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Flagship Report

Economic Impacts of Inadequate Sanitation in India

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Acknowledgements

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Executive Summary

The Economics of Sanitation Initiative (ESI)

The Water and Sanitation Program (WSP) has launched a multicountry Economics of Sanitation Initiative (ESI) to study the economic impacts of poor sanitation and the costs and benefits of improved sanitation options. The overall goal of ESI is to provide decision makers at the country and regional levels with the evidence they need to advocate for increased investment in improving sanitation and to provide an improved evidence-base for efficient planning and implementation of sustainable sanitation and hygiene options and programs.

The inter-related objectives of the ESI India Study[1] are to:

1. Carry out an impact study to generate evidence on the **economic impacts** of current sanitation arrangements and hygiene practices in relation to the management of human excreta (and related hygiene practices), in both the rural and urban areas of India, based on an analysis of secondary data. *The findings of the resulting impact study form the contents of this report.*
2. Carry out an options study to collect and analyze data on the actual **costs and benefits of different sanitation options** or interventions in a range of program delivery contexts. *These primary surveys are ongoing, and findings from them are likely to become available in 2011.*

The ESI Impact Study is highly relevant to the sanitation challenges that the people of India face today in both rural and urban areas of the country. These challenges are substantial, with large populations defecating in the open or using unimproved toilets and a very high proportion of human fecal waste being released untreated both onto land and into bodies of water (especially from urban areas). Inadequate sanitation and poor hygienic practices lead to huge public health costs (e.g., the associated costs of deaths and diseases that are *attributable to inadequate sanitation*) as well as environmental and other welfare impacts.

Despite widespread recognition of the human and social handicaps that poor sanitation places on developing countries, the considerable *economic losses* arising from inadequate sanitation are not well recognized, since they are not counted properly. This study attempts to estimate impacts in economic terms. It looks at the impacts of sanitation and associated hygiene practices separately, in a departure from the conventional approach of conjoint statements about water-and-sanitation or the effects of "water-borne diseases." Many communicable diseases are overwhelmingly explained by poor sanitation rather than by water (even though water may act as a medium and is therefore important). This study constructs the evidence about the adverse economic impacts of inadequate sanitation at the national level, using existing information on health (deaths and diseases) and other impacts, including those on the availability and quantity of drinking water, on welfare and tourism-related losses.

Measuring the Impact of Inadequate Sanitation

Sanitation is broadly defined to include management of human excreta, solid waste, and drainage. The ESI India study focused exclusively on the *safe management of human excreta and associated hygiene behavior*. This is not to discount the importance of the other aspects, but to focus on the key dimensions that cause a *substantial health burden* on Indians, especially the poor.

[1] Impact studies have been completed in Cambodia, Indonesia, the Philippines, and Vietnam (2008). Options studies are in progress currently in those four countries and in the Yunnan Province of China. In South Asia, the India Impact Study was commenced in 2008 and completed in 2010. Impact studies are also being carried out in Pakistan and Bangladesh.

The UN-WHO Joint Monitoring Programme for Drinking Water Supply and Sanitation (JMPDWSS, 2008, 2010) defines an "improved" sanitation facility as one that *hygienically separates human excreta from human contact*. These include facilities that flush or pour-flush into a piped sewer system, septic tanks, or pit latrines, as well as ventilated improved pit latrines (also known as VIP latrines) and pit latrines with slab or composting toilets.

"Unimproved" sanitation facilities include defecation in the open, bucket or hanging latrines, open pit latrines or those without a slab, and facilities flushing or pour-flushing into open drains or open areas (that is, not into a piped sewer system, septic tank, or pit latrine). Shared toilets are also considered unimproved facilities. It is not only a deficit of sanitary toilets that constitutes inadequate sanitation, but also the unsafe disposal of human excreta and, most important, the whole range of unhygienic practices that break down the separation of human excreta from human contact and thus expose people to fecal-oral pathogens. This report uses this broader understanding of inadequate sanitation.

For this study, economic impacts of inadequate sanitation are first estimated in non-economic units and then converted to economic units using appropriate valuation methods.

Health-related impacts include:

- *Premature mortality*, that is, lost lives, especially those of children due to diarrheal and other diseases caused by poor sanitation
- *Cost of healthcare* incurred in treating diseases caused by poor sanitation, and
- *Productivity losses*, that is, productive time lost due to people falling ill, as well as productive time lost when care-givers need to look after the ill.

Domestic water-related impacts include:

- *Household treatment* of drinking water by various methods
- Use of *bottled water* by households
- *Piped water* (a fraction of this use is attributed to inadequate sanitation, and the rest to factors like convenience), and
- *Hauling cleaner water from a distance* outside the household because a nearer source of water may be contaminated due to poor sanitation.

Access time impacts include:

- Cost of *additional time needed for accessing shared toilets* and *open-defecation sites* compared to using a private toilet within the household, and
- Cost of *school absence time* due to inadequate toilets for girls and *work-absence time* due to inadequate toilets for working women.

Tourism impacts include:

- Potential loss of *tourism revenues*, and
- The economic impacts of *gastrointestinal illnesses among foreign tourists*.

For each of the above, data on incidence or actual numbers (e.g., of diarrheal diseases and deaths) were processed from relevant secondary data sources, most importantly the National Family Health Surveys (the last round being done in 2005-06), the WHO Global Burden of Disease data, the National Sample Surveys, and the Census of India. Based on a review of the literature, attribution factors were used to trace back the proportions and numbers that may be attributed to poor sanitation. Finally, an economic valuation was carried out on the resulting numbers using costs/prices, again based on previous studies. In order to err on the side of caution, conservative assumptions were used in the economic valuation. The human capital approach was used for valuing human lives—this accounts for the economic loss during a person's productive years by valuing lost output due to premature death. To compute this, the study used the unemployment-adjusted labor share of GDP per worker. An analysis of this kind requires comprehensive data-sets on multiple dimensions of sanitation, health, water resources, and other identified areas. Estimations of sanitation impacts have been carried out for the year 2006, since only partial data was available for later years. Wherever data was not available for 2006, older or more recent data-sets have been processed to obtain estimates for the year 2006. The estimates for 2006 are, nevertheless, a good indication of the order of magnitude of impacts that inadequate sanitation poses annually in economic terms.

Impact of Inadequate Sanitation in India

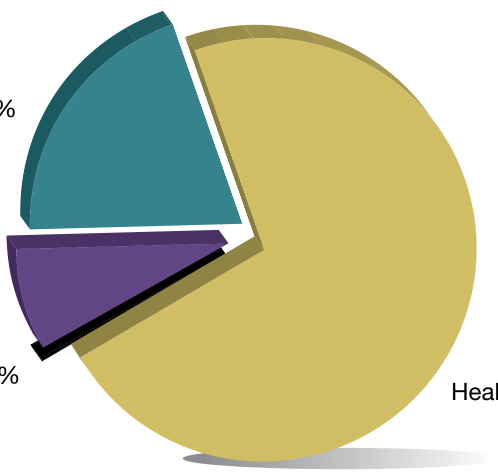
This study estimates that the total annual economic impact of inadequate sanitation in India amounted to a loss of ₹2.4 trillion ($53.8 billion[2]) in 2006. This implies a per capita annual loss of ₹2,180 ($48).

In purchasing power parity (PPP) terms, the adverse economic impact of inadequate sanitation in India was $161 billion, or $144 per person.

These economic impacts were the equivalent of about 6.4 percent of India's gross domestic product (GDP) in 2006. The health-related economic impact of inadequate sanitation was ₹1.75 trillion ($38.5 billion), which was 72 percent of the total impact. Access time and water-related impacts made up the other two main losses. (See Figure E.1.)

Figure E.2 presents the economic impacts by subcategories within each of the four impact categories. Within the health category, more than ₹1.3 trillion ($29 billion) was lost due to premature mortality, the single largest subcategory. Access-time costs for households, estimated at ₹478 billion ($10.5 billion), had the second-largest impact, and healthcare costs (₹212 billion, $4.7 billion) and health-related productivity losses (₹217 billion, $4.8 billion) made up the other main impact subcategories.

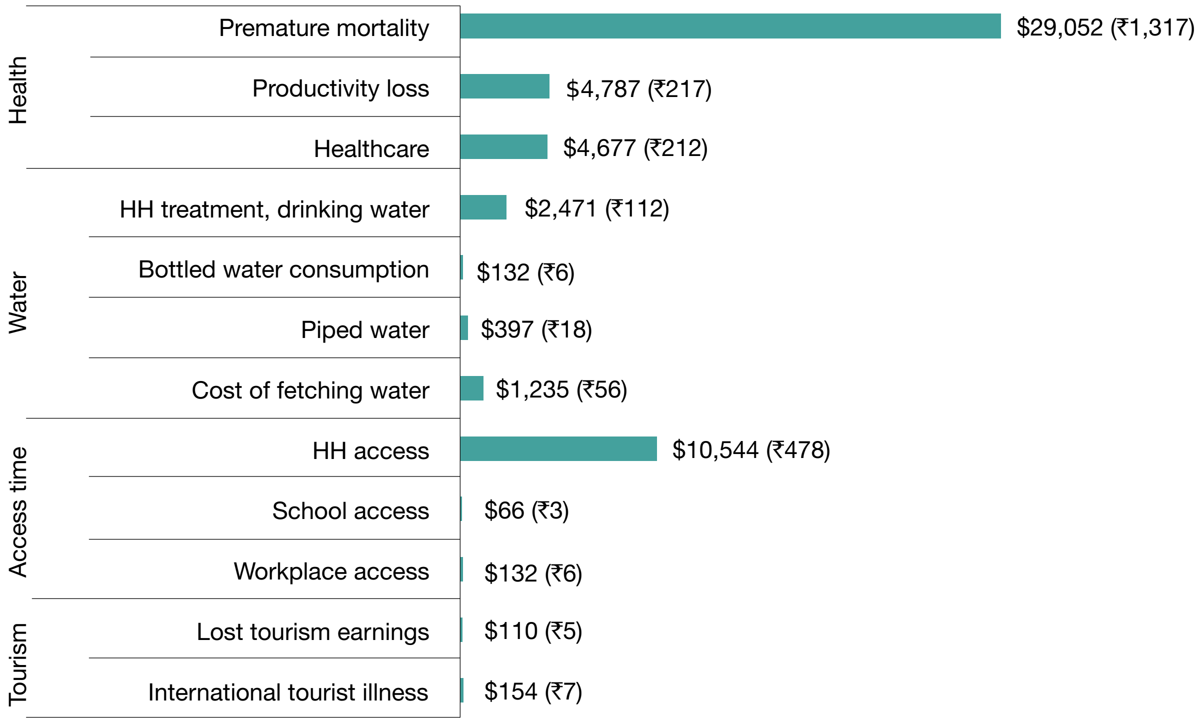
FIGURE E.1 COMPOSITION OF ECONOMIC IMPACTS OF INADEQUATE SANITATION, 2006



(in billion)

[2] Throughout this report, the symbol $ and other references to dollars always refer to US dollars. Dollar values are based on the 2006 exchange rate of $1 = ₹45.3325. The Indian rupee is represented by the symbol ₹.

FIGURE E.2 ECONOMIC IMPACTS OF INADEQUATE SANITATION, BY SUBCATEGORIES, 2006



(US$ in million; ₹ in billion)

Health-related economic impacts of diseases

Under the health-related impacts of ₹1.75 trillion ($38.5 billion), diarrhea is the largest contributor, amounting to two-thirds of the total impact, followed by acute lower respiratory infection (ALRI), accounting for 12 percent of the health impact (Figure E.3).

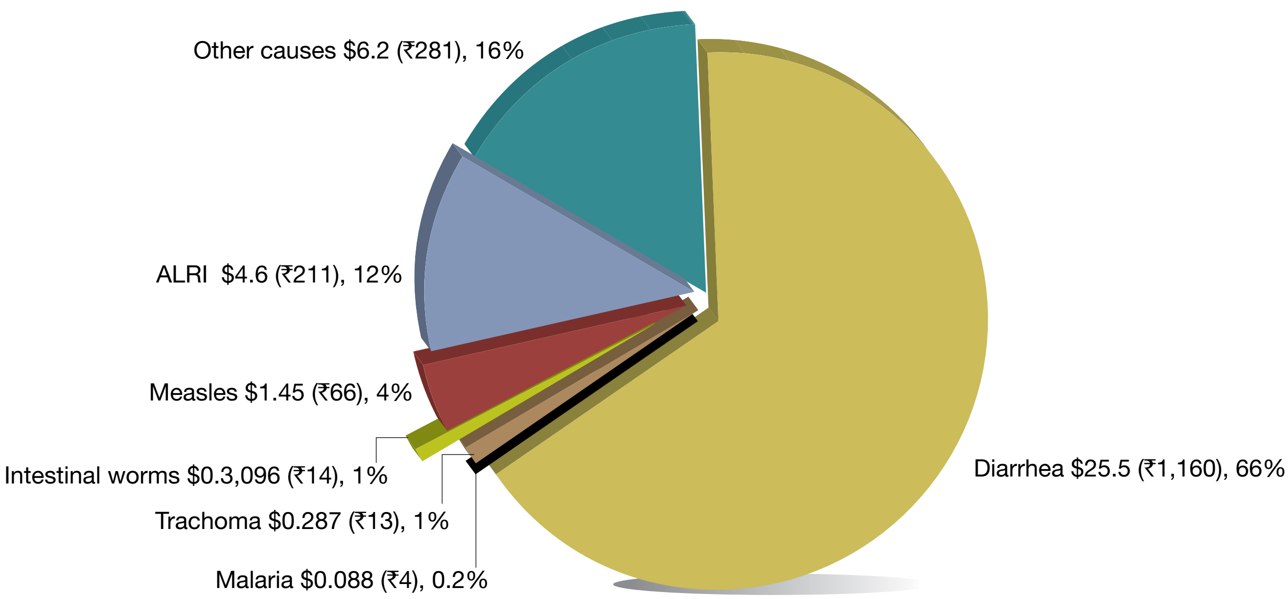
Most severe impact—suffered by children

Of the total economic losses related to premature mortality, 79 percent ($23 billion of $29 billion, or ₹1.04 trillion of ₹1.3 trillion) was due to deaths and diseases in children below age five. Diarrhea in children below age five accounted for more than 47 percent (₹824 billion, $18 billion) of the total health-related economic impacts.

Disproportionate impact on the poor

The poor in India suffer substantial harm to their lives, health, and scarce financial resources because of inadequate sanitation. Poorer families tend to lose wages and spend precious resources treating illnesses. Children in poorer households are, again, the segment that is most affected. However, mortality-related data is not available by income or wealth classification, so the differential impacts presented below are substantial underestimates, since they only include health-related impacts. Even with a conservative estimate that is based on cases of diarrhea, intestinal worms, and indirect impacts via cases of ALRI, in aggregate terms the poorest 20 percent of households are hit by a loss of ₹220 billion ($4.85 billion), which is 20 percent of the total computed losses.

FIGURE E.3 DISTRIBUTION OF HEALTH IMPACTS OF INADEQUATE SANITATION, BY DISEASE, 2006



(in billion)

Households in the poorest 20 percent that reside in rural areas bear a burden of ₹204 billion ($4.5 billion) or 28 percent of total losses to rural households. As presented in Figure E.4, the aggregate impacts are more heavily concentrated among the poor in rural areas, because most of the people in the lower quintiles[3] reside in those areas.

Per capita losses

Urban households in the poorest quintile bear the highest *per capita* economic losses due to inadequate sanitation, specifically ₹1,699 ($37.5)—1.75 times the national average of ₹961 ($21), excluding mortality impacts, and 60 percent more than the urban average of ₹1,037 ($22.9). (See Figure E.5, where "WQ1 Urban" signifies the poorest urban quintile.)

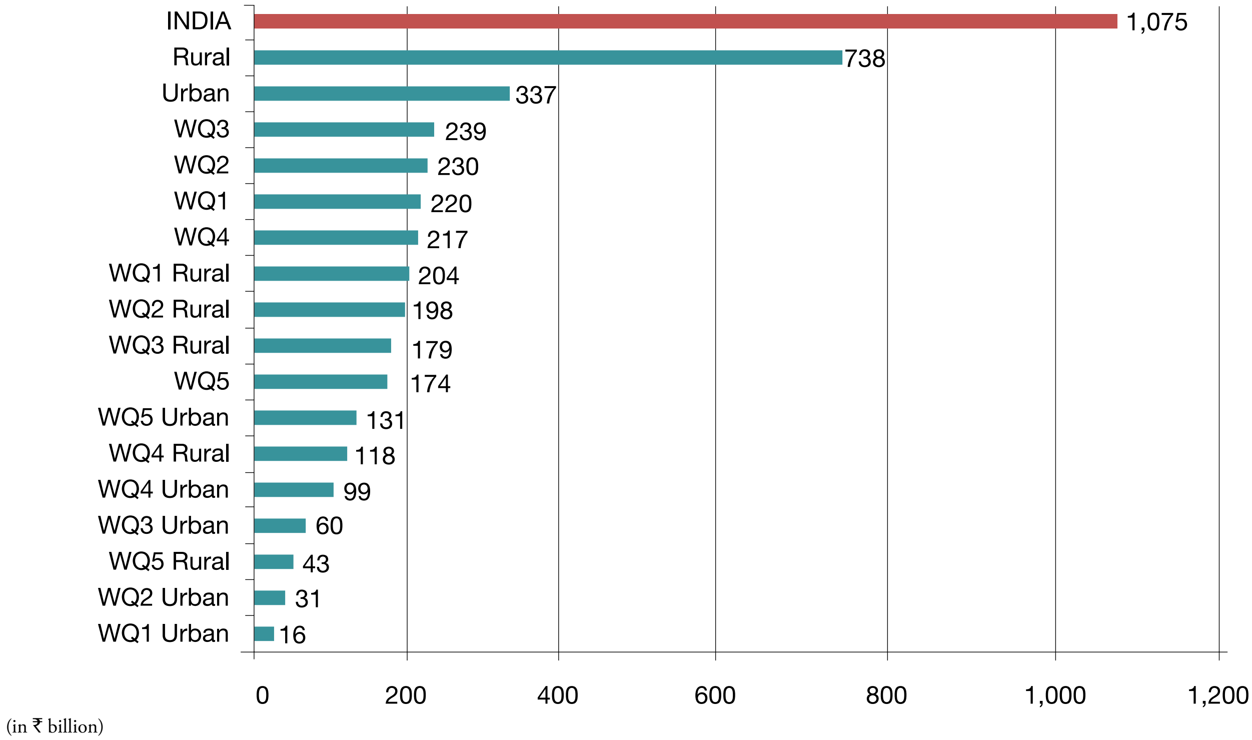
Rural households in the poorest quintile bear per capita losses in excess of ₹1,000 ($22), 8 percent more than the average loss for rural households of ₹930 ($20.5). As Figure E.4 shows, the aggregate loss for rural households in the poorest quintile is substantial (₹204 billion, or $4.5 billion) compared to that quintile's counterpart in urban areas (₹16 billion, $0.35 billion). It is also noteworthy that households in higher wealth quintiles also bear substantial impacts due to inadequate sanitation.

Monetary losses

Economic impact includes both monetary impact, that is, people actually spending or losing money, as well as non-monetary impact to which monetary values are imputed for valuation. Monetary losses, a subset of economic losses,

[3] Wealth quintiles are defined at the national level, not at the rural and urban levels. Therefore, "WQ1 Rural" denotes households in the nation's poorest wealth quintile that reside in rural areas (and not the poorest wealth quintile of rural areas), and so on.

FIGURE E.4 ECONOMIC IMPACT* OF INADEQUATE SANITATION, BY WEALTH QUINTILES AND RURAL/URBAN RESIDENCE, 2006



*Note: These estimates do not include losses from mortality and tourism resulting from inadequate sanitation, due to lack of data. Health-related losses included are only from cases of diarrhea, intestinal worms, and ALRI.

are estimated to have been ₹364 billion ($8 billion) in 2006. These losses were dominated by the cost of treating illnesses (₹212 billion, or $4.7 billion), which made up 58 percent of the total, followed by lost productivity due to illnesses (₹71 billion, $1.6 billion), the costs of treating water (₹49 billion, $1.1 billion), and accessing piped water (₹18 billion or $0.4 billion). Monetary impacts account for 15 percent of the total economic impact and are equivalent to about 1 percent of the 2006 GDP, or ₹326 ($7) per person.

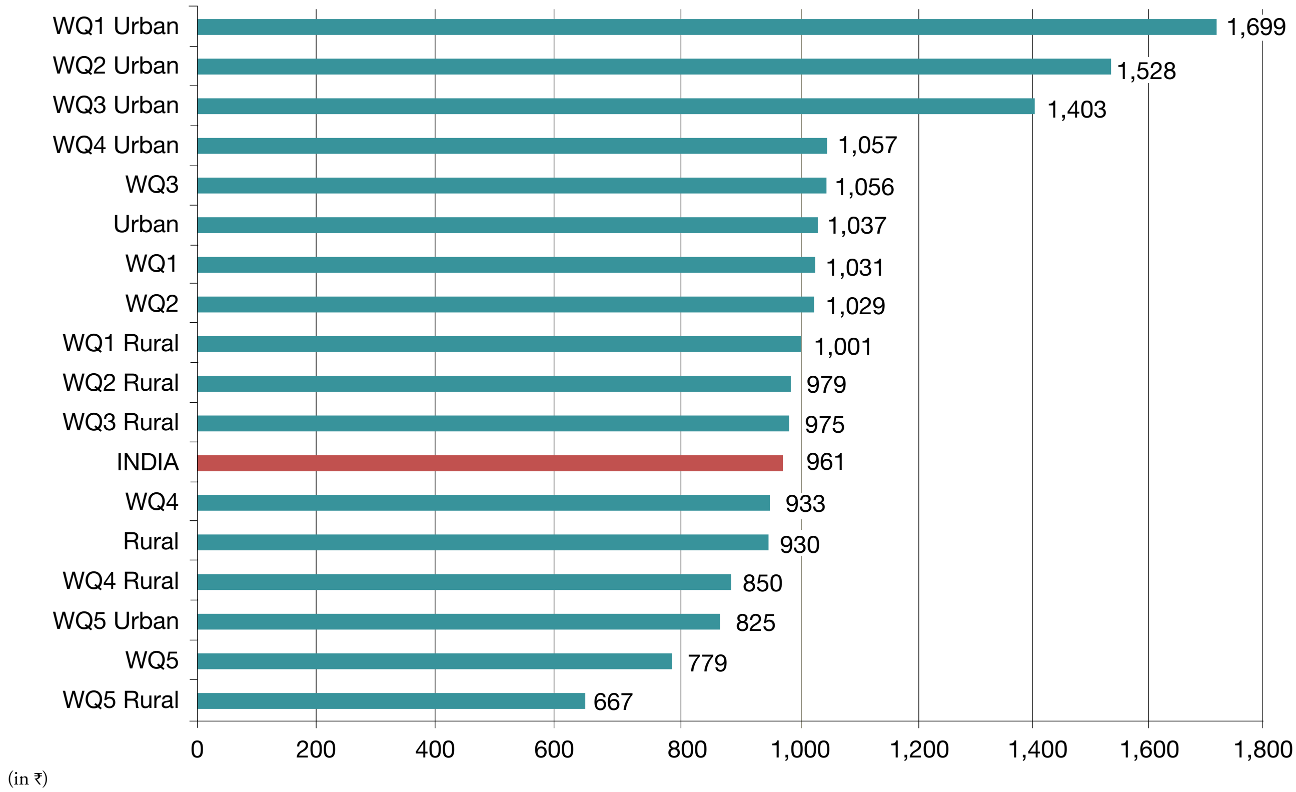
Present and future losses

Of the ₹2.4 trillion ($53.8 billion) lost, the loss of flow of 2006 economic value is ₹1.1 trillion ($24.8 billion), which is 46 percent of the total economic impact, equivalent to 3 percent of that year's GDP. Furthermore, deaths in 2006 resulted in a loss of human capital that would have generated economic flows that year and beyond. The discounted present value of these future losses are counted in 2006, amounts to ₹1.3 trillion ($29 billion), equivalent to 3.4 percent of 2006 GDP.

Potential Gains from Improved Sanitation in India

Previous research has shown that in low-income countries, investments in sanitation reap a high benefit at least five times greater than the amount invested (Hutton, Haller, and Bartram, 2007). The gains from improved sanitation are somewhat like the flip side of the economic costs of inadequate sanitation, although not all the adverse impacts of inadequate sanitation can be fully mitigated, due to a number of factors. Hence, the economic gains of improved sanitation are smaller than the loss due to inadequate sanitation. Nevertheless, this study estimates that a package of comprehensive sanitation and hygiene interventions, comprising greater use of toilets, improved hygiene practices, and improved access to water, could result in a potential gain of up to ₹1.48 trillion

FIGURE E.5 PER CAPITA ECONOMIC IMPACTS* OF INADEQUATE SANITATION, BY WEALTH QUINTILES AND RURAL/URBAN RESIDENCE, 2006



*Note: These estimates do not include losses from mortality and tourism resulting from inadequate sanitation due to lack of data. Health-related losses included are only from cases of diarrhea, intestinal worms, and ALRI.

($32.6 billion), avoiding up to 61 percent of the losses due to inadequate sanitation—or an equivalent of 3.9 percent of GDP in 2006. ***This signifies a potential gain of ₹1,321 ($29) per capita.***

Potential sanitation market

Increasing the public investment in meeting sanitation priorities, including mobilizing households to build toilets, construct and operate waste disposal systems, promote hygienic practices, combined with efforts by households to construct or upgrade to improved toilets are likely to generate a huge market for sanitary products and services in the coming years. While this is not an indication of gain in GDP, it nevertheless indicates potential *economy activity* that sanitation can generate. This study estimated the potential market for such activity.

The national cumulative sanitation market has the potential of ₹6.87 trillion ($152 billion) over the 2007-2020 period. This is projected to consist of ₹4.4 trillion ($97 billion) or 64 percent in infrastructure work and ₹2.5 trillion ($54 billion) or 36 percent in O&M (operations and maintenance) services. The annual sanitation market is estimated to grow from ₹300 billion ($6.6 billion) in 2007 to ₹683 billion ($15.1 billion) in 2020.

Study Limitations

Many economic impacts have not been covered in the current report. These include polio, skin diseases, HIV/AIDS, urinary tract infections, oral diseases, infectious heart diseases, cancers, influenza, and other diseases that are influenced by hygiene and sanitation. Impacts on pregnant women, low birth weight, and long-term health also are not included (Almond, Chay, and Lee, 2005). Also excluded from review are the costs of informal healthcare and home remedies, livestock impacts, losses to water management, agriculture, and pisciculture affected by sanitation and hygiene-related pathogens (e.g., salmonella), and impacts related to inadequate solid waste management and drainage. A number of adverse impacts have also had to be excluded from the present analysis because of a lack of robust data. These include intangible welfare benefits, such as the comfort and acceptability of sanitation arrangements; lack of convenience and privacy; lack of security, status, and dignity, especially for women and children. Poor environmental outcomes, including objectionable appearance, poor air quality, bad odors, and other aesthetic values have not been accounted for either. Other major questions that remain to be answered concern how inadequate sanitation affects trade and businesses and how it impacts the productivity of populations in different locations. These impacts are substantial and cannot be ignored, but it is difficult to impute economic values to them because robust data is lacking and there are conceptual difficulties as well. In other words, the full impact of inadequate sanitation is likely to be much higher than the estimates in this report show, since a number of health, welfare, social, and environmental dimensions are not captured in the economic analysis.

Issues for Further Consideration

The results of this exercise underline the substantial economic losses to India as a result of poor sanitation. The Government of India has been alive to this issue and has made major investments in rural sanitation since the mid-1980s. The national flagship Total Sanitation Campaign, which now covers all districts in the country, has sought to shift the focus from building more toilets to making communities totally sanitized and promoting better usage and hygienic practices. The current annual investment in this campaign is about ₹1,100-1,200 crore ($250 million to $270 million) (DDWS, 2009).

While urban sanitation was not accorded priority earlier, with the launch of the National Urban Sanitation Policy in 2008 a national initiative has begun to promote access and the appropriate infrastructure, systems, processes, and hygienic practices in urban India. The National Sanitation Rating Survey (2009-2010) of 423 Class I cities in the country has raised awareness about urban sanitation and propelled action from state and city stakeholders. National flagship programs, including the Jawaharlal Nehru National Urban Renewal Mission and the Urban Infrastructure Development Scheme for Small and Medium Towns, encourage cities to promote sanitation. It is likely that higher priority and greater investments will continue to be dedicated to the national agenda of achieving clean, livable cities. This study confirms that investments being made in rural sanitation and those proposed for urban sanitation are but critical public investments. ***This study underlines the finding that substantial investments are not only needed but can be regarded as effective only when they result in reducing the morbidity and mortality, the harmful impacts on drinking water, the costs to welfare, and the negative impact on tourism that are all associated with inadequate sanitation.*** This study further suggests the need for a new monitoring framework. There is a clear need to measure not just the number of toilets or their use or the number of sanitized communities and cities, but also the impacts of poor sanitation on health-related, water-related, environmental, and welfare-related indicators. Finally, the huge market for sanitation products and services provides an additional basis for crowding in private investments in the sector by adjusting public policies.

Areas deserving further empirical research and regular administrative data collection are suggested in Chapter 5. The proposed survey on sanitation by the National Sample Survey Organization, the Census of 2011, and the next rounds of the National Family Health Survey will also generate data. The ongoing ESI India Sanitation Options Study is expected to complement the ESI Impact Study findings and inform policies about the improved effectiveness of current and future investments in sanitation and behavior change in both rural and urban areas.

How this Report is Organized

This report is organized into five chapters. The Introduction provides the rationale for the study and reviews the current sanitation situation and government initiatives in India. Chapter 2 provides a brief overview of the methodology used to calculate the economic impacts. Chapter 3 presents the results of the analysis. Chapter 4 summarizes the estimates of the potential sanitation market. Chapter 5 provides conclusions and suggestions for further research. The Annexes present detailed methodology, additional data, and other supporting material for the report.

BASIC INDICATORS: INDIA

Indicator	Indicator value
Population (2006)	
Total population	1,117,734,000
Urban population	323,827,000 (29%)
Rural population	793,907,000 (71%)
Percent of population below age 5	11.15
Percent of population age 5 or older	88.9
Currency (2006)	
Currency exchange with US$ (₹/$)	45.3325
GDP at current prices in 2006-07	₹37.79 trillion ($0.84 trillion)
GDP per capita	₹33,908 ($750)
Sanitation (2006)	
Percent of households with improved toilets (total)	29.1
Percent urban households with improved toilets	52.8
Percent of rural households with improved toilets	17.6
Drinking water (2006)	
Percent households with piped drinking water (total)	24.5
Percent urban households with piped drinking water	50.7
Percent of rural households with piped drinking water	11.8
Infant mortality (IMR, 2005-06, per 1,000 live births)	
Infant mortality rate per 1,000 live births	57
Under-five mortality	
Mortality rate per 1,000 live births	74
Poverty and human development	
Total poverty rate (percentage of population below poverty line, head-count ratio)	27.5%
Rural poverty rate (defined as above)	28.3%
Urban poverty rate (defined as above)	25.7%
Literacy rate, men	76.9%
Literacy rate, women	54.5%
Human Development Indicator	0.612

Source: Population estimates from Technical Group on Population Projections (TGPP and NCP, 2006); age distribution of population and IMR/U5MR based on data from National Family Health Survey-3 (NFHS-3) (Measure DHS and IFC Macro, 2008); sanitation and drinking water coverage from NFHS-3 (IIPS and Macro International, 2007); average annual exchange rate from Reserve Bank of India (Reserve Bank of India, 2009); GDP is from Ministry of Finance (Department of Economic Affairs, 2009). Poverty and HDR Sources: Poverty (Planning Commission [2004-2005]); Literacy, Human Development (Human Development Report 2009).

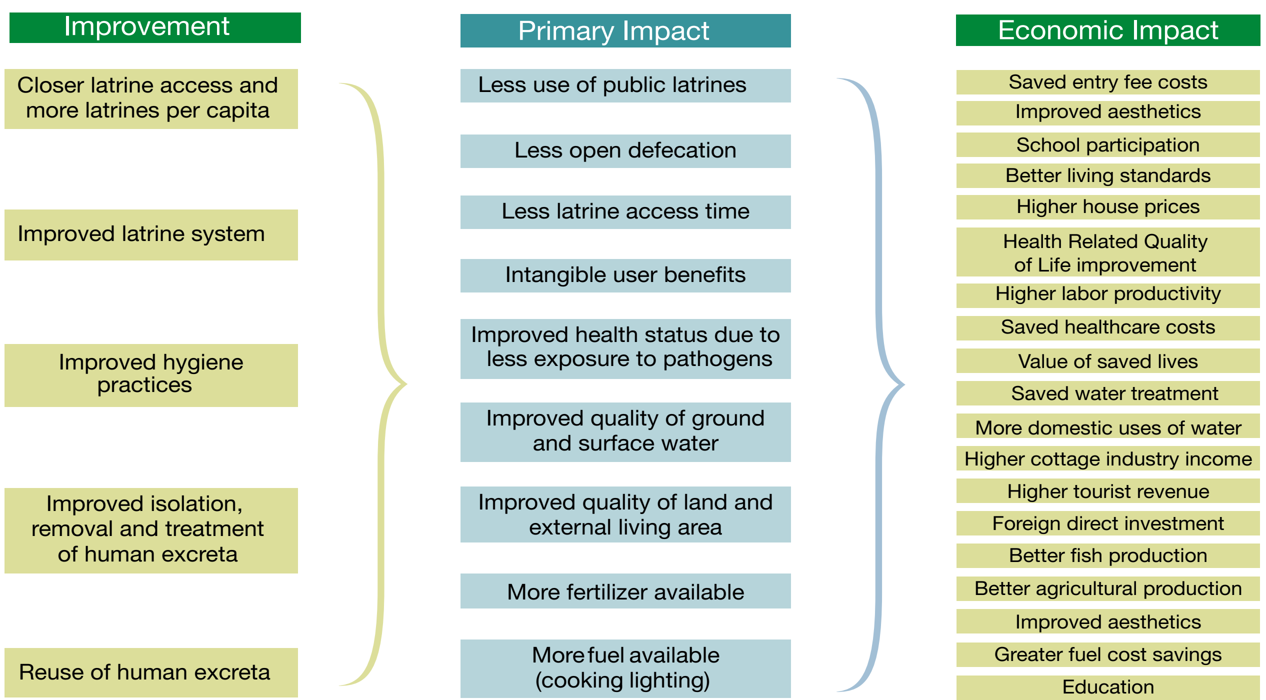
1. Introduction

WHY SANITATION?

Lack of adequate sanitation is a major cause of deaths and diseases in developing countries. Poor sanitation not only adversely affects the availability and quality of water, but also has the same harmful effects on education, on welfare, on tourism, and on people's time-use and life opportunities in general. Over the last two decades the importance of sanitation in South Asia's human development has been increasingly recognized, and greater public investments have been made in promoting access to and achieving improvements in sanitation. Noting its importance to ensuring basic human dignity, the South Asia Conclave on Sanitation-III (SACOSAN-III) and, more recently, the United Nations General Assembly have declared sanitation as a human right (SACOSAN-III, 2008; United Nations, 2010).

The aim of Millennium Development Goal (MDG) 7 for water and sanitation is to reduce by half the proportion of people without safe access to safe drinking water and basic sanitation by 2015. Improved sanitation also contributes in a number of ways to achieving MDG 4, "reducing child mortality," and MDG 2, "achieving universal primary education."

FIGURE 1.1 PRIMARY IMPACTS AND RESULTING ECONOMIC IMPACTS ASSOCIATED WITH IMPROVED SANITATION OPTIONS



Source: Hutton et al., 2008.
Note: "Intangible user benefits" include comfort, convenience, security, privacy. Improved aesthetics include visual effects, smell.

Since sanitation is linked in many ways to livelihoods and sustainable development in general, it also contributes to MDG 1, eradicating extreme poverty and hunger, and MDG 3, promoting gender equality and empowering women, and MDG 5, improving maternal health.

As evidence from East-Asian countries shows and as this report explores in detail for India, *inadequate sanitation also imposes a substantial economic burden* on nations (Hutton et al., 2008). Figure 1.1 presents the pathways by which improved sanitation brings about first-order impacts and then leads to many economic impacts that add up to substantial gains.

INADEQUATE SANITATION AND ITS IMPACTS

Sanitation is a broad subject covering the management of human excreta, hygiene practices, and the management of domestic, industrial, and medical wastes, animal wastes, drainage, among other things. This study looked at a core set of practices from the above list, specifically the *management of human excreta and associated hygiene practices*. This selection was not meant to discount the other factors, but was made because of the limited availability of data and to keep a focus on human excreta and related hygiene practices, which are often the cause of substantial health and environmental burdens on Indians, particularly on the poorest citizens of India.

Inadequate sanitation defined

The UN-WHO Joint Monitoring Programme for Drinking-Water Supply and Sanitation defines an *improved* sanitation facility as one that hygienically separates human excreta from human contact (JMPDWSS, 2008 and 2010). This includes facilities that flush or pour-flush to piped sewer system, septic tanks, or pit latrines; ventilated improved pit (VIP) latrines; and pit latrines with slab or composting toilets.

Unimproved facilities include defecation in the open, bucket or hanging latrines, open pit latrines or those without a slab, and facilities flushing or pour-flushing to drains or open areas (that is, not to piped sewer systems, septic tanks, or pit latrines). Shared toilets are also considered unimproved facilities.

This study builds on the above description—*inadequate sanitation being the lack of improved facilities (including safe disposal) and unhygienic practices (e.g., in washing of hands, handling of water, and personal hygiene) that break down the separation of human excreta from human contact and thus expose people to fecal-oral pathogens.*

Poor sanitation kills and causes diseases

Conventionally, most diseases related to poor sanitation have been lumped into the category of "water-borne diseases." Whereas water may be an important medium, the majority of water-related diseases are in fact in the fecal-oral category (Cairncross, 2003). A considerable body of scientific knowledge has established that diseases caused by poor sanitation and hygiene are viral, bacterial, parasitic, protozoal, helminth, and fungal in nature (Hutton et al., 2008).

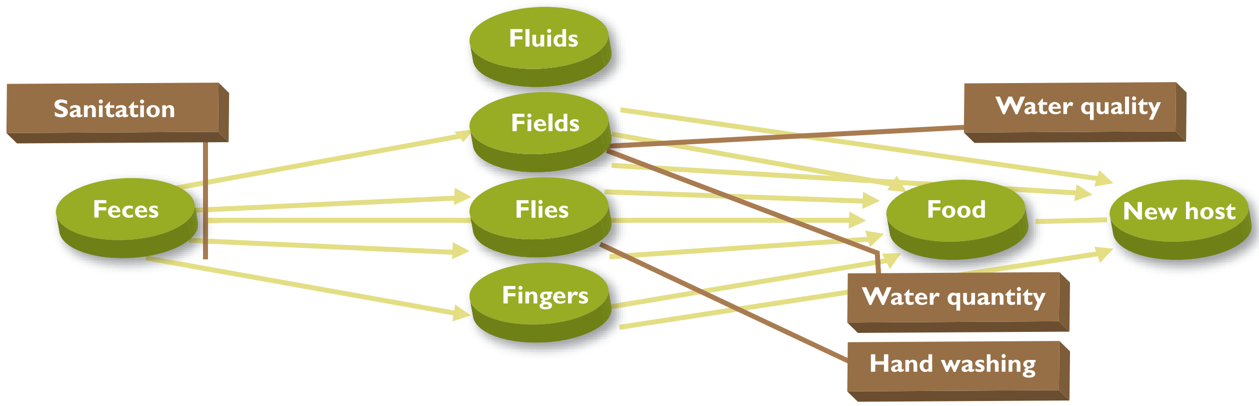
These diseases can be passed directly, from the infected surface of a latrine, through water or other fluids, person-to-person, by flies, or via soil. Food can also act as an intermediary for all of these direct transmission pathways (Hutton et al., 2008). Figure 1.2 shows how disease transmission takes place through and how sanitation and hygiene interventions can break disease transmission.

> "One gram of feces can contain: 10,000,000 viruses, 1,000,000 bacteria, 1,000 parasite cysts, and 100 parasite eggs."
>
> Source: WHO, 2008c.

As estimated in this report, diarrheal diseases resulting from poor sanitation and hygiene kill more than 400,000 persons in India every year. Contact with human excreta is a source of many deadly diseases with symptoms of diarrhea. Some of the common pathogens that cause diarrhea are viruses and bacteria (Vibrio cholerea, E.coli, Salmonella). Adults and children get diarrhea and other diseases from ingesting disease-causing germs in human excreta. This results in dehydration, malnutrition, fever, and even death, especially of children and those with compromised immune systems, like older persons and HIV/AIDS patients (Suresh et al., 2006).

In turn, malnutrition resulting from diarrhea can lead to enhanced vulnerability to diseases like measles, malaria, and respiratory infections, especially in children. Other illnesses linked with fecal transmission are polio, hepatitis A and E, intestinal worms, skin diseases like scabies, and eye infections like trachoma that can cause blindness. Polio can cause physical deformities and disability, hepatitis can lead to liver

FIGURE 1.2 TRANSMISSION PATHWAYS OF DISEASES CARRIED BY FECES, SHOWN BY THE F-DIAGRAM



Source: After Wagner and Laniox (1958), cited in Hutton et al., 2008.

infections and related problems, and intestinal worms can cause cognitive impairment and anemia.

Both the fecal-oral pathogen load and the risk of environmental exposure are very high in India, putting the country in the highest risk category in WHO's six-category classification. India falls in the risk category defined as:

> Population not served with improved water supply and no improved sanitation in countries which are not extensively covered by those services (less than 98 percent coverage), and where water supply is not likely to be routinely controlled. (Prüss-Üstün et al., 2004, p. 1,333).

The lowest-risk category is where the risk of environmental exposure to fecal-oral pathogens is very low and there is no transmission of diarrheal diseases by water, sanitation, and hygiene. Compared to this lowest category, the relative risk of contracting diarrheal diseases is estimated to be 11 times higher in highest-risk category, to which India belongs.

The high incidence of diarrheal and other diseases resulting from fecal-oral transmission indicates the inadequacy of sanitation in India.

Inadequate sanitation impacts water

UNICEF's Multi-District Assessment of Water Safety, part of a global study of water quality in eight countries (including India), concluded that water quality standards were relatively better in India than in the other study countries. But this same study, covering all districts of Madhya Pradesh and 13 districts from 11 other Indian states (11,757 sources tested), also showed that 40 percent of Indian water sources suffered bacteriological contamination attributable to poor sanitation (UNICEF, 2008). An important point regarding improved sanitation is that it is not enough to increase access to improved toilets—it is equally important to ensure the safe collection, conveyance, and treatment of sewage so that it can be safely released into the environment. An earlier study commissioned by the Government of India, conducted by the National Insitute of Urban Affairs (NIUA) from 1998 to 2003, examined 300 metros and Class I and Class II towns.[4] It found that

> …while all the metropolitan cities have a sewerage system, only a third of the Class I cities and less than one-fifth of the smaller-sized urban centers have a sewerage system. However, the coverage of population by the sewerage system is partial in all these urban centers (NIUA, 2005).

[4] Class I towns in India are urban areas with populations of 100,000 and above; Class II towns are those with populations between 50,000 and 100,000. Metros are areas with 5 million or more residents.

A 2009 study of 498 Class I and 410 Class II towns reported that while the total sewage generated was more than 38,000 million liters per day, treatment capacities were only about 12,000 million liters per day, just 31 percent of what was generated. In the 35 cities with one million-plus populations, installed capacity can treat 68 percent of the total wastewater generated (11,787 million liters per day), although nearly 39 percent of the treatment plants did not conform to discharge standards into water bodies. The Ministry of Environment and Forests' Central Pollution Control Board has estimated that only 13.5 percent of the sewage from Indian cities is treated (CPCB, 2009).

A national sanitation rating of 423 Class I cities, which cover 72 percent of the country's urban population, found that 90 percent of the cities (379) had less than 40 percent of their sewage treated. Moreover, 65 percent of the cities (274) had unsatisfactory arrangements for safe collection of human excreta, whether on-site or sewerage (Ministry of Urban Development, 2010). According to the Central Pollution Control Board, organic matter and bacterial population of fecal origin continue to dominate the water pollution problem. The mean levels of biological oxygen demand have increased in 6 of the 18 major rivers, accounting for 46 percent of the total river length nationally. Groundwater is also polluted due to discharge of untreated sewage (CPCB, 2009).

The widespread contamination of water was confirmed by a national rating exercise, in which more than two-thirds of Class I cities (285 cities) failed the test for quality of water bodies (outdoor use) in or around the city. A small minority (26) of Class I cities failed even the test of drinking water quality (bacteriological and chemical parameters) in all their samples when compared to national standards (also see NIUA, 2005).

> ...water bodies are saprobic and eutrophicated near large urban centers due to the discharge of partly treated or untreated wastewater (CPCB, 2008).

Poor sanitation has harmful effects on welfare

Apart from causing mortality and morbidity and polluting water, poor sanitation in India has harmful effects on many aspects of human welfare: education, mobility, use of public space, life choices, and, ultimately, livelihoods, incomes, and general well-being.

Health and health-related quality of life play major roles in educational and economic outcomes. When sanitation is absent, this imposes restrictions on people's time, movement, and choices in daily life. Children miss school, fall behind in class due to illness, and suffer the shame of using open spaces to relieve themselves. Girls have the additional burden of inconvenience, lack of safety, and inadequate arrangements for their special needs during menstruation. The lack of sanitation facilities at educational institutions, at workplaces, and in public places causes considerable inconvenience and loss in welfare.

Inadequate sanitation harms tourism

Inadequate sanitation also impacts tourist visits and causes illnesses among tourists (Ansart et al., 2005). Over a third of tourists visiting the Indian subcontinent suffer from gastrointestinal illnesses linked to lack of sanitation (Rack et al., 2005). Tourists are also at risk of getting malaria, which is partly attributable to lack of sanitation and prevalent standing water. Tourists also mention the poor quality of toilets as a reason for their dissatisfactory tourism experience. Not having access to good toilets or seeing people defecate or urinate in the open take away from the tourism experience.

HOUSEHOLD SANITATION COVERAGE IN INDIA

While sanitation has historically been a domain of household decision making, in the last two decades households' access to toilets has improved due to the increased public priority accorded to it, mainly in rural areas. The proportion of all households with toilets, rural and urban combined, increased from 1 percent in 1981 to 29 percent by 2005-06 (IIPS and Macro International, 2007).

In 2008, 31 percent of the total Indian population, including 54 percent of urban and 21 percent of rural Indians, had access to improved toilets. However, 54 percent of the total population, including 18 percent of urban and 69 percent of rural Indians, did not have any access to toilets, while the remaining 15 percent of the total population had access only to unimproved toilets (JMPDWSS, 2010).

More detailed statistics, covering household access to toilets, are presented in Table 1.1. The table shows that during 2005-06, 17 percent of urban and 74 percent of rural households had no toilet facilities, and another 30 percent of urban and 8 percent of rural households had unimproved toilets. This implies 47 percent of urban and 82 percent of rural Indian households did not have access to an improved toilet.

Based on data from the 2005-06 National Family Health Survey (IIPS and Macro International, 2007), in 2006 about 629 million people—575 million in rural areas and 54 million in urban areas—experience the forced indignity of defecating in the open every day or resorting to unimproved toilets facilities. As a result, they suffered from the considerable direct and indirect economic impacts of poor hygiene and the unsafe disposal of human excreta.

TABLE 1.1 PERCENT DISTRIBUTION OF URBAN, RURAL, AND TOTAL HOUSEHOLDS AND DE JURE POPULATION BY TYPE OF TOILET OR LATRINE FACILITIES, 2005-06

Type of toilet/latrine facility		Urban	Rural	Total
A	**Improved, not shared**	**52.8%**	**17.6%**	**29.1%**
	Flush/pour-flush to piped sewer system	18.8	0.6	6.6
	Flush/pour-flush to septic tank	27.6	10.6	16.1
	Flush/pour-flush to pit latrine	4.7	4.1	4.3
	Ventilated improved pit (VIP)/biogas latrine	0.2	0.1	0.2
	Pit latrine with slab	1.4	2.2	1.9
	Twin pit, composting toilet	0	0	0
B	**Unimproved**	**46.7**	**82.2**	**70.6**
	Any facility shared with other households	24.2	5.3	11.5
	Flush/pour-flush not to sewer/septic tank/pit latrine	4.4	0.2	1.6
	Pit latrine without slab/open pit	0.7	2.2	1.7
	Dry toilet	0.5	0.6	0.5
	No facility/open space/field	16.8	74	55.3
	Other	0.4	0.1	0.2
C	**Missing**	**0.2**	**0.1**	**0.1**
	Total	**100.0**	**100.0**	**100**
	Number	35,579	73,462	109,041

Source: NFHS-3 (IIPS and Macro International, 2007).

As outlined in the previous section, most of the sewage from urban areas is released into the environment without treatment, resulting in pollution of water and land.

Poor households suffer higher deficits

Poor households are disproportionately affected by lack of sanitation and hygiene. More than 86 percent of the poorest urban dwellers (the bottom wealth quintile) and more than 95 percent of the poorest rural dwellers defecated in the open in 2005-06, compared to less than 1 percent of the richest (top wealth quintile) urban dwellers and less than 10 percent of the richest urban dwellers.

A study of slums in Indian cities in 2008-09 found that 10 percent of notified[5] slums and 20 percent of non-notified slums did not have any latrine facilities (NSSO, 2010). While this is an improvement over the situation in 2002 (when 17 percent and 54 percent of these slums, respectively, did not have latrines) the absolute number of affected households remains large.

Moreover, the national average hides the huge deficits in the urban areas of certain states. One study highlighted the iniquities in the provision of latrines by noting that

> in four cities (Chennai, Delhi, Mumbai, and Kolkata), not even one out of every four slum households use improved toilet facilities. In slums in Meerut, Delhi, and Nagpur, the members of about one in six households defecate in the open. Once again, the poor in these cities suffer from the worst environmental conditions. For example, in Mumbai, Delhi, Kolkata, and Chennai, not even 10 percent of poor households use improved toilet facilities. In the other four cities, the proportion of poor households that use improved toilet facilities is also low—less than 30 per cent. In Meerut, Indore, Nagpur, and Delhi, 35-47 percent of poor households have no toilet facility at all (Gupta, Arnold, and Lhungdim, 2009).

The very low coverage in rural areas has been the greatest challenge—while the poorest households are again worst off, deficits are enormous even among the other households. India's national rural sanitation program ("Total Sanitation Campaign") has targeted the poorest households for incentives (although it targeted all households for awareness generation), and as a result iniquities may be lower in rural areas than in urban areas. However, considerable challenges remain in rural areas in terms of the enormous numbers of households, especially poorer households, still lacking sanitary toilets, as well as the lack of toilet usage and sustained hygienic behavior and the challenge of coping with deaths and diseases.

SANITATION PROGRAMS IN INDIA

Sanitation is a state-level responsibility according to the Indian Constitution, with state governments being responsible for allocating resources and for planning and implementing schemes and projects for rural water and sanitation. With the 73rd and 74th Constitutional Amendments (1993, 1994), sanitation was devolved to rural self-governments (Panchayati Raj Institutions) and urban local bodies, respectively. At the national level, the Ministry of Rural Development, and the Ministry of Urban Development (MoUD), and the Ministry of Housing and Urban Poverty Alleviation are nodal ministries for supporting states with technical and funding assistance in the rural and urban sanitation sectors. The Ministry of Environment and Forests is responsible for regulating the discharge of wastewater into land and water bodies.

Rural sanitation programs

In the rural water and sanitation sector, rural water investments enjoyed primacy in post-independence India, and sanitation showed little progress despite the declaration of the 1980s as the International Decade of Drinking Water and Sanitation. It was not until 1986 that rural sanitation received attention with the launch of the national Central Rural Sanitation Programme for below-poverty-line households, followed by state governments' own schemes. By 1991-92, these initiatives had covered about three percent of the rural population (Ministry of Rural Development, 1992).

At the turn of the 1990s, the limited coverage of central and state subsidy-driven programs contrasted with large-scale increase in access to sanitation through private initiatives.

[5] "Notified" slums in India are those that are legally recognized and usually identified for upgrading, improved services provision, or displacement/relocation depending on laws in each of the states (provinces).

Sample surveys in 1989 found that 8 percent of the rural households had constructed sanitation facilities through their own resources. Learning from program shortcomings (such as a focus on latrine construction) and from community-driven initiatives in different parts of the country, the Eighth Five Year Plan indicated a shift away from a concept of sanitation as latrines to a comprehensive concept of "total environmental sanitation," which highlighted:

- liquid and solid waste disposal
- personal, domestic, and environmental hygiene, and
- individual behavior change through information, education, and communication.

In the Ninth Five Year Plan, the necessity of converting the subsidy-based sanitation program into a demand-driven one was recognized. In 1999, the Total Sanitation Campaign was launched, in which the 'campaign' principles successfully employed in the Immunization and Literacy missions were now to be adopted in the sanitation sector.

The Total Sanitation Campaign was later scaled up as the national flagship for rural sanitation, and it now operates in all the rural districts of India. It involves the preparation of district-level proposals, usually implemented over a three-to-five-year duration, financed by the Government of India (about 65 percent of total outlay), and the states and the beneficiary households (the balance 35 percent) to cover the capital costs of household toilets for poor households. District-level Panchayats have Sanitation Missions and cells that implement the program with Block/Panchayat Samiti and Gram Panchayat-level elected leaders and functionaries. While the national guidelines provide the framework for implementing the rural sanitation program, the implementation is unique in each of the states, districts, and Gram Panchayats[6] with its local institutional, social, and economic characteristics. The Total Sanitation Campaign also finances capital subsidies for sanitation facilities in government schools (and specifies separate facilities for boys and girls in coeducational institutions) and anganwadis (centers for preschool children). The Total Sanitation Campaign budgetary outlays have grown nine-fold, rising from ₹1,350 million ($34 million) in 2001-2002 to ₹12,000 million ($300 million) in 2008-09.

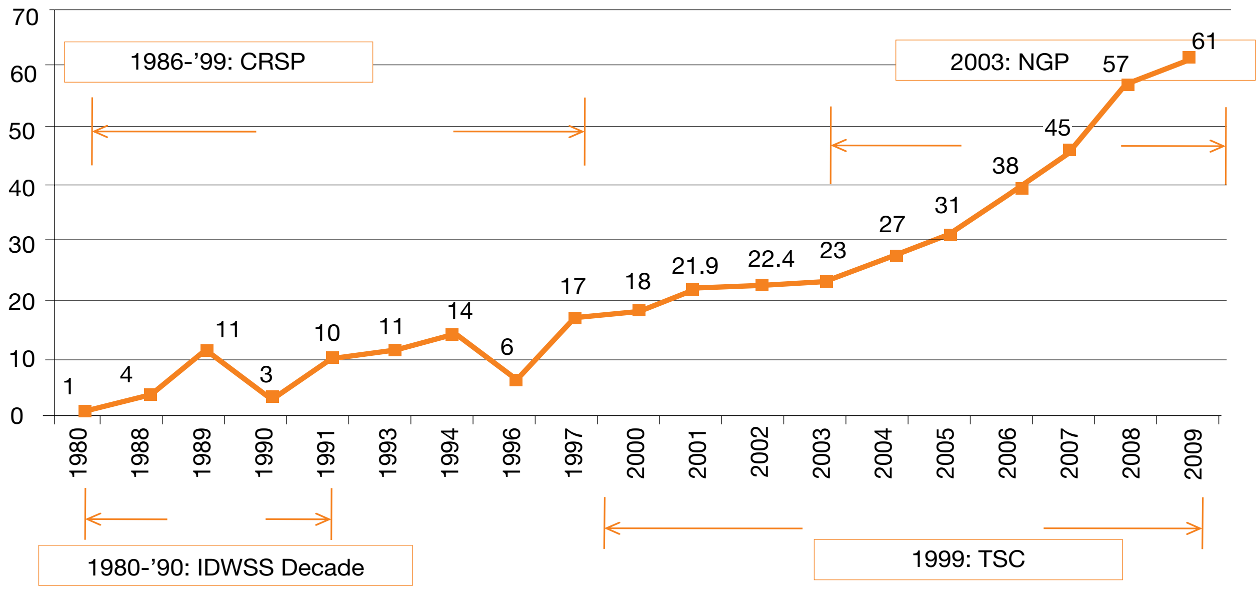
Between 1999 and 2008, the Government of India allocated about ₹4,400 crore ($1 billion), and current annual investments are about ₹1,100-1,200 crore ($250 million to $270 million). This signifies more than a nine-fold increase in the national sanitation budget since 2001 and has resulted in rapidly increasing latrine coverage, from 22 percent in 2001 to more than 60 percent as of 2009,[7] as presented in Figure 1.3.

While lessons and experiences from the Total Sanitation Campaign were emerging, in June 2003 the Government of India launched the Nirmal Gram Puraskar, which rewards local governments financially if they achieve 100 per cent open-defecation-free status and other cleanliness and sanitation goals. The Nirmal Gram Puraskar provides fiscal incentives[8] and national recognition that has mobilized a large number of Gram Panchayats to become totally sanitized—38 Gram Panchayats and 2 Block Panchayats (sub-district administrative unit comprising a set of Gram Panchayats) from six states received the award in 2005, growing to more than 12,277 Gram Panchayats, 105 Block Panchayats, and 8 Zilla (district) Panchayats in 2008.

Progress has been laudable, but challenges remain. According to the Government of India, about 40 percent of the rural population continues to defecate in the open. Sustained change in hygiene practices is yet to come about; weak monitoring and support for facility usage, poor program monitoring, and a plethora of implementation difficulties are all issues that the government and civil society organizations are seeking to address. Coverage of girls' toilets grew from 4 percent in 1993 to 35 percent in 2003, but the majority of

[6] A Gram Panchayat is the lowest elected tier of local self-government in rural India, usually comprising one or more revenue villages.
[7] The Government of India estimate of coverage is calculated on the basis of access to any type of latrine (sanitary or otherwise). In addition, it is reported that between 2005-06 and 2008-09, a large number of toilets were constructed in rural India under the Total Sanitation Campaign and by private investments. These factors explain the considerable difference between the National Family and Health Survey N-3 estimate presented in Table 1.1 and Figure 1.3.
[8] Depending on population size, Gram Panchayats receive ₹50,000 to ₹500,000 as prize; Nirmal blocks receive ₹1-2 million, and totally sanitized districts receive ₹3-5 million as reward.

FIGURE 1.3 IMPROVEMENTS IN RURAL SANITATION COVERAGE IN INDIA, 1980–2009



Source: Department of Drinking Water Supply (http://ddws.nic.in. Accessed October 16, 2008), cited in Bhaskar, 2009. Estimate for 2009 added from DDWS.

girls in rural India still do not have access to basic sanitation in schools.[9] Recent studies have shown that the improvements in many of the Nirmal Gram Puraskar villages have not been sustained, and a new generation of programmatic changes may be required.

Urban sanitation programs

Investment in and management of urban sanitation did not receive national priority in the post-independence period. Instead, that work was left to cities and states to provide for, with the national agencies providing guidance on technical standards. Investments were traditionally channeled toward building sewerage systems and, later, wastewater treatment plants in the larger cities. Most of the household toilets were installations made privately by households. At the national level, since the 1970s the Accelerated Urban Water Supply Program has financed some of the sewerage and treatment infrastructure in the cities. Sanitation for the urban poor was supported through subsidies for low-cost toilets under the national government's Integrated Low-Cost Sanitation Scheme and similar schemes of state governments). Community toilets were constructed for slum populations under the national VAMBAY (Valmiki Ambedkar Awas Yojana) scheme and its precursor, the National Slum Development Project. Thus, unlike the rural areas that have witnessed the implementation of a national-level Total Sanitation Program, programs in urban sanitation have received less attention.

In 2005, the government launched India's urban sector flagship, the Jawahar Lal Nehru National Urban Renewal Mission,[10] for 63 cities, accounting for 42 percent of the country's urban population. Its emphasis is on the provision of basic services to the urban poor, including housing, water supply, sanitation, road network, urban transport, and the development of inner (old) city areas. This national urban renewal mission consists of two sub-missions: (i) Urban Infrastructure and Governance and (ii) Basic Services to the Urban Poor. The Urban Infrastructure Development Scheme for Small and Medium Towns covers the rest of the cities and towns in the country.

[9] In India, almost every 6 out of 10 girls are unable to finish the constitutionally mandated 8 years of education; and beyond that only 3 girls out of 10 actually go on to complete 10 years of schooling (NFHS-3).

[10] The erstwhile schemes of the Accelerated Urban Water Supply program and Integrated Development of Small and Medium Towns have since been subsumed in the Jawahar Lal Nehru National Urban Renewal Mission to 63 mission cities; and as the Urban Infrastructure Development Scheme for Small and Medium Towns to cater to the non-mission urban areas (the rest of the 4,898 urban areas).

BOX 1.1 NATIONAL URBAN SANITATION POLICY

The vision of the National Urban Sanitation Policy is this:

All Indian cities and towns become totally sanitized, healthy, and livable; and ensure and sustain good public health and environmental outcomes for all their citizens with a special focus on hygienic and affordable sanitation facilities for the urban poor and women.

To transform urban India into community-driven, totally sanitized, healthy, and livable cities and towns, the policy sets out the following goals:

A AWARENESS GENERATION AND BEHAVIOR CHANGE

a) Generating awareness about sanitation and its linkages with public and environmental health amongst communities and institutions

b) Mechanisms to bring about and sustain behavioral changes aimed at adoption of healthy sanitation practices

B OPEN-DEFECATION-FREE CITIES

a) Promoting access to households with safe sanitation facilities (including proper disposal arrangements)

b) Community-planned and managed toilets wherever necessary, for groups of households who have constraints of space, tenure or economic constraints in gaining access to individual facilities

c) Adequate availability and 100 percent upkeep and management of public sanitation facilities in all urban areas to rid them of open-defecation and environmental hazards

C INTEGRATED CITY-WIDE SANITATION

1. *Re-orienting institutions and mainstreaming sanitation:*

a) Mainstream sanitation in all sectors and departmental domains as a cross cutting issue—especially in urban management

b) Strengthening national, state, city, and local institutions (public, private, and community) to accord priority to sanitation provision

c) Extending access to proper sanitation facilities for poor communities and other un-served settlements

2. *Sanitary and safe disposal:* 100 percent of human excreta and liquid wastes must be disposed of safely.

a) Proper functioning of network-based sewerage systems and ensuring connections of households to them wherever possible

b) Proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.)

c) All the human wastes are collected, safely confined, and disposed of after treatment—no hazard to public health or environment

3. *Proper operations and maintenance (O&M) of all sanitary installations:*

a) Promoting proper usage, regular upkeep, and maintenance of household, community, and public sanitation facilities

b) Strengthening Urban Local Bodies to provide, or cause to provide, sustainable sanitation services delivery

The policy envisages the preparation of State Sanitation Strategies within the overall national policy framework. In turn, cities are expected to prepare their citywide sanitation plans, assisted by the state government and the Ministry of Urban Development.

Source: Ministry of Urban Development, 2008.

While there is no explicit allocation for urban sanitation, the Ministry of Urban Development (2008) reported in November 2008 that 19 percent of the National Urban Renewal Mission's projects (66) pertained to sanitation. Regarding the scheme for small and medium towns, 94 of its 662 approved projects (as of October 2008) pertained to sewerage. Investment in slum sanitation by providing individual and community toilets is now an activity that forms part of the Jawahar Lal Nehru National Urban Renewal Mission. A major breakthrough in urban sanitation was made when the government, in discussion with the states, constituted a National Urban Sanitation Task Force in 2005. The purpose of the task force, comprising eminent policy makers, practitioners, experts, and NGOs, was to take stock and formulate a comprehensive policy to deal with the challenges of India's urban sanitation. Based on its recommendations, the National Urban Sanitation Policy was approved by the government in October 2008. The policy seeks to comprehensively address the issue of full-cycle human excreta management (access, safe collection, conveyance, treatment, and disposal) and associated hygiene behaviors (see Box 1.1).

Considerable policy progress has been made in the implementation of the National Urban Sanitation Policy in India since its launch in 2008. State sanitation strategies have been formulated for Maharashtra, West Bengal, and Madhya Pradesh, while 12 more states are drafting their sanitation strategies. The Ministry of Urban Development and external agencies have funded cities to prepare city sanitation plans, and 150 cities were doing so as of August 2010. Several state governments, institutions, NGOs, and international agencies are partners in this effort. To raise awareness about urban sanitation and recognize excellent performance in promoting it, the government carried out a *National Sanitation Rating* survey of the 423 Class I cities on urban sanitation indicators and published the results in May 2010, which generated considerable national interest. Other activities, like the National Service Level Benchmarking Initiative for select cities, are supportive actions intended to help elevate the priority accorded to sanitation and wastewater management. However, the implementation of these new measures will take time to show results on the ground.

Other initiatives in urban sanitation

Supportive national-level activities in urban sanitation also include the Integrated Low Cost Sanitation Scheme, which the government initiated in 1980-81 for the replacement of service latrines and the rehabilitation of workers engaged in the occupation of manual cleaning. About 2.3 million service latrines (of the 5.4 million reported by the 1989 National Sample Survey) were converted into sanitary ones by July 2007, and more than 50,000 scavenging workers were rehabilitated. But conservative estimates showed that more than 0.12 million workers remained to be retrained (Ministry of Housing and Urban Poverty Alleviation, 2006). The guidelines for this scheme were revised with a new target of converting 600,000 dry latrines into water-borne flush toilets during 2007-2010. The Self-employment Scheme for Rehabilitation of Manual Scavengers, launched in 2007 under the Ministry of Social Justice and Empowerment, aims to provide alternative occupations via self-employment to those who manually remove human excreta from remaining dry toilets and to assist their dependents by skills training and financial assistance (loans and subsidies).

The Ministry of Environment and Forests is the custodian of rivers and surface water bodies and has been concerned with the protection of river water quality. Beginning with the National River Conservation Plan in the early 1980s, this ministry has provided technical assistance and funding to riparian cities along the country's main rivers to build and manage sewage treatment plants. The outcomes have not been satisfactory for a variety of reasons. In 2009, the National Ganga River Basin Authority was established, and it has approved *Mission Clean Ganga* with an aim to stop all untreated municipal sewage and industrial effluents from flowing into the Ganga River. The authority estimates that ₹15,000 crore (₹150 billion) will be needed in the next 10 years to create treatment and sewerage capacity to meet this goal (National Ganga River Basin Authority, 2009). To sum up, while the past decade has witnessed increased attention to urban sanitation, especially in the wake of higher awareness about issues concerning an urbanizing India, and while the coverage of households by toilets is better in urban areas than in rural ones, nevertheless safe management of the complete cycle of human excreta up to its disposal/re-use has just started as a project. Access to individual and community sanitation facilities remains a knotty problem with unresolved deficits, since access to such facilities is tied to the nature of urban settlements and to tenure and other laws that prevent sustainable solutions.

2. Overview of Methodology

This study followed a standard peer-reviewed methodology based on the ESI (East Asia and Pacific) with adaptations and modifications made for the Indian context. This chapter provides a brief overview of the scope of the sanitation analysis and explains which impacts have been included, how attribution has been made to sanitation, how economic valuations have been carried out, and what aspects have been excluded.

The study was carried out at the national level in India. While it involved analyses of sub-national data, the estimations were made for national-level impacts. They have been disaggregated as appropriate into rural and urban domains and age-classes wherever the data permitted this.

DATA SOURCES

The main sources of data for this study included:

The National Family Health Survey 3 (NFHS-3)

India's National Family Health Surveys are large, nationally representative sample surveys covering various health, demographic, social, and political topics, and they are part of the larger Demographic and Health Surveys (DHS) (IIPS and Macro International, 2007). Field interviews for the Third National Family Health Survey (NFHS-3) were conducted from December 2005 to August 2006. This survey includes information on household characteristics including demography, health services use, sanitation, toilet type, water source, and disease episodes for selected diseases including diarrhea. The present study uses NFHS-3 information for household size, toilet type, water source and access, disease incidence and treatment, age distribution, weight-for-age categories and malnutrition indices, and time taken for a round trip (to fetch water from outside household premises), as well as other estimates. In addition to the NFHS-3 final report, the study used estimates computed from individual level NFHS-3 data and estimates from the online database.

Census of India and related population projections

Estimates based on India's 2001 Census are used for population projections for the years 2006 to 2020 (TGPP and NCP, 2006).

National Sample Survey

National Sample Survey (NSS) is an annual national economic survey conducted by the National Sample Survey Organization (NSSO) of the Ministry of Statistics and Program Implementation. Summary statistics on employment, workforce participation, unemployment, and other aspects from Report No. 522, based on the 62nd round of the survey in 2005-06, are used in this report (NSSO, 2007). The present study uses estimates from NFHS-3 for consistency with other estimates, when estimates are available from both NSS and NFHS-3—for example for the population's age distribution. Because both surveys are for similar periods and are based on representative national samples, the differences between them in results represent sampling error.

World Health Organization (WHO)

The World Health Organization reports estimates for disease episodes, deaths, burden-of-disease measures, sanitation, and water. Not all of these estimates are for 2006. For example, the latest available burden-of-disease estimates are for 2004. This study uses death rates by age from the "Global Burden of Disease" study update for 2004 (WHO, 2008a). These rates are combined with 2006 population estimates by age to estimate the number of deaths from diseases caused by inadequate sanitation in 2006. This study uses WHO national-level disease-incidence estimates where available, but otherwise uses WHO regional estimates.

Other government publications

Information used in this report also derives from publications issued by the Ministry of Finance (economic variables), the Ministry of Statistics and Program Implementation (national account statistics, inflation, others), the Central Pollution Control Board of the Ministry of Environment and Forests, the Ministry of Rural Development, the Ministry of Urban Development, the Ministry of Housing and Urban Poverty Alleviation, the Ministry of Social Justice and Empowerment, the Ministry of Tourism (tourism statistics), as well as the Reserve Bank of India (exchange rates). Sources include websites, published research articles, books, and reports (see following sections for details).

SCOPE OF SANITATION

As mentioned earlier, the scope of sanitation in this study includes the management of human excreta and associated hygiene practices. It excludes elements of the wider definition ("environmental sanitation"), as presented in Table 2.1.

The Joint Monitoring Programme for Water Supply and Sanitation defines an "improved" sanitation facility as one that hygienically separates human excreta from human contact (JMPDWSS, 2008 and 2010). As presented in Table 2.2, this definition encompasses the dimension of safe collection of human excreta as well, and not just the structure.

TABLE 2.1 SCOPE OF SANITATION—ASPECTS INCLUDED AND EXCLUDED IN THIS STUDY

Included	Excluded
Human excreta management	Solid waste management
Safe isolation, confinement, conveyance, treatment, and disposal of human excreta and sewage	Animal excreta management
Access, quality, and proximity of toilets	Agricultural waste
Hygiene, including hand washing, water treatment, water storage, food handling, and bathing	Industrial waste
Wastewater management	Medical waste
	Vector control
	Food safety
	Drainage and flood control
	Comprehensive hygiene and sanitation, including aspects other than human excreta

TABLE 2.2 DEFINITION OF IMPROVED AND UNIMPROVED SANITATION FACILITIES

Improved sanitation	Unimproved sanitation
Use of the following facilities: • Flush or pour-flush to: - piped sewer system - septic tank - pit latrine • Ventilated improved pit (VIP) latrine • Pit latrine with slab • Composting toilet	**Use of the following facilities:** • Flush or pour-flush to elsewhere (that is, not to piped sewer system, septic tank, or pit latrine) • Pit latrine without slab/open pit • Bucket • Hanging toilet or hanging latrine • Shared facilities of any type • Bush or field (no facilities)

Source: JMPDWSS, 2010.

It is important to note that provision and use of improved toilets does not ensure adequate sanitation. The whole cycle of safe collection to safe disposal needs to be adhered to. Further, sanitation includes all hygiene practices that prevent human contact with human excreta. *Therefore, sanitation involves all physical infrastructure and services used for safe management (isolation, treatment, and disposal) of human excreta, as well as associated hygienic behaviors.*

SCOPE OF IMPACTS

Selection of diseases

WHO has compiled the range of diseases linked to poor sanitation and hygiene, which include gastrointestinal tract infections, helminthes-related diseases, Hepatitis, and skin, eye, and other diseases (see Annex C). Based on a review of the scientific evidence, a set of key diseases that can be partly or fully attributable to inadequate sanitation (including poor hygiene) was selected for this study, as presented in Table 2.3. (Note that this study primarily includes direct impacts only on humans.)

As presented in Chapter 1, Figure 1.1, there are a number of pathways by which improved sanitation brings about first-order impacts that in turn result in many economic impacts. A set of four negative impact categories was also identified for analysis under this study. The categories of impacts and the justification for their inclusion are presented in Table 2.4.

TABLE 2.3 ATTRIBUTION OF DISEASES TO SANITATION

Disease	Attribution
Diarrhea	Partly attributed
Schistosomiasis	Full attribution
Trachoma	Full attribution
Ascariasis	Full attribution
Trichuriasis	Full attribution
Hookworm	Full attribution
Malaria	Via malnutrition
Acute Respiratory Infection	Via malnutrition
Measles	Only mortality, via malnutrition

TABLE 2.4 IMPACT CATEGORIES CONSIDERED AND JUSTIFICATION FOR THEIR INCLUSION

Impact of sanitation on…	Reason for inclusion
Health	• Scientific evidence points to sanitation and hygiene being a key part of the causal pathways that lead to diseases included in this study. • Diseases resulting from poor sanitation and hygiene lead to substantial premature loss of life, and the economic impacts from these are expected to be large.
Water	• Water is polluted by the release of human excreta into it. This leads to costly avoidance behaviors and resulting coping costs. These need to be accounted for in a study of economic impacts. • Households use various methods (filters, boiling, etc.) and purchase bottled water to avoid using water polluted by human excreta. These recourses cost money for households. • Household members have to travel longer distances to fetch water from cleaner sources in preference to polluted water from a nearer source, leading to loss of time.
Toilet access	• Poor sanitation results in poor health, absence from work or school, and restricted mobility, especially for women. These result in loss of education, social and economic opportunities, and incomes. • People from households without toilets have to spend time going to open-defecation sites, or have to wait to use community or shared toilets more than they would if they had toilets at home. • Inadequate toilet access leads to considerable losses of privacy, dignity, security, and convenience, especially for girls, women, children, the elderly, and the infirm.
Tourism	• Tourism is an important sector for the Indian economy, contributing over $8 billion in annual foreign exchange earnings. Inadequate sanitation is likely to result in discouraging tourism and lowering potential tourist inflow. • Tourist illnesses may result in loss of welfare and money to tourists.

This ESI India study also included an additional dimension: potential sanitation markets. The huge sanitation deficit in India signals considerable potential for generating economic activities to meet the future demand for sanitation and hygiene products and services.

MONETARY AND ECONOMIC IMPACTS

This study uses a societal perspective and examines the present generation to assess economic impacts. Monetary[11] impacts are those that have a direct associated monetary expense to someone, and one that is paid for in monetary terms by someone. The payer of the expense might not be the same person bearing the physical impact. For example, an insurer may be paying the medical cost for a patient, or the government may be subsidizing healthcare.

Economic impact is a more generalized concept than monetary impacts and includes imputed monetary values for non-monetary impacts. Some imputed non-monetary impacts have a direct equivalent in terms of market value; for example, time spent away from work due to illness. However, many other imputed non-monetary impacts, like the value of a lost life, do not have monetary equivalents in the market.

Table 2.5 presents the costs estimated for different categories and subcategories of impacts.

[11] Sometimes monetary impacts are also categorized as "financial" impacts; however modern financial accounting includes imputed values of non-monetary assets and liabilities, therefore "monetary", and not "financial", is the preferred term to indicate the costs being examined.

TABLE 2.5 MONETARY AND NON-MONETARY IMPACTS CONSIDERED

Impact type	Subcategory of impact type	Economic impacts	
		Monetary	**Imputed non-monetary**
Health	Premature mortality Healthcare Productivity and welfare	Healthcare	Discounted future value of labor share of output lost due to adult and child deaths Value of children's time lost from illness Value of adult time lost due to illness and accompanying care-giving to children during illness
Water	Household treatment of drinking water Piped water Bottled water	Water treatment by boiling, using chlorine, filtering, and electronic purifiers Part of piped water cost Cost of bottled water	Value of collected wood in rural areas, and value of time spent in boiling water and in storage and handling Value of time spent hauling water from cleaner sources outside the household
Access time, user preferences, and loss of welfare	Time loss Work/school absence		Value of excess time lost accessing open-defecation sites and shared toilets Value of time of absence of girls from schools and women from work
Tourism	Tourism losses Tourist illness	Revenue loss to tourism from loss of potential tourists due to poor toilet facilities Healthcare costs due to diarrhea among international tourists	Value of lost time due to diarrhea among international tourists

ESTIMATION OF IMPACTS AND THEIR VALUATION

The study's standard method involved, as a first step, analyzing various data sources to arrive at physical units for the indicators of the impact subcategories, such as incidence of diseases, number of households using a particular treatment method, number of girls missing school, and so on. These values were adjusted to calculate estimates for the year 2006. The second step was to attribute a portion of these indicators to inadequate sanitation. These attributions were based on a review of the scientific literature. The final step was to value the impact that was attributable to sanitation. For this, costs and prices were used from official sources as well as from available studies and meta-studies. Whenever studies of significant scale and reliability were unavailable, expert opinion was sought and assumptions were made based on that.

Considerable data processing was undertaken given the multiplicity of data sources, differences in scale and coverage, varying levels of detail, and even, sometimes, varying definitions. Some of the methodological highlights are presented below. (Detailed explanations about data sets, their processing, values used for economic valuation, and assumptions for each of these categories are presented in the Annexes.)

Health

The health impacts that were measured include premature mortality, economic and monetary costs of treatment, loss of productivity and welfare due to illness, and mortality. Direct-impact diseases whose economic impact is calculated in this report include these three:

- Diarrhea-related diseases
- Intestinal helminthes (worms)
- Trachoma.

Estimates are made for all ages for mortality from intestinal helminthes and for trachoma.

Diarrhea induces malnutrition, especially among children, which in turn increases susceptibility to diseases and increases the chances of death from other diseases. This indirect burden of diarrhea is captured for children below five years using estimates of relative risk from previous studies and malnutrition estimates based on NFHS-3. The indirect impacts of inadequate sanitation and hygiene via diarrhea-induced malnutrition (see Figure 2.1) are measured in children below age five, for the following conditions:

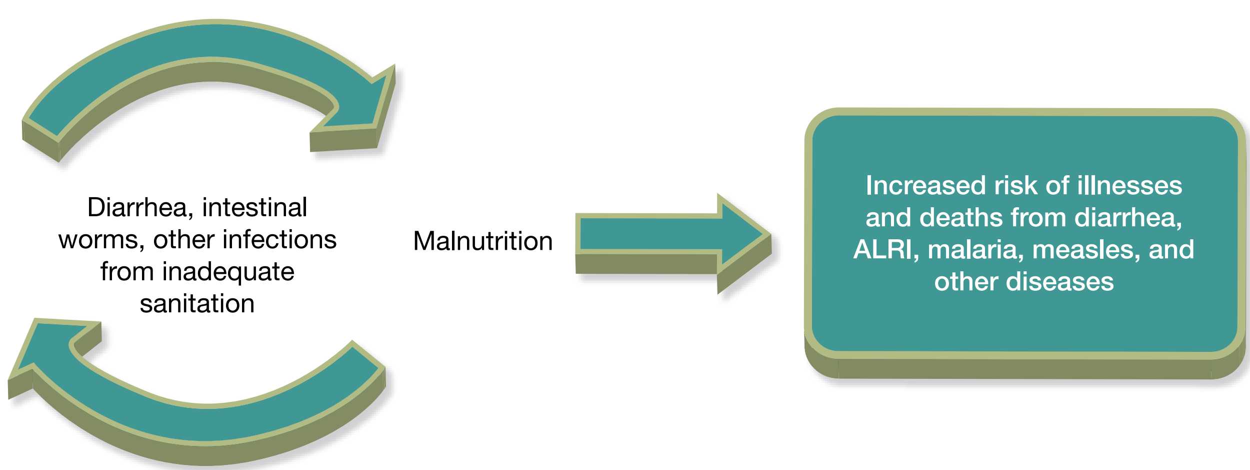
- Acute lower respiratory disease (ALRI)
- Malaria
- Measles, and
- A residual category of "other causes" of death.

Indirect mortality impacts via diarrhea-induced malnutrition in children below age five are estimated for ALRI, measles, malaria, and other unidentified diseases, while indirect morbidity (disease cases) impacts in children below age five are estimated only for ALRI and malaria cases.

For computing healthcare costs of treatment of diseases, available studies, and expert opinion of medical practitioners was used for rates of treatment.

For welfare and productivity losses, the loss of adult time is valued at less than the rate for economic loss of an adult engaged in production, at 50 percent of the full daily valuation based on unemployment-adjusted labor share of GDP per worker. Time lost by children is valued at 50 percent of the adult rate. For these valuations, the current study uses an eight-hour work day and assumes 250 working days a year.

FIGURE 2.1 INDIRECT HEALTH IMPACTS VIA MALNUTRITION



For calculating the economic value of a human life, the human capital approach was selected, although instead of using the average earnings of employees, the unemployment-adjusted labor share of GDP per worker was used. (See Box 2.1)

BOX 2.1 VALUATION OF HUMAN LIFE

While ascribing an economic value to the loss of life is fraught with problems, economic methods have been developed to impute values to different facets of life. Two common methods were considered for this study:

The Value of Statistical Life (VOSL) method: Studies based on the Value of Statistical Life approach implicitly or explicitly estimate what people are willing to pay for a reduction in chance of death, or what they are willing to accept for an increase in chance of death. Several "willingness to pay" studies ask respondents directly about what they would be willing to pay for reduction in chances of death or disease.

The Human Capital Approach: The Human Capital Approach aims to capture loss of productive human capital, reflected in loss of output due to a premature death. This approach accounts for economic loss during the productive years by valuing lost output due to premature death. The usual approach is by estimating the present value of future earnings of employees. Earnings of employees are a market-determined price of labor, influenced by relative bargaining power in the factor markets. Market imperfections may distort market prices, and earnings of employees may not reflect the contribution of labor to output. Market distortions of prices have been cited as a reason for not using market prices in such cost benefit studies, and shadow prices or opportunity costs have been recommended instead (Drèze and Stern, 1990). Labor share of output per worker captures the contribution of labor to output better than average compensation of employees. India lacks recent, large, representative, population-based VOSL studies for reduction in probability of death and disease. Using this method therefore would necessitate transferring VOSL values from OECD countries, but this was deemed inappropriate.

The Human Capital Approach was deemed suitable for the study—except that instead of using average earnings of employees, the unemployment-adjusted labor share of GDP per worker was used. This was calculated to be ₹50,589 ($1,119) (₹37,442 or $828 for rural and ₹84,918 or $1,878 for urban workers). These values are used to estimate the present value of the lost future labor share of output per worker, using a real annual growth rate of labor share of output per worker of 0.02 (2 percent), annual discount rate of future income of 0.03 (3 percent), and a working life from ages 15 to 65. Thus the present value of the expected lifetime contribution to output by children below age five was ₹1.75 million ($38,706), ₹1.91 million ($42,172) for persons between ages 5 and 14, and ₹1.24 million ($27,347) for persons above age 15.

Water

Water-related economic costs are considered in the following categories:

- Household treatment of drinking water
- Bottled water consumption
- Piped drinking and non-drinking domestic water production, and
- Fetching water from a cleaner source.

The cost of household treatment of drinking water at the national level is the sum of the estimated costs of household treatment computed for different treatment methods separately: boiling; straining through cloth; using alum, bleach, or chlorine; using ceramic, sand, or other water filter; and using an electronic water filter. The monetary and economic costs are calculated using a mix of direct costs or through the cost of cooking fuel used (for boiling).

Bottled water consumption costs are calculated using the reported proportion of households consuming bottled water and assumptions about volume and costs reported from the market.

Piped water costs are calculated by separating out water for drinking and non-drinking uses; using consumption and cost estimates from studies; and apportioning half the costs to sanitation (the balance being accounted for by other factors, like convenience).

Concerning *fetching water from a distance*, this study assumes that half of the extra time spent for fetching water from a distance is due to sanitation-related reasons.

Access time, user preference, and welfare loss

Three categories of impact were considered, those caused by:

- Open-defecation and shared toilets
- School sanitation and hygiene, and
- Workplace sanitation and hygiene.

Cost of excess time used to access shared toilets and open-defecation areas was calculated separately for persons in different age groups and for urban and rural areas. It was assumed that a person spends an extra 15 minutes in urban areas and an extra 20 minutes in rural areas to access open-defecation facilities compared to a person with a private toilet, while the extra time spent in journey and waiting to access shared toilets was assumed to be 5 minutes in both urban and rural areas. One toilet trip per day was assumed.

The study calculated the economic loss for school sanitation and hygiene only for school days missed by girls of post-puberty age, due to lack of a girls' toilet at school. It was assumed that, on average, a post-puberty girl in a school without a girls' toilet will miss 10 days of school in a year due to lack of sanitation and hygiene at school.

The study also assumed that 10 percent of rural and urban women would be absent for 10 days a year due to lack of adequate sanitation and hygiene at the workplace, a barrier especially during their menstrual period. On average, this loss is equivalent to one day (per year) for every working woman in rural and urban areas.

Tourism

Tourism losses are estimated as follows:

- Tourism potentially lost due to poor sanitation and hygiene, and
- Cost of illnesses among foreign tourists attributable to poor sanitation and hygiene.

The estimated loss to tourism due to inadequate sanitation is calculated as the difference between actual revenue earned by the tourism sector and the counter-factual potential revenue that would have been earned if sanitation had been adequate. This is computed by analyzing surveys reporting the number of tourists sufficiently dissatisfied to result in the loss of one tourist visit, that is, the tourist not returning or influencing another potential visitor not to visit the country. Potential revenue from tourism given adequate sanitation is estimated as the product of the potential number of tourists and the average spending per tourist.

Only gastrointestinal illnesses among foreign tourists were included, based on available data from published research. The treatment costs of their illnesses were based on unit treatment costs established by studies. Two days were assumed to be lost per gastrointestinal infection episode for each tourist. In addition, productivity and welfare losses were also computed.

As is clear from the foregoing account, the base values of indicators, their valuations, and assumptions (wherever they have been made) have all tended to be very conservative. Therefore, if anything, the estimates made by the current estimates are on the low side—the actual value of impacts is probably much higher.

Differential impacts on the poor

The availability of data across different socioeconomic classes is limited to the NFHS-3, which surveyed the asset ownership of households and based on which a wealth-index was created that divides all households into five wealth quintiles, each with about 20 percent of households ranked according to their wealth. NFHS-3 data also identifies whether a household is urban or rural, but the wealth quintiles are identified only at the national level and not within rural and urban areas. Therefore, a quintile labelled "WQ1 Rural," for example, stands for households in the poorest national wealth quintile that are also located in rural areas (and not the poorest quintile of rural households).

Limited data exists on morbidity patterns, so only the costs of health treatment have been computed in the wealth analysis. Mortality-by-disease is also unavailable for disaggregated wealth categories, so mortality estimates have also been excluded. Thus, the study results are underestimates of the relative economic impact on the poorer households, since poorer households are more likely to have deaths from diseases caused by inadequate sanitation. This provides a limited picture of inequities, due to under-reporting and classification problems as well as other factors, like greater health-seeking behavior among the rich. Nevertheless, it does provide some indication of differential impact across wealth categories.

Gains from sanitation

Economic gains from sanitation are somewhat like the reverse side of the economic costs of inadequate sanitation, comprising what can be saved by avoiding losses in health costs, water-related costs, access time, and tourism due to inadequate sanitation and hygiene. Practically speaking, it is very difficult to eliminate all the losses by making sanitation interventions in developing countries, since these are likely to be partial in their implementation, the impacts follow multiple pathways, and effects include geographical spillover of sanitation-related diseases.

A number of meta-analyses have been conducted to document the health impacts of different types of interventions in improving access to sanitation facilities, hygiene practices, and water quantity and quality (World Bank, 2008a). Since most of them have focused on reducing the incidence of diarrhea among infants, this analysis has attempted to answer the question: What are the impacts, in terms of reducing relative risk, of the various sanitation options and interventions?

Based on a review of those meta-analyses, the interventions have been classified into five types:

1. Improved toilet access and use
2. Improved hygiene behaviour (including toilet use)
3. Improved access to adequate quantity of water
4. Improved access to safe quality water, and
5. Safe confinement and disposal of fecal matter (septage/sewage treatment).

The estimates of these intervention activities were applied to health impacts in order to estimate potential gains from each category. However, it should be noted that these are based on meta-studies and, therefore, it is difficult to neatly separate out the various categories or measure combined effects.

Sanitation markets

In order to quantify the increased economic activity (although not any additions to GDP), a simple model was constructed to estimate the national market for sanitation products and services in India from 2007 to 2020. Following the government's policy targets, it was assumed that all households in India will have access to toilet facilities, either within the household or via community toilets, by 2012, ending the practice of open defecation (Bhaskar, 2009). It was also assumed that the current manually cleaned dry toilets and unimproved open-pit toilets will be converted to improved toilet types by 2012. The role of community toilets was also assumed to be enhanced in order to provide access to toilet facilities over the next few years, and that this role would then decline as households are able to move to owning and using their own individual toilets.

It was also assumed that the number of toilets with sewer connections and septic tanks will grow slowly over time, with more use of sewer-connected toilets by urban households. With gradual improvements, the percent of city/village wastewater collected (and treated) is expected to rise from an estimated 33 percent of wastewater collected (and 24 percent treated) in 2007 to 59 percent of wastewater collected (55 percent treated) in 2015, and then to 81 percent of wastewater collected (80 percent treated) in 2020. In the initial years, drainage systems are projected to receive wastewater from an estimated 25 percent households with on-site sanitation in urban areas (an insanitary disposal method), and this is projected to decline to 0 percent by 2020, with all sewage diverted to proper on-site and sewerage installations.

In rural areas, it was assumed that initially 5 percent of households using toilets with pits and septic tanks were treating wastewater on-site, and that this will increase to 59 percent in 2020. Almost all wastewater treatment in rural areas was assumed to be done through on-site soak-pits and sludge cleaning and treatment services.

Unit capital costs for toilets and treatment systems, as well as operations and maintenance (O&M) expenses, are based on studies and expert opinion. Accounting for population growth, the annual and cumulative market size was calculated for each category of toilets, collection/conveyance systems, and treatment systems.

IMPACTS NOT INCLUDED

Some adverse impacts were difficult to capture in economic terms, either because reliable data on universe estimates was missing, attribution to sanitation was difficult, or methods of valuation were unavailable. Therefore, the following have not been included in the current exercise.

Other health impacts

Sanitation-related diseases other than those listed in the previous sections are excluded, as have informal treatment of diseases and treatments at home. "Quality of life" health impacts were not included in the measure either, nor were health impacts related to livestock and animal health.

Water resources

Apart from impacting the availability and quality of water, poor sanitation also results in other indirect losses, including losses to agriculture, to cultural and religious uses of water, and, in many locations, to commercial uses such as fish production. Another aspect of water is the welfare benefits to household activities. Conceptual difficulties (e.g., some benefits are noted as well by use of wastewater in agriculture and pisciculture) as well as the lack of data prevent a full appreciation of these impacts in economic terms.

Individual needs and preferences, especially for women and children

Intangible welfare benefits are excluded, including the comfort and acceptability of sanitation arrangements, convenience and privacy, security, status, and dignity. It is well known that these are key factors impeding the welfare of women, children, and the elderly. However, it is difficult to ascribe an appropriate economic value to such deficits. Hidden behind the economic loss by way of treatment costs, are the losses in missed opportunities for children and the subsequent loss of future productivity, income, and employment.

Environmental impacts

It is commonplace to associate poor sanitation with poor environmental outcomes in terms of visual impact, smell, and other aesthetic values. Anecdotal evidence exists for valuation of land being affected if sanitary conditions are not acceptable; outdoor air quality is also known to be affected. However, these are dimensions that the current exercise was unable to quantify.

Other impacts

While an attempt has been made to estimate tourism losses, these can be considered conservative since tourism destinations are great in number and each has its own local peculiarities. Similarly, how sanitation conditions affect trade and businesses, and how these impact the productivity of populations in different locations, are additional questions that remain to be answered.

Detailed notes on sources of data and methods are presented in the Annexes.

3. ESI Results

This chapter presents the results of the analysis. Health impacts are explained first, followed in turn by impacts relating to domestic water; welfare losses due to loss of access time; and finally, the impacts on tourism. The total economic impact of inadequate sanitation is then summed up. The chapter ends with a presentation of the differential impacts of sanitation on the poor; potential gains from sanitation; and a sensitivity analysis. Note that unless otherwise indicated, all the health and economic measures discussed in this chapter are based on 2005 and 2006 observations.

HEALTH IMPACTS

The most important causes of morbidity and mortality that can be attributed to inadequate sanitation are diarrhea and acute lower respiratory infection (ALRI). About 88 percent of diarrhea is attributed to inadequate sanitation, poor hygiene, and unsafe water supply. ALRI causes malnutrition, which in turn causes diseases and deaths, especially among children. Only half of the diarrhea and ALRI cases in children are treated at a medical facility.

Diarrhea and ALRI among children under five years

Children below age five in India numbered about 125 million and made up 11 percent of the total population in 2006. For this year, this analysis estimates annual cases of diarrhea in children below age five to be 192 million, and for persons in all age groups to be 575 million. Rural areas account for 72 percent of all diarrhea cases, and 76 percent of cases in children below age five, while urban areas account for 28 percent of all cases, and 24 percent of those in children below age five.

Malnutrition induced by sanitation-related diseases is attributed to an annual 21.8 million cases of ALRI among children below age five. This burden among children under five is disproportionately shared by the rural population, which accounts for 81 percent of that age group's ALRI cases attributable to inadequate sanitation and 76 percent its diarrhea cases. The incidence of diarrhea and ALRI attributable to inadequate sanitation is presented in Table 3.1.

TABLE 3.1 ANNUAL CASES OF DIARRHEA AND ALRI ATTRIBUTABLE TO INADEQUATE SANITATION, 2006

Population	ALRI cases: children below 5 years		Diarrhea cases: children below 5 years		Diarrhea cases: all ages		Share in population	Share in population below 5 years
	Number	Percent	Number	Percent	Number	Percent	Percent	Percent
India	21.8	100.0	192.2	100.0	575.0	100.0	100.0	100.0
Rural	17.7	81.4	145.6	75.8	414.0	72.0	71.0	75.9
Urban	4.0	18.6	46.6	24.2	161.0	28.0	29.0	24.1

(Numbers in million)

Health impact of disease incidence

Mortality. About one in every 10 deaths in India is from causes related to inadequate sanitation and hygiene. Deaths from diarrhea alone accounted for every 20th death. Diarrhea induced by inadequate sanitation is estimated to have caused 450,000 deaths in 2006, of which 395,000 (88 percent) were among children below age five. Deaths caused by malnutrition induced by inadequate sanitation-related diseases in children under five numbered 315,000, and of that number, ALRI deaths numbered 115,000.

As presented in Figure 3.1, among children under five, inadequate sanitation causes more than 30 percent of all deaths. Diarrhea alone accounts for more than 17 percent of all deaths in this age group and more than half of all sanitation- and hygiene-related deaths in this age-class.

ALRI is another major cause of under-five mortality: one in every twenty of all deaths and one in six of the sanitation- and hygiene-related deaths. Other mortality-causing diseases attributable to inadequate sanitation among the population at large include measles (about 5 percent of all deaths and 1.7 percent of under-five deaths), malaria (0.24 percent and 0.1 percent for the two age classes), helminthes, and residual "other diseases" (20 percent and 7 percent).

Time lost due to diseases and their treatment

Sanitation-related diseases cause extensive loss of time for adults as well as children. In aggregate, more than 10 million person-years of normal activities are estimated to have been lost to these diseases during 2006 alone. A large majority of this loss resulted from diarrhea and diarrhea-induced illnesses, which account for over 90 percent of the lost time. Intestinal worms (helminthes) and ALRI are other major causes of time lost from normal activities. Table 3.2 also shows the low proportion of disease cases that receive treatment at a medical facility—less than half of diarrheal disease and ALRI cases and a small proportion of worm-related illnesses are treated.

FIGURE 3.1 DEATHS ATTRIBUTED TO INADEQUATE SANITATION AS PERCENT OF ALL DEATHS, 2006

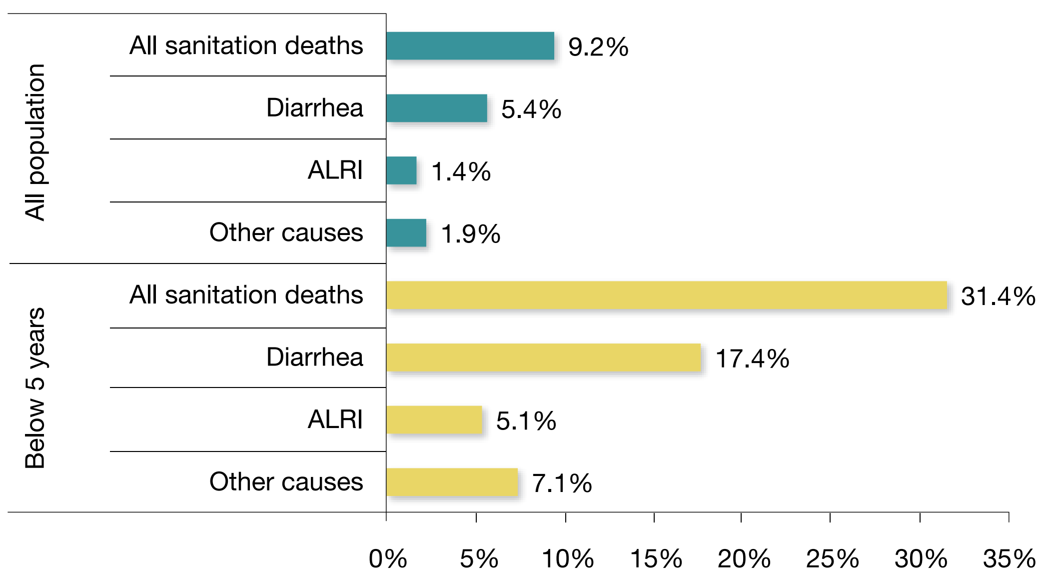


TABLE 3.2 NUMBER OF CASES, TREATMENTS, DEATHS, AND TIME LOST DUE TO DISEASES CAUSED BY INADEQUATE SANITATION, BY DISEASE, AND AGE GROUP, 2006

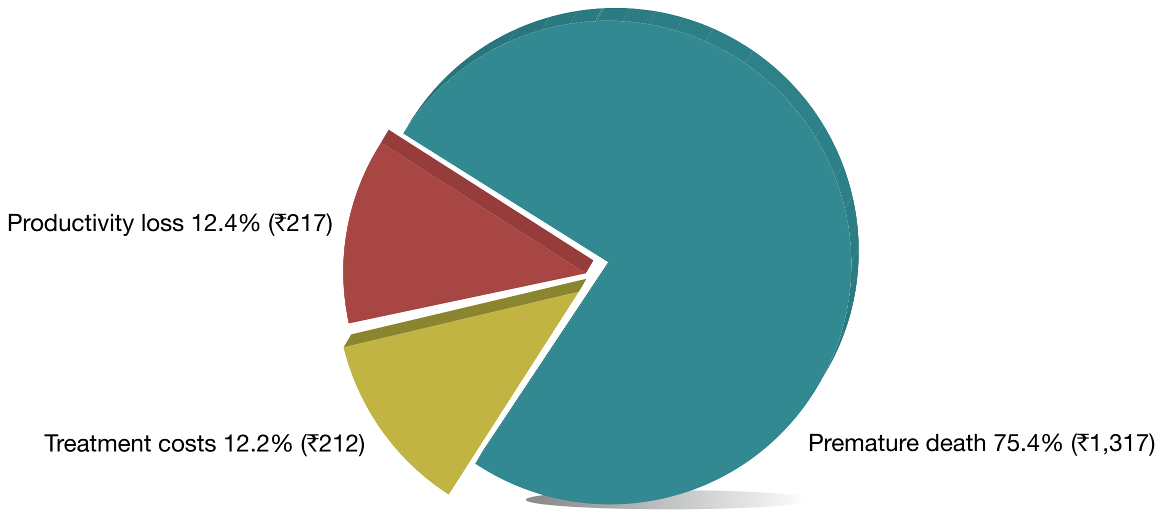
Disease	**Total cases** (million)	**Treated at medical facilities** (million)	**Deaths** (number of persons)	**Time lost** (1,000 years)
Diarrhea	575	249	449,839	9,960
Children below 5 years	192	100	395,423	3,336
Children 5-14 years	383	149	1,071	6,624
Population 15+ years			53,345	
Helminthes (intestinal worms)	151	13	2,945	131
Children below 5 years	16	2	449	15
Children 5-14 years	38	4	2,299	31
Population 15+ years	97	6	197	85
Trachoma	0	0	-	37
ALRI	22	11	115,033	303
Measles	-	-	37,674	-
Malaria	2	2	1,817	22
Other causes	-	-	160,808	-
Total	**750**	**275**	**768,117**	**10,453**

Economic costs of impacts on health

To calculate the economic value of human life, the Human Capital Approach was used: the unemployment-adjusted labor share of GDP per worker.[12] Available studies were used to identify the healthcare costs of disease treatment, and the expert opinion of medical practitioners was used to identify rates of treatment. For welfare and productivity losses, the loss of adult time is valued at less than the rate for the economic loss of an adult engaged in production, at 50 percent of the full daily valuation (based on unemployment-adjusted labor share of GDP per worker). Time lost by children is valued at 50 percent of the adult rate. For these valuations, the current study uses an eight-hour working day and 250 working days a year. As a result, the economic valuation of lives lost, treatment costs, and loss of productivity add up to a huge ₹1.75 trillion in 2006. Losses from premature deaths account for three-fourths of these losses at ₹1.3 trillion, and more than ₹200 billion each are lost to treatment costs and losses to productivity, as presented in Figure 3.2.

[12] As explained in Chapter 2, the present value of the expected lifetime contribution to output by children below five years was ₹1.75 million ($38,706), ₹1.91 million ($42,172) for persons between 5 and 14 years, and ₹1.24 ($27,347) million for persons more than 15 years.

FIGURE 3.2 DISTRIBUTION OF HEALTH ECONOMIC IMPACTS OF INADEQUATE SANITATION, 2006

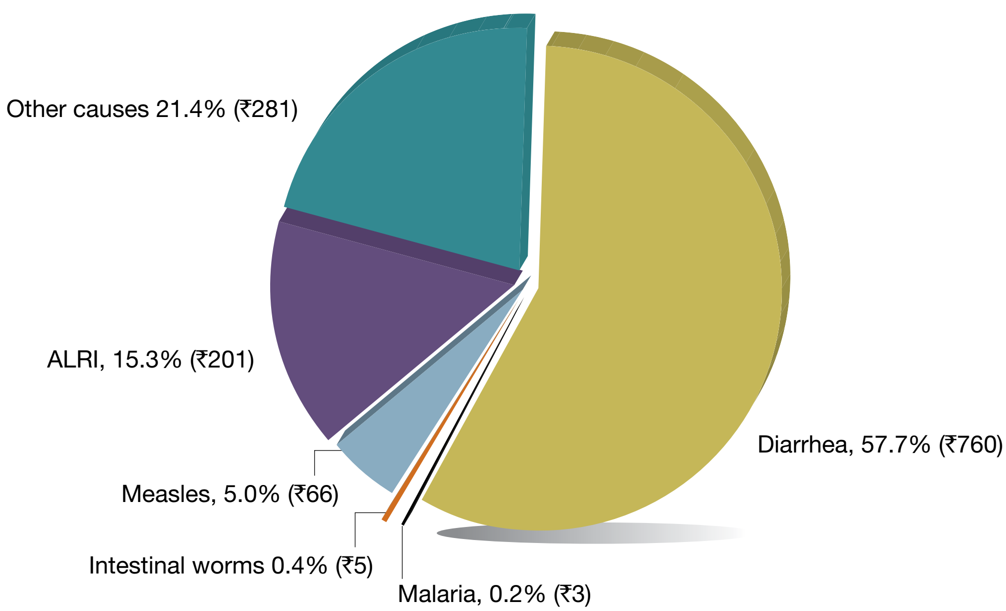


(in ₹ billion)

Distribution of mortality impacts, by disease

Diarrhea accounts for 58 percent (₹760 billion) of the economic impacts of premature mortality from inadequate sanitation, and ALRI (₹201 billion) is the other major contributor, as presented in Figure 3.3.

FIGURE 3.3 DISTRIBUTION OF ECONOMIC IMPACT OF PREMATURE MORTALITY FROM INADEQUATE SANITATION, BY DISEASES, 2006



(in ₹ billion)

Mortality from ALRI, measles, malaria, and other causes is the indirect result of malnutrition caused by sanitation-related diseases in children under five. Although trachoma causes serious illness, disability, and productivity loss, it is not identified as a significant cause of deaths. "Other causes" are unidentified causes derived by excluding the above diseases from non-perinatal mortality due to all causes.[13]

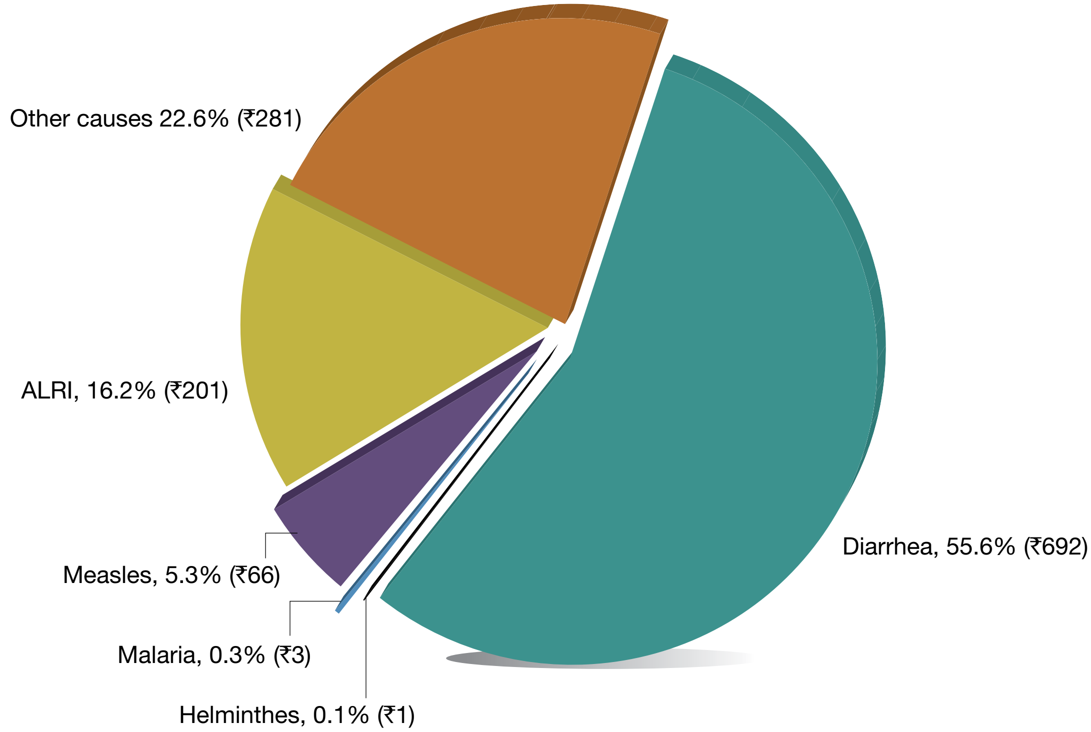
Highest burden: Among children under five years

Premature deaths of children under five made up an overwhelming 94 percent of the economic losses from premature death in India in 2006—valued at ₹1.24 trillion. Figure 3.4 shows that diarrhea caused the largest loss from premature deaths in children this age, followed by ALRI, measles, and malaria.

Treatment costs

The total cost each year of treating diseases caused by inadequate sanitation and hygiene is estimated at ₹212 billion. Most of these diseases are in children below five, who suffer diseases disproportionately to their share of the population. As presented in Figure 3.5, children below five account for 41 percent of total treatment costs (40 percent of diarrhea treatment costs and 16 percent of intestinal-worm prophylactics and treatment costs). Treatment costs for diarrhea in this age group make up 38 percent of all treatment costs for sanitation- and hygiene-related diseases.

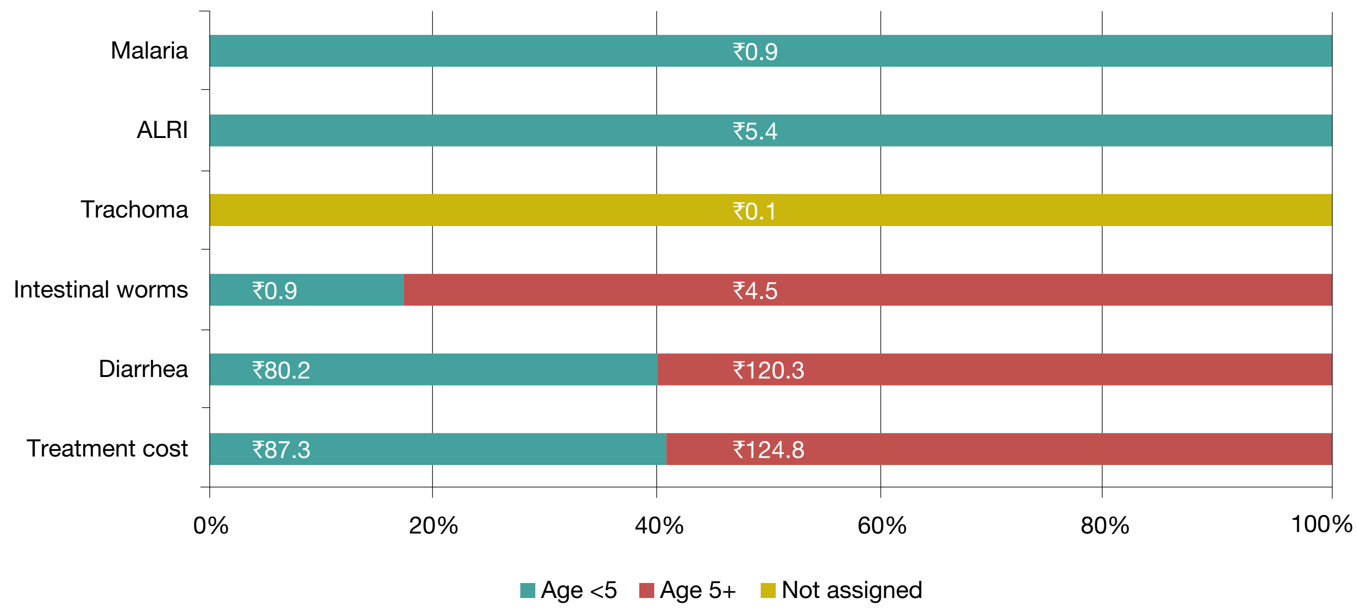
FIGURE 3.4 DISTRIBUTION OF ECONOMIC IMPACTS OF PREMATURE MORTALITY AMONG CHILDREN UNDER FIVE, ACROSS DISEASES, 2006



(in ₹ billion)

[13] Mortality from "other causes" is estimated only in children under five and results from malnutrition effects of diseases directly caused by inadequate sanitation. The review of literature and meta-analysis of relative risks of morbidity and mortality from underweight excludes perinatal causes because they are identified as not related to childhood malnutrition, but related to the health of pregnant women (Fishman et al., 2004).

FIGURE 3.5 TREATMENT COSTS OF SANITATION-RELATED DISEASES, BY AGE CLASSES, 2006



(in billion)

The high shares of treatment costs of children reflect higher incidence of diseases in children (1.75 per child per year) and also higher rates of treatment for children (69 percent) compared to adults (52 percent). Treatment costs for trachoma (not segmented into age-classes) were ₹144 million, and for malaria (all for children under five) ₹902 million.

Rural areas house 71 percent of the total population and 76 percent of children below five. Regarding treatment costs, rural populations bear 67 percent (₹135 billion) of the cost of diarrhea, 69 percent (₹3.7 billion) of the cost of intestinal worms, and 76 percent (₹4.1 billion) of ALRI costs. The relatively lower share of rural areas in economic burden reflects low treatment rates (67 percent rural and 74 percent urban), less treatment at medical facilities (71 percent rural, 83 percent urban), and lower valuation of time (average, ₹42 rural and ₹102.5 urban).

Productivity and welfare losses from morbidity

Illness can lead to substantial losses in productivity, welfare, income, and lifetime opportunities both for patients and for the family members who care for them. When workers miss work due to illness, they suffer monetary losses. This is especially true in a country like India, where 55 percent of workers are self-employed and 29 percent are casual workers. Non-workers, those engaged in household work, retired persons, and care-givers are also affected. Finally, children suffer, and miss school and recreational opportunities. Research evidence suggests that improved health in childhood improves school attendance, education outcomes, and income for persons when they become adults (Maccini and Yang, 2008; Alderman and King, 2006; Alderman, Hoddinott, and Kinsey, 2006; Currie, 2008).

The health-related productivity and welfare losses resulting from inadequate sanitation and hygiene are estimated at ₹217 billion. Figure 3.6 shows that children below five are still the largest segment of losers. Even when their time is valued at half the rate for adults, the economic impact on them is more than a quarter (₹57 billion) of the total, which is more than double their share (11 percent) of the population.

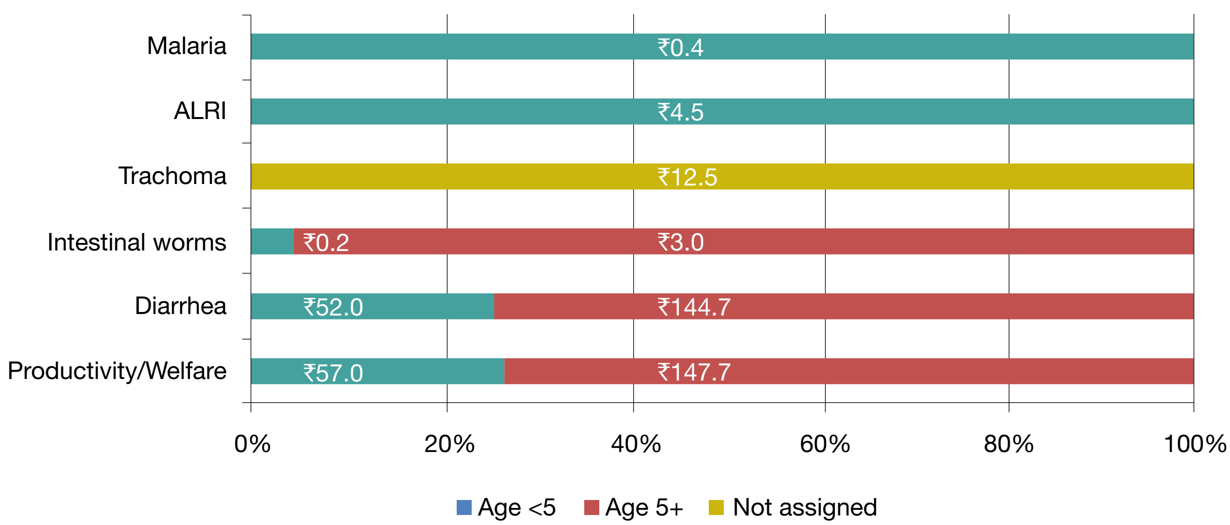
Diarrhea once again dominates the losses, at ₹198 billion. Productivity/welfare losses from trachoma (which may lead to vision loss) are ₹12.5 billion. Intestinal worm infections represent a loss of ₹3.1 billion, the bulk of which is in the population over age five. The estimated welfare losses of children below five due to ALRI—indirectly caused by poor sanitation via malnutrition—are ₹4.5 billion; and for malaria they are ₹0.4 billion.

Diarrhea-related productivity and welfare losses (loss of productive time) are considerable. Rural residents lose ₹101 billion (51 percent of the national total) in productivity and welfare due to diarrhea and within this amount the losses stemming from rural children due to this disease are estimated at ₹30 billion, which is 30 percent of this disease's rural productivity/welfare loss. Urban residents lose ₹96 billion in the same way due to diarrhea, and within this amount urban children account for ₹22 billion. Welfare losses from malnutrition-induced ALRI of ₹4.5 billion are evaluated only for children below five. Of these losses, rural children account for ₹2.9 billion (65 percent) and urban children account for ₹1.6 billion (35 percent).

Economic impacts of different diseases

Each of the sanitation-linked diseases causes economic impacts that vary depending on the disease's incidence, its treatment costs, and the productivity and time losses associated with its treatment. Table 3.3 summarizes the economic impacts that different diseases cause by their contribution to premature mortality, treatment costs, and losses of productivity.

FIGURE 3.6. HEALTH-RELATED PRODUCTIVITY AND WELFARE COSTS OF INADEQUATE SANITATION IN INDIA AND ITS BREAKDOWN ACROSS DISEASES AND AGE CLASSES, 2006



(in billion)

TABLE 3.3 HEALTH-RELATED ECONOMIC IMPACTS OF INADEQUATE SANITATION FROM VARIOUS DISEASES, 2006

Disease	Premature death	Treatment	Productivity	Total costs
Diarrhea	760	200	197	1,157
Intestinal worms	5	5	3	14
Trachoma	-	0.1	12.5	13
ALRI	201	5	4	211
Measles	66	-	-	66
Malaria	3	1	-	4
Other causes	281	-	-	281
Total	**1,317**	**212**	**217**	**1,746**

(in ₹ billion)

DIARRHEAL DISEASES

Deaths, treatment, and productivity losses from diarrheal diseases alone (₹1.16 trillion) account for two-thirds of the economic impact of all diseases. Of this, the bulk is from diarrhea mortality, which contributes 44 percent (₹760 billion) of total health-related impacts. Because diarrheal diseases are directly linked to inadequate sanitation, they cause the maximum number of cases, deaths, and economic losses from inadequate sanitation reported here. Even though overall diarrhea incidence appears low in the entire population (58 per 100 persons), it is highest of all diseases considered in this report for children below age five (at 175 per 100 children); and its case fatality ratio of 486 cases per death in children this age is comparable to the ratio of 437 for ALRI. While the occurrence of diarrhea cases is distributed 72 percent in rural areas and 28 percent in urban areas, the economic impacts of this illness (i.e., treatment costs and productivity losses) are distributed 59 percent in rural and 41 percent in urban areas. As explained earlier, this is due to lower treatment rates and lower average productivity losses in rural areas.

OTHER ILLNESSES

As mentioned earlier, in children under five mortality from ALRI, measles, malaria, and other causes is indirectly the result of the malnutrition caused by sanitation-related diseases. Intestinal helminthes incur a total cost of ₹14 billion. Although trachoma causes serious illness, disability, and productivity loss, it is not identified as a significant cause of deaths. However, it causes visual impairment that can be chronic and cause blindness if left untreated. Trachoma is a disease with a relatively high morbidity burden (2.9 percent, ₹13 billion) but low incidence (26 per 100,000 persons, or 0.026 per 100). Trachoma disability results in large productivity losses (₹12.5 billion), which are much higher than the relatively low treatment costs of ₹0.1 billion.

DOMESTIC WATER-RELATED IMPACTS

Arrangements for household drinking water supply

In 2005-06, about half of urban households and a little more than one-tenth of rural households in India had access to piped drinking water in their dwellings or in the yard of their residences. An additional 20 percent of urban and 16 percent of rural households accessed piped water through public taps.

Even these arrangements are hazardous from a health point of view, since contamination is likely, given that the supply of piped water is irregular and intermittent.

Table 3.4 shows that apart from the piped and tube-bore categories, which may be only apparently safe, a significant proportion of household water supply is dependent on completely unprotected sources.

It is worth noting that nearly one percent of urban households get their drinking water hauled by tanker or cart, and that about 0.1 percent of rural households and 1 percent of urban households use bottled water.

Lack of reliable and continuous drinking water supply forces households to store water, whether in the underground sumps and overhead tanks common in urban areas or in a variety of storage vessels that are common in both rural and urban areas. Storing of water may increase the chance of contamination by inappropriate handling. Households thus have to incur costs for household water treatment, go in for piped systems to avoid contamination to the extent possible, purchase bottled water, or haul cleaner water from a distance.

Economic impacts of domestic water

The domestic water-related economic impacts of inadequate sanitation in India in 2006 is estimated to be ₹191 billion ($4.2 billion). Economic impacts for rural residents are ₹111.5 billion (58 percent) and for urban residents ₹80 billion (42 percent).

TABLE 3.4 SOURCES OF HOUSEHOLD DRINKING WATER, 2005-06

Drinking water source	Rural	Urban	Total
Piped (derived)	11.8%	50.7%	24.5%
Piped to dwelling	3.9	31.9	13.1
Piped to yard	7.9	18.8	11.5
Public tap	16.1	20.3	17.5
Tube-bore	53.2	21.3	42.8
Rain	0.2	0.0	0.1
Protected spring	0.3	0.1	0.2
Protected well	2.8	1.8	2.5
Bottled	0.1	0.9	0.4
Unprotected spring	0.8	0.1	0.6
Unprotected well	12.4	2.9	9.3
River/surface water	1.8	0.8	1.5
Tanker	0.2	0.9	0.4
Cart	0.2	0.0	0.1
Other	0.1	0.2	0.2

Source: Based on NFHS-3 (IIPS and Macro International, 2007).

Figure 3.7 shows that of these costs, ₹112 billion (58 percent of total) results from the household treatment of water, ₹17.5 billion (9 percent) from the costs of piped water, ₹5.7 billion (3 percent) from purchasing bottled water, and about ₹56 billion (29 percent) from hauling cleaner water from outside the household premises.

Monetary losses

Of the total loss of ₹191 billion, the monetary impacts are about ₹75 billion ($1.6 billion). Of this, urban residents bear the burden of ₹47 billion, or two-thirds of the monetary losses, the balance being lost to residents of rural areas. A higher urban share is explained by the type of treatment methods used (e.g., more expensive filters compared with cheaper boiling or straining in rural areas), greater expenses for accessing piped water, and the costs of purchasing of bottled water.

Household water treatment costs account for two-thirds (₹49 billion) of the above monetary costs, and the cost of piped water attributable to sanitation accounts for a quarter (₹18 billion); the cost of bottled water purchases is ₹6 billion and the cost of hauling cleaner water is ₹2.3 billion

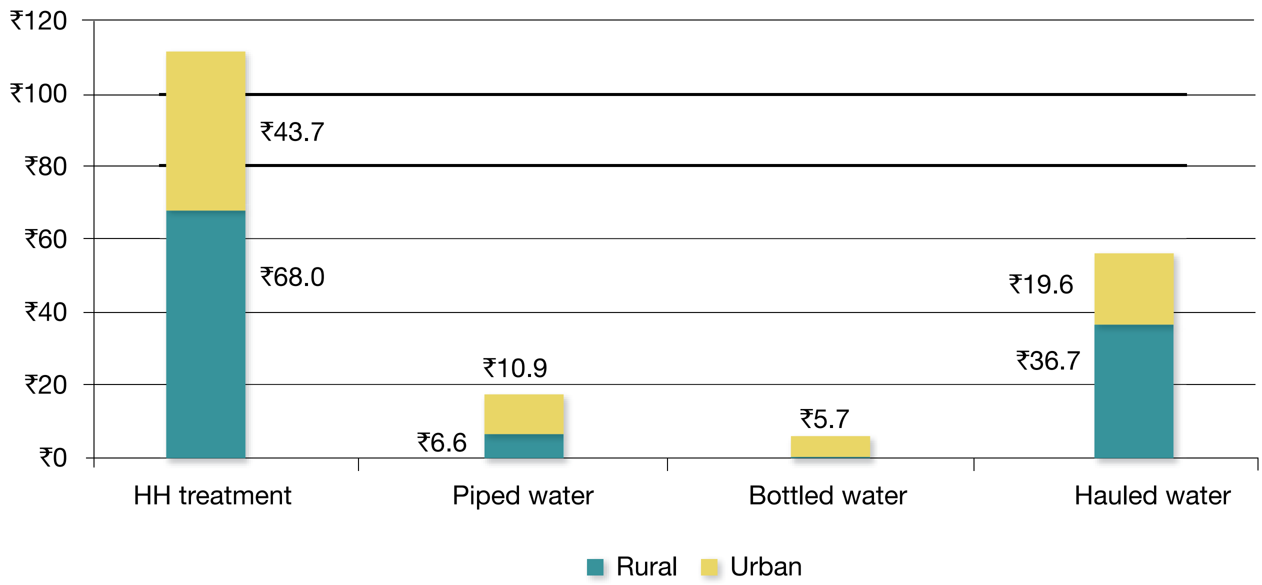
Household treatment of drinking water

The treatment of household drinking water mostly takes the form of boiling, and to a lesser extent it means use of filters or electronic purifiers, as presented in Figure 3.8. A tiny percent of households also use chemical purification or other methods like filtering water through a cloth.

Economic costs of domestic water treatment

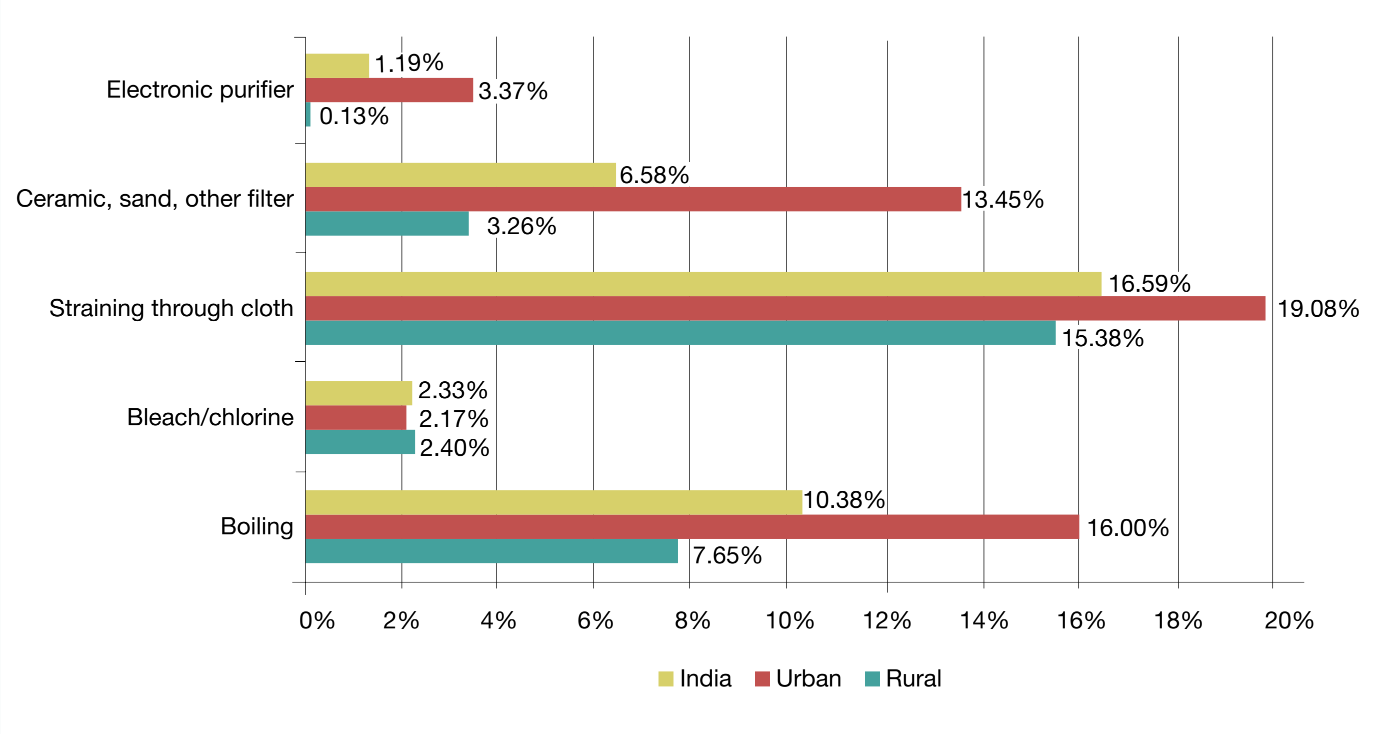
The economic costs of domestic water treatment form the bulk of the water-related impacts of inadequate sanitation at ₹111.7 billion. Of this total, rural residents bear

FIGURE 3.7 DOMESTIC WATER-RELATED ECONOMIC IMPACTS OF INADEQUATE SANITATION, 2006



(in billion)

FIGURE 3.8 DISTRIBUTION OF HOUSEHOLDS USING VARIOUS DRINKING WATER TREATMENT METHODS, 2006



Source: Estimates based on NFHS-3 data (Measure DHS, 2008).

₹68 billion (61 percent), the balance (₹44 billion) being borne by urban residents. These costs arise from using various drinking water treatment methods used by urban and rural households in India, as presented in Table 3.5 and Figure 3.9.

The cost of boiling water (₹80 billion) makes up 72 percent of all the water treatment costs by all methods; of this amount, ₹53 billion is spent in rural areas and ₹28 billion in urban areas. Straining water through cloth costs ₹14 billion, use of filters costs ₹10 billion, and use of electronic filters costs about

TABLE 3.5 ECONOMIC COSTS FOR TREATING HOUSEHOLD WATER DUE TO INADEQUATE SANITATION, 2006

Population	Boiling	Bleach/chlorine	Straining through cloth	Ceramic, sand, or other filter	Electronic purifier	Total
Rural	52,578	2,340	9,129	3,583	353	67,982
Urban	27,797	824	4,969	6,311	3,766	43,668
India	80,375	3,164	14,098	9,894	4,119	111,650

(in ₹ million)

₹4 billion, mostly in urban areas. It should be noted that the presence of water treatment equipment in a household alone may not ensure that drinking water is uncontaminated by fecal bacteria. Further, straining through cloth may not be effective in avoiding contamination.

Economic costs of piped water

Households use piped water because of convenience as well as because it is perceived to be of good quality, that is, safe from contamination in a way that unprotected sources like open wells are not. This study assumes that about half of the costs of obtaining piped water can be attributed to inadequate sanitation conditions causing potential contamination. Costs of public taps, assumed mainly for convenience, have not been included in this estimate (although time and productivity losses take this into account).

Total costs of piped domestic water attributable to inadequate sanitation are estimated at ₹17.5 billion—62 percent for urban households and 38 percent for rural households.

FIGURE 3.9. COST OF WATER TREATMENT: DISTRIBUTION OF ANNUAL RURAL, URBAN, AND NATIONAL WATER-RELATED ECONOMIC IMPACTS BY TREATMENT METHODS

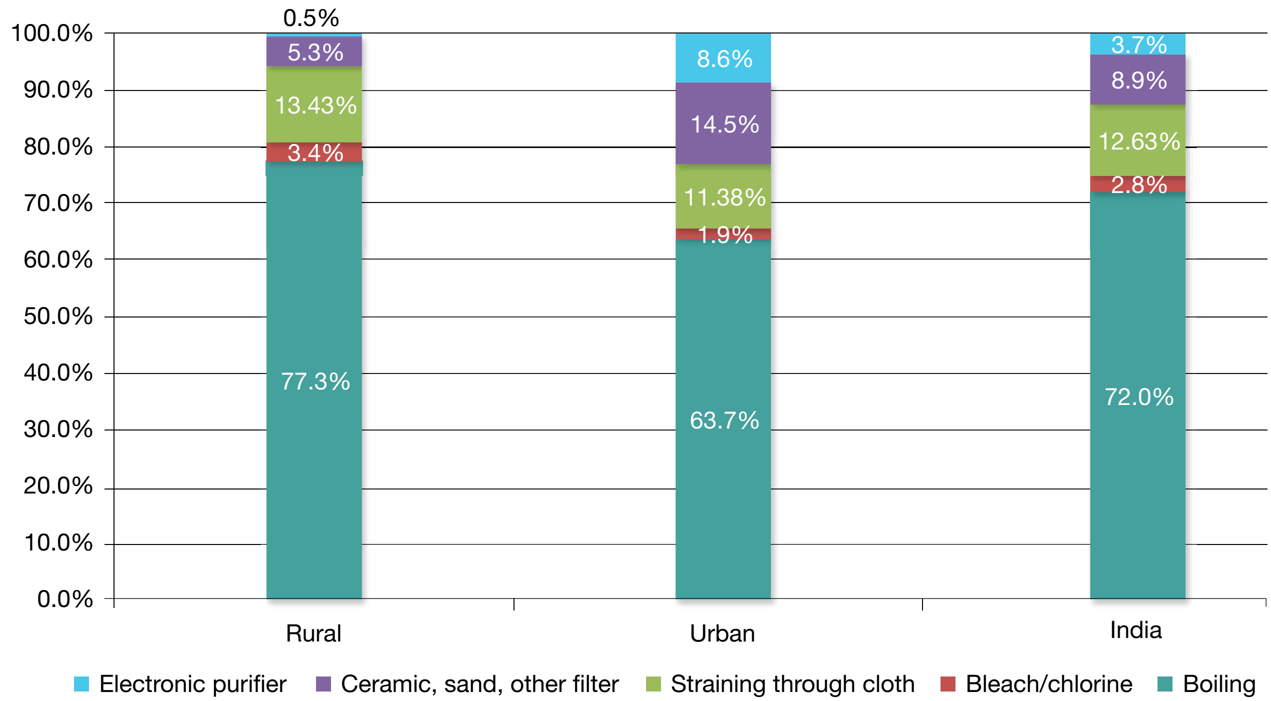
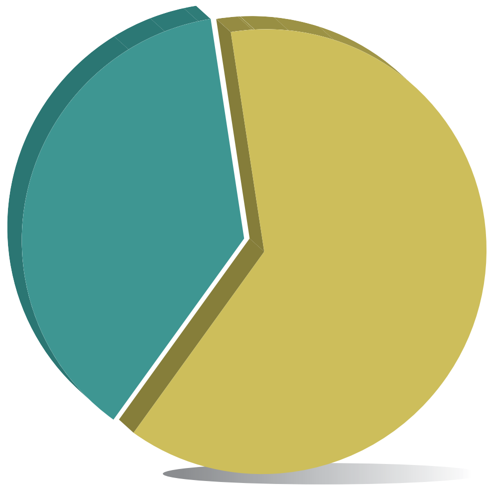


FIGURE 3.10 DISTRIBUTION OF COST OF PIPED WATER DUE TO INADEQUATE SANITATION AMONG RURAL AND URBAN HOUSEHOLDS, 2006



Economic costs of bottled water

About 0.8 million households are estimated to have been using bottled water in 2006. Households buy bottled water because it is perceived to be free of bacteria and other impurities.

Table 3.6 shows that an estimated 0.38 percent of households in India used bottled drinking water. This implies bottled drinking water consumption of 12.2 million liters per day and 4.4 billion liters annually, based on an average of 2.92 liters per person per day. The annual cost of bottled water purchased by households is estimated to be ₹6 billion, of which 94 percent is incurred in urban areas (see Figure 3.11). The cost of bottled water forms about 3 percent of the domestic-water-related economic costs of inadequate sanitation and about 8 percent of the monetary costs thereof.

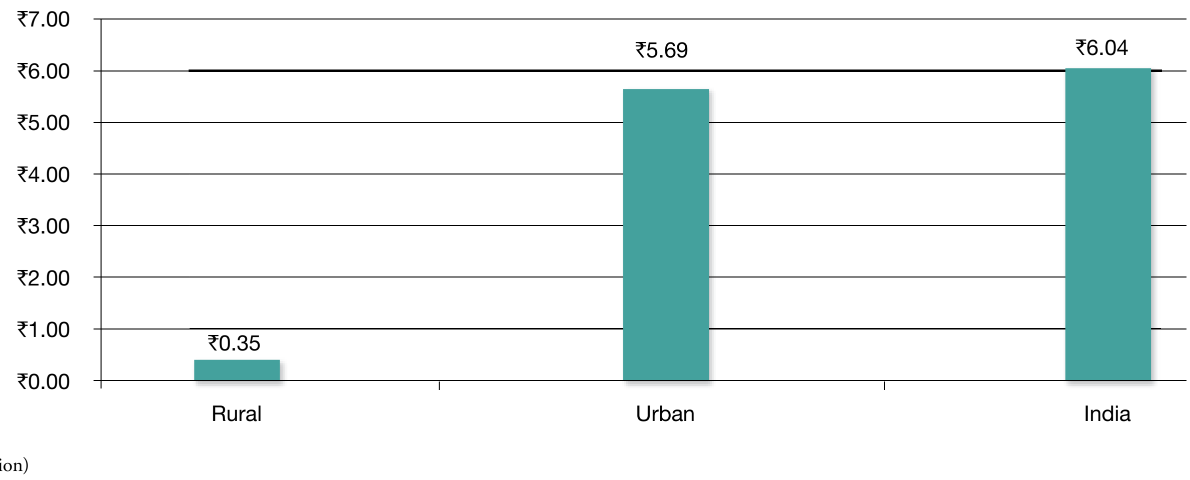
Economic costs of hauled water

In India, 29.4 percent of urban households haul water from outside their homes, spending an average of 18.4 minutes

TABLE 3.6. BOTTLED WATER CONSUMPTION, 2006

Population	Percent of households using bottled drinking water	Annual bottled drinking water consumption (billion liters)
Rural	0.14	1.4
Urban	0.86	3.1
India	0.38	4.4

FIGURE 3.11 COST OF BOTTLED DRINKING WATER, 2006



per trip in 2005-06 (Measure DHS, 2008). In rural areas, this percentage is nearly double that of urban areas at 57.8 percent, with 19.4 minutes per trip. Nationally, 48.5 percent of households haul water from outside, spending an average of 19.2 minutes per trip. This report conservatively attributes half the trip time to inadequate sanitation, since households must travel farther from alternate polluted sources to haul water; that is, the report attributes an additional 9.6 minutes per household per day to inadequate sanitation. This report estimates that this water-hauling time led to substantial loss of productive time in 2006: 673 million days for rural residents, 144 million days for urban residents, and 818 million days nationally. The total costs of hauling water are ₹54 billion for all households, with ₹36 billion (66.8 percent) for rural households and ₹17.9 billion (33.2 percent) for urban households. The costs in rural areas reflect the higher incidence of fetching water from distant sources, but their share is lower than their proportion of the population (71 percent) because of the lower productivity used for time in rural areas. In more than 83 percent of rural households and 75 percent of urban households, fetching water is a task mostly carried out by women and girls.

FIGURE 3.12 ECONOMIC COST OF HAULED WATER AMONG RURAL AND URBAN HOUSEHOLDS, 2006

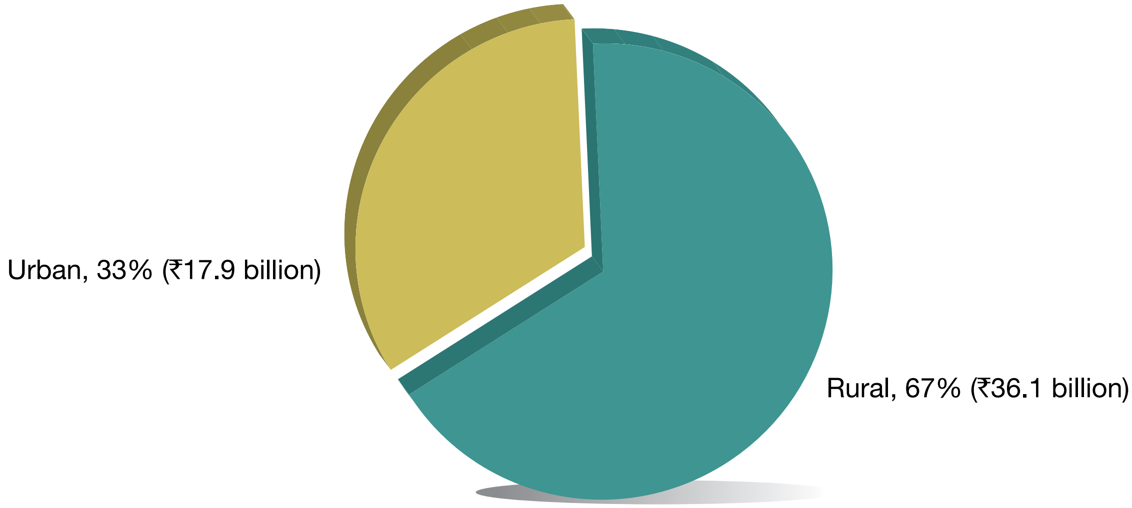
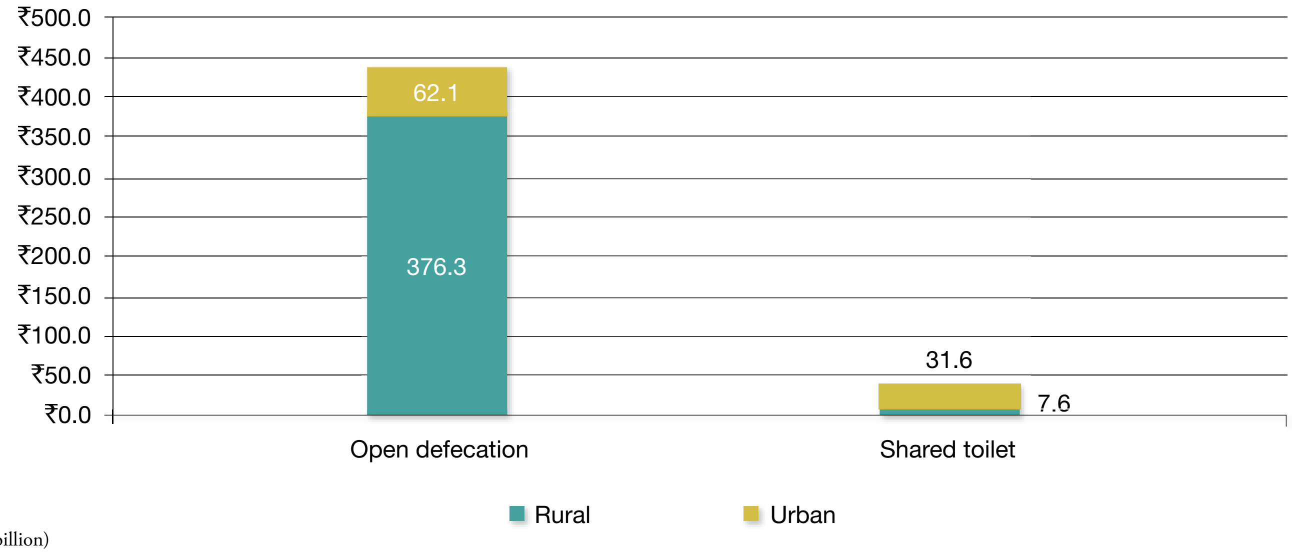


FIGURE 3.13 ECONOMIC COST OF ACCESS TIME LOST DUE TO INADEQUATE SANITATION, 2006



ACCESS TIME IMPACTS

Economic costs of accessing open-defecation areas and shared toilets

Not having access to good toilets results in a loss of time, comfort, convenience, security, dignity, and status, and it may also lead to conflicts within a community. These losses are felt more heavily by women and girls. A partial economic equivalent of this loss of welfare and ability to exercise preferences by persons who are forced to defecate in the open or to share toilets, has been estimated in this study. Estimates are based on a valuation of extra time that people use to access open-defecation sites and shared toilets. This economic loss is a conservative estimate, because it does not include many intangible aspects and welfare losses unrelated to loss of time, like embarrassment or convenience.

An estimated 629 million persons (56 percent of population) defecated in the open in 2006: this number comprises 575 million (72 percent) rural residents and 54 million (17 percent) urban residents. An additional 125 million persons (11 percent) used shared toilets, 45 million of them rural residents and 80 million urban. Thus, 754 million people, including 621 million in rural and 134 million in urban areas, either defecated in the open or used shared toilets.

It is estimated in this study that an extra 78.6 billion hours were spent accessing open-defecation sites and shared toilets in 2006. This estimate is based on a single visit to a toilet per person per day, using 20 extra minutes per person per day to access open-defecation sites in rural areas and 15 minutes in urban areas, and using 5 extra minutes to access shared toilets in both rural and urban areas. The economic cost of this lost access time is estimated at ₹477.5 billion ($10.5 billion). Since open defecation is more prevalent in rural areas, the time-cost of open defecation makes up 98 percent of the costs of access time in rural areas. Time lost for use of shared toilets makes up a much higher proportion of lost access time in urban areas (33 percent). This reflects the fact that shared toilets were used by 24.6 percent of urban residents and only 5.7 percent for rural residents. Rural residents bear a substantial 86 percent (₹376.3 billion, $8.3 billion) of the country's total time costs for accessing open-defecation sites, whereas for the time costs of accessing shared toilets, urban residents bear 81 percent of the burden (₹31.6 billion, $697 million).

Economic costs at schools and workplaces

This study also estimated losses from inadequate sanitation in schools and in workplaces. These estimates are made only for losses experienced by girls aged 11 to 17 in schools without girls' toilets and by working women due to absence from work during menstrual periods. Lack of disaggregated data presents difficulties in computing such losses, but using very conservative estimates lower bound values have been estimated. Assuming that an average of 10 days a year are missed by girls in schools without a girls' toilet, and that one day a year is missed by a working woman, this study estimates that annually 74 million school days were missed by girls and 94 million work days by working women. The economic cost of this loss of time is estimated as ₹3.4 billion ($74 million) for girls and ₹6.3 billion ($139 million) for working women, totaling ₹9.6 billion, as presented in Table 3.7.

TOURISM IMPACTS

International and domestic tourism have been growing rapidly in India. The average growth rate of international tourist arrivals rose from 2003 to 2006 by 17.7 percent per year (Ministry of Tourism, 2008). Tourism receipts from international tourists were ₹404 billion ($8.9 billion) in 2006, a year when 4.45 million international tourists arrived in India and 8.3 million Indian tourists went abroad from India. With these numbers, India's share of world tourist arrivals was 0.5 percent and its share of tourist receipts was 1.2 percent. India ranked 42nd in international tourist arrivals in 2006.

Leaving out visitors from Bangladesh, 32 percent of international visitors arriving in India are from the United Kingdom and the United States. In addition, Canada, France, Germany, Japan, Sri Lanka, Malaysia, and Australia are also significant sources of international tourists coming to India. Of the arriving international tourists, less than 10 percent were children below age 15, while 7 percent were elderly (over age 65). Domestic tourism has also been substantial in recent years, with 462 million Indians making day and overnight tourist visits in 2006.

If tourists are dissatisfied with sanitation, they may not visit again or may discourage other potential tourists from visiting. This study used this premise, along with data about tourist stays, spending, and dissatisfaction with toilets to estimate the loss of tourism earnings due to inadequate sanitation in 2006. The percentages of satisfied and dissatisfied tourists, along with reasons for dissatisfaction, are available for a sample of tourists visiting Buddhist centers located in all parts of the country.[14]

Many tourists also suffer health problems resulting from inadequate sanitation. Such illnesses among domestic tourists are potentially covered in health-related estimates discussed above. To avoid double counting, and for lack of tourist illness data for domestic tourists, this study separately estimates only the economic impact of illnesses among foreign tourists visiting India in 2006. Only gastrointestinal illnesses for foreign tourists are included, based on prevalence data from published research.

Tourism-related economic impact

Tourism-related economic losses from inadequate sanitation are estimated to be ₹12 billion ($266 million). Of these

TABLE 3.7. SCHOOL AND WORKPLACE ABSENCE: LOWER BOUND OF ECONOMIC COST OF INADEQUATE SANITATION FROM GIRLS' AND WOMEN'S ABSENCE, 2006

	Urban	Rural	India	Urban	Rural	Total
Girls' absence from school	1.4	2.0	3.4	41.5%	58.5%	100.0%
Women's absence from work	2.2	4.1	6.3	35.1%	64.9%	100.0%
Total	3.6	6.0	9.6	37.4%	62.6%	100.0%

(in ₹ billion and percent)

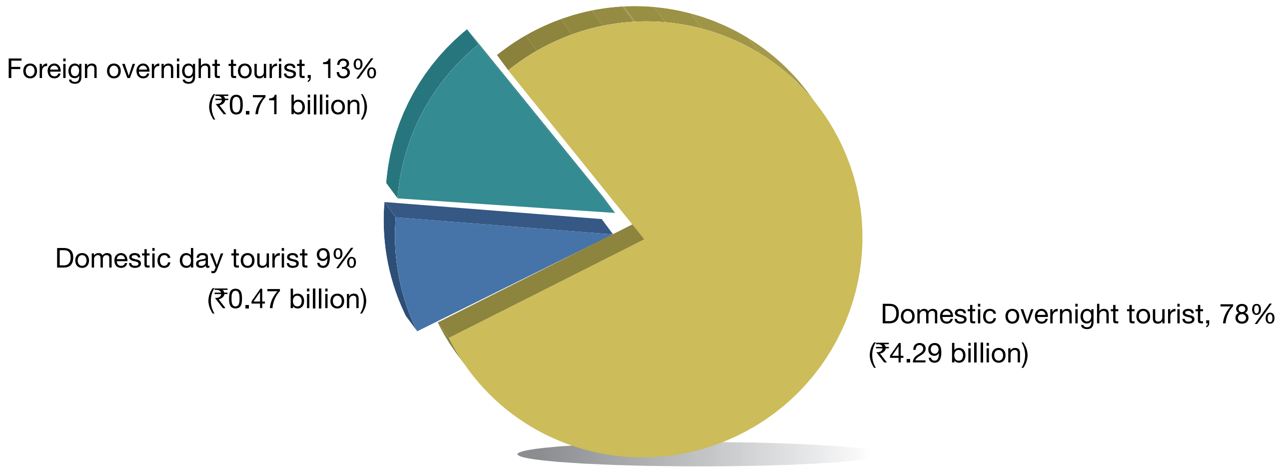
[14] The survey reports were from tourists in the following states: Uttaranchal, Uttar Pradesh, Rajasthan, Madhya Pradesh, Karnataka, Goa, Chhattisgarh, Bihar, Assam, and Orissa. Buddhist centers about which questions are asked are spread across India.

TABLE 3.8 ECONOMIC LOSSES TO TOURISM DUE TO POOR SANITATION, 2006

Impact type	Amount (₹ million)	Percent	Amount ($ million)	Type of loss
Loss to tourism earnings (international and domestic)	5,473	45.3	120.73	Monetary
Treatment costs for international visitors	938	7.8	20.70	Monetary
Value of welfare lost by international tourists	5,663	46.9	124.92	Economic
Economic loss due to gastrointestinal illness among international tourists	6,601	54.7	145.62	Monetary + Economic
Total tourism-related loss due to poor sanitation	12,074	100.0	266.35	Monetary + Economic

losses, 45 percent (₹5.5 billion, $121 million) are from loss of tourism earnings, and 55 percent (₹6.6 billion, $145.6 million) are from losses due to gastrointestinal illnesses among international tourists, as presented in Table 3.8. About 9.85 million tourism days are estimated to be lost due to inadequate sanitation and hygiene. Of these, half are domestic overnight tourism days, 46 percent are domestic day tourism days, and the remaining 4 percent are international tourism days. Of the total tourism earnings loss of ₹5.4 billion due to inadequate sanitation and hygiene, the bulk was accounted for by lost domestic overnight tourism, as presented in Figure 3.14.

FIGURE 3.14 TOURISM EARNINGS LOSS DUE TO INADEQUATE SANITATION FROM DOMESTIC AND FOREIGN TOURISTS, 2006



AGGREGATE ECONOMIC IMPACTS OF INADEQUATE SANITATION

Putting together all the impacts in the previous sections, this study shows that the total annual economic impacts of inadequate sanitation amount to ₹2.44 trillion ($53.8 billion). This implies a per capita annual loss of ₹2,180 ($48). This in turn translates into an impact that is equivalent to about 6.4 percent of the GDP of India in 2006.

Measured in purchasing power parity (PPP) terms, with the price level in India being about one-third that in the United States, the adverse economic impacts of inadequate sanitation in India add up to $161 billion, or $144 per person.

Composition of Impacts

As presented in Figure 3.15, the health-related economic impact of inadequate sanitation is ₹1.75 trillion, that is,

FIGURE 3.15 COMPOSITION OF ECONOMIC IMPACTS OF INADEQUATE SANITATION

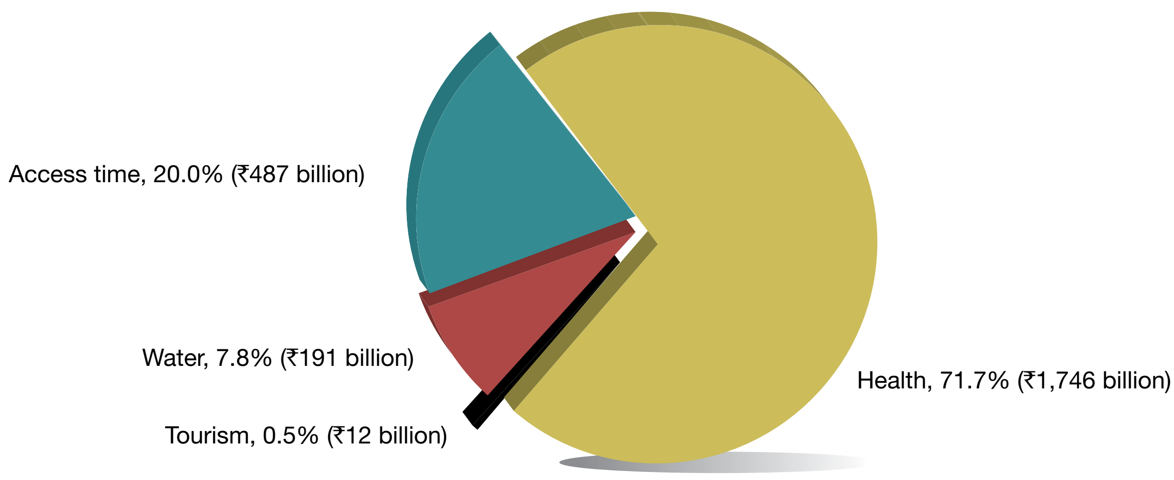
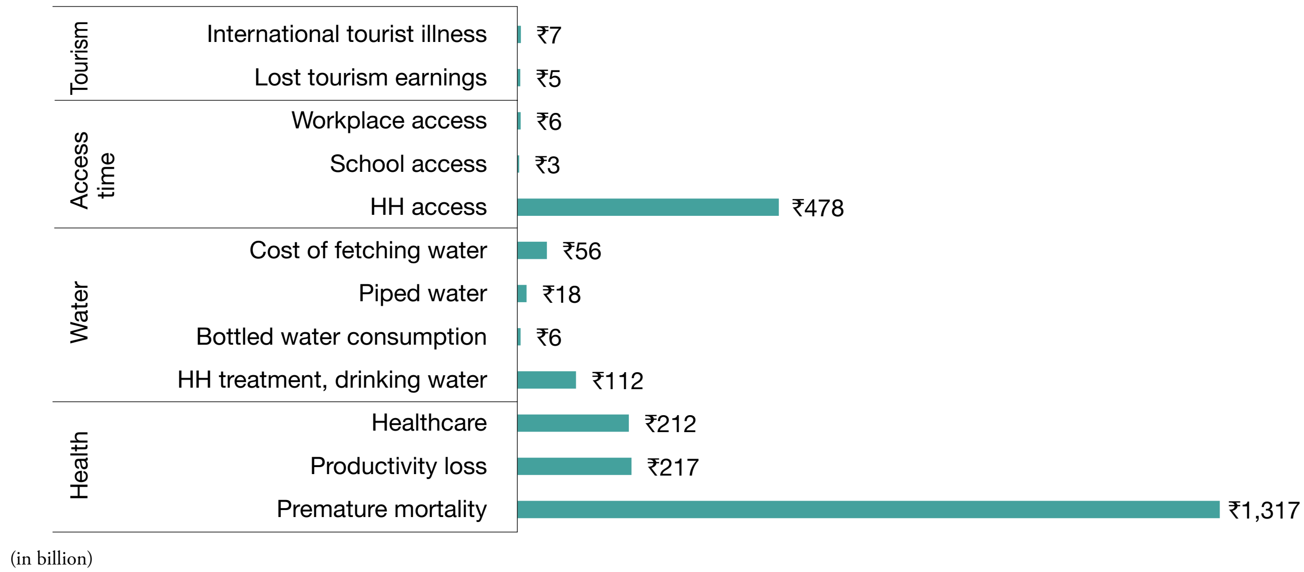


FIGURE 3.16 ECONOMIC IMPACTS OF INADEQUATE SANITATION IN INDIA BY SUBCATEGORIES, 2006



72 percent of the total impact in 2006. Loss of access time and impacts on water costs are the other two main losses. As a portion of health impacts, premature mortality makes up the main share at more than ₹1.3 trillion. Access costs for households at ₹478 billion show up as the next large subcategory of impacts. In addition, Figure 3.16 shows that healthcare costs and productivity losses are significant at more than ₹200 billion each.

TABLE 3.9 ECONOMIC AND MONETARY IMPACTS OF INADEQUATE SANITATION, 2006

Impact type	Economic impacts			Monetary impacts		
	Amount (₹ billion)	Amount ($ billion)	Percent of total	Amount (₹ billion)	Amount ($ billion)	Percent of total
Health	1,746	38.5	72	283	6.2	77.8
Premature mortality	1,317	29.1	54	-	-	-
Productivity loss	217	4.8	9	71	1.6	19.5
Healthcare	212	4.7	9	212	4.7	58.3
Water	191	4.2	8	74	1.6	20.5
Household treatment, drinking water	112	2.5	5	49	1.1	13.4
Bottled water consumption	6	0.1	0.2	6	0.1	1.7
Piped water	18	0.4	1	18	0.4	4.8
Cost of fetching water	56	1.2	2			
Access time	487	10.7	20			
Household access	478	10.5	20			
School access	3	0.1	0.1			
Workplace access	6	0.1	0.3			
Tourism	12	0.3	0.5	6	0.1	1.8
Lost tourism earnings	5	0.1	0.2	5	0.1	1.5
International tourist illness	7	0.1	0.3	1	0.02	0.3
Total impact	2,437	53.8	100	364	8.0	100
Total impact as percentage of GDP	**6.4%**			**1.0%**		

TABLE 3.10 COMPOSITION OF ECONOMIC IMPACTS OF INADEQUATE SANITATION

Type of loss	Loss (₹ billion)	Percent equivalent of GDP (rounded-off)
Monetary losses in 2006	364	1
Non-monetary economic losses in 2006	759	2
Loss of flow of value in 2006	1,123	3
Discounted present value of future losses resulting from the loss of human capital in 2006	1,314	3.4
Total economic impact of inadequate sanitation in 2006	**2,437**	6.4

Monetary losses

Economic impact includes monetary impacts (that is, someone paying out or losing money), as well as non-monetary impacts on which monetary values are imputed for valuation (e.g., that of time lost due to walking to an open-defecation location). This analysis shows that monetary losses, a subset of economic losses, are estimated to be ₹364 billion ($8 billion) in 2006, as presented in Table 3.9.

The costs of treating illnesses dominate the monetary losses (58 percent of the total), followed by lost productivity due to illnesses, treating water, and accessing piped water. In percentage terms, monetary impacts are 15 percent of the total economic impacts. These losses are equivalent to 1 percent of the GDP, or ₹326 ($7) per person.

Present and future losses

It may be noted that while the economic impacts of inadequate sanitation in 2006 estimated in this report total ₹2.4 trillion—equivalent to 6.4 percent of India's GDP—not all of these are losses of economic value that were created in 2006. For example, deaths that occurred in 2006 resulted in a loss of human capital in 2006 that would have generated economic flows in 2006 and beyond. Therefore, loss of human capital in 2006 also reflects economic losses of future flows of value, in addition to the flow of value in 2006. The discounted present value of these future losses is counted in the 2006 total. Thus, an economic impact of inadequate sanitation equivalent to 6.4 percent of GDP should not be interpreted as a loss of 6.4 percent of GDP during 2006. The discounted present value of loss of economic flows that may occur after 2006 due to deaths in 2006 is about 54 percent of the total economic impacts, equivalent to 3.4 percent of GDP. Thus, the actual loss of flow of 2006 economic value is the remaining 46 percent, equivalent to about 3.0 percent of GDP. Table 3.10 presents the composition of economic impacts by monetary and non-monetary losses in 2006, and shows the future losses that are also accounted for in the year 2006.

Per capita impacts

A large population of 1.12 billion (est. 2006) can appear to explain the large magnitude of impacts, but per capita impacts also show up as significant, as Figure 3.17 shows. The per capita losses are estimated to be ₹2,180 ($48.10)—consisting of ₹1,562 ($34.47) due to health-related losses, ₹171 ($3.78) related to water, ₹436 ($9.61) related to access time, and ₹11 ($0.24) related to tourism. A substantial 54 percent of per capita and total economic losses stem from premature deaths due to inadequate sanitation and hygiene.

Per capita monetary loss

The per capita monetary losses are ₹326 ($7), three-fourths of which are health-related and one-fifth of which are water-related. Table 3.11 shows that an equivalent of 0.96 percent of the GDP (or GDP per person) is lost as monetary losses due to inadequate sanitation and hygiene.

FIGURE 3.17 PER CAPITA ECONOMIC IMPACTS OF INADEQUATE SANITATION, 2006

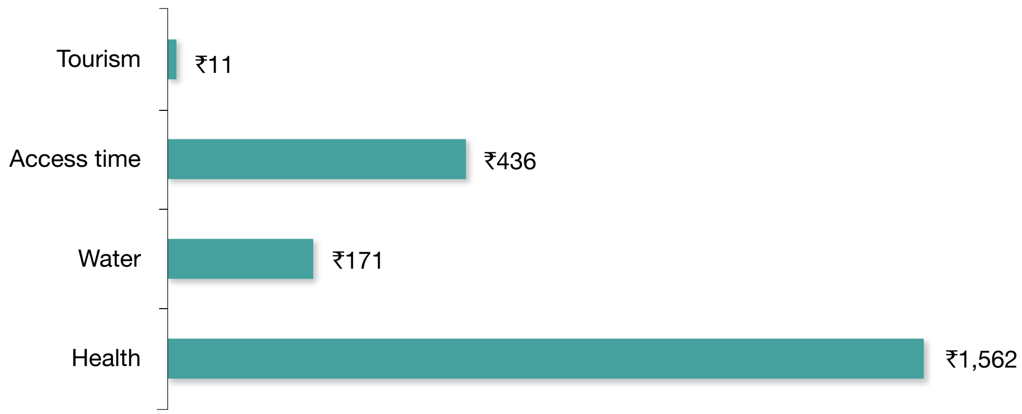


TABLE 3.11 PER CAPITA ECONOMIC AND MONETARY IMPACTS OF INADEQUATE SANITATION, 2006

Impact type	Economic impacts			Monetary impacts		
	Amount (₹)	Amount ($)	Percent of per-person GDP	Amount (₹)	Amount ($)	Percent of per-capita GDP
Health	1,562	34.47	4.6	253	5.59	0.75
Water	171	3.78	0.5	67	1.47	0.20
Access time	436	9.61	1.3			
Tourism	11	0.24	0.03	6	0.13	0.02
Total impacts	2,180	48.10	6.4	326	7.18	0.96

DIFFERENTIAL IMPACTS ON THE POOR

The poor in India have to bear substantial adverse impacts on their lives, health, and scarce financial resources because of inadequate sanitation. Diseases caused by inadequate sanitation disproportionately affect poor households, because these households have relatively little access to sanitary toilets, hygiene-related resources and practices, and clean and sufficient water. Compared with other households, poorer families tend to lose more of their wages and spend more of their precious resources on treating illnesses–affecting their well-being much more negatively than their counterparts in other socioeconomic classes are harmed. And within poorer households it is, again, the children that are relatively the worst affected.

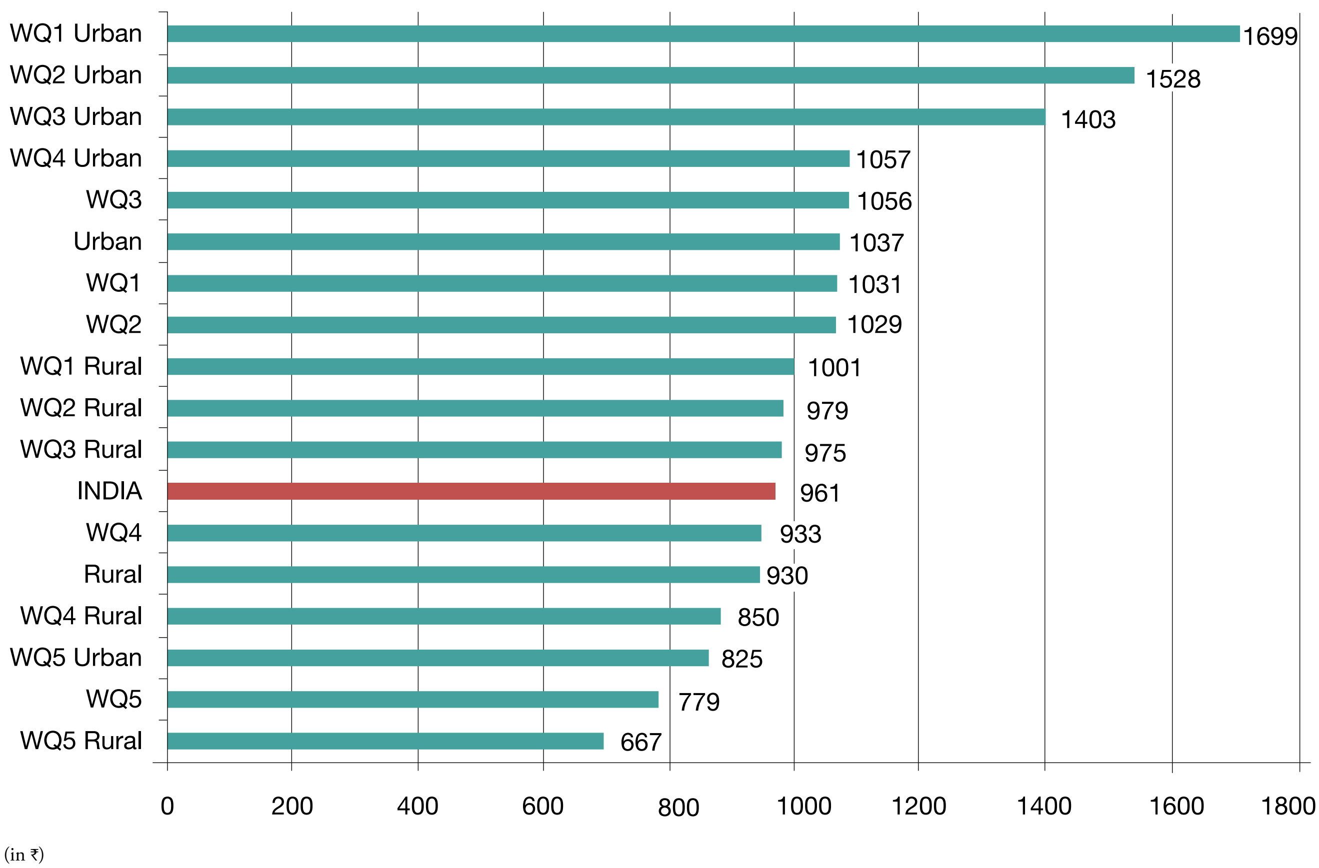
This study estimated the economic impacts of inadequate sanitation on the urban and rural poor and on other wealth quintiles according to categories of impact for which data was available. To identify poor households, classifications based on wealth quintiles from the National Family Health Survey-3 (NFHS-3) were used. Estimates of impact at the national, rural, and urban levels use data on the incidence of disease related to inadequate sanitation, as well as data on domestic water and toilet access, from NFHS-3, which adjusts adult incidence of disease proportionally. Mortality-related data is not available by income or wealth classification, and is therefore not included in these estimates. Health-related impacts only include estimates based on cases of diarrhea and intestinal worms and indirect impacts from cases of ALRI.

It is likely that poor persons in India bear a disproportionately high *mortality burden* stemming from inadequate sanitation, since they have lower access to and fewer resources for health care. *Therefore, the relative burden on the poor is likely to be underestimated in the estimates presented below.* It may also be noted that the wealth quintiles used are defined at the national level, not at the rural or urban levels. Therefore, "WQ1 Rural" denotes households in the poorest wealth quintile that reside in rural areas (and not the poorest wealth quintile *of* rural households), and so on.

Per capita losses

Figure 3.18 shows that urban households in the poorest quintile (WQ1 Urban) bear the highest per capita economic impacts of inadequate sanitation, at ₹1,699 ($37). That is 1.75 times the national average per capita losses and 60 percent more than the urban average. Rural households in the poorest quintile bear per capita losses in excess of ₹1,000—8 percent more than the average loss for households in rural areas.

FIGURE 3.18 PER CAPITA ECONOMIC IMPACTS* OF INADEQUATE SANITATION, BY WEALTH QUINTILES AND RURAL/URBAN RESIDENCE, 2006



*Note: These estimates do not include losses from mortality and tourism resulting from inadequate sanitation, due to lack of data. Health-related losses included are only from cases of diarrhea, intestinal worms, and ALRI.

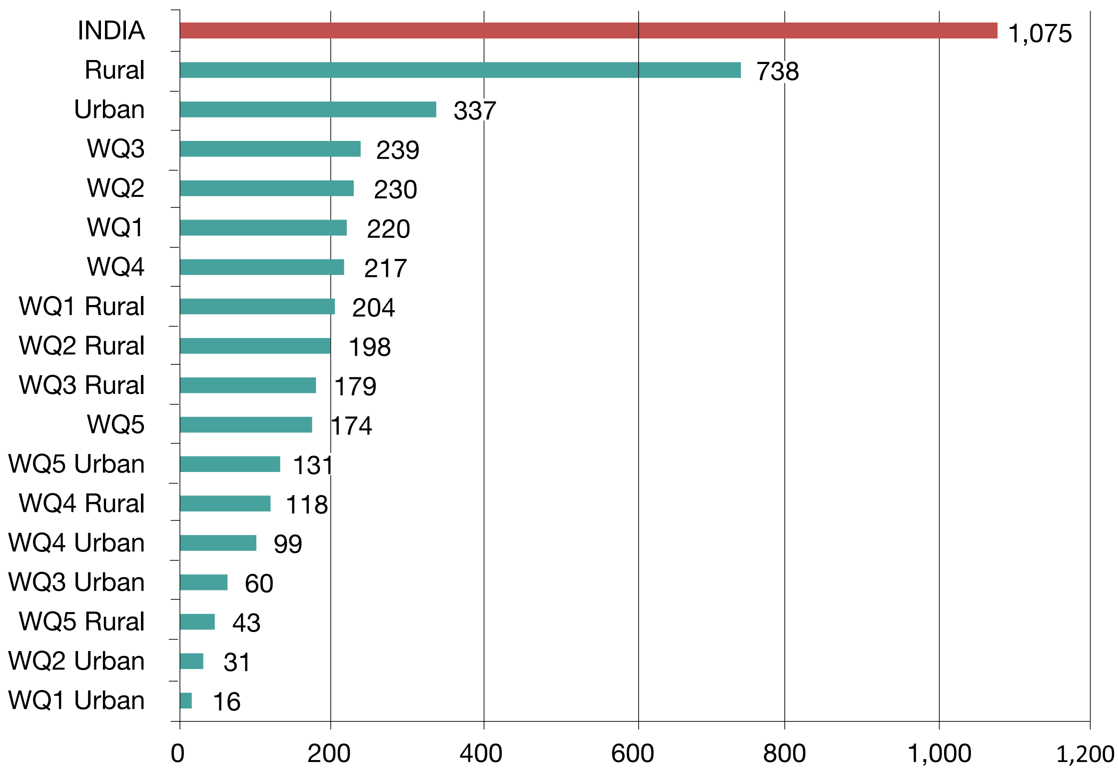
The richest 20 percent of all households (WQ5) experience lower economic impacts from inadequate sanitation, at ₹779 ($17) per capita. Among the richest 20 percent of households nationwide, those residing in urban areas experience economic impacts of ₹825 ($18.20) per capita, and those in rural areas experience impacts of ₹667 ($14.70) per capita—which are, respectively, half and two-thirds of the per capita losses suffered by the poorest households in those two categories.

Aggregate losses

In aggregate terms, the poorest 20 percent of households are hit by a loss of ₹220 billion—or 20 percent of the total losses computed. The poorest 20 percent residing in rural areas bear a burden of ₹204 billion ($4.5 billion), or 28 percent of total losses to households living in rural areas. As presented in Figure 3.19, the aggregate impacts are more heavily concentrated among the poor in rural areas, because most of the people in the lower quintiles reside in rural areas.

When looking at the relative impact on the urban poor, rather than poor people residing in urban areas per se, the relevant quintiles in urban areas are the first, second, and third quintiles, because most urban poor fall in these wealth quintiles. The poorest 20 percent of people living in urban areas

FIGURE 3.19 ECONOMIC IMPACT* OF INADEQUATE SANITATION BY WEALTH QUINTILES AND RURAL/URBAN RESIDENCE, 2006



(in ₹ billion)

*Note: These estimates do not include losses from mortality and tourism resulting from inadequate sanitation due to lack of data. Health-related losses included are only from cases of diarrhea, intestinal worms, and ALRI.

bear the highest per capita burden of inadequate sanitation, even though they are relatively fewer in number compared to the poorest 20 percent of persons living in rural areas. It is noteworthy that households in higher wealth quintiles also bear substantial impacts due to inadequate sanitation.

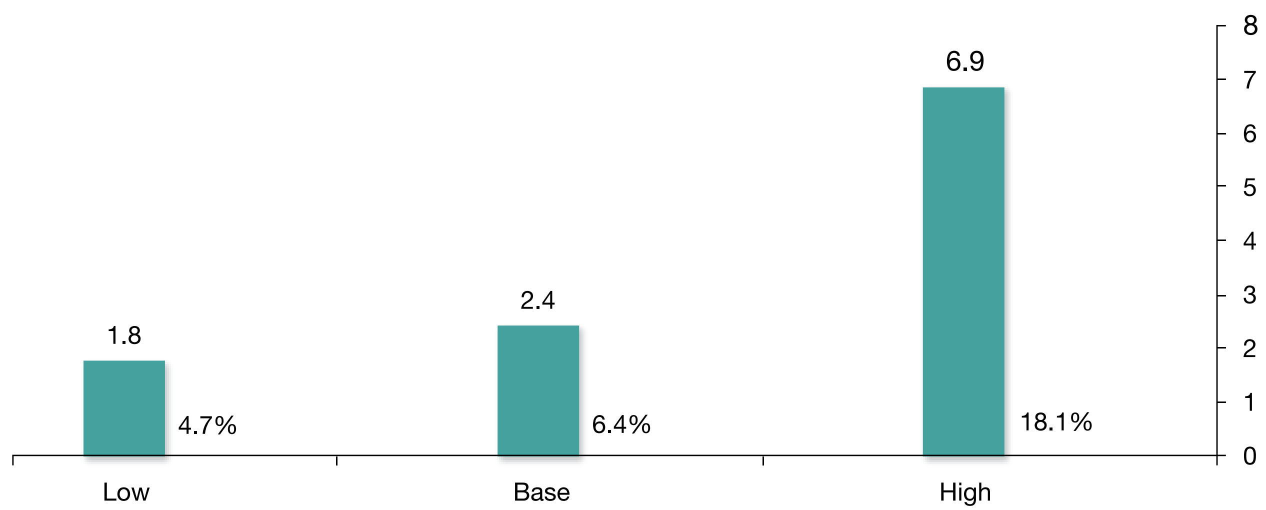
SENSITIVITY ANALYSIS

The estimates of economic impact presented above are based on some numbers that could have been selected differently. Whenever a choice of numbers was available, this study generally chose the more conservative number. Therefore, in addition to the "base" estimates presented so far, it is also instructive to look at a range—a low and a high estimate—of the economic impacts based on alternate methods and assumptions. Figure 3.20 presents input values used for the low, base, and high estimates presented in this section.

The low estimate for the total economic impact of inadequate sanitation is ₹1.8 trillion ($39.3 billion) or 4.7 percent of GDP, and the high estimate is ₹6.9 trillion ($151.6 billion) or 18.1 percent of GDP. The higher estimate is greatly influenced by a higher value for health impacts. Higher health impacts are driven by changing the method for the valuation of premature loss of life from the base scenario to a high scenario. Base estimates use employment-adjusted labor share of GDP per worker, while the high estimates use value of statistical life (VOSL) using the official exchange rate from OECD countries. Estimates for value of access time lost are much higher in the high case, since 100 percent of the unemployment adjusted labor share of GDP per worker is used for the valuation of time for adults and children instead of the much lower percentages used in the base case.

The low case uses a different method for valuation of premature loss of life based on average compensation of workers. The low case estimate for total health impact is ₹1.34 trillion ($29.5 billion or 3.5 percent of GDP), which is not much lower than the base case value of ₹1.75 trillion ($38.5 billion or 4.6 percent of GDP). The high case health impact, however, is much higher, at ₹4.4 trillion ($98 billion or 11.7 percent of GDP). From the scenario results it is evident that results are sensitive to valuation methods for premature loss of life and time.

FIGURE 3.20 LOW, BASE, AND HIGH ESTIMATES FOR ECONOMIC IMPACTS OF INADEQUATE SANITATION, 2006



(in ₹ trillion)

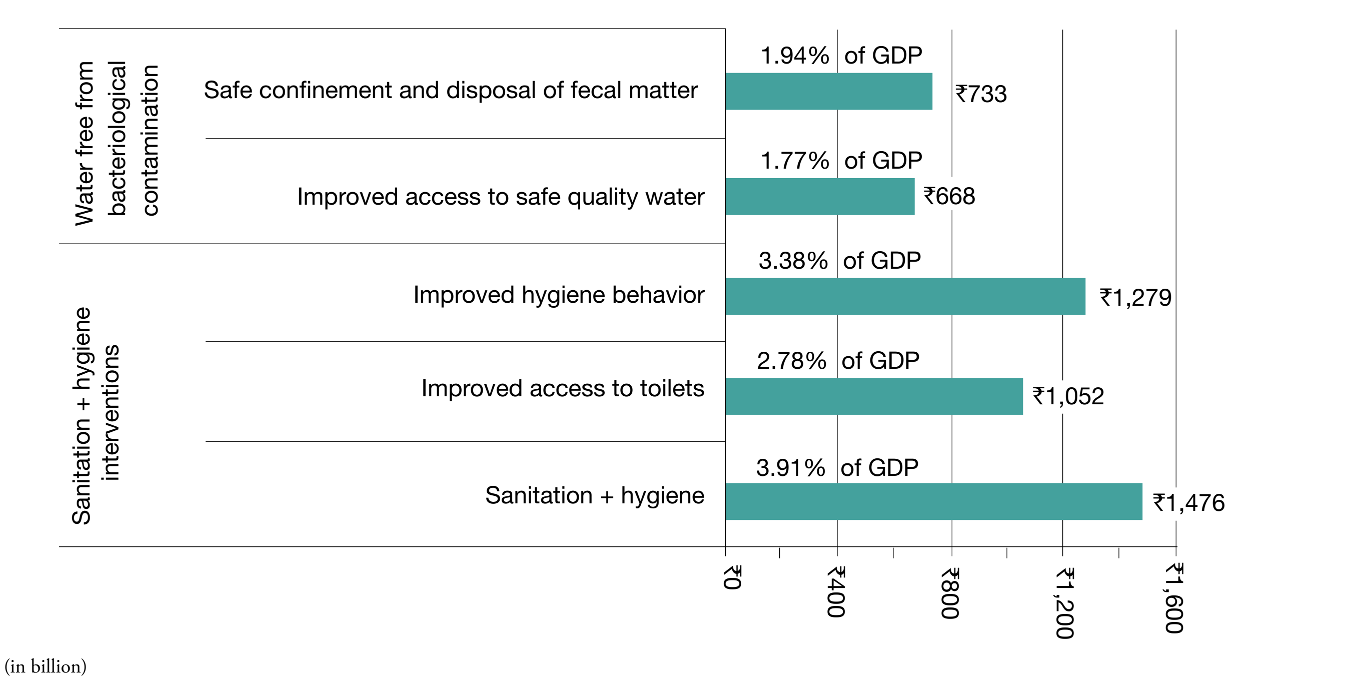
POTENTIAL GAINS FROM IMPROVED SANITATION AND HYGIENE

The potential gains achievable from adequate sanitation are somewhat like the flip side of the economic costs of inadequate sanitation—the savings that result by avoiding the health-related, water-related, access time-related, and tourism-related losses caused by inadequate sanitation and hygiene. Improved access to sanitary toilets and better hygiene practices (such as washing hands with soap, non-contamination while handling water and food) acts as a barrier to the five fecal contamination routes to sanitation-related diseases: fingers, flies, fields, fluids, and foods. In practice, it is very difficult to eliminate all the losses through sanitation interventions in developing countries, which are likely to be incomplete in their implementation and impacts due to the multiple pathways and geographical spillover that characterize sanitation-related diseases.

A review and meta-analysis (Fewtrell, et al., 2005) estimates a relative risk reduction in diarrhea of 32 percent through the use of improved toilets, a 45 percent reduction from hygiene interventions (primarily washing hands by soap), a 25 percent reduction from improved water supply, and a 39 percent reduction from household water treatment (primarily disinfection and safe storage). A World Bank review of about 100 impact studies of water and sanitation sector interventions (World Bank, 2008) found substantial evidence that "hand washing, sanitation, and household and point-of-use water treatment improve health outcomes (in terms of infant and child mortality, nutrition, and childhood diseases like diarrhea)."

Based on these meta-analyses, for this study the various interventions for estimating percent reduction in diarrhea were classified as follows:

FIGURE 3.21 POTENTIAL GAINS FROM SANITATION AND HYGIENE INTERVENTIONS, 2006



Note: Improved hygiene behavior may also include use of existing toilets; safe disposal of fecal matter includes sewage treatment.

1. Safe confinement and the disposal of fecal matter (sewage treatment)
2. Improved access to safe quality water
3. Improved access to adequate quantity of water
4. Improved hygiene behavior (including toilet use), and
5. Improved toilet access and use.

The estimates were applied to health impacts to estimate potential gains in each of the categories under this study. It may, however, be noted that these are based on meta-studies and it is difficult to neatly separate out the various categories.

It is estimated that sanitation and hygiene (including hand washing with soap) interventions could have prevented 346,000 deaths and 338 million cases of diseases and could have saved at least 1.7 billion days of time lost in 2006.

Figure 3.21 presents the potential gains from the different types of intervention (these are not additive categories). These range from ₹668 billion saved from improving access to safe water, to ₹1 trillion saved by improving access to toilets.

A package of comprehensive sanitation and hygiene interventions that includes increased use of toilets, hygiene promotion (including hand washing with soap and safe water management), and improved access to water will result in averting 45 percent of the adverse health impacts, and avoid all the adverse impacts of inadequate sanitation related to water, welfare losses, and tourism losses.

As a result of such a comprehensive intervention, this study estimates a potential gain of about ₹1.48 trillion ($32.6 billion, equivalent to 3.9 percent of GDP). This signifies a potential gain of ₹1,321 ($29) per capita.

4. Sanitation Markets

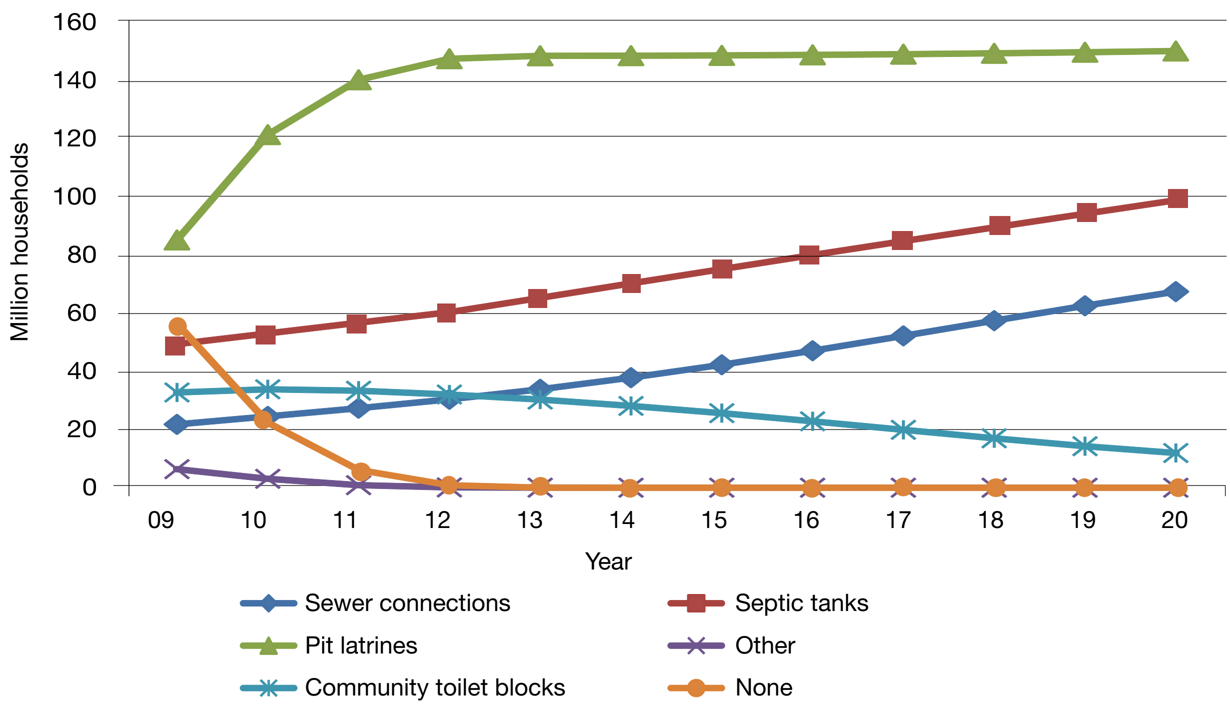
Estimates in this chapter of the potential sanitation market from 2007 to 2020 are based on the expectation that households will be switching from open defecation and unimproved toilets to improved toilets over this period. A steady increase in wastewater collection and treatment through 2020 is also assumed for this estimation.

PROJECTED CHANGES IN TOILETS AND WASTEWATER TREATMENT

The rapid expansion of sanitation facilities because of various initiatives by the government, including the Total Sanitation Campaign and the National Urban Sanitation Policy (both discussed in Chapter 1), is expected to be accompanied by households switching from no toilets, unimproved toilets, shared or community toilets to individual improved pit toilets, toilets with septic tanks and soakaways, or sewer-connected toilets. Figure 4.1 presents the projected number of households using different types of toilets in India, from 2009 to 2020.

It is also assumed that the current dry manually cleaned toilets and unimproved open-pit toilets will be converted

FIGURE 4.1 PROJECTED TRENDS IN NUMBER OF HOUSEHOLDS USING VARIOUS TYPES OF TOILETS IN INDIA, 2009-20



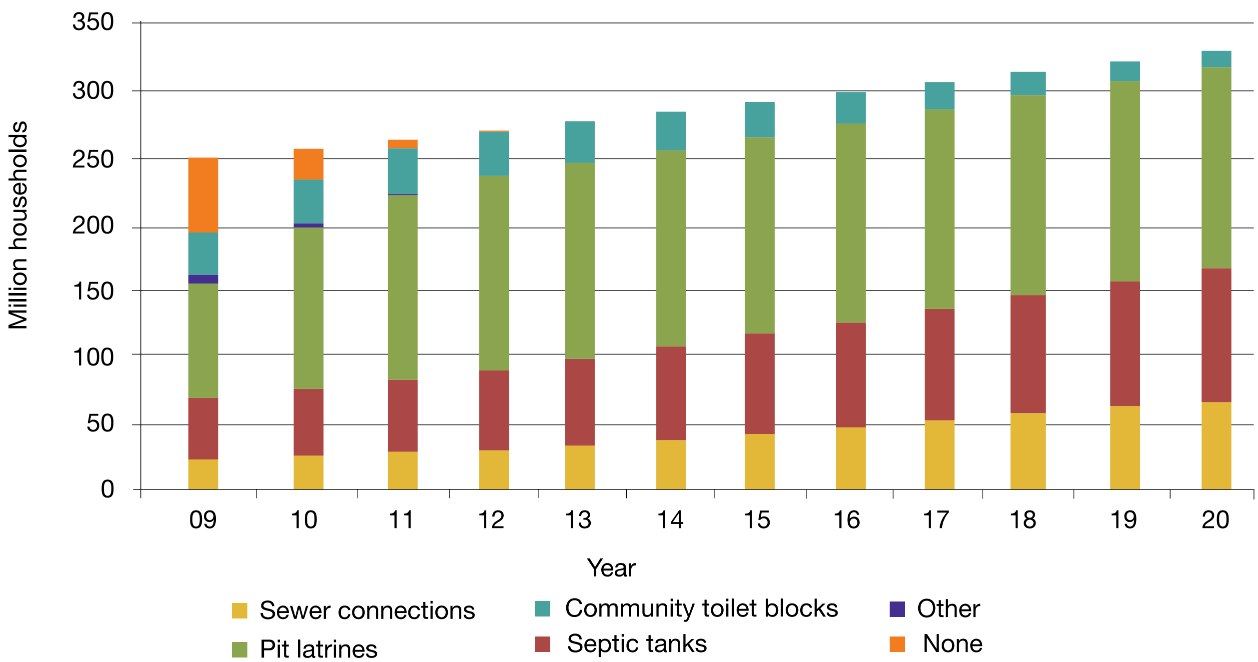
Source: Authors' analysis based on data for household toilet type from NSSO, 2007 and 2010; NIUA 2005; and JMPDWSS, 2006 and 2008.

to improved toilet types by 2012. Pit toilets, shared, and community toilets are expected to be intermediate steps in moving from no or unimproved toilets to improved toilets emptying into sewerage systems or, where sewerage systems are not available, to septic tanks with soakaways. As a result, the distribution of households by toilet types in India over the period under consideration will transform, as presented in Figure 4.2.

The use of toilets with sewer connections and septic tanks with soakaways is assumed to grow slowly over time, with more use of sewer-connected toilets by urban households. It is envisaged that when urban households switch from community toilets to private household toilets, the community toilet facilities will be converted into public toilets that will primarily be used by the floating population. Therefore, when urban households move to private toilets, annual spending on community/public toilets is expected to stabilize, though its percentage share in sanitation expenditures will decline.

In step with improvements in household arrangements, it is projected that following implementation of the National

FIGURE 4.2 PROJECTED DISTRIBUTION OF HOUSEHOLDS USING VARIOUS TYPES OF TOILETS IN INDIA, 2009-20

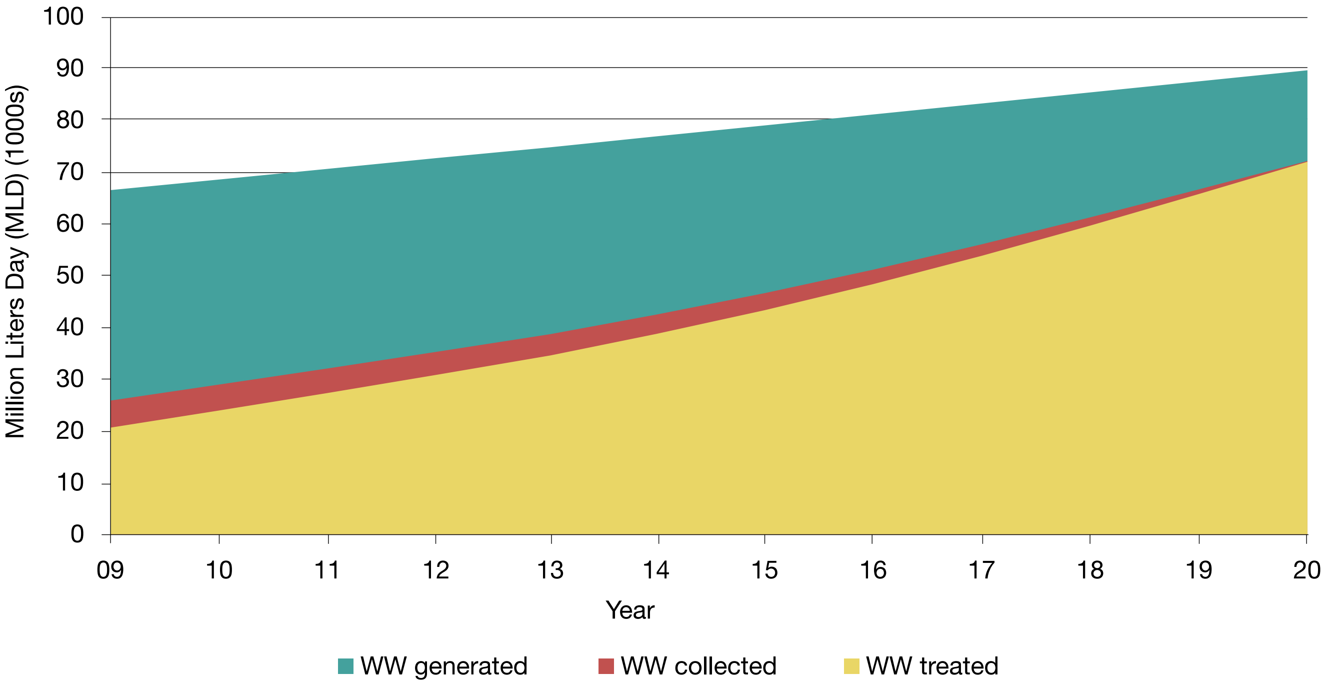


Source: Authors' analysis based on data for household toilet type from NSSO, 2007 and 2010; NIUA 2005; and JMPDWSS, 2006 and 2008.

Urban Sanitation Policy[15] wastewater collection and treatment facilities will be expanded in the coming years, closing the gaps between the wastewater generated, collected, and treated, as presented in Figure 4.3.

With gradual improvements, the proportion of city and village wastewater collected (and treated) is expected to rise from an estimated 33 percent in 2007 to about 59 percent collected (55 percent treated) in 2015, and then to 81 percent collected (80 percent treated) in 2020. In the initial years, in urban areas, wastewater from an estimated 25 percent households with on-site sanitation will discharge to open drains (in the absence of safe collection and treatment facilities). This is projected to decline to 0 percent by 2020, when all sewage will be diverted to proper on-site and/or sewerage installations. In rural areas, it is assumed that initially 5 percent of households using toilets with pits and septic tanks are treating wastewater on-site, and that this will increase to 59 percent by 2020. Almost all wastewater treatment in rural areas, it is assumed, will be done through on-site sanitation with sludge collection as well as treatment services.

FIGURE 4.3 PROJECTED TRENDS IN WASTEWATER GENERATED, COLLECTED, AND TREATED IN INDIA, 2009-20



Note: WW = Wastewater.

[15] While the Total Sanitation Campaign (TSC) at present assumes construction of toilets with on-site safe collection and treatment only, limited resources are made available for solid and liquid waste management in rural areas. In larger rural centers, this is also likely to take the form of some sort of small-scale organized treatment mechanism before moving to conventional systems like those available in urban areas.

ESTIMATION OF SANITATION MARKET SIZE

The national cumulative sanitation market has the potential to grow to ₹6.87 trillion ($152 billion) for the period of 2007 to 2020, of which ₹4.4 trillion (64 percent) is projected to be in infrastructure and another ₹2.5 trillion (36 percent) in operation and maintenance services. In rural areas during this period the market has a potential of ₹3.77 trillion ($83 billion) and in urban areas a potential of ₹3.1 trillion ($69 billion).

Figure 4.4 indicates that the estimated annual market size for sanitation products and services ranges from ₹300 billion ($6.6 billion) in 2007 to ₹683 billion ($15.1 billion) in 2020. Over time, the annual infrastructure expenditure is expected to rise from ₹223 billion in 2007 to ₹391 billion in 2020, and operation and maintenance expenditures are expected to rise from ₹77 billion in 2007 to ₹292 billion over the same period.

The annual rural sanitation market has the potential to more than double from 2007 to 2020, from ₹162 billion ($3.6 billion) to ₹369 billion ($8.1 billion). The annual urban sanitation market is projected to increase similarly, from ₹138 billion ($3.0 billion) to ₹314 billion ($6.9 billion), in the same period. The key indicators of the potential market and its components are summarized in Table 4.1.

FIGURE 4.4 PROJECTED GROWTH OF ANNUAL SANITATION MARKET, 2007-20

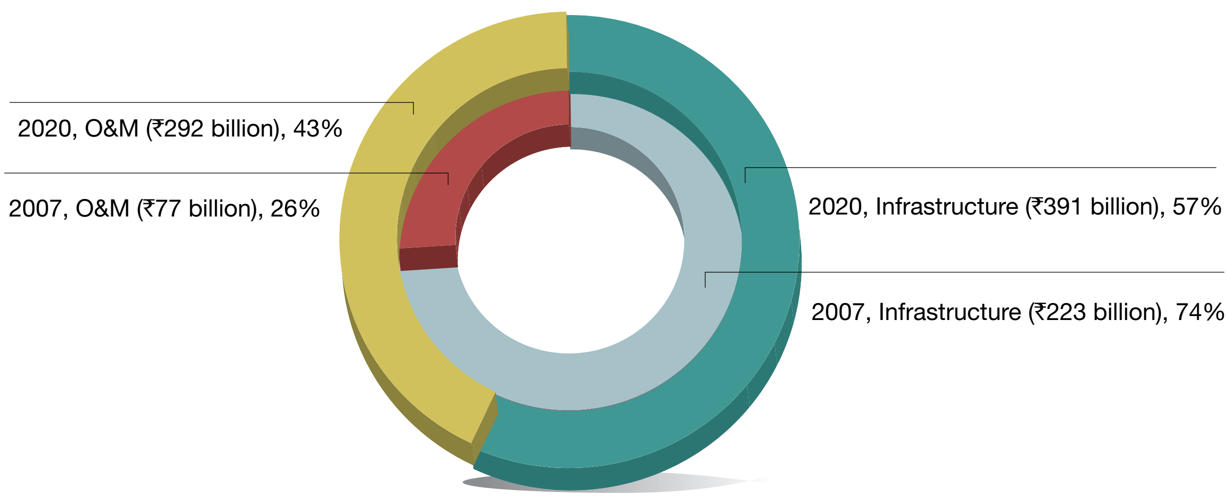


TABLE 4.1 SUMMARY OF POTENTIAL SANITATION MARKET IN INDIA IN 2009, 2012, 2015, AND 2020

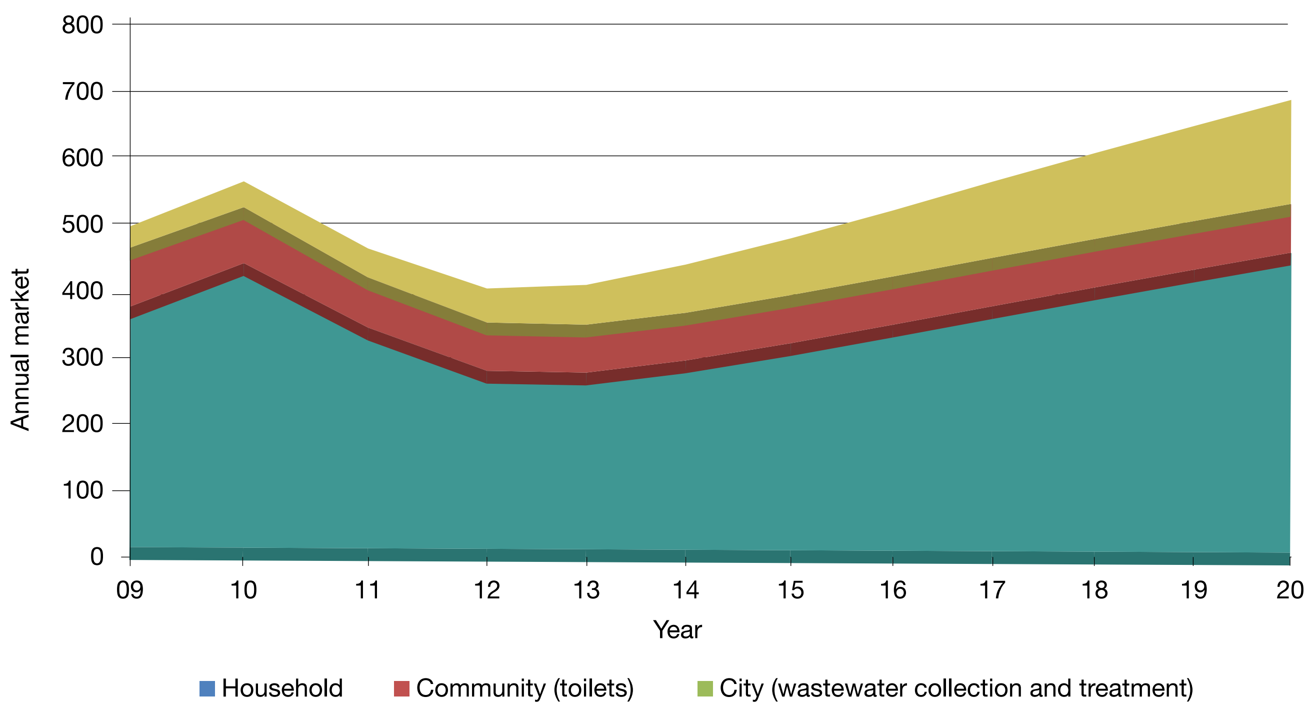
	2009	2012	2015	2020
Sanitation indicators (percent)				
Household with sewer connections	8.7	11.2	14.5	20.5
Household using community toilets	13.1	11.8	8.8	3.6
Household without toilet facilities	22.5	0.3	0.0	0.0
Wastewater treated	31.0	42.4	54.8	80.3
Annual market size (₹ billion)	484	392	470	683
Household	363	268	312	452
Community (toilets)	88	72	72	73
City (wastewater collection and treatment)	32	51	86	157
Investments (₹ billion)	378	235	272	391
Household	306	170	177	232
Community (toilets)	44	20	19	21
City (wastewater collection and treatment)	28	45	76	138
Operations and maintenance (₹ billion)	105	157	198	292
Household	57	98	135	220
Community (toilets)	45	53	53	52
City (wastewater collection and treatment)	4	6	10	19

Over time, the share of spending on household toilets and community toilets is expected to decline, and the share of spending on wastewater collection and treatment is expected to rise, as presented in Figure 4.5.

The decline in share of expenditure is expected to be relatively greater for community toilets than for household toilets as households using community toilets move to private toilets. The shares will stabilize after all households have moved to private toilets connected to sewer or septic tanks with soakaways, and when all of the wastewater that is generated is collected and treated. In all likelihood, these goals will be achieved after 2020.

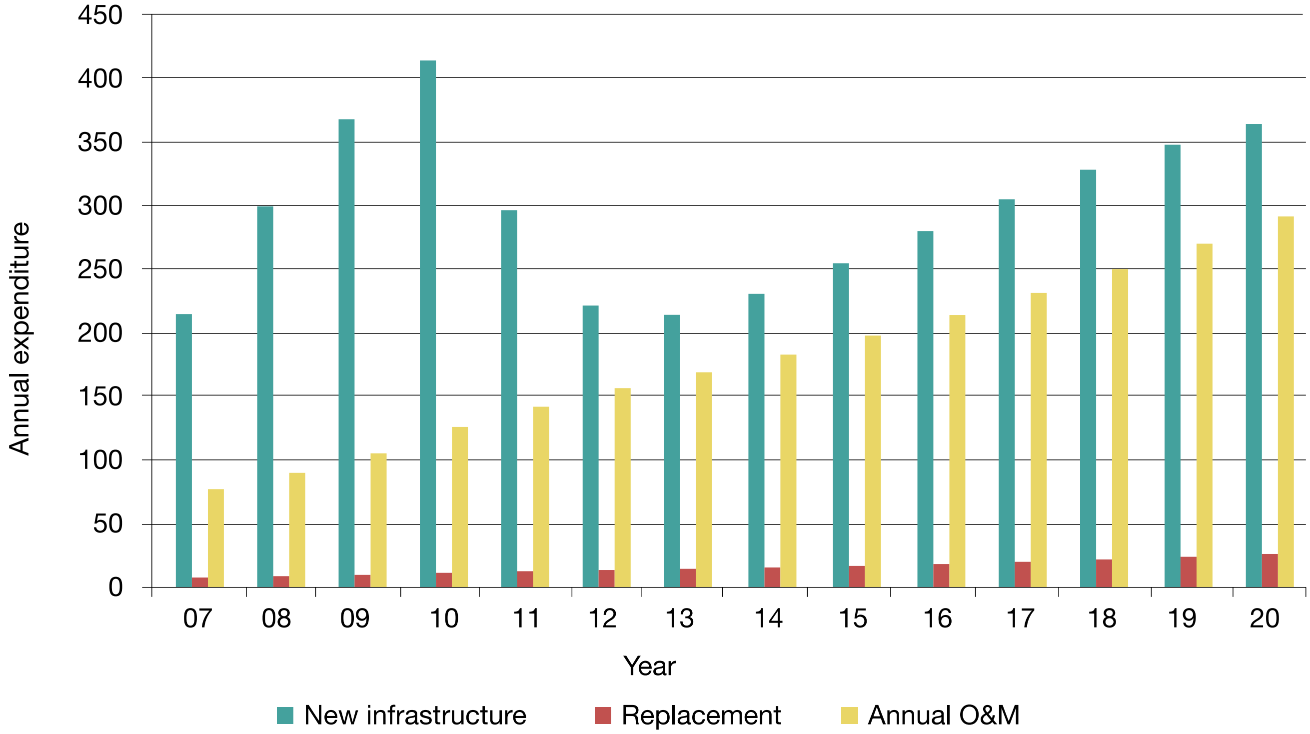
Of the annual city wastewater collection and treatment expenditures in 2009, ₹25 billion (77 percent) was for new infrastructure, ₹3.4 billion (10 percent) for infrastructure replacement, and ₹4 billion (13 percent) for annual operation and maintenance. Over time, the distribution of spending is projected to tilt in favor of infrastructure replacements and operation and maintenance as new wastewater collection and treatment infrastructure is built up. In 2015, new investment is expected to cost ₹76 billion, replacements ₹8.7 billion, and operation and maintenance ₹10 billion. By 2020, new wastewater investments will potentially cost ₹119 billion (76 percent), replacements ₹18 billion (12 percent), and operation and maintenance ₹19.5 billion (12 percent), for

FIGURE 4.5 DISTRIBUTION OF ANNUAL SANITATION MARKET, 2009-20



(in ₹ billion)

FIGURE 4.6 PROJECTED TRENDS IN POTENTIAL ANNUAL SANITATION EXPENDITURES ON INFRASTRUCTURE, REPLACEMENT, AND OPERATIONS AND MAINTENANCE, 2007-20



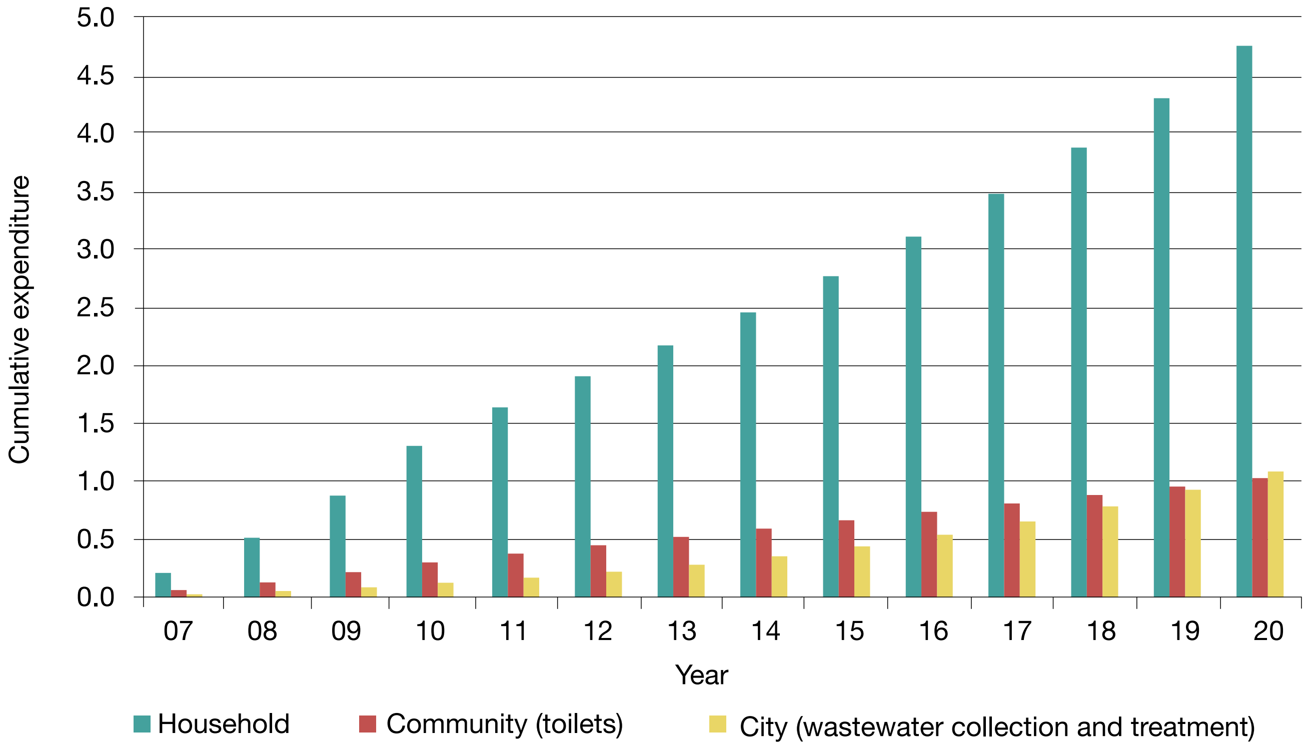
(in ₹ billion)

a total wastewater collection and treatment expenditure of ₹157 billion. While creating the infrastructure, whether at the household or the city level, will dominate the market during the initial years, over time the share of expenditures on infrastructure replacements and operation and maintenance will increase, as presented in Figure 4.6.

CUMULATIVE SANITATION MARKET

As mentioned above, the cumulative sanitation market, starting from 2007, is expected to reach ₹3.9 trillion by 2015 and ₹6.9 trillion by 2020. Of this total cumulative market size, the cumulative market of household toilets from 2007 is projected to be ₹2.8 trillion by 2015 and ₹4.8 trillion by 2020, as presented in Figure 4.7.

FIGURE 4.7 PROJECTED TRENDS IN POTENTIAL CUMULATIVE SANITATION EXPENDITURES AT HOUSEHOLD, COMMUNITY (TOILETS), AND CITY LEVELS, 2007-20

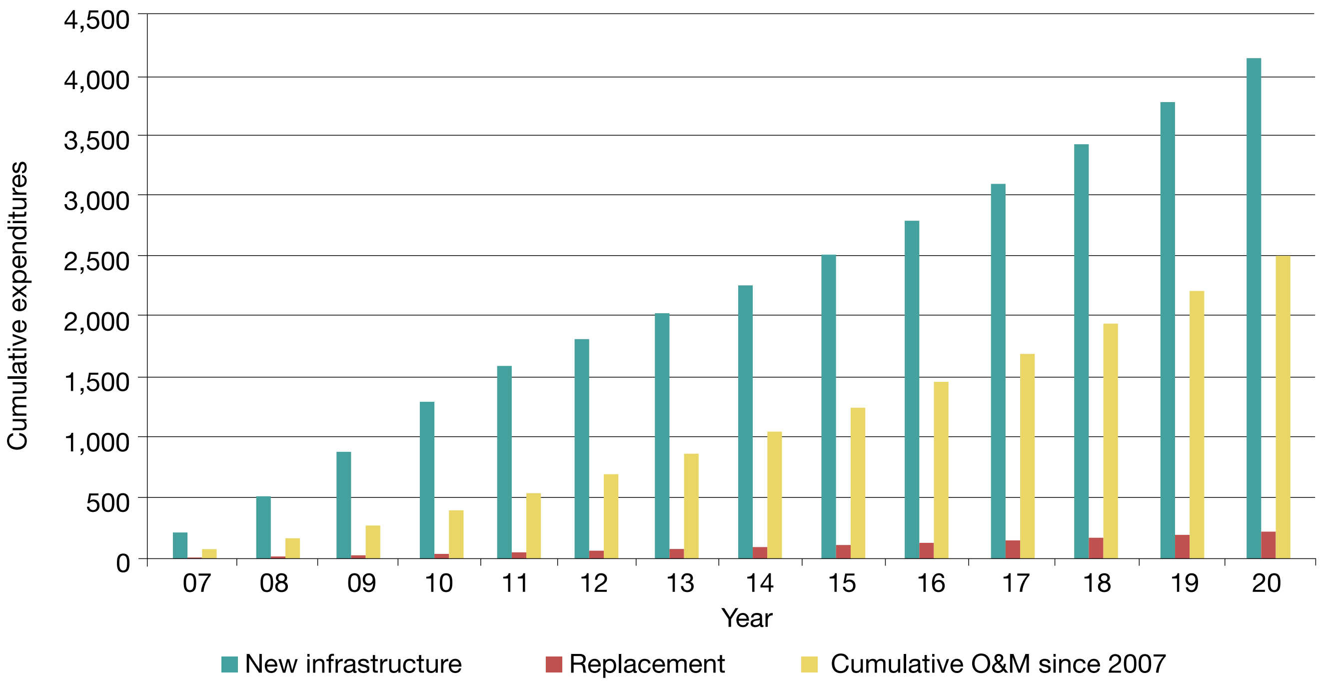


(in ₹ trillion)

Community toilets are projected to attract a *cumulative* investment of ₹665 billion by 2015 and ₹1 trillion by 2020, while wastewater collection and treatment has the potential to reach ₹440 billion by 2015 and ₹1 trillion by 2020.

The share of cumulative expenditures consisting of new infrastructure is projected to fall, from 75 percent (₹883 billion) in 2009, to 65 percent (₹2.5 trillion) in 2015, and to 60 percent (₹4.1 trillion) in 2020, as presented in Figure 4.8.

FIGURE 4.8 PROJECTED TRENDS IN POTENTIAL CUMULATIVE SANITATION EXPENDITURES ON INFRASTRUCTURE, REPLACEMENT, AND OPERATIONS AND MAINTENANCE, 2007-20



(in ₹ billion)

The share of replacement expenditures is projected to rise from ₹26 billion in 2009 to ₹222 billion in 2020, and the share of operation and maintenance expenditures will rise from ₹273 billion in 2009 to ₹2.5 trillion in 2020.

5. Conclusion and Areas for Further Research

SUMMARY OF FINDINGS

The annual economic impact of inadequate sanitation in India estimated in this report is ₹2.44 trillion ($53.8 billion). This implies an annual impact of ₹2,180 ($48) per capita.

This estimated impact is equivalent to 6.4 percent of the country's GDP in 2006. Monetary losses, a subset of economic losses, are estimated to be ₹364 billion ($8 billion), or about 1 percent of the GDP. Of the total impact, the loss of flow of 2006 economic value makes up 46 percent of the total impact, equivalent to 3 percent of the GDP, the balance being the discounted present value of flow of losses incurred in later years.

The per capita losses related to health are ₹1,562 ($34.47), while losses related to water are ₹171 ($3.78), those related to access time are ₹436 ($9.61), and those related to tourism are ₹11 ($0.24). A substantial 54 percent of per capita and total economic losses reflect economic loss from premature deaths due to inadequate sanitation and hygiene.

Previous research shows that investments in sanitation yield large benefits, which in low-income countries are at least five times higher than the amounts invested (Hutton, Haller, and Bartram, 2007). In India, additional sanitation and hygiene (hand washing with soap) interventions in 2006 would have prevented 346,000 deaths and 338 million cases of diseases and saved at least 1.7 billion days of time lost in 2006. It is also estimated that up to ₹1.48 trillion ($32.6 billion) of annual economic gains could result from a combination of sanitation and hygiene interventions; these interventions would need to include access to improved toilet facilities, hygiene education, and behavior change (including hand washing with soap), improved domestic water quality, improved water supply, improved food handling, and safe confinement and disposal of fecal matter (wastewater/sludge collection, treatment, and disposal). The benefits would result from improvements in health, domestic water supply and quality, access time, and tourism. Altogether, these gains are equivalent of about 3.9 percent of the GDP, or ₹1,321 ($29) per capita in 2006.

The poor in India have to bear substantial adverse impacts on their lives, health, and scarce financial resources because of inadequate sanitation. Diseases caused by inadequate sanitation affect poor households more than others because the poor have relatively lower access to sanitary toilets, hygiene-related resources and practices, and clean and sufficient water. Poorer families tend to lose wages and spend precious resources on treating related illnesses—impacting their well-being much more severely than that of their counterparts in higher socioeconomic classes. Within poorer households, children are most affected.

In the coming decade, the sanitation market is likely to play an important role in the local economy. Its potential annual market size is expected to increase after large investments are made in the initial years to provide improved toilets to all. The annual market is expected to rise from ₹0.39 trillion ($8.7 billion) in 2012 to ₹0.68 trillion ($15 billion) in 2020. The cumulative market size for the period of 2007 to 2012 is expected to be ₹2.58 trillion ($57 billion); for the 2007-2015 period ₹3.88 trillion ($86 billion); and for the 2007-2020 period ₹6.87 trillion ($151.6 billion).

POLICY PRIORITIES FOR SANITATION INVESTMENTS

The above results underline the substantial economic losses that India experiences as a result of poor sanitation. The Government of India has been alive to this issue and has made major investments in rural sanitation since the mid-1980s. Its national flagship program, the Total Sanitation Campaign, now covers all districts of the country. Moreover, in order to accelerate achievement of "total" sanitation, in 2004 the campaign instituted a fiscal award called *Nirmal Gram Puraskar* ("Clean Village Award"), which has resulted in a shift from building more toilets to making communities totally sanitized.

Between 1999 and 2008, the national government allocated to this campaign about ₹4,400 crore ($1 billion), and its current annual investment is about ₹1,100-1,200 crore ($250 to $270 million).[16] While the achievements have been laudable—more than 60 percent toilet coverage in rural areas—the sector is struggling with the issues of maintaining momentum in improving access, post-construction operations and maintenance, sustaining behavior change, and other issues of sustainability.

However, priority was not accorded explicitly to urban sanitation until as late as 2008, when the National Urban Sanitation Policy was approved by the government. The two urban flagship programs—the Jawaharlal Nehru National Urban Renewal Mission (for 63 cities) and the Urban Infrastructure Development Scheme for Small and Medium Towns for other urban areas—are sources of investments in water and sanitation by states and cities. The National Urban Sanitation Policy explicitly encourages states to develop with their sanitation strategies, help cities prepare citywide sanitation plans, and make infrastructure and software investments to rapidly improve urban sanitation. The results of a National Sanitation Rating Survey (2009-2010) of 423 Class I cities have further raised awareness about urban sanitation and propelled action from state and city stakeholders. It is expected that further priority will be accorded to infrastructure and behavior change in urban sanitation over the coming years.

This study confirms that such investments as have been made in rural sanitation, and those that are intended to be made in urban sanitation, are critical public investments. Apart from increased investments, greater efforts are required in making these investments effective, including targeting reductions in morbidity and mortality, mitigating impacts on water resources, improving welfare, and reducing impacts on tourism. The ESI analysis also provides this framework for periodic monitoring, since investments in sanitation must result in preventing economic losses apart from the benefits gained in the noneconomic dimensions.

The potential sanitation market described in this report also points to the economic potential that future investments in the sector have. Apart from public investments, policy direction for improved sanitation and hygiene, in managing the full cycle of safe collection, conveyance, and disposal of human excreta, is likely to crowd in significant household and private corporate investments.

AREAS NEEDING FURTHER RESEARCH

The current exercise also points to a number of areas for further research to strengthen the analysis of impacts and gains from mitigation actions in India. Many aspects of life related to the impacts of sanitation are not well documented in existing general surveys. Sanitation-specific surveys usually do not cover topics that give *information about the adverse impacts of inadequate sanitation*. Such information should be collected routinely at the national, state, and local levels. Workplace sanitation is another area that needs attention in data collection. Secondly, empirical research on the relationship between sanitation and its impacts, including potential gains from good sanitation, could benefit from *integrated information sources* that combined physical, psychological, and economic aspects. This could guide local policy and the implementation of plans.

Other areas deserving further study and other unmet research needs in India include:

- Longitudinal data from repeat surveys, which is needed on education, health, impacts on lifetime opportunities, future incomes, and sanitation.
- Epidemiological studies are needed to estimate disease risk reduction and other gains from sanitation and hygiene interventions at the total-population level.
- For refining economic impacts related to health, data is needed on seasonal variations in the incidence of diseases, their duration, the number of days an ill person is treated by different providers, and the costs of treatment at different providers.
- Detailed data needs to be collected about school enrollment by gender, the quality of school sanitation, reasons for school absence, and the welfare impacts of inadequate sanitation on school-age children.
- Surveys of potential tourist visits should include sanitary conditions, tourists' inclination to revisit locations, alternate choices, and so on.

[16] Figures from the Department of Drinking Water Supply's Outcome Budget 2009-10.

The proposed National Sample Survey on sanitation is a welcome step in filling some of the above gaps in data. Findings from the ongoing Census 2011 are also expected to provide better data on sanitation-related indicators. Finally, the next rounds of the National Family Health Survey will help assess the incremental progress and impacts on different dimensions of quality of life that the current exercise has begun addressing.

The ongoing ESI Options Study in India is expected to complement the findings of the current ESI Impact Study, especially in assessing the effectiveness of sanitation technologies at the household level and programmatic approaches at the community level and in informing policies about improved effectiveness of current and future investments in sanitation and behavior change in the country's rural and urban areas.

Annexes

Annex 1: Water Quality Standards

TABLE A.1 WATER QUALITY STANDARDS AND DESIGNATED-BEST-USE

Designated-best-use	Class of water	Criteria
Drinking water source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml shall be 50 or less; pH between 6.5 and 8.5; Dissolved Oxygen 6 mg/l or more; Biochemical Oxygen Demand 5 days 20°C 2 mg/l or less
Outdoor bathing (organized)	B	Total Coliforms Organism MPN/100ml shall be 500 or less; pH between 6.5 and 8.5; Dissolved Oxygen 5 mg/l or more; Biochemical Oxygen Demand 5 days 20°C 3 mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5,000 or less; pH between 6 and 9; Dissolved Oxygen 4 mg/l or more; Biochemical Oxygen Demand 5 days 20°C 3 mg/l or less
Propagation of wildlife and fisheries	D	pH between 6.5 and 8.5; Dissolved Oxygen 4 mg/l or more Free Ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	E	pH between 6.0 to 8.5; Electrical Conductivity at 25°C micro mhos/cm Max. 2250; Sodium Absorption Ratio Max. 26; Boron Max. 2 mg/l
	Below E	Not meeting A, B, C, D, and E criteria

Source: Central Pollution Control Board website, www.cpcb.nic.in.

TABLE A.2 STANDARDS FOR DRINKING WATER IN INDIA AND GUIDELINES OF WORLD HEALTH ORGANIZATION

Parameter	BIS, Indian Standards (IS 10500:1991)		World Health Organization (WHO Guideline)
	Desirable limit	**Permissible limit**	**Maximum allowable concentration**
Color	5 Hazen Units	25 Hazen Units	15 True Color Units
Turbidity	5.0 NTU	10 NTU	5.0 NTU
pH	6.5-8.5	No relaxation	6.5-8.5
Total hardness (as $CaCO_3$)	300 mg/l	600 mg/l	500 mg/L
Chlorides (as Cl)	250 mg/l	1,000 mg/l	250 mg/L
Residual-free chlorine (When protection against viral infection is required it should be min. 0.5 mg/l)	0.2 mg/l	-	-
Dissolved solids	500 mg/l	2,000 mg/l	1,000 mg/l
Calcium (as Ca)	75 mg/l	200 mg/l	-
Sulphate (as SO_4^{2-})	200 mg/l	400 mg/l	400 mg/l
Nitrate (as NO_3^-)	45 mg/l	100 mg/l	10 mg/l
Fluoride (as F-)	1.0 mg/l	1.5 mg/l	1.5 mg/l
Phenolic compounds (as C_6H_5OH)	0.001 mg/l	0.002 mg/l	-
Anionic detergent (as MBAS)	0.2 mg/l	1.0 mg/l	-
Mineral oil	0. 01 mg/l	0.03 mg/l	-
Alkalinity	200 mg/l	600 mg/l	-
Boron	1.0 mg/l	5.0 mg/l	-
***Micro pollutants (heavy metals and pesticides*)**			
Zinc (as Zn)	5.0 mg/l	15 mg/l	5.0 mg/l
Iron (as Fe)	0.3 mg/l	1.0 mg/l	0.3 mg/l
Manganese (as Mn)	0.1 mg/l	0.3 mg/l	0.1 mg/l
Copper (as Cu)	0.05 mg/l	1.5 mg/l	1.0 mg/l

Continued on Page 76

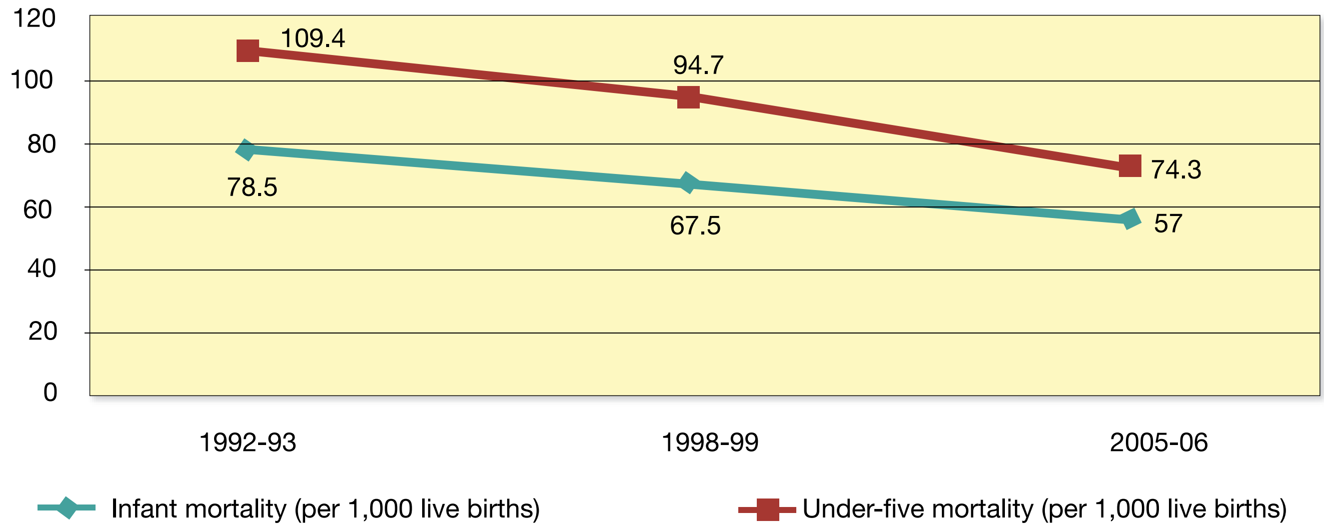
TABLE A.2 STANDARDS FOR DRINKING WATER IN INDIA AND GUIDELINES OF WORLD HEALTH ORGANIZATION (CONTINUED)

Parameter	BIS, Indian Standards (IS 10500:1991)		World Health Organization (WHO Guideline)
	Desirable limit	**Permissible limit**	**Maximum allowable concentration**
Arsenic (as As)	0.05 mg/l	No relaxation	0.05 mg/l
Cyanide (as CN)	0.05 mg/l	No relaxation	0.1 mg/l
Lead (as Pb)	0.05 mg/l	No relaxation	0.05 mg/l
Chromium (as Cr^{6+})	0.05 mg/l	No relaxation	0.05 mg/l
Aluminium (as Al)	0.03 mg/l	0.2 mg/l	0.2 mg/l
Cadmium (as Cd)	0.01 mg/l	No relaxation	0.005 mg/l
Selenium (as Se)	0.01 mg/l	No relaxation	0.01 mg/l
Mercury (as Hg)	0.001 mg/l	No relaxation	0.001 mg/l
Total pesticides	Absent	0.001 mg/l	-
Sodium	-	-	200 mg/l
Aldrin and dieldrin	-	-	0.03 µg/l
DDT	-	-	1.0 µg/l
Lindane	-	-	3.0 µg/l
Methoxychlor	-	-	30.0 µg/l
Benzene	-	-	10.0 µg/l
Hexachlorobenzene	-	-	0.01 µg/l
Pentachlorophenol	-	-	10.0 µg/l

Source: CPCB, 2007; Bureau of Indian Standards.

Annex 2: Change in Infant Mortality and Under-five Mortality

FIGURE A.1 INFANT AND UNDER-FIVE MORTALITY RATES IN INDIA, 1992-93 TO 2005-06



Source: Based on NFHS 2005-06 (Measure DHS and IFC Macro, 2008).

Annex 3: Diseases and Health Problems Related to Sanitation and Hygiene

TABLE A.3 DISEASES AND HEALTH PROBLEMS RELATED TO SANITATION AND HYGIENE

Disease/health impairment	Information about disease/health impairment
Diarrhea	88% of diarrhea is attributed to unsafe water supply, inadequate sanitation, and hygiene.
	Improved water supply reduces diarrhea morbidity by 6% to 25%, if severe outcomes are included.
	Improved sanitation reduces diarrhea morbidity by 32%.
	Hygiene interventions including hygiene education and promotion of hand washing can lead to a reduction of diarrhea cases by up to 45%.
	Improvements in drinking water quality through household water treatment, such as chlorination at point of use, can lead to a reduction of diarrhea episodes by 35% and 39%.
Campylobacter spp.	Diarrhea, occasionally bloody and severe. Cramping abdominal pain, fever, malaise.
Shigelladysenteriae	Severe abdominal pain, watery diarrhea, or stools containing blood.
Giardia spp.	Acute onset of diarrhea, abdominal cramps, bloating and flatulence, malaise, weight loss.
E. coli O157:H7	Severe bloody diarrhea and abdominal cramps; sometimes the infection causes non-bloody diarrhea or no symptoms.
Cryptosporidium spp.	Diarrhea, mild abdominal pain, mild fever.
Helicobacter pylori	Nausea, abdominal pain, gastritis, hypochlorhydria.
Legionella spp.	Fever, cough, prostration, diarrhea, pleuritic pain.
HIV/AIDS	With inadequate sanitation and hygiene people afflicted with HIV/AIDS become more susceptible to opportunistic infections. As a result, their health and quality of life suffers. Good sanitation and hygiene are important for maintaining health, productivity, and quality of life of people living with HIV/AIDS.
Schistosomiasis	An estimated 160 million people are infected with schistosomiasis. It is strongly related to unsanitary excreta disposal and absence of nearby sources of safe water. Basic sanitation reduces the disease by up to 77%.
Intestinal helminthes (ascariasis, trichuriasis, hookworm)	Access to safe water and sanitation facilities and better hygiene practice can reduce morbidity from ascariasis by 29% and hookworm by 4%.
Campylobacteriosis	Campylobacteriosis is a severe form of diarrhea that occurs worldwide. Sanitation and personal and food hygiene as well as safe water supply are important in its prevention.
	Campylobacteriosis is an infection of the gastrointestinal tract. Symptoms of the infection include diarrhea (often including the presence of mucus and blood), abdominal pain, malaise, fever, nausea, and vomiting. Death from campylobacteriosis is rare and is more likely in the very young, the very old, or those already suffering from a serious disease such as AIDS.

TABLE A.3 DISEASES AND HEALTH PROBLEMS RELATED TO SANITATION AND HYGIENE (CONTINUED)

Disease/health impairment	Information about disease/health impairment
Cholera	Cholera is an acute infection of the intestine, which begins suddenly with painless watery diarrhea, nausea, and vomiting. Most people who become infected have very mild diarrhea or symptom-free infection. Malnourished people in particular experience more severe symptoms. Severe cholera cases present with profuse diarrhea and vomiting. Severe, untreated cholera can lead to rapid dehydration and death. If untreated, 50% of people with severe cholera will die, but prompt and adequate treatment reduces this to less than 1% of cases.
Hepatitis	Hepatitis, a broad term for inflammation of the liver, has a number of infectious and non-infectious causes. Two of the viruses that cause hepatitis (hepatitis A and E) can be transmitted through water and food; hygiene is therefore important in their control.
	Among the infectious causes, hepatitis A and hepatitis E are associated with inadequate water supplies and poor sanitation and hygiene, leading to infection and inflammation of the liver. The illness starts with an abrupt onset of fever, body weakness, loss of appetite, nausea, and abdominal discomfort, followed by jaundice within a few days. The disease may range from mild (lasting 1-2 weeks) to severe disabling disease (lasting several months). In areas highly endemic for hepatitis A, most infections occur during early childhood. The majority of cases may not show any symptoms; fatal cases due to fulminant acute hepatitis are rare. Nearly all patients recover completely with no long-term effects.
Leptospirosis	Leptospirosis is a bacterial disease that affects both humans and animals. The early stages of the disease may include high fever, severe headache, muscle pain, chills, redness in the eyes, abdominal pain, jaundice, hemorrhages in skin and mucous membranes (including pulmonary bleeding), vomiting, diarrhea, and a rash.
	Pathogenic Leptospira spp. cause leptospirosis. Human infection occurs through direct contact with the urine of infected animals or by contact with a urine-contaminated environment, such as surface water, soil, and plants. Leptospires can gain entry through cuts and abrasions in the skin and through mucous membranes of the eyes, nose, and mouth. Human-to-human transmission occurs only rarely.
Malnutrition	Malnutrition is a major health problem, especially in developing countries. Water supply, sanitation, and hygiene, given their direct impact on infectious diseases, especially diarrhea and intestinal worms, are important for preventing malnutrition. Both malnutrition and inadequate water supply and sanitation are linked to poverty. The impact of repeated or persistent diarrhea on nutrition-related poverty and the effect of malnutrition on susceptibility to infectious diarrhea are reinforcing elements of the same vicious circle, especially amongst children in developing countries.
Spinal injury	Deformities of the spine may also occur when water has to be fetched and carried long distances over a considerable period of time.
Trachoma	Trachoma is an infection of the eyes that may result in blindness after repeated re-infections. It is the world's leading cause of preventable blindness and occurs where people live in overcrowded conditions with limited access to water and healthcare. Trachoma spreads easily from person to person and is frequently passed from child to child and from child to mother within the family. Infection usually first occurs in childhood but people do not become blind until adulthood. The disease progresses over years as repeated infections cause scarring on the inside of the eyelid, earning it the name of the "quiet disease." The eyelashes eventually turn in. This causes rubbing on the cornea at the front of the eye. The cornea becomes scarred leading to severe vision loss and eventually blindness.
Typhoid and paratyphoid enteric fevers	Typhoid and paratyphoid fevers are infections caused by bacteria which are transmitted from feces to ingestion. Clean water, hygiene, and good sanitation prevent the spread of typhoid and paratyphoid. Contaminated water is one of the pathways of transmission of the disease.

Source: WHO, 2008a, 2008b, 2008c; and United States, CDC, "Emergency Preparedness and Response," http://www.bt.cdc.gov.

Annex 4: Health

Reliable estimates for mortality by cause of death for children below five years and population above five years for 2006 are not available. This study estimates the disease-specific mortality by using disease-specific death rates for 2004 from the Global Burden of Disease study by the World Health Organization (WHO, 2008a). Age-specific death rates for 2004 are estimated by dividing deaths from diseases by total population in different age groups. To estimate death from various diseases in 2006, age-specific death rates for 2004 are multiplied by age-specific populations.

TABLE A.4 DISTRIBUTION OF POPULATION ACROSS AGE CLASSES (PERSONS)

Population	Total population	Children under 5 years	Children 5-14 years	Population 15+ years
India	1,117,734,000	125,146,982	265,318,060	727,268,955
Rural	793,250,994	95,053,046	199,087,334	499,110,614
Urban	324,483,006	30,093,936	66,230,726	228,158,340
Wealth Quintile-1	213,491,297	29,509,127	62,625,342	121,356,828
Wealth Quintile-2	223,193,287	27,521,502	59,396,324	136,275,461
Wealth Quintile-3	226,207,844	25,090,248	53,381,326	147,736,270
Wealth Quintile-4	232,044,077	23,782,141	49,172,733	159,089,203
Wealth Quintile-5	222,797,493	18,573,106	39,046,468	165,177,921

Source: Estimates based on population estimates from TGPP and NCPP (2006); and age and wealth-group distributions from the National Family Health Survey-3.
Note: Wealth Quintile-1 is the bottom 20% and Wealth Quintile-5 is the top 20%. For details of methodology of wealth groups see NFHS-3 Final Report.

TABLE A.5 CAUSE-SPECIFIC DEATHS IN CHILDREN UNDER FIVE AND DEATHS FROM DIARRHEA IN POPULATION 5+ YEARS

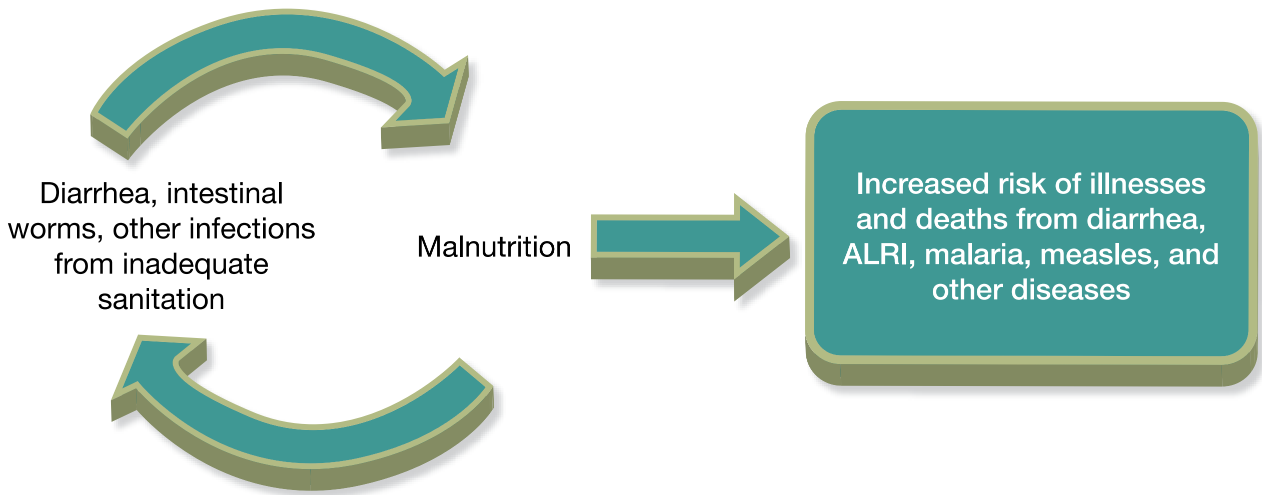
Children below 5 years	**Deaths**	**Percent of age-group total**
Diarrhea	449,345	19.83
ALRI	319,759	14.11
Intestinal nematode infections	449	0.02
Trachoma	6	0.00
Skin diseases	432	0.02
Measles	129,888	5.73
Malaria	4,733	0.21
Protein energy malnutrition	10,372	0.46
Low birth weight	372,043	16.41
Other perinatal conditions	530,916	23.42
Other causes	448,601	19.79
Total deaths, children below 5 years	2,266,544	100.00
Deaths from all causes, other than perinatal deaths	1,363,585	60.16
Population 5+ years		
Diarrhea, population 5-14 years	1,217	0.32
Diarrhea, population 15+ years	60,619	0.74

Source: Estimates are based on cause-specific death rates from the 2004 *Global Burden of Disease* study (updated 2008) of the World Health Organization (WHO, 2008a) and age-specific population for 2006.
Note: Perinatal deaths are defined as the sum of deaths due to low birth weight and other perinatal conditions.

Sanitation Attributable Fraction of 88 percent was applied to diarrhea deaths to estimate diarrhea deaths due to inadequate sanitation (Hutton, et al., 2008). This gives direct mortality due to diarrhea. Indirect deaths due to malnutrition induced by diarrhea, intestinal worms, and other infectious diseases related to inadequate sanitation in children under age five were estimated using an approach that looks at the impact of diarrhea, intestinal worms, and other infections on malnutrition, and the impact of malnutrition on relative risk of all-cause and cause-specific mortality (Larsen, 2008; Hutton et al., 2008; Prüss-Üstün, et al., 2008).

Malnutrition can also increase susceptibility to diarrhea, intestinal worms, and other infections resulting from inadequate sanitation or increase their severity, resulting in a positive feedback loop, as illustrated in Figure A.2

FIGURE A.2 INDIRECT HEALTH IMPACTS VIA MALNUTRITION



Malnutrition can be measured by using a variety of measures. One of the popular measures is the Weight-for-Age Z-score (WAZ), which measures how many standard deviations away is a child's weight compared to an international reference weight for children of the same age. This study uses this measure of malnutrition along with results from previous studies to estimate the fraction of deaths and disease cases that can be attributed to malnutrition induced by diarrhea (Fishman, et al., 2004). This fraction is the *Attributable Fraction* of deaths and disease cases. Attributable Fraction for each disease is multiplied by the total deaths from a disease to estimate the number of deaths from the disease that can be attributed to malnutrition induced by diarrhea.

Studies of the impact of diarrhea on nutritional status typically find that diarrhea-related infections account for 20 to 50 percent of a child's weight deficit (Larsen, 2008; Hutton et al., 2008; Prüss-Üstün et al., 2004) (Whitehead, Rowland, and Cole, 1976; Black, Brown, and Becker, 1984; Becker, Black, and Brown, 1991). A midpoint of 35 percent of the weight deficit attributable to diarrhea and intestinal helminthes is used in this study. Hence, if there were no diarrhea and intestinal helminthes, 35 percent of children's weight deficit would have been eliminated.[17] This will increase the WAZ score by 35 percent. A counter-factual WAZ score was calculated under the scenario where underweight due to diarrhea and other sanitation-related infections is eliminated in underweight children. Weight, age, and WAZ information for children in India is available from the National Family Health Study-3 data. Using this information, counter-factual WAZ scores were estimated using individual children's records from the NFHS-3 survey (2005-06), and the percentage distributions of children in the observed and counter-factual WAZ scenarios were estimated for WAZ categories corresponding to mild, moderate, and severe malnutrition status.

Health and medical literature reports impacts of malnutrition on illness and deaths. A review and meta-analysis by Fishman and others reports increased risk of mortality for various diseases due to malnutrition (Fishman et al., 2004). According to this study, compared to children with WAZ scores greater than -1 (children with weight one standard deviation below the standard international median weight), children who are mildly underweight (WAZ between -1 and -2) are two times more likely to die from ALRI; children who are moderately underweight (WAZ between -2 and -3) are four times more likely; and children who are severely underweight (WAZ

[17] Weight deficit is the difference between the standard age-specific median international weight and the actual weight of a child.

TABLE A.6 RELATIVE RISK OF DEATH FROM SEVERE, MODERATE, AND MILD UNDERWEIGHT (WAZ) IN CHILDREN BELOW FIVE YEARS

Weight for age Z-score (WAZ)	Diarrhea	ALRI	Measles	Malaria	All causes
<-3 SD	12.5	8.09	5.22	9.49	8.72
-2 to -3 SD	5.4	4.03	3.01	4.48	4.24
-1 to -2 SD	2.3	2.01	1.73	2.12	2.06
>-1 SD	1.0	1.00	1.00	1.00	1.00

Source: Fishman et al., 2004.

less than -3) are eight times more likely to die from ALRI. The study also reports the relative risk of death by measles, malaria, diarrhea, and all-cause mortality for children with mild, moderate, and severe malnutrition compared to the reference category of those with WAZ >-1.

A residual category for deaths from "other causes" was constructed by deducting deaths from diarrhea, ALRI, malaria, measles, and perinatal causes from all-cause mortality. Perinatal deaths[18] related to low weight are more likely to be of fetal origin and not likely to be caused by malnutrition induced by diarrhea among children, and are thus excluded from this study (Fishman, et al., 2004). It is possible that sanitation-related diseases among pregnant women may result in low birth weight in the newborn, for example diarrhea or intestinal worms in pregnant women may cause premature birth and low birth weight (Bhargava, Singh, and Saxena 1991; Bundy, et al., 2004; Hotez, et al., 2006). Low birth weight is associated with poor prognosis and health in children, and it also affects social and economic outcomes when low birth weight infants grow up to be adults (Almond, Chay, and Lee, 2005; Currie, et al., 2008; Fishman et al., 2004). This pathway was not explored in the present study.

Information on the prevalence of observed and counter-factual WAZ and on the relative risks was used to estimate Attributable Fractions for all-cause mortality, cause-specific mortality, and cause-specific morbidity using the following formula:

$$AF = \frac{\sum_{i=1}^{n} P_i RR_i - \sum_{i=1}^{n} P_i^c RR_i}{\sum_{i=1}^{n} P_i RR_i}$$

[18] Perinatal deaths are stillbirths and deaths of infants in the first seven days after birth.

Here P_i is the prevalence of the underweight risk categories and RR_i is the relative risk of death or illness for the underweight categories shown in the preceding tables. In the formula above, P_i^c is the counter-factual prevalence of underweight in each of the WAZ categories. The Attributable Fraction (AF) of deaths and illnesses from malnutrition is the fraction of deaths or illnesses caused by malnutrition.

Attributable Fractions for all-cause and cause-specific deaths were multiplied by the deaths from all causes, ALRI, measles, and malaria deaths in children below five years to estimate the deaths attributable to malnutrition resulting from diarrhea and other infections resulting from inadequate sanitation. An estimated 88 percent of diarrhea is caused by inadequate sanitation. This fraction was applied to indirect deaths from malnutrition to estimate the deaths from all causes, ALRI, measles, and malaria deaths attributable to inadequate sanitation in children below five years of age. Deaths from the residual category of "other causes" due to inadequate sanitation were estimated by deducting deaths due to diarrhea, ALRI, malaria, and measles from all-cause non-perinatal deaths due to inadequate sanitation. Indirect impacts via malnutrition are estimated only in children below five years of age, due to a lack of relevant information for other age groups.

This study also estimated the direct impact from intestinal helminthes (worms) and trachoma. Intestinal helminthes (worms) are important causes of growth retardation, cognitive impairment, chronic pain, malnutrition, and poor health, especially among children. Intestinal worm infections can cause obstruction of intestinal tracts, requiring surgery. They are also a cause of malnutrition, anemia, decreased fertility, babies with low birth weight, and impaired lactation in pregnant and lactating women. International visitors are also affected by worm infections. Fecal-oral route related to human excreta, lack of hygiene, and contaminated water is the major transmission mechanism. Prevention of intestinal worm infections is reported to lead to gains in school attendance and other outcomes (Hotez, et al., 2008; Hotez, et al., 2006; DCPP, 2008; Miguel and Kremer, 2004; Ansart et al., 2005).

Deaths from intestinal nematodes (helminthes) are estimated by applying the percentage distribution of cause of death to total mortality. This is similar to the estimation of total deaths by diarrhea, ALRI, and other diseases described earlier.

Morbidity burden of disease cases due to inadequate sanitation

Increased risks for illness in children below age five due to underweight are also reported in the study by Fishman and co-authors (Fishman, et al., 2004). Relative risks for illnesses due to malnutrition are reported for cases of ALRI, diarrhea, and malaria. For example, a WAZ less than -2 nearly doubles the risk of being ill from ALRI.

Cases of ALRI and malaria indirectly attributable to poor sanitation via malnutrition were estimated using an approach similar to the estimation of indirect mortality described above. Direct impact of inadequate sanitation manifested as cases of diarrhea in children below age five and in the population above age five were estimated using children's records and different age-group population figures at the national and sub-population levels in NFHS-3. The proportion of children reporting diarrhea episodes during a two-week recall period, reported in NFHS-3 (2005-06), was estimated first.

TABLE A.7 RELATIVE RISK OF ILLNESSES FROM UNDERWEIGHT (WAZ) IN CHILDREN BELOW FIVE YEARS

Weight for age Z-score (WAZ)	Diarrhea	ALRI	Malaria
<-2 SD	1.23	1.86	1.31
>-2 SD	1.00	1.00	1.00

Source: Fishman et al., 2004.

TABLE A.8 PERCENT OF CHILDREN BELOW FIVE YEARS WITH DIARRHEA DURING A TWO-WEEK RECALL PERIOD AND AVERAGE ANNUAL CASES OF DIARRHEA PER CHILD

Population, children <5 years	Diarrhea prevalence	Bloody diarrhea prevalence (percent)	Any diarrhea prevalence (percent)
India	7.62	0.81	8.42
Rural	7.50	0.90	8.40
Urban	7.96	0.54	8.49

Source: Estimated from NFHS-3.

Average annual cases of diarrhea per child were estimated by multiplying diarrhea prevalence (decimal proportion) by 52/2.5. Dividing by 2.5 reflects that reported diarrhea episodes may have started or ended outside the two-week recall period. Multiplying average annual cases per child by the number of children below age five yielded the number of episodes of diarrhea in children below five in 2006. The diarrhea episodes in the population above age five were not available. These were therefore estimated using the ratio of diarrhea prevalence in the population above five and the population below five. Based on regional estimates, this is assumed to be 25 percent (Hutton et al., 2008). Applying the fraction of diarrhea cases attributable to sanitation (88 percent), the total number of cases of diarrhea attributable to sanitation was estimated.

TABLE A.9 ANNUAL CASES OF DIARRHEA ATTRIBUTED TO SANITATION

Population	Children below 5 years	Population 5+ years	Total cases
India	192,962,706	382,849,175	575,811,881
Rural	146,176,274	268,428,997	414,605,271
Urban	46,786,432	114,420,178	161,206,610

TABLE A.10 TIME SPENT IN ILLNESS DUE TO DIARRHEA

Population	Children below 5 years	Population 5+ years	Total years
India	2,643,325	5,244,509	7,887,834
Rural	2,002,415	3,677,110	5,679,524
Urban	640,910	1,567,400	2,208,310

Estimates of episodes of ALRI are based on the estimated prevalence rates in NFHS-3 and the number of children below age five in 2006. This survey inquires about two-week prevalence of symptoms of ALRI in children. Responses to these questions are used to make estimates of annual cases of ALRI in children below five years. The prevalence rates are multiplied by 52/2.5 to arrive at an average number of cases per child in 2006. This is done to reflect that the illness reported in a two-week reference period may start or end outside the reference period. Total cases (episodes) of ALRI in children under five are estimated by multiplying the average number of cases per child by the number of children below age five in 2006. The number of children below age is estimated from the age distribution in NFHS-3 and the estimated population in 2006 from census-based projections (TGPP and NCP, 2006). The fraction of ALRI cases that can be attributed to malnutrition resulting from diarrhea is estimated based on observed and counter-factual WAZ scores, as explained earlier.

Malaria cases estimated for this report are fever cases in children below age five that were treated by malaria medicines. (The NFHS-3 asked respondents about treating fevers in children below age five with malaria medications.) This method provides a conservative number, because it may leave out some untreated malaria cases due to poor treatment-seeking behavior in tribal populations (Matta, Khokhar, and Sachdev, 2004; Singh, Singh, and Singh, 2003; Sharma et al., 2003; Vijayakumar et al., 2009). With widespread knowledge about the symptoms of malaria, its severity, and its easily recognized malaria chills, it is likely that a high percentage of malaria cases are treated, although treatment may not be at modern health facilities.

TABLE A.11 PERCENT WITH ALRI (TWO-WEEK RECALL), ANNUAL CASES OF ALRI, AND TIME SPENT IN ILLNESS BY CHILDREN BELOW AGE FIVE

Population	ALRI prevalence in preceding 2 weeks (percent)	Cases	Cases attributable to poor sanitation	Time spent in illness (years)
India	5.42	141,303,449	21,974,562	240,817
Rural	5.62	111,080,606	17,875,029	195,891
Urban	4.83	30,222,843	4,099,533	44,926

TABLE A.12 REPORTED INFECTIONS BY INTESTINAL HELMINTHES[19]

Type of worm	Total population (millions)	Population at risk (millions)	Infection prevalence	Infections in age groups (millions)				
				1-4 years	5-9 years	10-14 years	15+ years	All years
Ascariasis	1,027	808	14%	15	18	17	89	140
Trichuriasis	1,027	398	7%	8	9	9	47	73
Hookworm	**1,027**	**534**	**7%**	**2**	**5**	**8**	**56**	**71**

Source: de Silva et al., 2003.

[19] High intensity infection is defined to result in at least 20-40 worms per stool load for ascariasis, at least 250-500 worms per stool load for trichuriasis, and at least 80-160 worms per stool load for ancylostomiasis and necatoriasis.

TABLE A.13 PERCENT OF CHILDREN BELOW FIVE TREATED WITH MEDICINE FOR INTESTINAL WORMS IN A SIX-MONTH RECALL PERIOD

Population	Children treated for intestinal worms (percent)
India	10.88
Rural	10.43
Urban	12.19

Source: Estimates from NFHS-3 (Measure DHS and IFC Macro, 2008).

Valuation of premature deaths

Studies based on the Value of Statistical Life (VOSL) approach implicitly or explicitly estimate what people are willing to pay for a reduction in chance of death, or what they are willing to accept for an increase in chance of death. Several "willingness to pay" studies ask respondents directly about what they would be willing to pay for reduction in chances of death or disease. Early discussion of this can be found in research by Shelling (1968). Other studies indirectly estimate what people actually may be accepting for an increased probability of death—for example, by negotiating higher wages for a job with higher chances of death resulting from exposure to hazardous conditions. This is the valuation of compensating differentials in labor market by using money-risk trade-off. Workers normally expect to be paid an additional compensation to work in more hazardous conditions that increase chances of death, injury or illness. Therefore, differences in price of labor (wages) paid for different jobs partly reflect this compensation for bearing higher risk to life and health. Other studies capture extra payments made for additional safety in a toy or a car—the price-risk trade-off. People normally pay higher prices for cars with safety features like air-bags, which reduce the chances of death and injury.

To assign an economic value to deaths and disease cases resulting from inadequate sanitation, the present study could have used a VOSL estimate. There is, however, a lack of recent, large, representative, population-based VOSL studies for reduction in probability of death and disease in India. Even the number of small sample population- based studies in India is also low. This prevents constructing average VOSL estimates using meta-analysis. A VOSL study using 1990 data for the population of blue-collar workers in Chennai gives a VOSL ranging from $1 million to $4.1 million (Shanmugam, 1996/97, 1997, 2000, and 2001). In such circumstances, it is recommended that VOSL values be transferred from countries where such studies are available after adjustments for incomes and other factors affecting these valuations.

An estimate for VOSL can be obtained from reviews and meta-analysis that combine results from a large number of studies, instead of relying on one or a few studies in which methods and populations from which samples are drawn could have influenced the values. The high-VOSL cases presented below are based on the median value reported in the recent review and meta-analysis by Bellavance, Georges, and Lebeau (2009). For the medium-VOSL case presented below, $3.7 million is transferred with an income elasticity of 0.6. This is the median of values used by regulatory agencies in the United States mentioned in the review by Viscusi and Aldy (2003). This value is lower than the median and average values presented in the review studies by Bellavance and co-authors and Viscusi and Aldy discussed earlier.

For the low-VOSL case presented in the table below, the estimates are based on a VOSL of $2.35 million in year 2000 US dollars. This is the lowest VOSL value from an OECD country after 1996 presented in the review and meta-analysis of VOSL studies by Bellavance and co-authors discussed earlier in this sub-section. Per capita gross national income (GNI) estimates in 2006 for the United States and India from the World Bank were used for VOSL benefit-transfer (World Bank, 2008a).

The Human Capital Approach aims to capture loss of productive human capital, reflected in loss of output due to a premature death. This approach accounts for the economic loss during the productive years by valuing lost output due to premature death. The usual approach for doing this is by estimating the present value of future earnings of employees. Earnings of employees are a market determined price of labor, influenced by relative bargaining power in the factor markets. Market imperfections may distort market prices, and earnings of employees may not reflect the contribution of labor to output. Market distortions of prices have been cited as a reason for not using market prices in cost benefit studies, and shadow prices or opportunity cost have been recommended instead (Drèze and Stern, 1990). Labor share of output per worker captures the contribution of labor to output better than average compensation of employees. Therefore, in the present study, Human Capital Approach valuations are based on labor share of output per worker. For India this was reported to be 75 percent in 1982 and 67 percent in recent studies on macroeconomic growth accounting and productivity in India (Brahmananda, 1982; Virmani, 2004; Bosworth, Collins, and Virmani, 2007).

HCA valuation used in the current study reflects the present value of labor share of GDP per worker. Labor share of GDP per worker of ₹66,043 ($1,460) for fiscal year 2006-07 is used for this valuation. This is adjusted for unemployment in working-age population (15-59 years) using a male worker-population ratio of 76.6 percent.[20] This gives the unemployment-adjusted labor share of GDP per worker of ₹50,589 ($1,119). Corresponding values for rural and urban areas are ₹37,442 ($828) and ₹84,918 ($1,878). These values are used to estimate present value of lost future labor share of output per worker. Present value is estimated using a real annual growth rate of labor share of output per worker of 0.02 (2 percent), annual discount rate of future income of 0.03 (3 percent), and working life from 15-65 years. The 2 percent real annual growth rate of labor share of output per worker is reasonable given the recent annual growth rate of NDP per worker of well over 3 percent (Virmani, 2004). A midpoint at two years is used for present value estimation in the age category for children below five years. Present value of lifetime income for the population 5-14 years is estimated using the weighted average age of 9.5 years. For present value estimation for people 15+ years, a weighted average age for this age group of about 36.84 years was used, along with a remaining working life from average age to 65 years and the same growth and discount rates as for children below five years.

Present value of the expected lifetime contribution to output by children below five years is ₹1,754,657 ($38,706). Present value of expected lifetime contribution to output for persons aged 5-14 years is ₹1,911,776 ($42,172), for persons aged 15+ it is ₹1,239,723 ($27,347). These values are similar to the value of $39,201 updated to 2006 at 2 percent per year growth from $33,458, used in a 1998 case study of deaths from air pollution in Mumbai (Lvovsky, 1998). The base case estimates for the loss of life are based on the Human Capital Approach using unemployment adjusted labor share of GDP per worker as described.

The Commission on Macroeconomics and Health used Value of Statistical Year of Life at three times the per capita GDP in their illustration, while expressing uncertainty about this multiple of GDP (Commission on Macroeconomics and Health, 2001), but theoretical reasoning is lacking to support its use in valuation of premature loss of life. Aggregate losses based on these are presented in the following table, primarily to indicate the order of magnitude of the losses if they had been based on three times GDP per capita.

Healthcare costs of treatment

Healthcare costs of treatment of diseases are estimated for the cases of diarrhea that are seen by a healthcare provider, for children below five years, and for the population over five years. These costs are also estimated for morbidity from ALRI and malaria that is attributed to malnutrition induced by diarrhea in children below five years. Morbidity costs include those from treatment of helminthes (ascariasis, trichuriasis, and hookworms) and trachoma.

The percentages of diarrhea episodes in children below five years that were treated at a medical facility or pharmacy or

[20] The worker-population ratios used in the current study are based on current daily status definition of workers. The National Sample Survey also uses broader definitions based on usual status and weekly status. For example, the worker-population ratio using usual status was 84.2%, compared to 76.6% using the current daily status.

TABLE A.14 UNIT VALUES FOR ECONOMIC COST OF A PREMATURE DEATH

Human Capital Approach (₹)	**Earnings/W UNITS**	**L Share GDP/W**	**GDP/W**
Economic	Low	Base	High
0-4 years	1,311,862	1,754,657	3,418,918
5-14 years	1,429,332	1,911,776	3,725,062
15+ years	926,873	1,239,723	2,415,577
VOSL approach: Loss transfer with official exchange rate (₹)	Low	Middle	High
Income elasticity = 0.6	9,688,330	15,228,492	27,161,238
Income elasticity = 0.8	4,354,424	6,844,453	12,207,631
Income elasticity = 1.0	1,957,098	3,076,243	5,486,726
VOSL approach: Loss transfer with PPP (₹)			
Income elasticity = 0.6	18,892,030	29,695,226	52,963,818
Income elasticity = 0.8	10,608,086	16,674,201	29,739,776
Income elasticity = 1.0	5,956,559	9,362,751	16,699,217
Input values of VOSL approach ($)			
VOSL in OECD	2,353,931	3,700,000	6,599,247
GNI per person in the USA, exchange rate	44,710	44,710	44,710
GNI per person in India, exchange rate	820	820	$820
GNI per person in the USA, PPP	44,070	44,070	44,070
GNI per person in India, PPP	2,460	2,460	2,460
Exchange rate (₹/US$)	45.3325	45.3325	45.3325

Note: Earnings/W: Earnings per Worker; L Share GDP/W: Labor Share of GDP per Worker; GDP/W: GDP per Worker.

TABLE A.15 SENSITIVITY OF ECONOMIC LOSS FROM PREMATURE MORTALITY TO VALUATION OF PREMATURE MORTALITY

Human Capital Approach	Earnings/ worker	Unadjusted labor share of GDP/ worker	GDP/ worker	3xGDP/ person
Economic loss from premature mortality (₹ billion)	987	1,317	2,566	2,648
Economic loss from premature mortality as % of GDP	2.61	3.48	6.79	7.01
VOSL approach: Loss transfer with official exchange rate				
VOSL in OECD	$2,353,931	$ 3,700,000	$6,599,247	
Economic loss from mortality using loss transfer with income elasticity = 0.6 (₹ billion)	7,442	11,697	20,863	
Economic loss as % of GDP	19.69	30.95	55.20	
Economic loss from mortality using loss transfer with income elasticity = 0.8 (₹ billion)	3,345	5,257	9,377	
Economic loss as % of GDP	8.85	13.91	24.81	
Economic loss from mortality using loss transfer with income elasticity = 1.0 (₹ billion)	1,503	2,363	4,214	
Economic loss % of GDP	3.98	6.25	11.15	

Note: 3xGDP/person: Three times GDP per person.

by a traditional medical practitioner were estimated from children's records of the NFHS-3. Here traditional facilities include *Vaidya, Hakim*, homeopaths, and other unidentified traditional medical facilities reported by the survey respondents. Multiple responses are allowed in NFHS-3 for facilities where diarrhea was treated. This reflects the fact that more than one medical service provider may treat the same episode of diarrhea of a child. Information on the number of days a child is treated by a provider and the number of visits to the provider is not available through this survey.

Therefore, only the first medical service provider is used to estimate the percent distribution of episodes over treatment providers—the first treatment provider is the service provider to whom the child with diarrhea was first taken for treatment. This method is likely to give a good approximation, because the percentage of children treated at pharmacy and traditional providers is low, and evidence from the same survey suggests little use of multiple sources and switching of medical providers across categories used in the present study. Medical facilities are predominantly preferred for treatment of diarrhea in children. Using this information, the total number of diarrhea cases treated at medical facilities, pharmacies, and traditional medical practitioners was estimated. For the population above five years, a treatment rate of 50 percent of children below five years is used in the absence of empirical evidence. This is likely to give a conservative estimate of diarrhea treatment cost in this population. The percent of cases treated at different facilities was assumed to be same for the population above five years as for the population below five years. The estimates for the population above five years are derived at national and national subpopulation levels.

NFHS-3 does not inquire about treatment costs of disease episodes. Therefore, estimates are used from a recent study of the cost of illness in five rural and urban locations in resource-poor settings in different parts of India (Dror, van Putten-Rademaker, and Koren, 2008). This is a study of over

2,000 rural and 1,500 urban households with over 4,000 illness episodes.

This last study provides separate estimates for acute, chronic, and accidental episodes. It also provides separate estimates for hospitalization, consultations, medicines, and tests. The costs are reported for 2005. In the absence of a price index for medicines and medical services, these costs are adjusted to 2006 using 3.6 percent GDP deflator for 2006. Estimates of treatment cost of acute illnesses, excluding hospitalization costs, are used for estimating the cost of diarrhea treatment. This gives the average treatment cost per episode, excluding hospitalization, as ₹452.86. With over 20 percent of acute cases reporting hospitalization in the above-mentioned study, the average cost with hospitalization is ₹609.87. The study also reports that children below five years have higher average costs of treatment compared to persons aged 5 to 15, or to those aged 15 to 55. Similarly, the average cost of treatment of an episode at a pharmacy, with only the cost of medicine, is ₹312.90. In the absence of studies reporting treatment at traditional medical practitioners, it was assumed to be ₹100 per illness episode of five days based on the expert opinion of medical practitioners. The percentage of illness episodes treated at traditional facilities is less than 3 percent at the national level, and this choice of cost is unlikely to significantly influence the overall estimates. Costs for treatment of intestinal helminthes (high intensity infection) and trachoma cases (with visual impairment or blindness) at clinics are based on expert opinion of medical practitioners. Treatment costs are ₹235 and ₹1,000 per case, respectively. It was assumed that the treatment rates are 50 percent for helminthes with high intensity infection and for trachoma with visual impairment or blindness.

A larger number of people are treated for helminthes in mass treatment campaigns; with the cost of one course of treatment assumed to be ₹15. Taking this into account, the average cost of treatment per person treated for helminthes was estimated to be ₹31.42. The estimated costs include only outpatient costs, due to a lack of data about in-patient treatments. The costs are likely to be conservative.

The estimates of the cost of treatment of ALRI and malaria attributable to malnutrition induced by diarrhea and other sanitation-related diseases in children below five years were estimated in a manner similar to cost of treatment from diarrhea for children below five years. This estimation used costs of treatment per case, duration of illness of four and three days, respectively, and cases treated at medical facilities, pharmacies, and traditional healthcare.

TABLE A.16 PERCENT OF DIARRHEA CASES TREATED IN CHILDREN BELOW FIVE YEARS AND PERCENT DISTRIBUTION OF TREATMENT BY PROVIDER TYPE

Population, children <5 years	Percent of cases treated	Percent of cases treated at medical facility	Percent of cases treated at pharmacy	Percent of cases treated at traditional healthcare
India	69.12	74.34	8.72	2.82
Rural	67.47	71.07	8.42	3.03
Urban	73.94	83.01	9.51	2.27

Source: Estimates based on NFHS-3 (Measure DHS and IFC Macro, 2008).

TABLE A.17 PERCENT OF ALRI CASES TREATED IN CHILDREN BELOW FIVE YEARS, AND PERCENT DISTRIBUTION OF TREATMENT BY PROVIDER TYPE

Population	Percent of cases treated	Percent of cases treated at medical facility	Percent of cases treated at pharmacy	Percent of cases treated at traditional healthcare
India	70.94	74.68	7.10	4.13
Rural	68.64	69.99	8.05	4.34
Urban	77.77	86.96	4.63	3.59

Source: Estimates based on NFHS-3 (Measure DHS and IFC Macro, 2008).

Welfare and productivity losses

This study valued the loss of adult time at less than the rate for economic loss of an adult engaged in production, at 30 percent of the full daily valuation based on unemployment-adjusted labor share of GDP per worker. As in prior sanitation studies (Hutton, et al., 2008; Hutton, Haller, and Bartram, 2007; Haller, Hutton, and Bartram, 2007), in this study time lost by children was valued at 50 percent of the adult rate. For these valuations, this study used an eight-hour working day and 250 working days a year.

Labor share of GDP was estimated for national, rural, and urban areas by first estimating the average wage and number of workers, the wage bills, and the share of rural and urban wage bills in the total wage bill. It was assumed that rural and urban workers are paid the same percent of wages for their contribution to output—that is, the ratio of wage to labor share of output is the same in rural and urban areas. Thus, labor share of GDP at the national level was divided into rural and urban components according to their share in the wage bill, and the per-worker labor share of GDP was estimated for rural and urban workers.

Productivity losses were estimated for direct loss due to illness from diarrhea, helminthes, and trachoma and for indirect loss from ALRI and malaria cases. Time loss per case was assessed for patients, adults accompanying children to healthcare, and adults caring for the ill. Adults also have to spend time to care for ill persons and to accompany children to seek medical help. The time lost by adults in accompanying children to healthcare was assumed to be one hour per treated case. Time lost by adults in caring for ill children was assumed to be two hours per day of illness. The proportion of cases seen at a healthcare provider was estimated from NFHS-3 survey data. Monetary losses related to productivity loss for persons over 15 years were estimated by apportioning the value of time loss for persons above 5 years into the component attributable to those above 15 years. Of the population above five years of age, 73.38 percent are above 15 years (NSSO, 2008). Monetary loss for this population is likely to be less than 100 percent of the value of time loss when they are ill with diarrhea. This percentage was assumed to be 60.6 percent. This is based on worker-to-population ratio for persons over 15 years. Using these numbers, the portion of value of time lost due to illness that can be attributed as a monetary loss to working persons above age 15 was estimated. This was adjusted for unemployment and share of persons above 15 years.

Productivity losses were estimated at the national level by using a one-hour loss of productivity per day over three weeks for all cases with high-intensity infection.[21] As in the case of diarrhea, less than 100 percent of time losses are likely to be monetary. The percent of adults having monetary losses due to ill days was assumed to be 60.6 percent. This is based on the workers-to-population ratio for the working-age population (NSSO, 2008). These monetary losses were adjusted for

[21] *World Health Report 1999* mentions that in an Indonesian study, anemic men were found to be 20% less productive than non-anemic men (WHO, 1999).

unemployment. Helminthes infections can cause adverse effects over long periods of time if left untreated. Therefore, these estimates are conservative.

The value of time for adults is ₹9.08 per hour. It is ₹6.68 in rural and ₹15.49 for urban areas. This value is 30 percent of the value of an hour based on the unemployment-adjusted labor share of GDP per worker, 250 workdays a year, and on eight-hour workdays. The value of children's time was assumed to be half that of adult time.

Trachoma is an eye infection that can potentially cause blindness if left untreated. Case numbers for follicular or inflammatory trachoma prevalence are for people with low vision or blindness (corrected visual acuity in the better eye of less than 6/18). Cases of trachoma with visual impairment and blindness in the Indian population were estimated using the prevalence rate of 25.75 per 100,000 from the 2004 Global Burden of Disease Study by the World Health Organization (WHO, 2008a). Losses from trachoma in the present study are estimated only for trachoma-affected persons with blindness or low vision. For valuing loss from trachoma, it was assumed that visual impairment lowers productivity by 60 percent in blind persons and by 27.8 percent in those with low vision. These values are based on disability weight for blindness and low vision in studies of burden of disease (WHO, 2008a; Mathers, Lopez, and Murray, 2006). It was assumed that 50 percent of all trachoma cases were treated and that 10 percent of the cases lead to blindness and can be attributed to 2006. Treated persons are assumed to suffer a loss of productivity over 10 days of treatment, while untreated persons are assumed to suffer productivity losses over the entire year. Also assumed were two hours per day of adult caring during 10 days of treatment for those treated and a half-hour of adult caring for the untreated visually impaired persons. Similar to the estimation for helminthes, monetary loss is estimated for the population above 15 years based on the share of the working-age population in the total population (65.2 percent) and a worker-to-population ratio of 60.6 percent in this population.

The estimation procedure for productivity losses from ALRI and malaria is similar to that used for diarrhea. There are no monetary losses associated with productivity loss reported for these diseases, because the indirect losses via malnutrition are only estimated for children below five years. A part of the time loss for parents caring for sick children could be monetary, but they are treated as non-monetary in the present report. The percent of ALRI and malaria cases treated at health facilities (hospitals, centers, or clinics), pharmacies, or by traditional medical practitioners was estimated from children's records from the NFHS-3 individual records.

Annex 5: Water

TABLE A.18 ASSOCIATION BETWEEN ACCESS TO WATER AND HEALTH

Access	Access measure	Needs met	Health concern
No access: quantity collected often below 5 liters/person/day (L/P/D)	More than 1,000 meters or 30 minutes total collection time	Consumption cannot be assured. Hygiene not possible unless practiced at source.	Very high
Basic access: average quantity unlikely to exceed 20 L/P/D	Between 100 and 1,000 meters or 5 to 30 minutes total collection time	Consumption should be assured. Hygiene: hand washing and basic food hygiene possible. Laundry/bathing difficult to assure unless carried out at source.	High
Intermediate access: average quantity about 50 L/P/D	Water delivered through one tap on-plot (or within 100 m or 5 minutes total collection time	Consumption assured. Hygiene: all basic personal and food hygiene assured. Laundry/bathing should also be assured.	Low
Optimal access: average quantity 100 L/P/D and above	Water supplied through multiple taps continuously	Consumption: all needs met. Hygiene: all needs should be met.	Very low

Source: Howard and Bartram, 2003.

Household treatment of drinking water

Household cost of treatment of drinking water at the national level is the sum of estimated costs of household treatment of drinking water in urban and rural areas. These costs are estimated for different treatment methods separately: boiling; straining through cloth; using alum, bleach, or chlorine; using ceramic, sand, or other water filter; and using an electronic water filter.

Cost of boiling drinking water can be substantial for households. This includes monetary costs of materials and apparatus used for boiling water and non-monetary costs, like those of fuel collection in rural and semi-urban areas and the costs of time and effort spent in boiling and storing water. Households use a mix of fuels for boiling water, and may also use different fuels for boiling water and for cooking. This kind of detailed information is not available for India; therefore, it is assumed that cooking fuel is also used for boiling drinking water. The fuel costs for boiling water are based on monthly costs of liquid petroleum gas or wood used by households for boiling drinking water (Clasen, et al., 2008b).

Direct monetary cost of boiling water using gas is ₹0.24 per liter, and indirect non-monetary cost is ₹0.18 per liter. Direct monetary and indirect non-monetary costs for households using wood for boiling are ₹0.19 and 0.70, respectively. For rural areas all costs of wood are indirect non-monetary costs of ₹0.89 per liter. It is assumed that costs of wood and related fuels are monetary in urban areas and non-monetary in rural areas. It is assumed that boiling costs for liquefied petroleum gas also apply to boiling by electricity, biogas, kerosene, and coal, and that boiling costs for wood also apply to charcoal, straw, grass, shrub, crop waste, dung cakes, and other fuels. The amount of drinking

TABLE A.19 HOUSEHOLD SIZE, HOUSEHOLDS, BOILING, AND CHLORINE COST PER HOUSEHOLD

Population	Average household size (number)	Households (number)	Average boiling monetary fuel cost per HH (annual, ₹)	Average boiling non-monetary cost per HH (annual, non-monetary, ₹)	Average per HH economic cost of boiling (annual, ₹)	Per HH cost of bleach/ chlorine (annual, ₹)
India	4.79	233,472,198	594	2,945	3,779	40.82
Rural	4.90	161,918,134	130	4,235	4,365	41.77
Urban	4.56	71,206,661	1,099	1,540	2,639	38.85

Source: Household size from NFHS-3, household numbers based on household size and population from projections based on census, average annual costs as described in the text.

water per person is therefore assumed to be 2.92 liters per day (Milton et al., 2006).[22] The retail cost of chlorine, at ₹0.08 per chlorine tablet used for treating 10 liters of water, is based on a business plan for chlorine tablet production from the National Research Development Corporation. The average cost of straining cloth is assumed to be ₹365 per year for household, or one rupee per day. This includes the cost of washing and cleaning the cloth, cost of storing utensils, and time spent in straining, storing, and dispensing water. Average household annual costs for cleaning water with ceramic, sand, or other water filter is ₹650.61, including annualized cost of filter of ₹285.61 and ₹365 for storage and handling costs. Annualized cost of electronic purifier is ₹1,538.73. Annualized costs of filter and purifier are inflation-adjusted 2006 costs based on previous research (Jalan and Somanathan, 2008). The total number of rural and urban households using drinking water treatment of a particular type was estimated by multiplying the proportion of households using water treatment of a particular type by the total number of households. Estimates of the total number of rural and urban households were based on household size from NFHS-3 and estimates of rural and urban population from census population projections (IISP and Macro International, 2007) (TGPP and NCP, 2006).

Bottled water consumption

For estimating the cost of bottled water consumption, the annual number of bottles consumed by households were estimated and multiplied by cost per bottle in each wealth category. Annual consumption was estimated by estimating daily bottled water consumption. This in turn was done by estimating number of households using bottled water by multiplying the percent of households using bottled water times the total number of households, and multiplying this times the household size and bottled drinking water consumption per person per day of 2.92 liters. Percent of households using bottled drinking water in rural and urban areas was estimated from NFHS-3 household data (Measure DHS and IFC Macro, 2008). The cost for a 20-liter bottle was assumed to be ₹4 for households in the lower 80 percent of the wealth distribution, ₹6 for households in the highest 20 percent in rural areas, and ₹40 for households in the highest 20 percent in urban areas. The mean cost of 20 liters of branded bottled water is ₹40 in urban areas. It is however unlikely that such high costs are paid by households below the top 20 percent of the wealth distribution and in rural areas. It is likely that less well-off households and those in rural areas get water transported in jerry cans or other unbranded bottles; price of bottled water in these households reflects this.

[22] This is based on 73.04 ml/kg/day from a study in Bangladesh in the South Asia region and an average weight of 40 kg. This is less than 4.5 liters per person per day for those engaging in manual labor in high temperatures: conditions typically found among those vulnerable to dehydration (Howard and Bartram, 2003). Average drinking water consumption is not known, therefore a more conservative estimate is used.

TABLE A.20 BOTTLED WATER CONSUMPTION, AND PERCENT OF HOUSEHOLDS USING BOTTLED DRINKING WATER

Population	Households using bottled drinking water (percent)	Households using bottled drinking water	Population consuming bottled drinking water	Bottled drinking water consumption per day
India	0.38%	879,824	4,212,102	12,299,339
Rural	0.14%	231,914	1,136,165	3,317,603
Urban	0.86%	611,800	2,787,922	8,140,733

Source: Estimates based on NFHS-3 household data (Measure DHS and IFC Macro, 2008).

Piped water

The estimates of households using piped drinking and non-drinking water are based on the percentage of households using piped drinking and non-drinking water from their dwellings or yards, estimated from NFHS-3 household data. The amount of piped water per household is estimated by multiplying per capita piped water production by average household size. The present study conservatively uses the lowest per capita piped water production of 72 liters, as stated in the Asian Development Bank's compilation of water utilities data (Ministry of Urban Development and Asian Development Bank, 2007).[23] Drinking water is assumed to be 2.92 liters per person per day, and the remaining 69.08 liters for domestic uses other than drinking. The cost of piped water production is assumed to be ₹4.91 per cubic meter (1,000 liters) based on average water tariffs of water utilities (Ministry of Urban Development and Asian Development Bank, 2007).[24]

Households also seek piped water to their living premises for reasons other than those related to sanitation, like convenience. Therefore, only half of the piped water costs are assumed to be due to sanitation and the rest for other reasons, like convenience. It is assumed that use of public taps is primarily for convenience, and therefore not included in the estimates for piped water. However, a small portion of the time-cost for fetching water from public taps is included in the costs of fetching cleaner water.

TABLE A.21 ANNUAL PIPED WATER PRODUCTION (CUBIC METERS OR '000 LITERS)

Population	Drinking piped water production	Non-drinking domestic piped water production (cum/'000 liters)	Piped water production (cum/'000 liters)
India	292,014,100	6,965,965,358	7,257,979,458
Rural	99,867,385	2,377,487,159	2,477,354,543
Urban	175,458,912	4,189,640,447	4,365,099,359

Source: Estimates as described in the text.

23. This publication states that the average per capita production is between 100 and 120 liters, and the average among water utilities is stated to be 244 liters per capita per day.
24. This is a conservative cost because the production cost is likely to be higher due to subsidies. The extent of water subsidies is not known. A study of six cities reports that the production costs in Chennai of ₹13 and in Bengaluru of ₹17 per cubic meter (Brocklehurst and Pandurangi, 2002). It is, however, not possible to extrapolate from these studies to other urban areas.

Fetching clean water

This study assumes that half of the extra effort for fetching water is due to sanitation-related reasons. For conversion of hours to days, eight-hour days are assumed. Number of households fetching water was estimated from total number of households and the estimated percent of households fetching water from the NFHS-3 household data. Total time was estimated from the number of households fetching water and average time per round trip to fetch water was estimated from NFHS-3. The economic value of time spent fetching water is based on value of time discussed earlier. A proportion of that value is then attributed to sanitation.

TABLE A.22 TIME FOR FETCHING WATER AND PERCENT AND NUMBER OF HOUSEHOLDS FETCHING DRINKING WATER

	Households fetching drinking water (percent)	**Households fetching drinking water** (number)	**Average drinking water fetching time per trip** (minutes)
India	48.45	114,315,762	19.20
Rural	57.67	93,382,123	19.38
Urban	29.40	20,933,640	18.44

Source: Estimates from NFHS-3, and as described in text.

TABLE A.23 PERCENT OF HOUSEHOLDS WITH ADULT WOMEN FETCHING WATER

	Adult woman	**Adult man**	**Girl below 15**	**Boy below 15**	**Other**
India	39.42	6.12	2.16	0.55	0.20
Rural	47.90	6.18	2.73	0.65	0.21
Urban	21.91	5.98	0.97	0.35	0.18

Source: Estimates based on NFHS-3.
Note: The percentages refer to the person "mostly" fetching drinking water for a household.

TABLE A.24 DOMESTIC WATER-RELATED ECONOMIC IMPACTS OF INADEQUATE SANITATION IN INDIA IN 2006, BY LOCATION AND TYPE OF IMPACTS

	Economic			Monetary		
Cost type, location	**Cost** (₹ billion)	**Percent of national impacts in subcategory**	**Percent of total national impacts**	**Cost** (₹ billion)	**Percent of national impacts in subcategory**	**Percent of total national impacts**
Household treatment (national)	**111.7**	**100.0**	**58.4**	**48.7**	**100.0**	**65.3**
Rural	**68.0**	**60.9**	**35.5**	**19.8**	**40.7**	**26.6**
Urban	**43.7**	**39.1**	**22.8**	**28.9**	**59.3**	**38.8**
Piped water (national)	**17.5**	**100.0**	**9.2**	**17.5**	**100.0**	**23.5**
Rural	6.6	37.6	3.4	6.6	37.6	8.8
Urban	10.9	62.4	5.7	10.9	62.4	14.7
Bottled water (national)	**6.0**	**100.0**	**3.2**	**6.0**	**100.0**	**8.1**
Rural	0.4	5.8	0.2	0.4	5.8	0.5
Urban	5.7	94.2	3.0	5.7	94.2	7.6
Hauled water (national)	**56.1**	**100.0**	**29.3**	**2.3**	**100.0**	**3.0**
Rural	36.6	65.2	19.1	0.6	27.0	0.8
Urban	19.5	34.8	10.2	1.7	73.0	2.2
Total (national)	**191.3**	**100.0**	**100.0**	**74.5**	**100.0**	**100.0**
Total rural	111.5	58.3	58.3	27.3	36.7	36.7
Total urban	79.8	41.7	41.7	47.1	63.3	63.3

Annex 6: Access Time

The cost of excess time used to access shared toilets and open-defecation areas is calculated separately for persons in three age groups (below age 5, 5-14 years, and 15+ years) in urban and rural areas. Using NFHS-3 data and percentages of population in the three age groups, the percentages of population in each age group in households practicing open defecation or using shared toilet facilities were estimated (Measure DHS and IFC Macro, 2008). This information was combined with estimates of total population from census projections to yield numbers of persons in each age group as well as numbers using open defecation and shared toilet facilities. Due to lack of existing empirical evidence, it was assumed that a person spends an extra 15 minutes in urban areas and 20 minutes in rural areas to access open-defecation facilities compared to a person with a private toilet; while the extra time spent in journey and waiting to access shared toilets was assumed to be five minutes in both urban and rural areas. One toilet trip per day was assumed.

School sanitation and hygiene

This study estimated economic losses due to absence from school among post-puberty girls. The economic loss was estimated only for school days missed by girls of post-puberty age due to lack of a girls' toilet at school. The percentage and number of girls in the age group 11-17 years was available from population projections. The lower end of this age group may not coincide with puberty, but this is the closest age group for which data could be found. Number of girls in this age group was combined with net attendance ratio for girls at the secondary level of 59.5 percent in urban and 40.1 percent in rural areas to estimate the number of girls in this age group attending school.

School classifications could not be matched one-to-one with age groups. The school classification that includes girls 11-17 years combines upper primary, secondary (grades 6-10), and higher secondary (grades 11-12). Therefore, to estimate the number of post-puberty girls attending schools without a toilet for girls, percent of schools in this combined category without toilets was multiplied times the number of girls aged 11-17 years who are attending school. This was the best possible approximation with this data. It was further assumed that on average a post-puberty girl in a school without a girls' toilet will miss 10 days of school a year due to the lack of sanitation and hygiene at school. The value of a school day missed that was used for estimating economic loss was based on the same value of time for children as in other estimations of this study.

TABLE A.25 NUMBER OF PERSONS WITHOUT TOILET ACCESS OR USING SHARED TOILETS

	Persons without toilet access			Persons using shared toilets		
	Below 5 years	5-14 years	15+ years	Below 5 years	5-14 years	15+ years
India	77,838,164	168,672,153	391,963,497	13,868,004	27,242,219	82,777,472
Rural	73,178,021	154,760,934	356,998,824	5,618,106	9,902,994	28,169,648
Urban	6,145,157	13,911,220	34,964,672	8,249,898	17,339,225	54,607,823

Source: Estimates based on NFHS-3 household data.

TABLE A.26 PERCENTAGE OF CHILDREN AGED 6-17 YEARS NOT ATTENDING SCHOOL

	Male			Female			Total		
Age (years)	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All
6-10	12.4	16.4	15.4	11.7	21.5	19.0	12.1	18.9	17.1
11-14	17.2	21.4	20.1	19.2	33.6	29.6	18.1	27.4	24.7
15-17	47.9	52.9	51.2	49.5	72.3	65.6	48.7	63.3	58.7
6-14	14.6	18.5	17.4	15.1	26.6	23.6	14.8	22.5	20.4
6-17	**22.9**	**25.3**	**24.6**	**23.9**	**37.1**	**33.6**	**23.4**	**31.2**	**29.0**

Source: NFHS-3 (IIPS and Macro International, 2007).
Note: The table presents percentage of de facto household population aged 6-17 years attending school in 2005-06.

TABLE A.27 PERCENT OF SCHOOLS HAVING COMMON TOILETS IN SCHOOL, 2006-07

School types	2003-04	2004-05	2005-06	2006-07	Rural	Urban
Primary only	36.16	41.43	47.55	53.75	52.82	63.09
Primary with upper primary	56.93	61.61	63.86	69.01	67.44	75.48
Primary with upper primary and secondary/higher secondary	69.61	69.88	66.25	71.78	68.66	76.86
Upper primary only	44.25	48.52	56.25	60.33	59.61	66.57
Upper primary and secondary/higher secondary	63.61	60.49	64.39	66.91	64.73	73.80

Source: School and facility-related indicators 2006-07 (National Institute of Education Research and Training, 2008).

TABLE A.28. PERCENT OF SCHOOLS HAVING GIRLS' TOILETS IN SCHOOL, 2006-07

School types	2003-04	2004-05	2005-06	2006-07	Rural	Urban
Primary only	20.61	24.27	28.85	34.06	32.44	50.15
Primary with upper primary	41.86	46.76	49.09	55.37	51.05	73.12
Primary with upper primary and secondary/higher secondary	72.48	76.55	76.28	74.49	68.20	84.45
Upper primary only	32.91	36.91	46.58	52.62	50.62	69.91
Upper primary and secondary/higher secondary	69.31	70.47	72.42	72.32	68.67	83.74

Source: School and facility-related indicators 2006-07 (National Institute of Education Research and Training, 2008).

Workplace sanitation and hygiene

Workplace sanitation and hygiene are important for employee health and productivity. This study makes conservative estimates for days missed by urban and rural women due to lack of sanitation and hygiene facilities at work. Most of these days may be during the menstrual periods, when the lack of sanitation and hygiene at the workplace may be felt more acutely. This study assumes that 10 percent of rural and urban women will be absent for 10 days in a year, due to lack of adequate sanitation and hygiene at the workplace, especially during their menstrual period. On average, this loss is equivalent to one day per annum, for every working woman in rural and urban areas.

TABLE A.29 WORKER-POPULATION RATIOS (PERCENT) BY AGE GROUPS AND GENDER

Age group	Urban		Rural	
	Male	Female	Male	Female
India	51.30	11.80	49.10	20.30
1-14 years	2.00	1.00	2.50	2.20
15-29 years	55.90	13.60	62.50	23.10
30-59 years	91.40	19.90	89.60	38.30
60+ years	33.50	6.40	58.20	15.60
15-59 years	75.20	17.10	77.10	31.70
15+ years	71.50	16.00	75.10	29.80
5+ years	55.80	12.80	54.70	22.60

Source: NSSO, 2008.

Annex 7: Tourism Losses

TABLE A.30 TOURISM INDICATORS FOR INDIA IN 2006

Indicator	Numbers	Percentages
Foreign tourist arrivals (numbers)	4,447,167	
Tourists other than the nationals of Pakistan and Bangladesh	3,879,340	
Purpose of visit		
Business	4,447	0.10
Education and employment	84,496	1.90
Tourism and others	4,358,224	98.00
Sea cruise passengers	179,840	
Foreign tourist arrivals by mode of transport		
Air	3,873,483	87.10
Land	547,002	12.30
Sea	26,683	0.60
Foreign tourist arrivals from top 15 markets excluding Bangladesh		
UK	734,240	16.50
USA	696,739	15.70
Canada	176,567	4.00
France	175,345	3.90
Germany	156,808	3.50
Sri Lanka	154,813	3.50
Japan	119,292	2.70
Australia	109,867	2.50
Malaysia	107,286	2.40
Nepal	91,552	2.10
Singapore	82,574	1.90
Italy	79,978	1.80
Korea (South)	70,407	1.60
China (Main)	62,330	1.40
Netherlands	58,611	1.30

TABLE A.30 TOURISM INDICATORS FOR INDIA IN 2006 (CONTINUED)

Indicator	Numbers	Percentages
Others	1,570,758	35.20
Foreign exchange receipts from tourism		
₹ (million)	403,750	
$ (million)	8,934	
Foreign exchange earnings per tourist (₹)	90,788	
Foreign exchange earnings per tourist ($)	2,009	
Indian nationals going abroad	8,339,614	
Number of domestic tourist visits	461,700,000	
Approved hotels, December 2006		
Number of hotels	1,208	
Number of rooms	75,502	
Room occupancy		60.40
World		
World tourist arrivals	846,000,000	
World tourism receipts (billion $)	735	
Share of India in world tourist arrivals		0.52
Share of India in world tourism receipts		1.21
India's rank in world tourist arrivals	42	
India's rank in world tourism receipts	21	

Source: Ministry of Tourism, 2008.

Traveller's diarrhea is the most common disease related to travel in developing countries. A study of long-term tourists spending more than two months in India estimated that over 83 percent of the tourists had suffered from diarrhea during their stay (Hillel and Potasman, 2005). A study of illnesses among returning tourists that included tourists in India reports gastrointestinal symptoms in 34.6 percent of tourists and respiratory symptoms in 13.7 percent. It also reports that a visit to the Indian subcontinent doubles the risk of illness in returning tourists (Rack et al., 2005). Another study reports that 55 percent of respondents travelling to Asia had diarrhea and that the risk was higher for the Indian subcontinent (Redman, et al., 2006). Another study of stool samples from tourists from Europe and North America who had acquired diarrhea after travel to Mombasa (Kenya), Goa (India), and Montego Bay (Jamaica) reports that infections caused by E. coli were the most common, with shigella (10 percent in Goa) and viruses (rotaviruses and enteric adenoviruses) contributing significantly. High frequency of resistance of bacteria to traditional anti-bacterial medicines is also reported in these locations (Jiang et al., 2002).

In a survey of tourists visiting Buddhist centers in India, both domestic and international tourists mentioned toilet facilities as a reason for dissatisfaction. In this survey a substantially higher percentage of domestic tourists than international tourists stated that toilets were a reason for dissatisfaction. In a passenger survey at airports—places that have better than the country's average in cleanliness and toilets—passengers gave low ratings to cleanliness and toilets.

TABLE A.31 CLEANLINESS AND TOILETS AT AIRPORTS

Ratings	**Cleanliness** (percent of respondents)		**Toilets** (percent of respondents)	
	Non-Indians	Indians	Non-Indians	Indians
Very good	0	0	0	0
Good	10	22	0	0
Average	8	44	11	1
Poor	82	34	89	99

Source: Horizon International Consultancy Services, 2006.

Losses to tourism

Estimated economic losses to tourism from inadequate sanitation are the difference between actual revenue earned by the tourism sector and the counter-factual potential revenue that would have been earned by the tourism sector if there were adequate sanitation. Losses to tourism attributable to sanitation were estimated using the assumption that tourists who are dissatisfied from their visit because of inadequate sanitation will not re-visit or will each discourage one other tourist to visit—eliminating either a repeat visit by the tourist or a visit by another person known to them. The percent of satisfied and dissatisfied tourists, along with reasons for dissatisfaction, is available for a sample of tourists visiting Buddhist centers located in all parts of the country.[25] In this survey, tourists were also asked about reasons for their dissatisfaction. This data is not aggregated and is only available for each state separately. The midpoint of percent of "somewhat" or "very dissatisfied" tourists across states was used to estimate tourism loss. This yields 25.6 percent of domestic tourists and 33.55 percent of foreign tourists as "somewhat or very dissatisfied" with their visits.

The midpoints of the percent across states for toilet facilities as a reason for dissatisfaction are 15 percent for domestic and 9.5 percent for foreign tourists. Toilet facilities are one of the multiple reasons for dissatisfaction given by respondents. After scaling to 100, the relative percentages for dissatisfaction due to toilets were 3.49 percent and 2.30 percent for domestic and foreign tourists, respectively. These percentages were used as an indicator of additional tourist visits that could have materialized were there better sanitation in general, and better toilet facilities in particular. Potential revenue from tourism in the absence of inadequate sanitation was estimated as the product of the potential number of tourists and average spending per tourist, using Ministry of Tourism survey figures.

[25] The survey reports were from tourists in the following states: Uttaranchal, Uttar Pradesh, Rajasthan, Madhya Pradesh, Karnataka, Goa, Chhattisgarh, Bihar, Assam, and Orissa. Buddhist centers about which questions are asked are spread across India.

TABLE A.32 ACTUAL AND POTENTIAL TOURIST VISITS AND AVERAGE EXPENDITURES

	Actual	Potential
International		
Number of tourists	4,447,167	4,549,497
Average spending per tourist visit	90,788	90,788
Domestic overnight		
Domestic bed nights	81,519,218	84,370,504
Expenditure per day	873.33	873.33
Day tourists		
Day tourist visits	59,739,366	61,828,861
Expenditure per day	104.23	104.23

(in ₹)

Sources: Ministry of Tourism (Ministry of Tourism, 2008); tourism statistics for Uttaranchal, Uttar Pradesh, Chhattisgarh, Goa, Rajasthan, Orissa, Bihar, Assam, Karnataka, and Madhya Pradesh commissioned by Ministry of Tourism (AC Nielsen ORG-MARG, 2006a, 2006b, 2006c, 2006d, and 2007; JPS Associates, 2006a, 2006b; Intercontinental Consultants and Technocrats, 2006; Market Pulse Research, 2006; and Datamation Consultants, 2006).

Losses due to tourists' illnesses

The present study estimates economic losses from gastro-intestinal illness affecting international tourists visiting India. A study of international tourists reports that 34.6 percent of tourists got gastrointestinal diseases while visiting Kenya, Tanzania, Senegal, the Gambia, India, Nepal, Thailand, or Brazil. The risk of getting ill was almost double if the tourist traveled to Nepal or India (Rack, et al., 2005). The present study assumes that 34.6 percent of tourists were estimated to have been affected with an episode of gastrointestinal diseases while visiting India.

Total treatment cost for these episodes was estimated using the treatment cost per episode of ₹609.87, based on a study of treatment costs in poor-resource locations, as discussed earlier for diarrhea-related health costs (Dror, van Putten-Rademaker, and Koren, 2008). For estimating productivity and welfare losses, two days were assumed to be lost per gastrointestinal episode for a tourist. About 60 percent of international tourists visiting India are from high-income OECD countries and the rest (40 percent) from low- and middle-income countries. The average gross national income (GNI) per capita in high-income OECD counties is $38,120, and in low- and middle-income countries it is $2,000. The valuation of time lost in the current study was based on unemployment-adjusted labor share of GDP. The ratio of per capita unemployment-adjusted labor share of income to per capita GDP was about 1.5 in India. This ratio was applied to GNI per capita to estimate unemployment-adjusted labor share of GDP of $56,872 in high income OECD countries and of $2,984 in low- and middle-income countries. Per-day valuation was estimated by dividing the annual numbers by 250 working days. As in other valuations, adult-time valuation was taken to be 30 percent of the full value, and children's time was valued at half of adult time. Children below age 15 were 9.6 percent of international tourists in 2006. Using this number, a weighted average value of time for arriving international tourists was estimated. This value was applied to the number of days lost due to gastrointestinal diseases to estimate the value of productivity and welfare for international tourists due to gastrointestinal diseases.

Annex 8: Gains from Sanitation and Hygiene

A review of 33 studies (103 cases) focusing on the health outcomes from water and sanitation sector interventions was carried out by IEG and the World Bank (World Bank/IEG, 2008). The study noted the following:

- Hand washing reduces the risk of diarrhea in children in the household by over 40 percent, as reported by Fewtrell et al. (2005) and Curtis and Cairncross (2003) (with a range of the reduction of 24-63 percent).
- Far fewer studies have been conducted on sanitation interventions—but these three studies find reductions in diarrhea incidence of over 60 percent.
- Household water treatment (solar storage, filtration, chemical treatment, and so on) has been shown to reduce the risk of diarrhea by 25 to 85 percent.
- Impacts of water-connection interventions (household or nearby well, piped water, standpipe, etc.) have been subjected to relatively few studies, and the evidence is mixed with some showing positive effects.
- One study (Fewtrell and Colford, 2004) argued that the impact of combined interventions is no higher than that found in single-intervention studies, which shows that there is no intra-sector complementarity.

Based on results from meta-analysis of studies by Fewtrell and co-authors, this analysis estimated the range of values by which the risk of diarrheal diseases could be reduced.

TABLE A.33. RELATIVE RISK REDUCTION FROM SANITATION INTERVENTIONS

Intervention	Diarrhea risk reduction from intervention (%)			
	Low	**Mid**	**High**	**Number of studies included**
Household treatment of water	54	39	19	8
Water supply	38	25	9	6
Sanitation	47	36	13	2
Hygiene	60	45	25	8
Multiple interventions	41	33	24	5

Source: Based on Fewtrell, et al., 2005.
Note: Mid values are the estimates of diarrhea risk reduction. Low value is the lower bound of 95 percent confidence interval, and the upper value is the upper bound of 95 percent confidence interval.

These estimates are applied to health impacts for estimating potential gains. Similarly potential reductions in other costs are also estimated. The percentages of economic costs that can be potentially avoided by various interventions are listed in the following table, along with the percentages of reductions possible.

TABLE A.34 BENEFITS AND AVOIDED COSTS FROM SANITATION INTERVENTIONS

Intervention	Benefits and avoided costs
Comprehensive sanitation and hygiene	• 45% of health impacts • 100% of water-related impacts • 100% of welfare impacts • 100% of tourism impacts
Improved access to toilets	• 32% of health impacts • 100% of welfare impacts • 50% of tourism impacts
Improved hygiene behavior (may also include toilet use)	• 45% of health impacts • 100% of welfare impacts • 50% of tourism impacts
Improved access to adequate quantity of water: Adequate water, better hygiene and sanitation, better health, and toilet use/access	• 25% of health impacts • 100% welfare impacts • 50% tourism impacts
Improved access to safe quality water: Water free from bacteriological contamination	• 39% of health impacts • 100% of household water treatment cost • 100% of bottled water costs • 100% of costs of hauling water from cleaner sources
Safe confinement and disposal of fecal matter (sewage treatment)	• 32 of health impacts • 100% of household water treatment cost • 100% of bottled water costs • 100% of costs of hauling water from cleaner sources

Annex 9: Sanitation Markets

The unit prices of toilets are based on a recent study (WSP, 2008) and supplemented by the expert opinion of professionals working on rural and urban sanitation. These prices are based on an average of unit prices from various sources. An annual inflation of 5 percent is assumed for the costs of toilets. Replacement rates are assumed to be 3 percent of capital for community toilets, 2 percent for sewerage, and 0.5 percent for wastewater treatment facilities. Yearly maintenance costs are assumed to be 1.5 percent of capital cost for sewer maintenance and for toilets with sewer connection or pits. Yearly maintenance costs of 5 percent of capital cost are assumed for septic tanks, and of 2.5 percent of capital cost for sewage treatment plants.

TABLE A.35 UNIT COSTS OF SANITATION PRODUCTS AND SERVICES IN SELECTED YEARS, 2006-20

Product/service	Unit	2006	2009	2012	2015	2020
WC with sewer connection	₹ per household	8,471	9,806	11,352	13,141	16,772
WC with septic tank	₹ per household	17,036	19,721	22,830	26,428	33,730
Soak pit for septic tank	₹ per household	454	476	500	525	551
Pit latrine	₹ per household	10,691	12,376	14,327	16,585	21,168
House sewer connection	₹ per household	2,773	3,210	3,716	4,302	5,490
Upgrade existing service/ other latrine to sewer	₹ per household	3,804	4,404	5,098	5,901	7,532
Upgrade existing service/ other latrine to septic tank	₹ per household	12,369	14,319	16,576	19,189	24,490
Upgrade existing service/ other latrine to pit latrine	₹ per household	4,610	5,336	6,177	7,151	9,127
Upgrade existing pit to septic tank	₹ per household	7,760	8,983	10,399	12,038	15,364
Community toilet	₹ per household	6,662	7,712	8,927	10,334	13,189
Sewerage construction	₹ per household	6,909	7,998	9,259	10,719	13,680
Wastewater treatment facility	₹/MLD	3,768,879	4,362,949	5,050,659	5,846,769	7,462,123
Community toilet annual maintenance	₹ per household/year	1,386	1,604	1,857	2,150	2,744
Sewer connected toilet maintenance	₹ per household per year	127	147	170	197	252
Septic tank maintenance	₹ per household per year	852	986	1,141	1,321	1,686
Pit toilet maintenance	₹ per householdper year	160	186	215	249	318
Sewerage maintenance	₹ per householdper year	104	120	139	161	205
Sewage treatment plant maintenance	₹/MLD per year	94,222	109,074	126,266	146,169	186,553

Source: Various sources and assumptions, as explained in the text.
MLD = million liters per day.

Total rural and urban households are estimated for each year using information on rural and urban population projections from the National Commission on Population, and household sizes from NFHS-3 (TGPP and NCP, 2006) (IIPS and Macro International, 2007). NFHS-3 gives rural and urban household sizes as 4.8 and 4.3. These household sizes are used for 2006 to estimate the population's water use and wastewater generated at an 80 percent return factor. Household sizes from the 2001 census for rural and urban residents were 5.4 and 5.1. The model for estimating the sanitation market assumes that household sizes will decline linearly to 4.1 in rural and 4.0 in urban areas by 2020. Households using various toilet facilities were estimated by applying the percent distribution of toilets to the total number of households. It is assumed that average wastewater used will be 135 liters per person per day in urban areas, and will rise linearly from 40 to 60 liters per person per day in rural areas over the period.

The annual size of the market is estimated by combining information on the number of new or old households acquiring various types of toilets, the unit costs of new and upgraded toilets, the number of households continuing to use various types of toilets, toilet maintenance costs, the capacity for collection and treatment of wastewater, and the unit cost of building wastewater collection and treatment facilities.

Annex 10: Population Distribution by Wealth Quintiles

TABLE A.36 POPULATION IN WEALTH QUINTILES AND RURAL/URBAN LOCATIONS IN INDIA, 2006

All population (all ages)	Total population	Percent of total population
India	1,117,734,000	100
Rural	793,250,994	71
Urban	324,483,006	29
WQ1	213,491,298	19
WQ2	223,193,288	20
WQ3	226,207,844	20
WQ4	232,044,077	21
WQ5	222,797,493	20
WQ1 Rural	204,125,560	18
WQ2 Rural	202,668,771	18
WQ3 Rural	183,460,982	16
WQ4 Rural	138,642,464	12
WQ5 Rural	64,353,200	6
WQ1 Urban	9,365,737	1
WQ2 Urban	20,524,516	2
WQ3 Urban	42,746,862	4
WQ4 Urban	93,401,613	8
WQ5 Urban	158,444,293	14

Source: Estimates based on NFHS-3 and population projections.

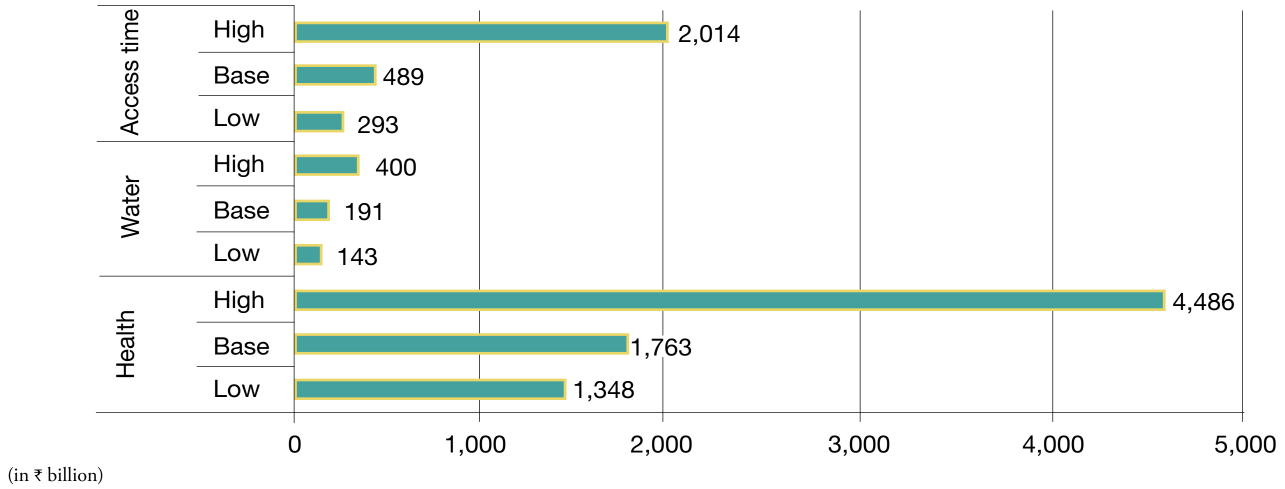
Annex 11: Sensitivity Analysis

TABLE A.37 INPUT VALUES FOR LOW, BASE, AND HIGH ESTIMATES OF INADEQUATE SANITATION IN INDIA IN 2006

Parameter	Low	Base	High
Valuation of premature mortality	Average compensation per worker, from National Sample Survey (NSSO, 2008)	Unemployment-adjusted labor share of GDP per worker (see methods)	Transferred value of statistical life (VOSL) based on lowest value after 1996 reported by an OECD study in a recent review by Bellavance (Bellavance, Dionne, and Lebeau, 2009), with income elasticity of 0.8.
Value of lost time of adults	30% of earnings per worker	30% of unemployment-adjusted labor share of GDP per worker	100% of unemployment-adjusted labor share of GDP per worker
Value of lost time of children	50% of adult value of time	50% of adult value of time	100% of adult value of time
Piped water consumption per person per day	2.92 liters for drinking, 72 liters total	2.92 liters for drinking, 72 liters total (see methods)	4 liters for drinking, 123.3 liters total (based on WHO recommendation and average consumption)
Cost of piped water	₹4.91 per 1,000 liters	₹4.91 per 1,000 liters (see methods)	₹8 per 1,000 liters (based on cost/collection ratio of 1.63)
Boiling per liter—LPG	₹0.34	₹0.415	₹0.49
Boiling per liter—wood	₹0.52	₹0.885	₹1.25

Source: Compiled by author from various sources.

FIGURE A.3. LOW, BASE, AND HIGH ESTIMATES FOR HEALTH, WATER, AND ACCESS TIME ECONOMIC IMPACTS OF INADEQUATE SANITATION IN INDIA IN 2006



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List of Abbreviations

ALRI	Acute Lower Respiratory Infection
CPCB	Central Pollution Control Board (Government of India)
DDWS	Department of Drinking Water and Sanitation (Government of India)
ESI	Economics of Sanitation Initiative
GDP	gross domestic product
GNI	gross national income
JMPDWSS	Joint Monitoring Programme for Drinking Water Supply and Sanitation
MDG	Millennium Development Goal
MLD	million liters per day
NFHS-3	National Family Health Survey (2005-2006)
NGO	non-governmental organization
NSSO	National Sample Survey Organization
OECD	Organisation for Economic Co-operation and Development
PPP	purchasing power parity
₹	Indian Rupee
UNICEF	United Nations Children's Fund
VIP	ventilated improved pit
VOSL	Value of Statistical Life
WAZ	weight-for-age Z-score
WHO	World Health Organization
WSP	Water and Sanitation Program

Economics of Sanitation

The Economics of Sanitation Initiative was launched in 2007 as a response by the Water and Sanitation Program (www.wsp.org) to address major gaps in evidence among developing countries on the economic aspects of sanitation. The study aims to provide evidence that supports sanitation advocacy, elevates the profile of sanitation, and acts as an effective tool to convince governments to take action.

The first study completed in Southeast Asia found that the economic costs of poor sanitation and hygiene amounted to over US$9.2 billion a year (2005 prices) in Cambodia, Indonesia, Lao PDR, the Philippines, and Vietnam. Its second phase analyzes the cost-benefit of alternative sanitation interventions and will enable stakeholders to make decisions on how to spend funds allocated to sanitation more efficiently.

Due to the study's successful traction, WSP carried out ESI studies in Bangladesh, India, and Pakistan. ESI studies are also planned for countries in Africa, Latin America, and the Caribbean.

WSP FUNDING PARTNERS

The Water and Sanitation Program (WSP) is a multi-donor partnership created in 1978 and administered by the World Bank to support poor people in obtaining affordable, safe, and sustainable access to water and sanitation services. WSP provides technical assistance, facilitates knowledge exchange, and promotes evidence-based advancements in sector dialog. WSP has offices in 25 countries across Africa, East Asia and the Pacific, Latin America and the Caribbean, South Asia, and in Washington, DC. WSP's donors include Australia, Austria, Canada, Denmark, Finland, France, the Bill and Melinda Gates Foundation, Luxembourg, Netherlands, Norway, Sweden, Switzerland, the United Kingdom, the United States, and the World Bank.

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