

Removal of arsenic in drinking water

The sooner, the cheaper, the better

MD. ASADULLAH KHAN

ARSENIC contamination of groundwater in the country has now assumed catastrophic proportions. About two crore people in 59 out of 64 districts in the country are now at risk of arsenic poisoning. "This is one of the worst man-made environmental disaster in human-recorded history Bangladesh is facing after Hiroshima disaster," says Dr. Dipankar Chakravarty, director of the School of Environmental Sciences (SOES) in the Jadavpur University of India. A year-long survey by the SOES team in collaboration with NIPSOM, Bangladesh; Miyazaki University, Japan and Japan-based Asia Arsenic Network in 1993 found groundwater in 19 of the 24 districts covered contaminated by arsenic beyond acceptable limit. That arsenic contamination of groundwater is no longer a scare-story to be summarily dismissed, but a very big challenge to the public health was highlighted in the recent "International workshop on Technologies for Arsenic Removal," jointly organised by Bangladesh University of Engineering and Technology and the United Nations University, Japan. The workshop held on May 5 attracted about 150 scientists, technologists and researchers from the UK, the US, Australia, Japan, the Netherlands, Canada, India, Nepal and the host country.

Experts believe that arsenic in the form of arsenopyrite remained deposited beneath the Ganges delta aeons ago after washing down from the ores in the Himalayas. As long as they remained submerged in groundwater they remained inert. The amount of arsenic compounds in the form iron oxide found in the sediment flowing down the Ganges were far in excess from other places in the world. Because of the high density of population in this region and intensive irrigation in the early 1960s, the aquifers dropped exposing the poisons to oxygen. Approximately, there are about 31,000 deep tube-wells and eight lakh 84 thousand shallow tube-wells in Bangladesh and in West Bengal at the moment (27,000 deep tube-wells and four lakh 84 thousand shallow tube-wells in Bangladesh alone). Besides, there are about 40 lakh hand-pumped tube-wells in India and Bangladesh. It has now become evident that arsenic contamination originating in West Bengal has now seeped into the south-western Bangladesh. Experts further believe that because of the country's peculiar location in the Ganges delta, western districts, especially the south-western border districts in the country are vulnerable to arsenic contamination. This is supported by the fact that sediments on both sides of the border have the same depositional history and geological environment. Interestingly, the aquifer of the contaminated zone in West Bengal and the region within Bangladesh are hydrologically connected. That means the groundwater aquifer supplying most of Bangladesh's clean drinking water is now contaminated by naturally occurring arsenic

compounds. Arsenic problem in drinking water is not altogether a rare phenomenon in other parts of the world but the problem did not reach a crisis situation in those places simply because those regions are sparsely populated. The threat of arsenic contaminated water is especially serious in Bangladesh where nature, poverty and population density compound the problem.

For the last 40 years at least thousands of tube-wells have been sunk for supply of safe drinking water and irrigation (both manually and mechanically operated). More than 90 per cent of the people in the country are now using drinking water supplied from ground water sources that appear to be contaminated to dangerous levels by naturally occurring arsenic. People in large numbers are now suffering from arsenic poisoning. Physicians say the arsenic affected patients develop fatigue, nausea, severe lesions in leg and hands, palms and soles of feet, stomach cramps, nerve disorders and lastly organ cancers. At the early stage of illness, an arsenic poisoned person is affected by a variety of diseases like melanosis, conjunctivitis, bronchitis and gastro-enteritis. At the last stage, gangrene in the limbs and malignancy lead to fatality. Other than restricted ingestion of arsenic contaminated food and water, there is practically no treatment of chronic arsenic toxicity.

Bangladesh lies in the downstream of the river Ganges that takes up the name Padma in Bangladesh. A large part of Bangladesh and West Bengal were formed by the deposition of the alluvial fill from the rivers Ganges and Brahmaputra called Jamuna in Bangladesh over thousands of years. Interestingly, the Ganges originates in the Rajmahal hills, an area rich in arsenic bearing rock. It has now been proved by analysis that this deltaic clay layered by stones is rich in arsenopyrite. The study further indicated that due to heavy groundwater withdrawal for irrigation and fluctuation of water table in different seasons and due to hundreds and thousands of bore holes, the underground aquifers have become aerated. This transforms an essentially anaerobic environment into an aerobic environment. Consequently, the newly introduced oxygen oxidises the arsenopyrite and releases free arsenic into the groundwater.

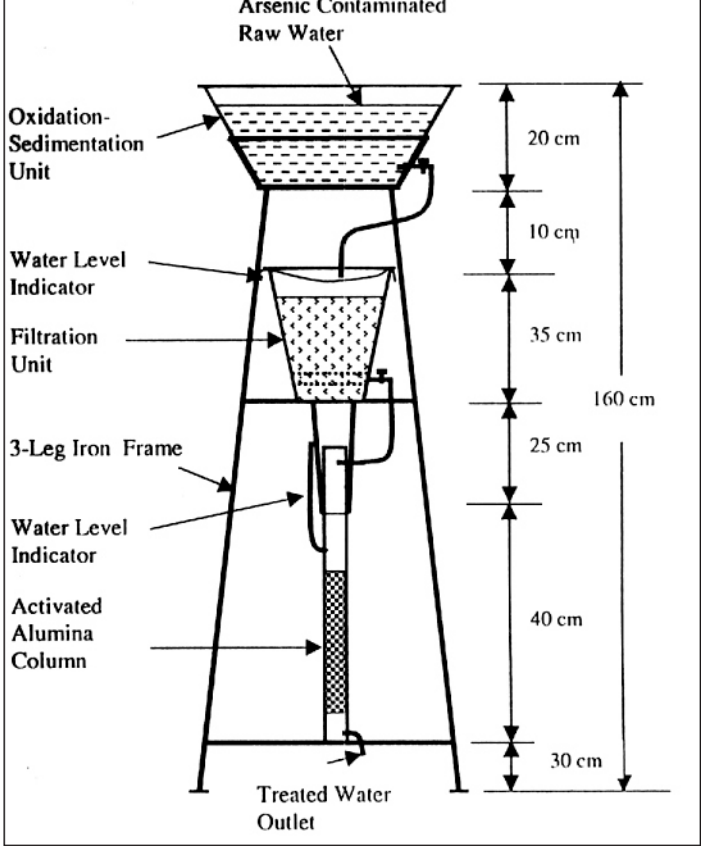
The toxicity of arsenic compounds depends on the physical and chemical form of the compound, the dose and duration of the exposure, ingestion levels of interacting elements and the age and gender of the exposed individual. According to WHO guidelines, the maximum permissible concentration of arsenic in water is 0.01 mg/litre that was reckoned previously 0.05 mg/litre which Bangladesh has taken up as the maximum permissible limit. Concentrations in the affected areas range from a minimum of 0.05 mg/litre to 3.0 mg/litre, a range many hundreds of times beyond the maximum safe level. Tests conducted by NIPSOM (National

Institute of Preventive and Social Medicine) Dhaka and other NGOs have now revealed that about 20-40 million people in 59 out of 64 districts in Bangladesh are now drinking tube-well water with arsenic content exceeding 0.05 mg/litre. The arsenic toxicity in water of the affected districts namely Bagerhat, Khulna, Satkhira, Jessore, Jhenidah, Chuadanga, Meherpur, Kushtia, Pabna, Rajshahi, Narayanganj, Chandpur, Rajbari Laxmipur and Noakhali - is 25 to 35 times higher than the safe level set by the WHO. The number of arsenic-poisoned tube-wells is on the rise exposing larger populations to the deadly scourge and creating panic across the rural belt.

The mass awareness campaign through TV, radio, newspapers and posters must be called into play. It must explain the causes and the effects, namely symptoms of arsenic poisoning and dispel the irrational myths shrouding the problem. The mass awareness campaign will urge households in the affected areas to have their drinking water supplies tested and go for the most competitive and effective abatement options.

The social fallout is creating havoc in rural Bangladesh with family ties torn asunder and income level dropping precipitously. Rahila Begum, 30, an arsenic victim in Satkhira who developed dark brown spot on her skin has been socially shunned. With her there are others. Girls don't find husbands. And married women are often ostracised and sent back to their parents. Women are the worst victims but males have their share of the societal neglect and ill treatment. Abul Kalam (30) in Santa village in Jessore whose hands and feet got cracked with sores was shunned even by his own family, denied job by all agencies and has been leading a miserable life. People with no knowledge about the scourge think that it might be a contagious disease like leprosy. In the context of the havoc it has started playing out, there is need for intensifying the government and non-government measures to fight this scourge that experts think has no equal in medical history. Our experience in rural Bangladesh lifestyle and health consciousness suggests that arsenic poisoning often takes months or years to become lethal or debilitating. Early diagnosis often helps relieving mild symptoms by drinking clean and uncontaminated water. But continued exposure to contaminated water can be fatal. Progress so far achieved limits governmental activities to identifying arsenic affected areas in the country and testing the tube-well water locally in the districts. But supplying people with arsenic free water is yet to be geared up in reality.

Now the urgent need is to provide households available options when a sample tests positive for arsenic contamination and help him buy the most suitable option available in the market. The first option is left to the government agencies, NGOs and contractors who must be prepared to resink existing tube-wells into deeper arsenic-free layers



Activated alumina based household arsenic removal unit

of the aquifers. Alternatively, the best device would be to go for low-cost household oriented decontamination appliances comprising filters, distillers or coagulators.

There is hardly any second thought now that the treatment of arsenic contaminated tube-well water is one important option in the acute arsenic affected areas in Bangladesh. Coagulation process available in the market is sometimes unable to efficiently remove arsenic to very low levels. As a result various alternate technologies have been developed or adopted that are capable of removing arsenic to trace levels. These options include ion exchange, activated alumina and membrane methods such as reverse osmosis and nano-filtration. But some of these methods are time-consuming and not suitable for a single household. It should be emphasised that due to widespread poverty among the affected people in rural Bangladesh, arsenic removal from ground water must be accomplished at very low cost, using materials that are either widely available or capable of being produced with only minor modification to existing techniques. At the same time, in a bid to minimise wasting of time materials that can be made using few resources other than human labour with scopes for sharing of duties by several families must be favoured. One such design proposed for Bangladesh by Phillip Thomas Crisp and Ahmedul Hye Chowdhury in the School of Chemical Engineering and Industrial Chemistry in the University of New South Wales, Sydney, Australia that allows 750 litre of water to be treated in one day is worth looking into. The device incorporates air/light oxidation process through selection of sediment trap, and a bed of adsorbent

chemicals in a brick tank placed next to a tube well. The method looks attractive and promising since most of the materials needed can be procured at low cost or no cost at all. The chemicals chosen for the construction of adsorbent bed are:

- \* Charcoal from heating coconut or rice husks in an oven in absence of air,
- \* Ash from combustion of coconut or rice husks in air,
- \* Magnesium salts from the brine after the recovery of salt from sea water, and
- \* Rust from clean scrap iron placed in water and exposed to air

Charcoal, well known to all, is an excellent adsorbent for organic compounds and may weakly adsorb arsenic species. Dr. M. Ashraf Ali, Dr. ABM Badruzzaman, Dr. M.A. Jalil and others of the BUET Civil Engineering Department has developed an arsenic removal method that looks promising. One of the systems is based on ferric chloride coagulation while the other on sorptive filtration through iron-coated sand bath like indigenous process involving very low cost. Field testing of the units done in the village of Adda and Barura thana of Comilla district has shown encouraging results and has been evaluated to be one of the most effective arsenic removal technologies, now being assessed by a third party at the behest of Bangladesh Arsenic Mitigation Water Supply Project. But the achievement of success, the benefit of research must reach the end-users.

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ENVIRONMENT WATCH

OECD agrees on an environment strategy

Washington under fire again for rejecting Kyoto protocol

AFP, Paris

A 30-member club of rich countries on Wednesday agreed a 10-year strategy to tackle their worst environment problems. However, fresh bickering over the Kyoto Protocol, the global-warming treaty rejected by Washington, marred the deal.

Ministers from the Organisation for Economic Co-operation and Development (OECD) declared they would achieve the goals by harnessing market forces and phasing out, by 2010, tax breaks and subsidies to agriculture and energy that damage the environment. Over-fishing, land degradation by chemicals, tropical deforestation, damaged bio-diversity as well as water and air pollution are among the so-called "red-light" issues deemed a priority for national action.

The aims are not legally binding, but progress towards them will be monitored by a new system of environment indicators.

They are enshrined in a document, "OECD Environmental Strategy for the First Decade of the 21st Century," adopted by environment ministers on the first day of talks that, on Thursday, will include OECD economy and finance counterparts.

The charter was hailed as another sign that environment, long the poor cousin of international affairs, was encroaching into the home of its big relatives, politics and economics.

But climate change, the most urgent problem of all, proved unsurprisingly to be a minefield.

A row triggered by President George W. Bush's rejection of the Kyoto Protocol, a treaty that seeks to head off global warming caused by burning fossil fuels, erupted once more.

"Several ministers," led by the current EU president, Sweden, kicked off the meeting with criticism of the Bush decision, and positive references to Kyoto in the strategy paper were deleted or watered down at US insistence, said Rob Visser of the OECD's environment directorate.

The final version simply said "a large majority" of OECD countries would seek to implement Kyoto by 2002, "with timely ratification processes and with the broadest possible support of the international community."

French Environment Minister Dominique Voynet said she was "reassured" that "an overwhelming majority" had reaffirmed their support for Kyoto, but environment groups savaged the subdued text as a US attempt at sabotage.

Talks aimed at completing Kyoto - it is a framework treaty, signed in 1997 but unratified, whose notoriously complex rulebook has yet to be agreed - are scheduled to take place in Bonn in July.

The treaty, if implemented, would require industrialised signatories to cut emissions of "greenhouse" gases blamed for a steady but potentially catastrophic warming of the Earth's atmosphere.

These gases are mainly the result of burning carbon-based fuels like oil, gas and coal. The US accounts by itself for around a quarter of the global gas emissions and would have had to make stringent, costly cuts, of around 30 per cent, to meet the 2010 target.

The Bush administration gave notice in March that it would not submit the treaty to the Senate for US ratification.

It argued that Kyoto was fundamentally flawed, as it does not require fast-growing developing countries such as China and India to make emission cuts and that it was unfair for the US economy.

Slaughter at Santana do Livramento

Foot-and-mouth disease sweeps across southern Brazil



PHOTO: AFP

Government agricultural employees of the province of Rio Grande round up cattle infected with foot-and-mouth disease for slaughter in Santana do Livramento, Brazil on Wednesday. The European Union has suspended import of Brazilian meat from due to the epidemic.

Satan Bug within reach

Pall of biowarfare looms large

AFP, Paris

Genetic engineers already have it within their grasp to devise a lethal bio-weapon for terrorists and rogue states, the British science publication *Nature* warns this week.

Small changes in the DNA of well-known bacteria and viruses could turn these agents into mass killers, the prestigious journal says in an article to appear in Thursday's issue.

"Making subtle genetic alterations to existing pathogens to increase their virulence or durability in the environment, or to make them harder to detect or to treat with drugs, is within the limits of today's technology," *Nature* says.

"With the decoding of a pathogen's entire genome now commonplace, and transgenic techniques advancing all the time, some researchers believe that the sinister potential of biology can no longer be ignored."

Biowarfare - use of germs or viruses such as anthrax or smallpox - has long been a scenario considered by military strategists.

However, the risk has increased thanks to advances in knowledge about how genes work; new techniques for moving pieces of DNA around; and the relative ease, compared with the past, with which a rogue organisation could build or hire a lab to build such a weapon.

Scientists interviewed by *Nature* ruled out, for the time being, the ability to build new, artificial agents from a set of component parts.

A far simpler way would be to tweak the performance of an existing bacteria to make it more resistant to antibiotics, they said.

The genetic sequences of bacteria such as tuberculosis, cholera, leprosy and the plague are already in the public domain - as is that of a food poisoning bug, *Staphylococcus aureus*, that is already becoming resistant to antibiotics.

By identifying the genes from *Staphylococcus aureus* that make the bug resistant, and inserting them into other bacteria, a scientist could make a killer for which there would be scant defence.

A scientist in the US, Willem Stemmer, chief scientist with Maxygen, a California pharmaceutical research firm, used one of these techniques to explore how resistance genes work, *Nature* reports.

He created a strain of the common intestinal bug *Escherichia coli* that was 32,000 times more resistant to the antibiotic cefotaxime than conventional strains. Stemmer destroyed the superbug in response to concerns from the American Society for Microbiology about potential misuse.

In a case published in January, a pair of Australian scientists, Ron Jackson and Ian Ramshaw accidentally created an astonishingly virulent strain of mousepox, a cousin of smallpox, among laboratory mice.

The scientists realised that if similar genetic manipulation was carried out on smallpox, an unstoppable killer could be unleashed. They decided to publish their findings to draw attention to the potential misuse of biotechnology.

"It's time for biologists to begin asking what means we have to keep the technology from being used in subverted ways," said Harvard University molecular biologist Matthew Meselson, who has repeatedly spoken out on the dangers of biowarfare.

Climate change of death

European migratory birds may be in decline, Dutch scientists say

AFP, Paris

Species of European migratory birds may be in decline because of global warming, which is disturbing their traditional breeding patterns, Dutch zoologists say.

Christiaan Both of Groningen University and Marcel Visser of the Netherlands Institute of Ecology looked at the pied flycatcher, which overwinters in western Africa but returns to north-western Europe in the spring-time, from mid-April to mid-May, and then builds a nest and breeds.

They found that the average air temperature at a breeding site in Hoge Veluwe, in the central Netherlands, had risen by about three degrees C (5.4 F) over the past two decades.

In response to this, the birds were laying their eggs at an earlier date - up to 10 days sooner than 20 years earlier.

However, the birds had not altered the date of their arrival from Africa. They were still returning at Hoge Veluwe at around the same time, the third week of April.

This has big implications for the species' survival, say Both and Visser.

The warmer weather is causing the local insect population to breed sooner, but the migrant birds are arriving after this vital source of food has peaked.

Medicinal plants under threat as fences fall

Western demand for "alternative medicine" is driving the uncontrolled collection of wild herbs in Central and East Europe. The threat to increasingly rare species is made sharper by ignorance about plants on the part of some of the new army of pickers. Sarah Roe of Gemini News



PEOPLE armed with large plastic bags and peering intently at the ground are becoming an increasingly common sight in the wild, mountainous regions and thick forests of Bulgaria's national parks. They are part of a growing band of illicit medicinal herb gatherers in Central and East Europe.

The uncontrolled trade is fuelled by demand for "alternative medicine" in Western Europe - and its growth is threatening some of the species on which it depends.

In the last decade, consumption of herbal medicine has doubled in Western Europe: there are an estimated 15 million users in Britain alone. Much of the supply comes from Bulgaria, Poland, Hungary and the territories of former Yugoslavia, and up to 90 per cent stems from unsustainable gathering in the wild.

As a result, conservationists believe that more than 150 medicinal plants in the region are at risk. Several species, such as Pheasant's Eye (*Adonis vernalis*), are close to extinction.

Gathering these plants in national parks should be strictly regulated, but the replacement of communism by a free-market system has been accompanied by a lack of effective controls.

"Nowadays it is just like a garden without any fence. Anyone can come in," sighs Mira Mileva, bio-diversity project manager at the Regional Environmental Centre in Szentendre, Hungary.

During communist rule, wild herb collection was organised by the State, which bought the plants through a central company. Most sales were to the domestic market. Today, hundreds of companies are competing for a slice of the profits.

The domestic market for herbs has shrunk dramatically while official statistics indicate a significant rise in overseas sales. Bulgarian exports, for example, more than doubled from 6,440 tonnes in 1992 to 15,446 tonnes in 1998.

Ironically, many of the Western consumers see themselves as nature-lovers and are ignorant of the environmental devastation they are helping to cause.

"We found that there is virtually no awareness amongst customers about where the herbs are coming from," says Wolfgang Fremuth, director of the Germany-based conversation organisation, European Nature Heritage Fund, which has investigated the trade in Germany - one of Europe's top five importers.

Conventional medicine is also playing its part. Around one in four of all prescription drugs dispensed by Western pharmacists are said to contain ingredients derived from plants, many sourced from natural habitats in East and Central Europe. The search is on for more.

There was an "almost crazy campaign of hypericum collection" because of its association with Viagra [a drug prescribed for impotence], recalls Petko Tsvetkov of the Balkan Wildlife Protection Society. "The drive damaged the natural locations of the species. Uneducated gatherers pulled up the plants by the roots, preventing regeneration."

In many areas of high unemployment, wild herb gathering provides an important source of income for local people. In one region of Albania, earnings from plant collection were found to contribute to the income of almost every rural household. The situation is similar in villages in the mountainous border regions of Bulgaria and Macedonia and in parts of rural Poland and Romania.

The business has also attracted people who became unemployed after the change to the free-market system. They know little or nothing about the plants they are picking and have no regard for sustainability.

Some environmentalists advocate educating gatherers about the importance of allowing regeneration of herbs. Others suggest encouraging importers to invest more in affected areas, to ensure they have a more lasting commitment to maintaining supplies.

Cultivation is also an option. In Hungary, only 30 to 50 per cent of herbs are collected in the wild and the remaining farmed crops give important seasonal employment. The country's camomile harvest provides some 15,000-20,000 people with work each year.

A number of companies are already involved in the search for sustainable options. In Britain, Planet Herbs, which claims to be the country's largest supplier to medical herbalists, is working with environmentalist David Bellamy's Conservation Foundation to encourage herbal retailers and their customers to give donations to help promote sustainable use of herbs.

Money raised in this way has been used to support a women's herb-growing co-operative in Bosnia.

"The aim is to tie up a source of quality herbs sustainably," explains James Fearnley, director of Planet Herbs.

The Swiss health products firm Weleda is also involved in various projects throughout the region.

Such efforts remain the exception rather than the rule. "As part of our investigation we tried to find Western companies who are interested [in investing in sustainable development of herbs] but we found none," notes Fremuth.

Most Central and East European countries are beginning to prepare strategies in accordance with the International Convention on Bio-diversity, but progress is painfully slow. Efforts to write mandatory training of gatherers into Bulgaria's Medicinal Plants Act proved unsuccessful. In Albania, control of herbal plants is still the responsibility of the Forestry Commission, which is unable to prevent the widespread practice of illegal logging never mind the more subtle trade in herbs.

Without more determined efforts and more funds from governments and companies, Central and East European herbal remedies are likely to continue their slow decline as they find their way to the health shops of the West.

Sarah Roe is a freelance journalist specialising in environmental issues, who after five years in East Europe is now based in Edinburgh, UK.