Application of Information Technology & Computer Programming In Arsenic Mapping

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Abstract-Arsenic in drinking waters, with a special focus on developing and third world countries where the problem is exacerbated by flooding and depressed economic conditions. The reason behind this review was to summarize the Technologies currently being investigated to remove for compiling this report is to provide background material and a description of competing technologies currently described in the literature for arsenic removal. Based on the sophistication and applicability of current technologies. This paper presents the use of GIS for integrated analysis of spatial and non spatial data to present the magnitude and distribution of arsenic concentration and TW user's socio economic information un most attractive way, which is very helpful in identify and visualize the arsenic affected areas and proper planning to implemented area based arsenic mitigation options. Latest technologies have been used to (Information & Comm. Technologies (ICT)) is tools have been used for participatory decision making in the drinking water sectors including pilot projects. GIS, remote sensing, satellite image processing and other software tools are used to assess water quality & enable efficient management of water resources.

Keywords –toxic effect of arsenic, mitigation, arsenic contamination, treatment of arsenic poisoning

1. Introduction:

The main objective of the project was to conduct action oriented research and implementation from which useful experiences and knowledge were gained about arsenic concentration level of hand pumps and tube wells installed in shallow depth (<200 meter) and TW user's knowledge and awareness about arsenic contamination in TW water. One of the major activities of the project was to create an integrated database system using Geographical Information System tool to develop a strong information base for decision-making.

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A GIS should include software for the display of maps, graphs and tabular information, which depict the spatial or aerial distribution of various objects and phenomena (Smith, et.al.., 1987). This was the reason to choose Arc/Info and Arc View GIS software including spatial analyst module to manage the storage analysis, interpolation and visualization of spatial and non spatial data.

This paper presents the use of GIS for integrated analysis of spatial and non spatial data to present the magnitude and distribution of arsenic concentration and TW user's socio economic information un most attractive way, which is very helpful in identify and visualize the arsenic affected areas and proper planning to implemented area based arsenic mitigation options.

2. Nature of Arsenic and its occurrence:

2.1 Arsenic in Nature

In nature, there is plenty of arsenic. Arsenic is present in air, soil and water. Rock contains 1.5-2.0 milligram of arsenic per kilogram. But, in contaminated soil, concentration of arsenic may be up to 500 mg/kg. Industrial wastes may emit arsenic to the atmosphere causing higher arsenic level in the near by air than usual level (0.04030 ng/cubic meter). Arsenic content of natural water may be up to 1-2 microgram/L. Most fruits, vegetables, meats and fishes contain arsenic; but arsenic levels in sea water and sea fishes are higher. Sea fish may contain 5 mg of arsenic per kg weight.

Living with nature means human beings take a little amount of arsenic every day through breaths, food or drinks. But, as they are negligible in quantity and organic in nature, they do no harm.

An intake of 150 microgram of arsenic per day should not cause any harmful effect to human being, but very sensitive person often becomes sick with as low as 20 microgram of

arsenic a day.

Table-1 shows the chemical nature of arsenic.

Table-1. Chemical Nature of Arsenic at a Glance

Formula	As
Atomic Number	33
Atomic weight	74.9216
Position in Periodic Table	VA
Density at 32 degree Fahrenheit	5.73
Melting point	1139^0F
Boiling Point	1497.2 degree Fahrenheit
Types of Arsenic compounds	Inorganic (trivalent, e.g. arsenites, and pentavalent, e.g. arsenates); Inorganic arsenic are more toxic. In Bangladesh both tri and pentavalent compounds have been found in water. Organic (mono and di-methyl arsonic acid, Na-cacodylate, atoxyl, stoversol, etc.)

2.2 Occurrence

Figure 1.A large sample of native arsenic

Arsenopyrite, also unofficially called mispickel, (FeAsS) is the most common arsenic-bearing mineral. In the lithosphere, the minerals of the formula M(II) AsS, with M(II) being mostly Fe, Ni and Co, are the dominant arsenic minerals.

Figure 2.Realgar

Orpiment and realgar were formerly used as painting pigments, though they have fallen out of use owing to their toxicity and reactivity. Although arsenic is sometimes found native in nature, its main economic source is the mineral arsenopyrite mentioned above; it is also found in arsenides of metals such as silver, cobalt (cobaltite: CoAsS and skutterudite: $CoAs_3$) and nickel, as sulfides, and when oxidised as arsenate minerals such as mimetite, $Pb_5(AsO_4)_3Cl$ and erythrite, $Co_3(AsO_4)_2{\cdot}8H_2O$, and more rarely arsenites ('arsenite' = arsenate(III), AsO_3^{3-} as opposed to arsenate (V), AsO_4^{3-}).

In addition to the inorganic forms mentioned above, arsenic also occurs in various organic forms in the environment. Other naturally occurring pathways of exposure include volcanic ash, weathering of the arsenic-containing mineral and ores as well as groundwater. It is also found in food, water, soil and air

3. Toxic Effects of Arsenic to Human Health

Arsenic is toxic substance to human health and toxicity depends on the amount of arsenic intake, which is classified into acute, sub-acute and chronic toxicity respectively. It is a silent killer. It is 4 times as poisonous as mercury and its lethal dose (LD) for human is 125 milligram. Drinking water Undetectable in its early contamination causes the last variety of toxicity. Stages, arsenic poisoning takes between 8 and 14 years to impact on health, depending on the

amount of arsenic ingested, nutritional status, and immune response of the individual.

Arsenic toxicity is dose dependent, and particularly on the rate of ingestion of arsenic compounds and their excretion from the body but it also accumulate into the body and passes slowly out through hair and nail. Most of the ingested arsenic is excreted from the body through urine, stool, skin, hair, nail and breath.

Figure 3: Signs of arsenicosis: spots on the hands

In excessive intake, some amount of arsenic is accumulated in Inhalation, ingestion and skin tissues and inhibits cellular enzyme activities. Contact are the primary routes of human exposure to the arsenic. Chronic arsenic ingestion from drinking water is known to cause skin cancer, and there is substantial evidence that it increases risk for cancers of the bladder, lung, kidney, liver, colon, and prostate. Recent studies have also shown that arsenic is associated with a number of non-neoplastic diseases, including cardiac disease, cerebrovascular disease, pulmonary disease, diabetes mellitus and diseases of the arteries, arterioles, and capillaries (Engel, R.R. and Smith, A.H., 2004). Individuals with chronic Hepatitis B infection, protein deficiency or malnutrition may be more sensitive to the effects of arsenic (WHO, 1999). Children and older adults may be other groups at special risk. The Table 1 shows problems and organ of the human body which is generally affected by arsenicosis. Observable symptom to the arsenic poisoning can be thickening and discoloration of skin, stomach pain, nausea, vomiting, diarrhea, numbness in hand and feet, partial paralysis, blindness.

Table 2: Arsenic infection

Organ System	Problems
Skin	Symmetric hyperkeratosis of palms and soles, melanosis or depigmentation, bowen's disease, basal cell carcinoma and squamous cell carcinoma.
Liver	Enlargement, Jaundice, cirrhosis, non-cirrhotic portal hypertension
Nervous System	Peripheral neuropathy, hearing loss
Cardiovascular System	Acrocyanosis and Raynaud's Phenomenon
Hemopoietic System	Megalobastosis
Respiratory System	Lung Cancer
Endocrine System	Diabetes mellitus and Goiter

4. Mitigation

There are two different, but not mutually exclusive, approaches to minimizing the human health impacts of arsenic contamination of groundwater:

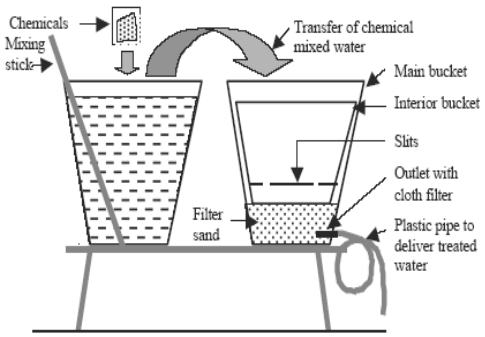
- Prevention
- Cure

Prevention: To prevent further exposure to Arsenic contamination, it is important to screen of all tube well and population to identify contaminated ones and level of contamination. The GOB has already finished the screening of the tube well. Once the tube well is detected with higher

concentration of arsenic than national standard, the tube is marked with red paint and with green paint which is safe to drink (Figure 6). The next steps to provide arsenic free water to all the populations.

Figure 4: Screening of tube well

The people are promoted to take water from the sources which are arsenic free. The people are advised to drink surface water after certain amount treatment with disinfectant or they also promoted for rain water harvesting. The people who are able to bear the cost are suggested to drill tube well in the deep aquifer where water is arsenic free. Where alternate options are not available are suggested and supported to make water arsenic free. There are several techniques to make the water arsenic free.



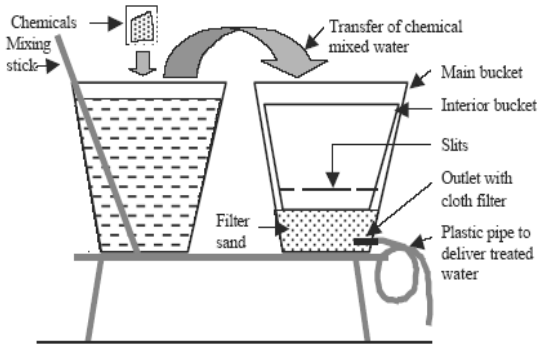


Figure 5: Stevens Institute Technology

5. Role of Information Technology

Geospatial technologies have emerged as powerful technological tools to identify the location of drinking water wells and also rain water harvesting structures while the remote sensing/ GIS investigations can narrow down the region of high yielding aquifers up to a minimum of 12 kms, the exact location of bore wells within that area has to be identified by geophysical surveys and studies. In Tamil Nadu the geospatial technologies are being used in all the blocks of the state ad favorable zones for ground water withdrawal and recharge has been successfully delineated. The TW & DB has successfully created a digital database for all the 386 blocks of states. These databases can be used to identify the groundwater sources with high yields for large water supply projects, particularly in remote areas inaccessible to geophysical surveying. A substantial achievement has been made in providing drinking water coverage for rural areas with bore wells, pumps and piped water supply schemes**.**

Latest technologies have been used to (Information & Comm. Technologies (ICT)) is tools have been used for participatory decision making in the drinking water sectors including pilot projects. GIS, remote sensing, satellite image processing and other software tools are used to assess water quality & enable efficient management of water resources.

Following are the various states where Information & Comm. Technologies have been used for arsenic mapping, and for efficient water resource management.

6. Role of GIS for Locating Arsenic Contamination in Groundwater

6.1 Groundwater Arsenic Contamination in Uttar Pradesh, India

Uttar Pradesh (UP) situated in the upper and middle Ganga plain has an area and population of 238,000 km^2, and 166 million respectively. The administrative structure of UP consists of 70 districts, each having several blocks, each block has several Gram Panchayets (GP), which are the clusters of villages.

Figure 6.Shows the study area Uttar Pradesh in India

7. Summary

A total of 4780 hand tubewell water samples were collected at random from 11 blocks (five from Ballia, four from Gazipur and one from Varanasi district), 74 GP/municipal areas and 122 villages / wards of three districts (Ballia, Gazipur and Varanasi) of Uttar-Pradesh. We found arsenic concentration above 10 □ g/L (WHO recommended provisional guideline value of arsenic in drinking water) in 100 villages and in 69 villages above 50 □ g/L (The permissible level of arsenic in drinking water in India). A summary of the present groundwater arsenic contamination status in UP is presented in Table.

Table 3. Summary of the present groundwater arsenic contamination status in UP

Physical parameters	Uttar Pradesh
No. of districts surveyed so far	3 (Ballia, Gazipur & Varanasi @)
Number of arsenic affected districts where groundwater arsenic above 10 µg/L so far identified.	3
Number of arsenic affected districts where groundwater arsenic above 50 µg/L so far identified.	3
No. of blocks surveyed so far	10
Number of arsenic affected blocks where groundwater arsenic above 10 µg/L	9
Number of arsenic affected blocks where ground water arsenic above 50 µg/L	7
Total number of hand tube-well water samples analyzed	4818
% of hand tube-wells having arsenic concentration >10 µg/L	45.48
% of hand tube-wells having arsenic concentration >50 µg/L	26.51
% of hand tube-wells having arsenic concentration >300 µg/L*	10
No. of villages surveyed so far	122
Number of arsenic affected villages(approx.) with ground water arsenic above 50 µg/L	69
Number of arsenic affected villages(approx.) with ground water arsenic above 10 µg/L	100
Districts surveyed for arsenic patients	2
Number of districts where we have identified people with arsenical skin lesions	2
People screened for arsenic patients from affected villages(preliminary survey)	989 (15.47)
Number of registered patients with clinical manifestations, including children	154
Total number of villages surveyed so far for arsenic patients	11
Total number of villages where arsenic patient identified	11

*During our last 20 years field experience in West Bengal and 10 years in Bangladesh we have observed that ingestion of arsenic contaminated water with 300 □ □g/L for prolonged period may cause arsenical skin lesions.@ Preliminary survey (water samples analyzed) done in Varanasi.

We have predicted that the northern part of the river close to Terai Region could be arsenic affected.

Figure7. Patient from Tiwaritola,
Uttar Pradesh

8. Remedies of Arsenic problem

Information on the signs and symptoms of arsenic poisoning

Headaches, confusion, drowsiness, convulsions, and changes in fingernail pigmentation may occur with chronic arsenic poisoning. Symptoms of acute arsenic poisoning include vomiting, diarrhea, bloody urine, muscle cramps and/or weakness, fatigue, hair loss, dermatitis, gastrointestinal pain, and convulsions. Arsenic poisoning primarily affects the lungs, skin, kidneys, and liver. The accumulation of toxic levels of arsenic can result in coma and death.

Exposure to arsenic has been implicated in the development of certain types of cancer as well. Workers involved include production, agricultural insecticide spraying, copper smelting, mining, sheep dipping, and metallurgical industries are at a high risk for skin cancer, scrotal cancer, a type of liver cancer, cancer of the lymphatic system, and lung cancer due to arsenic exposure. The toxic effects of arsenic are cumulative.

9. Home remedies for the treatment of arsenic poisoning

Eat eggs, onions, beans, legumes, and garlic to obtain sulfur. You can also obtain sulfur from garlic supplements. Sulfur helps eliminate arsenic from the body. The amino acid cysteine also provides sulfur. Sulfur can be purchased in tablet form as well.

If you have symptoms of chronic arsenic poisoning, have a hair analysis performed to determine the level of toxic metals in your body.

Chelation therapy is an option if you have arsenic poisoning. Chelation therapy is used to remove toxic metals such as cadmium, arsenic, lead and mercury from our bodies. Metals and minerals can clog our systems and can be removed with chelation therapy.

In case of accidental arsenic ingestion, immediately take 5 charcoal tablets, and take 5 more every fifteen minutes until you reach your health care provider or the emergency room of the nearest hospital. Charcoal tablets should be kept on hand in every household in case of accidental overdose of drugs.

Supplement your diet with plenty of fiber daily. *Note:* Always take supplemental fiber separately from other supplements and medications.

10. Conclusion

This paper presents the use of GIS for integrated analysis of spatial and non spatial data to present the magnitude and distribution of arsenic concentration and TW user's socio economic information un most attractive way, which is very helpful in identify and visualize the arsenic affected areas and proper planning to implemented area based arsenic mitigation options.

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