

GROUNDWATER ARSENIC CONTAMINATION IN DIFFERENT PARTS OF THE WORLD: A HIDDEN HEALTH THREAT

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ABSTRACT

Groundwater is one of the safe and portable water of the world. In groundwater arsenic can be found through the dissolution of minerals and ores. Arsenic is naturally occurring chemical element that found in the earth crust with symbol As raised greatly concern from environment and health perspective. The aim of this research paper is to investigate the level of arsenic contamination in groundwater and its health impact. Arsenic affects a broad range of organs and system including skin, nervous system, respiration system, liver, kidney, immune system etc. Arsenic poisoning occurs due to the high level of arsenic in the body. Interpolation method has been use to show the spatial distribution pattern of groundwater arsenic contamination with the help of Arc GIS 10.2.1. Many rural people of the study area use arsenic contaminated drinking water.

Key words: *Arsenic, Contamination, Groundwater and Distribution Pattern*

Introduction

According to United States Environment Protection agency arsenic is a harmful substance and a group A- carcinogen. Arsenic is a group V heavy element which atomic number 33 and its atomic weight 74.9amu, specific gravity 5.73g/cm. Drinking water is one of the main source of arsenic. According to World Health Organization the limit of arsenic in drinking water is 10 million of a gram per liter (10µg/L) of water (WHO, 1996).

Arsenic occur in the environment in several oxidation states (-3, 0,+3 and +5) in both inorganic and organic forms. Trivalent arsenic can exist as arsenous oxide (As₂O₃), arsenious acid (HAsO₂), arsenite (H₂AsO₃⁻, HAsO₃²⁻, AsO₃³⁻) ions, arsenic trichloride (AsCl₃) and arsenite (AsH₃). In natural waters, arsenic is mostly found in inorganic form as oxyanions of trivalent arsenite As III or pentavalent arsenic As V. both As III and As V compounds are highly soluble in water. Bureau of Indian Standards (BIS) arsenic concentration in drinking water should not exceed 50 ppb. World Health Organization value for arsenic in drinking water is 10 ppb.

Objectives

Based on the background outlined above, the objectives for the paper are:

- (i) to understand the level of arsenic contamination of groundwater in different parts of the world
- (ii) to investigate the impact of arsenic on human health.

Methodology

The amount of arsenic present in the water has been analyzed by using arsenic test kit. Interpolation method has been used to show the vertical distribution of groundwater arsenic contamination in the study area. Primary data regarding impact of arsenic on human health has been collected with the help of field surveys through well design schedule.

Study Area

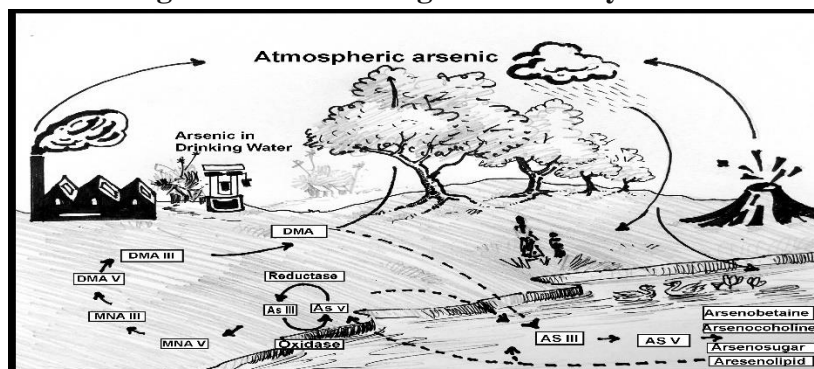
North Guwahati circle has been selected for the study of vertical distribution of groundwater arsenic contamination. North Guwahati circle is located in Assam between $26^{\circ}9'$ and $26^{\circ}20'$ North latitude and $91^{\circ}435'$ and $91^{\circ}52'$ East longitude.

Result and Discussion

Introduction to arsenic

Ground water is a dynamic resource and ground water monitoring is essential for sustainable development and management. Water level data is important for the development and management of a region.

Figure 1: Arsenic biogeochemical cycle



Source: Bhattacharjee and Rosen, 2007 (Art by-Tirthankar Sarma)

Figure 1: Biological cycle for arsenic

Possible Sources of Arsenic in Groundwater

In nature 150 minerals have arsenic bearing capability and three of them are considered as arsenic ore viz Arsenopyrite or Ferrous arsenic sulphide, Realgar or arsenic disulphide and Oripiment or arsenic trisulphide. In Bengal basin Arsenopyrite has been identified as main source of arsenic. Pentavalent arsenate and trivalent arsenite are commonly found in groundwater. Arsenic originates in the Himalayan head waters of the Ganga and Brahmaputra River. Arsenic contaminated ground water is found within the sediments between 20-100 m below ground level in Brahmaputra alluvial plain. The arsenic free groundwater occurs in deep aquifer. Thick clay bed act as a barrier to prevent the vertical percolation of

arsenic contaminated groundwater with the arsenic free groundwater below 150 m depth. Highly arsenic contaminated groundwater found in foothills. Alluvial sediments are deposited as a mix sequence of sands, silts and clay deposits eroded from surrounding mountains. Due to surface erosion arsenic contamination in those areas may be very high. The most of the arsenic contamination groundwater case in the Himalayan region are because of sedimentary mobilization under natural hydrological conditions. In the study area two main sources of arsenic can be found these are natural cause and anthropogenic source. Brahmaputra River has several types of sediment deposits. Earth's crust is an abundant natural source of arsenic. Exploration of groundwater, application of fertilizer and burning of coal are the main cause of arsenic contamination in groundwater.

Table 1: Abundance of Arsenic (mg AsKg⁻¹) in the Easth's Crust

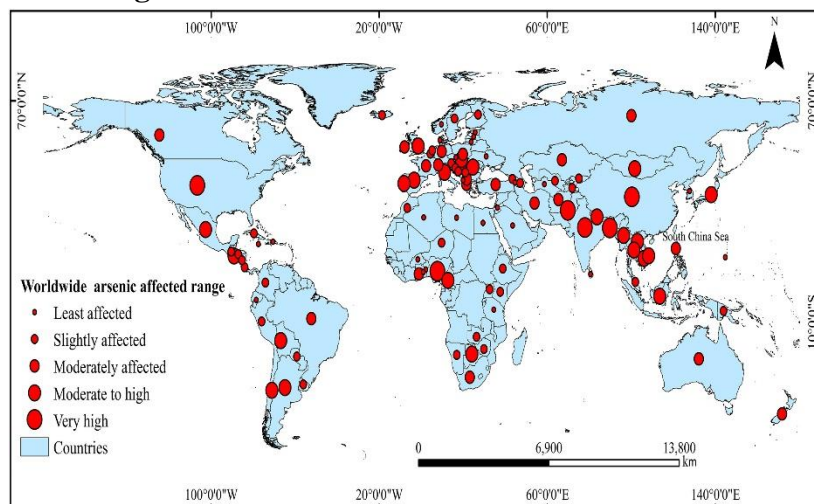
Rock Types		Range (mg AsKg⁻¹)
Igneous	Ultrabasics	0.3-16
	Basalts	0.06-113
	Andesites	0.5-5.8
	Granites/ silicic volcanicc	0.2-13.8
Sedimentary	Shales and clays	0.3-490
	Phosphorites	0.4-188
	Sandstones	0.6-120
	Limestones	0.1-20
	Coals	0.5-80

Source: NAS, 1977 Zheng et.al 1996

Global distribution of arsenic contamination region

Groundwater is one of the most important resources f drinking water in our Earth. The demand for good quality groundwater has increased with increasing population. Arsenic contamination in groundwater is major threat for human health. Drinking water is a major concern and challenges of human society. In present time 2.5 billion human population depend on groundwater for drinking. Several newly affected regions of arsenic contamination have been reported during the last decade. Nearly 108 countries of the world are affected by arsenic contamination in groundwater (with concentration beyond World health Origination limit of 10 ppb). Highest arsenic contaminated areas are from Asia and Europe followed by Africa, America and Australia. More than 230 million people are at risk of arsenic poisoning. Alluvial sediments are the major source for arsenic contamination. Arsenic contaminated groundwater consumption results in severe health issues like skin, lung, kidney and bladder cancer and heart diseases. Arsenic contaminated groundwater has been reported worldwide and majority of these belongs to South Asia and South American regions.

Figure 2: Arsenic affected countries of the World



Source: Ali et al; 2019

More than 107 countries are affected by arsenic contamination in groundwater with highest report from Asia (32) and Europe (31), followed by Africa (20), North America (11), South America (09) and Australia (4).

Table 2: List of countries affected by arsenic contamination in groundwater

Continent	Countries affected by arsenic in groundwater
North America	Canada, Costa Rica, Cuba, Dominica, Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua and USA (11)
South America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru and Uruguay (9)
Asia	Afganistan, Armenia, Azerbaijan, Kyrgyzstan, Bangladesh, Cambodia, China, Georgia, India, Indonesia, Iran, Japan, Jordan, Laos, Kazakhstan, Korea, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Russia, Saudi Arabia, Sri Lanka, Tajikistan, Thailand, Turkey, Turkmenistan, Uzbekistan and Vietnam (31)
Europe	Albania, Austria, Belgium, Croatia, Czech Republic, Bosnia-Herzegovina, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, Switzerland, Ukraine and United Kingdom (31)
Africa	Algeria, Botswana, Burkina, Cameron, Egypt, Ethiopia, Ghana, Kenya, Libya, Malawi, Morocco, Namibia, Niger, Nigeria, South Africa, Tanzania, Togo, Uganda, Zambia and Zimbabwe (20)
Australia	Australia, Guam, New Zealand, Papua New Guinea (4)

Source: Ali et al; 2019

Conclusion

Arsenic poisoning can occur due to arsenic contamination in drinking water. Groundwater arsenic levels is different in different places. In study area tube well depth are different in different region. In some areas of Kamrup district tube wells depth is very shallow and in another area tube well depth is very deep up to 120 meters below ground level. In the study area groundwater is contaminated with arsenic and other organic matter. The area under arsenic concentration is also changes with time. With the passage of time arsenic contamination area also increases due to pressure in the groundwater. As a result of this incident of arsenic contaminated diseases also increases.

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