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Good Evidences, Bad Linkages: A Review of Water and Health in South Asia

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Abstract: This review paper investigates the status of water and health in South Asia. Millions of people in South Asia lack access to safe water and sanitation. Increasing population, rapid urbanization, unsustainable agricultural and industrial developments have degraded freshwater resources. Although countries seem to have worked on the Millennium Development Goals to create infrastructure concerning water supply and sanitation, it is still questionable whether these measures have led to increased access to adequate safe water and proper sanitation at all. The preventable water-associated diseases contribute to the top ten causes of death in the region. Mortality due to these diseases has decreased in the past 10 years, but morbidity is on rise. Diarrhoea remains a primary cause for majority of deaths. Besides infectious diseases, chemical contamination of surface and ground water also create a great threat. The arsenic and fluoride contamination are emerging public health challenges. Although, countries have progressed in controlling water-associated diseases but achievements have been limited. The relationship between water and health is not linear, and is governed by various interlinked socioeconomic, political and cultural factors. This paper also discusses major complexities and challenges faced in the sector. The literature provides 'good' enough 'evidences' of lack of safe water leading to heavy burden of water associated diseases in South Asia. The existing governance system aims to provide good health, but fails to appreciate and address its link with safe water and sanitation. The paper recommends a more integrated and demand driven approach to conquer water-related health hazards.

Key words: Water and health, water and sanitation, pollution, water-associated diseases, challenges, South Asia.

Introduction

South Asia is marked by an increasing population, rapid urbanisation, unsustainable agricultural and industrial development and poor waste management regulations that are affecting the environment which in turn affects food production and human health. This review paper provides an overview of the status of water and health in South Asia. *'Good Evidences, Bad Linkages'* narrates the story of water and health in South Asia where there are 'good' enough 'evidences' of lack of safe water leading to the heavy burden of water-associated diseases. This scenario worsens due to bad 'interlinkages' of water and health at the policy and programme level. The existing governance system aims to provide good health, but fails to appreciate and address its link with safe water and sanitation. This paper is divided into four parts: part 1 studies interrelations between water and health at a conceptual level; part 2 provides an overview of water and health through country level secondary data on access to water supply and sanitation and prevalence of water associated diseases to understand the extent of water and health problems in South Asia; part 3 discusses the major challenges in providing access to water and health in South Asia with country specific examples; and part 4 concludes the paper with an agenda for action.

Interrelations between Water and Health: Conceptual Understanding

The relationship between water and health is complex. The most well recognised is that of water-transmitted diseases.

Ashbolt (2004) categorised infectious diseases linked to water into four categories: (a) water-borne, water-related, water-based and water-washed diseases. In *water-borne diseases*, water acts as a passive carrier for infecting pathogens. Diarrhoea is the most common form of water-borne diseases, which, if unchecked, leads to cholera, typhoid, bacillary and gastroenteritis. Vectors and insects reside in or close to water spread w*ater-related diseases*. Ponds with stagnant water provide the most suitable breeding grounds for disease spreading vectors such as mosquitoes, flies and insects. The common diseases are malaria, dengue, yellow fever, filariasis and sleeping sickness. Infecting agents, spread by contact with or ingestion of water, cause *water-based diseases* like schistosomiasis, dracunculosis, philariosis, threadworm and other helminths. Water supports an essential part of the life cycle of infecting agents, such as aquatic snails. *Water-washed diseases* are caused by the lack of adequate quantity of water for proper maintenance of personal hygiene; some are also caused due to poor sanitation. Scabies, trachworms, conjunctivitis, hookworm and amoebic dysentery are some of the common water-washed diseases.

However, apart from microbial contamination, chemical pollution of water is also a major health concern. Chemical pollution of surface water can create health risks, as these waterways are often used directly for drinking, washing and cleaning, and also for fishing and recreational purposes. Groundwater, the other major water source, often has low concentrations of pathogens as the water is filtered during its transit through underground layers of sand, clay or rocks. However, toxic chemicals such as arsenic and fluoride can seep through soil or rock layers and dissolve in groundwater. Use of chemically contaminated water in food preparation can result in contaminated food, as high cooking temperatures do not affect toxicity of most contaminants (Kjellstorm, 2006). Toxic chemicals can enter waterways from point or non-point sources. Direct contamination can also occur due to badly designed hazardous waste or industrial sites.

Table 1: Health impacts of water pollution from industrial waste

Industrial source	*Chemical pollutant*	*Health impact*
Base metal and iron ore mining, cement manufacturing, coal mining, foundries	Silica	High concentrations of soluble silicon compounds may disturb phosphorilation.
Copper smelting	Arsenic, cadmium	Arsenic: Skin lesions characterised by hyperkeratosis and melanosis. Other effects reported but not epidemiologically confirmed, include cancer (particularly of the skin, lungs and bladder), liver damage, diabetes, hypertension and reproductive effects (spontaneous abortions and still births). Cadmium: Cadmium poisoning (Ita-Ita disease), kidney and bone disease.
Lead and zinc smelting	Lead, cadmium, arsenic	Lead: Anemia and hypertension
Oil and gas development, petrochemicals manufacturing, petroleum refining	Hydrocarbons	Kidney diseases, reduced fertility and increased occurrence of stillbirths, birth defects and hormonally dependent cancers such as breast, testicular and prostate cancers
Pesticide manufacturing	Pesticides and toxic intermediates	Reproductive, developmental and behavioural problems
Fertilizer plants	Nutrients	Nitrate exposure: Methemoglobinemia “Blue Baby Syndrome”
Pulp and paper mills	Mercury	Mercury: Methylmercury poisoning (Minamata disease), disease of nervous system, kidney diseases
Tanning and leather finishing	Chromium	Chromium: Liver toxicity, kidney diseases
Textile manufacturing	Toxic dyes	Several cancers, cerebrovascular and lung diseases

Source: World Bank 1999, WHO and International Programme on chemical Safety 2002 and International Agency for Research on Cancer, 2004 (cited Kjellstrom, 2006)

Some of the major pollution-causing industries are paper and pulp mills, sugar mills, textile and dye industries, mining and steel industries. Pollution from non-point sources involves many small sources that combine to cause significant pollution. For instance, movement of rain or irrigation water over land attracts pollutants such as fertilisers, herbicides and insecticides and carries them into rivers, lakes, reservoirs, coastal waters or groundwater (Kjellstorm, 2006). Table 1 shows examples of industrial sources of various chemical pollutants and their impact on health. There are a number of other water-health associations that fall outside the above-mentioned categories, such as deficiency-related diseases, water injuries and other social disadvantages due to inaccessibility to proper water supply.

Lack of safe and adequate water due to negative externalities has posed public health hazards across the developing world, including South Asia, hindering the process of realising sustainable development. The following section will provide an insight into the status of water and health in South Asia.

Status of Water and Health in South Asia

South Asia comprises countries of Afghanistan, India, Pakistan, Bangladesh, Nepal, Bhutan and the island nations of Sri Lanka and Maldives. Considered one of the fastest growing regions in the world, and the most diverse, South Asia is home to half of the world's poor with approximately half a billion people living on less than a dollar a day. In 2005, the average Human Development Index (HDI) for the region, based on three measurable dimensions of human development – living a long and healthy life, education, and having a decent standard of living – was 0.546, compared to the world average of 0.741.

According to the 'Basic Statistics 2006' of Asian Development Bank (ADB), poverty levels in the region (as defined by national poverty lines) ranged from 49.8 per cent in Bangladesh to 30.9 per cent in Nepal, 26.1 per cent in India and 25.3 per cent in Bhutan (Babel and Wahid, 2008). Poverty alleviation is the biggest challenge for South Asian countries. It is also obvious that the world's poorest region is marked by disparities in access to water supply and sanitation, one of the basic services for healthy living. "Water contributes to poverty alleviation in many ways – through sanitation services, water supply, affordable food and enhanced resilience of poor communities faced with disease, climate shocks and environmental degradation. Water of the right quality can improve health through better sanitation and hygiene and when applied at the right time can enhance land productivity, labour and other productive inputs" (Björklund, 2009). The subsequent section throws light on the status of water and sanitation coverage across South Asia.

Water and Sanitation Coverage in South Asia

South Asia is the most densely populated region in the world, home to nearly a quarter of the world population. The region is endowed with vast water resources but the available water is unevenly distributed over space and time (GWP-South Asia, undated). Table 2 provides the water supply and sanitation coverage for all the eight South Asian countries. Based on 2006 Joint Monitoring Programme of UNICEF and World Health Programme, the data reveals that water supply sector is doing better than sanitation with exception in Afghanistan. Water supply ranges from a low of 22 per cent in Afghanistan to a high of 98 per cent in Sri Lanka. Similarly, access to improved sanitation data shows a range of 27 per cent in Nepal to 86 per cent in Sri Lanka. The high percentage of water supply and sanitation in Sri Lanka is attributed to government initiatives during early 1970s and 1980s in improving water supply and sanitation[1].

In terms of water supply, except in the case of Afghanistan, total population covered ranges from 80–90 per cent, indicating considerable achievements. Nepal, India and Pakistan have been able to provide water coverage to a considerably large population in 16 years, covering about 46, 41 and 35 per cent more of its population respectively. On the sanitation front, Pakistan has been able to provide access to safe places for defecation to about 40 per cent more of its people (Table 3).

[1] The primary responsibility for the provision and management of water supply and sanitation services in Sri Lanka prior to 1975 was divided among two key agencies among others viz. the Water Supply Division of the then Ministry of Irrigation, Power and Energy for the water supply sector and the Ministry of Health for the sanitation sector. The local authorities were assigned the responsibility for providing piped water and public wells. This institutional arrangement for the provision and management of water supply and sanitation services changed in 1974, when the National Water Supply Division Board (NWSDB) was established through an act of parliament under the then Ministry of Irrigation, Power and Highways. The NWSDB became the primary agency responsible for water supply and sanitation in the country. The current coverage level of water supply and sanitation is largely attributed to this initiative of the Sri Lankan government (ADB, 2007).

Table 2: Water and sanitation coverage in South Asian countries, 2006

Country	*Population*			*Improved water supply coverage*[2] *(%)*			*Improved sanitation coverage* [3] *(%)*		
	Total (thousands)	*% Rural*	*% Urban*	*Total*	*Urban*	*Rural*	*Total*	*Urban*	*Rural*
Afghanistan	26,088	74	26	22	37	17	30	45	25
Bangladesh	155,991	75	25	80	85	78	36	48	32
Bhutan	649	81	11	81	98	79	52	71	50
India	151,751	73	29	89	96	86	28	52	18
Maldives	300	70	30	83	98	76	59	100	42
Nepal	27,641	84	16	89	94	88	27	45	24
Pakistan	160,943	65	35	90	95	87	58	90	40
Sri Lanka	19,207	85	15	82	98	79	86	89	86

Source: WHO UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2008

Table 3: Percentage of additional population gained coverage between 1990 and 2006 with respect to median population 1998

Country	*Water supply*	*Safe sanitation*
Afghanistan	No data	No data
Bangladesh	27	21
Bhutan	No data	No data
India	41	20
Maldives	15	No data
Nepal	46	25
Pakistan	35	40
Sri Lanka	23	24

Source: WHO UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2008

However, sanitation coverage in the region is still poor, despite governments' claims, as the government figures mostly show the available infrastructure rather than the status of the resource itself. Water resources in South Asia are increasingly becoming scarce and mismanaged. This has a direct bearing especially on the status of domestic water supply. The scarcity of water is manifested in depleting groundwater resources, issues of water quality and competing demands. Apart from the quantity problems, the microbial and chemical contamination of fresh water bodies and quality of groundwater has been a major threat to drinking water supply.

Environmental Pollution and Water Quality in South Asia

The problem of insufficient, ill-managed supply is further compounded by poor quality of fresh water supply in the region, which is threatened by pollution, ecosystem degradation, changing land-use and indiscriminate development. For instance, the River Ganges in India is the recipient of raw sewage from about 114 towns and cities. The problem of water quality does not end with microbial contamination of surface water. Groundwater, especially shallow groundwater, in many sites of South Asia is contaminated with dangerously high levels of arsenic, fluoride and nitrates. The Jaffna Peninsula in Sri Lanka faces a nitrate problem in its shallow groundwater aquifers due to dumping from latrines. Bangladesh is struggling with issues of arsenic poisoning as millions of people are exposed to potentially fatal quantities of arsenic. According to World Bank estimates, 18-50 million people out of a total population of about 120 million in the country are at risk of arsenic poisoning (Bashkin, 2003). Intensive agricultural production practices to increase crop yields for feeding the ever growing population has resulted in unprecedented risks for the water resources. Fertilisers and pesticides used in agriculture readily penetrate the groundwater resources, while run-off caused due to rains increases contaminant levels in surface waters (Smith, 2001).

[2] An improved drinking water source is defined as a drinking water source or delivery point that, by nature of its construction and design, is likely to protect the water source from outside contamination, in particular from faecal matter. The Joint Monitoring Programme (JMP) includes piped water into dwelling, plot or yard; public tap/stand pipe; tube well/borehole; protected dug well; protected spring and rainwater collection as improved drinking water source.

[3] An improved sanitation facility is defined as one that hygienically separates human excreta from human contact. In JMP data, sanitation facilities are not considered improved when shared with other households, or open for public use. Improved sanitation means having access to flush or pour-flush toilet to [1] piped sewer system, [2] septic tank and [3] pit latrine; ventilated improved pit latrine; pit latrine with slab; and composting toilet.

South Asian economies are developing. This translates into the economy getting more reliant towards industrial production, primarily manufacturing. A common by-product of this industrial explosion is industrial waste, a mélange of chemicals that pose substantial risk to human health. This is a risk, particularly in the South Asian region, as industrial growth is occurring in the background of weak or rather evolving/half-baked policies. Companies that generate waste have strong financial incentives to pollute, based on the subsidies provided by the governments to promote industrial growth. Paying to pollute would reduce this contamination, but would reduce profits (Luby, 2008). Illegal discharges from small-scale industries are difficult to regulate and control.

Since independence, India has had strong policies to promote the small-scale industrial sector. This sector, being labour intensive, creates more jobs and contributes to decentralised industrial development. Its units are flexible and are able to quickly reorganise for the emerging market demands. In these units, Western technological systems are primarily adopted leading to production of enormous gaseous, liquid and solid wastes. But the pollution control technologies developed in the West are not economically suitable for these home-grown enterprises. Their numbers are huge and so is the pollution from them. They contribute some 40 per cent of the total industrial wastewater in India (Agarwal, undated).

Indeed, the frequency of water contamination is so common throughout South Asia that it is a necessary evil. A small percentage of the populace can afford to buy bottled water (again of spurious quality), but the majority have to consume the available contaminated water (Luby, 2008). However, countries in South Asia are beginning to put in place water quality laws, low cost test kits for water quality monitoring are being made available at the community level, awareness of water quality issues is increasing and water safety plans are being more widely used. People's expectations for increased quantity of improved water supply should however be matched with considerations for improved waste water disposal in order to prevent contamination of surface and groundwater.

Status of Water-Associated Diseases in South Asia

An important share of the total burden of disease worldwide – around 10% per cent – could be prevented by improvements related to drinking water, sanitation, hygiene and water resource management (Prüss-Üstün et al., 2008). Bradley estimated that excellent water supply can reduce most diarrhoea and dysentery (by 50 per cent), typhoid fever (by 80 per cent), paratyphoid, other *Salmonella* (by 40 per cent), trachoma (by 60 per cent), scabies (by 80 per cent), skin and subcutaneous infections (by 50 per cent), urinary schistosomiasis (by 80 per cent) and intestinal schistosomiasis (by 40 per cent) (White et al., 1972. quoted in Cairncross and Valdmanis, 2006). Although 85% of drinking water in South Asia meets the target of the Millennium Development Goal of coming from an improved source (WHO/UNICEF JMP, 2006), this water is, in fact, frequently contaminated with human faecal organisms and toxic chemicals (Tambe et al., 2008; Anwar et al., 2004 and Sirajul Islam, 2007; quoted in Luby, 2008). The failure to deliver clean water to the South Asian population means more childhood deaths, less cognitive development, less educational achievement and less economic growth (Luby, 2008).

Diseases related to water contribute to the top 10 causes of death in the region (Mathers et al., 2006). Based on the literature survey, it has been identified that there are 25 types[4] of water-associated diseases existing in South Asia. The mortality due to water-related diseases has decreased in the past 10 years, but morbidity is on the rise in the region. To illustrate, the water, sanitation and hygiene-related disease burden in South Asia, Tables 4 and 5 present country-level data for the year 2002. In 2002, percentages of total deaths caused due to water, sanitation and hygiene related diseases in the region ranged from 1.9 per cent in case of Sri Lanka to 16.2 per cent in case of Afghanistan, while disability-adjusted life year (DALYs) attributable to lack of water sanitation and hygiene, ranged from 3.2 per cent in Sri Lanka to 15.8 per cent in Afghanistan (Prüss-Üstün, 2008). Both the parameters related to burden of water-related diseases indicate that Afghanistan and Pakistan are the most affected countries, while Sri Lanka has made considerable progress in health outcomes.

[4] As per WHO, following water-associated diseases are prevalent in South Asia: anaemia, arsenicosis, ascariasis, bacillary dysentery (Shigellosis), chikungunya, campylobacteriosis, cholera, cyanobacterial toxins, dengue and dengue haemorrhagic fever, diarrhoea, drowning and other water-related injuries, filariasis, fluorosis, hepatitis, Japanese encephalitis (JE), lead poisoning, leptospirosis, malaria, malnutrition, methaemoglobinemia, polio, ringworm (Tinea), scabies, trachoma, typhoid and paratyphoid enteric fevers.

Table 4: Deaths ('000) attributable to water, sanitation and hygiene in 2002

Disease or Injury	*Afghanistan*	*Bangladesh*	*Bhutan*	*India*	*Maldives*	*Pakistan*	*Nepal*	*Sri Lanka*
Population ('000)	22930	143809	2190	1049550	309	149911	24609	18910
Total deaths	484.5	1106.8	21.0	10378.5	2.1	1386.4	233.3	145.5
Total WSH-related	**78.5**	**109.9**	**1.9**	**782.0**	**0.1**	**187.9**	**24.7**	**2.7**
% of total deaths	**16.2%**	**9.9%**	**9.2%**	**7.5%**	**6.0%**	**13.6%**	**10.6%**	**1.9%**
Diarrhoeal diseases	36.8	60.3	1.2	402.2	0.0	103.3	14.7	0.6
Intestinal nematode infections	0.0	0.2	0.0	3.2	0.0	0.8	0.1	0.0
Malnutrition (only PEM)	3.2	1.0	0.0	8.7	0.0	2.5	0.5	0.0
Consequences of malnutrition	19.5	26.0	0.3	217.0	0.0	51.7	4.3	0.1
Trachoma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Schistosomiasis	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0
Lymphatic filariasis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal water supply, sanitation and hygiene	**59.6**	**87.5**	**1.5**	**631.2**	**0.1**	**158.3**	**19.7**	**0.8**
Malaria	0.3	0.6	0.0	3.4	0.0	0.6	0.0	0.4
Dengue	0.0	2.0	0.1	5.2	0.0	0.5	0.2	0.0
Onchocerciasis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Japanese encephalitis	0.0	0.7	0.0	6.6	0.0	2.3	0.2	0.0
Subtotal water resource management	**0.3**	**3.3**	**0.1**	**15.1**	**0.0**	**3.4**	**0.4**	**0.5**
Drownings	1.7	6.1	0.1	50.4	0.0	5.9	1.3	0.7
Subtotal safety of water environments	**1.7**	**6.1**	**0.1**	**50.4**	**0.0**	**5.9**	**1.3**	**0.7**
Other infectious diseases	16.8	13.0	0.3	85.3	0.0	20.3	3.4	0.9

Source: Prüss-Üstün, 2008

Table 5: DALYs* ('000) attributable to water, sanitation and hygiene in 2002

Disease or Injury	*Afghanistan*	*Bangladesh*	*Bhutan*	*India*	*Maldives*	*Pakistan*	*Nepal*	*Sri Lanka*
Total DALYs	17011.0	36972.1	644.1	299909.8	59.7	44821.2	7469.1	3499.8
Total WSH-related	**2691.8**	**4058.1**	**65.1**	**29213.3**	**4.5**	**6437.5**	**873.5**	**111.7**
% of total DALYs	**15.8%**	**11.0%**	**10.1%**	**9.4%**	**7.5%**	**14.4%**	**11.7%**	**3.2%**
Diarrhoeal diseases	1192.4	2013.3	39.4	13644.2	1.5	3298	492.2	28.4
Intestinal nematode infections	13.0	79.0	1.5	594.8	0.2	109.6	15.3	15.8
Malnutrition (only PEM)	153.7	267.1	3.7	1493.2	0.5	280.1	55.5	7.8
Consequences of malnutrition	676.6	890.0	8.7	7421.2	0.7	1764.0	149.6	4.3
Trachoma	5.3	16.5	0.0	138.1	0.0	15.7	2.9	0.0
Schistosomiasis	0.0	0.9	0.0	0.0	0.0	0.0	0.8	0.1
Lymphatic filariasis	0.0	142.8	0.0	1011.4	0.3	0.1	24.1	12.5
Subtotal water supply, sanitation and hygiene	**2041.1**	**3409.7**	**53.3**	**24302.9**	**3.2**	**5467.4**	**740.4**	**68.7**
Malaria	23.1	44.1	0.4	303.7	0.1	61.1	5.3	17.1
Dengue	0.1	67.8	2.0	175.4	0.0	18.5	6.4	1.0
Onchocerciasis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Japanese encephalitis	0.9	23.2	0.7	214.1	0.1	77.4	5.2	0.0
Subtotal water resource management	**24.1**	**135.0**	**3.1**	**693.2**	**0.2**	**157.1**	**16.8**	**18.1**
Drownings	57.5	181.7	2.8	1392.2	0.2	171.2	39.9	15.6
Subtotal safety of water environments	**57.5**	**181.7**	**2.8**	**1392.2**	**0.2**	**171.2**	**39.9**	**15.6**
Other infectious diseases	569.1	331.6	5.8	1825.0	0.9	641.8	76.2	9.3

Source: Prüss-Üstün, 2008

* DALY: The WHO global burden of disease (GBD) is measured using the disability-adjusted life year (DALY). This time-based measure combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health.

Cases of water-transmitted diseases have been most frequent in South Asian countries. Diarrhoea still remains the primary cause for majority of deaths in the region. Nearly one million children died from preventable diarrhoeal diseases during 2006-2008 (Kothari, 2008). As per the Annual Health Bulletin 2007, Royal Government of Bhutan, Ministry of Health, the diseases linked to water, including diarrhoea, malaria and skin diseases, are among the 10 most common causes of morbidity. Diarrhoeal diseases in summer still top the list of infant morbidity due to poor quality of drinking water and sanitation. Diarrhoea, malaria and jaundice are three of the major diseases prevalent in India and Bangladesh. As per WHO statistics, in Maldives, worm infestation is high in the country and 50-75 per cent of children below five years of age are estimated to be affected by intestinal parasites. Skin infections, diarrhoeal diseases and intestinal worms are three dominant diseases in Nepal. India, Pakistan, and Afghanistan are now among the only few countries in the world with wild-type polio.

Meanwhile, Sri Lanka has shown a significant improvement in its health sector and presents a transitional mortality pattern. It appears to be moving away from a pattern seen in developing countries to a pattern observed in developed countries. In Sri Lanka, the trends in mortality indicate a decrease in deaths resulting from infectious and parasitic diseases.

Though the trends in general in most of the South Asian countries are negative, morbidity is still very high and significant. Take India, where reported deaths due to cholera reduced from 20 in 2000 to three in 2007, while the number of reported cholera cases in India declined from 4,053 in 2000 to 2,635 in 2007. Similarly, malaria, another major public health problem, claimed 2,803 lives during 1996 in India, which reduced to 990 in 2003, whereas the number of reported malaria cases showed a decline from 2,207,431 in 1993 to 1,781,336 in 2003, which is still very high. Higher morbidity and lesser mortality clearly indicate that the strategies adopted by the countries to conquer water-related disease are curative-oriented rather than prevention-oriented. On other hand, there are two distinct trends in Japanese Encephalitis (JE) incidences. In countries such as Bangladesh and India, where no specific diagnostic centres, vaccination programmes and surveillance systems are in place, the incidence of JE appears to have increased in recent years. On the contrary, in Sri Lanka, where vaccination programmes are being implemented and regular surveillance is pursued, the incidence of JE is declining (Erlanger et al., 2009).

However, problems concerning water and health do not end with microbiological contamination. Besides infectious diseases, chemical contamination of surface and groundwater also create a great threat to public health (Luby, 2008). Scarcity and pollution of surface water has led communities to use groundwater as an alternative source for various purposes, mainly for drinking and food production. Countries like India, Bangladesh, Pakistan and Nepal are struggling with arsenic poisoning as, at many sites, arsenic in drinking water has been detected at concentrations greater than the Guideline Value, 0.01 mg/l or the prevailing national standard (WHO, 2001). Arsenic contamination in groundwater in these countries is known to be of geological origin (Sarkar, 2008) and also appears to be exaggerated by present anthropogenic activities (Acharyya et al., 2000). In Bangladesh, when UNICEF introduced wells during 1970s and 1980s to supply drinking water safe from microbial contamination, it ended up in a bigger tragedy of arsenic contamination (Datta and Subramanian, 2002; Kjellstrom, 2006; Caldwell, 2008). Kinniburgh and Smedley (2001) estimate that 28-35 million people of Bangladesh's population of 130 million are exposed to arsenic levels exceeding 0.05 mg/l. Maddison et al. (2004) (as quoted by World Bank/WSP Report, 2005), estimates that in Bangladesh 6,500 people will die from cancer every year, a total of 326,000 people in a period of 50 years, while 2.5 million people will develop some kind of arseniocosis in one year.

In India, seven of the 16 districts of the state of West Bengal have been reported to have groundwater arsenic concentrations above 0.05 mg/l; the total population in these seven districts is over 34 million (WHO, 2001). In Nepal, as per UNICEF estimations, arsenic contamination could affect more than 1.4 million people (about 47 per cent of Nepal's population) across 20 districts in Terai (Lawoti, 2006). Even in Pakistan, arsenic contamination is an emerging threat to public health. In Punjab province over 20 per cent of the population is exposed to arsenic contamination of over 0.01 mg/l in drinking water, while nearly three per cent of the population is exposed to over 0.05 mg/l. In Sindh province, the situation is even worse with 36 per cent and 16 per cent of population exposed to arsenic contaminated water over 0.01 mg/l and 0.05 mg/l respectively. Both shallow and deep sources were found contaminated by arsenic (Ahmed et al., 2004).

High concentration of flouride in drinking water supply in Afghanistan, Pakistan, India, Bangladesh and Sri Lanka is further posing difficulties. Fluoride in water is mostly of geological origin in the region. High

concentrations of fluoride have been reported in groundwater from India, Pakistan and Sri Lanka. The WHO noted that mottling of teeth (i.e. dental fluorosis) is sometimes associated with fluoride levels in drinking water above 1.5 mg/l and crippling skeletal fluorosis can ensue when fluoride levels exceed 10 mg/l. As quoted by Fawell et al. (2006), in Sri Lanka, Dissanayake (1991) reported dental and possibly skeletal fluorosis in the Dry Zone, associated with usage of groundwater containing flouride concentrations of upto 10 mg/l in groundwater.

Endemic fluorosis is one of the major national health problems in India. In 1991, 13 of India's 32 states and territories were reported to have had naturally high concentrations of fluoride in water (Mangla, 1991), but this rose to 17 by 1999 (UNICEF, 1999). Andhra Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Tamil Nadu and Uttar Pradesh (Kumaran et al., 1971; Teotia et al., 1984) are the most seriously affected areas. The highest concentration recorded to date in India is 48 mg/l in Rewari district of Haryana (UNICEF, 1999).

No published estimates are available on the burden of disease from the overall effects of other chemical pollutants in water for South Asia. There are 1,176 industrial units in Bangladesh that heavily pollute the environment. The statistics from the Department of Environment in Bangladesh put the number of polluting textile mills at 365, tanneries at 198, pharmaceutical units at 149, engineering workshops at 129, chemical and pesticide factories at 118, jute mills at 92, rubber and plastic units at 63, food and sugar at 38, plastic recycling factories at 125, paper and pulp at 10, cement and fertiliser at five each and distilleries at four. A study conducted by the Society for Environment and Human Development (SEHD), a Dhaka-based non-governmental organisation, revealed that about 90 per cent of Hazaribag tannery workers die before the age of 50 due to unhygienic working conditions. About 58.10 per cent of workers suffer from ulcers while 31.28 per cent have skin diseases (Bangladesh National Report, 1996-2001).

The review of literature also suggests that the relationship between water and health is not linear. There are various socio-economic, cultural and political factors, which determine the status of water and health. The following section discusses major complexities and challenges faced by the South Asian region in this sector.

Challenges in Providing Access to Water and Health in South Asia

South Asia has been a water scarce region, especially the arid and semi-arid areas. Rapid urbanisation, population pressure and industrial development have aggravated the problem in recent years. The three prominent sectors – domestic, agriculture and industrial – now routinely vie for the same limited water supplies. Irrigation water, once the preserve of farmers, is now often tapped to supply water to industry and urban areas because new water systems are costly to develop. Estimates suggest that by 2025, the amount of water needed to meet demands in South Asia is expected to double, while the water going to industry and energy generation is expected to triple. Municipal and industrial water use will account for 27 per cent of total withdrawals in India by 2025, compared to 17 per cent in the mid-1990s (Meinzen-Dick, 2005).

Similar trends are evident in other parts of South Asia indicating that the domestic water sector will have to compete with other sectors, which is largely the case even now in many locations. These competitions are going to be starker in the near future, leading to major water-related health implications. The brunt of this process will definitely be borne by people living on the margins of society, who need access to safe water to maintain health and leading a productive life to sustain livelihoods. This section identifies four challenges bordering on water, sanitation and health in South Asia.

Challenges in Accessing Safe Water

The first challenge related to water supply is coverage. The water supply coverage figures of South Asia (Table 2) show that it is on track as far as MDG targets are concerned (WHO/UNICEF JMP, 2008). However, most of the coverage figures are calculated based on the existence of an infrastructure and that doesn't necessarily show whether water is accessible to people or not. Issues of water quality and groundwater depletion have much to contribute in providing lack of access to drinking water. Water quality is emerging as a major concern and greater emphasis needs to be placed on making safe water available at the point of source as well as at the point of consumption. Apart from developing infrastructure for safe water supply, maintenance of existing infrastructure is also a challenge. There are no proper mechanisms to monitor water quality in the distribution system. Processes for ensuring regular testing of water quality and working out the institutions responsible for doing this, and mechanisms for holding these institutions accountable are not yet in place.

Due to surface water getting more and more polluted, groundwater is seen as an alternate source of safe water supply. Most of the domestic water supply in South Asia is groundwater-based. In India, roughly 80 per cent of

rural water supply for domestic use is met from groundwater (Tripathi, 2000). Groundwater provides 50 per cent of the present water supply in Kathmandu and abstraction from both shallow and deep aquifers (Upadhyay, undated). Groundwater sources in the vicinity free people, particularly women, from their daily activity to collect water from distant springs or rivers. This provides them with adequate time for other activities. Furthermore, as water no longer needs to be carried over long distances, more is consumed. This leads to major health benefits. However, groundwater depletion due to overdraft, water logging and salinisation mostly due to inadequate drainage and insufficient conjunctive use, as well as pollution due to agricultural, industrial and other human activities, will accentuate the problem of access to drinking water for the poor and marginalised. Decentralisation of water quality monitoring at community level needs to be institutionalised and this demands capacity building at all levels (Srikanth, 2009).

Challenges in Managing Wastewater

Most of the cities in South Asia do not have a proper wastewater treatment plan. Each water user not only takes water out, but also puts something back into the water supply: agrochemicals, municipal wastes, and industrial effluents. Very little municipal sewage in South Asia is treated. The Noyyal Basin in Tamil Nadu, India, for example, has become a "dead river" because of discharges from textile factories and over 10,000 acres of irrigated area have become unproductive (Banerjee, 2002).

Challenges of Providing Safe Sanitation

Achieving sanitation for all remains a distant dream in South Asia. The region had sanitation coverage in 2006 of just 52 per cent compared to 72 per cent in Sub-Saharan Africa and 82 per cent in South-Eastern Asia. Country specific figures show that countries of South Asia, namely Bangladesh, India and Pakistan, have millions of people who are still without access to safe water and adequate sanitation. The growing economy of South Asia also brings contradictions of development in terms of number of people living below the poverty line and water and sanitation coverage. These figures tell a bleak tale despite claims of significant investments over the last 20 years. As a result, South Asia will miss the MDG target (UNICEF and WHO, 2008). The rapid urbanisation in the region is putting a strain on the already stressed urban sanitation systems. Slums are very rarely connected to cities' sanitation infrastructure and the sanitation situation is deplorable.

The emphasis to meet national and international coverage targets has led to construction of latrines only, so called 'latrinisation', while implementation of 'total sanitation' has taken a back seat. Based on the number of latrines constructed, communities are being declared as 'totally sanitised'. There is absence of monitoring regarding use of household latrines, hand washing and other hygiene practices and also provision of latrines in schools and public places. The existing monitoring systems focus on counting latrines and do not provide information on the number of totally sanitized communities and most importantly sustainability (WaterAid, 2006). Financing sanitation facilities also poses major challenges. In national budgets of most countries, allocation for water and sanitation are combined, leading to priority being given to water supply project, whereas sanitation is ignored (Pramanik, 2007).

Challenge Related to Health Governance

Regardless of diverse geographical, linguistic and political structures, Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan and Sri Lanka face common health challenges (Sadana, 2004). Healthcare services in South Asia that include both traditional and modern systems are delivered by public sector, private sectors and non-government welfare organisations. Although, all the countries in this region have shown their commitment for achieving 'Health for All' by signing Alma Ata declaration, the achievements are few and the progress is slow mainly due to poor execution of national policies and programmes, lack of a monitoring system for environmental health concerns, inadequate budget, insufficient health infrastructure and trained manpower, inequity, gender insensitivity and lack of proper health education. Some of the major challenges are discussed below:

- **Inadequate Health Financing and Inequalities:** Total expenditure on health in South Asia is one of the lowest in the world. The average per capita total expenditure per year on health from all sources – public, private and foreign aid was just USD 31.75 in 2003. Government expenditure is often very low. For example, per capita government expenditure on health in 2003 was just USD 4 per person in Bangladesh; USD 4 in Pakistan; USD 3 in Nepal; USD 4 in Afghanistan; USD 14 in Sri Lanka; USD 9 in Bhutan; and USD 7 in India, with an exception of Maldives, where per capita investment (USD 121) was much higher (World Health Report, 2006). The meagre amount spent by the government often benefits urban or wealthier people (Ursula Schäfer-Preuss, 2009).

Inadequate health budget leads to poor public health infrastructure and insufficient trained human resources. To illustrate this, due to inadequate budget and pressure to achieve targets, several states upgraded two-room sub-centres to full Public Health Centres (PHCs). With limited space for a laboratory, examinations, pharmacy, etc., many are not fully functional (WHO, 2007). Out of pocket, private expenditure, is often very high, with implications for equity and impoverishment. In Bangladesh, Nepal, India and Pakistan, about 70 per cent of total expenditure on health comes "out of pocket"(WHO, 2008). Even small payments like this can be a barrier to essential health care for poor people, and often become a source of increasing inequality and impoverishment. For example, a recent ADB study found that about 40 million people in India fell below the poverty line due to health payments (Ursula Schäfer-Preuss, 2009).

- **Systemic Complexities, Missing Interlinkages and Need for Inter-sectoral Coordination:** Public health mainly depends on adequate nutrition, safe drinking water, sanitation, a clean environment, primary education, etc., which are all interconnected. There are different policies and programmes initiated by various government departments dealing with these issues but the interlinkages are missing. Besides, the level of enforcement, monitoring and regulation has been extremely poor. Coordinating mechanism is missing. To illustrate this, in Maharashtra, a state of India, in spite of health investments infectious diseases emerged due to lack of expenditure in providing drinking water, failure in monitoring chlorination of water, maintenance of water supply, sewerage, sanitation and other related infrastructures (Saxena, 2007). The 1996 Expert Committee on Public Health System (Bajaj Committee) in India recommended inter-sectoral cooperation for the betterment of health services, suggesting setting up of two coordinating committees, i.e., cabinet committee on health and committee of secretaries, chaired by cabinet secretary comprising all departments concerned with activities influencing health outcomes, like education, sanitation, drinking water, environment, nutrition, etc. (WHO, 2005).

  There is a need for policies to be inter-related. The model of public health system adopted in Sri Lanka is inspirational[5] . An alternative governance structure is required with more emphasis on decentralisation.

- **Health Education and Behavioural Factors:** Apart from efficient public health services, individual behaviour plays a significant role in preventing and controlling health-related problems. These behavioural practices include personal hygiene, proper storage of water etc. Health education can play an important role in inculcating such behaviour during the formative years of an individual. But as access to education for the poor, both in urban and rural areas, is still a challenge, percolation of such behaviour is disappointedly slow.

- **Community Participation:** Involvement of the community as a stakeholder to address issues of water and health is also essential. Initiatives by governments alone cannot be effective unless communities appreciate importance of health in their development and responsibly work together to achieve it. Community as a standalone entity, and also through various institutional set-ups, can create the necessary environment for acceptance of required behaviour. Community participation has been valued since the Alma Ata declaration, but the South Asia region provides very few examples of true community participation. "Ensuring community participation in the true sense remains a challenge, as merely inviting community members to participate in programmes introduced by outsiders does not take into account the complexity of community psychology, culture, and other social issues" (Hossain, 2004). Active community participation is necessary to effectively strategise mechanisms to tailor policies at the local level, taking into account local social mores, culture and other inherent diversities.

[5] During the last decades, Sri Lanka has shown tremendous improvement in providing safe drinking water to its people. The Ministry of Health is not directly responsible for provision of water. Through its field health personnel, health education is implemented viz., motivating people to consume boiled cooled water, which is usually considered safe. Government functionaries viz. the Public Health Inspectors (PHI) conduct routine tests for adequate chlorination of drinking water sources during epidemics of bowel diseases, like diarrhoea and gastro-enteritis and disaster situations like floods etc. The health authorities ensure that there is no contamination of drinking water sources from toilets and other sources, before approving applications for construction of buildings.

The use of latrines by communities is also promoted (including enforcement of provisions of relevant legislation related to housing). It is mandatory for all new houses to process toilet facilities in order to obtain approval from local authorities. Additionally, the department of health services provides financial assistance to those who are unable to construct toilets due to limited resources (WHO, 2005).

Conclusions

For the South Asian region, which is already struggling to cope with exponentially growing scarcity of water, providing safe water has become a real public health challenge. Given the rapid rate of growth in the industrial and agricultural sectors along with an ever increasing population and a burgeoning section following an industrialised lifestyle, the pressure to provide adequate water from limited sources is intense. Although countries seem to have worked on the Millennium Development Goal (MDG) to create infrastructure concerning water supply and sanitation, it is still questionable whether these measures have led to increased access to adequate safe water supply and proper sanitation at all. Also, whether the concept of hygiene has been imbibed by individuals/ communities. The existing literature provides sufficient evidences of very high burden of preventable water-related diseases in South Asian countries. Though countries have progressed in controlling these diseases, achievements have been limited.

This failure can be attributed to lack of a holistic approach while formulating policies and implementing programmes for strengthening the public health system. This is easily visible in existing sectoral approaches that deal with managing water and health, as separate entities. Along with the holistic approach, decentralization of water quality and health monitoring system and capacity building at all levels are essential. The way forward for these countries is to revisit their existing strategies, to reform their governance structure and adopt a more integrated and demand driven approach by appreciating proven water and health linkages along with other governing factors such as socioeconomic, environmental and political to conquer water-related health hazards.

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Contents