Journal of Advances in Science and Technology

Vol. 11, Issue No. 22, May-2016, ISSN 2230-9659

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AN INTERNATIONALLY INDEXED PEER REVIEWED & REFEREED JOURNAL

www.ignited.in

Journal of Advances in Science and Technology
Vol. 11, Issue No. 22, May-2016, ISSN 2230-9659

Evaluation of Heavy Metals in Groundwater at Residential Area nearby Major Industrial Areas of Jaipur

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Abstract – Heavy metals contamination has been recognized as a major environmental concern due to their pervasiveness and persistence. These heavy metals are not biodegradable hence the need to develop a remediation technique that efficient, economical and rapidly deployable in a wide range of physical settings. Results obtained exhibited that As, Cd, Cr, Fe, Mn & Pb were not found in any studied groundwater samples whilst Cu (0.00 – 0.25 mg/L) found only in sample G2 & Ni (0.00 – 0.02 mg/L) were below recommended values. Only Zn (0.54 – 18.07 mg/L) was exceeded the ISI permissible limit for potable water in samples G2 & G3. Overall findings indicated that groundwater bodies at residential area nearby major industrial areas of Jaipur city were good and to be used as potable water except samples G2 and G3.

Keywords: Trace metals, Groundwater, Water Pollution, Monsoon, Residential Areas and Industrial Areas.

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INTRODUCTION

India's environment is becoming fragile and environmental pollution is one of the undesirable side effects of industrialization, urbanization, population growth and unconscious attitude towards the environment. At present, environmental protection is the main need of the society. It is now an accepted fact that environmental pollution leads to a depletion of the natural resources[6]. Though industrialization and development in agriculture are necessary to meet the basic requirement of people, at the same time it is necessary to preserve the environment. In India, too, the environmental pollution has become a cause of concern at various levels[12]. Rajasthan, though being the largest state of India has only % of surface water resources. Thus, water pollution control in Rajasthan is the need of hour.

The industrial effluents cause soil and groundwater pollution besides causing a number of adverse effects on agriculture producer, animals and health of people living in the neighboring areas since it contains waste chemicals and toxic heavy metals. Hence, there is need for the determination of heavy metals in groundwater resources, with the help of advance techniques.

Heavy metals are readily mobile in environment and accumulate in flora and fauna[4]. Excessive levels of ionic metals in groundwater have detrimental health risk to humans and posed environment stresses[7, 15].

The insufficient supply of potable water by Municipal Corporations for domestic and industrial sectors result into the use of groundwater or nearby available surface waters. These water sources may be contaminated by heavy metals owing to the incomplete treatment and may not be acceptable for drinking purposes[14].

Trace metals such as Fe, Zn, Co, Cu and Mg are known as essential micronutrients for normal healthy growth of any organism, while on the other hand the metals such as As, Cd, Hg, Se, Pb, etc. have inherent toxicity to plants and animals[10]. However, these elements are also reported toxic to any organism if exposure levels are sufficiently high[8, 11]. N. Gupta, D.K. Khan, S.C. Santra[18] studied heavy metal contamination in vegetables grown in wastewater-irrigated Areas of Titagarh, West Bengal, India

Study Area: Jaipur (longitude : 95^0 24' E ; latitude : 27^0 18' N), a city located at the central part of Rajasthan, is undergoing rapid urbanization and industrialization. The wastewater generated from diverse industries is proposed to be subjected to primary and secondary treatment at the individual industry itself. The climate of the city is dry and healthy and is subject to extremeness of cold and heat at various places. The minimum and maximum temperatures recorded in the city varies from 8.0 to 48 degree Celsius. Normal annual rainfall in this city is 55.64 cm. Number of large, medium & small scale

running units is 19,592 in this city. The areas under study were major industrial areas and its flanking spots. Almost all parts of Jaipur city and adjacent areas, a large number of industries have come up during last two decades like Vishwakarma, Sudershanpura, Bais Godown, Jhotwara, Malviya, Sanganer, Sitapura industrial areas, etc. which play a major role in polluting different water resources. Some of them industries are situated inside the city and others are outside but all are not free from human residential localities. All the wastes from domestic, municipal and industries are discharged in 'Amanishah Nala', which is the largest element of drainage system of this city and covers the whole city. The farmers for growing vegetables and other crops use water from some parts of 'Amanishah Nala'[19]. The direct use of the wastewater by the farmers necessitates evaluation of the quality of the water for the effects on the fertility of the soil and quality of the vegetables grown on it. 'Amanishah Nala' receives industrial and domestic wastes from various sites and seepage of this water also affects groundwater. Although, application of sewage effluents were reported to be beneficial in increasing crop yield and reduce fertilizer requirement but some other studies showed that metals like Cu, Cd, Cr enter in the food chain through their application in soil and this ultimately causes health concern significantly[16]. So the present study is intended to characterize the wastewater of 'Amanishah Nala' and industries.

Sources of Industries: So many types of industries discharges waste effluents in 'Amanishah Nala' but we concentrated on non-point sources of these effluents discharged by following industries like: ball bearings, bottling of LPG, ceramics, pottery, dyeing & printing, edible oil, electronic items, general engineering and manufacturing, granite slabs and tiles, handmade paper, handicraft items, hawai chappals, household electrical appliances, iodized salt, marble statues, marble tiles & slabs, moulded plastic components for electronics, PVC cables, PVC doors, tablets and capsules, washing soap, woollen carpet, re-fined vegetable oil, vanaspati ghee, automobiles, chemicals, consumable, engineering, electrical, food products, minerals, packing, and other miscellaneous categories.

METHODS AND MATERIALS

Groundwater samples were collected from nine different sites from the nearby localities of industrial areas of Jaipur city. Samples were collected in good quality screw–capped high–density pre–sterilized polypropylene bottles[1] of one litre capacity, labeled properly and analyzed in laboratory for trace metals by Atomic Absorption Spectrophotometer (AAS). For the assessment of water quality, monitoring was done during monsoon session. Only high pure (AnalR grade) chemicals and double distilled water was used for preparing solutions for analysis. Preservation and analysis of water samples were based on standard methods proposed by American Public Health Association (APHA)[3]. The selected heavy metals (As, Cd, Cr, Cu, Fe, Mn, Ni, Pb & Zn) were analyzed.

The results of analysis of the heavy metals from nine locations for the monsoon season are presented in Table 1 and discussed in light of the different standards for drinking water set by USPH, WHO and BIS–1999 recommended health based guidelines.

Table 1:

Heavy Metals Concentration of Groundwater of Jaipur City

Site Code	Seasons	Cr	Cu	Cd	Mn	Ni	Pb	Fe	As	Zn
G1	Monsoon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	00.65
G2	Monsoon	0.00	0.25	0.00	0.00	0.02	0.00	0.00	0.00	13.20
G3	Monsoon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.07
G4	Monsoon	0.00	0.10	0.00	0.00	0.01	0.00	0.00	0.00	00.54
G5	Monsoon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	00.87
G6	Monsoon	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	04.62
G7	Monsoon	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	00.57
G8	Monsoon	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	00.58

RESULTS AND DISCUSSION

In the present study, As, Cd, Cr, Fe, Mn and Pb were not detected during the monsoon season. Arsenic contamination in groundwater imparts ill effects on health of people. It is toxic even at a very low concentration. Consumption of excess quantity of arsenic causes damages to human health like renal, carcinogenic, neurological, hepatic, hematological, respiratory, etc[9]. The drinking water having more than 0.1 mg/L of cadmium can cause bronchitis, itai–itai, anemia, renal stone formation, hypertension and arteriosclerosis in animals and human[2, 17]. According to WHO, the level of hexavalent chromium in potable water should not be higher than 0.05 mg/L. It causes dermatitis, ulceration, lung cancer and perforation of nasal septum. Concentrations of iron in drinking water are normally less than 0.3 mg/L. The permissible concentration of manganese in drinking water has been recommended below 0.005 mg/L. Manganese is not toxic metal, but at excessive concentration, it affects the central nervous system, causes gait and speech disturbance tremors, uncontrollable laughter, lung troubles. Excess intake of lead creates dullness, restlessness, irritability, headaches, kidney damage, loss of memory, brain damage, lower IQ and can also lead to death. Although, all above heavy metals were totally absent in all studied samples.

Copper was only found in sample G2, its maximum values was detected (0.25 mg/L). The ingestion of acute toxic levels of copper may result in nausea, vomiting, diarrhoea, jaundice, extensive lever damage, hypertension, coma, hemoglobinuria and hematuria[5, 13]. Nickel in samples G1, G3, G5 & G6 were absent but in samples G2, G4, G7 & G8, it

varied from 0.01 to 0.02 mg/L. The maximum concentration of nickel was found in sample G2 & G8. The oral administration of large dose of nickel salts may cause gastrointestinal irritation, diarrhoea, vomiting, development of gastrointestinal and neurological disorder. The normal intake of nickel per day varies between 0.3 and 0.6 mg.

Only zinc was discovered in all samples and ranged between 0.54 and 18.07 mg/L. Zinc imparts an undesirable astringent taste to water. Excessive zinc consumption is linked to damaged pancreas, muscular stiffness, nausea and anemia.

It is concluded that the water samples from the various areas, during all the period of monitoring have been found to contain all trace metals below permissible limits except Zinc. In other words, there are not large variations in the concentrations of heavy metals like Cu & Ni in drinking water from different sites, while As, Cd, Cr, Fe, Mn and Pb are totally absent in all the studied samples. It is interesting to note that in all the studied samples, the trace metals are present in very low concentrations except Zinc. Zinc has cumulative effect and its consumption is linked to damaged pancreas, muscular stiffness, nausea and anemia. Due to these reasons, its presence is unacceptable in the domestic water supply. Overall findings indicated that groundwater bodies at residential area nearby major industrial areas of Jaipur city were good and to be used as potable water except samples G2 and G3 without prior treatment.

ACKNOWLEDGEMENT

One of the author (Vijendra Singh) is thankful to Rajasthan State Pollution Control Board, Jaipur for giving their valuable suggestions and possible laboratory facilities.

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