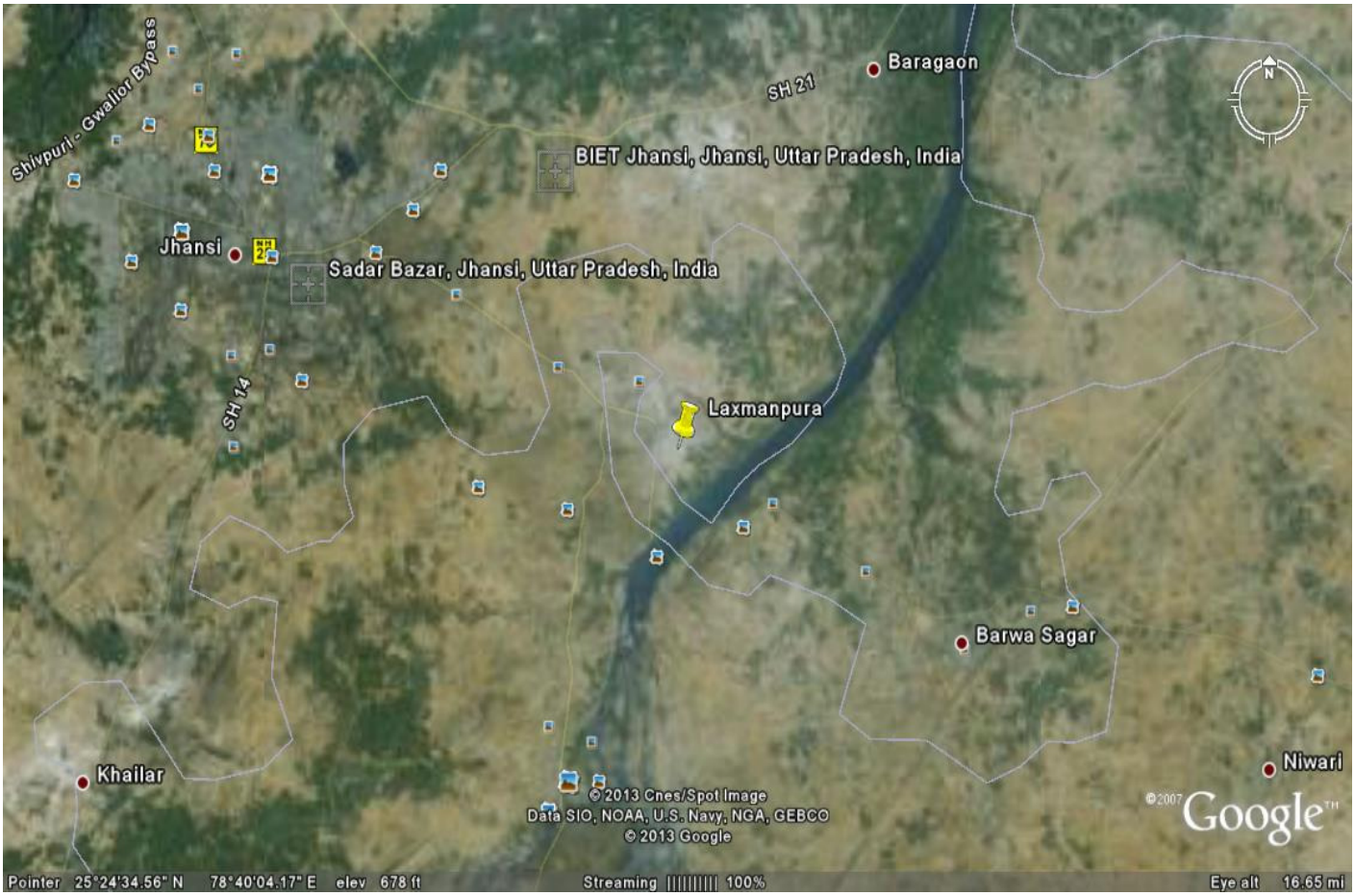

Figure-1
Map of Laxman pura village in Jhansi, district

Climate: Laxman pura being on a rocky plateau it experiences intense heat during summer. Winter begins in October with the retreat of the Southwest Monsoon (Laxman pura does not experience any rainfall from the Northeast Monsoon) and peaks in mid- December. The mercury generally reads about 4 degrees minimum and 21 degrees maximum. By the end of February month Spring starts which is a short-lived period. As April starts rise in temperature is recorded which goes up to 47 degrees in the month of May.

Water Sampling: During the study, sampling was carried out at the two different sites of Laxman pura residential (A1-G -1, A 1-G-2, A 1-G-3) and mining (A2-G -4, A 2-G-5, A 2-G-6) sites. The sampling and examination work for this study has been going ahead in the month of January 2010 and complete up to September 2010. Essential precautionary measures were taken during sampling of water[5]. Pre cleaned 2 L polythene bottles were used for sampling.

Sample Container: Plastic bottles were used for sampling process. Before starting sampling, plastic bottle have been soaked in HCl and rinsed with double distilled water. The bottle necks were sealed tightly.

Sample Collection: Before starting sampling, the sampler bottle has been rinsed 2 to 3 times for the sample which has to be examined. Samples were collected from different three sites of mining and residential area of Laxman pura. All samples are collected from hand pump which are used for drinking water, situated in different three sites of study area. The complete information was recorded about the source and the condition under which the samples were collected.

Water Analysis: During the present study ground water sample were collected and analyzed for different heavy metal concentrations to determine the characteristics of the ground water of Laxman pura, Jhansi. All the samples were examined to find out Cu, Pb, Zn, Ni, Mn and Cd concentration.

Results and Discussion

The result concerning the mean values of the various heavy metals concentration parameters of ground water collected in various months are given in the Table-1. The different samples were examined by AAS (Instrument model No. EC 4141) technique from I.C.A.R Pusa New Delhi.

Table-1
Showing the heavy metal concentration in ground water of Laxman Pura village in Jhansi District

Months	Sites	Heavy metals Parameters					
	Sample No.	Cu	Pb	Zn	Ni	Mn	Cd
January	A1-G -1	0.005	0.114	0.179	0.006	0.045	0.008
	A 1-G-2	0.007	0.126	0.184	0.013	0.036	0.004
	A 1-G-3	0.009	0.094	0.163	0.007	0.029	0.001
	A 2-G -4	0.002	0.082	0.053	0.004	0.007	0.005
	A 2-G-5	0.006	0.097	0.058	0.009	0.011	0.012
	A 2-G-6	0.001	0.126	0.046	0.006	0.005	0.003
May	A 1-G -1	0.019	0.133	0.156	0.004	0.062	0.009
	A 1-G-2	0.023	0.135	0.179	0.007	0.079	0.007
	A 1-G-3	0.017	0.130	0.210	0.009	0.042	0.007
	A 2-G -4	0.012	0.152	0.038	0.005	0.018	0.058
	A 2-G-5	0.008	0.143	0.072	0.008	0.011	0.069
	A 2-G-6	0.014	0.129	0.063	0.010	0.034	0.055
September	A 1-G -1	0.007	0.198	0.029	0.003	0.007	0.018
	A 1-G-2	0.014	0.235	0.038	0.008	0.004	0.007
	A 1-G-3	0.016	0.247	0.017	0.016	0.009	0.012
	A 2-G -4	0.005	0.192	0.011	0.015	0.020	0.014
	A 2-G-5	0.012	0.169	0.009	0.011	0.029	0.017
	A 2-G-6	0.003	0.201	0.023	0.013	0.014	0.002

All the values are expressed in mg/l.

Copper: Copper is a vital trace element with a maximum daily oral intake of 1-2 mg per individual. Naturally occurring copper concentrations in groundwater are without any health significance and scatter mostly around 20 µg/l. If drinking-water drawn from groundwater contains elevated levels, in most situations corrosion of copper pipes is the primary source. Liver cirrhosis occurs in babies when average concentration exceeds the limits of 2 mg/l in drinking water[6]. The prevalent endpoint of acute copper toxicity by time, concentration and dose is nausea. The health based guideline value for copper in drinking-water is 2 mg/l[7].

In the human metabolism copper is also a vital element and is generally considered to be non- toxic for man at the levels encountered in drinking water. The occurrence of Cu in a water supply, even though not considered as a health hazard, may obstruct with the intended domestic uses of the water. Copper in public water supplies add to the corrosion of galvanized iron and steel fittings. At levels above 5 mg/l, if also imparts a colour and an undesirable bitter taste to water.

Staining of plumbing fixtures and laundry occurs at Cu concentration above 1.0 mg/l. Copper is extensively used in domestic plumbing systems, and levels in taped-water can therefore be considerably higher than the level present in water entering the distribution system. The guideline value of 1.0 mg/l

is recommended for drinking water quality based on its laundry and other staining properties[8]. The results of this study, shows that all the samples concentration of copper are well within the permissible limits of WHO guidelines. The maximum value is 0.023 ppm and the minimum values are 0.001 ppm

The above study shows the concentration of copper are desirable in ground water and it is not contaminated by anthropogenic sources but it can come to soil by a variety of anthropogenic sources: mining and smelting activities; other industrial emissions and effluents; fly-ash; traffic; dumped waste materials; contaminated dust and rainfall; sewage and sludge; pig slurry; composted refuse; and agriculture fertilizers, pesticides, and fungicides[9].

Lead: The mining-related heavy metals as lead may originate in runoff from city streets, industrial dischargers, leachate from landfills, mining activities and a variety of other sources. Lead is toxic chemical, which are generally persistent in the environment, can cause reproductive failure or death in fish, shellfish and wildlife. In addition, lead can accumulate in animal and fish tissue, be adsorbed in sediments, or find their way into drinking water supplies, posing long term health risks to humans[10]. Lead is a general toxicant that accumulates in the skeleton as well as Infants, children up to 6 years of age pregnant women are most susceptible to its adverse effects. Lead also interferes with calcium metabolism, both directly and by interfering with vitamin D metabolism. Lead is exceptional in that, most lead in drinking water arises from fittings containing lead and plumbing[11]. In the study areas we found the concentration of lead is very high which a very severe problem. The concentration varies from 0.082 mg/l to 0.247 mg/l where as the WHO a guideline is 0.01mg/l, so the all the above samples are exceeded the permissible limits which may attribute by the various above human activities.

Mineral matter in coal, primarily with sulphides such as galena (PbS), clausthalite (PbSe) and pyrite, as well as alumina silicates and carbonates generally associated with lead. It was also suggests that lead may also be associated with organic matter, most likely in the lower ranked coals[12].

Zinc: Usually zinc is found in abundance in earth crust in the ore form (sphalerite – ZnS) with the associates of lead element. It is found in soil, water, air and in all food items. The process by which zinc comes in environment includes the human activity as well as natural phenomenon. The various human activities which led to entrance of zinc elements in the surrounding environment are mining, purifying of zinc, cadmium, and lead ores, coal burning, steel production, and burning of wastes. Most of the zinc in water bodies, such as lakes or rivers, settles on the bottom. However, a small quantity may remain either dissolved in water or as fine suspended particles. As the acidity of water rises the level of dissolved zinc in water may enhance. Most of the zinc in soil is bound to the soil and does not dissolve in water. However, depending on the characteristics of the soil, some zinc may reach groundwater. Zinc is an essential element in human nutrition. The daily requirement is 4-10 mg depending on age and sex. Food provides the most important sources of zinc[13].

All samples concentration of zinc in groundwater is well within the permissible level of WHO 84 3.0mg/l, which is also show in Table-1. In the study areas zinc, is found at minimum concentration of 0.009 mg/l and maximum concentration is 0.184 mg/l which are very low. Zinc is a vital element in all living organisms. Almost 200 zinc-containing enzymes have been recognized, including many dehydrogenases, aldolases, peptidases, polymerases, and phosphatases[14]. Nutritional zinc deficiency in humans has been found in a number of countries[15]. Drinking-water usually makes a insignificant input to zinc intake unless high concentrations of zinc occur as a consequence of corrosion of piping and fittings. Under assured conditions, tap water can give up to 10% of the daily intake[16].

Nickel: The soil utilization, pH and depth of sampling affect the concentration of nickel in groundwater. The lowest and highest concentration in groundwater of granite mining sites of Jhansi from the Table-1 is respectively 0.003mg/l and 0.016mg/l where as the WHO permissible limits is 0.02mg/l, so each samples are within the permissible limits of WHO. Mobility of nickel in the soil enhanced by acid rain which lead to increase its concentration in groundwater[17]. With pH less than 6.2 in groundwater the nickel concentration recorded up to 980 ppm[18].

In the polluted region it has been found that nickel concentration increased in ground water and municipal tap water[19]. The fittings used in plumbing system having nickel content shows concentration of 490 ppm when water left standing for overnight. Chromium–nickel stainless steel pipe shows the passive leaching of nickel but not of corrosive origin of nickel ions in pipe line water[20].

The effect of nickel is not fatal as it does not affect the function of liver severely in human beings[21]. The Serum nickel concentrations ranges from 13 and 1340 ppm in human shows following symptoms like shortness of breath, diarrhoea, nausea, vomiting, giddiness, headache, lassitude[22].

Manganese: In our earth crust manganese metal is found in plenty with iron ore therefore it is not found in pure form but as constituent of more than 100 minerals[23]. It is a necessary element for the appropriate working of both animals and human beings because it is an important mineral for the functioning of different types of cellular enzymes. The existence of manganese is generally found in 11 oxidative states. Mn^{2+}, Mn^{4+} or Mn^{7+} are the most environmentally and biologically significant compound of manganese.

In surface and ground water manganese are found naturally. Presence of manganese in soil can leach in water sources. At various region contamination of manganese in water sources are

attributed by human actions. Manganese concentration in ground water is more as compare to surface water by data provided by National Water Quality Assessment Program[24]. WHO guidelines for manganese in drinking water is 0.5 mg/l whereas the all the sampling areas manganese concentration are well within the limits that's shows the ground water of sampling areas are up to the mark. The upper limit level of manganese is about 0.079 mg/l and the lowest concentration is 0.004 mg/l.

The hazard produced by overexposure to manganese must be weighed beside the necessity for some minimum quantity of manganese in the diet, since manganese is an essential nutrient, performing as a component of numerous enzymes and a contributor in a number of significant physiological processes. Manganese intake from drinking-water is normally substantially lower than intake from food. Manganese lack in humans appears to be rare, because manganese is found in many general foods. Animals experimentally maintained on manganese-deficient diets exhibit impaired growth, skeletal abnormalities, reproductive deficits, ataxia of the newborn and defects in lipid and carbohydrate metabolism[25].

The greatest exposure to manganese is generally by the food. Adult persons take manganese between 0.7 and 10.9 mg/day in the diet[26]. The higher intake reported being associated with some vegetarian diets[27].

Cadmium: Cadmium is a metal with an oxidation state of +2. Cadmium is chemically similar to zinc and occurs naturally with zinc and lead in sulphide ores. Cadmium metal is used mainly as an anticorrosive, electroplated into steel. Selenide and cadmium sulphide are commonly used as pigments in plastics. Cadmium compounds are used in electric batteries, electronic components and nuclear reactors.

Fertilizers produced by phosphate ores are constitute a major source of diffuse cadmium pollution. The solubility of cadmium in water is influenced to a large degree by its acidity; suspended or sediment-bound cadmium may dissolve when there is an increase in acidity[28]. In natural waters, cadmium is present mainly in the bottom sediments and suspended particles. Cadmium concentrations in unpolluted natural waters are usually below 1 µg/l[29]. Median concentrations of dissolved cadmium measured at 110 stations around the world were <1 µg/l, the maximum value recorded being 100 µg/l in the Rio Rimao in Peru, where as the permissible level of by WHO is 0.003 ppm. In the study areas the maximum concentration is found is 0.069 ppm were as the minimum concentration is 0.001 ppm. In the study areas all most all the sampling areas are exceeds the WHO limits.

Food is the most significant source of cadmium intake for non-occupationally exposed people. Crops grown in contaminated soil or irrigated with polluted water may hold increased concentrations, as may be meat from animals grazing on contaminated pastures. The estimated lethal oral dose for humans is 350–3500 mg of cadmium; a dose of 3 mg of cadmium has no acute effects on adults. With chronic oral exposure, the kidney appears to be the most sensitive organ. Cadmium affects the respiration function of the proximal tubules, the first symptom being an increase in the urinary excretion of low-molecular-weight proteins, known as tubular proteinuria[30]. A lot of cases of Itai-Itai disease and low-molecular-weight proteinuria have been reported among people living in contaminated areas in Japan and exposed to cadmium through food and drinking-water.

Conclusion

Heavy metal parameters are analyzed in groundwater at different locations in Laxmanpura. The grades of the above work show that generally all the heavy metal concentrations are well within the tolerable limit apart from some samples of lead and cadmium which are mainly exceeded the value of WHO. The groundwater pollution may be caused by dissolution of rock minerals. The large entrance of contamination is due to the result of high industrial, human and agricultural actions in these areas. The results show from the above analysis that the groundwater standards is not up to the desire level and it is slowly humiliating.

The present situation is up to the mark and if the same carry on in the future, the groundwater resource will be completely polluted and becomes unfit for the drinking and various purposes. Now the moments come to protect and preserve this valuable groundwater resource. The contamination in the groundwater can be controlled by various methods. Which includes right way of mining technique, proper management of mining waste and above all, the public awareness is necessity for the conservation of these valuable groundwater resources.

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