Drinking water quality in the South-East Asia Region
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Introduction

Water in adequate quantity and safe quality is essential for human survival. Rapid population growth and economic development puts tremendous pressure on limited freshwater resources. In addition, the availability and safety of water resources is threatened by climate change.

Quality of drinking water is a universal health concern as water is a medium for disease transmission in all countries. There are several significant water quality problems that affect countries in the South-East Asia Region. Of these, contamination of drinking-water sources by pathogenic (disease-causing) microorganisms remains the most important. Some countries in the South-East Asia (SEA) Region are faced with chemical contaminants such as arsenic and flouride in groundwater, as well as contamination from industries and agriculture.

Water is the basis for life on earth. Although more than 70% of our planet is covered with water, a mere 2.5% is fresh water. About two thirds of this fresh water is in the form of glaciers and permanent snow cover. Less than 1% of the freshwater reserves on earth are accessible for direct human use in the form of lakes, rivers, reservoirs and shallow groundwater. It is only this minute amount that is renewed by rain and snowfall and is available on a sustainable basis.
**Microbiological contamination**

The most common and widespread health risk associated with drinking water is contamination, either directly or indirectly, by human or animal excreta and the microorganisms contained in faeces. Contamination of drinking water sources by pathogenic microorganisms and water stored within the home are the most important issues in this area. Contaminated water can cause disease outbreaks including cholera, dysentery, hepatitis (for example in Sri Lanka in 2009) and cryptosporidiosis. Pathogenic organisms include bacterial pathogens, viral pathogens, protozoans, helminths and toxic cyanobacteria.

The periodic outbreak of water-borne infectious diseases in the Region remains a problem in most countries. Therefore, the control of water-related infectious diseases is one of the most significant public health issues.

**Sources of microbiological contamination include:**

The main sources of microbiological contamination are from human and animal waste through various points such as defecation at water sources, cross contamination from sewer lines, sewage disposal without any treatment, seepage from septic tanks and pit latrines and improper handling and storage of water at the home.

- Open defecation is practiced where there is no access to a sanitary facility. More than 300 million people still defecate in the open in the South-East Asia Region. The excreta eventually contaminate surface water and groundwater. There are cases of many “hanging” latrines, where latrine superstructures are constructed but the pit or the septic tank (e.g. Maldives) is discharging directly (without any treatment) into water sources or aquifers. The Jajarkot diarrheal outbreak of 2009 in Nepal was a case of contamination through open defecation (absence and non-use of latrines), eventually spreading the disease through water sources (in the rainy season).
Many of the sewage treatment plants are either too old or are not adequate to handle the huge amount of sewage generated by rapid population growth. In such cases, sewage is collected from the cities and dumped directly into rivers, ponds and lakes.

In urban areas, many of the water supply pipes and sewerage lines are laid in the same place. Leaking sewage can enter broken water pipes especially where water supply systems are intermittent.

Water delivered from a piped water system or point sources (tube wells, handpumps, protected spring) may not be microbiologically safe if various operation and maintenance requirements are not in place. In addition, households that do not have access to a regular water supply or where people do not have in-house connections may have to store water in containers at home. If not handled properly, stored water will get re-contaminated at the household level during collection, storage and use. Unhygienic handling of water during transport or within the home can contaminate previously safe water.

Contamination can occur in storage tanks in buildings due to poor maintenance and cleaning. Overhead tanks in buildings, if not covered properly and not cleaned regularly, may be susceptible to water re-contamination during storage.

Water quality assessments carried out in some major cities in India in 2004 showed microbiological contamination at various water points. The assessment in Kolkata is summarized in the following table.
Water quality (bacterial contamination) status of Kolkata city water

<table>
<thead>
<tr>
<th>Samples collected (Nos)</th>
<th>Samples bacteriologically contaminated (Nos. &amp; %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep tubewells (privately owned)</td>
<td>Deep tube wells</td>
</tr>
<tr>
<td>40</td>
<td>11</td>
</tr>
<tr>
<td>600</td>
<td>(27.5%)</td>
</tr>
<tr>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>11</td>
<td>382</td>
</tr>
<tr>
<td>(27.5%)</td>
<td>(63.66%)</td>
</tr>
<tr>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

- Contamination at the source can occur, especially during monsoon. Human and animal excreta is washed into the source by rains. This happens when proper drainage and source protection is not provided.

**Chemical contamination**

In addition to microbiological contamination, chemicals in drinking water are a growing issue in many countries in the Region. Naturally occurring chemicals such as arsenic and fluoride in groundwater have been identified as a problem in six Member States, and various mitigation measures are in progress. Contamination of water bodies by industrial wastewater and agricultural run-off is one of the major issues threatening public health. Lack of data and surveillance and weak regulation are some of the issues that need to be addressed in preventing these man-made problems.

(a) **Arsenic contamination**

The extent of arsenic contamination in the Region is now better understood and it is clear that many countries in the Region are identifying arsenic presence in shallow groundwaters. Arsenic is a toxic element. Chronic exposure to arsenic-contaminated drinking water over the years starts manifesting itself in a condition known as arsenicosis. The initial symptoms of arsenic toxicity are skin manifestations (hyperpigmentation, depigmentation, keratosis etc.). However, various non-cancer manifestations, skin cancer, and cancer of internal organs can occur many years later.

The World Health Organization guideline value for arsenic content in drinking water is 0.01 mg/litre.
Bangladesh

Arsenic contamination affects approximately 30% of engineered groundwater supplies in Bangladesh. The most recent survey\(^1\) data indicate that approximately 20 million people are exposed to arsenic in drinking water that exceeds the Bangladesh standard of 0.05 mg/litre. However, if the WHO guideline value of 0.01 mg/litre is applied, then the exposed population is around 36 million people. The number of patients diagnosed with arsenicosis\(^2\) is estimated at 38 430, but it should be noted that this figure is considered to represent the “tip of the iceberg” of many health impacts, including cancers and lung and heart diseases.

India

In West Bengal, 8 of 17 districts are exposed to arsenic contamination in groundwater and it is also suspected in Bihar as well as in the Gangetic and Brahmaputra plains.

It is estimated that over five million people are exposed to arsenic in drinking water and about 300 000 people are suffering from various stages of arsenicosis.

Myanmar

Arsenic has been detected in some tubewells in the delta region. Active case detection of arsenicosis survey conducted in the Ayeyarwady Division (132 villages from five townships) and Bago Division (24 villages in five townships) with a total population of 21 543. Only two probable cases of arsenicosis were detected.

Nepal

Arsenic is mainly detected in groundwater in the southern flat land called terai. About 47% (11 million) of the total population live in the terai region and about 90% use groundwater for drinking and irrigation purposes.

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1 MICS, 2009
2 The WHO case definition of based on the WHO case definition of arsenicosis is based on (a) the presence of pigmentary and keratotic skin lesions, and (b) evidence of exposure to elevated levels of arsenic.
About 1.1 million tubewells are in use in the terai. As of June 2008, the blanket testing of tubewells in all 20 terai districts was completed, which showed that about 1.77% exceeded the national standard of 0.05mg/L and 5.62% exceeded the WHO guideline value.

In a health survey conducted in selected communities in six districts covering around 20 000 households, 590 persons were identified with arsenicosis symptoms among the population using drinking water with more than 0.05mg/L arsenic content.

**Thailand**

The southern part of Thailand faces the problem of arsenic contamination in groundwater. Arsenicosis was first reported in 1987 from Ronpibool district, Nakornsrithammarat in southern Thailand. To date more than 1000 cases have been identified. Till 2007, 20 cases of arsenicosis with cancer (skin, bladder, lung) were detected. About 10 of these proved fatal. In 2000, the prevalence of arsenicosis was 24.7%, with an estimated 7082 cases. Approximately 28 673 people from 16 villages had been exposed to arsenic-contaminated water.

**Fluoride contamination**

Fluoride is also a recognized problem in the Region, in particular within India, in some areas of Indonesia, Myanmar, Sri Lanka and northern Thailand. In India 17 states have been identified with the problem of excess fluoride in groundwater sources. Rajasthan and Andhra Pradesh are most severely affected. Fluoride pollution is mainly due to natural sources.

Fluorosis is caused by ingestion of excess fluoride over a long period. It affects multiple tissues, organs and body systems and results in clinical manifestations. Fluoride can enter the body through drinking water, food, drugs, dental products and industrial emissions.

The World Health Organization has set 1.5 mg/litre as the guideline value for fluoride content in drinking water.

**Nitrate contamination**

Natural nitrate levels in groundwater are generally very low, but nitrate concentrations grow due to human activities, such as agriculture/ fertilizers
(manure and slurries), industry, domestic/municipal effluents (sludge spreading and emissions from combustion engines.

The primary health concern regarding nitrate is the formation of methaemoglobinaemia, so-called “blue-baby syndrome”. Nitrate is reduced to nitrite in the stomach of infants, and nitrite is able to oxidize haemoglobin (Hb) to methaemoglobin (metHb), which is unable to transport oxygen in the body.

Testing is the only way to detect nitrate because it is tasteless, odorless and colorless. The World Health Organization has set 50 mg/litre as the guideline value for nitrate content in drinking water. (Nitrite: 3mg/litre [short-term exposure], 0.2 mg/litre [long-term exposure]).

(d) Iron contamination
Iron, while not harmful to the human body except in very high concentrations, clogs up well installations, pumps, pipes and storage tanks, discolours laundry (at levels above 0.3 mg/litre) and gives a distinct taste to water (above 0.3 mg/litre). Removing iron from water requires a set of treatment processes and thus is relatively expensive. Small iron removal plants have been set up in rural areas of Bangladesh, India and Sri Lanka.

(e) Manganese
Manganese is a mineral that naturally occurs in rocks and soil and is a normal constituent of the human diet. It exists in well water as a naturally occurring groundwater mineral, but may also be present due to underground pollution sources. Manganese may become noticeable in tap water at concentrations greater than 0.05 mg/l by imparting a color, odour, or taste to the water. It is recognized as a health concern when concentrations are approximately 10 times higher. It is a problem in groundwater in Bangladesh.

(f) Heavy metal contamination
Another emerging water quality problem is contamination of water bodies with heavy metals such as chromium, lead and cadmium, which are released through untreated industrial wastewater, agricultural runoffs and mining operations.
Some of these compounds may have chronic health effects and are at times difficult to remove from drinking water.

**Sources of chemical contamination include:**

The main source of chemicals in drinking water are either naturally occurring chemicals in soil or man-made ones from industries and agricultural activities. The details of some of the major sources are given below:

- The main source of arsenic in Sout-East Asia is naturally occurring in groundwater. Although arsenic occurs in alluvial sediments, the ultimate origin of arsenic is thought to be in outcrops of hard rocks higher up the Himalayas. Arsenic does not occur at all depths in the alluvial sediments. In a few countries the sources are anthropogenic sources (created by human intervention), mainly mining or petroleum extraction. Arsenic in coal can be released into groundwater and surface water through natural weathering processes, in glacio-fluvial deposits with underlying arsenic-rich coal-bearing deposits below the aquifers, or in mining wastes and mines. All arsenic-containing minerals, especially sulfides, which are frequently associated with gold ores, are a source of arsenic. Mining and smelting of these minerals create environmental hazards of arsenic leaching into groundwater and surface waters from slag pits, waste dumps, extraction basins and derelict mines.

- Intensification of food production to meet the ever-increasing demand has led to increased use of fertilizers and pesticides in agriculture. Pesticides, herbicides and other chemicals are used for the control of insects, weeds and fungal pathogens. The runoff from agricultural fields causes water pollution to nearby rivers, streams and lakes. The seepage of fertilizers and pesticides causes groundwater pollution, which is commonly known as leaching. Although the quantity of agricultural waste is low, the effects are highly significant. It causes nutrient and organic pollution to both water and soil. Nutrient pollution causes an increase in the nitrates and phosphates in the water bodies, which leads to eutrophication.
Another emerging source of surface and groundwater contamination is from manufacturing and processing industries, where untreated or partially treated industrial waste is released into water bodies. Industrial effluents contain organic pollutants and other toxic chemicals. Some of these pollutants are lead, mercury, asbestos, nitrates, phosphates and oils. In some countries, including Bangladesh, one of the main sources of chromium and cadmium contamination is the wastewater discharged from the leather processing industry.

Extractive industries include mining of mineral deposits (principally metal-bearing ores and coal deposits), oil and natural gas production, and quarrying for building and road-making materials. Poorly operated or abandoned mine sites are often significant sources of water contamination; contaminants of particular health concern from these sources include heavy metals and mineral-processing chemicals, such as cyanide. For example, zinc mining operations at Mae Sot on the Thai-Myanmar border have caused serious cadmium contamination of soil and water in the area, leading to elevated cadmium levels among humans and destruction of the rice crops.

Leachate from landfill sites is another source of water pollution. Solid waste from homes, offices, hospitals and commercial areas are all collected and disposed into landfill sites. These consist of biodegradable wastes as well as chemicals, and hazardous and toxic elements. Leachate from improperly managed landfill sites seeps into groundwater.
A study was carried out to understand the quality of groundwater around a municipal solid waste disposal site in Chennai, India. Chemical analyses were carried out on water samples collected at various radial distances from the boundary of the dumping yard, at intervals of three months and for a period of three years. The study has revealed that the groundwater quality does not conform to the drinking water quality standards as per Bureau of Indian Standards. The effects of dumping activity on groundwater appeared most clearly as high concentrations of total dissolved solids, electrical conductivity, total hardness, chlorides, chemical oxygen demand, nitrates and sulphates. Leachate collected from the site showed the presence of heavy metals.

Chemicals from water treatment and distribution reach drinking water by the most direct route. They fall into three broad categories:

- substances resulting from the addition of chemicals used in the treatment process for coagulation and disinfection—these chemicals are intentionally added and can give rise to residues or byproducts;
- disinfectants that are deliberately added with the intention of maintaining a residue in distribution, usually to the tap—these chemicals may also give rise to byproducts;
- substances that leach from materials used in distribution or plumbing, or that arise from the corrosion of pipes.

**Common water- and sanitation-related diseases**

**Ascariasis**

Ascariasis is an infection of the small intestine caused by *Ascaris lumbricoides*, a large roundworm. The eggs of the worm are found in soil contaminated by human faeces or in uncooked food contaminated by soil containing eggs of the worm. Children are infected more often than adults, the most common age group being 3-8 years. The infection is likely to be more serious if nutrition is poor. They often become infected after putting their hands in their mouths after playing in contaminated soil. Eating uncooked food grown in contaminated soil or irrigated with inadequately treated waste water is another frequent avenue of infection.
**Arsenicosis**

Drinking water rich in arsenic over a long period leads to arsenic poisoning or arsenicosis. Many water sources contain some arsenic, and excessive concentrations are known to naturally occur in some areas. Arsenicosis is the effect of arsenic poisoning, usually over a long period such as from 5 to 20 years. Drinking arsenic-rich water over a long period results in various health effects including skin problems (such as colour changes on the skin, and hard patches on the palms and soles of the feet), skin cancer, cancers of the bladder, kidney and lung, and diseases of the blood vessels of the legs and feet, and possibly also diabetes, high blood pressure and reproductive disorders.

Absorption of arsenic through the skin is minimal and thus hand-washing, bathing, laundry, etc. with water containing arsenic do not pose health risks to humans.

**Cholera**

Cholera outbreaks can occur sporadically in any part of the world where water supply, sanitation, food safety and hygiene practices are inadequate. Overcrowded communities with poor sanitation and unsafe drinking-water supplies are most frequently affected. If untreated, 50% of people with severe cholera will die, but prompt and adequate treatment reduces this to less than 1% of cases.

**Dengue and dengue haemorrhagic fever**

Dengue is a mosquito-borne infection which in recent years has become a major international public health concern. Dengue is transmitted by mosquitoes that breed in clean and stagnant water in and around homes, for example in water tanks, flower pots and small containers that are discarded. Proper disposal of solid waste helps to reduce the collection of water in discarded articles. Dengue, malaria, and chikunguniya are all important for overall vector control and water resources management and drainage.
Diarrhoea

Generally safe water plays an important role in preventing outbreaks of diarrhoeal diseases. Nearly 4 billion cases of diarrhoea occur annually, causing 1.8 million deaths, mostly among children under five years of age. Of the total cases of diarrhoea, of which 88% are attributable to unsafe water, inadequate sanitation and hygiene, it is estimated that 94% were preventable through modifications to the environment, including interventions to increase the availability of safe water, as well as improved sanitation and good hygiene practices.

Diarrhoea occurs worldwide and causes 4% of all deaths. It is most commonly caused by gastrointestinal infections, which kill around 2.2 million people globally each year, mostly children in developing countries. Microbiological contamination in drinking water is an important cause of diarrhoea.

Fluorosis

Ingestion of excess fluoride, most commonly in drinking water, can cause fluorosis, which affects the teeth and bones. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems. The control of drinking-water quality is therefore critical in preventing fluorosis.

Hepatitis

Hepatitis, a broad term for inflammation of the liver, has a number of infectious and non-infectious causes. Among the infectious causes, hepatitis A and hepatitis E are associated with inadequate water supplies and poor sanitation and hygiene, leading to infection.

Malaria

Malaria, a parasitic infectious disease, is transmitted by mosquitoes which breed in fresh or occasionally brackish water.

Methaemoglobinemia

Methaemoglobinemia is characterized by the decreased ability of blood to carry vital oxygen around the body. One of the most common causes is nitrates
in drinking water. It is most significant in bottle-fed infants, and water from wells in rural areas is of special concern. Controlling nitrate levels in drinking water sources to below around 50mg/litre is an effective preventive measure.

**Scabies**

Scabies is a contagious skin infection that spreads rapidly in crowded conditions and is found worldwide. Personal hygiene is an important preventive measure and access to adequate water supply is a key factor in controlling it.

**Typhoid and paratyphoid enteric fevers**

Typhoid and paratyphoid fevers are infections caused by bacteria that are transmitted from faeces through ingestion. Contaminated water is one of the pathways of transmission of the disease. Use of safe drinking water, improved sanitation and good hygiene practices prevent the spread of typhoid and paratyphoid.

**Some measures to prevent contamination of water resources**

**Sanitation and proper treatment of sewage before disposal**

In the South-East Asia Region, only about 60% of the population has access to an improved sanitary facility and more than 300 million are still defecating in the open. Therefore, providing improved sanitary facilities to everyone and ensuring that all the wastewater is properly treated before disposal into water bodies will prevent water contamination.

**Treatment of industrial waste water**

With economic development, a lot of small and large-scale industries are being established in the Member States. The wastewater produced from these industries is very toxic and therefore it’s very important to treat the wastewater before releasing it into water bodies. Effective legislation should be in place, implemented and monitored by relevant agencies.
Fertilizer and pesticide use in agriculture

Agricultural runoff which contains nutrients such as nitorgen and phosphorus (from commercial fertilizers, animal manure, domestic waste etc) pollutes water bodies. Governments should promote the use of nutrient management plans to reduce excess application of nutrients. To minimize pesticide impacts, governments should promote the use of integrated vector and pest management (IVPM) techniques (which includes biological pest control), which will also reduce reliance on chemical pesticides and protect water quality.

Solid waste management

Proper management of landfill sites, especially in cities, helps prevent groundwater contamination.

Some measures to prevent contamination of drinking water supply systems

Water safety plans

The water safety plan concept embedded in the WHO drinking water quality guidelines advocates a proactive effort to prevent water contamination in drinking water systems to reduce health risks. Emphasis has shifted to promoting a holistic framework for safe drinking water, which encompasses flexible and locally relevant health-based targets, a system of integrated risk assessment and incremental risk management in the chain of events from catchment to tap, and independent monitoring and surveillance.

A small community leader shows the way

Mr. Fazlul Haque Mollah is a caretaker of a water point at IG gate slum, Dhaka. He is 45 years old and plies a rickshaw to earn his livelihood. When he started to live in this slum about 15 years ago there was no safe water source or hygienic latrine.

A local NGO, Population Service and Training Centre (PSTC), installed three water points to improve the situation. They formed a users’ committee to manage the water points. Mr Mollah was selected as
the caretaker of one of the water points. While the water situation improved, the sanitation facilities continued to remain very poor. The drainage channels were filled with wastewater all the time, and the meter pits and the surroundings of the water points were inundated with wastewater. Very often the tap water had a foul smell. The hygiene behaviour and water handling practice was also not good, and the incidence of diarrhoeal disease was very high. However, the community did not understand why there was a high prevalence of diarrhoeal disease, given the fact that they were drinking safe water.

PSTC took the initiative to implement a water safety plan to improve the situation. The NGO staff mobilized the community and organized training on WSP for the caretakers. They discussed the concept of safe water, how it they can become unsafe, what are the results of drinking unsafe water and how to keep water safe. Mr Mollah was overwhelmed by the WSP initiative. He said, “Now I can understand why we are still suffering with water-borne diseases. Actually, though water is safe in the water points it is being contaminated by spilled waste water and due to unhygienic handling of water”.

Mr Mollah decided to do something for the people. He took the initiative with Dhaka City Corporation (DCC) to get the drains cleaned. He raised some funds and increased the height of the tubewell platform and meter pit. Now, the platform and meter pit are not under water. Mr Mollah monitors, standing beside the water points, the way the users collect water and transport it. He advises them to store the water in a clean and covered container and to use a separate, clean pot to take water from the storage container. A few months after the WSP intervention, the scenario had changed positively. The surroundings have become clean, there is no water logging, no litter and no bad smell. The people keep the water points and drainage channels clean and functional. WSP interventions changed many things, including
people’s behaviour towards water handling. The incidence of water-borne diseases has been reduced considerably.

Thus, Mr Mollah involved himself in many other constructive tasks. The people elected him the secretary of the community council. He is still leading the water safety plan in the community and is protecting the community’s health.

Household water treatment and safe storage

In places where safety of water is not certain, it can be made safe by treating it at home. The technologies available include boiling, filtering, solar disinfection of water (SODIS), use of bleaching powder, chlorine tablets etc.

Water treatment also needs to be accompanied by safe storage. This can be accomplished by using containers with secure covers and a dispensing device such as a tap or spigot to protect collected water against recontamination. These measures are particularly important because the microbial quality of drinking water frequently declines after collection.

A high percentage of people could therefore benefit from effective household water treatment and safe storage practices. Such household-level interventions can be very effective in preventing disease if they are used correctly and consistently.

Improved operation and maintenance of water supply systems

Water loss and water contamination occur in piped water systems as well as other point sources if the system is not well maintained. The water treatment plants should be operated as per standard operating procedures. The operation and maintenance would be improved with the use of water safety plans through risk assessment and management.
Ar鬓ic and flouride mitigation

Groundwater sources that are contaminated with arsenic (above the national standard value) should not be used for drinking. Alternative water sources such as surface water or rainwater have to be sought. The West Bengal Government, India has provided arsenic-free potable drinking water by various short-, medium- and long-term measures. Over the years it has reached a consensus that surface water–based water supply schemes are the only long-term solution. To this effect, the state government has already implemented three large surface water–based piped water supply schemes in the districts of Malda, South 24 Paraganas and North Paraganas, which aims to cover nearly one-third of the population at risk. The government has also implemented other short-term and medium-term measures such as provision of tubewells at deeper aquifers and arsenic treatment units with existing hand pumps.

In Nepal, the arsenic situation has been managed to a large extent and DWSS with partners like UNICEF, the Finnish government, UN HABITAT, WHO and others, have been working to control the problem over the last few years. Contaminated tubewells have been marked, test certificates provided and the people made aware of the problem. Different kinds of household-level arsenic filters have been distributed to more than 60% of families in the affected areas. Research, surveillance and provision of permanent mitigation measures, however, are still needed.

Similar interventions are applied for drinking water contaminated with flouride. Provision of treated surface water or rainwater harvesting is considered a long-term measure. For the short-term, there are indigenously developed simple procedures for removal of flouride, such as activated alumina defluoridation filters and Nalgonda domestic defluoridation technology.
References


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