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ASSESSMENT OF HEAVY METAL CONTAMINATION IN GROUNDWATER FROM PEERWADI WELL OF URAN, NAVI MUMBAI

RAUPHUNNISA F. INAMDAR[a] AND PRABHAKAR R. PAWAR[b1]

[ab]Veer Wajekar Arts, Science and Commerce College, Mahalan Vibhag, Phunde, Tal.–Uran, Raigad, Navi Mumbai, Maharashtra, India

ABSTRACT

In the present study, groundwater from Peerwadi well, Uran was analyzed for contamination of heavy metals from April 2014 to July 2014. The metals analyzed include Copper, Lead, Mercury, Chromium and Cadmium, among which values obtained for Cu ranges from 0.013 mg/l to 0.028 mg/l, which falls below the maximum permissible limit of 2.0 mg/l by the World Health Organization (WHO). Other heavy metals analyzed (Pb, Hg, Cr and Cd) were not detectable from the sample water. Occurrence of Cu in groundwater could be attributed to the discharge of Cu containing industrial waste in the coastal ecosystem of Uran from the maritime activities of JNPT and also to the disposal of sewage and municipal waste. This indicates that Peerwadi well water is not polluted in any way and is fit for human consumption and other domestic purposes. Presence of trace concentration of Cu in water reveals that frequent monitoring of well water for contamination by heavy metals is recommended to avoid the human health risk and precautionary measures should be immediately taken to avoid the future consequences.

KEYWORDS: Groundwater, Heavy Metals, Peerwadi Well, Anthropogenic Inputs, Jawaharlal Nehru Port, Uran, Pollution

Water covers about 70 percent of the globe's surface, but most of it is saltwater. Freshwater covers only 3 percent of the earth's surface and much of it lies frozen in the Antarctic and Greenland polar ice. Freshwater available for human consumption comes from rivers, lakes and subsurface aquifers. These sources account for only one percent of all water on the earth. Six billion people depend on this supply and a significant portion of the world's population is facing water shortages (Mebrahtu and Zerabruk; 2011, Musa et al.; 2013).

Groundwater is an important issue in water supply systems, so preservation and purification of ground water have a critical role in any community. Over the last few decades, competition for economic development, associated with rapid growth in population and urbanization, has affected the groundwater quality due to over exploitation and increasing demand for agriculture, domestic and industrial water supply, as well as improper sewage flow and solid waste disposal. The effluents discharged from industries and urban sewage finds their way into surface water bodies. These water bodies in turn act as recharge source for groundwater, thus making it vulnerable (Marbooti et al.; 2015).

Increase of industrialization and urbanization gradually decreases the groundwater quality due to unsustainable use of water resources. Groundwater may be contaminated by different contaminants which have an impact on the health and economic status of the consumers. Contaminants such as bacteria, viruses, heavy metals, nitrates and salt have found their way into water supplies due to inadequate treatment and disposal of waste, industrial discharges, and over-use of limited water resources. Improper solid waste management contributes large quantities of pollutants percolated into groundwater table that have been continuously introduced into ecosystems (Reddy et al.; 2012).

More than 100,000 chemicals are released into the global environment every year as a consequence of their production, use and disposal. Chemical substances discharged into the environment may be of natural origin or of anthropogenic origin. The presence of heavy metals in the environment has grown because of its large employment in some industrial and agricultural activities. Heavy metals are metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations in plants, animals and humans. Approximately 30 metals and metalloids are potentially toxic to humans. These elements affect cells and living organisms in various ways and are xenobiotic and highly toxic. Heavy metals are not biodegradable and persistent in the environment for long periods, cause serious eco-toxicological problems. They are dangerous because they tend to bioaccumulate (Chiarelli and Roccheri; 2014).

Heavy metals can be divided into four major groups based on their health importance (1) Essential metals such as Cu, Zn, Co, Cr, Mn and Fe, (2) Non-essential metals such as Ba, AI, Li and Zr, (3) less toxic metals such as Sn and As and (4) highly toxic metals such as Hg, Cd and Pb (Vaishaly et al.; 2015).

[1]Corresponding author

The traces of metal ions play an important role in human life. The essential heavy metals (Cu, In, Fe, Mn and Mo) play biochemical and physiological functions in plants and animals. Two major functions of essential heavy metals are, participation in redox reaction and direct participation, being an integral part of several enzymes (Vaishaly et al.; 2015). Heavy metals such as Cr, Zn, Co and Cu are vital for normal function of all organisms for smooth body functions and growth of the body. Cobalt is a metallic constituent of vitamin B_{12} where as Manganese is an activator of enzymes in the body (Mahar et al.; 2013). Standards set by World Health Organization for heavy metals in groundwater are Cu 2.0 mg/l, Pb 0.01mg/l, Hg 0.001mg/l, Cr 0.05 mg/l and Cd 0.0005 mg/l.

Human exposure to heavy metals occurs through three primary routes, i.e. inhalation, ingestion and skin absorption (Olafisoye et al.; 2013). Heavy metals may enter the human body via food, water, air, or absorption through the skin in agriculture, industrial, or residential settings. Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. Health risks of heavy metals include reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death. Exposure to some metals, such as mercury and lead, may also lead to autoimmunity (Malassa et al.; 2014).

Heavy metals "can bind to vital cellular components, such as structural proteins, enzymes, and nucleic acids, and interfere with their functioning." Long-term exposure to heavy metals can have carcinogenic, central and peripheral nervous system and circulatory effects (Rajeswari and Sailaja; 2014). It may result in slowly progressing physical, muscular and neurological degenerative processes, muscular dystrophy, multiple sclerosis, gangrene, diabetes mellitus, hypertension and ischemic heart disease (Fernandez-Luqueno et al.; 2013). The bio-toxic effects of heavy metals exhibit specific signs of their toxicity like gastrointestinal (GI) disorders, diarrhoea stomatitis, tremor, hemoglobinuria, ataxia, paralysis, vomiting and convulsion, depression, and pneumonia. The nature of effects could be toxic (acute, chronic or sub-chronic), neurotoxic, carcinogenic, mutagenic or teratogenic (Verma and Dwivedi; 2013).

Coastal environment of Uran has been under considerable stress since the onset of Jawaharlal Nehru Port (JNPT, an International Port), Oil and Natural Gas Commission (ONGC), LPG Distillation Plant, Grindwell Norton Ltd., Gas Turbine Power Station (GTPS), Bharat Petroleum Corporation Limited (BPCL) Gas Bottling Plant, DP World, Container Freight Stations (CFS), reclamation, sedimentation, tourism etc. These activities affect the terrestrial and coastal ecosystem of Uran coast, Navi Mumbai (Pawar; 2013).

Although many studies have been undertaken to evaluate the heavy metals in groundwater in India, no scientific studies have been carried out on the heavy metal contamination in groundwater of Uran, Navi Mumbai; hence, the present study is undertaken. Objective of the study is to evaluate the impact of anthropogenic inputs on quality of groundwater with respect to heavy metals.

MATERIALS AND METHODS

Study Area

Geographically, Uran (Lat. 18º 50'5" to 18º50'20" N and Long. 72º57'5" to 72º57'15" E) with the population of 28,620 is located along the eastern shore of Mumbai harbor opposite to Coloba. Uran is bounded by Mumbai harbor to the northwest, Thane creek to the north, Dharamtar creek and Karanja creek to the south, and the Arabian Sea to the west. Uran is included in the planned metropolis of Navi Mumbai and its port, the Jawaharlal Nehru Port (JNPT). Average annual precipitation at Uran is about 3884 mm of which about 80% is received during July to September. The temperature range is 12–36ºC, whereas the relative humidity remains between 61% and 86% and is highest in the month of August.

Peerwadi well is located about 210 mt away from the Peerwadi coast of Uran and was built up in 1945. The well is with 20 ft in diameter and 40 ft in depth, of which 25 ft is built up with stones. It has safety wall of about 3.6 ft in height at the surface. It is the only source of freshwater for livelihood of the local community. Well water is lifted by traditional Indian method using rope and bucket or other suitable utensils by nearby population of about 600 people of the Nagaon village, Uran till today. Municipal waste water canal and canal of Oil and Natural Gas Commission (ONGC) are passing from nearby the well (Fig. 1).

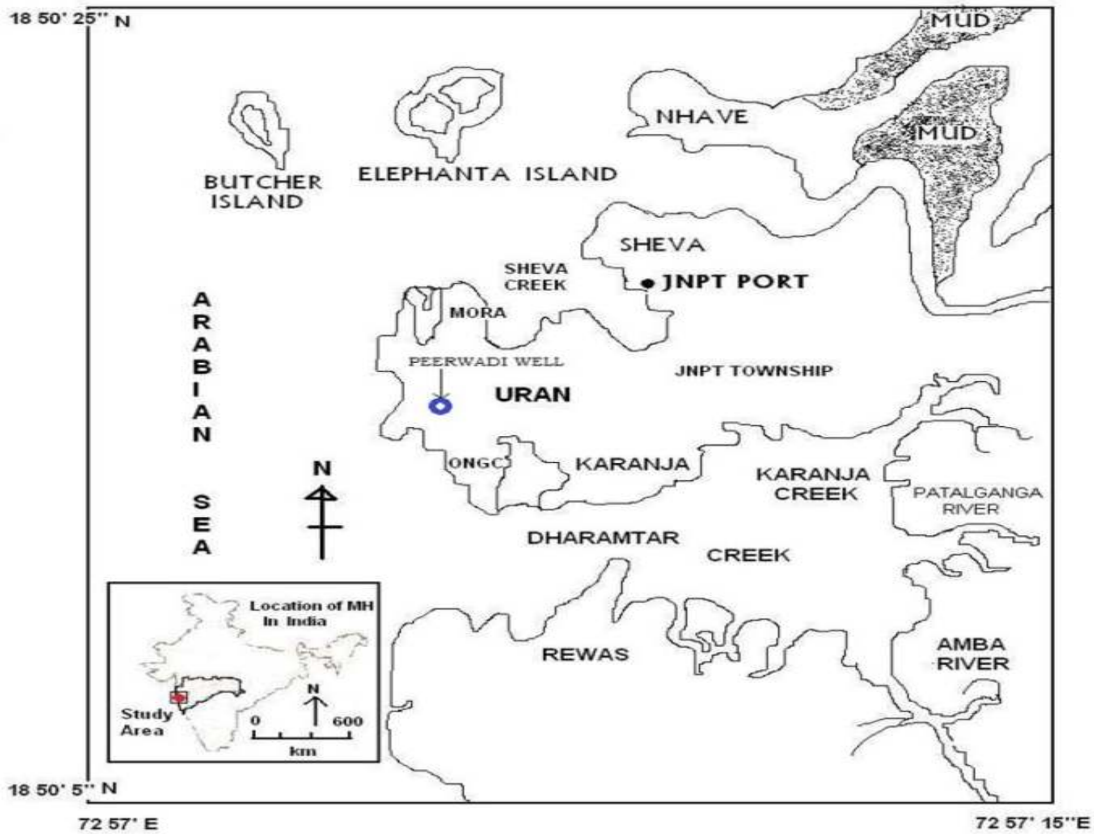

Figure 1: Location map of Peerwadi Well, Uran, Navi Mumbai

Many times during the year, local population claims that taste of water from the Peerwadi well of Uran differs from the normal and has repellent odour. Hence during present investigation, heavy metal contamination in groundwater of Peerwadi well is assessed to investigate impact of anthropogenic inputs on it.

Sampling Strategy and Analysis

The present study was carried out from April 2014 to July 2014. Water samples were collected in clean, sterilized and plain polyethylene containers. The containers were thoroughly cleaned with 1:1 HNO_3 and rinsed several times with distilled water, then dried in electric oven. After this, the containers were completely filled with water before they were corked to avoid trapping of air bubbles. The collected samples were labeled, sealed and transported to the laboratory and preserved in refrigerator at a temperature of about 4°C until analysis. The samples were tested for the occurrence of heavy metals such as Copper (Cu), Lead (Pb), Mercury (Hg), Chromium (Cr) and Cadmium (Cd). The laboratory analysis was made using Inductively Coupled Plasma Atomic Emission Spectroscopy at Sophisticated Analytical Instrument Facility, Indian Institute of Technology, Powai, Mumbai - 400 076.

RESULTS AND DISCUSSION

Results of the analysis of the heavy metals in the water samples of Peerwadi well is presented in Table 1, wherein, only one metal is investigated in the laboratory and the result of other metals analyzed were not detectable. The metals analyzed include Copper, Lead, Mercury, Chromium and Cadmium, among which values obtained for Cu ranges from 0.013 mg/l to 0.028 mg/l, which falls below the maximum permissible limit of 2.0 mg/l by the WHO. Results of other heavy metals analyzed (Pb, Hg, Cr and Cd) from the samples are not detectable.

The analysis shows that Peerwadi well water is not polluted in any way. This is because the result showed that the heavy metals analyzed were within the acceptable and desirable limits set by the WHO and were considered fit for human consumption and other domestic purposes. During present study, the minimum and maximum Cu concentration of were found to be

ND to 0.013 mg/l to 0.028 mg/l. This reveals that there was no health related risk due to the presence of copper in drinking water of the Peerwadi well.

Cu enters the water system through mineral dissolution, industrial effluents, because of its use as algaecide, agricultural pesticide sprays and insecticide. Cu may be dissolved from water pipes and plumbing fixtures, especially by water whose pH is below 7. Other sources of Cu into water bodies are anthropogenic activities like metal plating, industrial and domestic waste, mining, and mineral leaching were main sources for the presences in environment (Reddy et al.; 2012). Occurrence of Cu in water sample could be attributed to the discharge of Cu containing industrial waste in the coastal ecosystem of Uran from the maritime activities of JNPT and also to the disposal of sewage and municipal waste. Results of the present study are in agreement with Alhibshi et al. (2014), Rajeswari and Sailaja (2014) and Souzaa et al. (2016).

Though, Cu is a trace essential element for human health, its large concentration can cause eminent health problem. High levels of copper in drinking water have been found to cause kidney and liver damage in some people. Children under one year of age are more sensitive to copper because it is not easily removed from their system (Tadiboyinaa and Ptsrkb; 2016).

Mumbai is the largest of the metropolises of India with a 100 km long shoreline of the Arabian Sea. With the development of urban areas and rapid population growth, the topography of inter-tidal area around Mumbai has changed, resulting in the displacement as well as change of trophic level distribution. The Sheva creek receives wastes and effluents from Asia's largest industrialized zone namely Thane Belapur industrialized area and Navi Mumbai Urban area. Waste water from petrochemical complex and other industries are disposed into Dharamtar creek. Peerwadi coast is in close proximity to human population and receives domestic waste and sewage from Nagaon, Kegaon and Uran. Maritime activities of Jawaharlal Nehru Port (JNP) affect the coastal ecosystem of Uran due to anthropogenic threat (Pawar; 2013).

Since no earlier reports are available on concentration of heavy metals from groundwater of Peerwadi well from Uran coast, data presented here can be taken as a baseline data in knowing the status of groundwater from Uran ecosystem, effect of industrial development on it and for a better management of groundwater.

Table 1: Analytical report of Peerwadi well water for heavy metals

Sr. No.	Month & Year	Heavy metal ion concentration (mg/l)				
		Cu	Pb	Cd	Cr	Hg
1	April 2014	ND	ND	ND	ND	ND
2	May 2014	0.013	ND	ND	ND	ND
3	June 2014	ND	ND	ND	ND	ND
4	July 2014	0.028	ND	ND	ND	ND
5	Standard limits (WHO)	2.00	0.015	0.005	0.05	0.002

CONCLUSION

This study shows that heavy metal pollution of groundwater is an issue of environmental concern. In the present study, except Cu, no other heavy metal was detected in the water of Peerwadi well. Ion concentration of Cu is also found to be within the acceptable and desirable limits set by the WHO. This indicates that Peerwadi well water is not polluted in any way and is fit for human consumption and other domestic purposes. Presence of trace concentration of Cu in water reveals that frequent monitoring of well water for contamination by heavy metals is necessary to avoid the human health risk. It is recommended that precautionary measures should be immediately taken to avoid the future consequences.

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