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Assessment of Heavy Metal Concentration in groundwater of Shegaon City, Maharashtra, India

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ABSTRACT

Water is one of the most precious natural resource, essential for all activities of human beings as well as all life forms. Fresh water is consumed for domestic, industrial, agriculture, and commercial sectors. Use of water entirely depends on the quality of water. Polluted water affects health of human, plants and animal in different ways. Major sources of groundwater contamination include solid waste dumping, industrial effluents, domestic waste water and some natural sources. Heavy metals are usually discharged through waste materials from domestics, industries and agriculture too. From huge debris of solid waste dumping, and sanitary landfill techniques, heavy metals get accessed to the groundwater through percolation and leaching. Percolating water carries a large amount of heavy metals and get accumulated in aquifers and contaminates groundwater. The consumption of heavy metal contaminated ground water causes a variety of disorders and disease to the human and plants. This study was carried out to investigate the pollution of bore well water in residential areas of Shegaon City, Dist. Buldana Maharashtra, India. In this research, five samples were taken from residential areas of Shegaon City, 1) SBI Colony, 2) Rajeshwar Colony, 3) Shriram Nagar, 4) Akot Road 5) Alasana Road and analyzed to find out concentration of Arsenic, Lead, Cadmium, and Mercury. Five Samples were analyzed using Atomic Absorption Spectrophotometer (AAS).

Keywords: Mercury, AAS, Aquifer, Groundwater, Shegaon, Sanitary Landfill, Arsenic, Lead, Cadmium.

INTRODUCTION

There is no specific definition of a heavy metal, but literature has defined it as a naturally occurring element having a high atomic weight and high density which is five times greater than that of water. Among all the pollutants, heavy metals have received a paramount attention to environmental chemists due to their toxic nature (Fitzgerald and Lamborg, 2003). Heavy metals are usually present in trace amounts in natural waters but many of them are toxic even at very low concentrations. Metals such as arsenic, lead, cadmium, nickel, mercury, chromium, cobalt, zinc and selenium are highly toxic even in minor quantities (Mandal and Suzuki, 2002). Increasing the quantity of heavy metals in our resources is currently an area of greater concern, especially since a large number of industries are discharging their metal containing effluents into fresh water without any adequate treatment. Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. They may enter the human body through food, water, air or absorption through the skin when they come in contact with humans in agriculture, manufacturing, pharmaceutical, industrial or residential settings. Industrial exposure accounts for a common route of exposure for adults. Ingestion is the most common route of exposure in children. Natural and human activities are contaminating the environment and its resources, they are discharging more than what the environment can handle (Friberg et al.,1986).

Lead (Pb), a soft, silvery white or grayish metal in Group 14 (IVa) of the periodic table. Lead is very malleable, ductile, and dense and is a poor conductor of electricity. Known in antiquity and believed by the alchemists to be the oldest of metals, lead is highly durable and resistant to corrosion, as is indicated by the continuing use of lead water pipes installed by the ancient Romans. The symbol Pb for lead is an abbreviation of the Latin word for lead, *plumbum*.

Arsenic (As)

Arsenic appears in three allotropic forms: yellow, black and grey; the stable form is a silver-gray, brittle crystalline solid. It tarnishes rapidly in air, and at high temperatures burns forming a white cloud of arsenic trioxide. Arsenic is a member of group Va of the periodic table, which combines readily with many elements (Alexander 2002). The metallic form is brittle, tarnishes and when heated it rapidly oxidizes to arsenic trioxide, which has a garlic odor. The non-metallic form is less reactive but will dissolve when heated with strong oxidizing acids and alkalis (Reddy et al. (2012).

Mercury (Hg)

Mercury, also called **quicksilver,** chemical element, liquid metal of Group 12 (IIb, or zinc group) of the periodic table. A heavy, silvery, transition metal, mercury is one of five elements that are liquid at or near room temperature. Mercury is used in thermometers, barometers and other scientific apparatus, although the use of mercury in thermometers has been largely phased out in clinical and scientific environments (in favor of alcohol-filled, digital or thermistor-based replacements) due to concerns about the element's toxicity. Mercury, like lead, is a neurotoxin, and elevated blood mercury levels have led to retardation and deformities in children (Ros and Slooff, 1987).

Entry of Heavy Metals in Environment

Heavy metals enter into the environment through various routes that can be manmade and/or natural. Metals are introduced in aquatic systems as a result of the weathering of soils and rocks, from volcanic eruptions, and from a variety of human activities involving the mining, processing, or use of metals and/or substances that contain metal pollutants (Bhagure and Mirgane, 2010). The most common heavy metals pollutants are arsenic, cadmium, chromium, copper, lead and mercury. There are different types of sources of pollutants: point sources (localized pollution), where pollutants come from single, identifiable sources (Mridul and Prasad, 2013). The second type of pollutant sources are nonpoint sources, where pollutants come from dispersed (and often difficult to identify) sources. There are only a few examples of localized metal pollution, like the natural weathering of ore bodies and the little metal particles coming from coal-burning power plants via smokestacks in air, water and soils around the factory (CPCB,2008). The most common metal pollution in freshwater comes from mining companies (CPCB, 2013). They usually use an acid mine drainage system to release heavy metals from ores, because metals are very soluble in an acid solution (IS, 2002). After the drainage process, they disperse the acid solution in the groundwater, containing high levels of metals (Horton et.al. 2013).

Interference in Water body

When the pH in water falls, metal solubility increases and the metal particles become more mobile (Green and Woodhead, 1910). That is why metals are more toxic in soft waters. Metals can become 'locked up' in bottom sediments, where they remain for many years (Nalwa, 2001). Streams coming from draining mining areas are often very acidic and contain high concentrations of dissolved metals with little aquatic life (Genies, 1990). Both localized and dispersed metal pollution cause environmental damage because metals are non-biodegradable (Stejskal and Gilbert, 2002). Unlike some organic pesticides, metals cannot be broken down into less harmful components in the environment. Campbell and Stokes (1985) described two contrasting responses of an organism to a metal toxicity with declining pH, if there is little change in speciation and the metal binding is weak at the biological surface, a decrease in pH will decrease owing to competition for binding sites from hydrogen ions (Ogutveren et al. 1994). Where there is a marked effect on speciation and strong binding of the metal at the biological surface, the dominant effect of a decrease in pH will be to increase the metal availability (Mercier and Pinnavaia, 1998). Generally, the ionic form of a metal is more toxic, because it can form toxic compounds with other ions (Cohen et al. (2001). Electron transfer reactions that are connected with oxygen can lead to the production of toxic oxy radicals, a toxicity mechanism now known to be of considerable importance in both animals and plants. Some oxy radicals, such as superoxide anion (O_2^-) and the hydroxyl radical (OH^-), can cause serious cellular damage (Jaber et al. (2005). Some inorganic pollutants are assimilated by organisms to a greater extent than others (Wang and Chen, 2006). This is reflected in the Bioconcentration factor (BFC), which can be expressed as follows: BCF=concentration of the chemical in the organism/concentration of the chemical in the ambient environment (Gautam, 2010). The ambient environment for aquatic organisms is usually the water or sediments. With inorganic chemicals, the extent of long-term bioaccumulation depends on the rate of excretion. Toxic chemicals can be stored into tissues of species, especially fat tissues (Gautam, 2013). Bioaccumulation of cadmium in animals is high compared to most of the other metals, as it is assimilated rapidly and excreted slowly (Sharma and Sanghi, 2013). Also, the sensitivity of individuals of a particular species to a pollutant may be influenced by factors such as sex, age, or size. In general, the concentrations of metals in invertebrates are inversely related to their body mass. In fish, the embryonic and larval stages are usually the most sensitive to pollutants. Benthic organisms are likely to be the most directly affected by metal concentrations in the sediments, because the benthos is the ultimate repository of the particulate materials that are washed into the aquatic ecosystem (Campbell and Stokes, 2011).

MATERIAL AND METHOD

This was an observational study, conducted over a period of one-month January 2021, where five nearest and reachable residential areas in Shegaon city were selected. Five Houses were selected for borewell water analysis as samples randomly. The overall sample of five is selected for surface water and groundwater. This study was planned based on above sample criteria. The power supply to borewell was on and water was withdrawn and allowed to run from direct connection for fine minutes. The water sample was collected in five containers without contamination and labelled and lids were tightly closed. Within two hours of collection, samples were transported to the Laboratory. Atomic Absorption Spectrophotometry using Perkins Elmer AA 200 model was used to estimate the concentration of Arsenic, Lead, Cadmium and Mercury based on Indian Standards _ 3025 and results obtained.

Table 1: shows the levels Arsenic, Lead, Cadmium, Mercury of five tube wells from five houses

Sr. No.	Parameters	Location				
		SBI Colony	**Rajeshwar Colony**	**Shriram Nagar**	**Akot Road**	**Alasana Road**
1	Arsenic	0.0011 mg/l	0.001 mg/l	0.0014	0.006 mg/l	0.009 mg/l
2	Lead	0.0013 mg/l	0.001 mg/l	0.003 mg/l	0.008 mg/l	0.003 mg/l
3	Cadmium	0.005 mg/l	0.0001mg/l	0.006 mg/l	0.004 mg/l	0.0013 mg/l
4	Mercury	0.002mg/l	0.001 mg/l	0.001 mg/l	0.0002mg/l	0.0001mg/l

RESULTS

Table 1 shows the levels Arsenic, Lead, Cadmium, Mercury of five tube wells from five houses. All the samples contained heavy metals below 0.0016 mg/l. Result shows Lead is highly present in SBI colony bore well.

Conflicts of interest: The authors stated that no conflicts of interest.

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