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RESEARCH ARTICLE

ARSENIC IN GROUNDWATER AND ITS HEALTH IMPACTS: A CASE OF BALLIA DISTRICT, UTTAR PRADESH, INDIA

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ABSTRACT

Arsenic contamination in groundwater is a global problem and about 70 countries are affected by arsenic problem. Arsenic contamination in groundwater above the permissible limit of 50 µg/L in scattered places reported from seven States, particularly in the Holocene aquifers of Ganga-Brahmaputra alluvium plains are one of the major challenges of groundwater quality hazards before the Country. The consumption of highly contaminated water is reported to disastrous effects on human. The elevated level of arsenic is causes of pigmentation in skin, skin cancer, ulcer and hardening of palm skin. The inhabitants of the affected area are unaware and the local authorities totally oblivious to this grave problem. There had been several newspaper clippings indicating that arsenic contamination in drinking water sources in the Ballia district of Uttar Pradesh is creating hardship for the local people and several people are suffering from arsenicosis disease. The present study tries to find out the contamination level of arsenic in groundwater and its causes and effects on human health. 120 samples were collected from different sources and samples were analyzed by Econo Quick Arsenic Test kit in the field and correlated with health. After correlated with health we find that the evidence of arsenic lesions is found in that area where the contamination level is high. The results show that the Bairia Block (Ballia District) is highly contaminated and there are many people who are affected with arsenical skin lesions. Most of the people suffering from arsenicosis, they belong to very poor family and their socioeconomic status is very low.

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INTRODUCTION

Groundwater is a very important source of life on the earth. The contamination of groundwater is a worldwide problem (Ali et al., 2012b). World Health Organization (WHO) has reported that 10 ppb arsenic contamination in groundwater is suitable for human consumption as drinking water (WHO 2011). Elevated levels of arsenic contamination in groundwater have been reported from several other countries, including India, Mongolia, Argentina, Poland, Chile, Japan, Mexico, Taiwan, and some parts of the USA (Smedley and Kinniburgh 2002; GiangLuu et al., 2009; Uddin et al., 2006). Source of arsenic in the environment is a result of anthropogenic and natural activity and it comes to the environment naturally through mineral ore, ground water, and geothermal processes. In 1984, Arsenic contamination in groundwater and its impact on human health was first discovered in the lower Ganga plain

of West Bengal, India (Garai et al., 1984). The arsenic contamination in groundwater in North-Eastern states of India has been contaminated, which has spread to Ballia, Ghazipur and Varanasi districts in the eastern part of Uttar Pradesh (Ahamed et al., 2006). Various studies announced about arsenic contamination in groundwater that arsenic in drinking water can cause cancer (Canter 1997; Chakraborti et al., 2006; Chakraborti and Saha 1987). Consumption of arsenic contaminated drinking water causes skin cancer and skin pigmentation. Therefore, Arsenic intake during pregnancy can affect several reproductive endpoints (Mukherjee 2006; Roy et al., 2004). Excess amount of chronic arsenic can cause serious health problems in humans and animals such as ischemic heart disease, restrictive lung disease, hyperkeratosis and cancers (Mandal and Suzuki 2002). High level of arsenic contamination in groundwater is causes of various kind of sever diseases such as: hyperkeratosis of palms and soles, eczema of skin/mucous membranes, leukemia, warts, encephalopathy, acute renal failure, neuropathy and cancer, sensory disorders, pulmonary insufficiency, interstitial fibrosis, melanosis, rhinopharyngitis,

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hypertension and peripheral vascular disease (Hossain *et al.*, 2005; Singh *et al.*, 2010 and Katsoyiannis and Zouboulis 2004). Arsenic contamination in groundwater of Ballia district is highly contaminated and people are affected by various disease viz. keratosis, pigmentation and chromosomal abnormalities (Singh *et al.*, 2013, Kumar *et al.*, 2017). Installation of Arsenic Removal Unit (ARU) is very costly in rural part of India. Various kinds of ARU are working based on different technology. The dual treatment method by oxidation-coagulation-filtration and adsorption by activated alumina is a current technology to filter water with best results (Roy, *et al.* 2104 and Roy, *et al.* 2016). As we know even several technology are available and all are implemented at different arsenic affected rural areas in an around India. Most of the ARUs are not working due to lack of operation and maintenance. Beneficiary peoples are also not getting aware for making sustainable structure for a longer period and also to reduce the health impact related to arsenic diseases by adding more nutrition in the long run. Keeping in view, the overall objective of this paper is to assess the magnitude of arsenic in groundwater with health impact if available in part of Ballia district. The main objective of this paper is to find out the ill effect of consumption of arsenic contaminated water on human health.

MATERIALS AND METHODS

Study Area

Ballia district is the easternmost part of the Uttar Pradesh and borders on Bihar. The district lies between the parallels of 25°33 and 26°11 North latitudes and 83°38 and 84°39 East longitudes. Ballia is surrounded by Ganga River and Chhoti Saraju in south and Ghaghara River in the north. The district is drained by Ganga, Ghaghara and Chhoti Saraju River. There are many Tals and ponds such as Suraha Tal, Daha Tal, Sikanderpur Tal etc. Ballia district is the part of the Central Ganga Plain. There are two types of alluvial plain. One is older alluvial of Pleistocene and second one younger alluvial of the Holocene. The average rainfall of the Ballia district is 983 mm. The temperature ranges between 32 and 46° in the summers, and 2–15 °C in the winters.

Sampling and Chemical Analysis

An attempt has been made to carry out a preliminary investigation of the arsenic contamination of groundwater. About seven villages of Bairia block have been surveyed

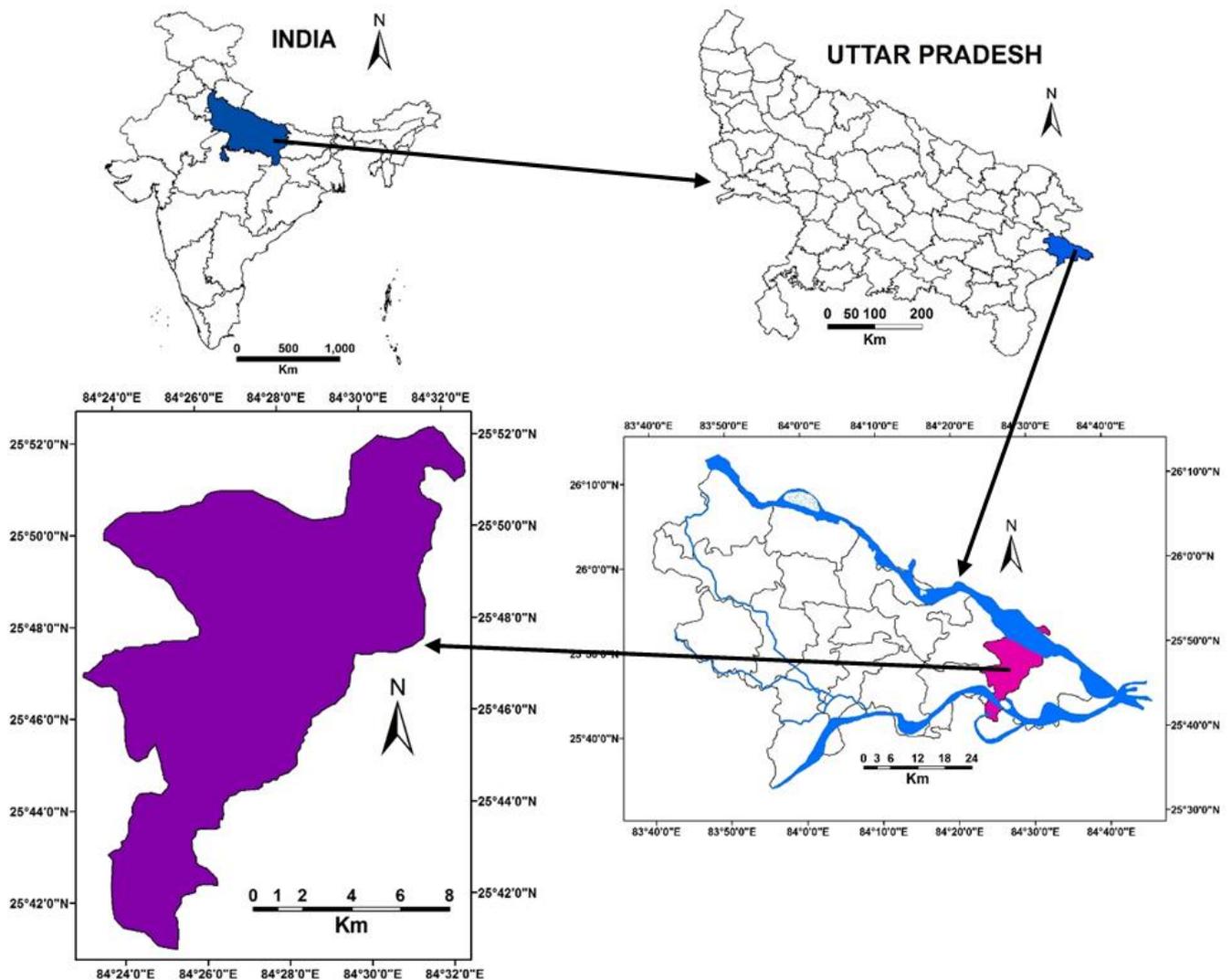


Fig. 1. Location map of Study Area Bairia Block Ballia District

(shown in Fig.1). Total of 100 groundwater samples were collected from India Mark II (30–35 m) and private tube wells (12–15 m) deep bore-well, which are the only available water sources for drinking and other domestic use in the area. GPS was used for the positioning of each location. In the field, after collection, the samples were immediately analyzed for arsenic content. The analysis had been taken in the field with the help of Econo Quick Arsenic Test Kit.

RESULTS AND DISCUSSION

Extent and Magnitude of Arsenic in Groundwater

Most of the arsenic contaminated hand pumps are located in Mishra KaMathia, Ramgarh, DayaChhapara and Gangapur village in Bairia block. Arsenic contamination in groundwater, a total of 100 water samples only 6 % result was under WHO permissible limit (10 ppb) and 9 % results were below BIS standard (50 ppb). The rest of them 85 % results were highly arsenic contaminated (shown in Fig. 2). In Mishra ka Mathiya and Ramgarh villages the level of arsenic contamination is more than 500 ppb. The result shows that eastern part of Ballia district is a flood plain and there is lack of canals so the irrigation system is totally based on bore well water. The water stakeholder are withdrawing excessive water to fulfill the demand of agriirrigation. Due to that water level is decreasing day by day. Geological Water Department, Uttar Pradesh has reported that the declination in water level “1998 to 2010” is about 20 cm/year. The unavailability of any other groundwater recharge source, the concentration of arsenic in ground water of this area become very high magnitude. In the lack of water recharge the concentration of arsenic is becoming rich in this area and number of contaminated water sources are increasing day by day.

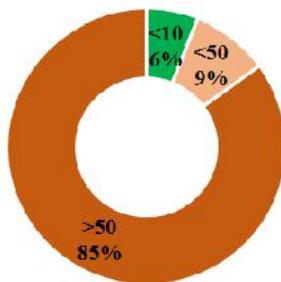


Fig. 2. Arsenic level in groundwater (ppb)

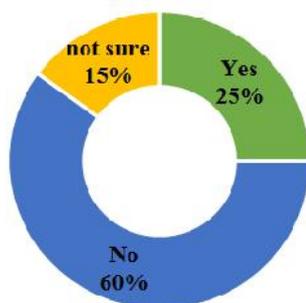


Fig. 3. Awareness level of Arsenic in Villagers

Awareness and Economical Level of Arsenic in Study Area

The result of the socioeconomic based survey shows that all these people are belong to low income family. Due to lack of

electronic and print media, the awareness level of arsenic is very low. This study found that 60 % of the population is not aware about arsenic contamination so they are still using arsenic contaminated water for drinking and cooking. Only 25% of the population know about arsenic, but they are not aware about arsenical diseases and 15 % population did not make any comment on arsenic due lack of awareness program (shown in Fig.3).



Photo 1. Arsenical disease symptoms found in Ballia District

This study found that about 60% population have bad economic condition and they are involve in primary activities and some of them are involve in daily wage labor activities They have not enough money to expend on filtered water so they are using contaminated water for domestic use.

Health Effects

Ingestion of elevated level of arsenic-contaminated water, it effects the human health. Arsenical diseases viz. hyperpigmentation, hypopigmentation, keratosis, melanosis and hardening in palm skin are very common and are first recognized health effects. From the arsenic affected area of six

villages (Baria, Mishra KaMathiya, Ramgarh, DayaChhapara, Tengarahi, Gangapur and Jagdeva) of Ballia district, UP (India) 23 persons (9 male and 14female) identified, who had symptoms of skin disease like hyperpigmentation and hypopigmentation. After analyzing all samples study showed that in those areas where the arsenic contamination level is high and people are using that contaminated water for a long time, arsenic symptoms detected in them such as Mishra kaMathia and Ram Garh villages in Bairia Block. In Mishra ka Mathia village, the contamination level is very high and people are suffering from arsenical disease like pigmentation in skin, skin cancer, ulcer and hardening in palm skin (shown in photo 1).

Conclusion

The present study has been carried out to determine the effect of consumption of elevated level of arsenic contaminated water on the individuals in the Ballia district of Uttar Pradesh. In the absence of filtered water people are drinking contaminated water and after long period due to consumption of arsenic people are suffering from arsenical skin disease such as pigmentation, keratosis and chromosomal abnormalities. However, a much detailed study is required in the near future to understand the mechanism facilitating the release of arsenic in the groundwater of the study area. Overall, this study contributed to increase the knowledge on the effects of arsenic.

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