

Heavy Metal Contamination in Groundwater around Industrial Estate vs Residential Areas in Coimbatore, India

K. MOHANKUMAR¹, V. HARIHARAN², N. PRASADA RAO³

ABSTRACT

Introduction: Water is the vital resource, necessary for all aspects of human and ecosystem survival and health. Depending on the quality, bore water may be used for human consumption, irrigation purposes and livestock watering. The quality of bore water can vary widely depending on the quality of ground water that is its source. Pollutants are being added to the ground water system through human and natural processes. Solid waste from industrial units is being dumped near the factories, which react with percolating rainwater and reaches the ground water. The percolating water picks up a large number of heavy metals and reaches the aquifer system and contaminates the ground water. The usage of the contaminated bore water causes the diseases. Mercury, Arsenic and Cadmium are used or released by many industries.

Aim: This study was conducted to investigate the pollution of bore water in the industrial region (Kurichi Industrial Cluster) of Coimbatore, in the state of Tamilnadu, India.

Materials and Methods: Four samples were taken from residential areas around Kurichi Industrial Cluster and analysed to find the concentrations of Mercury, Arsenic and Cadmium. Four more samples were taken from other residential regions far from the industrial estate and served as control. Samples were analysed using Atomic absorption spectrophotometry method.

Results: We found that the ground water of the areas surrounding the industrial cluster does not contain significant amount of those metals. Instead, Heavy metal contamination of ground water were observed in some residential areas of coimbatore.

Conclusion: The regulatory measures to contain and prevent ground water contamination by industries undertaken by Tamilnadu pollution control board may have lead to absence of heavy metal contamination in Kurichi Industrial cluster, Coimbatore, India.

Keywords: Arsenic, Cadmium, Kurichi, Mercury

INTRODUCTION

Many land based, water based activities and over exploitation are causing contamination of aquifers leading to unsafe ground water [1]. In areas of high population density and intensive human use of the land, ground water becomes especially vulnerable. Many industrial activities where chemicals or wastes may be released to the environment, either intentionally or accidentally, has the potential to pollute ground water [2]. When ground water becomes polluted by contaminants, it causes disease and poses big difficulty cleaning it. WHO (World Health Organisation) realised this problem earlier and started issuing standards for safe ground water from the year 1958 [3]. India, in this context woke up very late and setup 'Central ground water boards' in 1997. Even though centralized, such department and many such state bodies like 'Tamilnadu Pollution Control Board' exist, ground water contamination is still going on and poses a threat for millions of population [4].

Mercury, a heavy metal, occurs naturally in the earth's crust. Volcanic activity, weathering of rocks naturally releases mercury into the environment. But in the current world, human activity is the main cause of mercury release like coal-fired power stations, residential coal burning for heating and cooking, industrial processes, waste incinerators and as a result of mining for mercury, gold and other metals [5]. Mercury in its all forms such as inorganic form, organic form as methyl mercury is highly toxic to humans when consumed or inhaled [6]. Mercury can cause Respiratory, Nervous and Renal damages. Also it causes disease even when exposed to small amounts and can affect the fetus in utero [5].

Other activities of industries like metal smelting, combustion of fossil fuels, agricultural pesticide production in the estate can

contaminate groundwater with arsenic. Chronic exposure to arsenic can cause harm to the cardiovascular, skin, gastrointestinal, hepatic, neurological, pulmonary, renal and respiratory systems [7], reproductive system [8] as well as causes cancer [9]. Cadmium, a metal which is used mainly as an anticorrosive, used for electroplating of steel. Cadmium sulfide and selenide are commonly used as pigments in plastics. Cadmium compounds are used in electric batteries and electronic components [10,11]. Cadmium is toxic to the kidneys.

In a study by Bhagure GR et al., groundwater samples from highly industrialized areas of Thane, Maharashtra were analysed and found to contain high amounts of Mercury, Arsenic, Cadmium and Nickel [12]. The probable cause of this pollution is due to rain water washing away the air borne and soil pollutants and contaminating the aquifers. Another study in Assam found varying high levels of Arsenic and Cadmium in Dhemaji District of Assam [13].

There are more than 25,000 small, medium, large scale industries and textile mills in Coimbatore district of Tamilnadu [14]. Kurichi Industrial cluster contains SIDCO (Small Industries Development Corporation) estate and Private estate. It is located in 100 55' 11"N latitude and 760 57' 35" E longitudes. It contains many small scale industries and is a critically polluted region declared by government of India. Surrounding the estate are residential settlements in close proximity within 2 km radius. The Estate contains many factories which produce mercury containing items like batteries, measuring devices, such as thermometers and barometers, electric switches and relays in equipment lamps, dental amalgam, skin-lightening products and other cosmetics and pharmaceuticals.

AIM

This study was aimed to find whether Mercury, Arsenic using industries were causing contamination of groundwater in that region.

MATERIALS AND METHODS

This was an observational-cross-sectional study, conducted over a period of two months between May-June 2015, where 4 nearest residential areas circling the Kurichi Industrial Cluster in North, South, East and West Directions were selected. Four houses with borewells were selected as samples randomly, one house per each residential area, from areas of SIDCO housing unit I and II, LIC colony and Eachanari [Table/Fig-1]. Even though above said contaminants travels large distances through ground water, we selected areas which are more than 8km away from the industrial cluster as controls. So, 4 centrally located residential areas like Singanallur, Saibaba colony, Gandhipuram and Selvapuram which were located far from Kurichi or other industrial clusters (13.1 km, 10.1 km, 10.1km, 8.6km respectively) were selected and one water sample obtained randomly from each area and were taken as controls. The size of the samples, distribution, collection methods were determined using the document issued by Central Pollution Control Board of India (CPCB), who regularly monitors many such parameters in regular intervals for a long time [15].



[Table/Fig-1]: Study area: Kurichi Industrial Estate in Coimbatore district of Tamilnadu, India.

S.No	Parameters	Location			
		SIDCO-Housing unit I	SIDCO-Housing unit II	LIC colony	Eachanari
1	Arsenic	BDL	BDL	BDL	BDL
2	Cadmium	BDL	BDL	BDL	BDL
3	Mercury	BDL	BDL	BDL	BDL

[Table/Fig-2]: Levels of heavy metals in samples (Around industrial Estate).

*BDL- Below detectable level (detectable level – 0.0010)/mg/l=ppm

S.No	Parameters	Location			
		Singanallur	Saibaba colony	Gandhipuram	Selvapuram
1	Arsenic	0.0014 mg/l	BDL	0.0010mg/l	0.0022mg/l
2	Cadmium	0.002 mg/l	BDL	BDL	BDL
3	Mercury	BDL	BDL	BDL	BDL

[Table/Fig-3]: Levels of heavy metals in controls (Regions in the city-Non industrial surroundings).

*BDL- Below detectable level (detectable level – 0.0010)/mg/l=ppm

The overall sample size of four is usually done for air, surface water and ground water by CPCB for its monitoring work [16] for a given industrial region. This study was planned based on above sample selection criteria. The power supply of bore well motor was switched on and the water allowed to run from a direct connection for about 3 minutes and water was collected in the containers without contamination and labelled and lids were tightly closed. Samples were transported to Alpha labs, a ISO 9001:2008 certified lab for chemical analysis in geo chemistry, within 2 hours of collection. Atomic absorption spectrophotometry using Perkin Elmer AA 200 model was used to estimate the levels of Mercury, Arsenic and Cadmium based on Indian Standards-3025 [17-19] document and results obtained. Institutional Ethical committee clearance was obtained and Consent to collect and check their bore well were obtained prior to collection.

RESULTS

[Table/Fig-2] shows the levels of Mercury, Arsenic and Cadmium of four tube wells from four houses located near Kurichi industrial cluster. All the samples contained heavy metals below the detection limit of <0.0010 mg/Litre. [Table/Fig-3] shows the levels of those metals in non industrial areas like Singanallur, Saibaba Colony, Gandhipuram and Selvapuram of Coimbatore. We found an alarming presence of Arsenic in Singanallur, Gandhipuram and Selvapuram and Cadmium contamination in Singanallur.

DISCUSSION

Mercury, Arsenic, Cadmium and Lead causes more damage to humans especially paediatric age group. A meta analysis done on papers published in 10 developing countries including India shows that blood levels of these metals in children of these countries showed increased levels and one causative factor among many is consumption of polluted ground water due to industrial effluents [20].

Kurichi Industrial Cluster is located in 180 acres at a distance of 7 km from Coimbatore city. There were no agricultural activities and solid waste dump in this locality ruling out these sources of ground water contamination. CPCB developed a comprehensive Environmental Pollution Index (CEPI) and gave a score of 58.75 for ground water in Kurichi in 2009, which implies that the water was critically polluted. The current study was based on above said findings [21]. Due to aggressive monitoring and steps taken by Tamilnadu pollution control Board, RO (Reverse-Osmosis) water treatment plants were commissioned in two industries to treat effluents and Rain water harvesting implemented in all campuses along with water recycling implementation in one factory [21]. This assured that the effluents from industries were treated properly and ground water contamination prevented. Our study removed the longstanding fears of heavy metal pollution by industries among residents located in surroundings of Kurichi Industrial Cluster, Coimbatore. Recent data from CPCB shows that the ground water collected in 4 tube wells inside Kurichi cluster showed less than detectable limits of these metals [16]. The focus of the monitoring agencies is pointed towards 43 critically polluted areas in the country among which Kurichi is one of them [16]. The authors are of opinion that, they should monitor air and water indices in residential areas far from the industrial areas too, since water table constantly shifts underground carrying the contaminants with them [22] and wind may carry the air pollutants to sites far from the region of its production [23].

A similar monitoring by Central water commission on many rivers all over India and found non toxic levels of Mercury and Arsenic [24]. Cadmium levels were slightly increased only in a few rivers indicating that Heavy metal contamination risk is reducing in India due to aggressive monitoring and strict adherence to rules by industries.

The findings of Arsenic in Residential areas like Singanallur, Gandhipuram and Selvapuram regions and Cadmium in Singanallur region needs further elaborate studies and wide sampling. Similar results are obtained in a study where municipal landfill caused seepage of heavy metals into aquifers leading to contamination of ground water far from the source [25]. Continuous and periodic monitoring of air, water and soil is warranted in regions containing industries to prevent environmental diseases due to pollution.

LIMITATION

The sample size taken was small. A large study should be done to estimate the heavy metals in the industrial and residential areas of Coimbatore.

CONCLUSION

This study found that Mercury, Arsenic and Cadmium were not detected in the areas surrounding Kurichi Industrial Cluster. Instead Arsenic and Cadmium were found in regions far from the industrial estate. Further studies are warranted with wide sampling in residential areas to assess these parameters regularly, since many reasons for ground water contamination exists in urban regions. The monitoring and regulatory works of governing bodies of India is hugely welcoming to ensure the safety and well being of us. Even though much monitoring work is done by government bodies, very few studies by researchers have been done in relation to ground water contamination in heavy metals leading to less number of published articles regarding this subject. Research organizations, NGOs and Scientists should do much needed research regarding this topic since it carries paramount importance in public health.

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PARTICULARS OF CONTRIBUTORS:

1. MBBS Student, Karpagam Faculty of Medical Sciences and Research, Pollachi Main Road, Othakkalmandapam, Coimbatore, India.
2. Assistant Professor, Department of Biochemistry, Karpagam Faculty of Medical Sciences and Research, Pollachi Main Road, Othakkalmandapam, Coimbatore, India.
3. Professor and Head, Department of Biochemistry, Karpagam Faculty of Medical Sciences and Research, Pollachi Main Road, Othakkalmandapam, Coimbatore, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. V. Hariharan,
Assistant Professor, Department of Biochemistry, Karpagam Faculty of Medical Sciences and Research,
Pollachi Main Road, Othakkalmandapam, Coimbatore-32, India.
E-mail: drhariharanv@gmail.com

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