The Water and Sanitation Program is an international partnership for improving water and sanitation sector policies, practices, and capacities to serve poor people

November 2007

Research report

Economic Impacts of Sanitation in Southeast Asia

A four-country study conducted in Cambodia, Indonesia, the Philippines and Vietnam under the Economics of Sanitation Initiative (ESI)

Water and Sanitation Program - East Asia and the Pacific (WSP-EAP), World Bank
East Asia and the Pacific Region

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EXECUTIVE SUMMARY

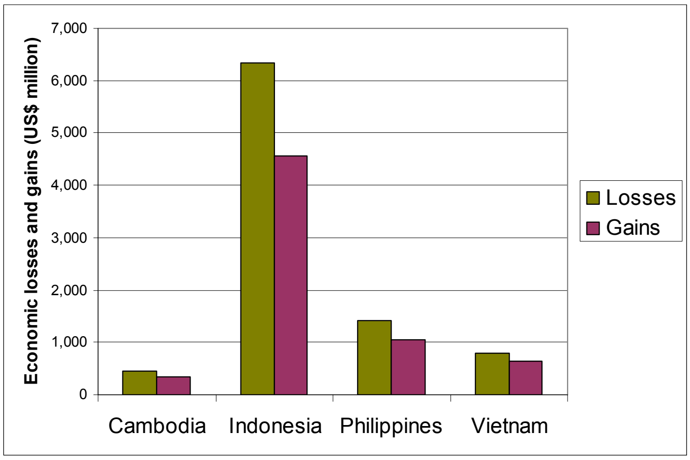
Sanitation is a neglected aspect of development in countries where spending is limited, and where many other priorities crowd the agenda. Improved sanitation coverage has increased gradually as economic growth has spread to Asia's poorer countries. However, latest estimates put improved sanitation coverage at 28% in Cambodia, 57% in Indonesia, 76% in the Philippines and 69% in Vietnam, far below the universal sanitation coverage achieved in other Southeast Asian countries such as Thailand and Singapore. Subsequently, hundreds of millions of people in the region still lack access to improved sanitation, which is seen more as a result, rather than a cause, of economic growth. Few governments and households identify poor sanitation as an impediment to economic growth.

This study examines the major health, water, environmental, tourism and other welfare impacts associated with poor sanitation in Cambodia, Indonesia, the Philippines and Vietnam. By examining the economic impacts of poor sanitation, and the potential gains from improved sanitation, this study provides important evidence to support further investment in sanitation. The goal of this report is to show decision-makers at the country and regional levels how the negative impacts of poor sanitation can be mitigated by investing in improved sanitation.

The study is based on evidence from other investigations, surveys and databases. The impact measurement reported in the study focuses mainly on a narrow definition of sanitation − human excreta management and related hygiene practices. The measurement of water resource impact also includes grey water, and the measurement of environmental impact includes solid waste management.

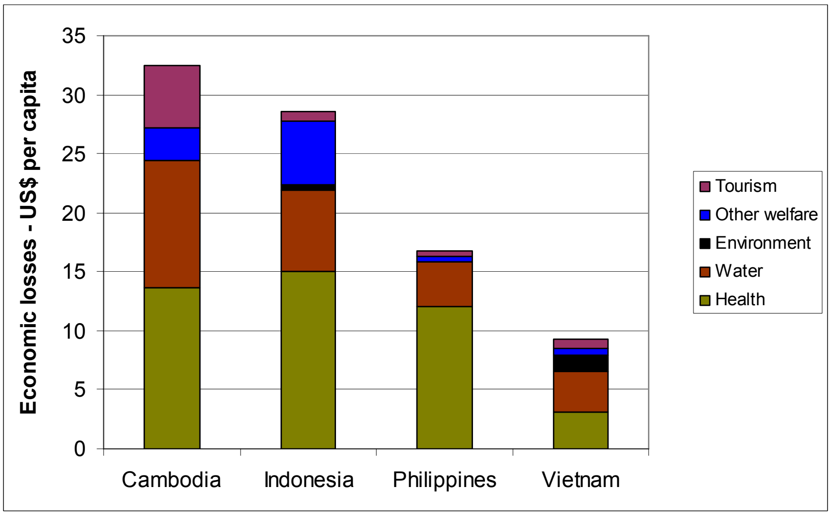
Cambodia, Indonesia, the Philippines and Vietnam lose an estimated US$9 billion a year because of poor sanitation (based on 2005 prices). That is approximately 2% of their combined Gross Domestic Product, varying from 1.3% in the Philippines and Vietnam, to 2.3% in Indonesia and 7.2% in Cambodia. The annual economic impact is approximately US$6.3 billion in Indonesia, US$1.4 billion in the Philippines, US$780 million in Vietnam and US$450 million in Cambodia. With the universal implementation of improved sanitation and hygiene, it is assumed that all the attributed impacts would be mitigated, except for health, for which 45% of the losses would be mitigated. This would lead to an annual gain of US$6.3 billion in the four countries, as shown in the figure below. The implementation of ecological sanitation approaches (fertilizer and biogas) would be worth an estimated US$270 million annually.

Overall annual economic losses and gains (in US$ million)



Annual per capita losses range from US$9.30 in Vietnam, US$16.80 in the Philippines and US$28.60 in Indonesia, to a high of US$32.40 in Cambodia. Of the four countries, those with the least sanitation coverage have significantly higher per capita losses.

Annual per capita losses, by impact (US$)



The four countries in this study contain a total of 400 million people. Health and water resources contribute most to the overall economic losses estimated in the study. Poor sanitation, including hygiene, causes at least 180 million disease episodes and 100,000 premature deaths annually. The resulting economic impact is more than US$4.8 billion a year, divided between US$3.3 billion in Indonesia, US$1 billion in the Philippines, US$260 million in Vietnam and US$190 million in Cambodia. Poor sanitation also contributes significantly to water pollution – adding to the cost of safe water for households, and reducing the production of fish in rivers and lakes. The associated economic costs of polluted water attributed to poor sanitation exceed US$2.3 billion per year, divided between US$1.5 billion in Indonesia, US$320 million in the Philippines, US$290 million in Vietnam and US$150 million in Cambodia. Poor sanitation also contributes up to US$220 million in environmental losses (loss of productive land) in

Indonesia and Vietnam, US$1.3 billion in other welfare losses (time to access unimproved sanitation), and US$350 million in tourism losses.

This is the first regional study to compile economic evidence on a range of impacts of poor sanitation. The results are a wake-up call to governments and the development community. Poor sanitation affects everyone, but especially the poor and vulnerable (children, women, disabled and senior people). The considerable socio-economic importance of sanitation shown in this study, and the key links improved sanitation has with other development goals (poverty and hunger reduction, gender equality, child health, access to safe drinking water, and the quality of life of slum-dwellers), demonstrates that sanitation should receive far greater attention from governments and other development partners of the countries of East and Southeast Asia that are interested in equitable and sustainable socio-economic development. Decision-makers should act now and in a concerted way to increase access to improved sanitation and hygiene practices.

FOREWORD

Countries in Southeast and East Asia, like those in other regions of the world, are on a development path that is lifting large numbers of people out of poverty. Economic indicators in the region are, generally, extremely positive.

As well as economic growth, populations demand improved quality of life through improved health, housing, access to welfare services, and living environment. However, in a world of multiple government and donor priorities, some aspects of development remain neglected.

Sanitation is one such neglected aspect of development. Among the many priorities of households as well as governments, it is often pushed down the agenda, and left as an issue to be dealt with by someone else, or not at all. Indeed, without information on the link between sanitation and economic development, it is hardly surprising that sanitation is sidelined.

If governments and households are to be convinced that expenditure on improving sanitation is worthwhile, stronger evidence is needed to better understand the various impacts of poor sanitation: on health, the environment, population welfare, and eventually on economic indicators.

Based on this premise, the World Bank's Water and Sanitation Program (WSP) in East Asia and the Pacific (WSP-EAP) is leading the 'Economics of Sanitation Initiative' (ESI) to compile existing evidence and to generate new evidence on socio-economic aspects of sanitation. The ultimate aim of the ESI is to assist decision-makers at different levels to make informed choices on sanitation policies and resource allocations.

The first major activity of the ESI was to conduct a 'sanitation impact' study, to examine the economic and social impacts of unimproved sanitation on the populations and economies of Southeast Asia, as well as the potential economic benefits of improving sanitation. Once these questions are answered, national stakeholders can continue the discussions about policy making and priority setting armed with a better evidence base for decision making. They will be further supported in their policy debates following the completion of the second ESI study, a 'sanitation options' study, which will examine the cost-effectiveness and cost-benefit of alternative sanitation improvement options and management approaches in a range of settings in each country.

The research under this program is initially being conducted in Cambodia, Indonesia, the Philippines, Vietnam and Lao PDR. This study reports results for the first four of these; the study results from Lao PDR are due for publication in 2008.

While the WSP has supported the development of this study, it is an 'initiative' in the broadest sense, which includes the active contribution of many people and institutions (see Acknowledgements).

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
ALRI	Acute lower respiratory infection
BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
DHS	Demographic and Health Survey
DO	Dissolved oxygen
EAP	East Asia and the Pacific
EASAN	East Asia Sanitation Conference
Ecosan	Ecological sanitation
ESI	Economics of Sanitation Initiative
FAO	Food and Agriculture Organization
FY	Financial year
GDP	Gross domestic product
GNP	Gross national product
HCA	Human capital approach
JMP	Joint Monitoring Programme (WHO, UNICEF)
Kg	Kilograms
MDG	Millennium Development Goal
Mg/l	Milligrams per liter
NGO	Non-governmental organization
OECD	Organization of Economic Cooperation and Development
PEM	Protein energy malnutrition
SEAR-B	WHO Southeast Asia region epidemiological strata B
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VOSL	Value-of-statistical life
WB	World Bank
WHO	World Health Organization
W&S	Water Supply and Sanitation
WPR-B	WHO Western-Pacific Region epidemiological strata B
WSP	Water and Sanitation Program
WTP	Willingness to pay

ACKNOWLEDGEMENTS

The sanitation impact study was conducted in Cambodia, Indonesia, the Philippines and Vietnam, and it is ongoing in Lao PDR. The study was led by the East Asia and Pacific Office of the World Bank's Water and Sanitation Program (WSP-EAP), with the contribution of WSP teams in each of the participating countries. The study took one year to complete, and has undergone two major peer review processes. This summary report is based on four full-length country reports and a full-length synthesis report (see CD-Rom in this publication, inside back cover).

Guy Hutton (WSP-EAP Regional Senior Water and Sanitation Economist) led the development of the concept and methodology for the ESI, and the management and coordination of the country teams. The study benefited from the continuous support of other WSP-EAP staff. Isabel Blackett was the Task Team Leader; and Jema Sy, Brian Smith, Almud Weitz and Richard Pollard provided input to the concept development and study execution. Bjorn Larsen (WSP Consultant) contributed to the study methodology and provided the figures for the malnutrition-related health effects of poor sanitation.

The country teams were composed of:

- Cambodia: Economics Institute of Cambodia – Phyrum Kov (country lead), Hach Sok (EIC Director), Sophannara Roth and Kongkea Chhoeun.
- Indonesia: Lydia Napitupulu (country lead) and Dedek Gunawan.
- The Philippines: U-Primo E. Rodriguez (country lead) and Nelissa Jamora.
- Vietnam: Pham Ngoc Thang (country lead) and Hoang Anh Tuan.

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Elena Strukova (consultant), Caroline van den Berg, Anjali Acharya, and Tracey Hart reviewed the methodology study before its implementation. Peer reviewers of the **synthesis** draft report were (World Bank staff unless otherwise stated): Eddy Perez, Anjali Acharya, Pete Kolsky, Elena Strukova (consultant), Bjorn Larsen (consultant), and Peter Feldman (Plan International).

Peer reviewers of the **Cambodia** country draft report were: Hilda Winarta (UNICEF), Jan Lam (SNV), Chea Samnang (Ministry of Rural Development), Ruud Corsel (Niras-Scanagri, Vietnam), and Oun Syvibola (Plan International). Peer reviewers of the **Philippines** country draft report were: Jema Sy and Andy Robinson (consultant). Peer reviewers of the **Vietnam** country draft report were: Samuel Leibermann, Doan Hong Quang, Pham Khanh Toan (Ministry of Construction), Nguyen Viet Anh (University of Civil Engineering), Nguyen Kim Thai (University of Civil Engineering), Nguyen Van Thuan (Australian Agency for International Development), and John Collett (Plan International).

In conducting the study, a wide range of experts and stakeholders provided valuable input, which WSP and the country consultants appreciate greatly. The stakeholders are acknowledged in the country reports.

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Reference for citation:
Economic impacts of sanitation in Southeast Asia: summary report. Hutton G, Rodriguez UE, Napitupulu L, Thang P, Kov P. World Bank, Water and Sanitation Program. 2007.

Summary reports are available for each country. Full-length country reports are accessible as follows:

- Economic impacts of sanitation in **Cambodia**. Kov P, Sok H, Roth S, Chhoeun K, Hutton G. World Bank, Water and Sanitation Program. 2007.
- Economic impacts of sanitation in **Indonesia**. Napitupulu L and Hutton G. World Bank, Water and Sanitation Program. 2007.
- Economic impacts of sanitation in the **Philippines**. Rodriguez UE, Jamora N, Hutton G. World Bank, Water and Sanitation Program. 2007.
- Economic impacts of sanitation in **Vietnam**. Thang P, Tuan H, Hang N, Hutton G. World Bank, Water and Sanitation Program. 2007.

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Annex A

Table of Basic Country Data[1]

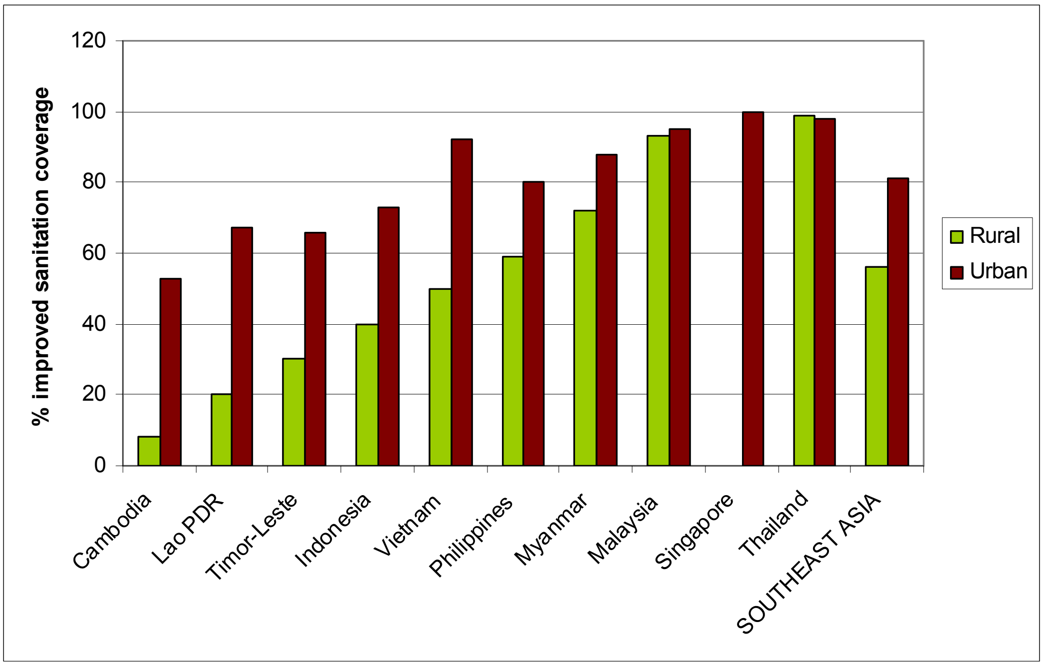
Variable	Cambodia	Indonesia	Philippines	Vietnam
Population				
Total population (millions)	13.8	221.8	84.2	84.2
Rural population (%)	83.8%	59.2%	65.4%	74.0%
Urban population (%)	16.2%	40.8%	34.6%	26.0%
Annual population growth	1.9%	1.0%	2.4%	1.0%
Under-5 population (% of total)	12.3%	10.8	12.6%	8.9%
Under-5 mortality rate (per 1,000)	83	36	33	19
Female population (% of total)	51.5%	50.2%	49.6%	51%
Population below poverty line	35%	27%	37%	29%
Currency				
Currency name	Riel	Rupiah	Peso	Dong
Year of cost data presented	2005	2006	2005	2005
Currency exchange with US$	4,050	8,828	55.1	16,080
GDP per capita (US$)	447	1,420	1,282	690
Sanitation				
% improved rural	15.7%	40%	59%	50%
% improved urban	56.1%	73%	80%	92%
% urban sewage connection treated	28.9%	2.0%	3.3%	14.0%

[1] Year 2005, unless otherwise stated

1. INTRODUCTION

As global population and resource consumption continue to grow, good sanitation practice becomes increasingly important. Sanitation is broadly defined here as 'the hygienic disposal or recycling of waste, as well as protection of health through hygienic measures'. Hence, the term 'sanitation' as used in this study encompasses hygiene measures. Figure 1 shows the coverage of improved sanitation in Southeast (SE) Asian countries, using the Millennium Development Goal (MDG) indicator which relates to household access to a safe and private latrine.[1] The figure shows considerable cross-country disparity as well as rural-urban differences in improved latrine coverage. Rates of improved basic personal hygiene practices such as hand washing are also low in the less developed countries of the SE Asian region. Annex Table A1 compares sanitation coverage in SE Asian countries to other world regions.

Figure 1. Improved sanitation coverage in Southeast Asia – MDG indicator (%), 2004



Source: http://www.wssinfo.org/

In the year 2004, 183 million people in the SE Asian region remained without access to improved household latrine.[1] In SE Asia, with the exception of Timor-Leste, the countries participating in the present sanitation impact study – Cambodia, Indonesia, Lao PDR,[2] Philippines and Vietnam – have the lowest regional access to improved sanitation.

Poor sanitation has a number of documented adverse impacts leading to disease and premature death, polluted water resources, time loss from daily activities, degraded environment, and lost opportunities for the use of human excreta for energy or fertilizer production. Some population groups – children, women and senior people – are

[1] Defined by WHO / UNICEF Joint Monitoring Programme as either: (1) flush or pour-flush to piped sewer system, septic tank or pit latrine; or (2) Ventilated Improved Pit-latrine; or (3) pit latrine with slab; or (4) composting toilet. See Table 2 in Chapter 2.
[2] The Lao PDR study results will be published at a later date.

particularly vulnerable to some of these impacts, which considerably affects their quality of life. Indeed, poor sanitation is a characteristic of everyday life of poor people.

In the policy dialogue, improved sanitation should be recognized as both a cause and an effect of economic development. Surveys indicate that households tend to invest in improved sanitation as their income rises; an effect also observable at country level. However, traditionally governments do not see improved sanitation as a necessary condition of economic development or source of improved welfare, and cost-benefit analysis is not commonly used to justify increasing spending on sanitation programs.[3] Along similar lines, it is not commonly perceived among policy makers that poor sanitation practices may prevent households from climbing out of poverty, as the adverse impacts of disease and environmental degradation on labor productivity and household resource allocation are not fully recognized. This downward cycle starts from an early age: early childhood infections contribute to malnutrition, poor rate of child growth, later childhood diseases, lower energy/activity levels, poorer schooling outcomes, and lower work productivity [1]. Childhood illnesses and poor physical access to latrines also affect the time use and productivity of women. These links with sanitation with other aspects of development are recognized by the Millennium Project Taskforce on Water and Sanitation [2]:

> "..increasing access to domestic water supply and sanitation services and improving water resources management are catalytic entry points for efforts to help developing countries fight poverty and hunger, safeguard human health, reduce child mortality, promote gender equality, and manage and protect natural resources. In addition, sufficient water for washing and safe, private sanitation facilities are central to the basic right of every human being for personal dignity and self-respect." (page 3)

As well as the role of water and sanitation in achieving the MDGs, policy makers need to become aware of the measures needed to achieve 'improved' sanitation as defined by the global WHO/UNICEF Joint Monitoring Programme. For example, a sewer system that flows into the nearest waterway is not considered 'improved'. This recognition is important given the very low rates of treated sewage or adequate isolation of human excreta in developing countries of SE Asia, and the high population densities there.[4] Indeed, SE Asian countries often rank among the bottom of global environmental indicators. For example, for environmental sustainability, Indonesia ranks 86th out of 122 countries, the Philippines 112th, and Vietnam 114th [3]. SE Asian countries are also reported to have "very severe water pollution" for fecal (thermotolerant) coliforms, biochemical oxygen demand (BOD) and lead, and "severe water pollution" for suspended solids [4].

In addition to latrine design and waste isolation, it is important to implement improved hygiene practices alongside or separately from narrower sanitation interventions, given the close association of hygiene practice with disease transmission. Figure 2 shows that hand washing practices are not common in six provinces of Indonesia, which partly reflects the situation in other developing countries of SE Asia. In the Philippines, a

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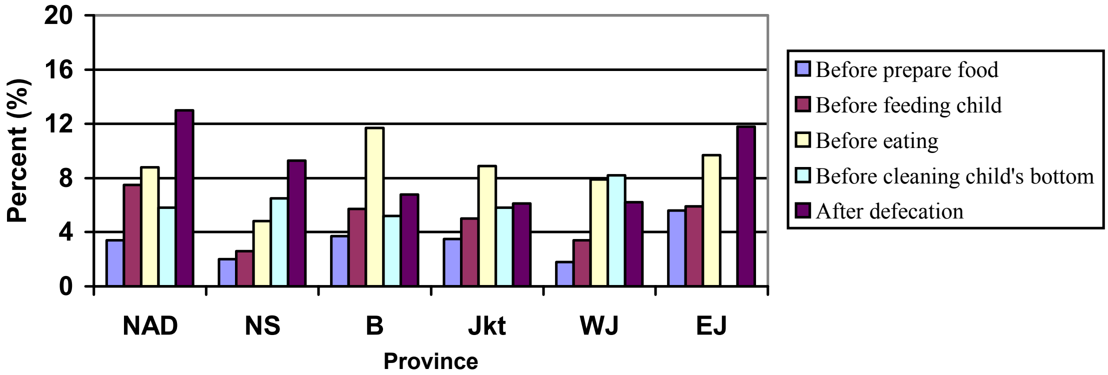
[3] Development banks such as the World Bank or Asian Development Bank commonly conduct financial and economic analysis of sanitation projects that they (partially) finance.

[4] For example, the Mekong Delta in Vietnam, Metro Manila in the Philippines, and Central Java in Indonesia.

nationwide survey in 2000 showed that only 45.1% of respondents wash their hands after using the toilet [5].

Figure 2. Percentage of mothers citing hand washing using soap during selected activities In Indonesia, for six selected provinces



Source: HSP Survey [6]. NAD: Nanggroe Aceh Darussalam; NS: North Sumatra; B: Banten; Jkt: Jakarta; WJ: West Java; EJ: East Java

Despite the importance of water and sanitation in the development process, until now policy makers have not been presented with comprehensive evidence on the impact of poor sanitation on the economy, the environment and population welfare. In order to make informed policy decisions, policy makers need to understand the long-term economic benefits of improved regulatory measures and increased resource allocations for sanitation. Likewise, claims for increased spending on sanitation need to be supported by reliable evidence showing that economic and social returns on sanitation investments are at least as high as returns in other sectors [7]. Therefore, policy makers and sanitation advocates require evidence not only of the negative impacts of poor sanitation, but also how these impacts can be mitigated by different sanitation options, and the comparative costs of these options.

Evidence takes many forms. Given the multiplicity of funding sources and channels as well as regulations for sanitation, relevant evidence of sanitation impact would need to be provided for different decision making levels: national, regional, provincial, district, city, village, community and household. However, to date, the global economic evidence base is extremely limited [8-13], and published local evidence even weaker. The majority of studies conducted to date focus on the health impacts of poor sanitation. However, to have resonance at the level of other line ministries (e.g. water resources, environment, rural development) and central ministries (e.g. finance), more comprehensive evidence of the economic impacts on a range of development outcomes is needed.

Therefore, the specific **goal** of the present sanitation impact study is to provide decision-makers at country and regional level with better evidence on the negative economic impacts of poor sanitation, and to provide tentative estimates of those negative impacts that can be mitigated by investing in improved sanitation. The **target audience** is primarily national-level policy makers with influence over the allocation of resources to sanitation, including central ministries (budgeting, economics, finance), line ministries (infrastructure, water, environment, rural development, urban planning) and external funding and technical partners (multilateral, bilateral and non-government agencies). The study is also targeted at sub-national decision making levels where the results and conclusions of this study are also relevant, particularly in a decentralized decision making environment. The study results disaggregate impacts by provincial groupings for each country, as well as providing a rural-urban breakdown. However, to inform local decisions, further studies are needed that disaggregate at provincial, district and city levels, and below.

Hence, the study presented here is a situation analysis, whose primary aim is to mobilize the different stakeholders and partners inside and outside the sanitation sub-sector to use better quality and comprehensive evidence in allocating resources to the sanitation sub-sector. In order to provide timely evidence, the study uses an evaluation methodology that draws largely on existing data sources available from governments, donors, non-government agencies and the scientific literature. The data gaps and weaknesses identified in this study enable recommendations for future strengthening of routine information systems and priority areas for scientific research to allow better estimation of sanitation impacts in the future. Separate full-length research reports and policy briefs are available for each country (www.wsp.org/pubs/index.asp). This current report provides a synthesis of the major findings from the four participating countries.

This present study is a first attempt to comprehensively evaluate the impacts of poor sanitation at country level, in four countries of SE Asia. Many of these impacts are quantifiable in economic terms. Other impacts that are less tangible or less easy to evaluate are also potentially important for economic development, quality of life, and political decision making. This study is the first application of a comprehensive sanitation impact evaluation methodology developed by the World Bank WSP [16]. Based on the experiences of this present study, the methodology will be revised for application in other countries and regions of the world.

The focus in this present study on sanitation, and not water *per se*, is justified for two main reasons. First, water has historically received greater emphasis than sanitation, in terms of research, policy development, programmatic support and resource allocation. The WHO/UNICEF Joint Monitoring Programme estimates that in the 1990s, water received US$12.6 billion annually, while sanitation received US$3.1 billion, a factor difference of 4 times [14]. In Asia, the factor difference between spending on water and spending on sanitation in the same period is 5.5 times. As a result of this skewed spending, sanitation is lagging behind other global development goals: 59% of the world's population had access to improved sanitation in 2004, compared to 83% for access to an improved water supply [15].

A second reason for the focus on sanitation is that poor sanitation practice is the starting point for many of the observed negative impacts of poor sanitation *and* water. For example, water quality is affected by poor sanitation; hence by improving sanitation, the quality of water for human consumption and productive purposes is improved. Also, the major share of water, sanitation and hygiene-related diseases are fecal-oral in nature, which means that they are transmitted because sanitation practice fails to isolate pathogens from contact with humans, and the lack of hygienic practice fails to prevent person-to-person transmission.

The results of this first study will contribute to the design and execution of a second study under the ESI, whose primary purpose is to evaluate the comparative costs and benefits of alternative sanitation improvement options in a range of country contexts. This second study will be based on the rationale that decision-makers need to know which sanitation improvements provide the best value for money, what the overall costs and benefits are, and who is willing or able to finance the improvements. Taken together, these studies together will provide an improved evidence base for the efficient planning and implementation of sustainable sanitation options in the East Asia and Pacific region.

2. STUDY METHODOLOGY OVERVIEW

The sanitation impact study follows a standardized peer reviewed methodology in all five countries [16] with a joint training session held for all study teams. Differences in the quality and level of detail of secondary data in the five countries required adaptation of the methodology to arrive at the same output data on economic impacts. However, the findings of the five country studies are still largely comparable.

This section describes:
1. The levels and units of analysis (2.1).
2. Which aspects of 'sanitation' are included in this study (2.2).
3. How impacts are classified and which are included in the study (2.3).
4. An overview of how the different economic impacts of unimproved sanitation are measured (2.4).
5. The methods used for predicting the economic benefits associated with improved sanitation ('impact mitigation') (2.5).

Annex A provides further background data (A1), describes the detailed methods for estimating the economic impacts of unimproved sanitation (A2 to A7), and how methodological weaknesses and uncertainty in input variables are evaluated in sensitivity analysis (A8).

2.1 Levels and units of analysis

The primary aim of this study is to describe and quantify sanitation impacts at national level, in order to inform policy makers about the overall negative impacts of poor sanitation and the potential benefits of implementing different types of sanitation improvement in their countries. The ultimate usefulness of these overall economic impacts of poor sanitation is to serve as the basis for estimating what impacts can be mitigated by improving sanitation, thereby motivating decision-makers to improve sanitation. It is key to note in the interpretation of the results of this study that the gains from improving sanitation will be fewer than the losses from unimproved sanitation, given that (a) sanitation interventions do not have 100% effectiveness to reduce adverse health outcomes associated with poor sanitation, (b) poor sanitation is one of many causes of water and environmental pollution, and the attributed impacts of poor sanitation may not be fully mitigated.

The aim of the study is to present impacts in disaggregated form, to aid interpretation and eventually policy recommendations. Geographical disaggregation of results is presented for some types of economic impact, at the regional level in Cambodia, the Philippines and Vietnam, and at the provincial level in Indonesia. Rural/urban breakdown is provided where feasible. Furthermore, health impacts are disaggregated by age group for selected diseases and descriptive gender analyses are also conducted.

The study uses a modeling approach and draws almost exclusively on secondary sources of data. The study presents impacts in terms of physical units, and converts these to monetary equivalents using conventional economic valuation techniques [17-26]. Results of economic impact are presented in United States dollars (US$) for a single year – the latest available data were for 2005 for most variables, and 2006 for others. Overall impacts are presented in terms of total and per capita impact in US$.

Results are also presented in international dollars[5] (I$) to enable cross country comparisons of the *relative* impact of poor sanitation in countries with different price levels in relation to the US$. Where quantification in economic terms is not feasible using secondary data sources, impacts are examined and reported descriptively.

Table 1 shows the population size by rural/urban area, and the administrative units in the study countries. Annex Table A2 provides population numbers at the first level of sub-national disaggregation.

Table 1. Population size and number of administrative units in study countries

Region (year of data)	Population size (millions)			Number of	
	Urban	Rural	Total	Regions	Provinces[1]
Cambodia (2005)	2.2	11.6	13.8	5 (zones)	24
Indonesia (2006)	94.8	127.0	221.8	6 [2]	33
Philippines (2005)	29.1	55.1	84.2	17	79
Vietnam (2006)	22.8	61.4	84.2	8	64
Total	**148.9**	**255.1**	**404.0**	**36**	**200**

Source: country reports
[1] Figures count cities with no provincial base as a province.
[2] There are six island groupings in Indonesia

2.2 Scope of sanitation

In conducting an impact study of sanitation, it should be clear what aspects of sanitation are being assessed given that 'sanitation' is used to describe many different aspects of hygiene and disposal or recycling of waste. Furthermore, what actually constitutes *improved* sanitation – as opposed to *unimproved* – will vary across countries and cultural contexts. In the international arena, the sanitation target adopted as part of the MDGs focuses on the disposal of human excreta. Hence for human excreta there is significantly better national data available on population numbers with access to improved coverage. Table 2 presents definitions used by the WHO/UNICEF Joint Monitoring Programme for improved and unimproved water supply and sanitation.

Despite the focus of the sanitation MDG target on human excreta as a key component of sanitation, the present study also recognizes that other areas of sanitation are relevant to the economic impacts measured, and in line with a broader definition of sanitation: that covers the hygienic disposal or recycling of waste, as well as protection of health through hygienic measures. Such a broader definition of sanitation includes management of human and animal excreta, solid waste, other agricultural waste, toxic waste, wastewater, food safety, and associated hygiene practices. However, not all of these could be included in the present study. Table 3 provides an overview of which aspects of sanitation were included. While the primary focus of the study is on human excreta disposal, other important components of domestic sanitation – gray water and solid waste – have been included for selected impacts. The health implications of poor hygiene as they relate to human excreta are assessed in all countries. In Cambodia and Vietnam, the implications of animal excreta are also assessed.

[5] International dollars (I$) take into account the different value of the US$ in each country, by comparing the price of a pre-defined bundle of goods in each country to a reference country, the United States.

Table 2. Definition of 'improved' and 'unimproved' sanitation and water supply

Intervention	Improved	Unimproved [1]

Sanitation	• Flush or pour-flush to:
	  • Piped sewer system
	  • Septic tank
	  • Pit latrine
	• Ventilated Improved Pit-latrine
	• Pit latrine with slab
	• Composting toilet
		• Flush or pour-flush to elsewhere
		• Pit latrine without slab or open pit
		• Bucket
		• Hanging toilet or hanging latrines
		• No facilities or bush or field

Water supply	• Piped water into dwelling, plot, or yard • Public tap/standpipe • Tubewell/borehole • Protected dug well • Protected spring • Rainwater collection	• Unprotected dug well • Unprotected spring • Cart with small tank/drum • Tanker truck • Bottled water • Surface water (river, dam, lake, pond, stream, canal, irrigation channels)

Source: This table reflects the updated definition of improved and unimproved sanitation and water supply presented in the 2006 JMP report [15].
[1] Defined as being unimproved due to being unsafe or costly.

In Vietnam, given that the term 'sanitation' is more broadly defined in the Vietnam 'Unified Sanitation Sector Strategy and Action Plan' (U3SAP), three further components of sanitation are included in addition to the standardized components for the five-country study: (1) storm water in urban areas; (2) agricultural waste (crop waste, fertilizer run-off),[6] and (3) waste from small enterprises (small-scale trade villages and handicraft or cottage industries). However, given the paucity of routine data on practices related to these broader definitions of sanitation, the presentation of results for these components was limited. The results for these aspects of sanitation are presented in the Vietnam report.

Table 3. Aspects of sanitation included in the present study, and those excluded

Included	Excluded

• Human excreta management:
  • Quality, safety and proximity of latrine
  • Safe isolation, disposal, conveyance, treatment
  • Hygiene practices
• Gray water management
• Household solid waste management
• Animal excreta management (Cambodia and Vietnam) and agricultural waste (Vietnam)
	• Drainage and general flood control
	• Industrial, trade village and medical waste
	• Vector control
	• Broader food safety
	• Other agricultural waste
	• Broader environmental sanitation

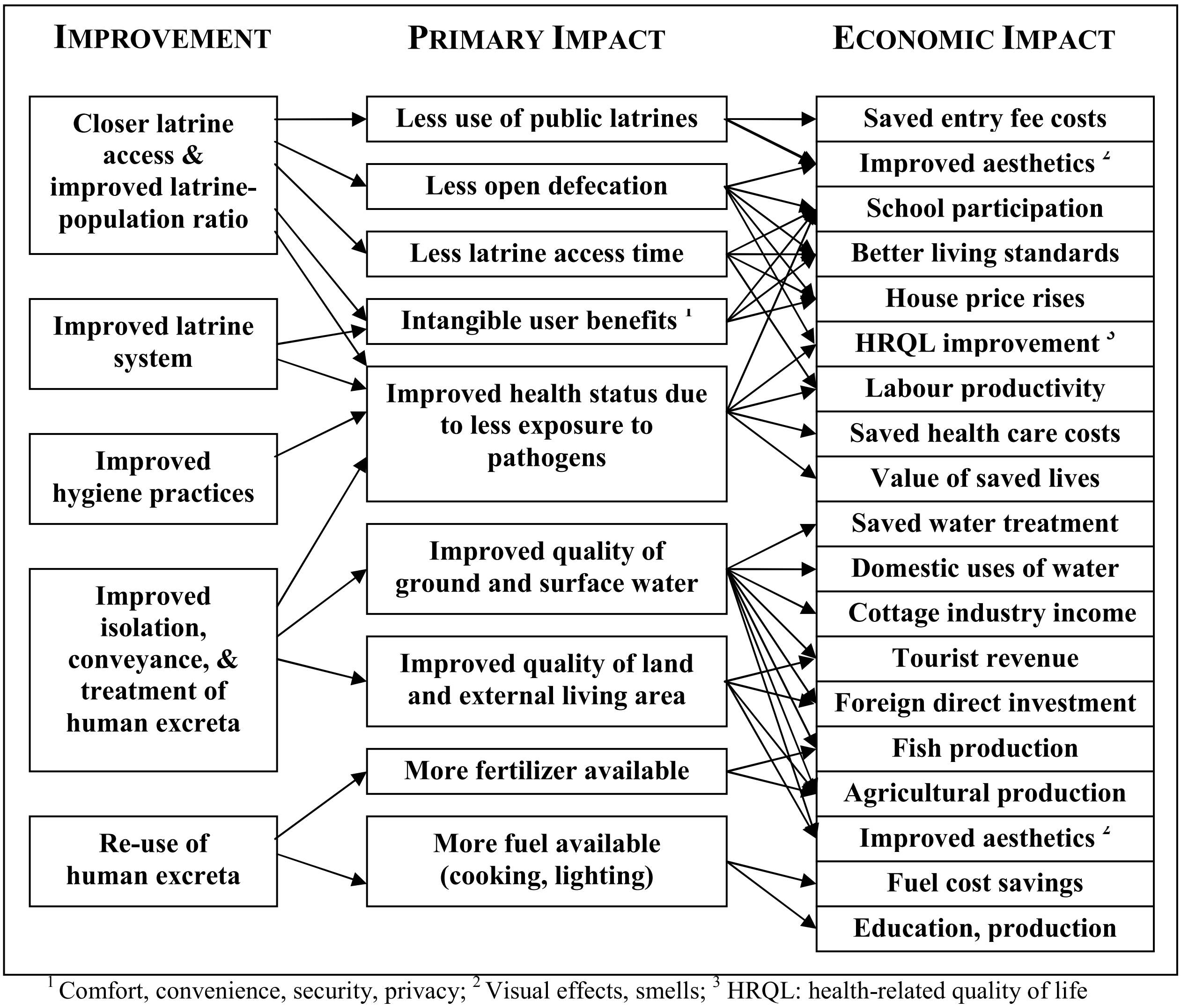
[6] Pesticides, an important part of agricultural waste and a cause of major negative health impacts like cancer, will be analyzed at a later stage.

While sanitation is often more broadly defined, it was not possible to apply a broader definition in this present study due to time and resource constraints. Hence, except for the additional sanitation components examined in Vietnam, the issues of drainage, flood control, hospital waste, agricultural waste and run-off, industrial waste, and broader environmental health such as food hygiene, air pollution and vector control, were not included in the present study (Table 3).

2.3 Impact identification and classification

Poor sanitation has many actual or potential adverse effects on populations as well as national economies. Conversely, measures for improving sanitation mitigate those negative impacts, hence stimulating economic growth and reducing poverty. Several impacts were introduced briefly in Chapter 1. Figure 3 presents a range of possible impacts of sanitation, as they relate to five key aspects of human excreta management: latrine access, latrine system, hygiene practices, excreta disposal and excreta re-use. The major links are shown with arrows.

Figure 3. Primary impacts and resulting economic impacts associated with improved sanitation options ("disposal of human excreta")



[1] Comfort, convenience, security, privacy; [2] Visual effects, smells; [3] HRQL: health-related quality of life

Based on the set of impacts shown in Figure 3, a shortened list of negative impacts of poor sanitation was selected for inclusion in the present study, shown in Table 5. These impacts are classified under five main impact categories: health impacts, water resource impacts, environmental impacts, other welfare impacts, and tourism impacts. Table 4 provides justification for the inclusion of these impacts, showing the presumptions based on preliminary evidence of importance [27] and discussion with country partners. Annex A provides further background on these impact categories.

Table 4. Justification for choice of impacts included in the study

Impact	Link with sanitation	Justification for inclusion
Health	- Poor sanitation and hygiene cause diseases, which lead to premature mortality and a range of direct and indirect economic effects	- Scientific evidence is available on the causal pathways between unimproved sanitation/hygiene and the causative disease pathogens/hosts - Health information systems, household surveys and economic studies testify to the diseases suffered by the population and the associated costs of disease
Water	- Released human and animal excreta pollutes water resources, which affects their usability or productivity and leads to costly averting behavior and/or production impact	- Unregulated sewage and wastewater release into water bodies is a proven significant contributor to inland (and marine) water resource pollution - Water is treated or purchased by households, and undergoes costly treatment by piped water providers for domestic and commercial purposes - Households hauling water themselves travel further to reach a cleaner, safer water supply - Fish are unable to reproduce and survive in heavily polluted water. At lower levels of pollution, fish numbers are affected by oxygen depletion and micro-bacteria. Humans are affected when they eat fish that have been exposed to raw sewage
External environment	- Neighborhoods with poorly managed sanitation are less pleasant to live in, and population welfare is thus affected	- Land and building prices are highly sensitive to environmental factors - Poor people tend to live on marginal land - As income rises, households are willing to pay more for better sanitation services
Other welfare	- Poor sanitation results from cultural barriers, low awareness, lack of design options, low income, and lack of home ownership - Poor sanitation in institutions affects life choices, or leads to absenteeism at schools or the workplace	- Household members have to spend time accessing toilet in the open (nature) or queuing to use shared or public facilities - Privacy, security and convenience are underestimated 'intangible' aspects in sanitation choices - There exists an income gradient in latrine ownership - Sanitation is more important to people who lack voice in household or community decisions – women and children
Tourism	- Poor sanitation affects the attractiveness of tourist destinations and tourist arrivals; and can lead to holiday sickness	- Tourism is an important source of national income and employment, offering high returns on investment - The most popular tourist destinations (generally) have clean environments, good toilet facilities, and a lower risk of getting sick

Based on available evidence, the major anticipated impacts of poor sanitation were on health and water resources, and therefore greater focus was devoted to data collection for these impacts in all of the participating countries. Hypothesized economic impacts such as saved entry fees which is related to public toilet users, house price rises due to improved sanitation, and foreign direct investment were not examined in the present study, either due to anticipated low importance or data limitations.

Table 5 details the sub-impacts examined under health, water resources, external environment, other welfare and tourism. The columns indicate the five key components of sanitation assessed (refer to Table 4) for the different impacts. Human excreta management is relevant for all impact areas. Poor hygiene mainly affects health, but also tourism. Gray water and animal excreta mainly affect water resources, and also tourism. Solid waste mainly affects mainly the external environment and tourism. Also, potential impacts of improved sanitation – the stimulation of local markets for sanitation inputs (labour, materials) and the reuse of waste for productive purposes – are also included.

Table 5. Categorization of impacts included in the present study[1, 2]

Impact	Sub-impacts	Human excreta	Hygiene practices	Gray water	Animal excreta	Solid waste
1. Health	Health status	√	√			
	Disease treatment costs	√	√			
	Productive time loss	√	√			
	Premature death	√	√			
2. Water resources	Water quality	√		√	√	
	Drinking water	√		√	√	
	Domestic uses of water	√		√	√	
	Fish production	√		√	√	
3. External environment	Aesthetics	√		√		√
	Land use and quality	√		√		√
4. Other welfare	Intangible aspects	√				
	Time used for toilet access	√				
	Life choices	√				
5. Tourism	Tourist numbers	√	√	√		√
	Tourist sickness	√	√	√		
6. Sanitation markets	Sanitation 'inputs'	√				
	Sanitation 'outputs'	√			√	

[1] A tick shows which impacts were measured in this study. The absence of tick does not indicate that no empirical relationship is anticipated; only that it was not evaluated in this study.
[2] The broader definition of sanitation in Vietnam was excluded here, but the additional components – storm water, agricultural waste and small-scale industry – have implications mainly for water resources (see country report).

2.4 Estimation methods for financial and economic costs of poor sanitation

Policy makers are interested in understanding the nature of the economic impacts being measured. For example, do the impacts have immediate implications for expenditure and incomes by households or governments, or are the effects non-pecuniary or longer-term in nature? The answer will naturally affect how the results are interpreted, and what level of support there will be for impact mitigation measures. Hence, while recognizing the difficulties in distinguishing between different types of economic impact, the present study attempts to distinguish broadly between two of them – financial and economic:

- Under **financial** impact, those costs which are most likely to affect quantified indicators of economic activity in the short term were included. Financial costs include changes in household and government spending as well as impacts likely to result in real income losses for households (e.g. health-related time loss with impact on household income) or enterprises (e.g. fishery loss). It should be noted that, while these 'financial' costs affect economic activity indicators in the short term, these impacts are not expected to affect Gross Domestic Product (GDP) by the same amount as the estimated impact, due to the substitution effect and transfer payments.

- Under **economic** impact, other costs were added to the above financial costs to approximate the overall population welfare impact of poor sanitation. These include the longer-term financial impacts (e.g. less- and fewer educated children, loss of working people due to premature death, loss of usable land, tourism losses), as well as non-financial implications (value of loss of life, time use of adults and children, intangible impacts).

Table 6 describes which cost components were included for quantified financial and economic definitions of cost for each sub-impact. It should be noted that costs presented are those attributed to poor sanitation using an attribution factor (variable by impact). The detailed methods of impact estimation are described in Annex A.

Table 6. Financial and economic costs of poor sanitation measured in the study

Impact category	Sub-impacts evaluated	Financial costs attributable to poor sanitation	Economic costs attributable to poor sanitation
1. Health (see Annex A2)	Health care costs	Marginal health-seeking costs, including patient transport, medication cost in public sector, and private sector tariffs	Full costs of health seeking, including full health care and patient transport costs
	Productivity costs	Income loss due to lost adult working days due to sickness	Welfare loss due to adult and child sickness time
	Premature mortality	Short-term household income loss due to adult death (1 year)	Discounted lifetime income losses for adult & child death
2. Water resources (see Annex A3)	Drinking water costs	Water treatment and distribution	*Financial* + Time spent hauling water from less polluted water sources, or fuel for boiling water
	Domestic water uses	Additional expenditure sourcing water from non-polluted sources	*Financial* + Time spent hauling water from less polluted water sources, or fuel for boiling water
	Fish losses	Lost sales value due to reduction in fish catch	Lost sales value due to reduction in fish catch
3. External environment (see Annex A4)	Land quality	-	Economic value of land made unusable by poor sanitation
4. Other welfare (see Annex A5)	Time loss	-	Welfare loss due to adult & child travel/waiting time for defecation
	Work/school absence	-	Temporary absence of women from work and girls from school
5. Tourism (see Annex A6)	Tourism costs	-	Revenue loss from low occupancy rates and failure to exploit long-term potential tourist capacity

2.5 Impact mitigation

Having estimated the financial and economic costs of poor sanitation, from a policy viewpoint it is important to know by how much these costs can be reduced by implementing improved sanitation options. It should be noted that, while this study initially presents total costs attributed to poor sanitation, it is unlikely that this total value can be averted by improving sanitation.

While there are many types and configurations of sanitation improvement available, the present study aims to estimate the potential benefits obtainable for a selected number of *features* of sanitation improvements. This study provides an initial, tentative estimate of the likely gains possible from improving these features. It is the aim of the second study of ESI to estimate the costs and benefits of specific sanitation options and management approaches, which are the most relevant policy options in each country context.

Table 7 shows the six main features of sanitation improvement (in columns) assessed in this study, and the relevance of these for each sub-impact category (in rows). The features are described in the table footnotes.

Table 7. Potential benefits of different sanitation improvement options (human excreta)

Impacts	**A**	**B**	**C**	**D**	**E**	**F**
	Access to latrines[1]	**Improved toilet system**[2]	**Hygiene practices**[3]	**Excreta treatment or disposal**[4]	**Excreta re-use**[5]	**Tourist facilities**[6]
Health		√	√	√		
Water resources				√		
Environment						
Aesthetics		√		√		
Land quality		√		√		
Other welfare						
Intangible effects	√	√	√			
Access time	√					
Life choices	√	√	√			
Tourism				√		√
Sanitation markets						
Sanitation inputs	√	√	√	√	√	√
Sanitation outputs					√	

[1] Close and improved latrine for those using open defecation; improved population: toilet ratios through increased coverage of latrines (less queuing time)
[2] Improved position or type of toilet seat or pan; safe, private and secure structure: walls / door / roof; improved & safe collection system (tank, vault, pit); improved ventilation; improved waste evacuation
[3] Availability of water for anal cleansing; safe disposal of materials used for anal cleansing; hand washing with soap; toilet cleaning
[4] Improved septic tank functioning and emptying; sealed top of pit latrine to withstand flooding; household connection (sewerage) with treatment; sewers with non-leaking pipes and a drainage system that can handle heavy rains; wetlands or wastewater ponds
[5] Urine separation, composting of feces, hygienization; use of human excreta products in commercial aquaculture, composting (fertilizer); biogas production (anaerobic digestion)
[6] Tourist toilet facilities (hotels, restaurants, tourist attractions) and general standard of cleanliness (smells, sights)

The impact mitigation estimation methods are described in Annex A7. In summary:

- Access to latrines has most important implications for other welfare impacts.

- Improved toilet system has implications for health, the environment and other welfare impacts.
- Hygiene practices have implications for health, other welfare and tourism impacts.
- Excreta treatment and disposal has implications for health, water resources, environment and tourism.
- Excreta re-use has implications for sanitation outputs.
- Improved tourist facilities leads to greater tourist numbers and creates larger market for sanitation inputs.

All interventions have implications for the sanitation input market, as all require spending on hardware (e.g. latrines, pipes) or software (e.g. education).

2.6 Uncertainty

This study has faced several challenges in attempting to both meet scientific criteria and present evidence that is useful for national as well as local policy makers. In order to provide timely evidence on sanitation impact, the present study is based on entirely secondary information collected from a variety of sources, and combined with assumptions where input data were missing. Therefore, in order to fill the gaps in evidence, several innovative and not previously tested methodologies were developed. Quantitative data was combined using the methodology outlined above and in Annex A to estimate the impacts of poor sanitation and the potential benefits of improving sanitation presented in Chapter 3. A number of impacts were excluded from quantitative estimation, which are described in Section 3.1.5. Three major types of uncertainty surround the quantitative figures presented in the study:

(1) Uncertainty in the input values for the estimation of overall economic impacts, such as in the epidemiological variables (for health) and economic variables such as market prices and economic values. In the study countries, there was a severe lack of data available from official information systems or research studies to feed into the quantitative model. Hence, in the absence of these data, relationships were modeled and assumptions made.

(2) Uncertainty in the attribution of the overall impact to poor sanitation. For example, when there are multiple sources of pollution, a fraction of the overall economic impact estimated must be apportioned to the component of pollution being examined (e.g. domestic waste’s contribution to overall water pollution). A second example is the importance of poor sanitation in keeping away tourists from a country.

(3) Uncertainty in the actual size of impact mitigation achievable.

The variables with greatest importance for the quantitative results were evaluated further in one-way sensitivity analysis by varying a single input value over a reasonable range, to assess the impact on overall findings. Alternative values used in the sensitivity analysis are provided in Annex A8 and the results presented in Section 3.9.

3. ECONOMIC IMPACT RESULTS

Section 3.1 presents a summary of the overall national level impacts of poor sanitation, and Section 3.2 the estimated economic gains from improved sanitation. Sections 3.3 to 3.8 provide further details of the specific sub-impacts, while Annex Tables C1 to C21 provide further breakdowns of selected health and water resource impacts at country level. Section 3.9 presents results from sensitivity analysis.

3.1 Economic impacts of poor sanitation

This study has found that poor sanitation causes considerable financial and economic losses in the four countries. Financial losses – reflecting expenditure or income losses resulting from poor sanitation – average 0.44% of annual GDP, while overall population welfare losses average 2% of GDP. The majority of economic losses are shared between health (54%) and water resources (25%), and time spent accessing unimproved sanitation facilities (15%).

3.1.1 Overall impacts

Table 8 presents a summary of the estimated financial and economic impacts of poor sanitation in the four study countries, showing those impacts that were valued in monetary units. The total impact of poor sanitation and hygiene in the four study countries is estimated at an annual US$2 billion in financial costs and an annual US$9 billion in economic costs (2005 prices).

Table 8. Annual financial and economic losses due to poor sanitation, by impact

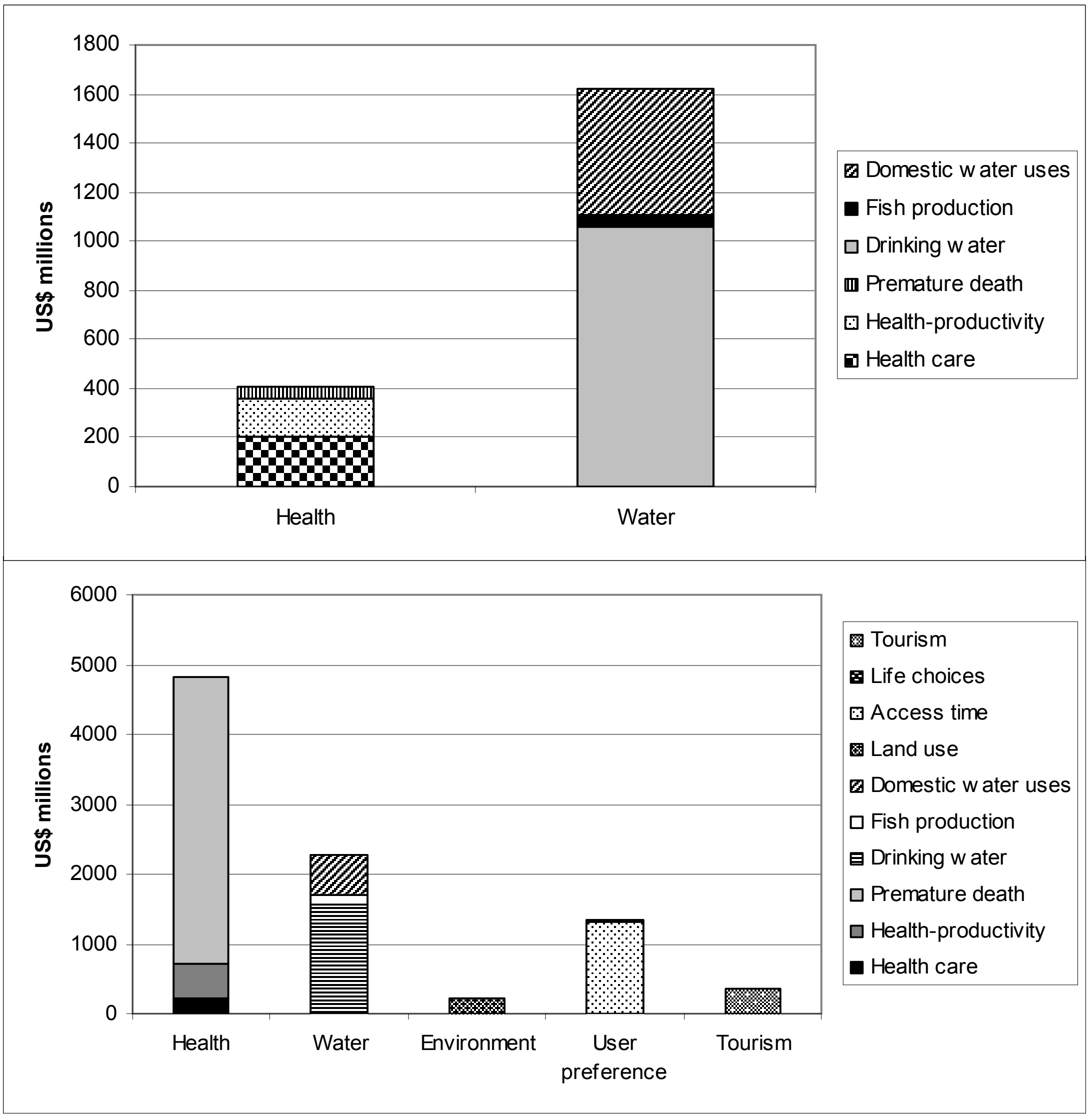
Country and impact	Financial losses			Economic losses		
	US$ million	Per capita	%	US$ million	Per capita	%
Cambodia	**160.1**	**11.6**	**100.0%**	**448.0**	**32.4**	**100.0%**
Health	13.3	1.0	8.3%	187.1	13.6	41.8%
Water	146.8	10.6	91.7%	149.0	10.8	33.3%
Other welfare	-	-	-	38.2	2.8	8.5%
Tourism	-	-	-	73.7	5.3	16.5%
Indonesia	**1,216.0**	**5.5**	**100.0%**	**6,344.0**	**28.6**	**100.0%**
Health	307.0	1.4	25.2%	3,350.0	15.1	52.8%
Water	909.0	4.1	74.8%	1,512.0	6.8	23.8%
Environment	-	-	-	96.0	0.4	1.5%
Other welfare	-	-	-	1,220.0	5.5	19.2%
Tourism	-	-	-	166.0	0.7	2.6%
Philippines	**359.0**	**4.3**	**100.0%**	**1,412.1**	**16.8**	**100.0%**
Health	37.0	0.5	10.3%	1,011.1	12.0	71.6%
Water	322.0	3.8	89.7%	323.3	3.8	22.9%
Other welfare	-	-	-	37.6	0.4	2.7%
Tourism	-	-	-	40.1	0.5	2.8%
Vietnam	**291.7**	**3.5**	**100.0%**	**780.1**	**9.3**	**100.0%**
Health	52.1	0.6	17.9%	262.4	3.1	33.6%
Water	239.6	2.9	82.1%	287.3	3.4	36.8%
Environment	-	-	-	118.9	1.4	15.2%
Other welfare	-	-	-	42.9	0.5	5.5%
Tourism	-	-	-	68.6	0.8	8.8%
TOTAL	**2,026.8**	**5.0**	**100.0%**	**8,984.2**	**22.2**	**100.0%**

Source: country reports

The major factor explaining the cross-country differences is population size, with Indonesia dominating the overall impact figures, with 71% of economic cost. The per capita impact appears to be higher in countries where improved sanitation coverage is lower, such as in Cambodia and Indonesia. This effect is present despite the lower average price levels in Cambodia. The overall losses in Indonesia are dominated by premature mortality from sanitation-related diseases and household water treatment costs.

Overall cost by impact, and contributors to financial and economic cost, are presented in Figure 4 below. Health and water resources were the only factors assumed to have financial impacts – the greater overall financial cost was attributable to water resources, of which the major contributor was the cost of accessing clean drinking water sources. The major contributors to overall economic losses were the cost of premature death (mainly of children under five years old), drinking water access, and time spent accessing unimproved sanitation facilities. Tourism losses, health care costs, sickness time, and domestic use of water also contributed to overall economic losses as shown.

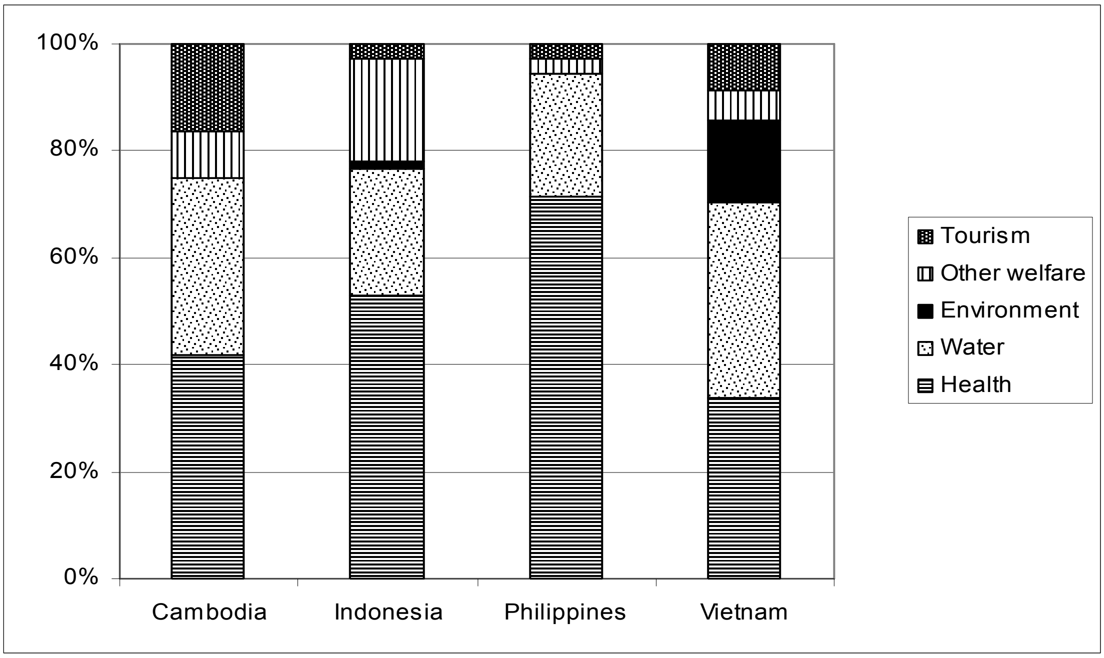
Figure 4. Overall annual financial costs (above) and economic costs (below) of poor sanitation in four countries, by impact



3.1.2 Contributors to impact by country

The contribution of major impacts to overall impact varies by country, and by financial and economic cost. In terms of financial costs, water-related costs are the main contributor in Cambodia, Indonesia and the Philippines, with a share of around 90%. In Vietnam, meanwhile, the contributions from water and health are 40% and 60%, respectively. Contributions to economic costs were different, as shown in Figure 5, with health-related costs dominating in Cambodia, Indonesia and the Philippines. Economic losses due to polluted water resources are is an important contributor to overall costs in all countries. In Cambodia and Vietnam, tourism losses are important, accounting for over 10% of economic losses. Time to access unimproved sanitation facilities (under the category 'other welfare') accounts for 7.5%, 8.5% and 11.4% of the economic losses in Vietnam, Cambodia, and Indonesia, respectively. The economic cost of unused land (under the category 'environment') due to unsanitary landfills and dumping practices was most important in Vietnam, with a share of 21% (not measured in Cambodia and Philippines).

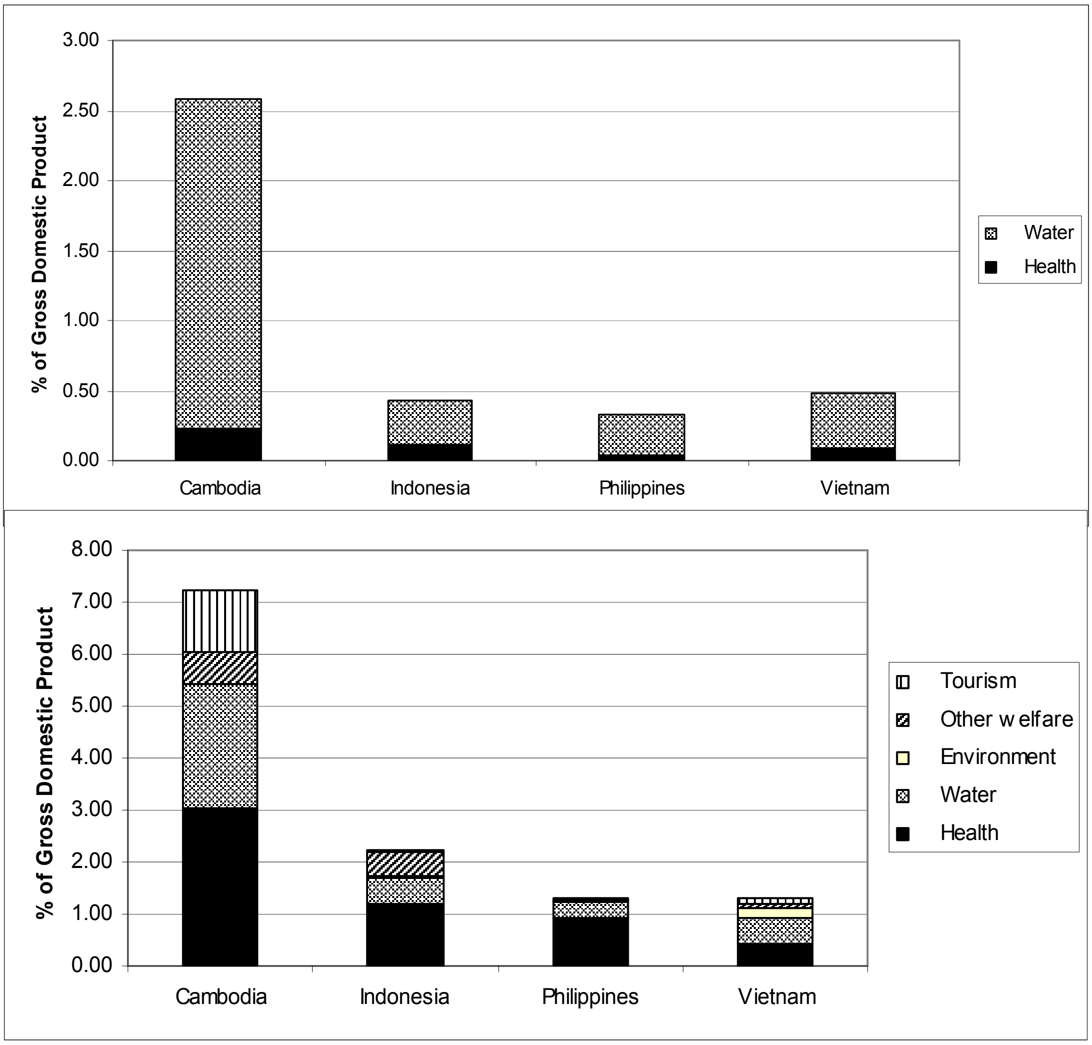
Figure 5. Contribution of impacts to overall economic cost, by country



3.1.3 Relative importance of impacts by country

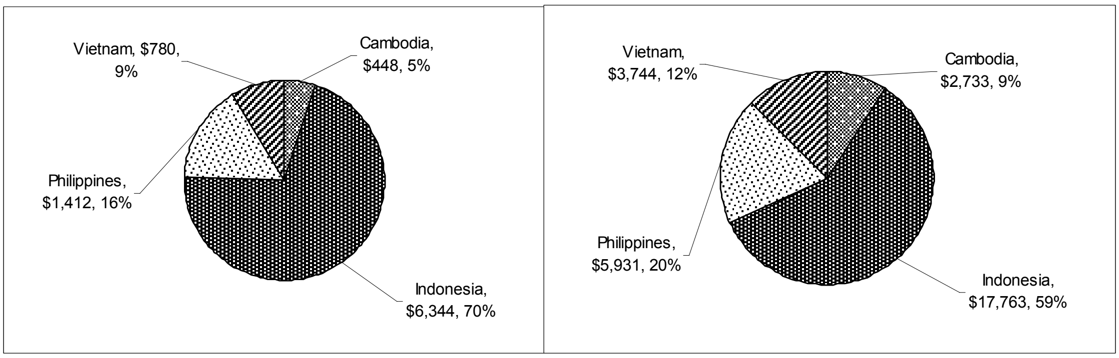
The overall size of impact of poor sanitation depends partly on the level of economic development and prices in each country. Figure 6 shows the financial and economic losses as a proportion of country GDP, broken down by major impact. Relative impacts are higher in Cambodia than the other countries, with financial losses totaling 2.6% of GDP and economic losses 7.2% of GDP. In other countries, the financial losses do not exceed 0.5% of GDP, while economic costs are 2.2% of GDP in Indonesia and 1.3% in each of the Philippines and Vietnam. A significant part of the difference between financial and economic costs in most countries is the health impact, which increases substantially when the economic viewpoint is taken, especially in Cambodia, which has the highest sanitation-related disease rates.

Figure 6. Financial (above) and economic (below) losses as % of GDP, 2005



The implications of the impacts presented above in US$ will vary by country, given that price levels – and hence the value of the US$ in local purchasing power – vary between study countries. Figure 7 compares the US$ economic impact with the impact valued in international dollars, taking into account purchasing power differences across countries (see Annex Table A3). The purchasing power measure also enables assessment of relative contributions to aggregate economic cost based on the purchasing power of each country. The greatest relative impact of poor sanitation is in Cambodia, where the factor difference between US$ and international dollars is 6.1, taking the economic impact at purchasing power parity values to I$2.7 billion. The implication is that Cambodia's contribution to overall economic impact increases to 9% at I$, up from 5% when valued at US$. For Indonesia, the factor difference is the lowest of the five countries at 2.8, hence reducing the contribution to overall economic cost to 59%, compared to 70% at US$. Vietnam and the Philippines, which each contain 21% of the combined country population, share (relatively) the lowest overall economic costs.

Figure 7. Country share of overall cost at US$ (left) versus international $ (right)[1]



[1] Obtained from World Bank comparison of GNI per capita US$ per capita (Atlas method) versus international dollars (purchasing power parity) (see Annex Table A3)

3.1.4 Rural-urban breakdown of impact

Table 9 shows the rural-urban breakdown of the aggregate financial and economic cost for each country. Figure 8 shows the breakdown for the four countries combined. In most countries, considerable shares of total impact could not be assigned due to the lack of input data disaggregated by rural-urban setting.

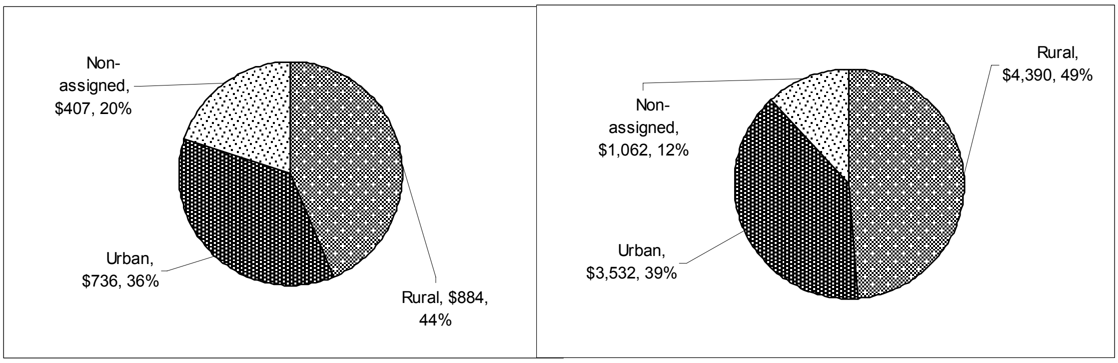
Table 9. Rural - urban breakdown of total economic impact

Impact	Financial losses			Economic losses		
	US$ million	Per capita[1]	%	US$ million	Per capita[1]	%
Cambodia	**160.1**	**11.6**	**100%**	**448.0**	**32.5**	**100%**
Rural	74.6	6.4	47%	111.8	9.6	25%
Urban	27.8	12.6	17%	31.0	14.1	7%
Non-assigned [2]	57.7	4.2	36%	305.1	22.1	68%
Indonesia	**1,216.0**	**5.5**	**100%**	**6,344.0**	**28.6**	**100%**
Rural	633.0	5.0	52%	3,232.0	25.4	51%
Urban	583.0	6.1	48%	2,946.0	31.1	46%
Non-assigned [2]	0.0	0.0	0%	166.0	0.7	3%
Philippines	**359.0**	**4.3**	**100%**	**1,412.1**	**16.8**	**100%**
Rural	18.4	0.3	5%	663.6	12.0	47%
Urban	18.6	0.6	5%	372.1	12.8	26%
Non-assigned [2]	322.0	3.8	90%	376.4	4.5	27%
Vietnam	**291.7**	**3.5**	**100%**	**780.1**	**9.3**	**100%**
Rural	157.7	2.6	54%	382.9	6.2	49%
Urban	106.6	4.7	37%	182.4	8.0	23%
Non-assigned [2]	27.4	0.3	9%	214.8	2.6	28%
TOTAL	**2,026.8**	**5.0**	**100%**	**8,984.2**	**22.2**	**100%**
Rural	883.7	3.5	44%	4,390.3	17.2	49%
Urban	736.0	5.0	36%	3,531.5	23.9	39%
Non-assigned [2]	407.1	1.0	20%	1,062.3	2.6	12%

[1] Rural and urban per capita cost calculated by dividing assigned cost by rural or urban population size; total and non-assigned per capita cost calculated by dividing cost by total population.
[2] 'Non-assigned' refers to those impacts that could not be assigned with certainty to total or urban populations.

In Cambodia and Vietnam, the majority of assigned impacts are in rural areas, due largely to the significantly greater rural populations. In the Philippines, water impacts were not assigned and hence significant shares of impacts are non-assigned. In Indonesia, most impacts were assigned, with around 51% of economic impacts in rural areas compared to 46% in urban areas. Overall, 49% of assigned economic costs occur in rural areas, compared to 63% of the population based in rural areas. Hence, this study indicates higher impacts in rural areas due to larger population shares living there. On the other hand, overall the per capita costs are higher in urban areas due to the higher unit costs of impacts (e.g. water treatment, health-related costs).

Figure 8. Overall rural-urban breakdown for financial (left) and economic (right) costs



3.1.5 Other non-quantified impacts of poor sanitation

As well as quantified, monetized impacts, there are a number of other key impacts that have not been valued in the present study, and that should be taken into account in interpreting the quantitative impacts discussed above. These non-monetized impacts include suffering from disease, the intangible aspects of environmental impacts (aesthetics) and user preference, time loss from seeking private places to urinate (especially women), loss from marine fisheries, the non-use value of clean water resources such as 'existence' and 'bequest' values,[7] and the losses to wildlife from polluted water resources and an unclean environment. Other impacts with less clear linkages with poor sanitation include the use of water for irrigation purposes (and hence agricultural productivity), the impact of poor sanitation on foreign direct investment, and the impact of unimproved sanitation (and running water) in institutions, which affect life decisions of the population, especially the decision of women to take employment and of girls to enroll in or complete school. Table 10 lists these and other excluded impacts.

[7] These are terms used in environmental economics to denote the welfare that is gained by the population from knowing a resource exists (irrespective of whether it is used or not) for themselves ('existence') or for future generations ('bequest').

Table 10. Description of importance of non-quantified impacts of poor sanitation

Impact	Excluded items	Link with poor sanitation
1. Health	Quality of life	Sanitation-related diseases cause pain and suffering beyond the measurable economic effects. Disability-adjusted life-years (DALY), which attempt to capture quality of life loss, indicate that sanitation-related diseases contribute significantly to national disease burden estimates
	Informal treatment-seeking and home treatment	This study has largely missed the large proportion of disease cases – especially for mild disease – that are not reported in official statistics, that are treated at home or by an informal care giver. These costs are largely unknown, but potentially significant
	Other sanitation-related diseases	The following disease and health conditions have been excluded: 1. Helminthes and skin diseases (Cambodia, Philippines) 2. Malnutrition and the costs of supplemental feeding 3. Reproductive tract infections for women bathing in dirty water 4. Dehydration resulting from low water consumption from lack of access to private latrines (especially women) 5. Specific health problems suffered by those working closely with waste products (sanitation workers, dump scavengers) 6. Health impacts due to flooding (physical, psychological) 7. Impact on education of childhood malnutrition 8. Unreported food poisoning due to contaminated fish products 9. Animal and insect vectors of disease (e.g. rodents, mosquitoes) 10.Avian influenza
2. Water resources	Household water use	Household time spent treating drinking water, including boiling, maintaining rain water collection systems, replacing filters, etc.
	Fish production	The study excluded the following: 1. Non-recorded marketed freshwater fish 2. Farmed freshwater fish (Indonesia) 3. Marine fish 4. Subsistence fishing losses 5. Nutrient losses from lower fish catch and effect on spending
	Water management	Economic losses associated with flooding from lack of drainage
	Irrigation	Polluted surface water may lead to extraction of scarce groundwater; or use of polluted water for irrigation has implications for agricultural productivity and human health
	Other welfare impacts	1. 'Non-use' value of clean water resources such as 'existence' and 'bequest' values 2. Wildlife use of water resources
3. External environment	Aesthetics	Welfare loss from population exposure to open sewers / defecation
	Land value	Economic value of land made unusable by poor sanitation (Cambodia, Philippines)
4. Other welfare	Intangible impacts	Welfare loss from lack of comfort, privacy, security, and convenience of unimproved sanitation; effects on status & prestige
	Time loss	Access time for urination in private place, especially women Access time for daytime defecation (when away from household)
	Life decisions and absence from daily activities	Poor sanitation in schools and the workplace affect attendance, especially of girls and women 1. Loss of time from temporary absence of women from workplace (Cambodia and Philippines) 2. Welfare loss from school absence (Cambodia and Philippines) 3. Work decisions and early drop-out of girls from school
5. Tourism	Tourist sickness	Expenditure by tourists becoming sick and welfare loss of sick tourists (Cambodia, Philippines).
6. Other	Foreign direct investment	Companies selecting investment locations may be influenced by, among other factors, the sanitation situation in a country; tangible secondary evidence is, however, very limited.
	Macroeconomic impact	Overall impact on GDP and economic growth of the diverse micro-economic impacts of poor sanitation

Together, the quantified and non-quantified financial and economic losses will affect the overall economic situation of a country, including economic growth. The main effects are likely to be through sickness time and income loss associated with premature death and household expenditure on health care, and accessing clean water. The production and sale of sanitation options can also provide a stimulus to the local economy through local employment; and re-use of human (and animal excreta) can lead to cost savings and higher productivity at the household level. Property prices also may rise due to better living standards brought about by improved sanitation. However, given the weak empirical evidence on the direct economic effects of improved sanitation, this study did not examine macro-economic or redistributive effects.

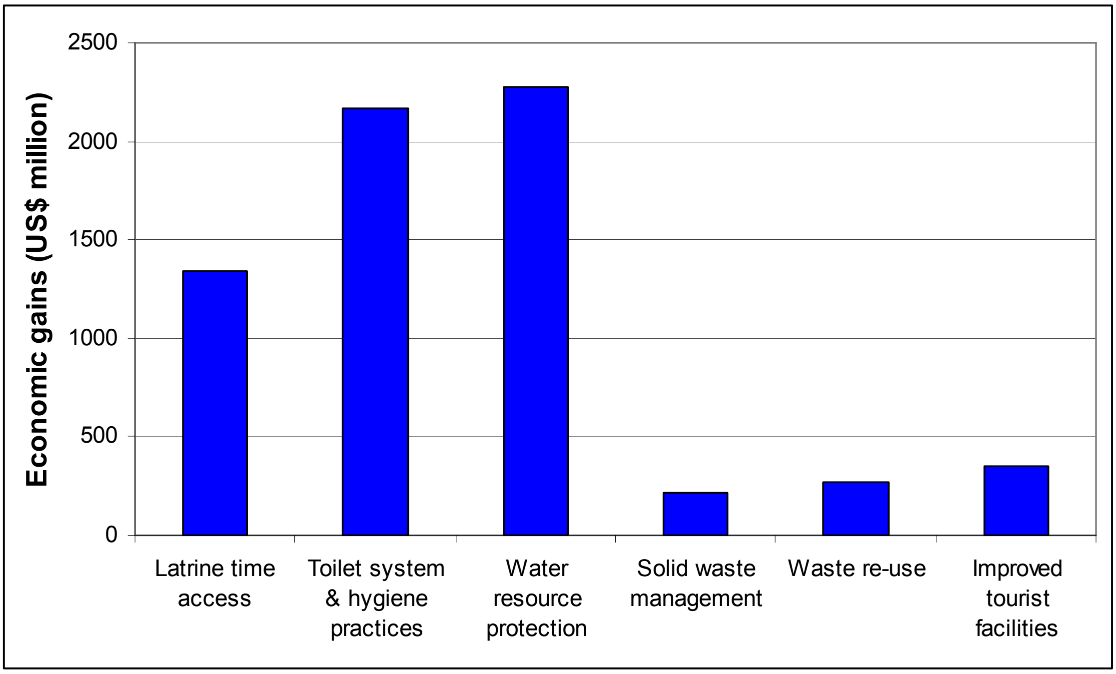
3.2 Economic gains from improved sanitation

For policy decisions, it is not adequate to know only the economic losses associated with poor sanitation, but also which of these costs will or might be mitigated by the implementation of different sanitation options. A number of generic features of improved sanitation options were defined in Table 7 (section 2.5) to enable estimation of costs mitigated under different options.

This study has estimated the losses associated with poor sanitation using an attributable fraction based on representative indicators of the various impacts. For example, the costs of polluted water were apportioned to poor sanitation based on the contribution of poor household sanitation to overall water pollution. Likewise, a proportion of sanitation-related diseases were attributed to exposure to human excreta, given that these diseases also have other causes.

Hence, based on this methodology, the reduction in pathogens, pollution and so on through improved sanitation, should lead to partial or full mitigation of the estimated losses shown in section 3.1. Estimates of economic gain are provided in Figure 9.

Figure 9. Estimated economic gains from different features of improved sanitation



Source: compiled from country reports

Better access to private latrines close to the household would bring about a US$1.4 billion economic gain, through saving time for those whose time access is not already minimized. The major share (91%) of this economic benefit would occur in Indonesia.

Improved toilet systems, combined with improved hygiene practices, would lead to a US$2.2 billion economic gain, mainly through a reduction by 45% of the measured health impacts. Two-thirds of these gains would be expected to occur in Indonesia.

Safe treatment or disposal of human excreta to protect water resources would lead to a US$2.3 billion economic gain, reflecting the total reversal of the estimated losses due to water pollution. The majority of water-related benefits would occur in Indonesia. Not included here are the contributions of this option to improved health (apportioned under toilet system and hygiene, above). In practice, there exists uncertainty of the extent of these economic gains, because in some cases the improvement is not fully effective in mitigating the costs. For example, the economic losses and gains of drinking water and domestic uses of water were estimated based on the contribution of domestic sources to overall water pollution, using BOD. However, this is an imperfect indicator, especially of household behavior in relation to mitigation measures concerning domestic water supply. On the one hand, it could be argued that households would still treat their water even in the absence of human waste and bacterial risk, due to habit, taste, and other water pollutants, both natural (e.g. silt) and manmade (e.g. pesticides, industry). Hence, very few costs may in fact be mitigated through complete isolation or treatment of sewage. On the other hand, the bacterial content of water is one of the major health risks from the majority of water sources, including groundwater. The absence of sewage release may make it less necessary for households to treat their water, depending on other types of pollutants in the water that can be effectively removed at the household level. It should also be noted that water sources used by treatment plants that contain sewage can increase considerably the unit costs of treatment, which are passed on to the consumer.

The reuse of human excreta would lead to an estimated US$271 million economic gain. This estimate is based on relatively conservative assumptions about the numbers of households adopting 'ecological sanitation' (Ecosan) solutions, and using the current prices of these largely non-market commodities. The assumptions on the numbers of households reached by Ecosan solutions are provided in Annex Table A31.

Through improving tourist sanitation facilities and the general environment of tourist locations, revenues could increase substantially in the study countries. Given that hotels are operating at well below optimal occupancy rates in all of the countries, and given the potential for tourist growth, it is not unreasonable to assume continued growth in tourist numbers in the medium-term. However, for international tourists to be attracted to the region, sanitary facilities in tourist establishments need to be further invested in, and governments need to issue and monitor standards. Based on the apportioned role sanitation plays in the overall growth of tourist numbers in each country, economic gains attributed to improved sanitation could be in the order of US$ 400 million annually.

Given that sanitation improvements (Table 2, section 2.1) feature several aspects of the above categories, it is possible to add together the savings associated with the categories above. For example, installing a private sanitary pit latrine would lead to health and time access benefits; and safe disposal or sewage treatment would add water benefits. In addition to these benefits, the implementation of ecological sanitation options has economic benefits related to the re-use of human excreta.

Omitted from Figure 9 is the value of sanitation input markets, which are in the order of US$2.2 billion per year (see section 3.8). The estimates captured under 'toilet system and hygiene practices' do not fully take into account the much larger investments required to convey, isolate and/or treat human excreta (except sludge management, which was included in Indonesia).

3.3 Health impacts

Poor sanitation causes substantial morbidity and mortality in all of the study countries, especially in younger age groups. Table 11 provides a summary of the number of cases of major diseases related to poor sanitation. Of over 140 million diarrhea cases in the study countries, Indonesia accounts for over 60%, followed by the Philippines with over 25%. Over a million helminthes cases and 28 million scabies cases (a skin disorder related to hygiene) occurred in Indonesia, although there is significant uncertainty related to the actual rates of these diseases in all of the countries. Trachoma is also important in Vietnam and Indonesia. Poor sanitation is also indirectly responsible for countless millions of cases of malnutrition, and the effects of this condition give rise to vulnerability to other diseases, such as acute lower respiratory infection (ALRI), with over 2 million cases annually, and malaria, with over 140,000 cases annually.

Table 11. Morbidity (cases) attributed to poor sanitation and hygiene

Disease	Cambodia	Indonesia	Philippines	Vietnam	Total
Direct morbidity					
Diarrheal disease	9,364,210	89,417,461	38,018,043	7,050,762	143,850,476
Helminthes	-	1,054,048	-	203,918	1,257,966
Scabies	144,596	28,659,082	-	1,370,042	30,173,720
Trachoma	-	174,079	-	864,747	1,038,826
Hepatitis A	-	715,330	-	39,050	754,380
Hepatitis E	-	23,770	-	-	23,770
Sub-total	*9,508,806*	*120,043,770*	*38,018,043*	*9,528,519*	*177,099,138*
Indirect morbidity (malnutrition-related, attributed to sanitation) among children under 5.					
Malnutrition	-	3,073,220	-	960,400	4,033,620
ALRI	159,706	1,066,935	588,854	325,474	2,140,969
Malaria	19,108	87,818	19,380	17,990	144,296
Sub-total	*178,814*	*4,227,973*	*608,234*	*1,303,864*	*6,318,885*
Total	**9,687,620**	**124,271,743**	**38,626,277**	**10,832,383**	**183,418,023**

Source: compiled from country reports
- (not available)

Significant loss of quality of life, and premature mortality, are associated with these diseases. Their severity and duration varies considerably, from brief and relatively mild diseases like acute watery diarrhea, to potentially protracted and painful diseases that considerably affect quality of life and performance of daily activities, such as (partial) blindness due to trachoma, severe diarrhea and malaria, and some skin diseases. Some diseases are long-term but lie beneath the surface for much of the time, such as helminthes, and have secondary effects such as causing malnourishment and affecting educational attainment and work performance.

Plate 1. Diseases related to poor sanitation are more likely to affect the vulnerable

Considerable mortality is associated with the cases of morbidity presented in Table 11. Diarrheal disease is estimated to cause at least 47,000 deaths annually, almost 90% of which are among children under five years of age (Table 12). Roughly half of these occur in the study's most populous country, Indonesia. Importantly, deaths from diarrhea are matched by indirect deaths that result from other conditions and diseases made worse by child malnutrition. It is estimated that at least 50,000 deaths of children under five can be attributed to poor sanitation annually, through the debilitating effect of malnutrition on childhood killers such as ALRI, measles, malaria, and others. Half of these occur in Indonesia, and 30% in the Philippines. With only 3% of the study countries' population, Cambodia accounts for 14% of diarrheal deaths and 11% of indirect deaths.

Table 12. Mortality (deaths) attributed to poor sanitation and hygiene

Disease	Cambodia	Indonesia	Philippines	Vietnam	Total
Direct mortality					
Diarrheal disease (<5 years)	5,808	20,592	10,471	4,136	41,007
Diarrheal disease (≥5 years)	643	2,288	2,955	440	6,326
Other[1]	-	1,362			1,362
Sub-total	*6451*	*24242*	*13426*	*4576*	*48,695*
Indirect mortality among children under five years (malnutrition-related)					
ALRI	1,786	8,049	4,923	1,475	16,233
Malaria	1,033	1,887	168	631	3,718
Measles	420	3,528	1,826	335	6,108
Other[2]	1,883	11,282	7,077	2,237	22,284
Protein energy malnutrition[2]	352	1,144	484	10	1,989
Sub-total	*5474*	*25890*	*14478*	*4688*	*50,332*
Total	**11,925**	**50,132**	**27,904**	**9,264**	**99,027**

Source: country reports

[1] Other: available for this study: helminthes 56 cases, scabies 583 cases, Hepatitis A 702 cases, Hepatitis E 21 cases.

[2] Not included in economic losses in this study. These consist, among others, of TB, other childhood cluster diseases, meningitis, hepatitis, dengue fever, and residual deaths (not assigned to other causes).

It is also important to consider the age distribution of the disease figures presented in Tables 11 and 12. In the Philippines, about two thirds of mild diarrhea and dysentery cases are accounted for by the under-five age group, while cholera and typhoid are more present in the adult population. In Cambodia, 90% of deaths from diarrhea are in the under -five age group. Other direct diseases in the Philippines (schistosomiasis, viral hepatitis, leptospirosis) are mainly present in adults, and in children aged 5-14. Diseases associated with malnutrition in all countries generally have higher incidence per capita in the younger age group, especially ALRI. Of the 50,000 deaths due to poor sanitation in Indonesia, at least 45,000 are estimated to be in the under-five age group. However, the over-five age group is not fully represented in the results reported here, due to the unreliability of official mortality statistics and the lack of research conducted on diseases of poor sanitation and poor nutrition in this age group.

Table 13 presents a summary of the health-related costs due to poor sanitation. Annex C2 presents further breakdowns by country and by disease. Roughly two thirds of the health-related costs are accounted for by Indonesia, reflecting its large population size. At the regional level, the main contributors to financial costs are health care costs and productivity costs; however, contributors vary significantly by country. The main contributor to health-related economic costs is premature death, which has a high 'unit cost', approximated by the human capital approach (HCA), which varies between US$10,000 and US$115,000 per death, depending on country and age of death. As a contributor to economic losses, health care costs are more significant in Vietnam (at 20% of health-related economic cost) while productivity costs are more significant in Indonesia (13%).

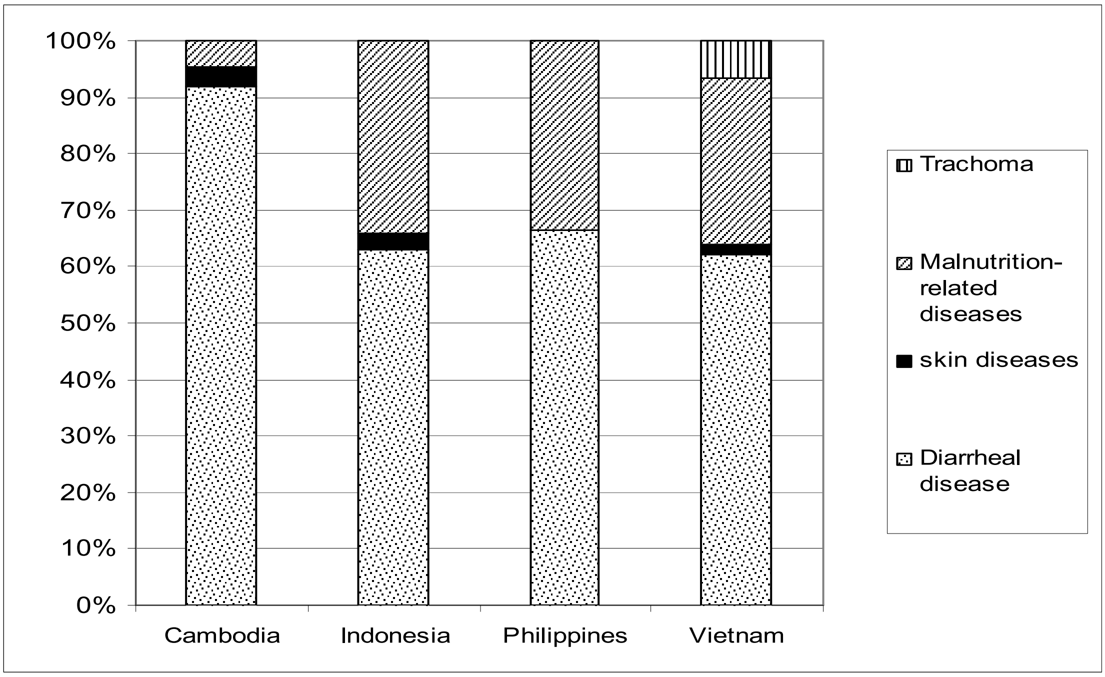
Table 13. Total health costs by sub-impact, US$ millions, 2005

Impact	Cambodia		Indonesia		Philippines		Vietnam	
	Cost	%	Cost	%	Cost	%	Cost	%
Financial costs	**13.3**	**100%**	**233**	**100%**	**37.0**	**100%**	**58.8**	**100%**
Health care	10.7	80%	86	37%	6.2	17%	50.7	86%
Productivity	2.5	19%	97	42%	29.7	80%	1.1	2%
Premature death	0.2	1%	49	21%	1.1	3%	7.0	12%
Economic costs	**187.1**	**100%**	**3,350**	**100%**	**1,011.2**	**100%**	**262.4**	**100%**
Health care	13.4	7%	114	3%	33.1	3%	53.1	20%
Productivity	5.1	3%	429	13%	55.3	5%	4.6	2%
Premature death	168.6	90%	2,807	84%	922.7	92%	204.7	78%

Source: country reports

Health care and productivity costs are determined by the number of cases of diseases – measured by incidence or prevalence – as well as treatment-seeking behavior and the unit costs of health services. The health care costs by disease are summarized in Figure 10 and presented in detail in Annex C2. The majority of health care costs are accounted for by diarrheal disease, followed by malnutrition-related diseases in all countries. Skin diseases contribute marginally to economic health care costs in Cambodia and Indonesia, and trachoma and skin diseases in Vietnam.

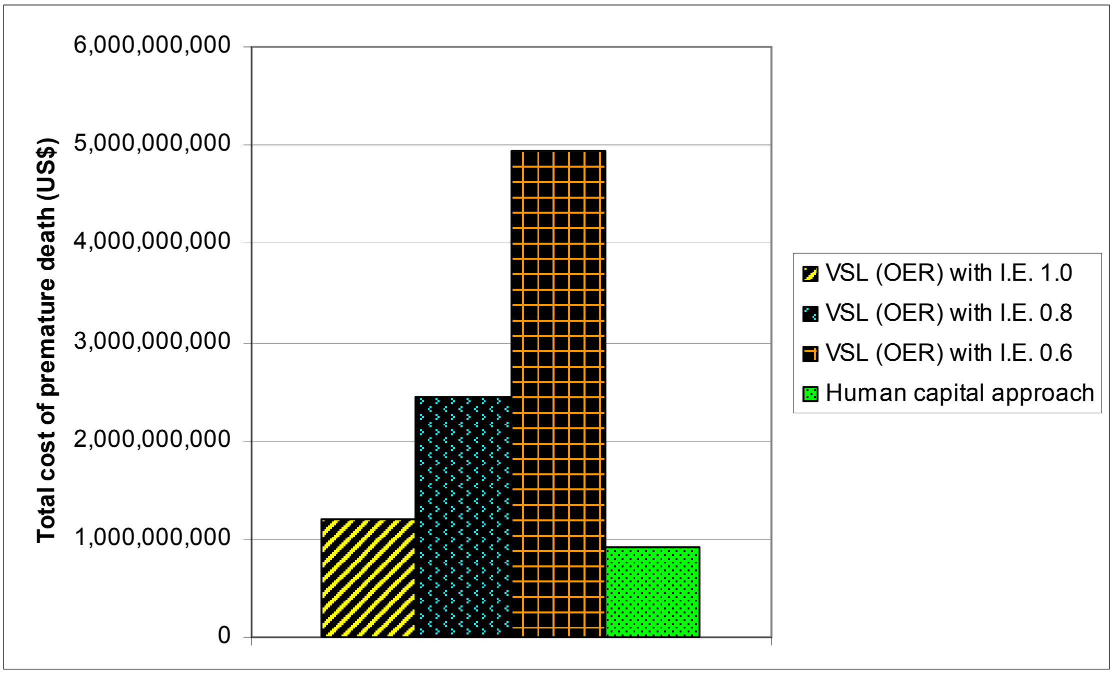
Figure 10. Share of major disease groups in economic costs



The importance of the different components of cost – partially reflecting who incurs them – varies considerably between countries. Costs incurred in private health facilities are relatively important in Cambodia, but of minor importance in Vietnam. Self-treatment is the number one cost in the Philippines and Vietnam, but relatively unimportant in Cambodia and Indonesia. Formal health providers are the number one cost in Indonesia, but the least important in the Philippines. In all countries, patient transport costs are relatively important. Further breakdowns are provided in Annex C2.

Given the importance of premature death in health-related economic costs, the value chosen for the economic value of life becomes important in the aggregate losses caused by poor sanitation. The HCA is a conservative method for estimating the value of premature loss of life, compared to the alternative willingness to pay (WTP) approach. Figure 11 shows the economic cost of premature death at different unit values for premature death, using the example of the Philippines. The WTP method converts the value of life in the USA (US$2 million) to the Philippines based on the ratio difference in GDP per capita between the two countries. This results in a VOSL of US$59,442 at an income elasticity of 1.0, which increases the economic impact from US$922 million to US$1.2 billion. At an income elasticity of below 1.0, the VOSL estimates increase significantly, as shown.

Figure 11. Economic cost of premature death at different unit values for premature death in the Philippines[1]



Source: Philippines report
[1] Refer to Table A19 for unit values used in the calculations.

The valuation of premature death using the HCA or WTP approaches is criticized on many grounds. While it is generally accepted that valuing human life in monetary terms is helpful for policy making and resource allocation purposes, the problem is one of choosing an appropriate value for human life. The values adopted here do not reflect household ability or willingness to pay, as most households in the study countries are unable to pay even the lower figures used (e.g. for example, US$10,000 in Cambodia is 22 times the GDP per capita). Instead, these figures reflect societal preferences, based on economic reasoning, empirical evidence, and established valuation methods. Hence, it is justified to include these estimates in the economic losses presented in this study.

3.4 Water resource impacts

The economic impacts of polluted water resources depend on three main factors: the extent of water resources in the country, the release of polluting substances in these water resources, and the actual or potential uses of water in the country. While water is recognized to have many economic and non-economic uses, three selected uses are evaluated in the present study: water for drinking; water for other household non-commercial uses; and water for freshwater fish production.

The countries in the study are all relatively 'water rich'. In 1999, internal freshwater resources per capita were 9,027 m^3 in Cambodia, 13,220 m^3 in Indonesia, 5,877 m^3 in the Philippines, and 4,513 m^3 in Vietnam.[8] Compared with other large Asian countries such as India (1,185 m^3) and China (2,183 m^3), water is abundant and relatively well distributed in the study countries.

In terms of major water resources, Cambodia contains the Tonlé Sap lake (measuring 13,000 km^2 in the wet season) and a lower section of the Mekong River, with a flow of 66,700 m^3 per second during the wet season. Indonesia has many rivers on its several large islands: on East Java, the Kali Brantas River (maximum flow 34,500 m^3 per second) and Bengawan Solo (13,500 m^3 per second) are the main ones, and there are many lakes with a volume of over 1 million m^3. The Philippines has 200,000 hectares of lakes, 31,000 hectares of rivers, 19,000 hectares of reservoirs and 246,063 hectares of swamplands, as well as an extensive coastline that stretches over a distance of 32,289 kilometers [28]. Vietnam has nine major rivers, the two main ones being the Red River (4,000 m^3 per second) and the lower section of the Mekong River.

Despite the fact that the region has many water resources, most of these resources suffer from pollution due to human activities. The water bodies near cities or densely populated areas are usually more polluted than remote water bodies due to the excessive discharge of pollutants generated by human settlements and industrial activities.

Plate 2. Sewer drains emptying into rivers are a common site in Asia.

Estimates of the total pollution of water sources from human excreta and gray water are presented in Table 14. Feces weight released to inland water sources is estimated at 13

[8] World Bank 'Little Green Data Book', 2005.

million tons per year, urine 122 million m^3, and at least 11 billion m^3 of gray water (mainly urban populations included). Biochemical oxygen demand (BOD) is estimated as at least 3.4 million tons per year. The total production of these polluting substances has been adjusted downwards by the proportion of sewage that is treated in each country, or that is assumed to be absorbed by the soil before reaching groundwater sources. It is presumed that the majority of the estimates of polluting substances in Table 14 find their way to rivers, lakes, and eventually the sea.

Table 14. Total annual release of human excreta and household wastewater to inland water bodies

Region	Total release (volume)			Biochemical Oxygen Demand (tons)
	Feces (‘000 tons)	Urine (‘000 m^3)	Gray water (million m^3)	
Cambodia	85	852	3	181,500
Indonesia	6,406	64,059	8,541	2,137,000
Philippines	4,237	33,900	1,962	762,000
Vietnam	2,275	22,754	610	357,500
Total	**13,003**	**121,565**	**11,116**	**3,438,000**

Source: country reports
NC – Not Calculated

As well as human sources, BOD from industry and agriculture should be taken into account when assessing the overall impact on water quality. In Cambodia, for example, the release of human excreta combined with industrial and agricultural waste introduces about 765 tons of BOD per day to the country’s water bodies. In Indonesia, the majority of the 163,000 tons of animal excreta produced each day finds its way into the environment without proper processing, which constitutes a multiple of five times the human excreta.

The implication of the polluting substance volumes estimated in Table 14 is that they are a major cause of water pollution in the study countries. With small populations and abundant water resources, pollutants would be diluted naturally. However, given the high density of population in many parts of the study countries, sufficient dilution is not guaranteed, and water quality indicators suggest that significant pollution is taking place. Furthermore, over-extraction of some rivers and water sources for irrigation purposes leads to greater pollution of the water resources. Indeed, there is increasing evidence from all countries of pollution in surface, ground and coastal waters. Although the quality of upstream river waters is generally good, downstream sections of major rivers reveal poor water quality and most of the lakes and canals in urban areas are fast becoming what can only be described as ‘sewage sinks’. Table 15 shows the water quality indicators in a selection of the most polluted rivers in the region. Annex C3 shows water quality indicators from more locations in the study countries.

Recordings of BOD vary greatly, from around 1.0 mg/l to as high as 880 mg/l. Readings of over 30 mg/l are common in the rivers listed in Table 15, which is higher than the Vietnamese maximum standard of 25 mg/l. Readings of Total Suspended Solids (TSS) are also high, with many readings exceeding the Vietnamese maximum standard of 80 mg/l. Dissolved Oxygen (DO) levels are low, compared to a proposed minimum for fish production of around 5.0 mg/l, with readings of below 4.0 mg/l very common. In Vietnam coliform readings are also available, with many readings proving to be a multiple of the maximum proposed standard of 10,000 MPN/100ml adopted in the country. The most polluted rivers in the study countries are the Brantas River in Indonesia; rivers in the NCR, CAR and Region 3 sectors of the Philippines, and rivers in the Red River Delta and the Thi Vai River in the South East of Vietnam.

Although the study countries experience dry and rainy seasons, there is no clear relationship between the season and water pollution. In general, it might be expected that during rainy seasons, rivers and lakes might exhibit a higher capacity to assimilate waste. However, this is not necessarily the case. In Indonesia, for example, monitoring at the Brantas River Basin in East Java showed higher suspended solid loads during the wet season (70-500 mg/l) than in the dry season (20-150 mg/l). This is compared to the Indonesian standard of 50 mg/l. BOD at Brantas river ranges from 5-12 mg/l during the dry season, and 6-15 mg/l during the wet season, which is significantly higher than the Indonesian standard of 2.0 mg/l. One of the most polluted river sections even exhibited BOD values ranging from 10 to 20 mg/l.

Table 15. Water quality indicators in selected rivers in study countries

Country and river	Location	BOD	TSS	DO	Coliform
	USUAL STANDARD	**<25 mg/l**	**Max. 80 mg/l**	**Min. 5.0 mg/l**	**<10,000 MPN/100ml**
Cambodia					
Tonlé Sap River Wet	Phum Prek	-	119.8	3.4	23,509
Dry		-	54.9	4.4	71,162
Mekong River Wet	Chroy Changva	-	174.5	5.5	17,121
Dry		-	30.8	4.4	59,51
Tonlé Sap Lake Wet	Phnom Krom	-	661.3	6.5	-
Dry		-	214.0	5.1	-
Bassac river Wet	Chamkamon	-	186.0	-	24,750
Dry		-	68.2	-	58,871
Indonesia					
Deli River	N. Sumatra	3.2-7.7	20-104	0.7-7.7	
Batang Hari River	Jambi	1.0-4.0	4-206	3-6.5	
Musi River	S. Sumatra	1.7-8.7	24-33.7	1.9-7.9	
Air Benkulu River	Benkulu	1.0-20	24.2-156	1.1-4.1	
Rangkui River	Bangka-Belitung	4.5-12	Na	1.6-7.5	
Ciliwung River	Jakarta	0.8-47.1	7-59	0-5.8	
Citarum River	W. Java	8.2-34	75-3220	0-5.9	
Brantas River	E. Java	110-268	20-98	0-8.3	
Philippines					
Marilao River	Region 3	41.5		1.0	
Meycauayan River	Region 3	119.8		1.2	
Parañaque River	NCR	29.5		1.5	
Bocaue River	Region 3	6.4		2.0	
San Juan River	NCR	33.5		2.4	
Pasig River	NCR	24.2		2.4	
Calapan River	Region 4B	2.9		2.9	
Vietnam					
Hong River	Red River Delta	6.1-91.2	16-635	0.1-4.78	500-480,000
Thai Binh River	Red River Delta	37.5	41	3.16	11,000
Day River	Red River Delta	36.8	29	1.09	
Huong River	N Central Coast	1.0-4.6	21.0-31.2	4.96-5.56	250-1,100,000
Vu Gia-Thu Bon River	S Central Coast	0.5-5.8	12.5-32.0	4.17-5.73	21-5,000
Thi Vai River	South East	880	na	< 0.5	30,000-690,000

Source: country reports

As well as the scientifically-based measurements presented in Table 15 and Annex C3 (Tables C9, C10, C12, C14, C15, and C17), there are also classifications of water bodies by country, provided in Annex Tables C11, C13 and C16. In Indonesia, upstream segments of rivers have been classified according to whether they can be used for raw drinking water (Annex Table C11). The classifications indicate that only 3 out of 29 rivers have satisfactory water quality for drinking purposes, while the rest have at least mild pollution, with 8 classified as having (seasonal) heavy pollution. As well as upstream river segments for raw drinking water, downstream segments have also been classified for the purposes of recreational activities. The data in Annex Table C11 suggest that no rivers should be used for domestic activities such as bathing and cooking, without proper treatment.

For the Philippines (Annex Table C13), an inventory of 495 classified water bodies in 2004 indicates that 190 water bodies are 'Class A' and 'AA', providing potential drinking water sources following partial or full treatment. Eighty-seven water bodies have been classified as 'Class B' for contact recreation (bathing, swimming, etc); 161 as 'Class C' for non-contact recreation (boating, fishery production), and 15 as 'Class D' for agriculture, irrigation, and livestock watering. In Vietnam, urban pollution has been cited as one of the causes of poor quality river water, especially in downstream locations (Annex Table C16).

One of the major impacts of polluted water in wells, springs, rivers and lakes is that populations and water supply agencies will have to treat water, or treat water more intensively, for safe human use. Alternatively, populations and water supply agencies can access cleaner water from more distant sources, thus increasing access costs. Those who do not take precautionary measures are exposed to higher risk of infectious disease, or poisoning due to chemical content. Table 16 shows the *drinking water* access costs attributed to poor sanitation, based on an assumed minimum daily intake of 4 liters per capita. A large share of the financial and economic costs occur in Indonesia, with US$803 million financial costs, and US$1.36 billion economic costs. Costs in Vietnam are US$62.5 million, in Cambodia US$93.8 million, and in the Philippines US$117 million per year. Some of the inter-country variations, however, are due to different estimation methods and assumptions.

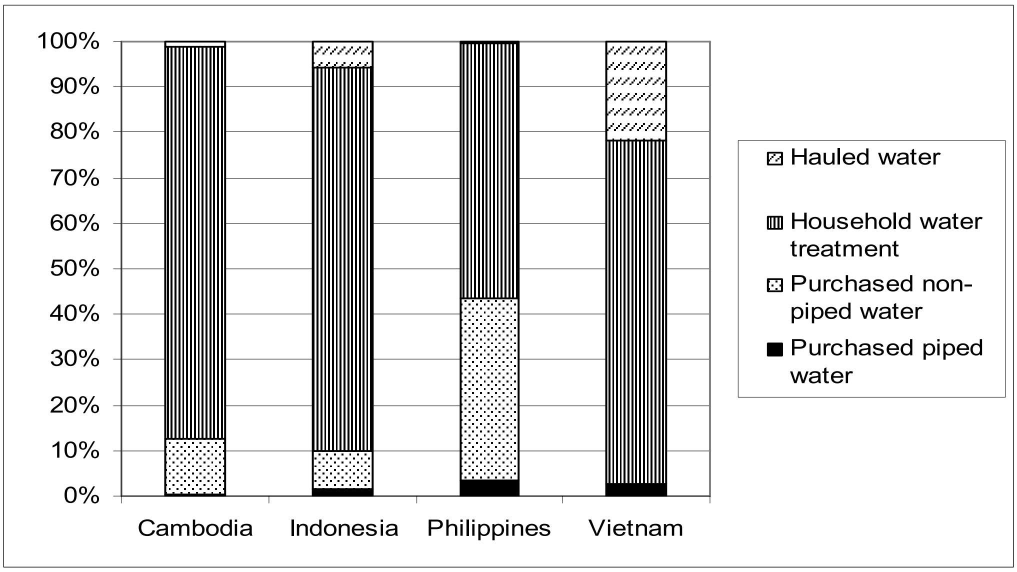
Table 16. Drinking water access costs, US$ millions

Water source	Financial cost		Economic cost	
	Value	%	Value	%
Cambodia	**92.7**	**100.0%**	**93.8**	**100.0%**
Rural	67.0	72.3%	68.0	72.5%
Urban	25.7	27.7%	25.8	27.5%
Indonesia	**803.0**	**100.0%**	**1,364**	**100.0%**
Rural	450.5	56.1%	780.5	57.2%
Urban	352.5	43.9%	583.5	42.8%
Philippines [1]	**116.5**	**100.0%**	**117.0**	**100.0%**
Vietnam	**49.1**	**100.0%**	**62.5**	**100.0%**
Rural	37.4	76.1%	49.7	89.5%
Urban	11.7	23.9%	12.8	20.5%
TOTAL	**1061.3**	**100.0%**	**1,637.3**	**100.0%**

Source: country reports
[1] Rural-urban disaggregation could not be calculated at regional level for the Philippines.

Figure 12 shows the contribution to economic costs of different types of mitigating strategies for accessing clean drinking water. In all countries except Vietnam, household water treatment practices account for the major share of economic cost, while for Vietnam the major cost component is hauled water. Purchased non-piped water is relatively important in the Philippines and Cambodia compared to the other countries. Purchased piped water supply is relatively unimportant in all of the countries.

Figure 12. Contribution of water sources to total drinking water cost (%)



As well as for drinking, water is required by households for basic living – cooking, laundry, household cleaning and washing of utensils, personal hygiene activities (showering, bathing), and sanitation (if water is used to flush waste away). The study used an estimated minimum requirement of 28 liters per person per day in addition to the 4 liters of drinking water. Households may in fact use more than this for these basic items, as well as for other purposes such as watering plants, domestic animals, leisure activities, and rituals. Table 17 shows the costs are more equally divided between Indonesia, Vietnam and the Philippines.

Table 17. Water access costs for domestic uses, 2005

Water source	Financial (US$)		Economic (US$)	
	Value	%	Value	%
Cambodia	**9.8**	**100.0%**	**10.9**	**100.0%**
Rural	7.6	77.5%	8.6	78.9%
Urban	2.2	22.5%	2.3	21.1%
Indonesia	**105.6**	**100.0%**	**131.4**	**100.0%**
Rural	29.8	28.2%	46.0	35.1%
Urban	75.8	59.1	85.3	64.9%
Philippines [1]	**195.9**	**100.0%**	**196.7**	**100.0%**
Vietnam	**163.2**	**100.0%**	**197.4**	**100.0%**
Rural	79.4	48.6%	105.6	53.5%
Urban	83.8	51.4%	91.8	46.5%
TOTAL	**474.5**	**100.0%**	**536.4**	**100.0%**

Source: country reports
[1] Rural-urban disaggregation could not be calculated at regional level for the Philippines.

As well as domestic uses, water also has many recreational uses and aesthetic benefits, if it is sufficiently clean for its intended purpose. In developed countries, strict guidelines are applied for recreational water (seaside beaches, lakes), especially for swimming, where the water is in direct contact with the body and orifices. However, in the study countries, the benefits of swimming are largely unrecognized by the authorities, and the population is exposed to dirty water and exposed to a heightened risk of adverse health events (see Plate 3).

Plate 3. Children want to have fun. But do they understand the health consequences?

The third aspect of water quality assessed quantitatively is the potential impact of poor water quality on fish catch in inland (freshwater) water bodies. As stated above, all of the study countries have abundant water resources, which provide favorable conditions for fishing and aquaculture, and which make the fishery sector a key economic factor, with high contributions to GDP as well as to subsistence living.

Table 18 shows that fisheries account for between 1% (the Philippines) and 7.3% (Cambodia) of GDP in the study countries, and between 3% (Cambodia) and 6.6% (the Philippines) of the workforce. It is estimated that 11% of the Cambodian households in the fishing-dependent communes around the great lake and along the Mekong and Bassac Rivers are engaged in full-time fishing and related activities, while another 35% are engaged part-time [29]. Some countries are net exporters of fish: in the Philippines, net exports were valued at US$376 million in 2005 [30]; in Vietnam, fish is the second largest export product after oil; and Cambodia exported 26,300 tons of fish and seafood in 2005. In addition to economic importance, nutrition from fish and fish products is important in countries with traditionally higher (child) malnutrition rates. For example, fish protein accounts for 75% of dietary protein in Cambodia [31], and 40% in Vietnam.

Table 18. Employment and income statistics for the fishery sector

Country (year)	Employment		Income	
	People	% workforce	Value	% GDP
Cambodia (2006)	259,000	3.0%	US$ 525 million	7.3%
Indonesia (2005)	4,464,292	4.7%	US$ 6.8 billion	2.2%
Philippines (2005)	1,394,000	6.6%	US$ 2.7 billion	1.0%
Vietnam (2005)	1,477,000	3.5%	US$ 2.0 billion	3.9%

Sources: Cambodia (EIC Economic Watch, April 2007); Indonesia [32-34]; Philippines [35, 36]; Vietnam (GSO).

Water quality clearly affects fish production. There are many stories of fish dying due to high water pollution and environmental conditions. In Vietnam, the media highlights cases of severe river water pollution with heavy losses in aquaculture productivity. In Indonesia, farmed fish are given increasing amounts of antibiotics to help them deal with pollutants in the water, especially from human excreta. While the effects of water pollution and reduced DO can be controlled (to some extent) in fish ponds, in rivers there are many reported losses of farmed caged fish (e.g. Ha Nam province, Vietnam).

Plate 4. Water pollution affects fish production and catch.

Table 19 shows the estimated loss of fish value in each country, which reflects the difference between actual and potential fish catch in each country, of which a fraction is attributed to poor sanitation (final column). Annex Tables C18 to 21 show the region-by-region values for each country. The estimated difference between actual and potential fish catch amounts to over US$600 million in the study countries, of which approximately US$170 million is attributed to poor sanitation, annually. While the fish production figures differed slightly (see table), the data reflect the best estimates for each country. The highest estimated loss is in US$92 million in Indonesia followed by US$44.4 million in Cambodia. Aside from the assumptions made to estimate fish loss, the data do not reflect the incomplete statistics of marketed and non-marketed (subsistence) fish catch.

Table 19. Fish catch value – actual and estimated loss (US$ million)

Country	Fish value included	Estimated fish catch value	Potential fish catch value	Attributed fish catch loss due to poor sanitation
Cambodia	All inland	223.7	292.0	44.4
Indonesia	Wild freshwater[1]	330.3	779.4	92.0
Philippines	Inland fishery	85.1	114.3	9.6
Vietnam	All inland	392.7	461.1	27.4
Total		**1,031.8**	**1,646.8**	**173.4**

Source: country reports

[1] Includes only fish caught in the wild

3.5 Environmental impacts

The environmental aspect of poor sanitation focused on in this study was the improper disposal of household solid waste. Solid waste management can be classified by 'safe' and 'unsafe' disposal practices. Unsafe practices involve open dumping and semi-controlled dumping with limited or no environmental control. Engineered landfill with basic waste accounting and some environmental control is a safe practice. The safest practice is sanitary landfill where waste accounting and waste placement are practiced, there is fencing and staff are onsite, and regular environmental monitoring, leachate[9] collection and treatment are conducted. In Vietnam, no waste pickers are allowed to work on a sanitary landfill [37].

In the study countries, good practices in solid waste management have only reached a small proportion of the population, mainly in urban areas. In Cambodia, waste collection does not occur in rural areas, and is relatively weak in outlying areas of cities and in unplanned settlements that are home to millions of the poorest families. In Indonesia, even when household solid waste is collected, about 90% of the waste is disposed of illegally through open dumping practices without proper environmental considerations. The majority of cities (85 small cities and 53% of medium-sized cities) implement open dumping, and only a small proportion of solid waste is recycled or properly disposed of in controlled dumping sites or sanitary landfills [38]. In the Philippines, the World Bank in 2001 reported that the collection rate averaged 40%, with rates reaching 70% in key cities [39]. Hence, a substantial proportion of the solid waste was not collected. Of the waste collected, the World Bank reports that only 2% is disposed of in sanitary landfills and 10% is composted [39]. This leaves about 88% disposed in open dumps or other facilities. In Vietnam, only 12 out of 64 cities and provincial capitals have engineered or sanitary landfills, and most of these have been constructed during the past four years. The World Bank estimates that in 2004, only 17 out of the 91 landfills were sanitary [37]. Discussion with Ministry of Construction indicated an even lower number of sanitary landfills.

In Indonesia, it is estimated that the average urban resident produces 2-3 liters of solid waste per day, weighing about 0.76 kg, and on average urban residents produce twice to three times as much solid waste than rural residents. About 75% of municipal solid waste is organic [40]. In large cities, at least half of solid waste comes from households. Table 20 gives population numbers with improved and unimproved sanitation in Indonesia, covering human excreta and solid waste.

[9] Leachate is the liquid that drains or 'leaches' from a landfill.

Table 20. Population exposed to poor practices of waste disposal in Indonesia

Location	Improved sanitation (%)		Exposed population (million inhabitants)		
	Enclosed defecation sites	Solid waste collected	Exposed to open sewers	Exposed to open defecation sites	Exposed to open dumping of solid waste
Rural	0.72	0.01	3.78	35.97	3.47
Urban	0.92	0.41	6.90	7.87	5.33
Total	**0.80[1]**	**0.18[1]**	**10.68**	**43.84**	**8.80**

Source: Indonesia report
[1] Reflects weighted average of rural and urban populations, based on population size

In the Philippines, residents in rural and urban areas are estimated to generate 0.3 to 0.5 kg/capita of garbage per day, respectively [41]. Using the population estimates presented earlier, this implies that the country produces about 11.4 million metric tons of garbage per year. Nearly 18%, or 2 million tons, come from the NCR alone. About 42% is kitchen waste, and the remainder is accounted for by paper (19%), plastic (17%), metal (6%), garden waste (7%) and others (9%) [39].

In Vietnam, a high proportion of households burn their rubbish (53%) causing air pollution and debris; and many throw household solid waste into a river (13%) or bury it (19%). Only 22% dispose through garbage truck collection, most of which are in urban areas (Table 21).

Table 21. Solid waste disposal practices of household by urban and rural areas in Vietnam

Location	Garbage truck	Burning	Burying	Throwing into river	Throwing to animal closure	Other
Rural	6.8%	63.0%	23.0%	15.0%	16.7%	18.9%
Urban	71.0%	20.0%	7.5%	6.3%	4.1%	2.8%
Total[1]	**21.9%**	**52.9%**	**19.4%**	**12.9%**	**13.7%**	**15.1%**

Source: [42]
[1] Reflects weighted average of rural and urban populations, based on population size

Hence, in study, countries, thousands of tons of waste are discarded daily into unofficial dump sites that are not properly planned and managed, resulting in large areas of land becoming unusable for other purposes, and contamination of ground and surface water sources. In both urban and rural areas, the lack of coverage of waste management services means that littering is the norm, household garbage is left lying in streets, garbage is burned thus creating local air pollution, and uncollected garbage is scattered by animals and humans, reaching water sources and blocking drains and generally creating unsanitary conditions. In rural areas, it is common to dig garbage into the ground, thus affecting the future productivity of the land for other purposes. In urban areas such as Metro Manila, it is not uncommon to find garbage accumulating in canals, sewers, empty lots and sidewalks. The collection of solid waste was brought to the forefront as a national issue by the garbage crisis in Metro Manila during the early 2000s [39, 43, 44]. This event was triggered by the closure of three disposal sites for the region that had reached their capacity.

Plate 5. Who disposes of the rubbish?

Besides household solid waste, the management of waste at most marketplaces has been very poor. For example, in Phnom Penh (Cambodia), market waste is untidily scattered around the sellers or at the entrance to the market. Such waste produces bad odors and transform the market place into unregulated dump sites for the households situated nearby. Markets should be pleasant places that are attractive to customers; markets with improper waste disposal keep customers away. This may result in some economic losses for the market sellers.

The coverage of human excreta disposal is dealt with in other sections, where it is stated that open defecation practices are still common across the region, and human excreta finds its way to water sources and land through inadequate disposal via sewer pipes into water courses and onto unused land, and through leakage from pit latrines.

The mismanagement of human and solid waste described above is known to cause an unpleasant living environment for many inhabitants, although there are few studies beyond newspaper reports that provide an evidence base for the present study. Human and solid waste produces odor and spoils aesthetic appearance. This waste sometimes decomposes prior to being picked up by waste collectors, and produces bad odors in the surrounding environment. This polluted air quality creates an unpleasant atmosphere not only for the households nearby, but also any pedestrians passing by. In addition to the odor, scattered waste has damaged the visual aesthetic of many cities of the study countries, making cities less attractive to tourists. In addition, inadequately disposed of waste poses health hazards that until now have not been quantified.

The poor performance with respect to collection and disposal of garbage creates a wide variety of problems in the Philippines, including heath risks, flooding arising from clogged sewers and waterways, pollution of groundwater from leachate, foul odor due to rotting garbage and lower real estate values [45]. This is, of course, a bigger issue for the people living in areas where the garbage accumulates. However, the greatest threat is to the health of people who live in dumpsites and make a living from the garbage, as they are in regular and direct contact with the waste and its various contaminants. While national estimates are not available, there are some indications that Filipino people take issue with poor garbage disposal and collection. For example, a survey of households in Tuba rated solid waste as the number one environmental problem in the area [46]. The World Bank also remarked in 2001, the growing public awareness of the problem [39]. However, the report is also quick to add that there is still a lack of maturity with respect to "appropriate and suitable management practices" in the Philippines.

In many places in Vietnam, human excreta and solid waste are major causes of reduced air quality and spoiled visual appearance due to inadequate treatment and/or disposal. Furthermore, due to a lack of planning and infrastructure, human excreta mixes with household solid waste in some degenerated urban and rural spaces. The problems of the Dong Thanh Dump Site in Ho Chi Minh City are described in Box 1.

Box 1. Problems at the Dong Thanh Dump Site in Ho Chi Minh City, Vietnam

Dong Thanh is the second biggest dump site in Vietnam (40 hectares), located outside Ho Chi Minh City. As the site is not sealed, wastewater percolates into the soil, causing underground water pollution. Many nearby residents dig and drill wells; however, now households are not able to use this water within a 20 km radius because of its poor quality and obnoxious odours.

Additionally, the leachate from the landfill and wastewater storage lakes has caused economic damage to the local people. Fish, pigs, chickens and ducks have died and agricultural productivity is reduced. Wastewater from the waste storage lakes (about 200,000 m^3 with an average COD concentration of about 40,000 – 50,000 mg/l) is not treated to environmental requirements, and penetrates into the underground water strata.

In June 2000, persistent heavy rain caused a 6-meter-high dumpsite wall to collapse, releasing a great deal of waste, causing environment pollution and harming production and health of the local people.

Source: Institute of Environment and Natural Resources, 2004

In addition to scattered household and market wastes, the impact of designated dumpsites on nearby residents in Phnom Penh, Cambodia, are claimed to be even more severe. A ten-hectare dumpsite in Phnom Penh is situated not far from residential areas. While bad odor from the dumpsite disturbs the residents, smoggy air pollution due to waste burning could also be harmful to their health and that the dumpsite scavengers. In addition, the dumpsite may be contaminating ground water quality, and so damaging local land quality through the penetration and spillover of waste and chemically contaminated water. In the case of Indonesia, there has been a case of residents living close to an open dump site (at Bantargebang, in Bekas) requesting, and having approved, a compensation of Rp 50,000 (US$4.5) per month per household for the odor they have to endure [47].

The price of land close to solid waste disposal areas can be highly depressed, as in the case of Bantargebang, above, where the average price of land close to the disposal site (Rp 20,000 to Rp 30,000 per m^2) was about 10% of the average price of northern Bekasi (Rp 300,000/m^2) [48].The size of land affected is very hard to estimate. One open dumping site in northern Jakarta, which has only been in operation for two weeks (receiving 300-400 truckloads of solid waste), has reached half a hectare, and foul smell can be detected four kilometers away.

in Vietnam, if a landfill or dump is not sanitary, it is necessary to establish a 'buffer zone' around its operational area. A distance of 1,000 meters from the fence of a landfill to the nearest house provides the buffer zone required to prevent households from experiencing seriously negative impact from waste. Within this buffer zone, land areas become temporarily unusable for other purposes, for example for constructing buildings, for agricultural use or for children's play areas.

The present study estimated the amount of land that has been rendered temporarily unusable or unproductive for other uses for all unsanitary landfills in Vietnam as a result of buffer zones. Buffer zones were estimated to extend for 1,000 meters around an unsanitary landfill. Based on an estimated total buffer zone area of 170 km^2, the annual land value loss is estimated at over US$118 million (Table 22).

Table 22. Economic loss due to unsanitary dumps in Vietnam

Region	Number of landfills		Area of landfills (hectares)		Area of buffer zone (m^2)	Total value loss (US$)
	Unsanitary	Sanitary	Unsanitary	Sanitary		
Red River Delta	21	3	112.4	96.3	41,162,948	25,598,848
North East	12	4	31.6	24.0	27,007,490	16,795,703
North West	3	-	41.0	-	12,836,249	7,982,742
North Central Coast	6	3	93.8	-	2,202,400	14,474,310
South Central Coast	12	2	68.5	8.0	25,344,171	15,761,300
Central Highland	2	1	43.0	22.0	5,463,962	3,397,986
South East	7	3	282.0	8.0	25,555,333	15,892,620
Mekong River Delta	11	1	108.5	-	30,501,179	18,968,395
Vietnam	**74**	**17**	**780.8**	**158.3**	**170,073,731**	**118,871,905**

Source: Vietnam report

Table 23 shows that the estimated land area lost due to human and solid waste in Indonesia is 50 km^2, giving a total annual loss of over US$96 million.

Table 23. Economic loss due to degraded and unavailable land in Indonesia

Location	Land mass (m^2 million)		Average land value ($/m2)	Total land value loss ($ million)	
	Human excreta	Solid waste		Human excreta	Solid waste
Rural	41.5	20.9	0.28-1.13	-	15.6
Urban	7.9	29.5	0.57-2.27	27.8	52.8
Total	**49.5**	**50.4**		**27.8**	**68.5**

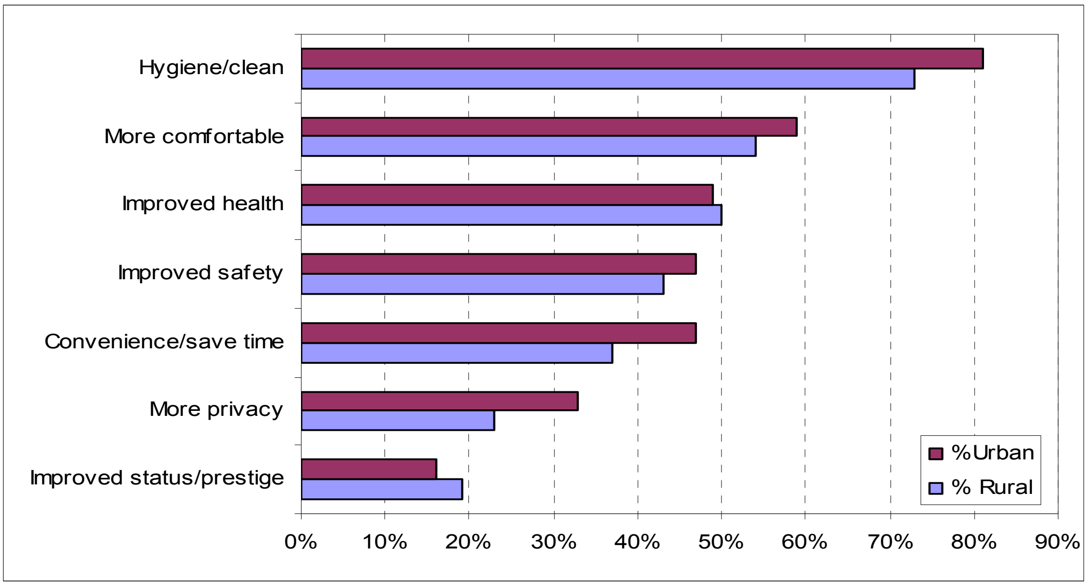
Source: Indonesia report

3.6 User preference impacts

The impact of poor sanitation on user preferences was evaluated in relation to the type and condition of latrine coverage, implications for time use, and the potential impacts on school and work choices of girls and women. In general, the evidence is quite weak for the study countries for all aspects of user preferences. However, there have been some informative country studies that have conclusions that may be generally applied to other countries.

From survey work conducted by the WSP, the importance of type and location of latrine is presented for Cambodia in Figure 13. Among the sampled households, more than 80% of urban and 70% of rural households recognized that improved latrines will provide better hygiene and a generally clean environment for living [49]. Comfort, health improvement, safety, and convenience are the next most important perceived benefits of improving latrines. Although mentioned by fewer households as being benefits, privacy, improved family status and prestige are cited as other advantages of having an improved latrine at home. Referring to Figure 13, rural and urban people tend to have similar patterns of perception regarding the benefits of latrine. However, fewer people in urban areas perceive 'improved health' and 'improved status/prestige' as benefits than those in rural areas. For other perceived benefits, however, there is higher proportion of urban people than rural people.

Figure 13. Perceived importance of improved latrine to households in Cambodia



Source: Demand sanitary latrine assessment in Cambodia, 2007 [49].

The importance of cleanliness was highlighted in a survey of 312 respondents in San Fernando, La Union, Philippines, which reported that almost all households disinfect their toilet bowls at least once every week, and at least half of the respondents said that they do so at least three to seven times a week [50]. The same study also showed that, while Filipinos may be conscious about the cleanliness of their toilets, they are not as diligent when it comes to de-sludging septic tanks. This is based on the finding that 71% of households never de-sludged their septic tanks or, if they did, this has been done more than five years prior to the survey. The study argued this may be due to the fact that septic tanks are not watertight, and hence wastewater seeps from them directly into the ground.

In Vietnam, a survey conducted by WSP in 2002 showed that 7 of 12 focus groups considered 'reputation with neighbors and guests' as a motivating factor in building a latrine. Households are motivated by the desire to be considered modern, save face with guests, and get respect from neighbors, which shows that aesthetics are an important factor of sanitation [51]. A recent study by the Vietnam National Handwashing Initiative focusing on hand washing habits looked at the availability of sanitation factors such as water and soap in and around the household. The study showed that there is a gap between hygiene knowledge and actual practice, with both cultural and practical factors explaining why many households do not regularly practice hand washing [52].

For populations relying on them, public toilets are important, especially as a daytime option for those working in open urban areas with no latrine facilities (e.g. markets). In general, public latrines are rarely as clean as those found within households. Moreover, many public toilets do not have the basic necessities for good hygiene practices, such as running water, toilet paper, and soap. As a result, people are forced to make adjustments in order to cope with the situation. For example, one study from the Philippines reports that the absence of water for flushing and hand washing in public restrooms has meant that women now habitually bring their own toilet paper [53].

The findings of the available studies from the SE Asia region are much in line with Cairncross [54], who in a global review suggested that the number one reason for satisfaction with latrines is the "lack of smell." This is followed by "cleaner surroundings", "privacy", "less embarrassment when friends visit" and "fewer gastrointestinal diseases". Vulnerable groups tend to be more sensitive to poor sanitation, due to frailty (elderly and disabled people) or the danger (children) of poorly functioning, unimproved latrines and open defecation practices. The special sensitivities and needs of girls and women are examined later in this section.

One impact that was quantified in this study was time-saving, given the high usage of shared latrines and open defecation in study countries. In Cambodia, for example, a private on-site latrine is perceived to save time for around 40% of Cambodian households [55]. Based on the time saving assumptions used in the present study, the total time spent using both open defecation and shared facilities was estimated (Table 24). The total annual economic value of time lost while using open defecation sites is US$38 million in Cambodia, US$1.2 billion in Indonesia, US$24 million in the Philippines and US$42 million in Vietnam. These costs include loss of productive time for both adults and children, although these losses are assumed not to have any financial implications. The time loss only includes daily time for defecation and does not include urination, which may be an issue, especially for women who tend to seek more private places.

Table 24. Time spent used using latrines and associated economic costs

Location	Population size (million)		Total time (million hours)		Economic loss (US$ million)		
	Open[1]	Shared[2]	Open	Shared	Open	Shared	Total
Cambodia	**9.8**	**0.6**	**594**	**11**	**37.5**	**0.7**	**38.2**
Rural	9.0	0.5	550	9	34.7	0.5	35.3
Urban	0.7	0.2	44	3	2.8	0.2	3.0
Indonesia	**22.2**	**15.7**	**2,026**	**2,083**	**501.6**	**618.3**	**1,220.0**
Rural	17.7	8.6	1,613	781	479.0	231.9	710.9
Urban	4.5	7.1	413	1,302	122.6	386.4	509.0
Philippines	**9.0**	**15.1**	**92**	**153**	**9.3**	**15.2**	**24.5**
Rural	7.5	9.1	76	93	7.0	5.9	12.9
Urban	1.5	5.9	15	60	2.3	9.3	11.6
Vietnam	**9.2**	**13.5**	**557**	**823**	**16.8**	**24.8**	**41.6**
Rural	8.3	10.5	504	639	15.2	19.3	34.5
Urban	0.9	3.0	52	185	1.6	5.5	7.1
Total	**50.2**	**44.9**	**3269**	**3070**	**565.2**	**659**	**1324.3**
Rural	42.5	28.7	2743	1522	535.9	257.6	793.6
Urban	7.6	16.2	524	1550	129.3	401.4	530.7

Source: country reports
[1] Refers only to population using open defecation
[2] Refers only to population with shared facilities

Poor and unavailable sanitation facilities in schools and work places were also evaluated by the study. Table 25 presents data on toilet and water supply access in schools in the study countries. A 2005 national review in Cambodia showed 41.6% of schools without a toilet, and 50.7% of schools without a water supply. Less than 20% of schools, from a smaller sample of 78 schools, had functioning latrines, and in 50% open defecation was commonly practiced .

Table 25. Educational performance and water and sanitation coverage in schools

Country & establishment (year)	Educational performance						Adequate W&S access (%)			
	Enrolment		Completion		Drop-out		Toilet		Water supply	
	F	M	F	M	F	M	With	w/o	With	w/o
Cambodia (2005-6)										
Primary school	1.27m	1.42m	90%	94%	12%	11%	70%	30%	61%	39%
Secondary school	0.30m	0.41m	76%	77%	22%	20%	75%	25%	58%	42%
Indonesia										
Primary school	93%	93%	89%	86%	2.9% [1]					
Secondary school	61%	63%								
Philippines										
Primary school	88%	90%	79%	67%	1%	2%	97%	3%	66%	34%
Secondary school	65%	59%	58%	42%	4%	9%				
Vietnam										
Primary school	95%		84%	84%	4%		50%	50%	84%	16%
Secondary school	96%		94%		6%		60%	40%	96%	4%

Sources: Cambodia: Ministry of Education Youth and Sports; Indonesia: [56]; Philippines: [57]; Vietnam: [58].
F – Female; M – Male.
[1] Total drop-out rate of boys and girls combined is 2.9% (60% girls and 40% boys).

The statistics refer to the presence of toilet facilities in schools, where coverage ranges from 50-97%. However, the statistics do not indicate the actual sanitary condition of the facilities, nor whether the numbers of toilets/cubicles are sufficient for the school. While the physical infrastructure may exist in many schools, it is often poorly maintained and unhygienic. For example, consultants from the Indonesia School Improvement Grants Program who visited potential grantee schools in Pandeglang (West Java), observed that in almost all schools, toilets and washrooms were out of order. Those which were still working were of inadequate number compared with the number of students using them. On average, there were two toilets per school, and clean water access was also lacking. At many schools, students are forced to use streams or fish ponds nearby for their toilet needs, posing particular problems during the rainy season. In Pandeglang, the proportion of grant funds allocated to building or improving sanitation and water supply averages 14% for primary schools and 10% for junior secondary schools [59].

A key question related to the sanitation-education link is whether poor sanitation results in early school drop-out. The rates of school drop-out shown in Table 25 are relatively low, except in Cambodia where it reaches 22% in secondary schools. Drop-out rates between girls and boys are relatively similar, but they are higher for boys in the Philippines, and higher for girls in Indonesia. Thus it is difficult to support the hypothesis that poor sanitation is actually causing pupils, especially girls, to drop out of school earlier than they would have otherwise.

However, the lack of any toilets, or sanitary toilets, clearly has an impact on pupils in school and adults in the work place, especially girls and women. At best, the inadequate toilet situation causes some lack of comfort and inconvenience. At worst, health is affected, thus causing absences, and perhaps constituting a contributing factor in them dropping out of school or quitting their jobs. Girls and women are likely to be the most sensitive during their menstrual period. However, there is no data to indicate their opinions. For example, a survey of children in the Philippines did not indicate sanitation as a leading factor in early drop-out (Table 26), as 'poor sanitation' was not included in the list of options to answer. Hence, it cannot be known whether sanitation was a contributing or leading factor for any of those interviewed. Table 26, shows that factors such as schooling cost, distance, the child's interest in continuing, and other opportunities for work are the key factors in school drop-out.

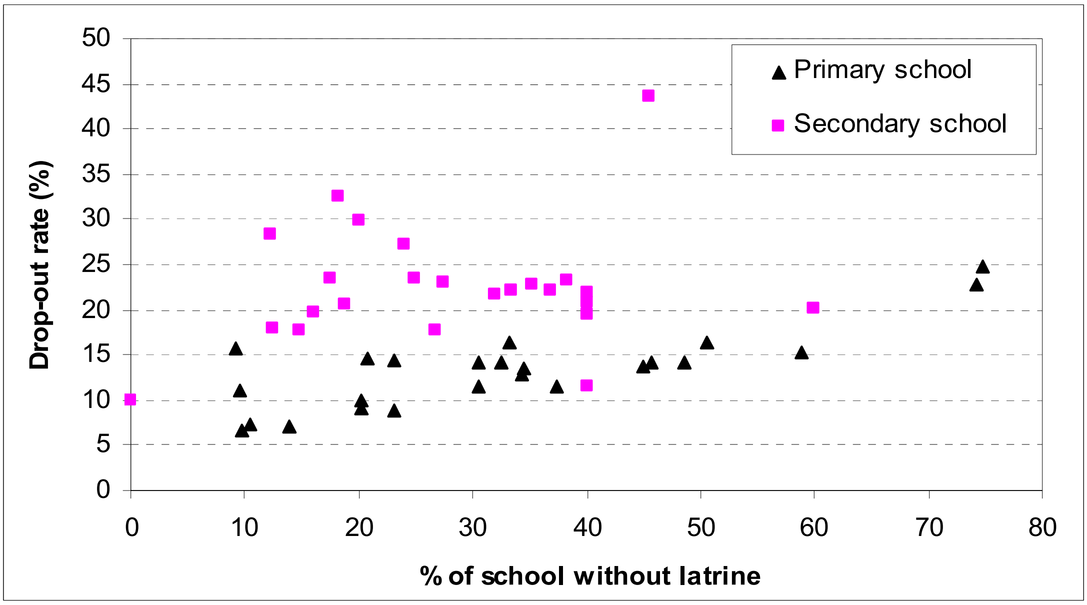
Table 26. Reasons for dropping out of school in the Philippines

Principal reason cited for drop-out	Responses of parent/guardian, percent of total (%)		Responses of student, percent of total (%)	
	Male	**Female**	**Male**	**Female**
High cost of schooling	19.4	30.8	22.9	41.5
Child not interested	48.1	24.3	37.3	16.9
School too far	4.4	9.1	6.2	6.8
To work for wages	6.9	7.7	9.6	10.8
To help in household enterprise	7.4	5.3	10.8	4.7
Disability or illness	3.8	5.3	3.8	5.4
To help in housekeeping	0.9	4.0	0.3	0.9
Teachers not supportive	1.5	0.4	1.4	0.7
No suitable school available	0.5	0.7	-	-
To attend to sick member of the family	-	-	0.8	3.8
Other	7.1	12.4	6.9	8.5
Total	**100%**	**100%**	**100%**	**100%**

Source: [60]

In exploring the relationship between sanitation and school completion, Figure 14 cross-tabulates drop-out rate with latrine coverage in primary and secondary schools in Cambodia. A general positive relationship can be observed, as is the hypothesis of the present study. However, no definitive conclusions can be drawn from this data set, as there are many factors determining drop-out rate, some of which are highly correlated with latrine coverage (e.g. level of school budget allocation).

Figure 14. Female school drop-out rate and school sanitation in Cambodia



Source: Cambodia Ministry of Education Youth and Sports, 2006

Table 27 shows water and sanitation coverage rates in selected workplaces. Sanitation coverage in work places is reported to be high in the Philippines and Vietnam, although in Vietnam at some external work places, such as markets, latrine coverage rates are very low.

Table 27. Water and sanitation coverage in workplaces

Establishments	With toilets		Without toilets	Running water supply or well close-by	
	'Adequate' latrines	'Inadequate' toilets		Adequate	Inadequate or none
Cambodia	NA	NA	24.7	NA	NA
Philippines	85.9%	14.1%	-	94.1%	5.9%
Vietnam					
Health Station	85.7%	11.2%	3.1%	96.9%	3.1%
Commune People's Committee	50.2%	36.9%	12.9%	89.3%	10.7%
Market	4.8%	13.2%	73.4%	22.7%	77.3%

Sources: Philippines [61]; Vietnam [58].
NA – Not Available.

Table 28 compares male and female workforce participation. In most professions shown by the table, men dominate the workforce, except in Vietnam where the ratio is equal. In the Philippines, approximately 80% of men are employed compared to approximately 50% of women, and men dominate the agricultural and industrial sectors by an approximate ratio of 3 to 1. The finding is similar in the education sector in Cambodia. However, the role of sanitation in explaining the male-female differences in workforce participation is unclear; there are many reasons for men dominating some sectors in some countries, and only targeted surveys will reveal the role of sanitation.

Table 28. Workforce participation and male-female split

Country and sector	Female	Male	Total
Cambodia			
Teachers (male-female split)	37.0%	63.0%	100%
Indonesia			
Employment (male-female split)	37.5%	62.5%	100%
Philippines (2005-6)			
Overall workforce participation (%)	49.8%	79.7%	64.7%
Agriculture (male-female split)	25.9%	74.1%	100.0%
Industry (male-female split)	30.3%	69.8%	100.0%
Services (male-female split)	50.9%	49.1%	100.0%
Schools (male-female split)	74.7%	25.4%	100.0%
Unemployment rate (%)	7.3%	7.4%	7.4%
Vietnam			
Employment (male-female split)	51.0%	49.0%	100%

Sources: Indonesia: labor participation 2002 [62]; Philippines: workforce participation [57]; employment and unemployment, [35]; Vietnam [63]

Quantified estimates of the role of sanitation in school and work place absences for women and girls were made in the Philippines and Vietnam. For establishments without adequate latrine facilities, girls and women were assumed to be absent from their day activities roughly one day a month, corresponding to a conservative estimate of the menstrual period when hygiene and privacy are of significantly higher importance to women. Whether this reflects actual measurable losses in school and the workplace can be disputed. However, the fact that conditions are sub-standard for women at this key moment – thus leading to welfare losses – is not under dispute. Table 29 shows that the economic cost is US$13 million in the Philippines and US$1.28 million in Vietnam, the majority of costs being to the work place in both countries.

Table 29. Economic impacts of poor sanitation on female productivity

Establishment	Absences ('000 days/year)	Economic cost	
		Value (US$ million)	%
Philippines	**14,886**	**13.0**	**100.0**
Secondary School[1]	996	0.5	3.5
Workplace[2]	13,890	12.5	96.5
Vietnam	**4,625**	**1.28**	**100.0**
Secondary School[1]	115	0.002	0.2
Workplace[2]	4,510	1.28	99.8

Source: country reports
[1] Includes only girls in secondary school.
[2] Includes all working women under the age of 44.

3.7 Tourism impacts

Tourism is an important source of income, employment and foreign currency in all of the study countries. Table 30 provides some key statistics on the tourism sector. The contribution of tourism to GDP varies from 1.7% in the Philippines to 14.6% in Cambodia, and the total annual value of the tourist sector in the study countries is US$10.5 billion. As a source of employment, tourism is very important, both directly in hotels, restaurants and the transport sector, and in the whole supply chain (which is not fully captured in Table 30). Roughly 14 million foreign tourists visited the region in 2005, equivalent to about 3.5% of the population of the study countries, although this proportion varies between countries (as high as 12% in Cambodia). Also, official statistics reveal that internal tourism is also common, with over 100 million domestic tourists.

Table 30. Key tourist sector statistics for study countries, latest available year

Variable	Cambodia	Indonesia	Philippines	Vietnam
Numbers of tourists				
Foreign tourists	1,700,041	5,002,000	2,550,615	3,600,000
Domestic tourists	7,901,039	112,701,000	NA	17,500,000
Average daily expenditure per tourist				
Foreign tourist (US$)	95	100	76.3	76.4
Domestic tourists (US$)	NA	NA	NA	31.5 daily
Average length of stay (days)	6.5	9.05	8.92	16.8
Tourist income				
Total value (million US$)	1,049	4,520	1,702	3,200
% of GDP	14.6%	5.15%	1.73%	5.25%
Investment in tourism				
Government expenditure (million US$)	NA	340.0	25.6	50.6
Private sector investment (million US$)	352	600.0	NA	1491.3
Establishments supporting tourism	2368	9,700	NA	8556 hotels
Employment in tourism				
Total	225,000	NA	1,222,538	3,364,000
% of jobs	3%	7%	3.8%	7.7%

Sources: Cambodia: Budget Law 2006; Indonesia: [64]; Philippines [35, 65]; NA – Not available or not collected.

Plate 6. A sight for tourists? - By the riverside in central Phnom Penh.

There are no studies of participating countries examining the link between tourism and sanitation conditions. Unarguably, the quantity of tourists choosing a country for their holiday is partially related to the sanitary conditions of that country. Whether tourists, especially ‘high value’ tourists, can expect private, hygienic, and culturally appropriate toilet conditions, as well as running water and soap, will determine their choice of a tourist destination,. This is true not only in hotels or rented accommodation, but also in restaurants, bus stations, and tourist sites. Whether a country or specific tourist destination is prone to events such as cholera epidemics is also an influencing factor. Furthermore, environmental quality (unsightliness, odor, quality of water for swimming) and food safety will play a central role [66]. Also, with an ageing tourist population, the needs and preferences of elderly people will play an increasing role in tourist standards.

On the other hand, a tourist location that is popular and running at capacity may not indicate that sanitation conditions are good, but rather that the attraction is 'unmissable', such as Angkor Wat. In recognizing the importance of sanitation in tourism, the Ministry of Tourism in Cambodia is now committed to improving toilets in restaurants and hotels, which will be rated and classified according to their toilet facilities. It is believed that this will provide an incentive for those establishments to improve their restrooms.[10]

Tourist hotel occupancy rates are far from their efficient levels, ranging from an average of 45% in Indonesia to 70% in Vietnam (Table 31). Hence, the study countries could all further exploit existing tourist capacity to generate significantly greater revenues from tourism and at relatively little cost. The current study assumes that the study countries could increase the number of foreign tourist arrivals in the near future, which requires a number of measures to attract tourists. It is assumed that sanitation is one of these measures, accounting for roughly 5% (or 10% in Cambodia) of those required to raise the number of tourists to the target level of 90% occupancy.

Table 31. Economic impact of lower tourist numbers

Country	Current tourism value (US$ million)	Hotel occupancy rate		Potential value (US$ million)	Attribution to sanitation	Annual economic loss (US$ million)
		Current	Target			
Cambodia	1,049	54.8%	90%	1,786	10%	73.7
Indonesia	4,520	45.0%	90%	8,748	5%	215.0
Philippines	1,784	61%	90%	2,589	5%	40.1
Vietnam	3,200	70.0%	90%	4,571	5%	68.6
Total	**10,553**	**-**	**-**	**17,694**	**-**	**397.0**

Source: country reports

Based on this methodology, the estimated annual economic losses attributable to sanitation total US$397 million in the study countries, ranging from US$ 40 million in the Philippines to US$215 million in Indonesia.

Plate 7. Beach resorts will not attract tourists if drains muddy the waters

The economic impact of holiday sickness episodes was estimated in Indonesia and Vietnam. Table 32 shows that the total financial cost of such episodes ranged from

[10] *Cambodia Daily*, Volume 37 Issue 67, August 17, 2007.

US$0.7 million in Indonesia to US$5.4 million in Vietnam. Economic cost, which takes into account daily welfare loss due to sickness, was considerably greater at US$25.5 million in Indonesia and US$495 million in Vietnam.

Table 32. Economic impact of sickness episodes of tourists

Region	Disease episodes	Average treatment cost (US$)	Average length of episode	Welfare loss per case / day (US$)	Value (US$ millions)	
					Financial	Economic
Indonesia	18% (1.8% severe)	8.5	3	100.0	0.7	25.5
Vietnam					5.4	495.4
Domestic	20%	0.29	3	31.5	3.0	331.1
International	20%	1.10	3	76.4	2.4	164.3

Source: country reports

3.8 Sanitation markets

Table 33 provides more details of the market value of sanitation inputs, based on the average market prices for each option. As is shown in the table, over half of total benefits are accounted for by rural areas in the Philippines. Note that the unit costs of sanitation inputs include only the fixed, one-time investment in sanitation facilities. The costs of maintaining and operating such facilities were not fully accounted for in the study. Furthermore, these additional revenues/expenses should be analyzed only in a general equilibrium framework, taking into account imported products, changes in spending patterns, and so on.

Table 33. Sanitation input market values (US$ million)

Variable	Simple pit latrine	VIP	Septic tank	Ecosan	Piped	Other	Total
Cambodia	**0.33**	**0.25**	**0.36**	**1.25**	**0.62** [1]	**-**	**2.8**
Indonesia	**19.4**	**26.5**	**221.5**	**3.3**	**3.3** [1]	**322.4** [2]	**596.4**
Rural	17.6	19.6	144.7	2.4	2.4 [1]	112.6 [2]	299.2
Urban	1.8	6.9	76.8	0.9	0.9 [1]	209.8 [2]	297.2
Philippines		**54.7**	**1218.0**	**226.4**			**1499.0**
Rural	-	51.8	1022.4	141.2		-	1215.5
Urban	-	2.8	195.6	85.2		-	283.6
Vietnam	**-**	**31.3** [3]	**62.6**	**29.9**		**3.4** [4]	**127.2**
Rural	-	29.0 [3]	57.9	27.7		3.1 [4]	117.7
Urban	-	2.3 [3]	4.7	2.2		0.3 [4]	9.5

Source: country reports
[1] Piped sewer connection.
[2] Includes markets for soap, toilet paper and sludge removal associated with sanitation improvements.
[3] Pour-flush.
[4] Biogas.

Table 34 shows the breakdown of potential market size for sanitation outputs, based on assumptions for household choice between simple Ecosan options providing fertilizer, and more complicated and costly biogas digesters. A large share of benefits accrues in Vietnam, where Ecosan options have more significant potential than other countries.

Table 34. Sanitation output market values ('000 US$)

Variable	Fertilizer value	Biogas value	Total economic value
Cambodia			**578**
Indonesia	**-**	**68,000**	**68,000**
Rural	-	15,000	15,000
Urban	-	53,000	53,000
Philippines	**180**	**-**	**180**
Vietnam	**163,755**	**38,318**	**202,057**
Rural	163,702	38,306	202,008
Urban	40	9	49

Source: country reports

In addition to the estimated economic benefits shown in Table 34, biogas can bring other benefits to countries promoting it. The reductions in greenhouse gas emissions from biogas activities are eligible to receive 'carbon credits' under the Clean Development Mechanism (CDM) of the United Nations Framework Convention on Climate Change. These credits can be sold on the international market, resulting in revenues for the country. In Vietnam, for example, each biogas tank is equivalent to two credits that can be sold at 6 Euro each. With large national programs, this could lead to considerable sums of further income. However, due to lack of reliable data, this present study does not include the benefit in the total economic impact of improved sanitation.

Plate 8. Biogas digesters are becoming increasingly popular in Asia.

3.9 Sensitivity analysis

This study is based on secondary information collected from a range of sources, combined in a model to estimate economic costs. One major source of uncertainty is the fact that some impacts of poor sanitation were not quantified, meaning that the estimates presented in section 3.1 are underestimates of the economic impacts of poor sanitation. This source of uncertainty has not been evaluated in sensitivity analysis due to lack of data on these variables; or if there are data, due to the expected lower level of importance compared to the impacts evaluated.

A second major source of uncertainty surrounding the input values of the variables included in the estimates of economic impact. This uncertainty stems from the estimates of the absolute size of overall impacts, as well the attribution of these overall impacts to poor sanitation. Uncertainty in selected key variables was evaluated using one- and two-way sensitivity analysis. As explained in Annex A8, input values used for health variables, water resource variables, other welfare variables and tourism variables were all varied in one-way sensitivity analysis using a lower and an upper value, giving a lower and an upper range for the economic impacts. The resulting ranges of the five main impacts were added together to give overall lower and upper values, which gives an indication, albeit imperfect, of the possible ranges of the impacts. Table 35 and Figure 15 show the summary results. The central bar for each impact in Figure 15 reflects the base case, and hence the other bars indicate the extent of variation from the base case. Table 35 shows the total variation by country. In units of millions, economic costs range from US$234 million to US$629 million in Cambodia (base case US$448 million); US$3.7 billion to US$18.8 billion in Indonesia (base case US$6.3); US$1 billion to US$6 billion in the Philippines (base case US$1.4 billion); US$504 to US$1.1 billion in Vietnam (base case US$780 million).

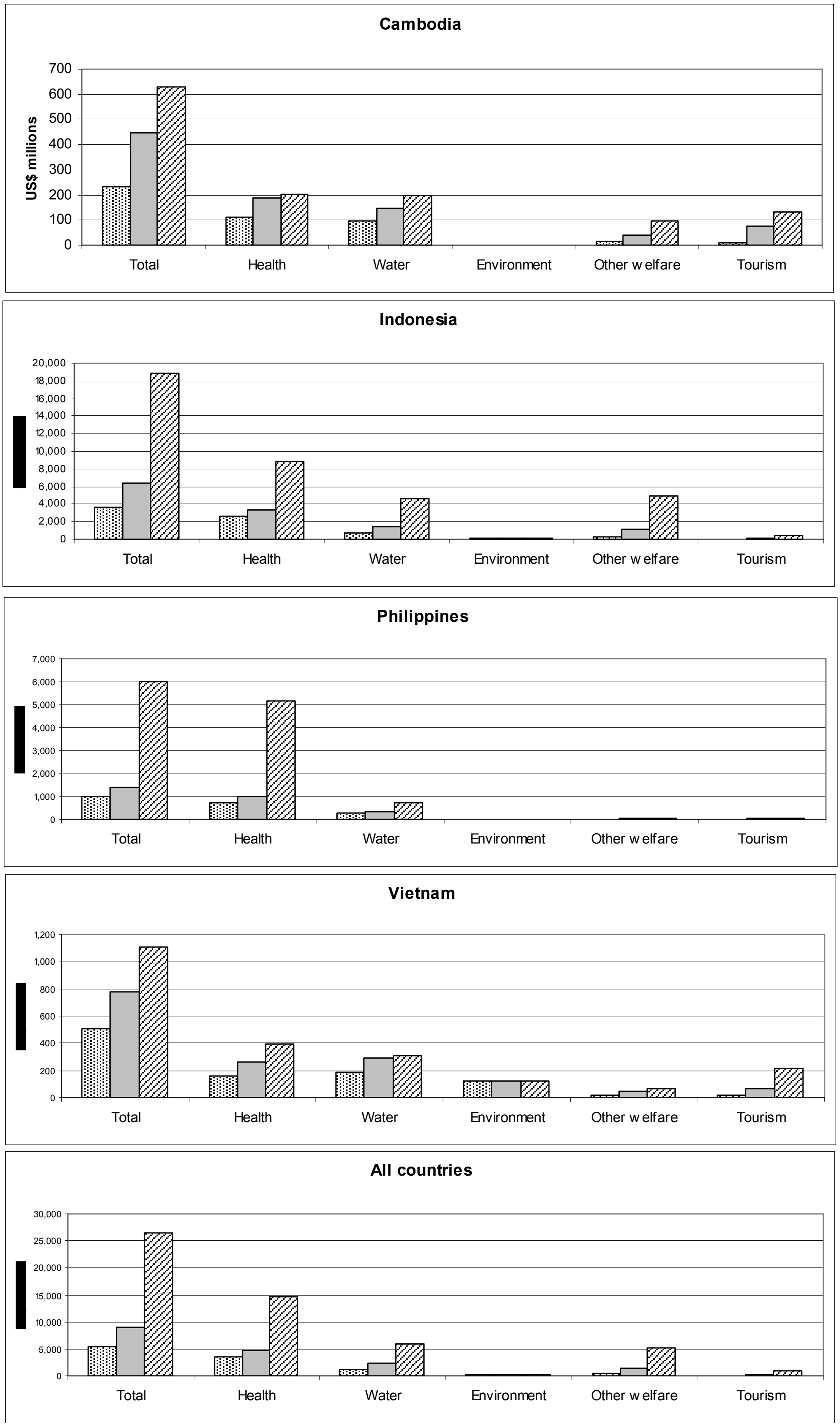
The most outstanding finding from the sensitivity analysis is that the ranges of health economic impacts account for the largest share of the variation. This variation is largely due to the different values used for the value of saved lives, for which there is considerable uncertainty. If less conservative values for VOSL are used (i.e. higher), then the overall economic impacts of poor sanitation increase considerably by a factor of up to five times when using the transferred value of US$2 million from developed country studies (adjusted by the GDP ratio of the USA to each country). Another significant source of variation is the assumption for the attribution of tourism losses to poor sanitation. This variable is most important in Vietnam. Another source of variation is the value of time, which is applied to calculate health-related productivity losses and time losses from sanitation use.

Table 35. Ranges of economic costs from the sensitivity analysis

Country	Financial cost (US$ millions)			Economic cost (US$ millions)		
	Low	Mid	High	Low	Mid	High
Cambodia	103.3	160.1	211.6	234.3	448.0	629.1
Indonesia	742.0	1,216.0	2,493.0	3,658.7	6,344.0	18,801.0
Philippines	265.3	359.0	836.0	1,025.6	1,412.1	6,024.8
Vietnam	157.2	291.7	363.8	504.1	780.1	1,106.5
Total	1,267.8	2,026.8	3,904.4	5,422.7	8,984.2	26,561.4

Source: country reports

Figure 15. Lower, mid and upper ranges of impacts using sensitivity analysis



While the level of uncertainty may appear to be of 'manageable' proportions, as shown in Table 35 and Figure 15, some caution is recommended in the interpretation of the sensitivity analysis figures presented here. First, the selection of upper and lower ranges of input variables was not entirely based on evidence, but more on expert opinion about a feasible range. Second, only selected variables were tested in the sensitivity analysis. Other variables could have been tested, but in the interests of time and space, they were not all included here. However, the variables selected were the key variables that determine economic impact. Third, the one- and two-way sensitivity analyses conducted here do not reflect the ranges that might be possible if there is uncertainty simultaneously in all input parameters. Conducting multi-way sensitivity analysis would lead to wider ranges of each impact variable. However, there are serious data constraints to conducting more detailed sensitivity analyses.

4. DISCUSSION, RECOMMENDATIONS AND CONCLUSIONS

4.1 Reiteration of major findings and interpretation of study results

This study has shown that the financial and economic impacts of poor sanitation and hygiene are considerable, at approximately US$2 billion in financial impact and US$13 billion in economic impact per year. This corresponds to between 0.44% (financial losses) and 2% (economic losses) of total GDP for all the countries combined. The key economic impacts in descending order of importance were health, water resources, user preferences (access time cost), and tourism. Other environmental impacts (aesthetics and land use) were not quantified in all countries to feature fully in these summary figures.

The current study examined the impacts in the latest available year of full data sets – which was the year 2005 for most variables. As economies develop and populations grow further, the impacts in the study countries will be likely to grow if sanitation and hygiene are not improved. For example, as water pollution increases, some thresholds may be reached whereby even greater impacts are felt – such as fish production and tourist numbers declining. Furthermore, for some impacts there are specific locations ('hot spots') where the impacts are felt (open dump sites, lakes and rivers for fish production, and tourist areas) while other impacts are more spread out, affecting mainly those with unimproved sanitation (environmental impacts of open defecation, access time impacts, intangible user preferences, health impacts).

As well as the economic impacts of *poor* sanitation and hygiene, the potential economic savings and other economic gains from *improving* sanitation were estimated. The study predicted that some negative impacts could be fully averted if the proper measures are taken. Negative health impacts of poor sanitation can only be reduced by between one third and one half, depending on the type and implementation efficiency of the intervention. The extent of mitigation of the negative water resource impacts depends on the extent of water pollution from other sources, and household behavior change leading to a reduction in pollution from poor sanitation. In the case of tourism, other factors or preconditions are necessary for the benefits to accrue. However, in the case of all impacts, only a fraction of overall impacts were attributed to sanitation; hence, if sanitation is improved, the attributed negative impacts could to a large extent be averted.

Throughout the presentation of results, some distinction has been made between financial losses and economic losses. While attempts were made to follow conventions used in economic evaluation techniques, it was in practice difficult to distinguish between financial and economic. It is largely context-specific whether a loss is felt as a real financial cost (involving monetary impact) or as affecting resource use but non-pecuniary in nature, However, this distinction can be useful in interpreting study results.

4.2 Sanitation and the broader development agenda

Sanitation (and hygiene) are strongly linked or associated with other areas of human development, as illustrated by the role of sanitation in many of the MDGs [2]. As shown or implied by this study, improved sanitation has positive effects on child and adult health, gender equality, hunger, environmental sustainability, and water resources (clean drinking water). Both directly and through the various pathways to development, improved sanitation will contribute to lifting populations out of poverty, as well as preventing them from slipping back into poverty. Furthermore, improved resource allocations and incomes at micro-economic level will eventually lead to positive macro-economic effects that can lead to greater distribution of resources and further lift populations out of poverty.

One of the leading arguments for improving sanitation is health improvement, which not only has direct welfare affects through improvements in the quality of life and a reduced risk of premature death, but also affects the household economy and leads to greater production in enterprises. Diarrheal disease is one of the leading causes of disease, as reflected by the number of related cases and deaths; at least 80% of diarrheal disease in developing countries is due to poor sanitation and hygiene (and via unclean water resulting from poor sanitation). Diarrheal disease predominantly affects children under five, but also children of school age, thus affecting their education.

An understated but key argument for improving sanitation is the significant but unmet demands of women. The effects of sanitation on women are not only direct – such as preferences for private, clean and convenient sanitation facilities for them and their children – but also indirect, such as the impact on local water supplies of sewage discharge into groundwater and surface water sources, and the caretaking of children who fall sick. Having to treat sick children makes women more vulnerable to sickness themselves. Women naturally need more privacy, which can affect life decisions and also cause short-term absences from school and work. Travel to and from places of defecation can be hazardous, especially for women and at night.

A key but previously unexplored impact included in this study is that of fish production in inland water resources. Fish provide a key source of income, employment, and nutrition in all of the study countries. Due to population and economic pressure, inland waters are becoming increasingly exploited, thus endangering the long term survival of fish stocks. As stated by the Food and Agriculture Organization "small-scale fishing communities are faced with an array of serious problems, including overexploitation and depletion of resources, lack of alternative sources of employment, rapid population growth, migration of populations, displacement in coastal areas due to industrial development and tourism, *pollution and environmental degradation* and conflicts with large commercial fishing operations. However, small-scale fisheries are critical for food security and poverty alleviation in many countries." (Page v, italics added) [67].

Similarly, Virdin et al (2004) in their report 'Saving Fish and Fishers" highlight the issues of over-exploitation and inland water resource pollution, and sum up succinctly the current problems facing the fish industry: "increasing human populations and their clustering around sea and lake coasts and the productive floodplains of the great rivers are another root cause of over-fishing and degradation of aquatic ecosystems in developing countries. The population living within 100 kilometers of the coast has grown to 2.2 billion people (39 percent of the global population), leading to pollution and degradation of major marine ecosystems. *Pollution* effects and declining water levels have been even more significant in inland water bodies. The high price of fish relative to other primary agricultural commodities has acted as a spur to over-extraction. Population pressure and loss of terrestrial commons drive the poor, the landless, and those without alternative employment to exploit aquatic resources to which access is often open and free. The inherent nature of open-access fishery resources leads to overexploitation as economic opportunities attract more fishers. Even when profits decline, individual fishers continue to increase their fishing effort in an attempt to harvest a greater share of the limited resource shared with competitors…overexploited inland capture fisheries or those suffering from environmental degradation are found in many of the major inland fish producers such as Bangladesh, China, and India, the countries of the *lower Mekong Basin… pollution* is a significant contributor to the direct mortality of fish, and pollutants constrain reproductive success and render fish more susceptible to disease... increasingly frequent *algal blooms* in coastal areas deplete oxygen and are associated with shellfish poisoning." (Italics added) [68].

Hence, this study has attempted, albeit crudely, to put figures on the impacts of pollution on fish numbers, attributing a portion of the effect to poor sanitation. While the figures may not be accurate, this study points to the urgency of the water pollution problem, and the knock-on effects on livelihoods, diets, domestic and export markets, and eventually entire economies.

All the micro- and location-specific effects described in this study will eventually have macro-economic consequences. Micro-macro linkages in terms of sanitation impact could be further examined that relate to the impact of sickness time and access time on the availability and productivity of the labor force; implications of changes in household income (fish, tourism, sanitation markets, small-scale projects) on consumption statistics and knock-on effects ('multiplier' effect); implications for business income and profits (worker productivity, foreign direct investment, tourism); and implications for resource productivity and prices (land). The current study provides some of the basic data needed to begin modeling the macro-economic effects of sanitation.

4.3 Study recommendations

The central aim of the present study was to generate an evidence base to enable recommendations to be made for improved sanitation policies. This study has identified a broad range of impacts of poor sanitation, and quantified those impacts most amenable to secondary analysis. The following policy recommendations are based on eight major findings of the study:

Major finding 1. Poor sanitation causes significant losses to the national economy
The study has found that poor sanitation is responsible for at least US$9 billion, or an average of 2% of annual GDP, in economic losses per year in the four study countries. Of these costs, at least US$2 billion are financial (0.44% of GDP), involving additional expenditure or actual income loss for the population. In addition to these quantified impacts, a range of other negative economic and social effects of poor sanitation result. By improving sanitation, a significant proportion of these socio-economic impacts can be mitigated.

Recommendation 1. Decision-makers from various sectors are advised to act now
Sanitation 'players' are advised to act now, otherwise the negative impacts of poor sanitation are likely to increase over time. Governments and other stakeholders should jointly reassess the current and planned spending levels in the sanitation and related sectors, covering health, water resources, environment, rural and urban planning and

development, fisheries, and tourism. Increased political importance and budget allocations should be given to sanitation. Decision-makers should use an evidence-based approach to design efficient sanitation policies and implementation strategies, to increase value-for-money from public and private investments into sanitation.

Major finding 2. Poor sanitation has greater impact on the poor and vulnerable
A greater share of the socio-economic burden of poor sanitation – health impacts, time access, water pollution, aesthetics, land use – falls on the population currently without improved sanitation, causing inequities in society. The population group without improved sanitation tends to be the poorer and more vulnerable members of society. A disproportionate share of the burden falls on women, children and the elderly, especially the health burden and other welfare effects such as intangible welfare impacts and life decisions.

Recommendation 2. Governments must define and target the needs of priority groups
Governments should give priority to the populations with no latrine, recognizing that effective demand may be low in these groups due to low income and poor awareness of the benefits of investing in sanitation. As well as stimulating demand through public health and latrine advocacy campaigns, governments should target programs, subsidies and financing mechanisms to the most disadvantaged population groups.

Major finding 3. Negative impacts result from several poor sanitary practices
Economic impacts occur not just through the use of unimproved latrines, but also through poor hygiene practices, poor isolation of wastewater from the environment and water sources, and poor solid waste management. Countries on track to meet the sanitation MDG target still fall short of meeting broader environmental sanitation standards.

Recommendation 3. Players should broaden the scope of sanitation beyond latrines
Sanitation investments should not be made just in latrine extension programs, but in improved sludge, water and solid waste management, and in hygiene programs to raise population awareness of personal and community hygiene issues.

Major finding 4. Health-related economic impacts have a significant toll on society
This study has confirmed that the major and most tangible impact of poor sanitation is an increased risk of infectious disease and premature death. In the four study countries, at least 183 million disease episodes and at least 100,000 deaths are attributed annually to poor sanitation. Half these deaths are from the indirect diseases resulting from poor sanitation through childhood malnutrition. This study has shown that economic losses of over US$4.8 billion, or US$12 per capita, result annually from health care costs, health-related productivity costs and premature mortality costs.

Recommendation 4. Health aspects of sanitation programs deserve central focus
Governments should focus on the easy health wins from improved sanitation, through targeting children and focusing on safe but simple latrine designs, improved excreta isolation measures, and improved hygiene practices. Given the key role of hygiene practices in health improvement, high-impact hygiene components should be integrated in the planning and implementation of sanitation programs. Ministries of Health should (continue to) play a central role in the health aspects of sanitation programs.

Major finding 5. High water pollution levels are partially caused by poor sanitation
The majority of human excreta eventually finds its way to water bodies; so do gray water, animal excreta, solid waste and industrial wastewater. Together, these cause significant water pollution in the study countries, with associated high economic losses. Quantified economic losses associated with polluted water from domestic sources reach US$2.3 billion in the four study countries (US$5.6 per person per year), while other impacts include loss of aesthetics, leisure activities, and tourism.

Recommendation 5. Sanitation solutions should focus on reducing water pollution
Governments should urgently implement sanitation standards that reduce the release of waste matter into water resources. Low technology, low cost and effective options should be explored as a matter of priority. Focus should not be just on excreta, but also solid waste, household, agricultural and industrial wastewater. The contamination of groundwater with microbiological pathogens should be averted through better planning, increased resource allocation, and awareness raising. Water quality monitoring should be conducted to assess the extent and nature of water pollution and to inform populations which water sources are safe to use.

Major finding 6. Sanitation is linked with sustainable development in many ways
Sanitation has a major role in sustainable development, due to its links to other development goals: health, hunger, education, environment, gender equality, quality of life and poverty reduction. Some sanitation impacts not fully explored in this study – in particular tourism and the investment climate – are potentially major arguments for improving sanitation, and point to the adoption of a broader understanding of the term 'sanitation' beyond household latrine coverage.

Recommendation 6. Several coordinated measures are needed to improve sanitation
Sanitation cannot be only the responsibility of an individual sector/ministry, nor of a single level of government. The fact that sanitation touches on many sectors and line ministries should be used as a strength, and clear roles and responsibilities need to be defined. The development of a policy and regulatory framework for environmental and health protection is crucial and imperative in the context of rapid industrialization and high economic growth in the study countries. While further progress is needed at the highest levels to ensure political support and resource allocations for sanitation, further emphasis is needed on the implementation levels, where sanitation demand must be stimulated and affordable and attractive solutions for sanitation must be available.

Major finding 7. Variability is expected in the actual impacts of poor sanitation
While the national per capita costs in rural and urban areas was found to be similar, there will exist significant variation in the impacts of poor sanitation between different geographic locations, depending on sanitation coverage, demographics, environment, and practices related to health and water consumption.

Recommendation 7. Local as well as national studies should inform sanitation policy
To convince local decision-makers such as city mayors or district officers to invest in sanitation, local studies would be more credible in convincing local decision-makers that sanitation investment is a neglected issue that can result in significant improvements in population welfare. The methodology used in this study can be applied equally to local micro-level studies and the national level. Furthermore, local as well as national decision-makers need to be informed of the efficiency of different

measures to improve sanitation. Local-level cost-benefit studies should be made available to inform national decision-makers how to invest efficiently in sanitation.

Major finding 8. Existing data sources are weak for quantifying sanitation impact
This study has used a number of available data sources, but has been limited by the lack of specific information on outcomes related to sanitation. With the exception of basic latrine coverage indicators, surveys tend not to include questions related to sanitation, such as expenditure, preferences, access time, health-related time loss, sanitation and hygiene practices, and gender. Questions related to broader sanitation 'coverage' (waste disposal, environmental quality) are largely left out. Routine government reporting systems such as health indicators and health service use, and water quality monitoring, only imperfectly capture the substantial impacts of poor sanitation. Water quality is known to be important for fish reproduction, growth and safety for human consumption, but little is known about the exact relationships, and the role poor sanitation plays.

Recommendation 8. Future survey and research work is key to monitoring progress
Surveys and government reporting systems should be assessed for extension to include behavior and outcomes related to sanitation. Selected research studies could fill important gaps in knowledge about the economic and welfare effects of poor sanitation, including providing further insight to the gender perspective. Further research is required on the population benefits of improved sanitation, and what levels of benefit the different types of sanitation options can deliver. The link between poor sanitation and tourism and foreign direct investment losses is poorly understood, and merits further assessment. Country-specific studies on the value of time and the value of life will allow a better understanding of the importance of the identified health and time impacts.

ANNEXES

ANNEX A: STUDY METHODS

This Annex is supplemented by Annex B which contains generalized algorithms (equations) for the quantified impacts.

A1. Background data

A1.1 Coverage data

Table A1 shows 1990 and 2004 data for improved sanitation coverage for SE Asian countries, compared with other developing world regions.

Table A1. Improved sanitation coverage statistics for Southeast Asian countries versus other developing world regions – MDG indicator for latrine access (%)

Country	*Rural*		*Urban*		*Total*	
	1990	**2004**	**1990**	**2004**	**1990**	**2004**
Cambodia	-	8	-	53	-	17
Indonesia	37	40	65	73	46	55
Laos	-	20	-	67	-	30
Malaysia	-	93	95	95	-	94
Myanmar	16	72	48	88	24	77
Philippines	48	59	66	80	57	72
Singapore	-	-	100	100	100	100
Thailand	74	99	95	98	80	99
Timor-Leste	-	30	-	66	-	33
Vietnam	30	50	58	92	36	61
SOUTHEAST ASIA	**40**	**56**	**70**	**81**	**49**	**67**
OTHER REGIONS						
East Asia	7	28	64	69	24	45
South Asia	8	27	54	63	20	38
West Asia	55	59	97	96	81	84
Oceania	46	43	80	81	54	53
Latin America & Caribbean	36	49	81	86	68	77
North Africa	47	62	84	91	65	77
Sub-Saharan Africa	24	28	52	53	32	37
Commonwealth of Independent States	63	67	92	92	82	83

Source: http://www.wssinfo.org/

A1.2 Population data and sub-national disaggregation

Table A2 shows the first level of sub-national disaggregation, for which selected impacts were estimated in each country, and the rural and urban population therein. The individual country reports provide the full sub-national results.

Table A2. Population by major zones or regions in study countries

Zone, region or province	Population size (2005)		
Cambodia			
Zone	**Rural**	**Urban**	**Total**
Phnom Penh	0.6	0.7	1.3
Plains	5.3	0.2	5.5
Tonlé Sap	3.6	0.6	4.2
Coastal	0.7	0.3	1.0
Plateau/Mountain	1.3	0.3	1.6
Total	**11.5**	**2.1**	**13.6**
Indonesia			
Province	**Rural**	**Urban**	**Total**
Sumatra			
NAD	3.0	1.0	4.0
North Sumatra	6.8	5.8	12.6
West Sumatra	3.2	1.4	4.6
Riau	3.0	1.7	4.7
Jambi	2.0	0.7	2.7
South Sumatra	4.6	2.3	6.9
Bengkulu	1.1	0.4	1.5
Lampung	5.7	1.5	7.2
Bangka Belitung	0.6	0.4	1.0
Riau Archipelago	0.3	1.1	1.4
Java-Bali			
Jakarta	0.0	9.0	9.0
West Java	19.2	20.4	39.6
Central Java	19.1	13.0	32.1
Yogyakarta	1.4	2.0	3.4
East Java	21.7	15.0	36.7
Banten	4.4	4.9	9.3
Bali	1.7	1.7	3.4
Nusa Tenggara			
West Nusa Tenggara	2.7	1.5	4.2
East Nusa Tenggara	3.7	0.7	4.4
Kalimantan			
West Kalimantan	3.0	1.1	4.1
Central Kalimantan	1.4	0.6	2.0
South Kalimantan	2.1	1.3	3.4
East Kalimantan	1.3	1.7	3.0
Sulawesi			
North Sulawesi	1.4	0.8	2.2
Central Sulawesi	1.9	0.5	2.4
South Sulawesi	5.3	2.3	7.6
Southeast Sulawesi	1.6	0.4	2.0
Gorontalo	0.7	0.2	0.9
West Sulawesi	0.8	0.2	1.0
Maluku and Papua			
Maluku	0.9	0.4	1.3
North Maluku	0.7	0.2	0.9
West Papua	0.5	0.2	0.7
Papua	1.4	0.5	1.9
National	**127.2**	**94.9**	**222.1**

Zone, region or province	Population size (2005)		
Philippines			
Region	**Rural**	**Urban**	**Total**
National Capital Region	-	11.2	11.2
Cordillera Admin. Region	1.2	0.3	1.5
Ilocos Region	3.7	0.8	4.5
Cagayan Valley	2.7	0.4	3.1
Central Luzon	6.5	2.1	8.6
CALABARZON	7.7	2.5	10.2
MIMAROPA	2.2	0.3	2.5
Bicol Region	4.7	0.4	5.1
Western Visayas	4.3	2.6	6.9
Central Visayas	3.9	2.2	6.1
Eastern Visayas	3.5	0.7	4.2
Western Mindanao	2.1	1.1	3.3
Northern Mindanao	2.4	1.6	4.0
Southern Mindanao	2.8	1.3	4.1
Central Mindanao	2.9	0.8	3.7
Caraga	1.9	0.6	2.4
ARMM	2.6	0.1	2.7
Total	**55.1**	**29.0**	**84.1**
Vietnam			
Region	**Rural**	**Urban**	**Total**
Red River Delta	13.3	5.0	18.3
North East	6.9	2.6	9.5
North West	1.9	0.7	2.6
North Central Coast	7.8	2.9	10.7
South Central Coast	5.2	1.9	7.1
Central Highlands	3.5	1.3	4.8
South East	9.9	3.7	13.6
Mekong River Delta	12.8	4.7	17.5
Total	**61.3**	**22.8**	**84.1**

Source: country reports

A1.3 Currency value

Table A3. Conversion of local currency to US$, and US$ to I$[1]

Country	Currency	Exchange rate with the US Dollar	GDP per capita (2006)		Factor difference
			US$[1]	I$	
Cambodia	Rial	4,050	480	2,920	6.1
Indonesia	Rupiah	8,828	1,420	3,950	2.8
Philippines	Peso	55.1	1,420	5,980	4.2
Vietnam	Dong	16,080	690	3,300	4.8

Source: country reports

[1] Obtained from World Bank comparison of GNI per capita US$ per capita (Atlas method) versus international dollars (purchasing power parity) http://siteresources.worldbank.org/DATASTATISTICS/Resources/GNIPC.pdf

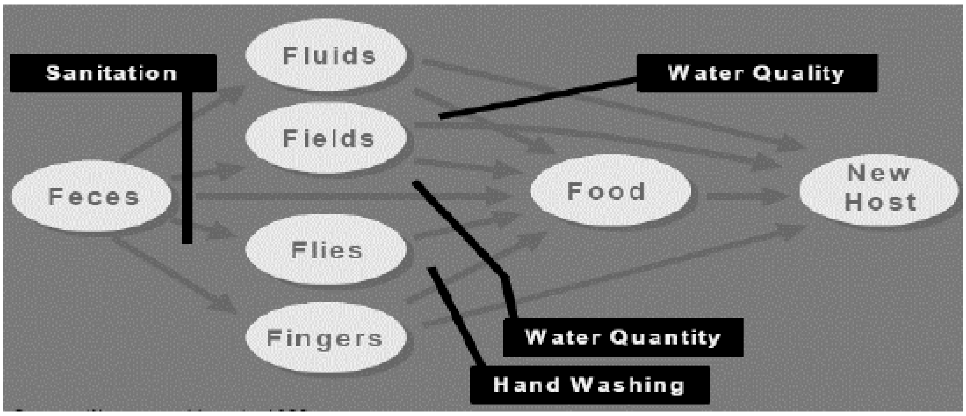
A2. Health impact

Health impacts are usually considered to be one of the most significant impacts associated with poor sanitation and hygiene, and both national surveys and context-specific scientific studies testify to the population burden of sanitation and hygiene-related diseases. There are many diseases associated with poor sanitation and hygiene practices, among them diarrhea, dysentery, cholera, salmonellosis, shigellosis, typhoid fever, hepatitis A, trachoma, and some parasitic diseases (ascariasis, trichuriasis, hookworm, schistosomiasis). Other diseases are indirectly linked to poor sanitation and hygiene through malnutrition. All these diseases are important to populations: they not only have direct implications for population welfare through their impact on the quality of life, but they also have financial and economic impacts, and hence are linked to poverty [69-71]. The impacts assessed in the present study include spending on health care, loss of income or production associated with disease, and the value associated with premature loss of life.

A2.1 Selection of diseases

Many diseases are associated with exposure to human excreta due to poor sanitation and poor hygiene practices (Table A4). Diseases related to poor sanitation and hygiene can be viral, bacterial, parasitic, protozoal, helminth, and fungal in nature, and have many pathways: fecal-oral, urine-oral, and fecal-eye; the main one being fecal-oral [72, 73]. Pathogens can be passed from the **F**eces through **F**luids, **F**ields, **F**lies and **F**ingers, as illustrated in the 'F-diagram' in Figure A1 [74]. In addition, **F**ood can act as an intermediary for all of these four direct transmission pathways. Some pathogens can also be transmitted through human and animal urine, most notably typhoid, digenetic trematodes, and leptospirosis. Skin diseases common in developing countries (e.g. ringworm, scabies) are usually passed through person-to-person contact.

Figure A1. The F-diagram and four main methods for breaking disease transmission



Source: Wagner and Lanoix (1958) [74]

The principle 'poor practices' that support heightened transmission of disease from human excreta include an unsanitary toilet area, poor personal hygiene practices following toilet-going, open defecation in fields or water sources, lack of protection or treatment of drinking water, poor food preparation practices, and lack of latrine and water-source protection in flood-prone areas. Furthermore, exposure to household solid waste, agricultural and industrial wastes can also lead to disease and premature death, from contact with toxic materials or other dangerous substances.

Poor sanitation is directly and indirectly affecting population health. Directly, poor sanitation causes diarrheal infections and other health effects which in turn lead to mortality, especially in young children. Indirectly, poor sanitation contributes to child malnutrition through the effect of diarrheal infections on nutritional status. Malnutrition, or poor nutritional status, increases the risk of child mortality from other diseases such as ALRI, malaria and measles, and increases vulnerability and hence incidence of diseases such as ALRI and malaria (Fishman et al., 2004) [75]. This indirect effect of sanitation mainly affects children under the age of five years, while the direct effect of sanitation affects the whole population.

Table A4. Diseases linked to poor sanitation and hygiene, and primary transmission routes and vehicles

Disease	Pathogen	Primary transmission route	Vehicle
Diarrheal diseases (gastrointestinal tract infections)			
Rotavirus diarrhea	Virus	Fecal-oral	Water, person-to-person
Typhoid/ paratyphoid	Bacterium	Fecal-oral and urine-oral	Food, water + person-person
Vibrio cholera	Bacterium	Fecal-oral	Water, food
Escherichia Coli	Bacterium	Fecal-oral	Food, water + person-person
Amebiasis (amebic dysentery)	Protozoa [1]	Fecal-oral	Person-person, food, water, animal feces
Giardiasis	Protozoa [1]	Fecal-oral	Person-person, water (animals)
Salmonellosis	Bacterium	Fecal-oral	Food
Shigellosis	Bacterium	Fecal-oral	Person-person +food, water
Campylobacter Enteritis	Bacterium	Fecal-oral	Food, animal feces
Helicobacter pylori	Bacterium	Fecal-oral	Person-person + food, water
Protozoa			
Other viruses [2]	Virus	Fecal-oral	Person-person, food, water
Malnutrition	Caused by diarrhoeal disease and helminthes		
Helminthes (worms)			
Intestinal nematodes [3]	Roundworm	Fecal-oral	Person-person + soil, raw fish
Digenetic trematodes (e.g. Schistosomiasis Japonicum)	Flukes (parasite)	Fecal/urine-oral; fecal-skin	Water and soil (snails)
Cestodes	Tapeworm	Fecal-oral	Person-person + raw fish
Eye diseases			
Trachoma	Bacterium	Fecal-eye	Person-person, via flies, fomites, coughing
Adenoviruses (conjunctivitis)	Protozoa [1]	Fecal-eye	Person-person
Skin diseases			
Ringworm (Tinea)	Fungus (Ectoparasite)	Touch	Person-person
Scabies	Fungus (Ectoparasite)	Touch	Person-person, sharing bed and clothing
Other diseases			
Hepatitis A	Virus	Fecal-oral	Person-person, food (especially shellfish), water
Hepatitis E	Virus	Fecal-oral	Water
Poliomyelitis	Virus	Fecal-oral, oral-oral	Person-person
Leptospirosis	Bacterium	Animal urine-oral	Water and soil - swamps, rice fields, mud

Sources: WHO http://www.who.int/water_sanitation_health/en/ and [76, 77]

Notes to Table A4

[1] There are several other protozoa-based causes of GIT, including

- Balantidium coli – dysentery, intestinal ulcers
- Cryptosporidium parvum - gastrointestinal infections
- Cyclospora cayetanensis - gastrointestinal infections
- Dientamoeba fragilis – mild diarrhea
- Isospora belli / hominus – intestinal parasites, gastrointestinal infections

[2] Other viruses include:

- Adenovirus – respiratory and gastrointestinal infections
- Astrovirus – gastrointestinal infections
- Calicivirus – gastrointestinal infections
- Norwalk viruses – gastrointestinal infections
- Reovirus – respiratory and gastrointestinal infections

[3] Intestinal nematodes include:

- Ascariasis (roundworm - soil)
- Trichuriasis trichiura (whipworm)
- Ancylostoma duodenale / Necator americanus (hookworm)
- Intestinal Capillariasis (raw freshwater fish in Philippines)

Table A5 presents data available from the national health information systems on the number of recorded cases and deaths from key sanitation and hygiene-related diseases. Given the large number of diseases and health effects due to poor sanitation, the present study selected the key health impacts based on their epidemiological and economic importance in each country. The availability of health data from national statistics, local research studies and international sources also played an important role in disease selection. Although these data are not representative of the total disease burden at national level due to underreporting, they provide an indication of which diseases are of most significance nationally to aid selection of diseases in the present study. In all countries except the Philippines, the number of people seeking treatment from private providers is excluded from these figures.

Table A5. Reported cases and deaths of sanitation and hygiene-related diseases

Disease	Reported cases or prevalence (%) and deaths (in brackets)			
	Cambodia	Indonesia	Philippines	Vietnam
Population size	13,800,000	221,900,000	84,200,000	84,200,000
Child mortality (per 1,000) [1]	83	36	33	19
Diseases directly related to poor water and sanitation				
Diarrheal diseases	706,083 (99)	1,950,745 (na)	636,084 (4,015)	964,420 (42)
Diarrhea	395,364 (42)	-	614,884 (na)	na (na)
Dysentery	310,719 (8)	3,768 (6)	7,509 (na)	na (na)
Typhoid	10,408 (48)	160,099 (438)	13,528 (892)	na (na)
Cholera	125 (1)	4,104 (5)	163 (85)	na (na)
Rotavirus	na (na)	na (2,230)		na (na)
Helminthes (worms)	na (na)	40-60% (10)	na (na)	24,545 (na)
Schistosomiasis	na (na)	41 (2)	9,383 (na)	na (na)
Trachoma	na (na)	911 (0)	na (na)	982,667 (na)
Skin diseases	202,786 (0)	346,829 (246)	na (na)	206,137 (na)
Hepatitis A	na (na)	4,000 (45)		7,834 (na)
Hepatitis E	na (na)	179 (5)	3,907 (950)	na (na)
Poliomyelitis	na (na)	303 (na)		na (na)
Leptospirosis	na (na)	na (na)	209 (na)	na (na)
Diseases indirectly related to poor water and sanitation, via malnutrition (children under five)				
Stunted children[3]	597,485 [2] (na)	19.2% (na)	3,036,224 (na)	1,818,939 (na)
Wasted children[3]	na (na)	11% (na)	2,958,868 (na)	na (na)
Associated diseases				
ALRI	964,688 (926)	625,611 (na)	417,038 (na)	488,610 (2,476)
Measles	1,350 (1)	5,811 (44)	2,894 (na)	8,160 (na)
Malaria	63,167 (282)	0.02% (53)	5,272 (na)	99,276 (18)

Sources: National Health Information Systems; Cambodia malnutrition statistics from DHS.

[1] World Development Indicators, except Cambodia, which is per DHS 2005.

[2] Statistic reflects underweight children in Cambodia

[3] Malnutrition: 'Stunting' is low height-for-age; wasting is low weight-for-height; underweight is low weight-for-age

In all countries, diarrheal diseases and diseases related to malnutrition were included due to their high rates. Diseases related to malnutrition include ALRI, measles and malaria, where relevant. In Cambodia and the Philippines, diarrheal diseases were disaggregated by principle sub-types: mild diarrhea, dysentery, cholera and typhoid. Skin diseases were included in all countries except the Philippines. In Indonesia and Vietnam, helminthes, trachoma and hepatitis A were included. In Indonesia, hepatitis E was also evaluated. Other diseases listed in Table A4 were omitted due to being relatively unimportant (e.g. schistosomiasis) or lack of data (e.g. poliomyelitis, leptospirosis).

A2.2 Disease burden from diseases directly related to poor sanitation

In order to estimate the full impact of diseases on the daily activities of afflicted people, it is necessary to estimate the total number of episodes, and not just the episodes seeking treatment, as indicated imperfectly from routine health information systems. As shown by household surveys such as the nationally representative Demographic and Health Surveys, a proportion of the sick do not seek official care, and can approach an informal carer, or they may self-treat by visiting the local pharmacy, or they wait to see if the disease gets better with no action (Table A15).[11] Hence, for diarrheal disease in under-fives (or under-threes) the incidence rates from DHS are used (Table A6). A DHS usually reports prevalence during a two-week recall period based on self-diagnosis. Note that the national averages from DHS data presented in the table hide a considerable variation by age group (<1 versus >1) and geographical location. For the over five population, sub-regional incidence rates used previously by WHO are used [78, 79]. In estimating total cases, an attributable fraction of diarrheal disease to poor sanitation and hygiene of 88% was applied to the rates in Table A6 [72]. For other diseases, to estimate incidence, official statistics reporting those seeking treatment at public health providers were adjusted by the proportion disease cases seeking care from DHS statistics.

Table A6. Diarrheal disease incidence

Country	Cases of diarrhea per person, by age group			
	0 to 4[1]	5 to 14[2]	15 to 59[2]	60+[2]
Cambodia	4.06	0.33-0.52	0.16-0.26	0.16-0.26
Indonesia	2.06	0.36-0.57	0.18-0.29	0.18-0.29
Philippines	2.30	0.33-0.52	0.16-0.26	0.16-0.26
Vietnam	2.35	0.33-0.52	0.16-0.26	0.16-0.26

[1] DHS data used for children under five years. Latest DHS data: Cambodia 2005; Indonesia 2003; Philippines 2003; Vietnam 2002. Based on DHS data of 2-week recall, the calculation is to take the proportion of children with diarrhea in the past 2 weeks, and scale up to a one-year period by multiplying by 52 (weeks) and dividing by 2.5 (recall period 2 weeks, but cases recalled 2 weeks ago would have contracted diarrhea up to half a week before that).

[2] WHO regional estimates for population over five years of age. Lower WHO figure represents improved sanitation, while upper WHO figure reflects unimproved sanitation.

[11] As shown by the regional and socio-economic disaggregations of these survey data, treatment-seeking behaviour varies significantly between different populations, and depends on such factors as geographical proximity to health services, out-of-pocket costs of treatment and transport, attitudes towards health providers, and cultural factors.

A2.3 Burden from diseases indirectly related to poor sanitation

The approach used here to estimate the indirect health effects of sanitation (via malnutrition) in children is taken from a report by Larsen (2007) [93] for a World Bank study [1], and was executed as follows:

(a) the effect of diarrheal infections on children's nutritional status is first determined from a review of the research literature;
(b) counterfactual nutritional status is then estimated, i.e., the nutritional status that would have prevailed in the absence of diarrheal infections; and
(c) health effects of currently observed nutritional status and health effects of counterfactual nutritional status are estimated.

The difference in health effects of observed versus counterfactual nutritional status is then the indirect health effect of diarrheal infections, caused largely by poor sanitation.

Commonly used indicators of poor nutritional status are underweight, stunting and wasting.[12] Underweight is measured as weight-for-age (WA) relative to an international reference population.[13] Stunting is measured as height-for-age (HA), and wasting is measured as weight-for-height (WH). Underweight is an indicator of chronic or acute malnutrition or a combination of both. Stunting is an indicator of chronic malnutrition, and wasting an indicator of acute malnutrition. Underweight status is most commonly used in assessing the risk of mortality and morbidity from poor nutritional status.

A child is defined as mildly underweight if his or her weight is in the range of -1 to -2 standard deviations (SD) below the weight of the median child in the international reference population, moderately underweight if the weight is in the range of -2 to -3 SDs, and severely underweight if the child's weight is below -3 SD from the weight of the median child in the reference population. The standard deviations are also called z-scores and noted as WAZ (weight-for-age z-score).

Repeated infections, and especially diarrheal infections, have been found to significantly impair weight gains in young children. Studies documenting and quantifying this effect have been conducted in communities with a wide range of infection loads in a diverse group of countries such as Bangladesh [80-82], Gambia [83, 84], Guatemala [85], Guinea-Bissau [86], Indonesia [87], Mexico [88], Peru [89], Philippines [90], Sudan [91], and the United Republic of Tanzania [92].

These studies typically find that diarrheal infections impair weight gains in the range of 20-50%. A mid-point – i.e., 35% of children's weight deficit – is here attributed to diarrheal infections to estimate the indirect disease burden from sanitation.[14] So in the absence of weight retarding infections, the WAZ of an underweight child would be

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[12] Micronutrient deficiencies are not explicitly evaluated here, but are found in other studies to have a significant cost (World Bank, 2006; Horton and Ross, 2003; Horton, 1999). Also, Alderman and Behrman (2006) find a significant cost associated with low birth weight, which in part is caused by low maternal pre-pregnancy body mass index (Fishman et al, 2004).

[13] The international reference population is defined by the National Center for Health Statistics (NCHS standard), United States or by the World Health Organization's international reference population.

[14] A child's weight deficit is the difference in weight between the child's observed weight and the weight of the median child in the international reference population.

approximately 40% greater than the observed z-score (i.e., observed WAZ x (1-0.4)).[15] For instance, if a child has a WAZ=-3, then in the absence of weight retarding infections, the child's WAZ would be -1.8.

The underweight malnutrition prevalence rates are presented in Table A7. Current rates are for the most recent year available. None of the countries officially report the prevalence of mild underweight. Mild underweight is, however, important in relation to the increased risk of child mortality [75]. This rate was therefore calculated for Cambodia and Indonesia from the original household data in the Cambodia DHS 2005 and the Indonesia National Socioeconomic Survey 2005. For the Philippines and Vietnam, the rate of mild underweight is assumed to be about the same as in Indonesia.

Counterfactual underweight prevalence rates – that is, prevalence rates in the absence of weight-retarding infections – where calculated for Cambodia using the original household data in the Cambodia DHS 2005. This was performed through the following procedure: Counterfactual WAZ-scores were calculated for each underweight child in the survey using the formula discussed above (i.e., WAZ reported for each child in the survey multiplied by (1-0.4)). Counterfactual underweight prevalence rates were then tabulated using the counterfactual WAZ. The original survey data in Indonesia, the Philippines and Vietnam were not readily available for this purpose. Counterfactual prevalence rates were therefore estimated using counterfactual rates calculated for Ghana and Pakistan [93]. These comparator countries, along with Cambodia, reflect a sufficient range of counterfactual prevalence rates to estimate such rates for Indonesia, the Philippines and Vietnam.[16]

Table A7. Current and estimated counterfactual underweight prevalence rates in children under five

Prevalence	Cambodia	Indonesia	Philippines	Vietnam
Current prevalence rates				
Severe underweight (< - 3 SD)	6.6%	8.8%	8.8%[1]	3.3%
Moderate underweight (-2 to -3 SD)	29.1%	19.2%	19.2%[1]	18.6%
Mild underweight (-1 to -2 SD)	38.5%	29.3%	29.3[1]	30.0%[2]
Non-underweight (> -1 SD)	25.9%	42.7%	42.7%	48.1%
Counterfactual prevalence rates				
Severe underweight (< - 3 SD)	0.07%	0.10%	0.10%	0.05%
Moderate underweight (-2 to -3 SD)	3.0%	2.0%	2.0%	2.0%
Mild underweight (-1 to -2 SD)	47.7%	32.0%	32.0%	30.0%
Non-underweight (> -1 SD)	49.2%	65.9%	65.9%	68.0%

Source: Current prevalence rates – Cambodia DHS 2005; Indonesia National Socioeconomic Survey 2005 (SUSENAS); Philippines National Nutrition Surveys 2003 (ENRI); Vietnam Health Statistics Yearbook 2005 (data from National Institute of Nutrition).

[1] Moderate and severe underweight prevalence combined was 28% in the Philippines, and is not reported separately. Nor does the Philippines report the prevalence of mild underweight. The combined rate of moderate and severe underweight is the same as in Indonesia. Mild, moderate and severe underweight prevalence in the Philippines is therefore assumed to be the same as in Indonesia.

[2] Vietnam does not report its mild underweight prevalence rate. It is therefore assumed to be about the same as in Indonesia and the Philippines.

[15] This is calculated using the WHO Anthro 2005 software.

[16] Current underweight prevalence rates in Vietnam are very similar to rates in Ghana. Current rates in Indonesia and the Philippines are between the rates in Ghana and Pakistan.

In the absence of diarrheal infections, it is estimated that practically no children would be severely underweight and the prevalence of moderate underweight would be as low as 2-3%. The prevalence of mild underweight would increase significantly in Cambodia, slightly in Indonesia and the Philippines, and remain the same in Vietnam.

Various health and debilitating effects from malnutrition are documented in the research literature. These include long-term chronic illnesses from low birth weight, the effects of iodine, vitamin and iron deficiencies, and impaired cognitive development [94, 95]. The focus here is on mortality and morbidity in children aged below five years associated with underweight.

Fishman et al (2004) present estimates of increased risk of cause-specific mortality and all-cause mortality in children under five with mild, moderate and severe underweight from a review of available studies [75]. Severely underweight children (WA < -3 SD) are 5 times more likely to die from measles, 8 times more likely to die from ALRI, nearly 10 times more likely to die from malaria, and 12 times more likely to die from diarrhea than non-underweight children (WA > - 1 SD). Even mild underweight doubles the risk of death from major diseases in early childhood (Table A8).

Table A8. Relative risk of mortality from mild, moderate and severe underweight in children under 5[1]

Weight-for-age (WA)	< - 3 SD	-2 to -3 SD	-1 to -2 SD	> - 1 SD
Pneumonia/ALRI	8.1	4.0	2.0	1.0
Diarrhea	12.5	5.4	2.3	1.0
Measles	5.2	3.0	1.7	1.0
Malaria	9.5	4.5	2.1	1.0
Other causes of mortality	8.7	4.2	2.1	1.0

Source: Fishman et al (2004) [75].
[1] Not including mortality from perinatal conditions.

Child underweight also increases the risk of illness. Fishman et al (2004) present estimates of increased risk in children under five with moderate and severe underweight (WA < - 2 SD). The largest increased risk of illness is for pneumonia/ALRI. No increased risk of measles is confirmed (Table A9).

Table A9. Relative risk of illness from moderate and severe underweight in children under five

Weight-for-age (WA)	< - 2 SD	> - 2 SD
Pneumonia/ALRI	1.86	1.0
Diarrhea	1.23	1.0
Measles	1.00	1.0
Malaria	1.31	1.0

Source: Fishman et al (2004) [75]

These relative risk ratios can be applied to the underweight prevalence rates in Table A7 to estimate attributable fractions (AF) of mortality and morbidity from diarrheal infections through their effect on nutritional status (underweight status).[17] The

[17] The attributable fraction of mortality or morbidity from malnutrition is the percentage of deaths or percentage of cases of illness (e.g., percentage of ALRI deaths or cases of ALRI) caused by malnutrition.

following formula is used to calculate attributable fractions of ALRI, measles, malaria, and 'other causes' of mortality, and attributable fractions of ALRI and malaria morbidity incidence from diarrheal infections:

$$AF = \frac{\sum_{i=1}^{n} P_i RR_i - \sum_{i=1}^{n} P_i^C RR_i}{\sum_{i=1}^{n} P_i RR_i} \qquad (1)$$

where RR_i is relative risk of mortality or morbidity for each of the WA categories (i) in Tables A8 and A9; P_i is the current underweight prevalence rate in each of the WA categories (i); and P_i^c is the counterfactual underweight prevalence rate in each of the WA categories (i). This formula is also called the 'potential impact fraction' because it estimates the mortality or morbidity that would have been avoided for a different counterfactual population distribution (e.g., fewer children being underweight) exposed to those levels of risk of mortality or morbidity.

For diarrheal mortality and morbidity, the AF estimation procedure would be different because there are two risk factors, i.e. the direct effect of sanitation and the indirect effect through malnutrition. As already 88% of diarrheal infections and mortality is estimated to originate from sanitation (or mediated from sanitation through water), the additional effect of malnutrition is minimal and is therefore ignored here.[18]

Annual cases of mortality and morbidity from diarrheal infections caused by poor sanitation, through the effect of infections on nutritional status, are estimated as follows:

$$M = c \sum_{j=1}^{j=m} AF_j M_j^0 \qquad (2)$$

where AF_j is the AF in equation (1) for each cause of mortality or type of disease '(j)', M_j^0 is the current total annual cases of mortality or disease incidence in each of the categories in Tables A8 and A9, and 'c' is the fraction of diarrheal infections caused by poor sanitation (88%).

Table A10. Estimated cause-specific annual deaths in children under five in 2005

Disease	Cambodia	Indonesia	Philippines	Vietnam
Diarrheal disease	7,500	25,500	9,800	4,600
ALRI	5,400	22,400	11,600	4,700
Measles	1,600	12,400	5,500	1,400
Malaria	2,900	4,900	400	1,900
PEM	900	2,800	1,000	20
LBW	4,000	36,200	7,800	5,400
Other perinatal conditions	6,800	22,400	14,900	3,800
Other causes	5,600	30,400	16,200	6,300
Total	**34,700**	**157,000**	**67,200**	**28,120**

[18] See Larsen (2007) for methodology and estimation of environmental health effects from multiple environmental risk factors in Ghana and Pakistan.

Source: Adjusted to 2005 from WHO country estimates of mortality by cause in 2002 (WHO, 2004a), by applying child mortality rate in 2005.

The most recent available estimates of annual cases of mortality (M_j^0) in children aged under five are presented in Table A10. These estimates reflect under five child mortality rates in 2005, and the structure of cause-specific deaths is estimated from WHO country estimates of cause-specific mortality in 2002 [96].

Table A11. Demographic and mortality data in 2005

	Cambodia	Indonesia	Philippines	Vietnam
Mortality rate, under-5 (per 1,000)*	83	36	33	19
Population, total**	13,806,974	218,868,791	84,221,578	83,119,900
Number of children under five**	1,694,990	19,297,054	10,650,271	7,356,100
Estimated annual births***	369,682	4,003,538	2,202,745	1,499,715

Source: * World Bank (2007) and Cambodia DHS 2005 for child mortality; ** country population statistics; *** estimated from the number of children under five.

Complete records or statistics on annual cases of ALRI and malaria in children under five are not available in any country. This is due to many reasons, including incomplete reporting and record systems, cases never treated by health care providers, and incomplete or potentially incorrect case identification and diagnostics. Annual cases therefore need to be estimated. WHO provides regional estimates of ALRI for the year 2002, the most recent available [97]. These data suggest that the incidence of ALRI in children under five in Asia is on the order of 0.35 to 0.7 cases per child per year. An annual incidence of 0.35 cases of ALRI is therefore applied to Indonesia, the Philippines and Vietnam. In Cambodia, which still faces more health challenges than many of the other countries in the region, an annual incidence of 0.5 is applied. Annual incidence in all children under five is the incidence per child multiplied by the number of children (Table A11).

The incidence of malaria is likely more uncertain than the incidence of ALRI. The regional WHO data for 2002 suggest that the incidence of malaria in SEAR-B is 0.07 cases of malaria per child per year. Indonesia holds a large share of the population in this region. The incidence of malaria in WPR-B is only 0.001 per child per year, as China constitutes more than 80% of the population in this region and has a very low incidence of malaria.

A recent WHO paper estimates that the global incidence of malaria in 2004 was 6 times higher than recorded in national health information systems, and around 17 times higher in non-African countries [98]. The estimated country population incidence in Korenromp (2005) indicates that the incidence in children under five could range from 0.16 cases per child per year in the Philippines, 0.27 in Vietnam, 0.39 in Indonesia, and 0.8 in Cambodia.[19] These estimates are, however, highly uncertain. A much more conservative estimate would be to assume that the incidence in children under five in Indonesia is 0.07 cases per child per year (as reported for SEAR-B for the year 2002) and that the incidence in the other countries is in the same proportion relative to the

[19] Korenromp provides the only present population incidence. The WHO regional data indicate that the incidence in children under five in SEAR-B is 4.5 times higher than the population incidence. This ratio is applied to the estimated population incidence in Korenromp to estimate incidence in children under five.

estimated incidence in Korenromp (2005). This approach gives an estimated incidence of 0.03 in the Philippines, 0.05 in Vietnam, 0.07 in Indonesia, and 0.14 in Cambodia. Using the incidence rates, annual cases of malaria in children under five are presented in Table A12.

Table A12. Estimated annual cases of illness in children under five (thousand cases)

Disease	Cambodia	Indonesia	Philippines	Vietnam
ALRI	847	6,754	3,728	2,575
Malaria	242	1,351	298	355

Sources: Estimated from regional WHO incidence data (WHO, 2004b) and Korenromp (2005).

Applying equation (2) to the cases of mortality and illness provides an estimate of mortality and morbidity from poor sanitation (Table 13). Mortality in children from protein-energy malnutrition (PEM) is estimated separately using the methodology in Fishman et al (2004) and attributing a fraction of this mortality to sanitation in proportion to the effect of diarrheal infections on malnutrition. Diarrheal mortality from poor sanitation is 88% of total diarrheal mortality.

About 95% of estimated annual mortality is of children under five. In children under five, mortality directly attributable to poor sanitation (i.e. diarrheal mortality) constitutes 13-19% of total under five child mortality. Mortality attributable to sanitation from malnutrition (i.e. the indirect effect of infections through malnutrition) constitutes 16-20% of total under-five child mortality. Total mortality attributable to sanitation is 30-37% of total under-five child mortality (Table A13). However, only malaria, measles and ALRI are included in VOSL estimates, and hence the 'other' category and PEM are excluded.

Table A13. Percentage of total under-five child mortality attributable to poor sanitation

Variable	Cambodia	Indonesia	Philippines	Vietnam
Directly attributable mortality to sanitation	19%	14%	13%	14%
Mortality attributable to sanitation from malnutrition	18%	18%	20%	16%
Total mortality attributable to sanitation	37%	32%	33%	30%

For morbidity in children under five, ALRI attributable to sanitation from malnutrition constitutes 13-19% of annual cases, and malaria attributable to malnutrition constitutes 5-8% of annual cases (Table A14).

Table A14. Percentage of cases of illness in children under five attributable to poor sanitation

Variable	Cambodia	Indonesia	Philippines	Vietnam
ALRI attributable from malnutrition	19%	16%	16%	13%
Malaria attributable from malnutrition	8%	7%	7%	5%

A2.4 Health care cost estimation

Health care costs result from treatment-seeking for diseases associated with poor sanitation and hygiene. Health care cost estimation requires information on disease prevalence or incidence for the selected diseases, treatment-seeking rates, and health system variables such as treatment practices and unit costs. Health care costs can fall on both the patient and the public health system, depending on where the sick person seeks care and the tariff rates in public as well as private facilities. A public-private distinction is made in Cambodia and Vietnam, but not in Indonesia and the Philippines due to the lack of disaggregated data on treatment-seeking in those countries. In Cambodia and Vietnam where a public-private distinction is made, private health care is assumed to be fully financed by the patient, and costs are both financial and economic in nature. Financial costs include the marginal costs of treating patients at public facilities (mainly drugs), patient transport costs and the full cost of treatment in private clinics or self-treatment. In the absence of data on the actual production costs of health care provided by the private sector, the tariffs are taken to reflect the health care costs. Economic costs include the financial costs *plus* the short-term fixed costs of public health facilities such as staff, capital items and overheads.

In order to estimate the costs of health care, it is necessary to know the total number of cases seeking health care from different providers. Given that government statistics are often incomplete, public facility treatment-seeking figures were adjusted to reflect the total cases seeking care. Table A15 presents the most recent and nationally based figures on treatment-seeking for diarrheal disease. In most countries, treatment-seeking rates were available for other diseases evaluated (found in the individual country reports).

Based on the number of reported cases in the public health system (Table A15), and the place of treatment-seeking (Table A15), the total cases seeking treatment are estimated for each disease, for each health care provider, and for each region of a country. To arrive at the total figure of disease attributable to poor sanitation and hygiene, the figures are adjusted *upwards* by an estimated factor to account for underreporting of national health information systems (10% in all countries except the Philippines where no adjustment was made), and then adjusted *downwards* to account for the fraction of attribution of the disease to poor sanitation and hygiene: 88% for diarrhea [72], 50% for malnutrition [73], 50% for skin diseases [99, 100], and 100% for helminthes, trachoma, and viral hepatitis.

Table A15. Treatment-seeking behaviour for diarrheal disease, by provider

	% seeking treatment from:					No treatment
	Public provider	Private formal clinic	Private informal care	Self-treatment	Other	
Cambodia	10.5%	8.6%	16.3%	33.5%	2.1%	29.1%
Indonesia[1]	33%		2%	66%	-	-
Philippines	43.7%		13.0%	13.0%	0.0%	30.3%
Vietnam	3.0%	8.0%		66.0%	0.0%	23.0%

Sources: Cambodia: Socioeconomic Survey 2004. Indonesia: Welfare Statistics 2006; Philippines: Demographic and Health Survey 2004; Vietnam: National Health Survey 2002.

[1] Figures reflect outpatient treatment-seeking for all diseases. Of those seeking care in Indonesia, 47.2% seek a public facility, 27.4% a private facility, 18.5% a paramedic, 2.1% traditional care, and 4.9% others.

In order to calculate the costs associated with the cases seeking health care, it is necessary to know the treatment practices, the proportion of cases that are admitted for inpatient stay, the average length of hospital stay, and the costs associated with health care for each disease. Table A16 shows these variables for diarrhea cases receiving their care from public providers and the private formal sector, distinguishing between financial and economic cost per visit and day. In Indonesia, place of treatment is distinguished by formal and informal care. Informal care and self-treatment cost for other countries, and the costs of treatment of other diseases, are found in the individual countries reports.

Table A16. Health service use and unit costs associated with treatment of diarrhea

Country	Facility	Outpatient cost (US$)			Inpatient cost			
		Financial	Economic	Other[3]	ALOS[4]	Financial	Economic	Other[3]
Cambodia	**Public**	0.60	1.60	1.80	4.0	1.2	2.8	1.8
	Private	3.10	3.10	0.60	2.7	16.2	16.2	0.6
Indonesia	**Formal[1]**	2.30	5.50	0.45	3.0	2.27	8.09	0.91
	Informal	1.10	2.75	0.45	-	-	-	-
Philippines	**Public & private[1]**	1.03 - 3.46	3.91 - 10.16	0.25	1.00 - 5.00	1.00 - 5.01	9.1 - 16.4	0.25
Vietnam[2]	**Public**	3.87	0.96	2.90	4.55	6.25	22.83	4.56
	Private	3.27	0.80	4.29	4.55	1.44	18.05	1.05

Source: Country reports.
[1] Public and private providers are not distinguished in Indonesia and the Philippines. The range provided for the Philippines reflects unit cost variation between mild and severe diarrhea.
[2] Figures for Vietnam reflect the average of rural and urban unit costs.
[3] Other: non-health patient costs such as transport, food, and incidental expenses.
[4] ALOS: average length of stay. Variation in the Philippines reflects the difference between acute watery diarrhea (1 day) and acute bloody diarrhea, cholera and typhoid (5 days).

A2.5 Health-related productivity cost estimation

Disease takes people away from their occupations and daily activities, and regular sickness-related absences from school affect the ability of children to keep up with the curriculum and complete their education. Therefore, time lost from work, school or daily activities has a value. Disease numbers are based on reported national statistics, except for diarrheal disease and indirect diseases, where alternative estimation methods are used. For diarrheal diseases, incidence for children aged below five years is taken from DHS data, and for the over-fives from WHO regional statistics (Table A6). For indirect morbidity estimates (ALRI and malaria), see Tables A12 and A13.

Given that time off work is determined by the severity of the disease, as well as whether the case was treated or not, assumptions were made on the proportion of cases that are severe, and the treatment-seeking behavior associated with these cases. Table A17 shows the data inputs. Major differences in assumptions used can be observed between countries; however, this largely reflects how data on incidence was sourced in each country and how adjustments were made to the available data.

Table A17. Variables for estimating amount of time lost from disease

Disease	% cases		Days off daily activities			
	Severe	Non-severe	Treated		Not treated	
			Severe	Non-severe	Severe	Non-severe
Cambodia						
Diarrheal diseases	12.3	87.7	5.8	1.2	-	0.7
Skin disease	12.3	87.7	3.5	0.9	-	0.4
Malnutrition	6.9	93.1	17.0	4.8	-	4.3
ALRI	12.3	87.7	8.3	1.5	-	1.0
Measles	12.3	87.7	7.0	1.4	-	0.9
Malaria	12.3	87.7	9.2	1.6	-	1.1
Indonesia						
Diarrheal diseases	10	90	7	2	3	0
Helminthes	10	90	3	0	0	0
Skin diseases	10	90	7	0	0	0
Trachoma	10	90	7	2	3	0
Hepatitis A	10	90	7	2	3	0
Hepatitis E	10	90	7	2	3	0
Malnutrition-related diseases	10	90	7	0	5	0
Philippines						
Acute watery diarrhea[1]	100	0	1	na	2	na
Acute bloody diarrhea[1]	100	0	5	na	7	na
Typhoid[1]	100	0	5	na	7	na
Cholera[1]	100	0	5	na	7	na
Other diarrhea[1]	0	100	na	1	na	2
ALRI	100	0	3	na	7	na
Measles	100	0	3	na	5	na
Malaria	100	0	5	na	14	na
Vietnam						
Diarrheal diseases	4.2	95.8	5.0	2.0	2.0	1.0
Helminthes	12.2	87.8	2.0	-	1.0	-
Trachoma	12.2	87.8	3.0	-	1.0	-
Scabies	12.2	87.8	1.0	-	1.0	-
Hepatitis A	12.2	87.8	30.0	5.0	30.0	5.0
Malnutrition	12.2	87.8	7.0	5.0	7.0	5.0
ALRI	12.2	87.8	7.0	1.0	3.0	1.0
Measles	12.2	87.8	10.0	5.0	10.0	5.0
Malaria	12.2	87.8	10.0	5.0	5.0	3.0

Source: Country reports

[1] All acute watery diarrhea, acute bloody diarrhea, typhoid, and cholera reported in health statistics (i.e. seeking care) are assumed to be severe in the Philippines. Other diarrhea cases, estimated as the difference between reported figures and DHS incidence data, are assumed to be non-severe.

Given that time off work has an opportunity cost, and in some instances involves a real financial loss, time away from daily activities also needs to be given a unit value to estimate the overall financial and economic losses associated with disease. A commonly applied economic valuation technique for time loss is the HCA, which values time loss according to what the sick person could be earning in productive employment. Even when the person would not be earning income (especially in the case of children), time for leisure and other activities can be assumed to have a value greater than zero [101-104]. A second common approach, which measures the sick person's willingness to pay to avoid disease, can more accurately reflect the welfare effects of disease; but due to lack of data on willingness to pay in the study countries, this approach was not used in the study. Hence, HCA is used as it is simple and it reflects the time loss component of disease.

This study distinguishes between financial and economic cost. For some adults, time spent away from productive activities will result in a direct income loss, while for others the salary may be paid for a maximum number of sick days per year. Given the self-employed and/or agricultural nature of the societies of many SE Asian countries, loss of time from productive activities may not result in an immediate financial loss, but may lead to income losses in the future unless a family member or business partner replaces the lost labor. In order to be conservative, financial cost is estimated as immediate income loss for those not paid their wage or earning an income from time lost due to sickness. For each country, this population is estimated based on the available published literature and interpretation of official statistics according to local work patterns and conditions (Cambodia 70%; Indonesia 40%; Philippines 60%; Vietnam 50%).

For those not directly losing income, there will also be a welfare loss, which may include longer-term income earning potential as mentioned above. In estimating economic cost, this study recognizes the value of time lost from daily activities, whether productive working time, school time, or leisure time. Given that the value of time varies according to what the person is doing with their time, economic 'welfare' losses are valued at less than the financial losses described above. Research studies have shown a whole range of results on the value of time. The present study takes the economic value of time as 30% of the unit value of time. Furthermore, this study distinguishes between the value of adults' and children's time, given expected differences in the value of time. On the other hand, children's time is not worthless, given that children are or should be at school learning and hence time away from school would mean lost education and eventually lower income levels [105]. Also, for young children of non-school age, sickness will involve more time input from a carer, and hence incurs a cost. In the study countries, caring for a child is mostly the mother's task and thus ill children are more likely to take the time of women than men, hindering women from working. Given the limited empirical work on the value of children's time, and very few precedents in terms of valuing children's time, a time value of 50% of adults' time is given in the present study [79].

Table A18 shows some alternative sources of economic value, comparing GDP per capita, average compensation of employees, minimum wage and average wage. The annual value was converted to hourly value by assuming eight working hours per day and by taking into account the number of working days per year in each country, public holidays and annual leave. Hourly minimum and average wages were converted to annual figures by using the reverse calculation. Compensation of employees was considered the most appropriate global figure to reflect the average value of time, given that it reflects the average salary encompassing all formal employees, and hence best approximates the actual average value of time. Compensation of employees per capita was calculated at regional level in each country by multiplying national compensation of employees by the ratio of GDP per capita at regional compared to national level, and dividing by the total full-time equivalent workforce. In Vietnam, this statistic is less reliably calculated and hence GDP per capita was chosen as the value of time. For calculations at sub-national levels (regional or provincial), Gross Regional Product was used to reflect different economic levels within the study countries. Other sources of time value were used in sensitivity analysis.

Table A18. Comparison of alternative sources of time value (US$)

Country	GDP per capita		Average compensation of employees		Minimum wage		Average wage	
	Annual	Hourly	Annual	Hourly	Annual	Hourly	Annual	Hourly
Cambodia	447	0.24	489	0.26	600	0.32	293	0.27
Indonesia	1,337	0.66	2,776	1.38	819	0.41	1,033	0.51
Philippines	1,282	0.60	780	0.40	819	0.40	-	-
Vietnam	723	0.12	411	0.07	-	-	134	0.02

Source: Country reports

A2.6 Premature death cost estimation

The cost of premature death is calculated by multiplying the number of deaths by the unit financial and economic value of a death.

Premature death affects society in a number of ways, and has proven to be difficult to value with any degree of precision. As a result, economists have employed a range of methods for valuing premature loss of human life [106]. The most tangible economic impact of premature death is the loss of a member of the workforce, with implications for the economic outputs generated. Hence, HCA approximates welfare loss by estimating the future discounted income stream from a productive person, from the time of death until the end of (what would have been) their productive life. However, this technique has been criticized for that fact that it values human life exclusively for its productive potential. Empirical evidence indeed proves that life has a value beyond the productive worth of a human, which both society as a whole and individuals are willing to pay for in order to safeguard [107, 108].

Various other methods are available to estimate the broader economic as well as inherent worth of human life:

1. Observations of actual market and individual behavior with respect to what individuals pay to reduce the risk of death (e.g. safety measures) or what individuals are willing to accept for an increase in the risk of death (e.g. wage premium for risky jobs). This approach is known as ‘hedonic pricing’.
2. Stated preference from individuals exposed to risk, using interview techniques. This approach is known as ‘contingent valuation’.

Both these approaches estimate directly the willingness to pay of individuals, or society, for a reduction in the risk of death, and hence are more closely associated with actual welfare loss compared with the HCA.

The problem in making an evaluation of life is that the alternative methods can result in very different estimates, and applications of the same techniques to different contexts can also reveal very different implicit values in reducing the risk of death. For example, willingness to pay studies generally show greater value of life than the HCA. These variations and differences will affect the credibility of economic studies when used for policy decisions, and hence considerable care is needed in estimating and presenting the economic impact of premature loss of life to policy makers. Therefore, in order to sound more plausible to policy makers, the present study uses the more conservative

HCA, described below. Sensitivity analysis explores the implications of alternative values for loss of human life using the 'willingness to pay' approach.

Human capital approach
The human capital approach summates the future years of income at the average age of death. Given lack of data on exact age of death, three time points of death were used: 2 years of age for the 0-4 age group; 9 years of age for the 5-14 age group; and 40 years of age in the 15+ age group. The discount rate applied was 3%, reflecting the social rate of time preference approximated by the long-term real interest rate. Also, given that per capita income grows over time, a presumed long-term per capita income growth of 2% was applied to future incomes. Average income was taken from the average compensation of employees for each country, and adjusted to sub-national level by applying gross regional product per capita ratios. For younger age groups that will not be in the work force for several years, the net present value of future earnings are further discounted to take this into account. The values are shown in Table A19.

Financial costs of premature death were approximated using the HCA by assuming a coping period following the loss of an adult member of the family. The coping period could be the period after which the income of the lost adult is expected to be replaced. A period of one year is conservatively used in this study. Therefore, the average compensation of employees for a single year is applied to the number of adult deaths to estimate the financial impact of premature death. The average annual compensation of employees used is US$489 in Cambodia, US$2,776 in Indonesia, US$780 in the Philippines and US$411 in Vietnam.

'Willingness to pay' approach
Given the lack of estimates of willingness to pay for avoiding death in developing countries, and SE Asian countries in particular, the benefits-transfer method was applied for the willingness to pay method. This essentially involves taking VOSL values from a meta-analysis of studies in developed countries and transferring the value directly using an adjustment for differences in income. While this approach has many weaknesses [109], the absence of data from developing countries justifies the use of this 'benefits transfer' approach. The VOSL reported in North American and European studies is highly variable, ranging from around US$1 million to more than US$ 10 million [107, 110-114]. A meta-analysis of 40 VOSL studies by Bellavance et al in 2007 reported an average VOSL of US$9.5 million and a median VOSL of US$6.6 million [115], similar to the mean estimate of US$5.4 million found by Kochi et al (2006) [116]. Developing country studies are few. A study of the Indian labor market found a VOSL varying from roughly US$0.14 million to US$0.38 million [117]. Given the large number of studies from OECD countries, an adjusted benefit transfer is justified rather than transfer from a single study from a comparable developing country. In order to remain highly conservative, a VOSL estimate of US$2 million is used, which is significantly lower than the values presented in the meta-analyses conducted by Bellavance (2007) [115] and Kochi (2006) [116], but consistent with the mid-range in the meta-analysis conducted by Mrozek and Taylor (2002) [118]. This value also reflects the lower end of the US$2 million to US$4 million recommended by Abelson for public policy [107].

The VOSL of US$2 million is transferred to the study countries by adjusting downwards by the ratio of GDP per capita in each country to GDP per capita in the

USA. The calculation is made using official exchange rates, assuming an income elasticity of 1.0. Direct exchange from higher to lower income countries implies an income elasticity assumption of 1.0, which may not be true in practice. Therefore, the benefits transfer from OECD studies was also made at income elasticities of 0.8 and 0.6. Alternative VOSL values used are shown in Table A19.

Table A19. Unit values for economic cost of a premature death, in US$ 2005

Variables	Human capital approach[1]			Willingness to pay using benefits transfer[2]		
	0-4 years	5-14 years	15+ years	IE = 1.0, at OER	IE = 0.8, at OER	IE = 0.6, at OER
Cambodia	17,223	20,328	10,795	20,439	51,118	127,846
Indonesia	97,760	115,387	61,278	58,528	118,603	240,341
Philippines	45,787	54,042	28,700	59,442	120,083	242,588
Vietnam	25,464	30,056	15,961	33,059	75,100	170,603

[1] Low and high values are produced by using income per capita growth of 1% and 4% (base case 2%).
[2] Low and high values are produced by using US$1 and US$4 million as VOSL (base US$2 million). IE = income elasticity; OER = official exchange rates; PPP = purchasing power parity.

A3. Water resources

The 2003 United Nations Report 'Water for people, Water for Life' states that many rivers, lakes and groundwater resources are becoming increasingly polluted, and that human excreta is one of the most frequent sources of pollution [119]. In SE Asian countries, a significant proportion of human excreta is flushed directly into water resources due to low coverage of sewage treatment for piped sewerage, or else human excreta eventually finds its way into water resources through open defecation, leaking septic tanks or seepage from pit latrines. As a result, levels of suspended solids in rivers in Asia have risen by a factor of four over the last three decades and Asian rivers have a higher BOD and bacterial content than the global average [119]. The results of polluted water on human activity are many: previously safe drinking water sources are rendered unusable, and water becomes less productive or less usable for agricultural purposes including fish production, or for industrial and domestic uses. According to the Asian Development Bank, the threat to fish production is especially important, given the economic importance, subsistence value and nutritional value of fish in the SE Asian region [120].

While domestic sources contribute importantly to water pollution in most developing countries, the presence of other sources of water pollution means that overall economic impact of polluted water cannot be attributed to poor sanitation alone. Pollutants affecting water-related activity include microorganisms, organics, chemicals, solids, gases and heat [121], and originate from:

- Households (sewage and grey water from bathing, laundry, cooking).
- Offices, medical establishments.
- Small industries (garments, washing, brewery).
- Manufacturing industries (production or processing).
- Chemical fertilizers, pesticides, and treatment of acid-sulfate soils.
- Animal excreta.
- Soil flushed into water courses.
- Silt release following build-up behind dams.
- Salinity intrusion from coastal areas.

Major categories of water use include drinking water, domestic uses, crop and fish production, energy production, industry, recreation and transport. For some of these activities, good quality water is important – such as for drinking – while for other uses water quality standards are not so strict, such as in agricultural and some industrial uses. Therefore, only selected impacts of polluted water are examined in the present study, with the selection of uses of water where there is a strong proven association between poor sanitation and the associated costs.

Inland water quality is affected by many variables, the two main ones being the quantity of polluting substances released and the overall quantity of water resources for absorption of the pollution load. Hence, water quality indicators will need to be interpreted based on these two variables, as well as the multitude of factors that determine them. Furthermore, the economic impact of polluted water depends on what productive and non-productive uses the different water resources have, or *could have,* in different country contexts.

A3.1 Water quality measurement

Water quality monitoring is limited in the study countries. Water quality guidelines from the four countries are incomplete, and as shown in Table A20, some criteria vary between countries, and with the WHO guideline on which most are based. A variety of organizations and agencies are involved in the monitoring of water quality, and the indicators and geographical areas they focus on vary according to their specific interests or mandate. Most, if not all, water quality monitoring is of surface water as opposed to groundwater.

In Cambodia, the Phnom Penh Water Supply Authority conducts water quality tests for the purposes of supplying water to Phnom Penh residents, covering three locations close to the city. The Mekong River Commission conducts water quality tests in many locations in all lower Mekong countries, covering Cambodia, Lao PDR, Vietnam and Thailand.

In Indonesia, water quality monitoring is mainly done by the Government, either at the central, provincial or local level, depending on the water body location. Major monitoring activities include the Clean River Program, which since 1995 has targeted the most heavily polluted rivers, including monitoring and rating of industrial wastewater discharge. The Clean City Award Program targets urban areas, and since 1998 water quality has been evaluated. In addition, a centrally-supported government program has monitored one river in each province between 2002 and will continue to do so until 2008. Further to these government-based activities, water companies also conduct water quality monitoring for the purposes of sourcing water supplies.

In the Philippines, the Environmental Management Bureau (EMB) is tasked with the regular monitoring of 238 water bodies throughout the country; depending on the resources of each region, monitoring is done either on a monthly or quarterly basis.

Table A20. Selected drinking water quality guidelines in study countries

Indicator	Unit	WHO	Cambodia	Indonesia	Philippines	Vietnam
Colour	TCU	15	5	-	5	15
pH value	Unit	6.5-8.5	6.5-8.5	6-9	6.5-8.5	6.0-8.5
Suspended solids	Mg/l	1	-	50	NS	-
Turbidity	NTU	<0.1	5	-	5	5
Total dissolved solids	Mg/l	600	800	1000	500	1,200
Dissolved oxygen	Mg/l	<10	-	6	NS	-
Total coliform	Cfu/100ml	0	0	-	0	50
Fecal coliform[1]	Cfu/100ml	0	0	-	0	0
Taste and odor			-	-	Unobjectionable	
Aluminum	Mg/l	.05-.2	.2	-	0.2	-
Chloride	Mg/l	25-250	250	-	250	300
Copper	Mg/l	0.02-1	1	0.02	1	-
Hardness ($CaCO_3$)	Mg/l	70	-	-	300	-
Hydrogen sulfide	Mg/l		-	-	0.05	-
Iron	Mg/l	.1-.3	.3	0.3	1	0.5
Manganese	Mg/l	.05-.5	.1	-	0.5	0.5
Sodium	Mg/l	-	-	-	200	-
Sulfate	Mg/l	25-250	250	-	250	-
Zinc	Mg/l	.5-3	3	-	5	3
N-Ammonia (NH_3-N)	Mg/l	.05-.5	-	0.5	NS	3
Nitrate (by NO_3^-)	Mg/l	5-50	50	10	NS	50
Nitrite (by NO_2^-)	Mg/l	1-3	3	-	NS	3
Arsenic	Mg/l	-	-	0.05	NS	0.05
Cobalt	Mg/l	-	-	0.2		
Barium	Mg/l	-	-	1		
Cyanide	Mg/l	.07-1	.07	-	NS	0.07
Fluoride	Mg/l	.1-1.5	1.5	-	NS	1.5
Lead	Mg/l	-	-	-	NS	0.01
Manganese	Mg/l	.05-.5	.1	-	NS	0.5
Mercury	Mg/l	-	-	-	NS	0.001

Sources: WHO: [122]; Cambodia: Phnom Penh Water Supply Authority, 2006; Indonesia: Government Regulation No 82 Year 2001 [123]; Philippines [124]; Vietnam [125].
NS = either no standard exists or not available from accessed documents.
[1] Fecal coliform is also termed 'thermotolerant coliform'.

In Vietnam, the Ministry of Natural Resources and the Environment (MONRE) is responsible for monitoring both surface and ground water, with a network of about 230 hydrological monitoring stations. MONRE also operates a national groundwater monitoring network with 300 regional monitoring stations and more than 600 observation wells across the country. Samples are taken once or twice monthly, with monitoring mainly for hydrological and meteorological purposes. With respect to monitoring water quality for environmental purposes, there are fewer stations under the Vietnam Environment Protection Agency that frequently monitor water quality in selected water bodies. In Vietnam, the Ministry of Fishery monitors water quality in aquaculture areas and the Ministry of Health is responsible for monitoring quality of drinking water.

A3.2 Contribution of poor sanitation to water pollution

Water pollution from domestic sources can be estimated from the annual release or eventual seepage of untreated feces, urine and gray water into inland water bodies. It is estimated by applying the number of population with unimproved sanitation, the proportion of sewage released to water bodies, and average human (and animal) waste production per year. Table A21 presents the figures and assumptions behind the release of human excreta into water bodies. The pollution load from human excreta is based on an average of 0.15 kg of feces and 1.2 litres of urine per person per day in all countries [126]. In urban areas, the average individual produces about 50 grams of BOD per day (15 from gray water and 35 from sewage) and 68 grams of total suspended solids (48 from gray water and 20 from sewage) [127-129]. Rural households without a pipe connection are assumed to have the same amount of sewage as urban households, but zero gray water.

Table A21. Proportion of untreated sewage discharged to water bodies

Country	% sewage discharged directly into inland water body	% sewerage systems leaking	% open defecation in inland water courses	Sewage leakage from septic tanks		Leaking pit latrine	
				Total %	% of which to groundwater	Total %	% of which to groundwater
Cambodia	84%	84%	1.0%	90%	40%	100%	50%
Indonesia	28%	-	7.4%	20.3%	10.2%	14.3%	7.2%
Philippines	70%	10%	-	90%	-	8%	-
Vietnam	100%	-	12.7%	13%	10%	13%	10%

Source: country reports

Table A22 shows the percentage of overall water pollution assumed from different sources, using as a basis the proportion of BOD from each major source. In the Philippines, where secondary data exist on relative shares of major categories of BOD emitters, the overall contribution of domestic sources is 33%. The BOD contributions by agriculture in Indonesia are based on the Philippines baseline rate, and allocated to provinces according to the number of livestock. As data on total BOD from industry and agriculture could not be found in Cambodia and Vietnam, 40% is assumed from domestic sources in Vietnam, and 65% in the less industrialized Cambodia.

Table A22. Contribution of domestic sources to overall water pollution, using biochemical oxygen demand

Country	Domestic	Industry	Agriculture	Other
Cambodia	65%	-	-	-
Indonesia	35%	57%	9%	-
Philippines	33%	27%	29%	11%
Vietnam	40%	-	-	-

Source: The Philippines [130]; Cambodia, Indonesia, Vietnam: assumptions.

A3.3 Cost implications of water pollution for drinking water supply

Both consumers and providers treat water because water sources are not clean. More wealthy populations even purchase bottled water which is either chemically treated or from a protected (mineral) source. The more polluted the water source, the more likely it is that the household will take some form of precautionary measures, and this can increase the unit cost of treatment. In some cases, households will not haul water from more polluted water sources if less polluted sources are available, but it may lead to further time or financial costs. Water treatment plants will also have to spend more to treat polluted water properly, or else source their water from different, less polluted sources. For example, in Vietnam the Dong Nai River at Hoa An Pumping station, which supplies water to Ho Chi Min City and Bien Hoa City, is now polluted with BOD_5 concentrations at twice the Vietnam standard[20]. Consequently, the average price per m^3 has increased from US$0.27 to US$0.56 [131].

Given that drinking water is polluted by several sources and not just from poor sanitary practices, the need to treat water is not altogether removed by removing the human (and animal) waste component of polluted water. However, the removal of human and animal excreta content from water sources may reduce the necessity for treatment or lower the unit cost of treatment.

This present study compares selected indicators from the water quality guidelines with available water quality measures to conclude how polluted water is for drinking purposes. Some of the main indicators that will cause households to purchase or treat water, or walk further to reach cleaner water, are the perceived or actual presence of infectious pathogens (microbial agents) and heavy metals, bad odor due to organics, turbidity caused by solids, and bad taste due to a low pH level and the presence of solids.

For the purposes of cost estimation, household drinking water sources are sub-divided into the following three categories, data for which are presented in Table A23 at national level and in a rural-urban breakdown:

1. Households receive piped water supply, either from water treatment companies or from open community sources. This is an important category in urban areas. The Philippines has the highest rate of household piped water supply at 78.7% of households, compared to Cambodia with 10.1%.
2. Households purchase water from other non-piped suppliers, such as tanker truck, water by the bucket, or bottled water. This is the least important principal source of household water supply in all countries, with rates higher in urban areas, but generally remaining below 5% of all households.
3. Households collect water from free or low-cost community or public sources. This is the most important source for rural areas in all countries except the Philippines, accounting for over 80% of total water supply. In Indonesia, 28% of households collecting water from free sources spend 5-30 minutes doing so, and 8% more than 30 minutes. Time costs are estimated at average compensation of employees, except in Indonesia where 50% of this value is assumed.

In Table A23, the six columns from piped water to hauled water add up to 100%, reflecting the principal source of household water supply. The final column reflects the proportion of households treating water themselves. Except for further household water treatment, rain water is assumed to have zero cost.

[20] BOD measures the rate of oxygen uptake by micro-organisms in a sample of water at a fixed temperature (20°C) and over a period of five days in the dark

Table A23. Sources of drinking water (% households)

Location	Piped water		Other purchased water		Rain water	Drilled and dug wells	Hauled water	Households treating water themselves
	From treatment plant	From other source	Vendor	Bottled water				
Cambodia	**10.1%**	**-**	**3.4%**	**1.5%**	**-**	**85.0%**		**66.3%**
Rural	4.8%	-	3.1%	0.6%	-	91.5%		63.7%
Urban	38.7%	-	4.7%	6.6%	-	50.0%		80.4%
Indonesia	**13.7%**	**2.8%**	**1.8%**	**3.4%**	**2.5%**	**76.7%**		**70-90%** [1]
Rural	9.0%	-	1.0%		3.4%	86.7%		70-90% [1]
Urban	30.8%	-	9.0%		1.4%	58.9%		70-90% [1]
Philippines	**46.7%**	**32.0%**	**2.3%**	**0.4%**	**18.7%** [2]			**44.2%**
Rural	22% [3]		0.8% [3]	1.3 [3]	0.8% [3]	75.1% [3]		- [3]
Urban	56% [3]		2.2% [3]	9.8 [3]	0.1% [3]	31.9% [3]		- [3]
Vietnam	**19.1%** [4]		**0.5%**		**-**	**54.2%**	**26.2%** [5]	**77.0%**
Rural	6.3% [4]		0.3%		-	61.0%	32.3% [5]	89.1%
Urban	57.0% [4]		1.1%		-	34.0%	7.9% [5]	40.9%

Sources: Cambodia: CDHS 2005; Indonesia [132]; Philippines: [35, 133]; Vietnam: [134].

[1] 70% is assumed in four of the poorest Eastern provinces of Indonesia, and 90% in the rest of the country.

[2] For the Philippines, water from wells that is piped to households is included under piped water category; the figures in this column reflect spring, lake, river, and harvested rain water.

[3] For the Philippines, a rural/urban breakdown for the analysis was not possible at regional level; here rural-urban piped and improved non-piped water sources are sourced from JMP data (www.wssinfo.org).

[4] 'Piped water' here includes private tap and nearby public standpipes.

[5] 'Hauled water' here includes filtered spring water, rain water, river, lake, spring, and pond water.

In all countries, household water treatment is common, ranging from 44% of households in the Philippines, to 66% in Cambodia, 77% in Vietnam, and as high as 90% in Indonesian households. These rates are mostly available at sub-national level, and disaggregated by source of water, for cost estimation purposes. As shown by the example of the Philippines in Table A24, households accessing more reliable sources of water do not have significantly lower household water treatment rates. Methods used by households for water treatment include chemical treatment, custom-made filter, improvised filter, boiling, and solar disinfection. The main method used in all countries is boiling. In addition to households, some industries also treat water that does not conform to the required properties for industrial processes. These costs are excluded in the present study.

Various methods are available to estimate the costs of households avoiding drinking polluted water caused by sewage released into water sources. While a lower bound on financial cost could be reflected by identifying specific actions to remove bacteria (e.g. chemical treatment), this is likely to underestimate the associated costs of water pollution. A more realistic estimate of financial cost is calculated by apportioning to poor sanitation a fraction of the total financial costs of water treatment and purchase. However, it is noted that households choose more convenient but more costly water sources (e.g. household piped water, tanker truck), for a variety of reasons, which include pollution of alternative water sources, convenience of access, and time-saving. Hence, for estimating the financial costs of water pollution, the attributed cost to poor sanitation is adjusted downwards by a factor of 0.5 to 0.7 (Cambodia, Indonesia, and the Philippines 0.5, and Vietnam 0.7), indicating that clean water accounts for at least half of the overall benefits of piped water, the main other benefit being convenience and time-saving. Unit prices of household water treatment are provided in Table A25.

In addition to the financial costs, the economic costs of access to clean drinking water includes efforts made by households to access clean water, such as walking further to reach cleaner water sources, or the time taken to treat water in the home.

Table A24. Treatment practices of households by water source in the Philippines (%), 2003

Source of drinking water	No treatment	Boil	Chlorine	Custom filter	Improvised filter	Other
Piped into dwelling	47.6	30.3	1.8	10.8	9.3	0.3
Piped into yard	61.7	24.9	1.2	3.0	9.0	0.2
Public tap	58.2	29.7	1.2	1.8	8.7	0.4
Open dug well	46.1	28.3	1.7	1.3	22.6	0.0
Protected well	60.1	23.8	2.2	2.7	10.6	0.5
Developed spring	64.4	18.3	1.0	1.8	14.5	0.0
Undeveloped spring	62.7	17.5	0.5	1.0	18.0	0.3
River/stream/pond/lake	45.2	29.9	0.7	3.7	19.8	0.7
Rainwater	25.9	26.6	3.3	1.7	40.7	1.7
Tanker truck/peddler	59.3	29.3	2.0	1.5	7.3	0.7
Bottled water/refilling station	75.8	9.4	0.4	7.6	5.6	1.2
Average	**55.8**	**26.0**	**1.6**	**5.5**	**10.6**	**0.4**

Source: [133]

Table A25. Unit prices of water treatment

Treatment method		Cambodia	Indonesia	Philippines	Vietnam
Piped from treatment plant	Rural	US$0.34	US$0.17[1]	US 0.20 - US 0.33[3]	US$0.155 - US$0.498[5]
	Urban	US$0.07			
Piped from other sources			US$2.4	US 0.23	
Purchased from vendor	Rural	US$4.94	US$5.4	US 1.00 - US$1.62[3]	
	Urban	US$2.47			
Bottled water (jerry can)		US$43.21	US$52.6		
Bottled water (0.5-1 liter)			US$380.0	US$325.5	
Home boiling	Rural	US$8.23	US$21.3[2]	US$6.17[4]	US$4- US$5
	Urban	US$16.46			

Source: country reports

[1] Varying from US$ 0.08 to US$ 0.27 by province. Given this reflects financial price to consumers, and given subsidies provided water suppliers, the financial price was multiplied by 1.25 to approximate economic cost.

[2] Based on unsubsidized price of kerosene of US$ 0.60 per litre. For those using collected firewood, the cost of collection and boiling time was estimated separately.

[3] Range reflects variation between regions.

[4] US$ 7.8 per m^3 for filter, and US$ 18.1 per m^3 for chlorination.

[5] Based on government-stipulated price.

Algorithms were applied at sub-national level where disaggregated data were available, using data on drinking water sources, average prices for different water sources, and household water treatment practices (data provided in country reports). Drinking water per capita per day was assumed to be 4 liters, based on the WHO minimum requirement [135]. For hauled water, the proportion of households traveling further to access cleaner water was based on populations living close to polluted water sources that are unusable for drinking (lakes, rivers and polluted groundwater); while additional journey time was taken from surveys of time used to collect drinking water. The attribution to poor sanitation of the overall costs of sourcing clean water was made based on the percentage contribution of poor sanitation to overall water pollution (Table A22).

A3.4 Water quality and domestic uses of water

Water is an essential factor in many other human and non-human activities [136]. In the present study, it is not possible to conduct an exhaustive analysis of all the different uses of water. It focuses rather on non-commercial household (domestic) activities, which include water for cooking purposes, washing clothes and kitchenware, and personal hygiene. Water also plays an important part in some traditional customs and leisure activities. Some of these activities require good quality water, given that it will be ingested. There is evidence from the region that households and businesses save on the cost of treated piped water by accessing other water sources for non-drinking purposes, which requires treatment [137].

When available water sources are below the standard quality for non-drinking domestic uses, households have two main options: (1) they continue to use untreated or unprotected surface or ground water for cooking, washing and bathing, which has possible health and economic effects; or (2) they switch water source due to the a preference for clean water for domestic activities; for example, some households may purchase water (via pipe or vendor) for laundry and bathing rather than using local water bodies; others may travel further to haul water from cleaner sources. For the purpose of estimation, this study assumes domestic water use for non-drinking purposes to be 28 liters per day (excluding drinking water of 4 liters), based on the minimum requirements defined by WHO.

Although potentially important, non-human consumption of water, such as by plants and animals, is not assessed in the present study. The dependence of wildlife on standing or flowing water, which is potentially polluted (as opposed to direct rainfall) varies greatly with climatic conditions the species found in each country. It is sufficient to mention that many species of flora and fauna in the region are under the threat of extinction. These threats come from many sources, among them over-exploitation, destruction of forests, the expansion of construction, and man-made pollution. Although it is not possible to determine the contribution of poor sanitation to the deterioration of wildlife, improved sanitation and less polluted water resources will contribute to the protection of bio-diversity.

A3.5 Water quality and fish production value

Fisheries and fish catch play a very important role in the region, providing employment, income and food security to many people. All four study countries have coastline and marine fishing accounts for an important part of the total fish catch. In inland waters, fish farming accounts for an increasing share of fish catch, in part due to the drop in fish stocks in the sea. Fish farming leads to further water pollution, due to the presence of unconsumed fish feed in the water. Rights and responsibilities for fishing vary by country. In the Philippines, approximately one third of fish catch value is recorded by each of the three following main categories: commercial, municipal, and aquaculture.

Pollution and fish production

Pollution and river diversion have allegedly driven freshwater fisheries into collapse worldwide, and the extinction of freshwater species far outpaces the extinction of mammals and birds [138-140]. Fish populations are affected by a multitude of changes taking place due to human interventions, such as hydroelectric dams, water diversion for agriculture, flood control levees, dredging, water pollution, and habitat degradation through processes such as logging. According to the Food and Agriculture Organization "the long-term productivity of fish stocks are related to the carrying capacity of their environment, which alter as a result of natural variability and of changes induced by human activity, such as coastal habitat degradation, destructive fishing methods and pollution." ([67] page 47). In countries of the lower Mekong basin, environmental degradation has been cited as one of the key threats to inland fish producers [68]. Of particular concern for water quality for fish production in SE Asia are suspended solids, DO, heavy metals and pesticides [141]. However, as one of the few publications on water quality and fish production in Asia notes (writing in 1986) "data on the effect of water quality on Asian species of fish are not readily accessible" ([141] page 15). Furthermore, it is difficult to predict the exact impact of water pollution on fish production given variations between fish species and the multiple other determinants of fish production such as food availability, and the depth, flow, and temperature of water.

Domestic sources contribute importantly to water pollution, largely through the BOD exerted by organic matter, which reduces DO levels [142].[21] Fish living below a sewage treatment plant have been shown to have a significantly higher mortality rate than fish upstream [143-147]. Pharmaceutical discharge in urine can affect fish health directly. The scientific literature testifies, albeit incompletely, to the determinants of fish reproduction, fish health and fish growth.

One key determinant of fish health that has received attention from scientists is the level of DO [143-145, 148-155]. For example, experiments undertaken in Canada on native fish and benthic macro invertebrate species showed that exposure to low DO and low temperatures caused delays in the hatching of eggs, reduced mass of fish post-hatch, depressed feeding rates and lowered fish survival [151].

Additionally, micro-organisms contained in human and animal excreta such as parasites and bacteria have a number of implications for fish health [68, 149, 150, 154, 155], as well as the safety of fish for human consumption [143, 148, 156-159]. Common illnesses from contaminated fish and shellfish include typhoid, salmonellosis, gastroenteritis, infectious hepatitis, *Vibrio parahaemolyticus* and *Vibrio vulnificus* infections, paralytic shellfish poisoning,and amnesic shellfish poisoning.

A further consideration that needs to be addressed is the fact that, in many contexts, the nutrients from sewage act as a source of food for fish, and hence *positively* affect the production of fish. This happens both intentionally, when sewage is fed to farmed fish in a regulated way, and unintentionally when fish in bodies of open water are exposed to untreated sewage released upstream. Hence, in recognizing the benefits of sewage for fish production, the present study addresses only unregulated, unintentional,

[21] A major determinant of fish reproduction, growth and survivability is dissolved oxygen (DO). When an organic waste is discharged into an aquatic system, a BOD is created. BOD is a measure of the oxygen required to break down organic compounds, and high BOD levels significantly deplete the amount of dissolved oxygen in surface water. Consequently, high BOD levels have a detrimental effect on the health of aquatic species that require elevated levels of DO. From human waste, damage results from direct BOD, as well as increased growth of algae from nitrates and phosphorous contained in human waste. The algae biodegrade the nutrients, thus reducing the amount of DO available.

pollution of water with sewage. It should be noted, though, that sewage-fed farmed fish may not be optimally managed, leading to compromised human and fish health.

Methods for modeling the relationship between sewage release and fish production
Given the lack of empirical evidence linking water quality and fish production in SE Asia, this study uses innovative methods to examine the likely importance of sewage release for fish production. While the following three key links are identified, only the first is assessed quantitatively in this study:

1. The proven link between sewage and DO levels, and the resulting impact of lowered DO levels on fish production.[22]
2. The proven link between the micro-biological content of water and fish disease, and hence survival.
3. The link between micro-biological content of water inhabited by fish and the transmission of disease to humans via fish consumption, due to inadequate de-contamination procedures.

This study assesses the water quality indicators available for different freshwater locations where fish are farmed or caught, and examines the various issues related to fish reproduction, fish populations, and overall fish health. Given that domestic sources are one of several sources of BOD and water pollution generally, the economic impact due to poor sanitation (sewage and grey water release) is attributed using the factors in Table A22.

The focus of this study is on freshwater fish, given that DO is more affected in water bodies where oxygen depletion is more acute, resulting from release of untreated sewage into fresh water. In Indonesia, only fish caught in the wild are included in the calculations, since it is assumed that the ambient level of the habitat for farmed fish has been specifically conditioned to result in improved fish growth.

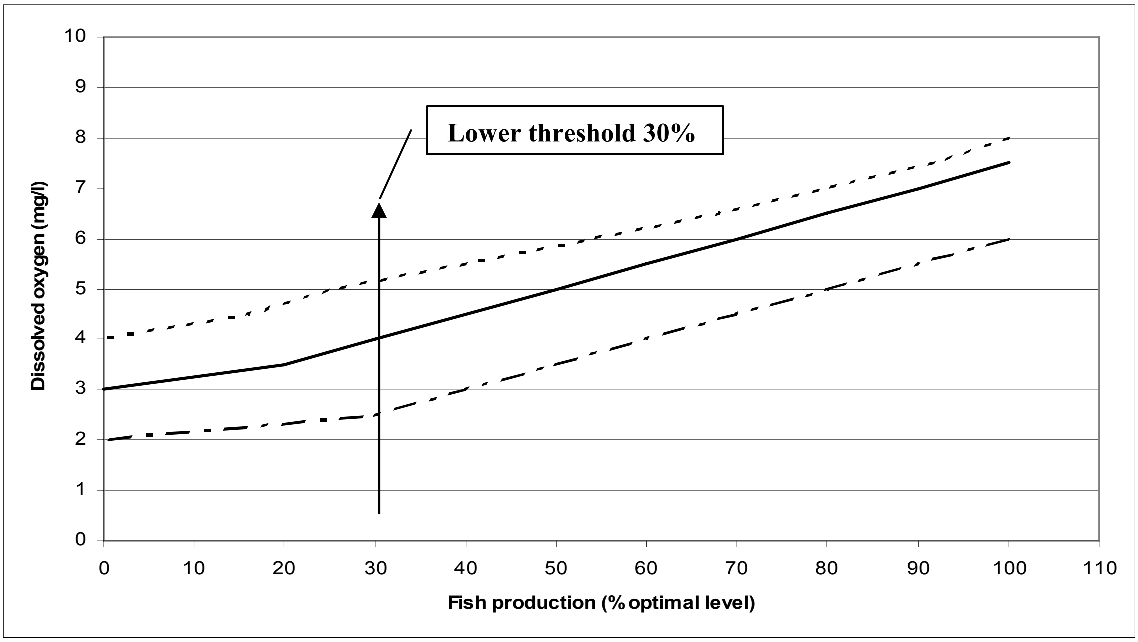
For a crude quantification of the possible loss in fish value due to water pollution, a modeled relationship based on assumptions is used. Figure A2 shows the estimated reduction in volume of fish caught at lower levels of DO for an average fish species in the region. Given the lack of published studies on the empirical relationship between these two variables, the following assumptions are made used based on a mixture of available scientific literature, internet sources, and expert opinion. A range is assessed in sensitivity analysis, shown by the dotted lines in Figure A2.

[22] Dissolved oxygen (DO) was selected as the key water quality parameter because aquatic organisms require oxygen in specified concentration ranges for respiration and efficient metabolism, and because dissolved oxygen concentration changes above or below this range can have adverse physiological effects. Even short-lived anoxic and hypoxic events can cause high mortality rates in aquatic organisms. Exposure to low oxygen concentrations can have an immune suppression effect on fish that can elevate their susceptibility to diseases for several years. Moreover, the toxicity of many toxicants (lead, zinc, copper, cyanide, ammonia, hydrogen sulfide and pentachlorophenol) can double when DO is reduced from 10 to 5 mg/L. The amount of oxygen available in the water also decreases in lower temperatures, and also decreases when plants die. Oxygen requirements of fish increase at a higher temperature (e.g. an increase in water temperature from 10 to 20°C at least doubles the oxygen demand). The presence of other pollutants such as nitrogen and marine life overcrowding reduce DO levels. In cloudy conditions, plants use up more of the available DO. Plants proliferate with the presence of nitrates and phosphates from agricultural run-off, sewage and excess fish feed.

- Water with an oxygen concentration of less than 3.0 mg/l will generally not support fish. When concentrations fall to about 3.0-4.0 mg/l, fish start gasping for air at the surface or huddle around water falls or higher concentration points.
- Numerous scientific studies suggest that 4.0-5.0 parts per million (ppm) of DO is the minimum amount that will support a fish population for short periods of 12-24 hours.
- Above 5.0 mg/l, almost all aquatic organisms can survive indefinitely, provided other environmental parameters are within allowable limits. When there are too many bacteria or aquatic animals in the area, they may overpopulate, using up the available DO [144].
- Levels of 6.0 mg/l and above support spawning, and above 7.0 mg/l support growth and activity [151, 152].
- The DO level in good fishing waters generally averages about 9.0 parts per million (ppm).

While these values are largely from global sources, some validation from local agencies was possible. For example, the Philippines Department of Natural Resources (DENR) states that fish need at least 5 mg/l of DO to live [130].

Figure A2. Modeled relationship between dissolved oxygen levels and fish production (with lower and upper range[1])



[1] The upper line represents the maximum effect of reduced DO levels on fish production volume, with a linear reduction from 8mg/l to 4mg/l. In the base case, the linear reduction ranges from 7.5mg/l to 3mg/l, while for the least effect, the linear reduction ranges from 6mg/l to 2mg/l.

In order to assess likely impacts of polluted water on fish production, geographical locations of the principal fish catches and water quality indicators were matched for major selected inland water bodies in each country. Based on the observed DO levels in these water bodies, the function in Figure A2 is applied that estimates the loss of fish catch due to lower than optimal levels of DO. Where upper and lower limits for DO were available for a single water body (Indonesia), the mid-point is used in the base case. In cases where official statistics on fish value could not be matched for specific water bodies, average (arithmetic) DO levels were used at sub-national (regional or provincial) level to estimate fish catch loss.

The current fish production levels are adjusted upwards to predict what the fish catch *would be* in the presence of optimal DO levels, using the algorithm shown in Annex B3. Given the very low DO levels recorded in some rivers of the region, a lower threshold of 30% is selected to avoid unrealistic fish catch estimates in the absence of pollution.

The focus of the initial analysis is on fish production and fish sales value reported in national statistics. The economic impact of low DO levels on non-recorded fish catch is also assessed in Vietnam, by scaling up the financial values by a factor of 1.1 to account for non-recorded fish catch. However, due to lack of data the fish catch from subsistence fishing was not included.

In interpreting the results of the quantitative assessment, it is important to bear in mind the crudeness of the assumed average relationship between DO levels and fish catch. According to Meck [153] and others, the minimum limiting oxygen concentration for a fish is dependent upon its species, physical state, level of activity, long term acclimation, and stress tolerance. Also, the amount of oxygen needed for the survival of fish varies with time of year and species. Oxygen needs vary even with the life stage of a species. Young fish tend to be more sensitive to low oxygen conditions than adults. Furthermore, the duration of low oxygen period determines the overall impact on fish. Most species can survive short periods of reduced oxygen, but suffer during longer periods. A research study from the USA examined the lowest DO at which different fish species survived for 24 hours, varying from 6.0 mg/l down to 3.3 mg/l [152]. Usually larger fish are affected by low DO before smaller fish.

A4. Environment

The release of waste into the environment has other effects besides water pollution, given the unpleasant odor emanating from feces, urine, and other waste products [160, 161]. In countries where open defecation and unofficial dumping of waste are common, the quality of land is affected, rendering it unattractive and unusable for productive use. Even in Asian countries where municipalities are responsible for collecting solid waste, this is not commonly done, or it is inadequately done. Unregulated waste dumping presents a threat to those disposing of waste, those living in the vicinity of the dumping area, and the poorest of the poor who often live off the waste (e.g. recycling activities). Waste grounds are also inhabited by stray dogs or other animals, which are diseased and pose a threat to human health. Even where there is a private or public agency taking care of disposal, it is often not performed according to plan. In cities, waste carts stay on the streets for many days, resulting in odor and unsightliness affecting local inhabitants and tourists. These aesthetic aspects of sanitation cause a loss of welfare for those coming into contact with the waste. However, given the lack of available data on these aspects, there is considerable uncertainty on the overall importance of these impacts.

A4.1 Aesthetics

Economic evaluation studies do not usually value aesthetics such as odor and sight in economic terms, hence there is limited evidence of any relationship between the aesthetic impacts of poor sanitation on the one hand, and welfare, productivity or income on the other. Studies assessing user preferences for sanitation options, including willingness to pay studies, tend to limit the focus to the physical boundaries of the household (see section A5), and hence not assess impacts on the broader environment [162, 163]. Hence, findings on welfare aspects of 'aesthetics' in this study are presented mainly in qualitative terms based on what information could be gathered from interviews and published sources in each country. Since in most countries the problem of solid waste is seen as a major environmental concern, the focus is on the inadequate disposal of solid waste by households and waste disposal services, as well as human excreta.

A4.2 Land quality

Land in most countries is a tradable commodity. Hence, land that is used inefficiently for improper, unofficial disposal of solid waste or for open defecation will be unusable for other, more productive purposes. Moreover, there is an opportunity cost to society when land is used for less efficient, rather than more efficient, purposes. The present study focuses on the waste disposal practices and resulting effects on land availability and land quality in Indonesia and Vietnam, with economic estimates reflecting the lost opportunity to use land in more productive ways.

In Indonesia, land loss due to both open defecation and poorly managed household solid waste disposal are assessed using data from the National Socioeconomic Survey on the type of solid waste disposal practices of households in 2004. This data is used to directly estimate the area of land being contaminated by solid waste and – in combination with data on open defecation behavior – human excreta to estimate the loss in land value due to poor sanitation practices. The price per m^2 of land varies by province from US$0.28 to US$1.13 in rural areas, and US$0.57 to US$2.27 in urban areas.

For Vietnam, only household solid waste is assessed quantitatively in this study. In Vietnam, solid waste management is classified according to whether 'safe' or 'unsafe' disposal practices are being applied. Unsafe practices involve open dump and controlled dump with limited or no environmental control. Engineered landfill is a safe practice with basic waste accounting and some environmental control. The safest practice is sanitary landfill where waste accounting is practiced, waste placement, fencing and staff are onsite, and there is regular environmental monitoring and leachate (liquid that drains from a landfill) treatment. No waste pickers are allowed to work on the sanitary landfill [37]. In Vietnam, there are 74 unsanitary landfills and 17 sanitary landfills [164]. For unsanitary landfills, it is necessary that a 'buffer zone' is established surrounding its operational area. A buffer zone of 1,000 meters is necessary to avoid the negative impact of waste. Within this buffer zone, large areas of land become temporarily unusable for other purposes, such as for constructing buildings, agricultural use or children's play areas. The study estimated the amount of land that has been rendered temporarily unusable or unproductive for other uses for all unsanitary landfills in Vietnam as a result of these buffer zones. The surface area of land is then multiplied by an estimated value for the affected land, taken from the lowest government-set price of agricultural land of US$0.60 per m^2.

A5. Other welfare

The type of sanitation facility a household has will have a range of impacts on population welfare. An important but difficult to quantify aspect is the welfare impact on individuals and families who use a sub-standard, uncomfortable latrine or who have no latrine at all. Except for the disease impact (see section A2), these less tangible aspects of human welfare have limited direct financial implications, and cannot easily be captured by market values. However, in the broader assessment of welfare impact on households and individuals, they are potentially important [49]. Intangible aspects include user preferences for sanitation options. For women and girls especially, there can be physical dangers involved in using distant toilets or open spaces, especially at night; this practice may also cause damage to a person's status. More tangible impacts of sub-standard latrines or the absence of facilities is the time spent journeying to open defecation sites or public latrines, or waiting due to insufficient shared or public latrines per head of population [165]. Time savings can be used for other productive or leisure activities, and thus have an economic value. Also, life decisions such as schooling or choice of employment, and absences from school and the workplace, can be linked to the presence of sub-standard or the absence of latrines [166].

A5.1 Intangible user preferences

User preferences that could be described as 'intangible' – or difficult to quantify – take many forms, and based on gathered evidence, can include [13, 49, 121, 167, 168]:

- Comfort and acceptability – the comfort of and preference for the squatting or seating position of the latrine; the ease of performing personal hygiene functions; and the freedom from rushing to complete toilet-going due to unhygienic latrine conditions, flies and foul-smelling air.
- Privacy and convenience – the benefits of not being seen using the toilet; or being seen walking to toilet facilities (women).
- Security – the location of the latrine within or near to the home means that excursions outdoors do not need to be made for toilet-going needs, in particular at night, where there may be danger (theft, attack, rape, and injuries sustained from animals or snakes).
- Conflict – on-plot sanitation can avoid conflict with neighbors or the community, where tensions exist over shared facilities, or fields and rivers for open defecation.
- Status and prestige – when visitors come to the house, it gives prestige to the household to be able to offer their guests a clean and convenient toilet to use. Families may hold more social events at their house as a result of a clean latrine.

Table A26 presents indicators of latrine conditions and access, in units of millions as well as proportion of the population. The data show that in Cambodia, two thirds of the population have to take more time than necessary to use latrine facilities, while in other countries this proportion is reversed, with between 60.4% (Indonesia) and 72.6% (Vietnam) of the population assumed to have access time minimized, based on household sanitation coverage.

Table A26. Indicators of latrine conditions and access (millions) [1]

Area	Access time minimized		No latrine (open defecation)		Other unimproved latrine		Shared toilet facilities	
	Number	%	Number	%	Number	%	Number	%
Cambodia	**3.1**	**22.5%**	**9.8**	**71.4%**	**0.37**	**2.7%**	**0.63**	**4.5%**
Rural	1.8	15.5%	9.0	78.1%	0.29	2.5%	0.47	4.1%
Urban	1.3	59.0%	0.7	32.3%	0.08	0.1%	0.16	7.1%
Indonesia	**134.0**	**60.4%**	**43.7**	**19.7%**	**- [2]**	**- [2]**	**44.4**	**20.0%**
Rural	49.0	51.7%	26.8	28.2%	- [2]	- [2]	18.7	19.7%
Urban	91.4	72.0%	10.7	8.4%	- [2]	- [2]	25.0	19.7%
Philippines	**59.9**	**71.3%**	**9.1**	**10.9%**	**6.8**	**8.0%**	**15.2**	**17.9**
Rural	37.7	69.6%	7.9	13.9%	6.1	10.9%	9.5	16.7
Urban	22.2	74.6%	1.2	5.0%	0.7	2.6%	5.7	20.3
Vietnam	**61.5**	**72.6%**	**9.2**	**11.2%**	**- [2]**	**- [2]**	**13.5**	**16.2%**
Rural	42.6	69.4%	8.3	13.5%	- [2]	- [2]	10.5	17.1%
Urban	18.9	82.9%	0.9	3.8%	- [2]	- [2]	3.0	13.3%

Source: country reports

[1] Columns may exceed 100% due to overlap in categories.

[2] Included in 'access time minimized' column.

Altogether in the four countries, there are close to 70 million people who practice open defecation, and almost 65 million who use shared facilities. Of those practicing open defecation, around 70% live in rural areas. Since open defecation is a practice which does not provide comfort and privacy for toilet going, it can be argued that the majority of these people still experience discomfort and lack of privacy. In addition, many more millions of people use uncovered latrines that are open to flies, causing health hazards and creating bad odors that affect them in intangible ways, which are included in 'access time minimized' column. Also, those using shared or public latrine facilities suffer welfare loss, as these facilities tend to be less well maintained and cleaned, and cause inconvenience.

A5.2 Access time

Welfare loss from increased access time due to unimproved sanitation can be due to journey time for open defecation or waiting time for shared or public latrines. The resulting financial loss is estimated based on a proportion of adults, whose time loss reflects an income loss, while the economic loss is based on the entire population and the average unit of time value for each population group. As with health time savings, children's time is valued at 50% of adults' time. The calculation does not assume that all those with access to shared toilet facilities must spend extra time in using them; but only a proportion that varies by country based on average numbers of households per shared toilet. Average time access for unimproved sanitation facilities is not available from published evidence in any of the countries, and hence the following assumptions on time per capita per day: Cambodia (10 minutes open defecation; 3 minutes shared facility); Indonesia (15 minutes open defecation; 15 minutes shared toilets in rural areas; 30 minutes shared toilets in urban areas); Philippines (5 minutes; 5 minutes); and Vietnam (10 minutes; 15 minutes).

A5.3 Impact on life decisions and behavior

In much of the developing world, schools infrequently offer a running water supply, sanitary latrines and hand washing opportunities. Also, in many workplaces latrines are likely to be unhygienic, poorly maintained, lack running water supply and soap, and rarely cater adequately for the special needs of women. The presence of hygienic and private sanitation facilities in schools has been shown to affect enrolment and attendance, especially for girls [166, 169]. Good latrine access at the workplace has implications for women's participation in traditionally male-dominated occupations. Furthermore, sanitary and adequate latrines in schools and at workplaces do not only affect overall participation rates; they are also likely to affect school attendance during girls' menstrual periods, and the general welfare of all pupils and employees.

Given the complex web of causative factors and eventual life decisions, and the many factors determining absenteeism from school or the workplace, it becomes difficult to quantify the exact relationship between poor sanitation, education and work decisions, and eventual economic outcomes. There is also some variation between and within the study countries, based on differences in ethnicity, religion and economic conditions, among others.

In recognizing that poor sanitation and education are linked in some way, this study assesses the following aspects:

- General preferences of girls for sanitation in schools, assessed qualitatively.
- The links between poor sanitation and overall school performance (enrolment, completion, and drop-out), assessed qualitatively. In the Philippines and Vietnam, drop-out rates of girls attributed to poor sanitation were assumed to be 1.5% and 2%, respectively.
- Numbers of school days missed due to the assumption that girls attending schools with inadequate latrine access miss an average of 10 days each year during their menstrual periods. These school absentee days are valued at half the adult value of time, which is 30% of average compensation of employees, giving 15% the average compensation of employees.

There is no information on the magnitude by which sanitation, if at all, affects the employment and workforce participation of women. Hence, this study did not compute the potential losses. However, the study estimated the number of days absent from work, using the same method as for education, assuming 10-12 days per year (varying by country) for women employed in workplaces with unsanitary toilets.

A6. Tourism

Tourists[23] are sensitive to their environment, and are less likely to choose destinations that they perceive as dirty or where the risk of disease is high. Countries may be losing tourist revenues due to degraded environments and high infectious disease rates among the general population, as well as the actual or perceived health risks to tourists. Hence, any initiative to attract more tourists to a country will need to consider the part sanitation plays in this [170-172].

A6.1 Introduction to tourism

Tourism is a booming industry, and continues to experience double-digit growth in many developing countries around the world [173], fuelled by cheaper airfare costs coupled with the realization by developing country governments and the private sector

[23] Here, 'tourists' refers to holiday travelers,; business travelers have been excluded from this study.

of its potential economic benefits. Tourism is playing an important role in boosting the revenues of governments as well as contributing to much-needed economic growth in the developing world. Countries of SE Asia have been among those enjoying year-on-year increases in tourist numbers and income (Table A27). Tourism directly employs at least 18 million people in the five ESI countries and accounts for roughly US$75 billion of economic activity.

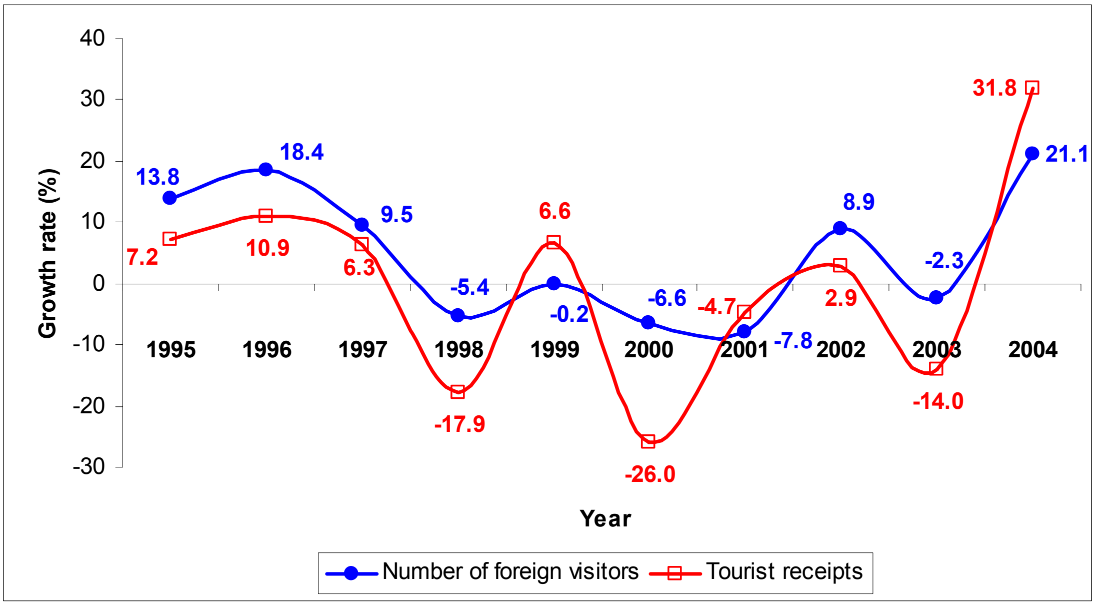
Table A27. Comparative sanitation and travel and tourism statistics for selected Southeastern and East Asian countries (%)

Country	**Pop. Size (m.)**	***Sanitation coverage***		***Economic activity 2006***		***Growth***	
		1990	**2004**	**Demand (US$ billion)**	**Jobs (million)**	**2007**	**2008-2015**
Cambodia	14	-	17	1.9	1.1	6.5%	5.7%
China	1,322	23	44	439.8	72.0	13.3%	9.6%
Indonesia	222	46	55	43.5	6.1	3.6%	6.4%
Korea, Republic	48	-	-	104.1	1.75	3.7%	5.9%
Laos	6	-	30	0.45	0.15	7.1%	6.0%
Malaysia	25	-	94	33.6	1.2	4.5%	6.6%
Philippines	84	57	72	16.3	7.0	7.0%	5.6%
Singapore	4	100	100	37.2	0.2	6.3	6.3%
Thailand	64	80	99	47.8	4.1	3.3%	5.5%
Vietnam	84	36	61	12.2	3.5	10.5%	7.8%

Source: World Travel and Tourism Council.

In Cambodia, Angkor Wat in Siem Reap alone accounts for 31% of total tourist arrivals in the country. In the past decade, hundreds of hotels and restaurants have been established to cater for the influx of tourists. Likewise, tourism in Lao PDR is quickly taking off, and Vietnam is still experiencing rapid growth in tourist numbers. On the other hand, in more established tourist destinations such as the Philippines and Indonesia, the performance of the tourist sector has been rather sluggish over the past 10 years, due in part to the Asian economic crisis of 1997. In the Philippines, foreign visitor arrivals grew at an average annual rate of about 5% between 1994 and 2004, although the growth pattern has been erratic, as shown in Figure A3. Over the period of analysis, tourist receipts only grew by an average rate of 0.3% per year, thus reflecting declining expenditures per tourist over time. Tourism nonetheless remains an important source of income and employment for the Philippines and Indonesia, accounting in the Philippines for about 2% of GDP and 3.6% of employment, and in Indonesia 5.2% of GDP and 8% of employment.

Figure A3. Growth rates (%) of foreign travelers and tourist receipts in the Philippines, 1994-2004



Source: National Statistics Coordination Board [35].

A6.2 Tourism and sanitation

Data from the World Travel and Tourism Council presented in Table A27 suggest that some countries have done better than others at exploiting the growth in tourism in the SE and East Asia region. Tourist preferences clearly play a key role in this: there are many factors that determine tourists' choice of destination. Tourists are often heavily influenced by the availability of information (positive media) on a destination, the offer of package tours or package deals in their home country, and/or the ease of booking flights and hotels on the internet or by telephone. The availability of package deals and the ease of bookings are themselves a function of the level of development of a tourist destination. Hence, there is a self-reinforcing loop, which can – over time – lead to large resort complexes and tourist destinations such as the various coasts and islands of Southern Europe and the Caribbean, coastal areas of Thailand and Malaysia, and well known tropical islands (Zanzibar, Maldives).

Tourist growth depends on what the country can offer, such as tourist transport infrastructure, the quality of accommodation and restaurants, the type of experience offered (culture, climate, culinary, relaxation), and safety. Also, the price of tourist services determines the relative attractiveness of a country for foreign tourists, which is partially determined by the stability and level of the local currency with international currencies.

In addition to these factors, the present study presents the hypothesis that there are important but under-recognized links between tourism and sanitation. Two different sets of economic impacts are assessed in this study: (1) the sub-optimal exploitation of tourism potential in the country, which is partially related to poor sanitation; and (2) the estimated cost to tourists associated with health episodes and welfare losses resulting from poor sanitation (Vietnam and Indonesia only). Where data were available, estimates are made for domestic as well as international tourists. However, to avoid potential double-counting of the disease episodes of domestic tourists, and to avoid including the welfare losses of foreign tourists in national estimates, the second impact above is not included in the total cost estimates of poor sanitation in section A6.3.

A6.3 Estimation of tourist losses due to poor sanitation

While there is evidence that the standard of tourist facilities in the study countries are improving over time, the present study assumes that the sanitary standards remain sub-optimal. Hence, it is hypothesized that more tourists could be attracted to the countries now and in the future: one of the areas that must improve for that to happen is hygiene and sanitation.

Given the limited options for countries to boost tourist numbers and hotel occupancy rates from improved sanitation in the short-term, the tourism losses are not estimates as a financial cost. However, in the longer term it is assumed that the study countries can not only increase hotel occupancy rates under the existing capacity constraints of tourist infrastructure (airport, hotels, internal transport, restaurants), but also expand the tourist infrastructure as well as making tourist destinations more attractive for tourists. Infrastructure requirements were based on mid- to long-term government targets for tourist growth and total numbers; where these were not available, realistic assumptions are made of the tourist growth achievable over a five year period until 2010. A target occupancy rate of 90% is assumed; this rate does not necessarily reflect the actual future occupancy rates expected, but enables an assumption of increased tourist flow (which may be partially accommodated by increased tourist capacity, hence occupancy stays below 90%). The attribution factor to poor sanitation is assumed to be 5% except in Cambodia where 10% is assumed. This means that 5% (or 10% in Cambodia) of the low existing exploitation of tourists is due to poor sanitation, the rest being accounted for by other infrastructural and environmental factors. The values used are presented in Table A28.

Table A28. Inputs for calculating financial losses from tourist receipts [1]

Parameter	Cambodia	Indonesia	Philippines	Vietnam
Actual occupancy (%)	55%	45%	61%	60%
Potential occupancy (%)	90%	90%	90%	90%
Contribution of sanitation to tourist losses (%)	10%	5%	5%	5%
Actual number of tourists (millions)	1.7	4.7	2.62	3.58
Average expenditure per tourist (US$)	95/day	100/day	681/trip	1283/trip

Source: country reports

[1] Table reflects values used for calculation of losses due to lower than optimal numbers of foreign tourists.

A6.4 Tourist sickness

Once tourists are on-site, they may experience a reduction in enjoyment of their holiday experience by becoming sick due to a disease related to poor sanitation and hygiene. While having an illness episode is not only a bad experience in itself, it also eats into valuable holiday time, and may incur some expenses related to treatment. In the worst cases, the return journey of the tourist is affected or they need to get emergency transport to a medical facility. The losses from tourist sickness were estimated in selected sites of Indonesia and Vietnam only. The financial costs were estimated based on the estimated disease incidence and an assumed cost per episode. The economic cost was estimated by adding an estimated ‘welfare loss’ from days of sickness to the financial cost of sickness treatment. The welfare loss was approximated by multiplying the average holiday spending per day by the average length of incapacitation.

The General Statistics Office of Vietnam conducted a survey in 2005 to assess the health expenditures of both foreign and local tourists. On average, a foreign tourist spends US$1.1 per day on health care, while a Vietnamese tourist in Vietnam spends US$0.29 [174]. The study conservatively assumes that 20% of travelers' diarrhea is caused by poor hygiene and sanitation. An average length of episode is assumed at three days.

A7. Impact mitigation associated with improved sanitation and hygiene

A7.1 Health impacts mitigated

The financial and economic gains from improved sanitation and hygiene will be a proportion of the total losses estimated for diseases associated with poor sanitation and hygiene. The proportion of costs avertable will depend on the expected effectiveness of the interventions employed to prevent disease. No health intervention, as implemented in practice, will be 100% effective in reducing the overall loss. However, sanitation and hygiene interventions have been proven to be effective in a number of field trials [175, 176]. Given that good quality epidemiological studies are limited in number, and have already been reviewed in previous meta-analyses, no additional country-level studies were used to estimate disease cases prevented. Hence, the estimates of intervention effectiveness are based on the international literature, which includes the most up-to-date reviews on effectiveness [175-178].

The latest and most authoritative review by Fewtrell et al (2005) presented summaries of effectiveness from a meta-analysis of field trials on water, sanitation and hygiene separately, as well as together [176]. The reader is referred to the paper for details of individual studies. Table 29 below shows the summary of the meta-analysis.

Table A29. Summary of meta-analysis results on water, sanitation and hygiene intervention efficacy for diarrheal disease reduction

Intervention	Number of studies included[1]	Estimate of effect (relative risk) [2]		
		Low	Mid	High
Household treatment of water	8	0.46	0.61	0.81
Water supply	6	0.62	0.75	0.91
Sanitation	2	0.53	0.68	0.87
Hygiene	8	0.40	0.55	0.75
Multiple interventions	5	0.59	0.67	0.76

Source: Fewtrell et al (2005) [176].
[1] Includes only studies of good quality, as defined by Fewtrell et al.
[2] Relative risk of disease when intervention tested against baseline of no intervention.

These relative risk reductions are used to estimate expected rates of diarrhea under a situation of basic improved sanitation and hygiene practices, and carried through to estimations of health care cost, productivity and income, and premature deaths. Hence, based on the literature, the following reductions of disease incidence are predicted:

- Sanitation: % incidence reduced = 32% (range 13% to 47%).
- Hygiene: % incidence reduced = 45% (range 25% to 60%).

Interpretation of results needs to take into account that hygiene and sanitation interventions implemented together will not have the sum of the individual effects. The literature does not provide evidence for the proposition that two interventions implemented together are more effective than one [176].

A7.2 Other economic losses mitigated

Given that the attributed costs of poor household sanitation are the object of the study (described in sections A2 to A6 above), the effect of improving sanitation will – in theory – be to mitigate the *full* estimated losses. This assumes that the interventions are fully effective in isolating human excreta (at least in its harmful form) from the environment, and it assumes a linear reduction in economic impact at different levels of attribution. In other words, it is assumed that by removing x% of the pollution source, a similar x% of economic losses would be averted. However, such linearity cannot necessarily be assumed. Also, for some environmental effects where the environment has been degraded considerably over time, there will need to be expenditure on a clean-up operation to bring the land and water resources back to usable or fully productive condition. These costs are not estimated in the present study.

A7.3 Market for sanitation inputs

Given the needs of sanitation programs for human labor and materials, they will have a number of economic effects – on revenue, employment and profit – whether for small local entrepreneurs or larger companies. Table A30 presents the unit costs of different sanitation options, reflecting the investment cost only. Financial costs are made up of purchased services (labor, materials, equipment), while economic costs also include non-purchased inputs to the sanitation option (such as household and community-provided labor). These unit costs are multiplied by the expected annual coverage increase with different sanitation options to estimate total annual potential market values. While on the one hand this reflects government and household spending, it also represents an economic gain for those involved in providing the services and will have broader economic effects.

The estimates made here are crude and speculative, based on the assumption that a certain number of households improve their sanitation facility. Also, the figures exclude expenditure on the maintenance and operation of such facilities, which can be substantial in some instances. In Indonesia, the value of hygiene products (soap, toilet paper) and sludge removal services is estimated based on the expected coverage increases.

Table A30. Unit prices and household numbers to receive different sanitation improvement options

Variable	Simple pit latrine	VIP	Septic tank	Simple Ecosan	Piped sewer connection
Cambodia					
Households	16,171	8,085	8,085	4,225	8,085
Unit price (total)	20.5	31	45	297	77
Super structure	14	14	19	-	19
Slab	3.5	3.5	10	-	10
Underground	3	13.5	16	-	48
Indonesia					
% households					
Rural	0.2%	0.1%	0.6%	0.05%	0.05%
Urban	0.05%	0.1%	0.75%	0.05%	0.05%
Unit prices (Java)					
Rural	85	170	227	34	34
Urban	113	227	340	57	57
Unit prices (Off Java)					
Rural	57	85	170	45	45
Urban	85	113	227	57	57
Philippines		**VIP**	**Septic tank**[1]	**Ecosan1**[2]	**Ecosan2**[2]
Total households (annual)	-	602,000	2,030,000	202,000	202,000
% total households	-	3.6%	12%	1.2%	1.2%
Unit price	-	90.8	600.0	363.0	757.7
Vietnam	**Double-vault**	**Pour flush**	**Septic tank**	**Biogas**	**Others**
Rural households (annual)	451,086	428,114	785,224	12,530	411,407
Urban households (annual)	36,623	34,758	63,751	1,017	33,402
Unit price	62	68	75	249	NA

Sources: Cambodia: [179] and National Bio-digester Programme for Ecosan; Philippines: VIP [180], Ecosan [181], Septic tank [182].

[1] The price is for a septic tank that has a capacity of 1,500 gallons.

[2] Ecosan1 toilets utilize light building materials while Ecosan2 is built with a concrete structure.

A7.4 Market for sanitation outputs

Where human excreta is used as fertilizer, the availability of nutrients from human excreta can lead to the replacement of chemical fertilizer, which saves costs [183]. Furthermore, where fertilizer was not being used optimally before, the nutritional content and economic value of crops may increase. Also, there are long-term benefits in reducing the use of chemical and mineral fertilizers, especially taking into account the fact that some fossil resources are in increasingly short supply (e.g. phosphorous). Alternatively, families with livestock may invest in a biogas reactor, which provides biofuel for cooking, and space heating, and can even be used for lighting where other improved sources (electricity) are not available [184].

Table A31 shows unit economic values for re-use of human excreta. The analysis is conducted for all countries; however the assumptions are conservative as the reuse of human excreta for fertilizer or biogas production cannot be assumed to be population-wide, given cultural attitudes towards its handling and re-use, and low practical feasibility in many locations. Success often depends on local perceptions of the expected returns on re-use of human excreta, whether it be for biogas or fertilizer.

Table A31. Input values for estimation of return to re-use of human excreta

Country and variable	Fertilizer	Biogas
Cambodia		
Rural households (number)	432	600
Annual unit benefit per household	-	US$132
Indonesia		
Rural households (number)	-	198,000
Urban households (number)	-	710,000
Annual unit benefit per urban household	-	US$74
Vietnam		
Households (number)	86,795	144,658
Annual unit benefit per household	?	?

Sources: Cambodia: National Biodigester Programme [185].

A8. Sensitivity analysis

Tables A32 and A33 provide alternative input values to reflect three main types of data uncertainty in the present study:

(1) Uncertainty in the estimation of overall impacts, such as in epidemiological and economic variables (Table A32).
(2) Uncertainty in the attribution of the overall impact to poor sanitation (Table A32).
(3) Uncertainty in the actual size of impact mitigation achievable (Table A33).

Table A32 presents a selection of uncertain economic variables, and the alternative – low and high values – used in the one-way sensitivity analysis. The selection of basis for lower and upper values of hourly time valued varies by country, due to GDP per capita being higher than compensation of employees in some countries (e.g. the Philippines), and lower in others (e.g. Cambodia). The hourly productive time of children was varied from zero to the full adult value. Fish production impact was varied according to the lower and upper bounds presented in Figure A2 (section A3.5).

Table A32. Assumptions and values used in one-way sensitivity analysis

Variables selected	Low estimate of impact	Base case estimate	High estimate of impact
Health			
Diarrhea incidence and attribution to poor sanitation	Use of DHS data for under-fives Diarrheal cases attributed to poor sanitation: 80% (Cambodia, Vietnam); 70% (Indonesia); 67.5% (Philippines)	Use of DHS data for under-fives 88% of diarrheal cases attributed to poor sanitation	Use of WHO regional data for under-fives: • < 1 year old: 6.56-10.49 (except Indonesia - 7.13-11.41) • 1-4 year old: 2.46-3.93 (except Indonesia - 2.67-4.28) 88% of diarrheal cases attributed to poor sanitation (95% Cambodia)
Hourly value of productive time	30% of GDP per capita (Cambodia); 75% of base case (Philippines); 30% of average income (Indonesia, Vietnam)	30% of compensation to employers (Cambodia, Indonesia, Philippines); 30% of GDP per capita (Vietnam)	Minimum wage (Cambodia); GDP per capita (Philippines, Indonesia, Vietnam)

Variables selected	Low estimate of impact	Base case estimate	High estimate of impact
Hourly value of productive time for children	Children given value of zero	Children given 50% of adult value	Children given same value as adults
Premature death	HCA, using 2% growth and GDP per capita	HCA, using 2% growth and compensation of employees	VOSL benefit transfer of US$2 million, using 0.6 income elasticity
Water			
DO value used	Higher value of DO (Indonesia)	Average value of DO (Indonesia)	Lower value of DO (Indonesia)
Fish production and DO relationship	Lower range used (fish less affected by low DO)	Mid range used	Higher range used (fish more affected by low DO)
Water pollution attributed to poor sanitation	50% (Cambodia); 10% Indonesia); 24.8% (Philippines); 30% (Vietnam)	65% (Cambodia); 30% (Indonesia); 33% (Philippines); 40% (Vietnam)	70% (Cambodia); 50% (Indonesia, Vietnam); 41.3% (Philippines)
User preferences			
Time access (minutes per day)	5 (Cambodia, Vietnam); 5-15 (Indonesia); 3.75 (Philippines)	10 (Cambodia, Vietnam); 15-30 (Indonesia); 5 (Philippines)	15 (Cambodia, Vietnam); 6.25 (Philippines)
Value of time	See under 'health' above		
Tourism			
Tourist numbers impact attributed to poor sanitation	5% (Cambodia); 1% (Indonesia); 2% (Philippines, Vietnam)	10% (Cambodia); 5% (Indonesia, Philippines, Vietnam)	15% (Cambodia); 10% (Indonesia, Philippines, Vietnam)

Table A 33. Alternative assumptions for impact mitigation

Variables selected	Low estimate of impact	Base case estimate of impact	High estimate of impact
Health			
Sanitation-related diseases mitigated	13%	32%	47%
Hygiene-related diseases mitigated	25%	45%	60%
Water			
Sanitation-related drinking water pollution costs mitigated	70% (Cambodia); 50% (Indonesia, Philippines, Vietnam)	100%	Not tested
Sanitation-related fish production costs mitigated	70% (Cambodia); 50% (Indonesia, Philippines, Vietnam)	100%	Not tested
Tourism			
Sanitation-related tourist losses mitigated	70% (Cambodia); 25% (Indonesia); 50% (Philippines, Vietnam)	100%	Not tested
Sanitation markets			
Sanitation output coverage (households adopting Ecosan)	1,000 (Cambodia); 1% (Indonesia); half base case (Philippines, Vietnam)	4,375 (Cambodia); 10% (Indonesia)	5,000 (Cambodia); 20% (Indonesia)

ANNEX B: ALGORITHMS

B1. Aggregating equations

Total costs of sanitation and hygiene

$$C = CH + CW + CL + CU + CT \quad (1)$$

Health-related costs of poor sanitation and hygiene

$$CH = CH\_HC + CH\_P + CH\_D \quad (2)$$

Water-related costs of poor sanitation and hygiene

$$CW = CW\_Drink + CW\_Domestic + CW\_Fish \quad (3)$$

User preference losses of poor sanitation and hygiene

$$CU = CU\_T + CU\_AS + CU\_AW \quad (4)$$

Tourism losses from poor sanitation

$$CT = CT\_RL \quad (5)$$

B2. Health costs related to poor sanitation and hygiene

Total health care costs

$$CH\_HC = \sum_i CH\_HC_i \quad (6)$$

Health care cost per disease

$$CH\_HC_i = \alpha_i \cdot pop \cdot \beta_i \cdot \sum_h \chi_{ih} \cdot v_{ih} \cdot phealth_{ih} \quad (7)$$

Total productivity costs

$$CH\_P = \sum_i CH\_P_i \quad (8)$$

Productivity cost of disease type i

$$CH\_P_i = \alpha_i \cdot pop \cdot \beta_i \cdot dh_i \cdot ptime \quad (9)$$

Total cost of premature death

$$CH\_D = \sum_i CH\_D_i \quad (10)$$

Cost of premature death per disease

$$CH\_D_i = \sum_a death_{ia} \cdot \gamma_{ia} \cdot pdeath_a \quad (11)$$

B3. Water-related costs associated with poor sanitation and hygiene

Total cost associated with accessing clean drinking water

$$CW\_Drink = \sum_m CW\_Drink_m \tag{12}$$

Cost of accessing clean drinking water per source/treatment method

$$CW\_Drink_m = h_m \cdot wdrink_m \cdot pwater_m \cdot \delta \cdot \pi_m \tag{13}$$

Total domestic water access cost (excl. drinking water)

$$CW\_Domestic = \sum_m CW\_Domestic_m \tag{14}$$

Domestic water access cost by source/method

$$CW\_Domestic_m = h_m \cdot wdom_m \cdot pwater_m \cdot \delta \cdot \theta_m \tag{15}$$

Fisheries loss

$$CW\_Fish = AFP - PFP \tag{16}$$

Potential fish production level

$$PFP = \frac{AFP}{\varepsilon} \tag{17}$$

B4. Land costs

$$CL = ql \cdot pland \tag{18}$$

B5. User preference costs algorithm

Time access cost for unimproved latrine

$$CU\_T = pop\_u \cdot taccess \cdot ptime \cdot 365 \tag{19}$$

Cost of days absent from school

$$CU\_AS = egirls \cdot \phi \cdot das \cdot pstime \tag{20}$$

Cost of days absent from work

$$CU\_AW = ewomen \cdot \eta \cdot daw \cdot pwtime \tag{21}$$

B6. Tourism losses

Lost revenues

$$CT\_RL = \varphi \cdot \left(\frac{oc_O}{oc_A} - 1 \right) \cdot ta \cdot et \tag{22}$$

Tourist health cost and welfare loss

$$CT\_HT = td \cdot \mu \cdot \left(pahc + pawl \right) \quad (23)$$

B7. Variable definition summary

Tables B1 to B3 present the subscripts, variables and parameters used in the algorithms in Sections B1 to B6 above.

Table B1. Subscripts used in algorithms

Code	Description	Elements[1]
a	Age group	Less than one year, 1-4 years, 5-14 years, 15-65 years, over 65
i	Disease types	Diarrhea, cholera, typhoid, malnutrition-related diseases, etc
h	Health care provider	Public hospital, private hospital, informal care, self-treatment
m	Treatment method	Piped water, non-piped water, home-treated water, hauled water

[1] Varies by country.

Table B2. Variables used in algorithms

Symbol	Description
C	Total cost of poor sanitation and hygiene
CHC	Health costs of poor sanitation and hygiene
CH_HC	Health care costs of all diseases
CH_HC_i	Health care cost of disease type *i*
CH_P	Productivity costs of diseases
CH_P_i	Productivity cost of disease type *i*
CH_D	Premature death costs of diseases
CL	Land cost
CT	Tourism losses associated with poor sanitation and hygiene
CT_RL	Revenue losses
CT_HT	Tourist health and welfare losses
CU	User preference losses associated with poor sanitation and hygiene
CU_T	Time access cost for unimproved latrine
CU_AS	Cost of days absent from school
CU_AW	Cost of days absent from work
CW	Water-related costs of poor sanitation and hygiene
CW_Drink	Clean water drinking access costs
CW_Drink_m	Clean water drinking access cost for method *m*
CW_Domestic	Domestic water access costs
$CW\_Domestic_m$	Domestic water access cost for method *m*
CW_Fish	Fisheries production loss
$death_{ia}$	Number of premature deaths, by disease type *i* and age group *a*
dh_i	Number of days taken off work or daily activities due to disease *i*
das	Days per girl per year taken off school due to poor sanitation
daw	Days per woman per year taken off work due to poor sanitation
egirls	Number of adolescent girls enrolled in school
et	Expenditure per tourist (US$)
ewomen	Number of women in paid employment
h_m	Number of households using water source or treatment method
oca	Actual occupancy rate (%)

oco	Optimal occupancy rate (%)
pahc	Average health care cost per case
pawl	Average welfare cost per case
$pdeath_a$	Value of premature death for age group *a*
PFP	Potential fish production value
$phealth_{ih}$	Unit price of care (per visit or day) for disease type *i* at health facility *h*
pland	Unit value of land per m^2
ptime	Daily value of time
pstime	Daily value of school time lost
pwtime	Daily value of work time lost
$pwater_m$	Water price or time value per m^3 of water
pop	Population
pop_u	Population with unimproved access to sanitation
ql	Quantity of land made unusable by poor sanitation
ta	Actual number of tourists
taccess	Average access time (journey or waiting) per day
td	Total diseases suffered by tourists
v_{ih}	Visits to or days for disease type *i* at health facility *h*
$wdrink_m$	Consumption per household of drinking water (m^3) from water source/treatment method *m*
$wdom_m$	Consumption per household for domestic purposes (m^3) from water source/treatment method *m*

Table B3. Parameters used in algorithms

Symbol	Description
α_i	Incidence rate per person of disease type i
β_i	Proportion of episodes attributed to poor sanitation for disease type i
χ_{ih}	Proportion of cases seeking care for disease type i and provider h
γ_{ia}	Proportion of deaths attributable to poor sanitation, by disease type *i* and age group *a*
δ	Attributable water pollution to poor sanitation
ε	Ratio of the fish production at the current DO level to fish production at the optimal DO level
ϕ	Proportion of schools with inadequate sanitation facilities
η	Proportion of work places with inadequate sanitation facilities
μ	Proportion of diseases related to poor sanitation
π_m	Importance of averting drinking polluted water in relation to overall benefits of piped water supply; where $\pi_m = 1$ for $m \neq$ piped-water
θ_m	Importance of averting using polluted water in domestic activities in relation to overall benefits of piped water supply; where $\theta_m = 1$ for $m \neq$ piped-water

ANNEX C: STUDY RESULTS

C1. Summary results

Table C 1. Financial and economic losses due to poor sanitation in Cambodia

Impact	Financial losses			Economic losses		
	Value (million US$)	Per capita (US$)[1]	%	Value (million US$)	Per capita (US$)[1]	%
Health costs	**13.3**	**1.0**	**8.3**	**187.1**	**13.6**	**41.8**
Health care costs	10.7	0.8	6.7	13.4	1.0	3.0
Productivity costs	2.5	0.2	1.5	5.1	0.4	1.1
Premature death costs	0.2	0.0	0.1	168.6	12.2	37.6
Water costs	**146.8**	**10.6**	**91.7**	**149.0**	**10.8**	**33.3**
Drinking water	92.7	6.7	57.9	93.8	6.8	20.9
Fish production	9.8	0.7	6.1	10.9	0.8	2.4
Domestic water uses	44.4	3.2	27.7	44.4	3.2	9.9
Other welfare				**38.2**	**2.8**	**8.5**
Time use				38.2	2.8	8.5
Tourism				**73.7**	**5.3**	**16.4**
Tourist loss				73.7	5.3	16.4
TOTAL	**160.1**	**11.6**	**100**	**448**	**32.4**	**100**

Source: Cambodia report

Table C2. Financial and economic losses due to poor sanitation in Indonesia

Impact	Financial losses			Economic losses		
	Value million US$	Per capita	%	Value million US$	Per capita	%
Health costs	**307.0**	**1.4**	**25.2%**	**3,350.0**	**15.1**	**52.8%**
Health care costs	140.0	0.6	11.5%	114.0	0.5	1.8%
Productivity costs	117.0	0.5	9.6%	429.0	1.9	6.8%
Premature death costs	50.0	0.2	4.1%	2,807.0	12.6	44.2%
Water costs	**909.0**	**4.1**	**74.8%**	**1,512.0**	**6.8**	**23.8%**
Drinking water	803.0	3.6	66.0%	1,289.0	5.8	20.3%
Fish production				92.0	0.4	1.5%
Domestic water uses	106.0	0.5	8.7%	131.0	0.6	2.1%
Environment				**96.0**	**0.4**	**1.5%**
Land use				96.0	0.4	1.5%
Other welfare				**1,220.0**	**5.5**	**19.2%**
Time use				1,220.0	5.5	19.2%
Tourism				**166.0**	**0.7**	**2.6%**
Tourist loss				166.0	0.7	2.6%
TOTAL	**1,216.0**	**5.5**	**100.0%**	**6,344.0**	**28.6**	**100**

Source: Indonesia report

Table C3. Financial and economic losses due to poor sanitation in the Philippines

Impact	Financial losses			Economics Loss		
	Value (US$)	Per capita[1]	%	Value (US$)	Per capita[1]	%
Health costs	**37.0**	**0.5**	**10.3%**	**1011.1**	**12.0**	**71.6%**
Health care costs	6.2	0.1	1.7%	33.1	0.4	2.3%
Productivity costs	29.7	0.4	8.3%	55.3	0.7	3.9%
Premature death costs	1.1	0.0	0.3%	922.7	11.0	65.3%
Water costs	**322.0**	**3.8**	**89.7%**	**323.3**	**3.8**	**22.9%**
Drinking water	116.5	1.4	32.5%	117.0	1.4	8.3%
Fish production	9.6	0.1	2.7%	9.6	0.1	0.7%
Domestic water uses	195.9	2.3	54.6%	196.7	2.3	13.9%
Other welfare				**37.6**	**0.4**	**2.7%**
Time use				24.6	0.3	**1.7%**
Life choices				13.0	0.2	**0.9%**
Tourism				**40.1**	**0.5**	**2.8%**
Tourist loss				40.1	0.5	**2.8%**
TOTAL	**359.0**	**4.3**	**100.0%**	**1412.1**	**16.8**	**100.0%**

Source: Philippines report

Table C4. Financial and economic losses due to poor sanitation in Vietnam

Impact	Financial losses			Economics Loss		
	Value (US$)	Per capita[1]	%	Value (US$)	Per capita[1]	%
Health costs	**52.1**	**0.6**	**17.9%**	**262.4**	**3.1**	**33.6%**
Health care costs	50.7	0.6	17.4%	53.1	0.6	6.8%
Productivity costs	1.1	0.0	0.4%	4.6	0.1	0.6%
Premature death costs	0.3	0.0	0.1%	204.7	2.4	36.8%
Water costs	**239.6**	**2.9**	**82.1%**	**287.3**	**3.4**	**36.8%**
Drinking water	49.1	0.6	16.8%	62.5	0.7	8.0%
Fish production	27.4	0.3	9.4%	27.4	0.3	3.5%
Domestic water uses	163.2	1.9	55.9%	197.4	2.3	25.3%
Environment				**118.9**	**1.4**	**15.2%**
Land use				118.9	1.4	15.2%
Other welfare				**42.9**	**0.5**	**5.5%**
Time use				41.6	0.5	5.3%
Life choices				1.3	0.0	0.2%
Tourism				**68.6**	**0.8**	**8.8%**
Tourist loss				68.6	0.8	8.8%
TOTAL	**291.7**	**3.5**	**100.0%**	**780.1**	**9.3**	**100.0%**

Source: Vietnam report

C2. Health care costs

Table C5. Health care costs by disease in Cambodia

Disease	Financial costs (thousand US$)				Economic costs (thousand US$)				
	Public clinics	Private clinics	Trans-port	Total	Public clinics	Private clinics	Trans-port	Self-treat ment	Total
Diarrhea	789	6,810	2,288	9,887	2,041	6,810	2,288	1,161	12,300
Skin disease	130	36	198	364	239	36	198	5	477
Malnutrition	5	-	3	8	27	-	3	-	30
ALRI	55	184	121	360	136	184	121	22	462
Malaria	41	27	22	90	69	27	22	-	118
Total	**1,021**	**7,056**	**2,632**	**10,709**	**2,511**	**7,056**	**2,632**	**1,188**	**13,388**

Source: Cambodia report

Table C6. Health care costs by disease in Indonesia

Disease	Financial costs (million US$)				Economic costs (million US$)				
	Public clinics	Private clinics	Transport	Total	Public clinics	Private clinics	Trans -port	Self-treat ment	Total
Diarrhea	17.97	20.17	5.73	43.87	22.05	24.74	5.73	4.89	57.41
Helminthes	1.51	1.69	0.16	3.35	1.93	2.16	0.16	0.27	4.52
Skin diseases	27.25	30.59	2.62	60.46	32.75	36.75	2.62	8.22	80.34
Trachoma	0.33	0.38	0.03	0.74	0.43	0.48	0.03	0.06	1.00
Hepatitis A	0.82	0.92	0.08	1.82	0.97	1.09	0.08	0.26	2.40
Hepatitis E	0.03	0.03	0.00	0.06	0.03	0.03	0.00	0.01	0.07
Malnutrition, indirect costs	1.23	1.38	0.27	2.89	1.49	1.67	0.27	0.40	3.82
Malnutrition, direct costs	21.98	nc	nc	27.20	31.40	nc	nc	5.22	36.62
Total	**71.12**	**55.15**	**8.90**	**140.39**	**91.04**	**66.93**	**8.90**	**19.33**	**186.19**

Source: Indonesia report

Table C7. Health care costs by disease in the Philippines (Thousand US$)

Disease	Financial costs (thousand US$)				Economic costs (thousand US$)				
	Hospi-tals	Self-treat-ment	Trans port	Total	Hos-pitals	Infor-mal Care	Self-treat-ment	Transp ort	Total
Diarrheal diseases									
Acute Watery Diarrhea	356.8	33.4	168.0	558.2	2,741.6	122.0	33.4	168.0	2,897.0
Acute Bloody Diarrhea	6.9	0.5	2.2	9.6	66.6	1.8	0.5	2.2	68.9
Cholera	0.3	0.0	0.0	0.3	1.5	0.0	0.0	0.0	1.6
Typhoid	28.7	0.2	3.6	32.5	138.1	2.5	0.2	3.6	140.8
Other	-	1,925.3	2,026.2	3,951.6	-	7,036.9	1,925.3	2,026.2	8,962.2
Malnutrition-related									
ALRI, Malaria	1,505.7	nc	154.6	1,660.2	21,074.6	nc	nc	154.6	21,074.6
Total	**1,898.4**	**1,959.4**	**2,354.6**	**6,212.4**	**24,022.5**	**7,163.2**	**1,959.4**	**2,354.6**	**33,145.1**

Source: Philippines report

Table C8. Health care costs by disease in Vietnam

Disease	Financial costs (thousand US$)				Economic costs (thousand US$)				
	Public clinics	Private clinics	Self-treatment	Total	Public clinics	Private clinics	Self-treatment	Transport and other	Total
Diarrhea	2,259	1,827	21,869	25,955	1,872	1,911	18,298	5,688	27,768
Helminthes	45	52	175	272	19	38	95	168	320
Trachoma	16,919			16,919	16,015			1,037	17,052
Scabies	597	726	2,611	3,934	419	635	2,074	1,126	4,255
Hepatitis A	24	30	377	432	23	30	358	32	442
Malnutrition	164	208	2,533	2,905	155	207	2,378	253	2,992
ALRI	11	14	256	281	10	14	246	15	286
Malaria	20,019	2,858	27,821	50,697	18,512	2,836	23,449	8,317	53,114
Total	**20,019**	**2,858**	**27,821**	**50,697**	**18,512**	**2,836**	**23,449**	**8,317**	**53,114**

Source: Vietnam report

C3. Water quality indicators

Table C9. Cambodia – Phnom Penh Water Supply Authority, 2006

Location	Water body	Water quality indicators				
	Characteristics	pH	DO (mg/l)	TSS (mg/l)	Total coliform	Fecal coliform
Chroy Changva	Mekong River (Upstream Phnom Penh)					
Wet season	Water level: 2-10m Flow: 2800-36100m^3/s	7.4	5.5	174.5	17120.8	1317.2
Dry season	Water level: 2-5m Flow: 1700-5900m^3/s	7.7	4.4	30.8	5950.8	415.8
Chamkamon	Bassac river (Downstream Phnom Penh)					
Wet season	N/A	7.6	N/A	186.0	24750.0	2993.9
Dry season	N/A	7.4	N/A	68.2	58871.0	1241.0
Phum Prek	Tonle Sap (Dual flow)					
Wet season	Water level: 2-9m Flow: 85-8900m^3/s	7.4	3.4	119.8	23509.2	8692.5
Dry season	N/A	7.3	4.4	54.9	71162.2	3475.9

Source: Cambodia report

Table C10. Cambodia – Mekong River Commission, 2005

Location and date	Water body		Water quality indicators			
	Characteristics	Type	pH	DO (mg/l)	CODMN (mg/l)	TSS (mg/l)
Phnom Krom	Tonle Sap Lake	Lake				
Wet season			6.9	6.5	4.6	661.3
Dry season			6.9	5.1	5.3	214.0
Prek Kdam	Tonle Sap	River				
Wet season	Water level: 2-9m Flow: 85-8900m^3/s		7.0	6.4	2.8	78.8
Dry season	N/A N/A		6.7	5.9	6.0	48.3
Kratie	Mekong (upstream)	River				
Wet season	WL: 17-21m Flow: 28500-42800m3/s		7.2	6.3	2.6	92.6
Dry season	WL: 6-11m Flow: 3300-10290m3/s		7.3	7.3	4.8	26.2
Chroy Changva	Mekong (midstream)	River				
Wet season	Water level: 2-10m Flow: 2800-36100m^3/s		7.2	7.4	1.6	99.7
Dry season	Water level: 2-5m Flow: 1700-5900m^3/s		7.2	7.5	6.3	20.0
Takhmao	Bassac	River				
Wet season			7.0	6.6	3.2	94.5
Dry season			6.8	6.8	5.6	23.3
Khaom Samnor	Mekong (downstream)	River				
Wet season			7.1	7.3	3.7	100.0
Dry season			7.3	7.1	5.4	13.8

Source: Cambodia report

Table C11. Indonesia – water quality indicators

Province	River	Location and Batch	DO	BOD	TSS	TDS	DO (2005)
			(mg/l)				
NAD	Krueng Tamiang	Upstream: I	6.7	0.6	nd	250.0	6.2 - 9
		Upstream: II	7.0	0.7	nd	500.0	
		Downstream: I	6.0	3.3	nd	580.0	
		Downstream: II	6.6	2.5	nd	1700.0	
North Sumatra	Deli	Upstream: I	5.7	3.2	36.0	nd	0.7 - 7.7
		Upstream: II	8.4	4.1	36.0	nd	
		Downstream: I	2.4	6.5	20.0	nd	
		Downstream: II	2.4	7.7	104.0	nd	
West Sumatra	Batang Agam						5.2 - 7
Riau	Kampar						1.2 - 7.8
Jambi	Batang Hari	Upstream: I	5.7	4.0	206.0	59.0	3 - 6.5
	Hari	Upstream: II	5.9	1.0	72.0	76.0	
		Downstream: I	5.3	1.4	4.0	74.0	
		Downstream: II	5.7	4.0	76.0	104.0	
South Sumatra	Musi	Upstream: I	3.2	8.0	24.0	nd	1.8 - 7.9
		Upstream: II	3.2	1.7	33.7	nd	
		Downstream: I	4.2	8.7	25.0	nd	
		Downstream: II	3.0	1.8	32.2	nd	
Bengkulu	Air Bengkulu	Upstream: I	4.1	1.0	24.2	30.0	1.1 - 3.8
		Upstream: II	2.9	20.0	95.2	90.0	
		Downstream: I	nd	nd	nd	nd	
		Downstream: II	3.8	3.4	156.0	20.0	
Lampung	Way Sekampung						1.9 - 4
Bangka-Belitung	Rangkui	Upstream: I	1.6	12.0	nd	68.2	1.6 - 7.5
		Upstream: II	7.4	4.5	nd	87.4	
		Downstream: I	2.1	6.0	nd	11.4	
		Downstream: II	8.8	5.2	nd	15.7	
Jakarta	Ciliwung	Upstream: I	2.7	0.8	7.0	nd	0 - 5.8
		Upstream: II	4.1	5.1	10.0	nd	
		Downstream: I	0.4	20.8	30.0	nd	
		Downstream: II	2.1	47.1	59.0	nd	
West Java	Citarum	Upstream: I	0.8	34.0	98.0	667.0	0 - 5.9
		Upstream: II	3.9	8.2	800.0	170.0	
		Downstream: I	3.1	12.0	75.0	310.0	
		Downstream: II	2.6	17.2	3220.0	134.0	
Banten	Cisadane	Upstream: I	7.0	3.4	38.0	nd	5.1 - 6.3
		Upstream: II	7.6	2.7	47.0	nd	

		Downstream: I	3.4	3.9	24.0	nd	
		Downstream: II	0.2	16.9	14.0	nd	
Central Java and Yogyakarta	Progo	Upstream: I	7.7	2.8	28.0	180.0	6.3 - 8 a
		Upstream: II	7.7	1.1	18.0	212.0	4.9 - 6.5 b
		Downstream: I	6.8	6.8	nd	126.0	
		Downstream: II	7.3	7.8	nd	171.0	
East Java	Brantas	Upstream: I	nd	110.0	28.0	nd	0 - 8.3
		Upstream: II	nd	268.0	98.0	nd	
		Downstream: I	nd	139.0	98.0	nd	
		Downstream: II	nd	177.0	20.0	nd	
Bali	Tukad Badung	Upstream: I	5.1	1.9	10.0	nd	2.8 - 5
		Upstream: II	6.8	1.9	16.0	nd	
		Downstream: I	7.1	4.6	20.0	nd	
		Downstream: II	6.9	2.5	21.0	nd	
West Nusa Tenggara	Jangkok						4 - 7.4
East Nusa Tenggara	Kali Dendeng						1.1 - 3.5
West Kalimantan	Kapuas						2.5 - 5
Central Kalimantan	Kahayan						5.1 - 6
South Kalimantan	Martapura						nd
East Kalimantan	Mahakam						3.1 - 5.7
North Sulawesi	Tondano						6.7 - 9
Central Sulawesi	Palu						3 - 7.8
South Sulawesi	Jeneberang, Tallo						4 - 9
Southeast Sulawesi	Konaweha	Upstream: I	5.0	3.5	2.8	60.0	1.1 - 9
		Upstream: II	5.0	3.1	2.8	50.0	
		Downstream: I	6.0	4.0	10.5	136.0	
		Downstream: II	6.2	4.0	10.5	136.0	
Gorontalo	Bone	Upstream: I	7.4	2.0	1.7	34.5	5.3 - 7.8
		Upstream: II	nd	nd	nd	nd	
		Downstream: I	6.9	4.2	3.4	27.2	
		Downstream: II	nd	nd	nd	nd	
North Maluku	Tabobo	nd	nd	nd	nd	nd	4.8 - 5.4
Papua	Anafre	nd	nd	nd	nd	nd	3.3 - 7

Source: Indonesia report
a: Central Java; b: Yogyakarta

Table C12. Indonesia - quality of main rivers in Indonesia based on Class I (drinking water) and Class II standards, 2005

Province	River	Location	
		Upstream*	Mid- and downstream*
NAD	Krueng Aceh	Mild to medium pollution	Mild to medium pollution
North Sumatra	Deli	Mild to medium pollution	Mild to medium pollution
West Sumatra	Batang Agam	Satisfactory to mild pollution	Mild pollution
R i a u	Kampar	Mild to heavy pollution	Mild to medium pollution
J a m b i	Batang Hari	Mild to medium pollution	Mild to medium pollution
South Sumatra	Musi	Mild to medium pollutio	Mild to medium pollution
Bengkulu	Air Bengkulu	Mild to medium pollution	Mild pollution
Lampung	Way Sekampung	Medium pollution	Mild to medium pollution
Bangka Belitung	Rangkui	Mild to heavy pollution	Mild to heavy pollution
Jakarta	Kali Angke	Mild to heavy pollution	Mild to medium pollution
West Java - Jakarta	Ciliwung	Mild to heavy pollution	Medium to heavy pollution
West Java	Citarum	Mild to heavy pollution	Medium to heavy pollution
Central Java - Yogyakarta	Progo	Satisfactory to mild pollution	Mild to heavy pollution
East Java	Brantas	Mild to medium pollution	Satisfactory to mild pollution
West Java - Banten	Cisadane	Mild to heavy pollution	Mild to medium pollution
B a l i	Tukad Badung	Mild pollution	Mild pollution
West Nusa Tenggara	Jangkok	Mild to medium pollution	Medium pollution
East Nusa Tenggara	Kali Dendeng	Mild pollution	Satisfactory to mild pollution
West Kalimantan	Kapuas	Satisfactory to mild pollution	Mild to heavy pollution
Central Kalimantan	Kahayan	Heavy pollution	Mild to heavy pollution
South Kalimantan	Martapura	Mild to heavy pollution	Medium pollution
East Kalimantan	Mahakam	Mild pollution	Mild to medium pollution
North Sulawesi	Tondano	Mild pollution	Mild pollution
Central Sulawesi	Palu	Mild to medium pollution	Mild to medium pollution
South Sulawesi	Tallo	Mild pollution	Mild to heavy pollution
	Jeneberang	Mild pollution	Mild to heavy pollution
Southeast Sulawesi	Konaweha	Mild pollution	Mild pollution
North Maluku	Tabobo	Mild pollution	Satisfactory to mild pollution
Papua	Anafere	Mild pollution	Medium pollution

Source: Indonesia report. Indonesia State of the Environment [186]

* Water quality evaluated based on Government Regulation No 82 Year 2001 on Water Quality Management and Water Pollution Control. Upstream river quality evaluated based on Class I criteria (suitability as source of raw drinking water); mid- and downstream quality based on Class II criteria (suitability for water-based recreation activities, aquaculture, husbandry, plant watering and other uses) [186] [187]

Table C13. Philippines – inventory of classified water bodies, 2004

Region	Freshwater surface waters					Coastal and marine waters				Total
	AA	A	B	C	D	SA	SB	SC	SD	
NCR		1		4						5
CAR	2	9	19	6						36
1		10	4	10			1			25
2		3	8	19	4					34
3		17	6	22	1		2	2		50
4		15	6	40	1	2	1	2		67
5		23	11	12	2					48
6		16	6	11			6	2		41
7	1	22	4	2	1	1	5	3		39
8				13				3	3	19
9		19	8							27
10		33						1		34
11	2	4	8	7	3		3			27
12		3	6	9	3			4		25
13		10	1	6		1				18
ARMM										-
Total	**5**	**185**	**87**	**161**	**15**	**4**	**18**	**17**	**3**	**495**

Source: Philippines report. National Statistics Coordination Board [35]

For freshwater surface waters (rivers, lakes, reservoirs, etc.)

AA - Public water supply - waters that require disinfections to meet the national standards for drinking water
A - Public water supply - waters that require full treatment to meet the NSDW
B - Recreational water - waters for primary contact recreation (e.g., bathing, swimming, skin diving, etc.)
C - water for fishery production; recreational water class II (boating, etc.); industrial water supply class I
D - for agriculture, irrigation, livestock watering; industrial water class II; other inland waters

For coastal and marine waters (as amended by DAO 97-23)

SA - water suitable for fishery production; national marine parks and marine reserves; coral reefs, parks, and reserves
SB - tourist zones and marine reserves; recreational water class I; fishery water class 1 for milkfish
SC - recreational water class II (e.g., boating); fishery water class II (commercial); marshy and/or mangrove areas declared as fish and wildlife sanctuaries
SD - industrial water supply class II; other coastal and marine waters

Table C14. Philippines – water quality measurements – DENR, 2005

Region	Water Body	BOD (mg/l)	DO (mg/l)
NCR	Marikina River	12.1	3.4
	San Juan River	33.5	2.4
	Parañaque River	29.5	1.5
	Pasig River	24.2	2.4
CAR	Balili River*	31.8	4.9
3	Meycauayan River	119.8	1.2
	Marilao River	41.5	1.0
	Bocaue River	6.4	2.0
4A	Imus River	9.0	5.3
	Ylang Ylang River	8.4	4.6
4B	Calapan River	2.9	2.9
5	Anayan River	2.3	6.3
	Malaguit River	5.8	5.6
	Panique River	5.6	5.7
6	Iloilo River	4.9	4.9
7	Luyang River	2.0	7.6
	Sapangdaku River	0.9	7.1
10	Cagayan de Oro River	1.3	8.1

Source: Philippines report. [130]

Table C15. Philippines – water quality measurements – DENR, 2007

Name of River	Year	Ave Concentration (mg/l)					
		DO		BOD		TSS	
		Average	Status	Average	Status	Average	Status
Region 3							
Angat River	2005	7.8	P	2.3	P	28.1	F
Bocaue River	2002-2004	3.4	F	10.1	F	27.2	P
Marilao River	2002-2004	2.2	F	53.4	F	56.5	F
Meycauayan River	2002-2004	3.0	F	43.8	F	73.2	F
Pampanga River	2003-2005	6.2	P	19.3	F	128.4	F
Mabayuan River	2003-2004	7.7	P	1.7	P	17.6	P
Binictican River	2003-2004	-		-		19.3	P
Malawaan River	2003-2004	-		-		24.5	P
Binanga River	2004	7.6	P	1.0	P	28.5	P
El Kabayo River	2004	7.3	P	1.0	P	17.5	P
Ilanin River	2004	7.5	P	1.0	P	20.5	P
Triboa River	2004	7.3	P	1.0	P	20.5	P
Benig River	2002	3.5	F	51.7	F	190.3	F
Region 6							
Iloilo River	2001-2005	4.6	F	3.4	P	103.3	F
Jaro-Tigum-Aganan River	2001-2005	7.2	P	3.1	P	188.0	F
Jalaur River	2001-2005	7.1	P	4.6	P	85.6	F
Panay River	2001-2005	7.2	P	2.5	P	122.3	F
Region 12							
Allah River	2004-2005	7.4	P	3.8	P	116.8	F
Banga River	2003	7.4	P	2.4	P	21.6	P
Kapingkong River	2005	7.0	P	2.6	P	239.6	F
Silway Klinan River	2002	8.1	P	5.2	F	39.4	P
Buayan River	2003	7.6	P	2.7	P	89.3	F
Maribulan River	2003	7.9	P	2.4	P	42.3	P
Malaang River	2004-2005	7.9	P	2.4	P	13.0	P
Kabacan River	2005	7.2	P	2.4	P	27.2	P
Kipalbig River	2004	8.1	P	3.2	P	148.4	F
Lun Masla River	2005	7.6	P	1.5	P	40.6	P
Lun Padidu River	2003	7.9	P	1.7	P	9.2	P
Malasila River	2003	8.4	P	2.3	P	6.0	P
Marbel River	2001	8.3	P	7.7	F	38.0	P
Siguel River	2005	8.6	P	2.1	P	78.6	F
Lake Sebu	2002	9.1	P	5.5	F	6.4	P

Source: Philippines report. DENR: Water Quality Status Reports [188-190]
P= passed, F=Failed

Table C16. Vietnam – water body quality classification, 2003

Region	Rivers		Ground water	Coastal Water	Issues
	Upstream	Downstream			
Red River Delta	++++	++	+++	+++	Urban and Industrial pollution, Saline intrusion, Agrochemical pollution, transport pollution risks
North East	+++++	++	++++	+++	Urban pollution, Saline intrusion, Marine transport pollution risks
North West	+++++	++++	+++++		
North Central Coast	++++	+++	++++	++++	Urban pollution, Saline intrusion
South Central Coast	+++++	++	++++	++++	Urban pollution, Saline intrusion
Central Highlands	+++++	++++	+++++	-	-
South East	++++	+	+++	++	Urban and Industrial pollution, Saline intrusion
Mekong River Delta	++++	++	+++	+++	Saline intrusion, low pH in rivers (Acid Soils) Agrochemical pollution, transport pollution risks

Source: Vietnam report. Vietnam Environment Monitor 2003 [191]
Note: A high score (+++++) means water is abundant or good quality, a low score (+) means water is scarce or the water quality is unacceptable and out of range of standards

Table C17. Vietnam – selected water quality measurements, 2005

Location	Year / month	Water body location	Water body type	Selected water quality indicators				
				pH	DO	BOD	TSS	Coliform
Vietnam's Standard				**5.5 - 9.0**	**> 2mg/l**	**<25mg/l**	**80**	**<10,000 MPN/100ml**
Red River Delta								
Hong River	26-Nov-05	At Lien Mac Culvert	Hong River	8.42	4.78	8.85	85	500
	15-Dec-05	At Lien Mac Culvert	Hong River	7.39	4.57	6.08	152	900
	26-Nov-05	At Van Phuc village in the morning	Hong River	8.21	4.68	9.34	635	700
		At Moi brigde	To Lich River	7.7	0.1	96	58	480,000
		At Thanh Liet dam	To Lich River	7.55	0.3	91.2	97	410,000
		At the centre of West Lake	West Lake	8.3	4.02	17.2	16	1,300
Cau River	9-Dec-05	At Nhu Nguyet brigde	Cau River	6.89	4.25	6.13	61	1,200
Thai Binh River	6-Dec-05	At Pha Lai	Thai Binh River	6.73	4.06	3.94	216	600
Nhue River	3-Dec-05	At border with Tu Liem district and Ha Dong	Nhue River	7.58	3.26	26.1	47	11,000

		At downstream from Ha Dong bridge	Nhue River	7.58	3.16	37.5	41	11,000
Day River		At Mai Linh bridge	Day River	6.72	1.09	36.8	29	22,000
Cam River	17-Nov-05	At km 9, National Road No. 5	Cam River	7.82	4.95	10.4	94	1,100
		At Chua Ve port	Cam River	7.71	4.17	16.9	98	2,700
North Central Coast								
Huong River	1-Jul-05	At Tuan confluence	Huong River	7.48	5.49	4	31.2	400,000
	1-Sep-05	At Tuan confluence	Huong River	7.83	5.48	4.6	32	220,000
	1-Jul-05	At Sinh confluence	Huong River	7.67	4.96	4	25.4	1,100,000
	Nov-05	At Sinh confluence	Huong River	7.8	5.56	1	21	250
South Central Coast								
Vu Gia - Thu Bon River	Jul-05	At Giao Thuy	Vu Gia - Thu Bon River	8.14	5.1	2.9	16.7	25
	Nov-05	At Giao Thuy	Vu Gia - Thu Bon River	7.69	5.25	0.5	16.5	21
	Jul-05	At Cua Dai	Vu Gia - Thu Bon River	8.11	5.73	2.4	16.7	200
	Nov-05	At Cua Dai	Vu Gia - Thu Bon River	7.38	5.09	1.3	12.5	500
Han River	Jul-05	At Thuan Phuoc bridge	Han River	7.93	4.17	5.8	32	5,000
	Nov-05	At Thuan Phuoc bridge	Han River	7.74	4.32	3.8	14	3,100
South East								
Thi Vai River	2004 - 2006	From Long Tho commune, Nhon Trach District, Dong Nai province to My Xuan commune, Tan Thanh district, Ba Ria Vung Tau	Thi Vai River	9 - 10.5	< 0.5	880	na	30,000 – 690,000

Source: Vietnam report. Vietnam Environmental Protection Agency (2005)

C4. Fish production loss

Table C18. Cambodia – fish catch value and estimated loss

Region	Dissolved Oxygen (mg/l)	Fish catch in 2005 (MT)	Actual value of fish catch (million US$)*	Fish catch compared to optimal (base case)	Estimated value of fish lost from poor sanitation (US$ m)
Plains Region		**50,500**	**84.3**		**2.7**
Phnom Penh	7.46	9,000	15.0	100%	-
Kandal	7.46	21,500	35.9	100%	-
Kampong Cham	6.80	10,000	16.7	88%	1.5
Prey Veng	6.67	5,000	8.3	87%	0.8
Takeo	7.21	5,000	8.3	93%	0.4
Tonle Sap Great Lake Region		**78,500**	**131.1**		**40.9**
Kampong Thom	6.15	9,000	15.0	72%	3.8
Siem Reap	5.77	15,000	25.0	65%	8.8
Banteay Meanchey	5.77	3,000	5.0	65%	1.8
Battambang	5.77	15,000	25.0	65%	8.8
Pursat	5.77	15,000	25.0	65%	8.8
Kampong Chnang	6.15	21,500	35.9	72%	9.1
Upper Mekong Region		**5,000**	**8.3**		**0.7**
Stung Treng	6.80	2,500	4.2	88%	0.4
Kratie	6.80	2,500	4.2	88%	0.4
Total inland fishery production		**134,000**	**223.7**		**44.4**

Source: Cambodia report

* Estimation of fish value is based on Consumer Price Index 2005

Table C19. Indonesia – fish catch value and estimated loss in (wild capture)

Province	Recorded DO range for major river(s) 2005	Latest year fish catch (2005)		% fish catch compared to optimal (upper range DO)	Sanitation as % water pollution	Estimated value of lost fish catch due to poor sanitation (US$ m)
		Volume (ton)	Value (US$ thousand)			
Nanggroe Aceh Darussalam	6.2 - 9	1,319	1,555	100%	19%	-
North Sumatra	0.7 - 7.7	11,671	10,162	100%	18%	4.24
West Sumatra	5.2 - 7	8,000	10,280	100%	37%	1.63
R i a u	1.2 - 7.8	24,694	56,674	100%	9%	8.16
J a m b i	3 - 6.5	5,554	6,791	80%	39%	5.16
South Sumatra	1.8 - 7.9	43,188	38,599	100%	22%	15.74
Bengkulu	1.1 - 3.8	453	638	30%	62%	0.98
Lampung	1.9 - 4	8,100	7,105	30%	36%	6.36
Bangka Belitung	1.6 - 7.5	n.a.	n.a.	n.a.	18%	n.a.
Riau Archipelago	1.2 - 7.8	n.a.	n.a.	n.a.	3%	n.a.
Jakarta	0 - 5.8	n.a.	n.a.	n.a.	8%	n.a.
West Java	0 - 5.9	6,677	5,654	70%	15%	2.08
Central Java	6.3 - 8	16,177	11,750	100%	23%	0.25
Yogyakarta	4.9 - 6.5	1,255	1,033	80%	29%	0.20
East Java	0 - 8.3	11,871	6,776	100%	16%	2.63
Banten	5.1 - 6.3	536	347	80%	12%	0.03
B a l i	2.8 - 5	590	628	50%	38%	0.62
West Nusa Tenggara	4 - 7.4	2,851	2,548	100%	69%	1.14
East Nusa Tenggara	1.1 - 3.5	n.a.	n.a.	n.a.	73%	n.a.
West Kalimantan	2.5 - 5	13,486	18,372	50%	27%	13.59
Central Kalimantan	5.1 - 6	27,506	35,051	70%	42%	10.20
South Kalimantan	n.a.	49,613	56,035	50%	29%	11.42
East Kalimantan	3.1 - 5.7	30,593	38,211	70%	3%	2.04
North Sulawesi	6.7 - 9	1,043	1,246	100%	41%	-
Central Sulawesi	3 - 7.8	297	144	100%	54%	0.06
South Sulawesi	4 - 9	19,950	4,145	100%	51%	0.57
Southeast Sulawesi	1.1 - 9	3,990	6,622	100%	52%	3.58
Gorontalo	5.3 - 7.8	860	644	100%	66%	0.11
West Sulawesi	4 - 9	161	66	100%	14%	0.00
Maluku	4.8 - 5.4	105	132	50%	75%	0.10
North Maluku	4.8 - 5.4	105	132	50%	57%	0.08
West Irian Jaya	3.3 - 7	3,363	4,488	90%	25%	1.13
Papua	3.3 - 7	3,363	4,488	90%	63%	2.84
Indonesia		**297,370**	**330,316**			**92.0**

Source: Indonesia report

Table C20. Philippines – fish catch value and estimated loss in inland fisheries[1]

Region	DO average 2003	Production (metric ton)	Value (US$ m)	Loss Due to Sanitation (US$ m)
NCR	4.3	na	na	na
CAR	Na	899.0	0.5	0.06
1	7.0	2,278.0	1.3	0.15
2	Na	6,801.0	4.0	0.46
3	3.7	9,843.0	5.9	0.66
4a	6.7	72,011.0	42.6	4.80
4b		761.0	0.5	0.05
5	5.3	2,825.0	1.7	0.19
6	7.7	5,740.0	3.4	0.39
7	6.7	170.0	0.1	0.01
8	7.2	2,761.0	1.6	0.19
9	5.6	584.0	0.3	0.04
10	7.8	1,993.0	1.2	0.13
11	7.0	175.0	0.1	0.01
12	na	15,811.0	9.4	1.06
13	6.9	3,681.0	2.2	0.25
ARMM	na	17,475.0	10.3	1.17
Total	**6.3**	**143,808.0**	**85.1**	**9.65**

Source: Philippines report. [36, 192, 193]

[1] Since there is no regional disaggregation of the value of production for inland municipal fisheries, the implicit price using national data was used in the calculations.

[2] The DO values are simple averages for the different water bodies in the region. A regional breakdown is available in Annex Table B3.7 and B3.8.

na – not applicable

Table C21. Vietnam – fish catch value and estimated loss in inland fisheries

Water body name and type	% fish catch comp-ared to optimal	Fish volume (Farm and Inland Catch 2005)		Potential Fish Volume		Loss Value (Narrow Definition) (US$ m)	Loss Value (Broader Definition) (US$ m)
		Weight (tons)	Value (US$ m)	Weight (tons)	Value (US$ m)		
Red River Delta	70%	206,794	62.0	295,421	88.6	10.6	21.3
North East	90%	48,760	14.6	54,177	16.3	0.7	1.3
North West	90%	7,933	2.4	8,815	2.6	0.1	0.2
North Central Coast	90%	48,071	14.4	53,412	16.0	0.6	1.3
South Central Coast	90%	65,787	19.7	73,097	21.9	0.9	1.8
Central Highlands	90%	15,367	4.6	17,074	5.1	0.2	0.4
South East	70%	53,332	16.0	76,189	22.9	2.7	5.5
Mekong River Delta	90%	862,984	258.9	958,871	287.7	11.5	23.0
Total		**1,309,027**	**392.7**	**1,537,055**	**461.1**	27.4	54.7

Source: Fish volume [63]

C5. Sensitivity analysis

Table C22. Ranges of economic costs using one-way sensitivity analysis

Country and impact	Economic cost (US$ millions)		
	Lower	Mid	Upper
Cambodia	**234.3**	**448.0**	**629.1**
Health	110.7	187.1	203.9
Water	96.9	149.0	198.2
User preferences	17.7	38.2	94.2
Tourism	9.0	73.7	132.8
Indonesia	**3,658.7**	**6,344.0**	**18,801.0**
Health	2,621.8	3,350.0	8,787.0
Water	723.0	1,512.0	4,696.0
Environment	96.0	96.0	96.0
User preferences	300.1	1,220.0	4,888.0
Tourism	13.8	166.0	430.0
Philippines	**1,025.6**	**1,412.1**	**6,024.8**
Health	731.8	1,011.1	5,140.6
Water	256.7	323.3	733.7
User preferences	21.1	37.6	70.3
Tourism	16.0	40.1	80.2
Vietnam	**504.1**	**780.1**	**1,106.5**
Health	160.3	262.4	397.3
Water	187.5	287.3	312.6
Environment	118.9	118.9	118.9
User preferences	21.5	42.9	64.4
Tourism	16.0	68.6	213.4
All countries	**5,422.7**	**8,984.2**	**26,561.4**
Health	3,624.6	4,810.6	14,528.8
Water	1,264.1	2,271.6	5,940.5
Environment	214.9	214.9	214.9
User preferences	360.4	1,338.7	5,116.9
Tourism	54.8	348.4	856.4

Source: country reports

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