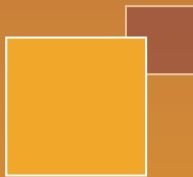
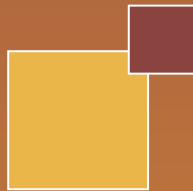


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# Economic Impacts of Sanitation in Indonesia

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



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





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## Executive Summary

At 55% in 2004, sanitation coverage in Indonesia is below the regional average for Southeast Asian countries of 67%. Nationwide, sanitation coverage has increased by 9 percentage points since 1990, representing significant progress towards the target of 73% set by the Millennium Development Goal joint water supply and sanitation target. However, at current trends Indonesia will fall short of the MDG sanitation target by 10 percentage points, equivalent to 25 million people. The Government of Indonesia recognizes that in terms of providing adequate water supply and sanitation facilities, it is facing a "...losing battle in keeping up with the population increase".

This study shows that the high number of people living with unimproved household sanitation is imposing large financial and economic costs to the Indonesian economy, not only to private individuals but also to the public and commercial sectors. The results of this study support the need for greater investment in water and sanitation infrastructure and in promoting improved hygiene practices. The results will be of interest to national policy makers, local authorities, civil advocacy groups, universities and donor agencies.

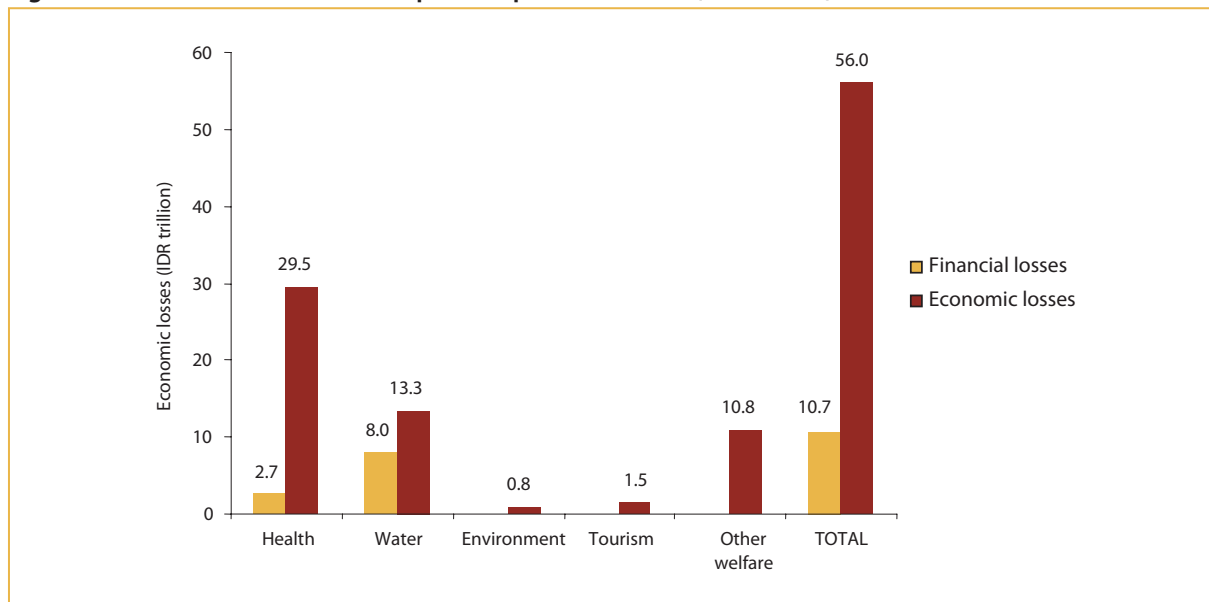
Unimproved sanitation and hygiene have a wide array of impacts, which can be categorized into impacts on: health, water-related activities, the external environment, life choices, population preferences, and tourism. For Indonesia, impacts are evaluated for all these categories since they are all important at the national level. The study is based on information from national and provincial data and surveys, smaller scale research studies, and consultations with experts.

In 2006, Indonesia lost an estimated IDR 56 trillion (USD 6.3 billion) due to poor sanitation and hygiene, equivalent to approximately 2.3% of gross domestic product (GDP). Figure A shows overall economic losses by impact type.

At IDR 275,000 (USD 31.10) annually in urban areas, per capita costs of poor sanitation and hygiene were estimated to be higher than in rural areas at IDR 224,000 (USD 25.40); however, significantly more people still do not have access to improved sanitation in rural areas.

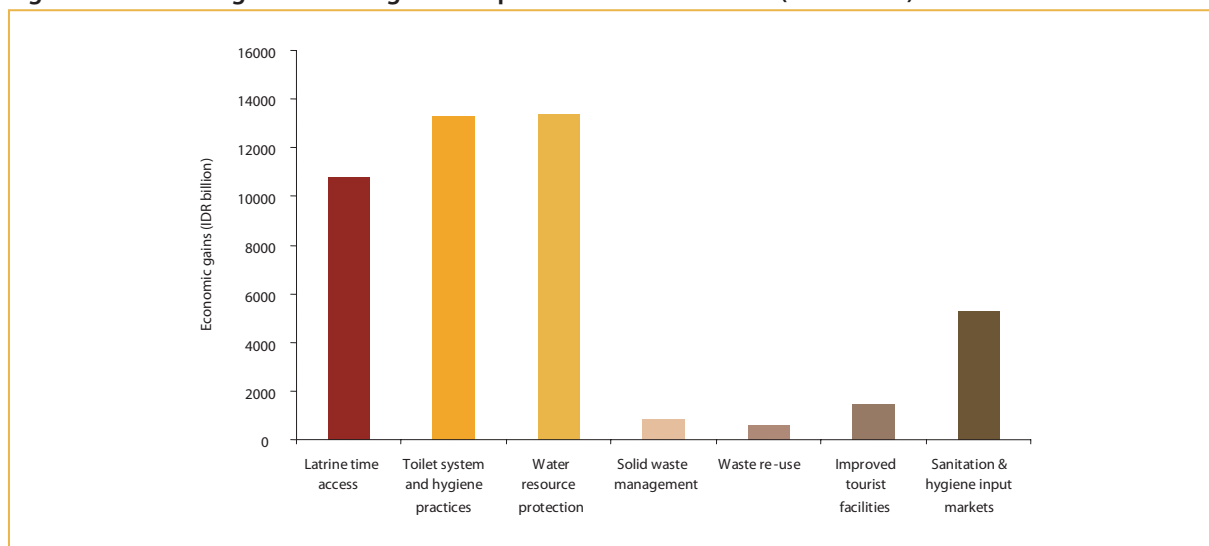
Of the impacts evaluated, health and water resources contribute most to the overall economic losses estimated in the study. These impacts are expected to cause financial losses to populations, as shown in Figure A, who have to pay for health services or who pay more to access clean water supplies, or who may lose income due to poor health.

Poor sanitation, including hygiene, causes at least 120 million disease episodes and 50,000 premature deaths annually. The resulting economic impact is more than IDR 29 trillion (USD 3.3 billion) per year. 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 IDR 13 trillion (USD 1.5 billion) per year. Poor sanitation also contributes up to IDR 11 trillion (USD 1.2 billion) per year in population welfare losses (due to additional time required to access unimproved sanitation), IDR 1.5 trillion (USD 166 million) per year in tourism losses, and IDR 0.9 trillion (USD 96 million) in environmental losses due to loss of productive land. A number of intangible effects, relating to the population's preferences for a safe, convenient and private place to defecate, were not quantified in this study but are known to influence population behavior and overall welfare.

**Figure A. Economic and financial impacts of poor sanitation (IDR trillion)**

With the universal implementation of improved sanitation and hygiene, it is assumed that all the attributed impacts shown in Figure A would be mitigated, except for health impacts, for which up to 45% of the estimated losses would be mitigated.

Figure B shows the gains according to different components of sanitation improvement. The overall economic saving would be IDR 40 trillion (USD 4.5 billion) annually. In addition, the implementation of ecological sanitation approaches (biogas and fertilizer) in 900,000 households would be worth an estimated IDR 0.6 trillion (USD 67 million) annually; and input markets generated from improved sanitation and hygiene—corresponding to 2.3 million households reached per year to attain the sanitation MDG target—could be worth an estimated IDR 5.3 trillion (USD 600 million) per year, generating jobs and revenue for the private sector.

**Figure B. Economic gains resulting from improvement in sanitation (IDR billion)**

This is the first study in Indonesia to compile economic evidence on a range of impacts of poor sanitation and hygiene. The results indicate that poor sanitation and hygiene have significant financial and economic costs, with major implications for the socio-economic development of Indonesia and the attainment of short-, medium- and long-term development goals. The study highlights the links between improved sanitation and several other MDG targets, including poverty, hunger reduction, gender equality, child health, access to safe drinking water, and the quality of life of slum-dwellers.

The study demonstrates that poor sanitation affects everyone, but especially the poor and vulnerable, including children, women, the disabled and senior citizens. Hence, sanitation should receive greater attention from all levels of Indonesian government, and from development partners, the private sector and households. Decision makers should act now, and in a concerted way, to stimulate demand for improved sanitation and hygiene practices, at the same time increasing the opportunities for households to satisfy their demand.

## Foreword

Indonesia, like other countries of Southeast Asia, is on a development path that is lifting large numbers of people out of poverty, and the economy is now growing at over 5% per annum. As well as economic growth, populations demand improved quality of life through improved health, housing, access to welfare services, and living environments. 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, ultimately, 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 various levels to make informed choices on sanitation policies and resource allocations.

The first major activity of the Economics of Sanitation Initiative 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. 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 Acknowledgments).



## Abbreviations

|         |  |
|---------|--|
| ALRI    | Acute lower respiratory tract infection              |
| BEST    | Bina Ekonomi Sosial Terpadu, an NGO in Indonesia     |
| BPS     | Indonesian Bureau of Statistics                      |
| BOD     | biochemical oxygen demand                            |
| DHS     | Demographic and Health Survey                        |
| DO      | dissolved oxygen                                     |
| EAP     | East Asia and the Pacific                            |
| EcoSan  | ecological sanitation                                |
| ESI     | Economics of Sanitation Initiative                   |
| GDP     | gross domestic product                               |
| HRQL    | Health-Related Quality of Life                       |
| ID      | international dollar                                 |
| JMP     | Joint Monitoring Programme (WHO, UNICEF)             |
| MDG     | Millennium Development Goal                          |
| MOH     | Ministry of Health                                   |
| N       | nitrogen   |
| NAD     | Nanggroe Aceh Darussalam Province                    |
| NGO     | non-governmental organization                        |
| OECD    | Organization of Economic Cooperation and Development |
| P       | phosphorous  |
| IDR     | Indonesian rupiah                                    |
| Susenas | National Socioeconomic Survey                        |
| TSS     | total suspended solids                               |
| USD     | United States dollar                                 |
| VIP     | ventilated improved pit latrine                      |
| VOSL    | value of a statistical life                          |
| WHO     | World Health Organization                            |
| WSP     | Water and Sanitation Program                         |

## Acknowledgments

The Sanitation Impact Study was conducted in four countries: Cambodia, Indonesia, the Philippines, and Vietnam. A study 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), 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.

Guy Hutton (WSP-EAP senior water and sanitation economist) led the development of the concept and methodology for the Economics of Sanitation Initiative (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 until December 2007, and Jema Sy, Brian Smith, Almud Weitz, and Richard Pollard provided inputs to concept development and study execution. Bjorn Larsen (WSP consultant) contributed to the study methodology and provided the figures for malnutrition-related health effects of poor sanitation.

The country team in Indonesia consisted of Lydia Napitupulu (WSP consultant, country lead), and Dedek Gunawan (WSP consultant). Guy Hutton led report drafting and finalization.

The ESI Indonesia study has been financed by the regional component of the Sustainable Sanitation for East Asia (SUSEA) Program, funded by the Swedish International Development Agency (SIDA). ESI has also received funding from the UK Department for International Development, the Danish International Development Agency, and the Dutch Ministry of Foreign Affairs. WSP and the report authors are grateful to the funding agencies for their support.

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### References for other reports

- Economic impacts of sanitation in **Southeast Asia**. Hutton G, Rodriguez UE, Napitupulu L, Thang P, Kov P. World Bank, Water and Sanitation Program. 2008.
- Economic impacts of sanitation in **Cambodia**. Kov P, Sok H, Roth S, Chhoeun K, Hutton G. World Bank, Water and Sanitation Program. 2008.
- Economic impacts of sanitation in **the Philippines**. Rodriguez UE, Jamora N, Hutton G. World Bank, Water and Sanitation Program. 2008.
- Economic impacts of sanitation in **Vietnam**. Thang P, Tuan H, Hutton G. World Bank, Water and Sanitation Program. 2008.

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## Basic country data – Indonesia, 2006

| Variable   | Value        |
|--|--------------|
| <b>Population</b>  |              |
| Total population (million)                                       | 221.8        |
| Rural population (%)   | 57.5         |
| Urban population (%)   | 42.5         |
| Annual population growth (%)                                     | 1.26         |
| Under 5 population (% of total)                                  | 8.7          |
| Under 5 mortality rate (deaths per 1,000)                        | 38           |
| Female population (% of total)                                   | 50.3         |
| Population below poverty line (million)                          | 39.5         |
| <b>Economic</b>  |              |
| Currency name  | Rupiah (IDR) |
| Year of cost data presented                                      | 2006         |
| Currency exchange with USD                                       | 8,828        |
| GDP per capita (USD)   | 1,420        |
| GDP per capita (International \$, adjusted for purchasing power) | 3,950        |
| <b>Sanitation (2004)</b>   |              |
| Improved rural (%)   | 40           |
| Improved urban (%)   | 73           |
| Urban sewage connection treated (%)                              | 2            |

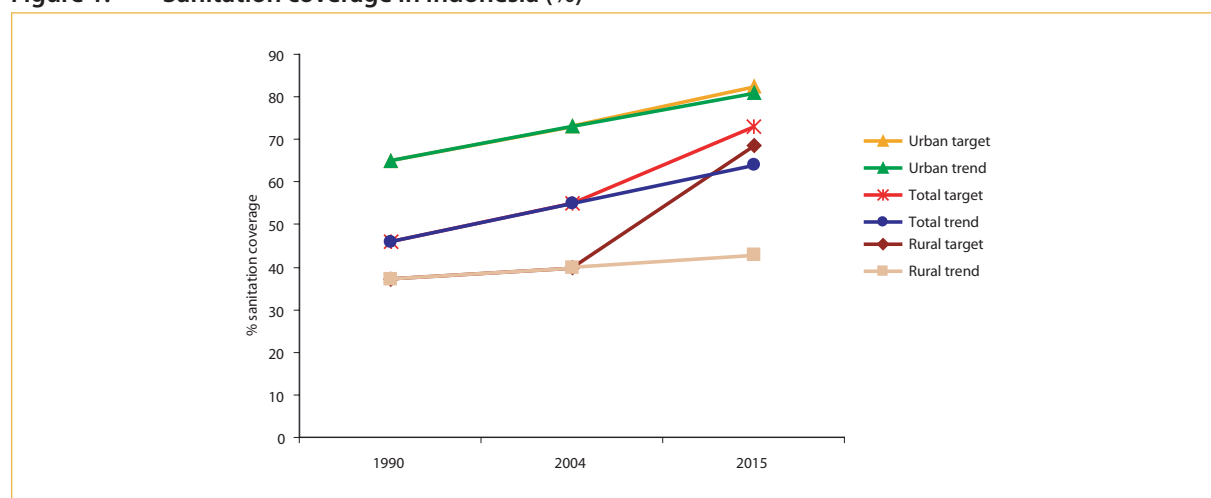


# 1 Introduction

Sanitation is a global concern. One of the targets of the United Nations Millennium Development Goals (MDG) is to halve – between 1990 and 2015 – the proportion of people without access to improved sanitation. Compared with other countries in Southeast Asia, in 2004 Indonesia was below average in establishing sanitation access, at 55% compared with an average of 67% for all countries in Southeast Asia<sup>1</sup>.

Forty-five percent (45%) of the Indonesian population without improved sanitation corresponds to **one hundred million Indonesians without improved sanitation**, that is, without an easily accessible, private and safe place to urinate and defecate. According to the UNICEF/WHO Joint Monitoring Programme, progress over the 14-year period between 1990 and 2004 has been slow in Indonesia, especially in rural areas where coverage increased 3 percentage points from 37% to 40% in a 14-year period, compared with an 8 percentage point increase in urban areas. While the 9 percentage point increase in 15 years is an impressive feat in a country of Indonesia's population size and geographical spread, progress is slower than in other countries in the region of similar economic development, such as Vietnam, which recorded a 25 percentage point increase, Thailand (19 percentage point increase) and the Philippines (15 percentage point increase). Figure 1 compares trends with national target figures for rural (lower lines), urban (upper lines) and total sanitation coverage, up to 2015.

**Figure 1. Sanitation coverage in Indonesia (%)**

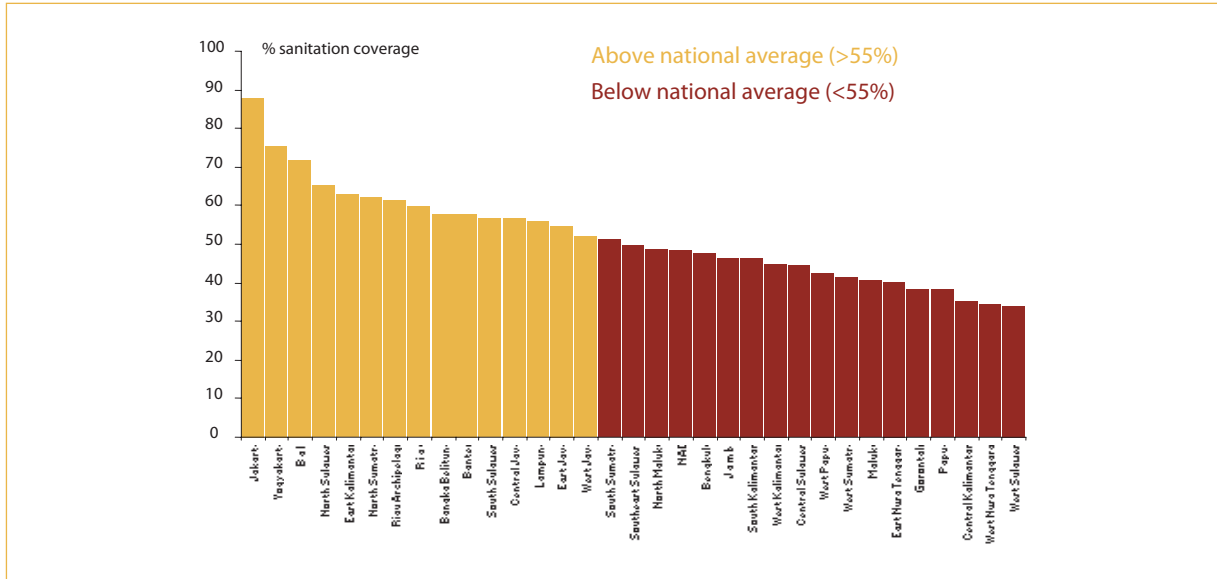


Source: <http://www.wssinfo.org/>

Efforts to increase sanitation coverage must also compete with population growth in Indonesia, which stands at an estimated 1.3% per annum. At this rate, an additional 2.8 million Indonesians will require improved sanitation facilities every year from now until 2015, thus adding to the 100 million people currently without improved sanitation. **Forecasts at current rate of progress suggest that Indonesia will fall short of the MDG target of 73% by 10 percentage points, equivalent to 25 million people<sup>2</sup>.** The Government of Indonesia (GOI) recognizes that in terms of providing adequate water supply and sanitation facilities, it is facing a "...losing battle in keeping up with the population increase"<sup>3</sup>. Furthermore, significant rural-urban and inter-provincial disparities exist, which sanitation improvement efforts must address. Figure 2 shows regional variations in coverage, ranging from 34% in West Sulawesi to 88% in Jakarta (see Annex Table C1 for population figures and Annex Table C2 for coverage ratios by province and rural/urban breakdown).

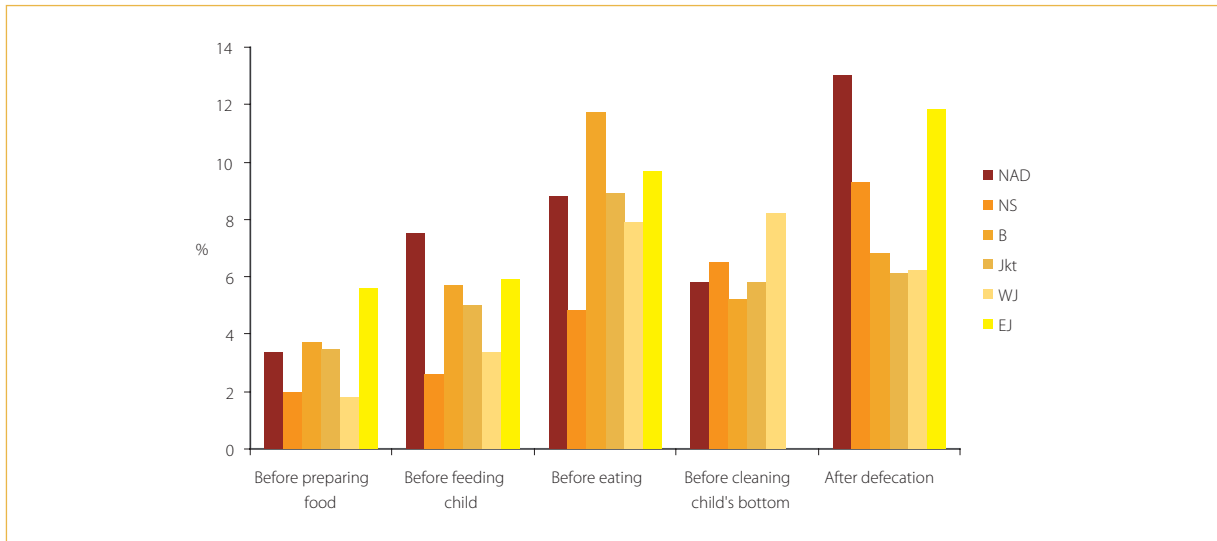
- 1 According to the UNICEF/WHO Joint Monitoring Programme, national coverage stood at 55% in 2004. Not all national surveys in Indonesia give the same figures for improved sanitation coverage. Annex Table A1 shows the sanitation coverage from four national surveys conducted between 2002 and 2006.
- 2 Universal Sanitation in East Asia. Mission Impossible? Water and Sanitation Program, United Nations Children's Fund, World Health Organization. 2007.
- 3 *National Policy: development of community-based water supply and environmental sanitation*. Bappenas, Kimpraswil, Ministry of Health, Ministry of Home Affairs, Ministry of Finance. 2003.

**Figure 2. Improved sanitation coverage by province, year 2004**



Hygiene practices in Indonesia are another concern. A survey conducted in six provinces in 2005 found that less than 15% of mothers cite washing hands with soap before or after five critical activities (see Figure 3). Given that poor hygiene is a major risk factor for a range of infectious diseases that have a particularly large impact on children, the low rates of improved hygiene practices are a major cause for concern.

**Figure 3. Percentage of mothers citing they wash their hands with soap before or after five critical activities, by province**



Key: NAD: Nanggroe Aceh Darussalam; NS: North Sumatra; B: Banten; Jkt: Jakarta; WJ: West Java; EJ: East Java. Source: USAID BHS Baseline Survey<sup>4</sup>

4 University of Indonesia Center for Health Research. *Survei rumah tangga pelayanan kesehatan dasar di 30 kabupaten di 6 provinsi di Indonesia 2005*. Final report to USAID - Indonesia Health Services Program: Jakarta. 2006.

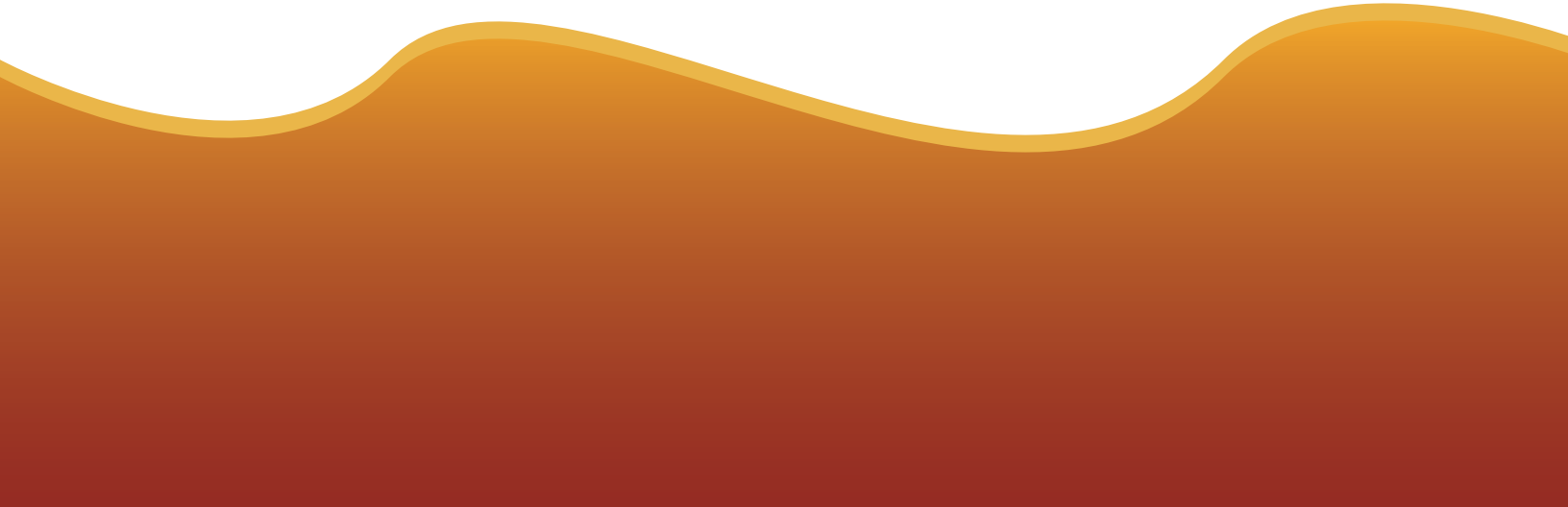


That **sanitation is low on the list of political priorities is reflected in the low level of investment in this sub-sector in Indonesia, which is estimated at IDR 200 per household, or roughly 0.5% of the investment needed to meet the MDG target.** As well as lack of top-down investment in the sector, opportunities for attracting private sector engagement in the financing and provision of sanitation services have not been adequately exploited, especially the potential for contribution by small-scale entrepreneurs. To date, most sanitation investment has been by household self-provision. Furthermore, starting in 1990, and notably with the onset of decentralization in 1999, the mandate for provision of water and sanitation services was passed to local governments, where technical capacity to provide water and sanitation services has been inadequate.

Hence a number of pre-conditions and actions are needed to raise the profile of sanitation in government as well as in household spending. One major constraint to further investment in sanitation is a lack of knowledge of the effects of inaction, and conversely, the role improved water supply and sanitation services plays in the development process. Therefore, evidence is needed to support advocacy for increased investment in sanitation; evidence that does not focus exclusively on a single impact such as health impact, but on the full range of impacts that also include water and environmental quality, population preferences, and the various knock-on economic impacts of poor sanitation. Indeed, economic evidence can be a powerful advocacy tool, at the higher level, in motivating a range of players who influence key government decisions and sectoral resource allocations; and at the lower level, in motivating households to make the decision to invest their limited funds in an improved latrine or toilet.

Therefore, **the aim of this study is to provide decision makers in Indonesia with better evidence on the negative economic impacts of poor sanitation and hygiene**, to provide sanitation stakeholders with a better basis for arguing for increased investment and for more rational policy making in the sub-sector. The study also seeks to generate tentative estimates of the impacts that can be mitigated by investing in improved sanitation and hygiene.

# 2 **Methods**



## 2.1 Study approach

This study in Indonesia employs a standardized peer-reviewed methodology<sup>5</sup>, which was also implemented in four other countries: Cambodia, Lao PDR, the Philippines and Vietnam. **The primary aim of the study is to provide national estimates of the economic impact of poor sanitation and hygiene.** Results for selected impacts are also presented by provincial level, rural/urban breakdown and specific population sub-groups such as women and children.

The study uses a modeling approach and draws almost exclusively on routine data sources such as national surveys as well as published studies. It presents the impacts in physical units and converts these into monetary equivalents using conventional economic valuation techniques. Results on economic impact are presented for a single year – 2006 – in Indonesian rupiah (IDR) and United States Dollars (USD). For those impacts where quantification in economic terms is not feasible, impacts are examined and reported descriptively. A complete listing of the equations used in calculating costs is provided in Annex A. Annex B shows the data inputs and results at national level, while Annex C shows the data inputs and results at provincial level.

## 2.2 Scope of sanitation

The term ‘sanitation’ is used to describe many different aspects of hygiene and the disposal or recycling of waste. In the international arena, the sanitation indicator adopted as part of the Millennium Development Goals (target number 10 on water supply and sanitation) focuses on the availability of a private latrine and the safe disposal of human excreta. Despite the focus of the MDG target on human excreta, the importance of other aspects of sanitation is recognized. The management of human excreta, animal excreta, solid waste, agricultural waste, toxic waste, wastewater, food, and associated hygiene practices are all included in a broader definition of sanitation. However, not all of these could be assessed in the present study. Table 1 provides an overview of which aspects of sanitation were included, with the main focus being on the human excreta aspect.

**Table 1. Aspects of sanitation included in the present sanitation impact study**

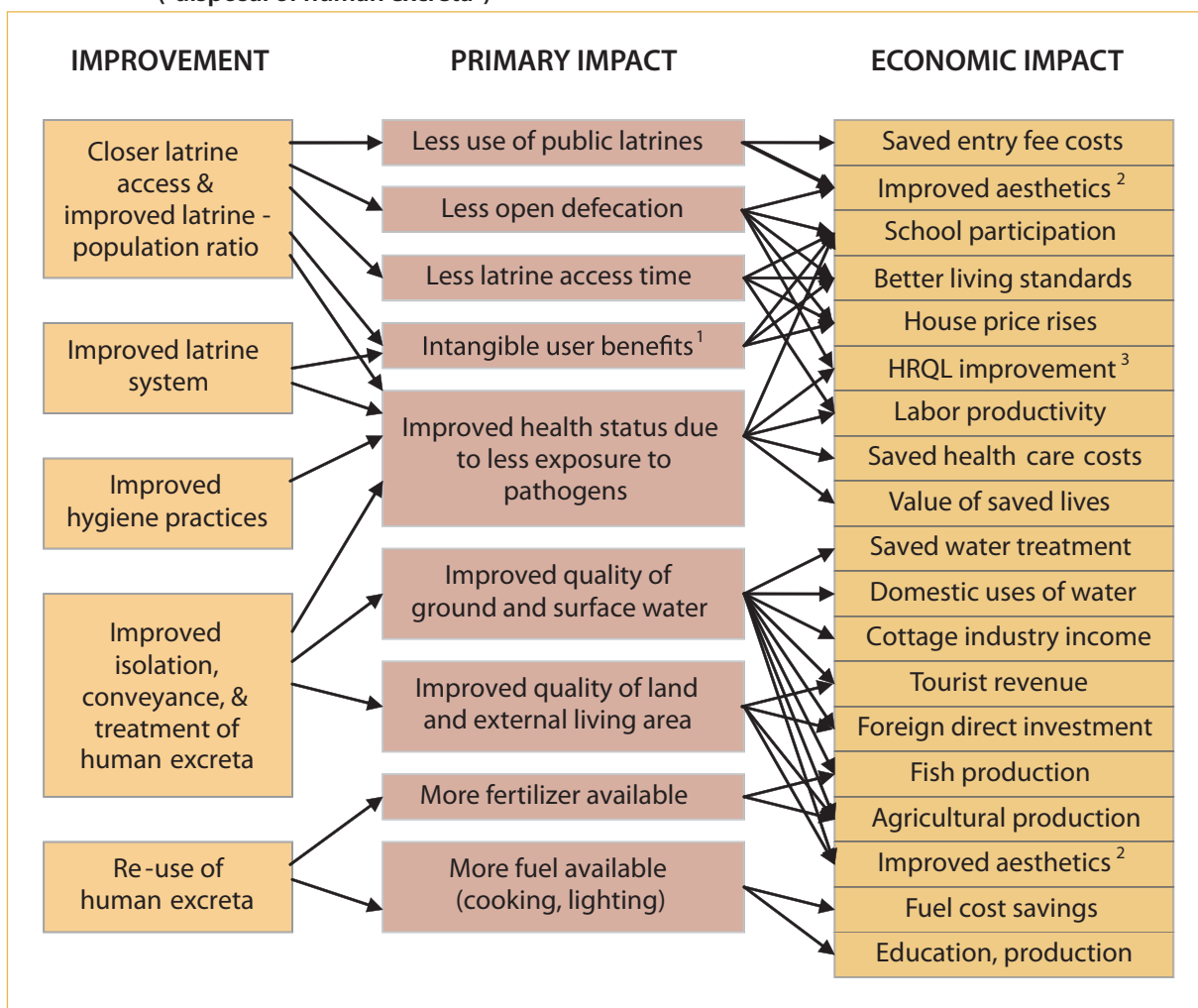
| Included  | Excluded   |
|---|--|
| <ul style="list-style-type: none"> <li>• Practices related to human excreta               <ul style="list-style-type: none"> <li>• Quality, safety, and proximity of latrine system</li> <li>• Disposal or treatment of waste and impact on the (inhabited) outdoor environment</li> <li>• Hygiene practices (hand washing with soap)</li> </ul> </li> <li>• Practices related to disposal or treatment of gray water</li> <li>• Practices related to disposal or treatment of household solid waste</li> </ul> | <ul style="list-style-type: none"> <li>• Drainage and general flood control measures</li> <li>• Industrial effluents, toxic waste, and medical waste</li> <li>• Agricultural waste</li> <li>• Broader environmental sanitation</li> <li>• Vector control</li> <li>• Broader food safety</li> <li>• Practices related to use or disposal of animal excreta</li> </ul> |

## 2.3 Impacts evaluated

Poor sanitation has many actual and potential negative effects. Conversely, improved sanitation has a large number of potential economic impacts, as shown in Figure 4. The impacts of poor (and improved) sanitation are related to five main features: (1) latrine location, (2) latrine system, (3) hygiene practice related to human excreta management, (4) excreta isolation, conveyance and treatment or disposal, and (5) excreta re-use (recycling).

<sup>5</sup> The full methodology is described in the synthesis report “Economic impacts of sanitation in Southeast Asia”. Water and Sanitation Program, 2008.

**Figure 4. Primary impacts and resulting economic impacts associated with improved sanitation options (“disposal of human excreta”)**



<sup>1</sup> Comfort, convenience, security, privacy; <sup>2</sup> Visual effects, smells; <sup>3</sup> HRQL: health-related quality of life

Based on this initial assessment of a long list of sanitation impacts, a shortened list was selected for evaluation in this present study. These are

- Health impacts
- Water resource impacts
- External environment impacts
- Other welfare impacts
- Tourism impacts
- Excreta re-use

Table 2 shows the financial and economic costs quantified in this study. Note that some impacts such as fish and tourism losses have multiple causes, and hence a fraction of overall losses are attributed to poor sanitation. Economic losses include additional expenditures, income, productivity or time losses, and the value of premature death associated with poor sanitation. Financial costs are distinguished from the broader economic costs, focusing on direct out-of-pocket expenses or income losses. Non-pecuniary welfare impacts were assessed but not quantified in monetary units; these along with other non-quantified impacts are listed in Annex Table A3.

**Table 2. 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  |
|--------------------------------|-----------------------|--|---|
| <b>1. Health</b>               | 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   |
| <b>2. Water resources</b>      | Drinking water costs  | Water treatment and distribution   | <i>Financial</i> + 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  | <i>Financial</i> + Time spent hauling water from less polluted water sources                            |
|                                | Fish losses           | -  | Lost sales value due to reduction in fish catch   |
| <b>3. External environment</b> | Land quality          | -  | Economic value of land made unusable by poor sanitation   |
| <b>4. Other welfare</b>        | Time loss             | -  | Welfare loss due to adult & child travel/ waiting time for defecation                                   |
| <b>5. Tourism</b>              | Tourism costs         | -  | Revenue loss from low hotel occupancy rates   |

## 2.4 Impact mitigation

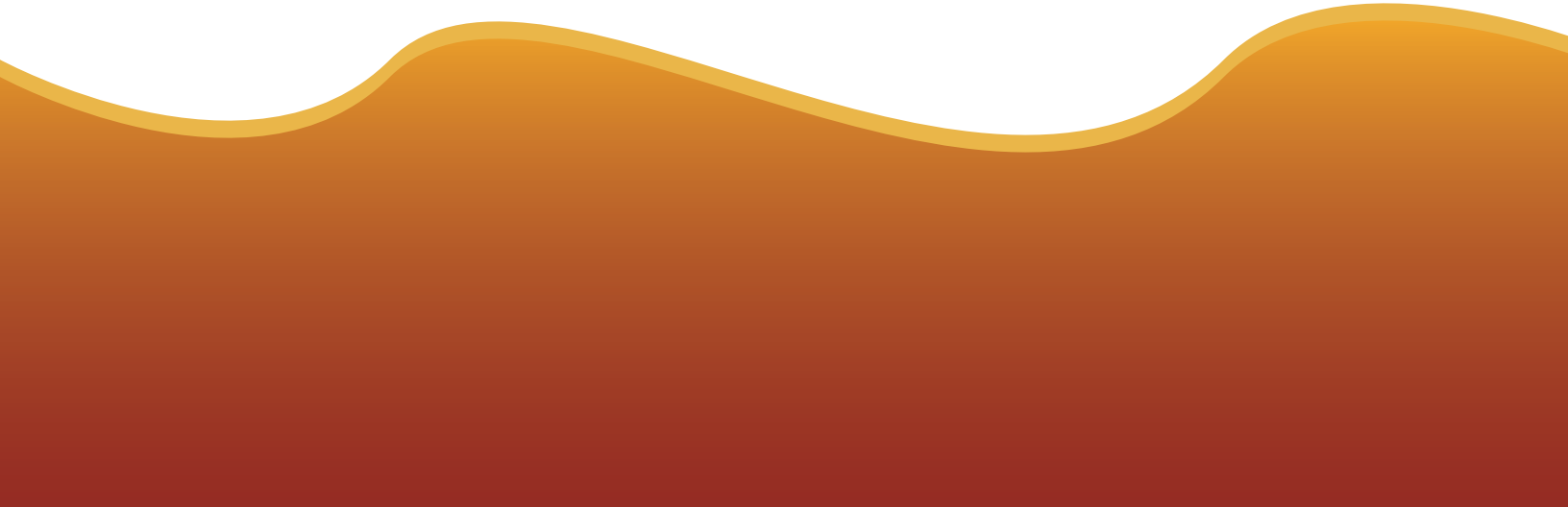
From a policy viewpoint, it is important to know how much of the estimated losses resulting from poor sanitation can be averted by implementing improved sanitation options. This study estimates the potential benefits of the five *features* of sanitation improvements shown in Figure 4, plus improved sanitation for tourists, as shown in Table 3. Therefore the study provides an initial estimate of the likely gains from improving these features. These estimates are by nature fairly crude and generalized, and will be supplemented by more precise estimates of the full costs and benefits of sanitation improvements from field settings in Indonesia, available from a forthcoming study.

**Table 3. Features of sanitation interventions for assessing economic gains**

| Intervention                                  | Detail   | Gains evaluated   |
|---|--|---|
| Latrine access                                | Toilets closer and more accessible (private rather than shared or public)  | Save latrine access time  |
| Making toilets cleaner and safer              | Improved position or type of toilet seat or pan, structure, collection system, ventilation, and waste evacuation   | Avert health impacts (32% reduction); and generates market value in sanitation products                         |
| Hygiene practices (hand washing with soap)    | Availability of water for anal cleansing, safe disposal of materials for anal cleansing, hand washing with soap, toilet cleaning   | Avert health impacts (45% reduction); and generates market value in hygienic products                           |
| Isolation of human waste from water resources | Improved septic tank functioning and emptying, flood-proof, treatment, and drainage system   | Avert costs of accessing clean water for drinking and other household uses, and avert losses in fish production |
| Reuse of human waste                          | Composting of feces for biogas production  | Value of replaced fuel  |
| Sanitary conditions for tourists              | Culturally appropriate improved tourist toilet facilities (hotels, restaurants, tourist attractions) and general sanitary conditions of tourist leisure facilities (e.g. water for swimming, environmental sanitation) | Avert tourist losses  |



# 3 Results



### 3.1 Summary of economic impacts of poor sanitation

The overall economic losses from poor sanitation and hygiene amount to IDR 56 trillion (USD 6.3 billion) per year (see Table 4). This sum is equivalent to 2.3 % of GDP in 2005, amounting to approximately IDR 252,000 (USD 28.60) per person per year. To give an indication of the relative impact on the Indonesian economy, where the average price level is 36 percent of that of the United States (when prices are compared at market exchange rates), the impact in international dollars is ID 17.8 billion.

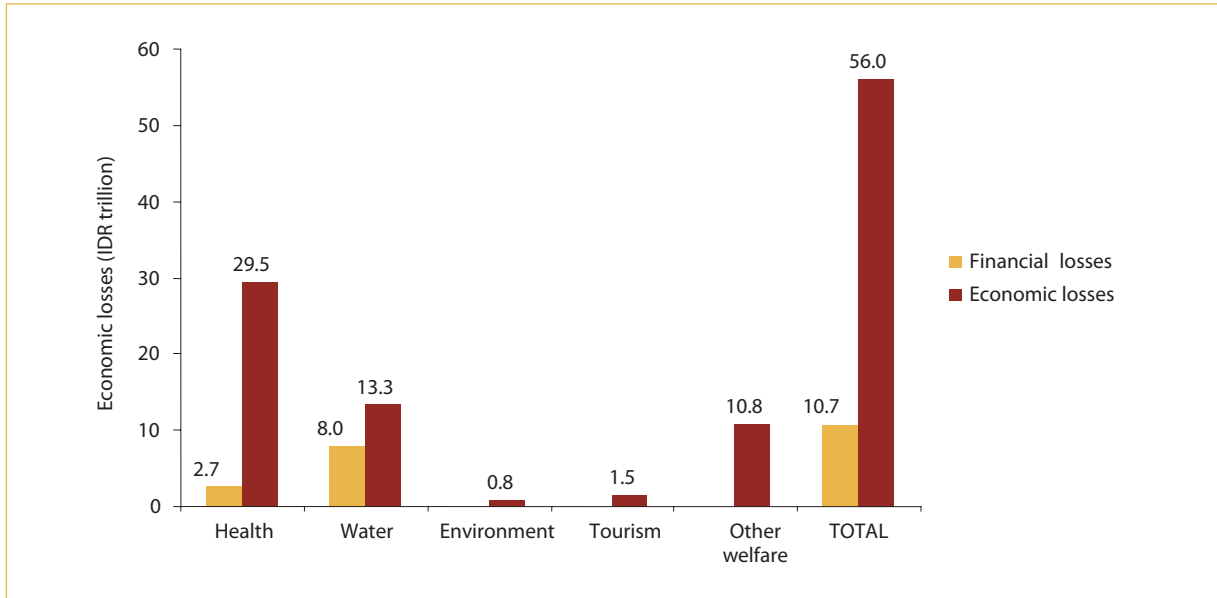
**Table 4. Financial and economic losses due to poor sanitation, by impact type**

| Impact                | Financial losses    |                           |              | Economic losses     |                           |              |
|-----------------------|---------------------|---------------------------|--------------|---------------------|---------------------------|--------------|
|                       | Value (IDR billion) | Per capita (IDR thousand) | %            | Value (IDR billion) | Per capita (IDR thousand) | %            |
| <b>Health costs</b>   | <b>2,719</b>        | <b>12.4</b>               | <b>25.3</b>  | <b>29,512</b>       | <b>133.3</b>              | <b>52.7</b>  |
| Health care costs     | 1,236               | 5.3                       | 11.5         | 1,642               | 7.1                       | 2.9          |
| Productivity costs    | 1,033               | 4.4                       | 9.6          | 3,090               | 14.1                      | 5.5          |
| Premature death costs | 441                 | 1.8                       | 4.1          | 24,780              | 112.1                     | 44.3         |
| <b>Water costs</b>    | <b>8,016</b>        | <b>36.2</b>               | <b>74.7</b>  | <b>13,348</b>       | <b>60.0</b>               | <b>23.9</b>  |
| Drinking water        | 7,089               | 31.8                      | 66.0         | 11,379              | 51.2                      | 20.3         |
| Domestic water uses   | 936                 | 4.4                       | 8.7          | 1,156               | 5.3                       | 2.1          |
| Fish production       | -                   | -                         | -            | 812                 | 3.5                       | 1.5          |
| <b>Environment</b>    | <b>-</b>            | <b>-</b>                  | <b>-</b>     | <b>847</b>          | <b>3.5</b>                | <b>1.5</b>   |
| Land use              | -                   | -                         | -            | 847                 | 3.5                       | 1.5          |
| <b>Tourism</b>        | <b>-</b>            | <b>-</b>                  | <b>-</b>     | <b>1,465</b>        | <b>7.1</b>                | <b>2.6</b>   |
| Tourist loss          | -                   | -                         | -            | 1,465               | 7.1                       | 2.6          |
| <b>Other welfare</b>  | <b>-</b>            | <b>-</b>                  | <b>-</b>     | <b>10,770</b>       | <b>48.6</b>               | <b>19.3</b>  |
| Time use              | -                   | -                         | -            | 10,770              | 48.6                      | 19.3         |
| <b>TOTAL</b>          | <b>10,735</b>       | <b>48.6</b>               | <b>100.0</b> | <b>55,952</b>       | <b>252.5</b>              | <b>100.0</b> |



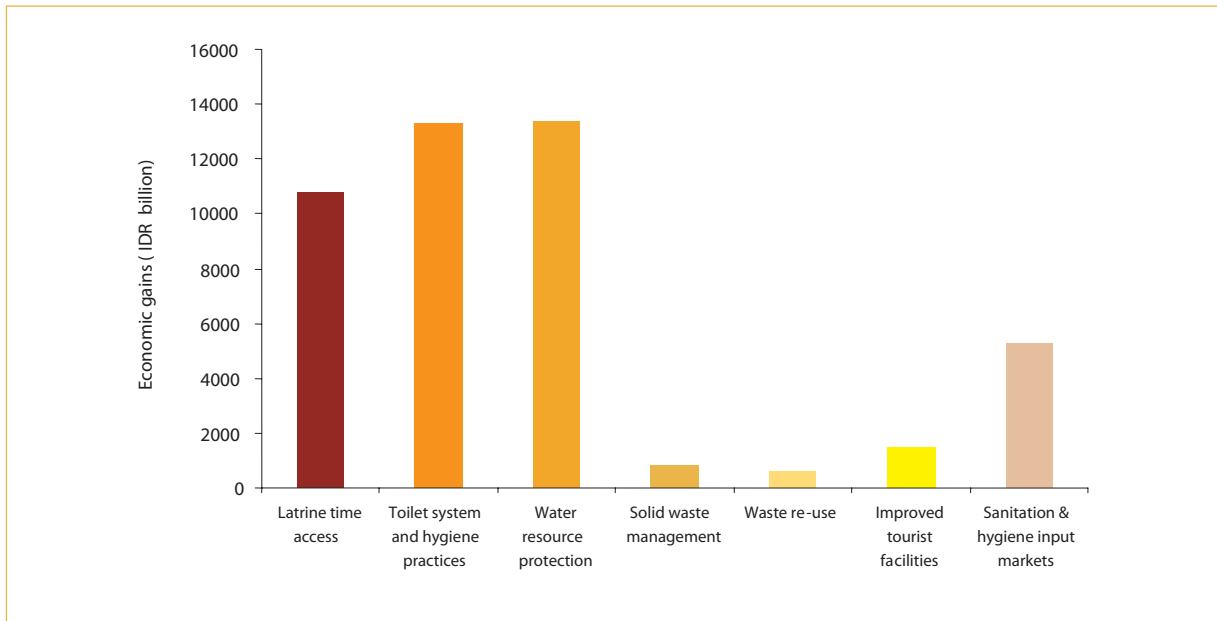
Out of the IDR 56 trillion annual economic losses, health impacts account for 53% (IDR 29.5 trillion) and water impacts 24% (IDR 13.3 trillion). The remaining 23% of economic cost is attributed to access time, tourism and loss of land use (see Figure 5). These figures exclude a whole range of other impacts which were not quantified in this study (see Annex Table B2). At IDR 275,000 (USD 31.10) annually in urban areas, per capita costs of poor sanitation and hygiene were estimated to be higher than in rural areas at IDR 224,000 (USD 25.40); however, significantly more people still do not have access to improved sanitation in rural areas. Financial costs – reflecting estimates of actual expenditures or income losses due to poor sanitation and hygiene – amount to IDR 10.6 trillion (USD 1.2 billion) annually, or 19% of economic losses – made up of water and health impacts.

**Figure 5. Financial and economic losses due to poor sanitation, by impact type (IDR trillion)**



By improving sanitation and hygiene, the majority of negative impacts can be averted (see Figure 6). Closer latrines reduce time losses valued at IDR 10.6 trillion (USD 1.2 billion), while improved toilet systems and hygiene practices bring health benefits worth at least IDR 13.2 trillion (USD 1.5 billion). Water resource protection measures due to improved management of human excreta also lead to potential savings of IDR 13.2 trillion (USD 1.5 billion), mainly by reducing the costs associated with access to safe drinking water. Investment in improved sanitation and the re-use of human excreta can lead to sanitation markets of at least IDR 5.3 trillion (USD 600 million) per annum. Improved sanitation for tourist locations can lead to annual economic gains of at least IDR 1.5 trillion (USD 166 million).

**Figure 6. Economic gains from universal coverage of improved sanitation and hygiene, by impact type (IDR billion)**



In conclusion, protecting water resources, averting health impacts and reducing access time are the three major potential benefits of a sanitation program, as quantified in this study. Positive impacts on tourism, employment from sanitation programs, and waste re-use are also potentially important benefits from sanitation programs. Non-quantified intangible benefits such as comfort, privacy and security, especially for women and the elderly, are also likely to bring major welfare improvements for populations receiving improved sanitation. However, further field studies collecting primary information are needed to actually show these benefits in an Indonesian context.

## 3.2 Health impacts

### 3.2.1 Burden of disease

The financial and economic health costs assessed in this study include (1) spending on health care, (2) loss of income or production associated with disease, and (3) the value associated with premature loss of life.



Poor sanitation and hygiene cause significant burden of disease in Indonesia through illness and premature death. Given the large number of diseases and health effects due to poor sanitation and hygiene (see Annex Table B3), this study selected key health impacts based on their epidemiological and economic importance, and on the availability of data from national statistics and research studies. Table 5 shows the estimated number of episodes and deaths attributed to poor sanitation for the selected diseases: diarrheal diseases, helminthes, scabies, trachoma, hepatitis A, hepatitis E, malnutrition and diseases related to malnutrition. Eighty-nine million cases of diarrhea were attributed to poor sanitation and hygiene, estimated using data from the national DHS, which collected diarrheal incidence rates for the under five population (2.5 cases per child per year). Twenty-

eight million cases of scabies are estimated to be attributed to poor hygiene practices. In addition, from the national health information system, three million malnourished children, one million cases of helminthes, and a further one million disease cases related to malnutrition, are attributed to poor sanitation and hygiene. However, these figures – especially those from routine government sources – are likely to be heavily underestimated, due to the majority of disease cases not seeking health care from a public service provider in Indonesia. Other studies suggest significantly higher rates of disease than those reported by government systems. For example, in East Asia helminthes are cited to have prevalence rates of 36% (roundworm), 28% (whipworm) and 26% (hookworm)<sup>6</sup>, which would lead to significantly more than one million cases. Three million malnourished children may also be a significant underestimate, in a country where it is estimated that 28% of children under five – or 5.4 million – are severely or moderately underweight.

The total number of deaths attributed to poor sanitation and hygiene exceeds fifty thousand, of which 24,000 are accounted for by direct diseases (mainly diarrhea) and 26,000 by indirect diseases related to malnutrition. These latter deaths include only children under five and therefore underestimate the total deaths in all age groups.

<sup>6</sup> Hotez P, Bundy D, Beegle K, et al. Helminth Infections: Soil-Transmitted Helminth Infections and Schistosomiasis. Chapter 24 in *Disease Control Priorities in Developing Countries*. 2006. Jamison D, Breman J, Measham A, Alleyne G, Claeson M, Evans D, Jha P, Mills A and Musgrove P, Editors: 2nd Edition. New York: Oxford University Press.

**Table 5. Estimated number of annual cases and deaths attributed to poor sanitation, 2006**

| Disease  | Morbidity (cases)  | Mortality (deaths) |
|--|--------------------|--------------------|
| <b>Direct diseases</b>   |                    |                    |
| Diarrheal disease  | 89,417,461         | 22,880             |
| Helminthes   | 1,054,048          | 56                 |
| Scabies  | 28,659,082         | 583                |
| Trachoma   | 174,079            | 0                  |
| Hepatitis A  | 715,330            | 702                |
| Hepatitis E  | 23,770             | 21                 |
| <i>Sub-total</i>   | <i>120,043,770</i> | <i>24,242</i>      |
| <b>Indirect diseases related to malnutrition among children under five years</b> |                    |                    |
| Malnutrition   | 3,073,220          | - <sup>1</sup>     |
| ALRI   | 1,066,935          | 8,049              |
| Malaria  | 87,818             | 1,887              |
| Measles  | 0                  | 3,528              |
| Other <sup>2</sup>   | - <sup>1</sup>     | 11,282             |
| Protein energy malnutrition <sup>2</sup>   | - <sup>1</sup>     | 1,144              |
| <i>Sub-total</i>   | <i>4,227,973</i>   | <i>25890</i>       |
| <b>Total</b>   | <b>124,271,743</b> | <b>50,132</b>      |

<sup>1</sup> Not available

<sup>2</sup> 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).

### 3.2.2 Health care costs

To estimate health care costs, the study compiled information on disease rates, treatment-seeking rates, treatment practices, and unit costs. Disease incidence and treatment seeking rates were estimated for each province (see Annex Tables C3 and C4). According to the national socio-economic survey (Susenas), two-thirds of Indonesians self treat or take no treatment when sick, while the majority of those who seek care do so at a formal caregiver (Annex Table B4). To estimate the costs of treatment seeking, standard health care unit costs were applied country-wide, based on the available costing studies conducted in Indonesia (Annex Table B5). Table 6 shows the marginal and full costs of treatment as well as the patient transport costs used in the study. For example, a diarrhea case seeking outpatient care at a government or private formal facility would have a marginal cost of IDR 34,429, and including fixed costs, the figure would amount to IDR 48,554. In addition, transport costs would cost an average IDR 3,973 per patient.

**Table 6. Unit health care costs used in the study (IDR, 2006)**

| Provider and disease            | Marginal cost per patient | Full unit cost per patient | Non-medical cost (transport) |
|---------------------------------|---------------------------|----------------------------|------------------------------|
| Formal outpatient care          | 34,429                    | 48,554                     | 3,973                        |
| Formal inpatient care (per day) | 50,320                    | 71,507                     | 8,033                        |
| Informal outpatient care        | 16,773                    | 24,277                     | 3,973                        |
| Malnutrition care (per case)    | 164,201                   | 229,528                    | 3,973                        |
| Self treatment <sup>1</sup>     | 4,855 - 15,008            | 4,855 - 15,008             | 0                            |

Source: Annex Table B5. <sup>1</sup> Range reflects costs of treatment for different diseases.

The total health care costs amount to IDR 1.6 trillion (USD 186 million), of which IDR 1.2 trillion (USD 140 million) is direct marginal expenditure made by patients or the health facilities on medical care or transport. Diseases with the greatest financial and economic impact are skin diseases (due to high treatment seeking), malnutrition (due to higher unit costs) and diarrheal disease (due to high numbers). Public clinics account for 49% of economic cost, or IDR 803 billion (USD 91 million), followed by private clinics at 36%, self-treatment at 10% and transport costs at 5%. Hence a significant proportion of the economic costs would be saved to patients and to government budgets if sanitation and hygiene-related diseases were prevented.

**Table 7. Total health care costs by disease (IDR billion)**

| Disease                | Financial costs | Economic costs |                 |             |                |                | % costs     |
|------------------------|-----------------|----------------|-----------------|-------------|----------------|----------------|-------------|
|                        |                 | Public clinics | Private clinics | Transport   | Self-treatment | Total          |             |
| Diarrheal diseases     | 387.5           | 195.1          | 218.1           | 50.3        | 43.3           | 506.7          | 31%         |
| Helminthes             | 30.0            | 16.8           | 19.4            | 1.8         | 2.6            | 39.7           | 2%          |
| Skin diseases          | 534.1           | 289.6          | 324.9           | 23.0        | 72.4           | 708.9          | 43%         |
| Trachoma               | 6.2             | 3.5            | 4.4             | 0.0         | 0.9            | 8.8            | 1%          |
| Hepatitis A            | 15.9            | 8.8            | 9.7             | 0.9         | 2.6            | 21.2           | 1%          |
| Hepatitis E            | 0.9             | 0.0            | 0.0             | 0.0         | 0.0            | 0.9            | 0%          |
| Malnutrition, indirect | 25.6            | 13.2           | 15.0            | 2.6         | 3.5            | 33.5           | 2%          |
| Malnutrition, direct   | 240.1           | 277.2          | 0.0             | 0.0         | 45.9           | 323.1          | 20%         |
| <b>Total</b>           | <b>1,239.5</b>  | <b>803.3</b>   | <b>590.6</b>    | <b>78.6</b> | <b>170.4</b>   | <b>1,643.8</b> | <b>100%</b> |

### 3.2.3 Health-related productivity costs

Disease takes people away from their occupations and daily activities, and regular sickness-related absence from school affects the ability of children to keep up with the curriculum and complete their education. Hence the time lost from these activities has a value. Financial costs were estimated as immediate income losses for adults not paid their wage or earning an income from time lost due to sickness<sup>7</sup>. Economic costs were estimated as the time lost from daily activities, valued for adults at 30% of the average compensation to employees of IDR 12,183 (USD 1.38) per hour, giving IDR 3,655 (USD 0.41) as the national average value of lost time (see Annex Table C5 for provincial values<sup>8</sup>, as well as other sources of time value including GDP per capita, minimum wage and average wage). Child time was valued at half that of adult time at IDR 1,827 (USD 0.21) – to account for the time taken off school or other productive activities. Time off daily activities varied from two to ten days depending on the severity of the disease, and whether treated or not.

Table 8 shows total productivity losses of roughly IDR 3 trillion (USD 350 million) per annum, two-thirds of which is accounted for by adults. Eighty-four percent of economic costs are accounted for by diarrheal diseases, and 65% represent losses to the adult population. Financial costs associated with income loss for adults are in the order of IDR 1 trillion (USD 117 million) per annum.

- 7 In 2005, 61% of all adults aged over 15 were in some kind of employment: salaried position (27%), self employed without employees (18%), self employed with employees (25%), casual workers (10%), and unpaid workers (20%).
- 8 Compensation of employees per capita was calculated at provincial level by multiplying national compensation of employees by the ratio of GDP per capita at the provincial to national GDP per capita, and dividing by the total full-time equivalent workforce.

**Table 8. Total productivity costs (IDR billion)**

| Disease                | Financial costs | Economic costs, by age group |              |                |                |
|------------------------|-----------------|------------------------------|--------------|----------------|----------------|
|                        |                 | 0-4                          | 5-14         | 15+            | Total          |
| Diarrheal diseases     | 823.7           | 704.5                        | 286.0        | 1,606.7        | 2,597.2        |
| Helminthes             | 7.1             | 0.9                          | 0.9          | 14.1           | 15.9           |
| Skin diseases          | 192.5           | 15.0                         | 33.5         | 374.3          | 422.9          |
| Trachoma               | 1.8             | 0.0                          | 0.0          | 4.4            | 4.4            |
| Hepatitis A            | 9.7             | 0.9                          | 1.8          | 18.5           | 21.2           |
| Hepatitis E            | 0.0             | 0.0                          | 0.0          | 0.9            | 0.9            |
| Malnutrition, indirect | 0.0             | 30.0                         | 0.0          | 0.0            | 30.0           |
| <b>Total</b>           | <b>1,035.5</b>  | <b>752.1</b>                 | <b>322.2</b> | <b>2,019.0</b> | <b>3,093.3</b> |

### 3.2.4 Costs of premature death

Premature death affects society in a number of ways. The most tangible economic impact is the loss of a member of the workforce, which has implications for economic outputs and wages generated now and in the future. One method used in cost-benefit analysis is to approximate the value of human life using the estimated future discounted income stream from a productive person, termed the 'human capital approach'. Given that this technique gives more conservative (lower) estimates of the value of human life compared with alternative methods commonly applied, such as value-of-a-statistical-life (VOSL), the human capital approach was used in this study. As an approximate average wage, or value of time, the average annual compensation to employees of IDR 24.5 million (USD 2,775) was applied. This gives an equivalent value of life of IDR 540 million (USD 61,278) for those dying as productive adults (those over 15 years of age, with a median age of 40 years old); IDR 1 billion (USD 115,387) for those dying between the ages of 5 and 14 (median age of 10 years old); and IDR 860 million (USD 97,760) for the death of a child under five (median age of 2.5 years old).

These values reflect an economic cost for a premature death. To estimate the financial cost of premature death – to reflect short-term direct income loss – it is conservatively assumed that a household loses the equivalent of one year of income, or IDR 24.5 million (USD 2,775). These figures all reflect national average. Provincial value of life figures are provided in Annex Table C6. In sensitivity analysis, the VOSL method is used. Due to the absence of studies on VOSL in Indonesia, an average VOSL of USD 2 million is transferred from OECD country studies. The transfer is made at an income elasticity of 0.6, and adjusted by the difference in GDP per capita between these countries and Indonesia. The resulting economic value for premature death valued using VOSL is IDR 2.1 billion (USD 240,341).

Table 9 presents the total costs of premature death. Of a total economic cost of IDR 25 trillion, the majority (95%) is attributed to deaths in the 0-4 year old age group – but this proportion is higher because deaths in this age group have been more comprehensively assessed. Financial costs total IDR 440 billion (USD 50 million). Economic and financial costs would be higher if the 'other' category of indirect deaths had been included (see footnote to Table 5).

**Table 9. Total costs of premature death (IDR billion)**

| Disease                | Financial costs | Economic costs, by age group |              |              |                 |
|------------------------|-----------------|------------------------------|--------------|--------------|-----------------|
|                        |                 | 0-4                          | 5-14         | 15+          | Total           |
| Diarrheal diseases     | 432.6           | 13,807.0                     | 582.6        | 485.5        | 14,875.2        |
| Helminthes             | 0.0             | 0.0                          | 0.0          | 0.0          | 0.0             |
| Skin diseases          | 8.8             | 26.5                         | 61.8         | 105.9        | 194.2           |
| Trachoma               | 0.0             | 0.0                          | 0.0          | 0.0          | 0.0             |
| Hepatitis A            | 0.0             | 8.8                          | 26.5         | 44.1         | 79.5            |
| Hepatitis E            | 0.0             | 0.0                          | 0.0          | 0.0          | 8.8             |
| Malnutrition, indirect | 0.0             | 9,613.7                      | 0.0          | 0.0          | 9,613.7         |
| <b>Total</b>           | <b>440.2</b>    | <b>23,464.8</b>              | <b>670.9</b> | <b>644.4</b> | <b>24,780.2</b> |

### 3.2.5 Summary of health-related costs

Figure 7 summarizes the estimated economic cost of the health impacts of poor sanitation and hygiene in Indonesia (Annex Table A5 provides the figures). The economic cost is estimated at IDR 29.6 trillion (USD 3.35 billion) per year, with the majority – 84% – accounted for by premature death.

**Figure 7. Health-related costs of poor sanitation and hygiene (IDR billion)**

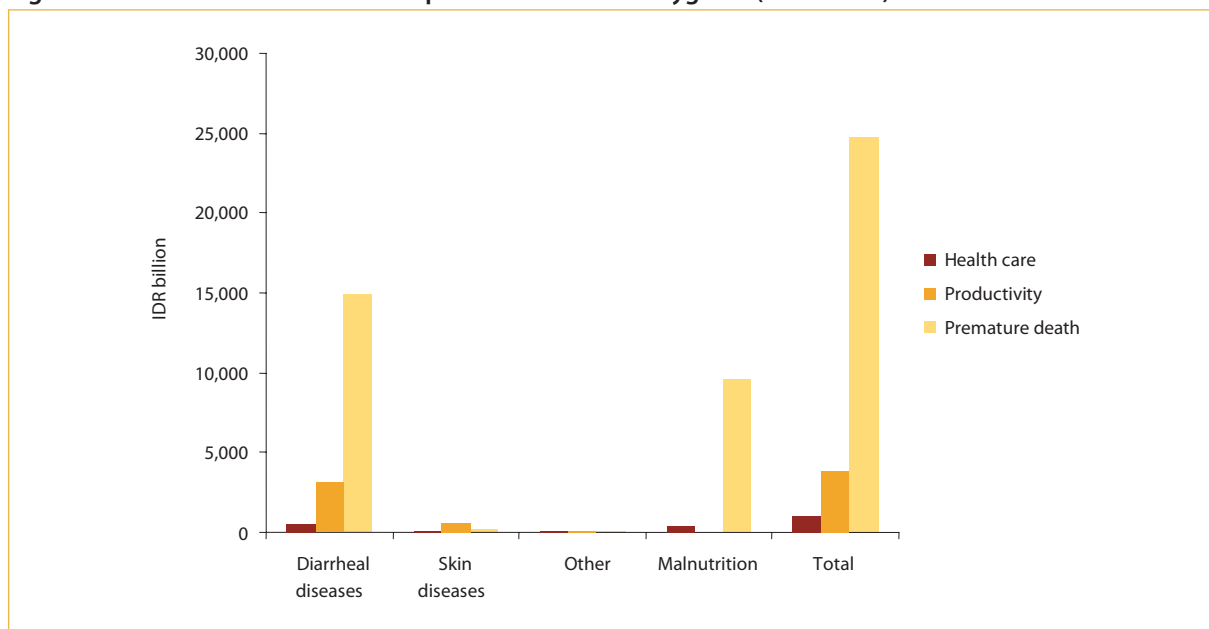
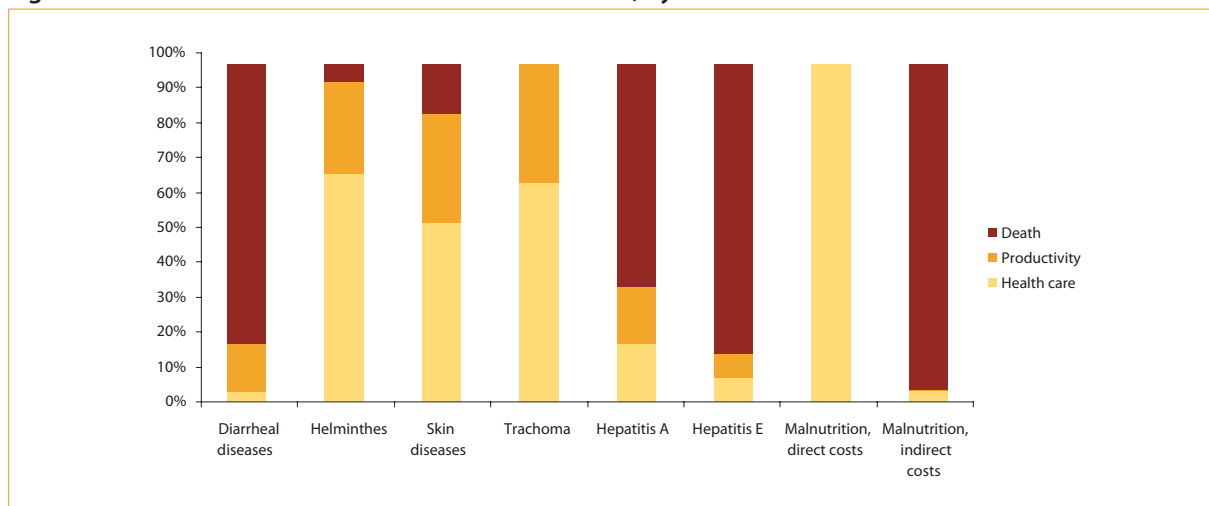


Figure 8 shows the contribution of various costs to overall cost, by disease. For helminthes, skin diseases, trachoma and malnutrition, the losses stem mostly from the cost of health care. For diarrheal disease, hepatitis and indirect diseases of malnutrition, losses from premature death are the most significant component of cost.

**Figure 8. Contribution of various costs to total cost, by disease**





### 3.3 Water resource impacts

Indonesia is well-endowed with water resources, with an average surface water volume of 15,500 m<sup>3</sup> per person per year. Major rivers include the Kali Brantas and Bengawan Solo rivers in East Java, the Cenranae river in South Sulawesi, and the Barito river in Central Kalimantan (see Annex Table C7). Major lakes include Air Siku and Kolong Kac in South Sumatra and Palaguna lake in South Sulawesi (see Annex Table C8). However, water availability is highly variable between regions and seasons, with some rivers drying up during the dry season. On Java, the average available surface water is one tenth the national average due to high population density.

The impact of pollution on the economic value of water resources is determined by three main factors: the extent of water resources, the release of polluting substances in water resources, and the actual or potential uses of water. At the national level, currently about 93% of freshwater resources are withdrawn for irrigation, 6% for domestic activities and 1% for industrial use<sup>9</sup>. For some of these activities, such as for drinking, good quality water is important; while for other uses, such as for agricultural and some industrial uses, water quality standards are not so strict.

#### 3.3.1 Water pollution from poor sanitation

Domestic sources contribute significantly to water pollution in Indonesia, where the majority of households do not have sewage or wastewater safely disposed of or treated. However, the presence of other sources of water pollution means that overall economic impact of polluted water cannot be attributed to poor sanitation alone. Pollutants that affect water-related economic activity originate from households, industry, agriculture (fertilizers, pesticides, animal waste), erosion, and salinity intrusion from coastal areas.

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. Table 10 shows the proportion of the total population with sanitation options that discharge directly or indirectly to ground or surface water. The total effluent of human excreta to water bodies is then estimated by combining population size by province (Annex Table C1), access to different types of sanitation facilities (Annex Table C2), the proportion of sewage released into water bodies (Table 10, or Annex Table C9 for provincial breakdown), and average human waste production per year<sup>10</sup>.

**Table 10. Proportion of rural, urban and total households with untreated sewage discharged to water bodies**

| Location     | Sewage discharged to water body | Open defecation in water courses <sup>1</sup> | Septic tank effluents to groundwater <sup>2</sup> | Pit latrine effluents to groundwater <sup>3</sup> | Total       |
|--------------|---------------------------------|---|---|---|-------------|
| Rural        | 27.6                            | 10.7  | 6.1   | 8.9   | 53.2        |
| Urban        | 28.6                            | 3.1   | 15.6  | 4.9   | 52.2        |
| <b>Total</b> | <b>28.0</b>                     | <b>7.4</b>                                    | <b>10.2</b>                                       | <b>7.2</b>  | <b>52.8</b> |

<sup>1</sup> One-quarter of total open defecation

<sup>2</sup> 50% of septic tanks

<sup>3</sup> 50% of unimproved pit latrines

Based on the above data and assumptions, the total release of polluting substances to inland water bodies in Indonesia is estimated at 6.4 million tones of feces annually, 64 million m<sup>3</sup> of urine, and 854 million m<sup>3</sup> of gray water (Table 11). This translates as approximately 2.1 million tones of biochemical oxygen demand and 385,000 tons of nitrogen compounds per year. A provincial distribution is shown in Annex Table C10. In Jakarta alone, roughly 0.3 million tons of feces and 2 million m<sup>3</sup> of urine are estimated to be released in into inland water bodies.

<sup>9</sup> *Water pricing and valuation in Indonesia: case study of the Brantas River Basin*. C Rodgers and P Hellegers. International Food Policy Research Institute *Discussion Paper 141*. Washington, DC. 2005.

<sup>10</sup> Equal to 0.15 kg of feces, 1.5 liters of urine and 200 liter of gray water per person per day.

**Table 11. Total release of domestic human waste to water bodies**

| Province        | Total release          |                        |                      | Polluting substances (thousand tons) |     |    |       |                                       |
|-----------------|------------------------|------------------------|----------------------|--------------------------------------|-----|----|-------|---------------------------------------|
|                 | Feces<br>(thousand kg) | Urine<br>(thousand m3) | Gray<br>(million m3) | BOD                                  | N   | P  | TSS   | Coliform count<br>(10 <sup>15</sup> ) |
| <b>Daily</b>    |                        |                        |                      |                                      |     |    |       |                                       |
| National        | 17,565                 | 176                    | 2,340                | 6                                    | 1   | 0  | 8     | 12                                    |
| Jakarta         | 714                    | 7                      | 95                   | 0                                    | 0   | 0  | 0     | 1                                     |
| <b>Annually</b> |                        |                        |                      |                                      |     |    |       |                                       |
| National        | 6,411,223              | 64,059                 | 854,115              | 2,137                                | 385 | 98 | 2,906 | 4,545                                 |
| Jakarta         | 260,731                | 2,607                  | 34,764               | 87                                   | 16  | 4  | 118   | 185                                   |

Source: Authors' estimate

Other sources of water pollution are industrial and agricultural activities. However as with domestic wastes, there is no existing national level estimate. Based on authors' estimates using available studies on industrial waste in Jakarta (Annex Table C11), approximations of animal waste, and other studies from the Asia region, the proportion of biochemical oxygen demand from domestic, agricultural and industrial sources is estimated (Annex Table C12). Nationally, an estimated 35% of BOD is released from domestic sources (varying 3% to 69% across provinces), compared with 57% from industry and 9% from agriculture. There is a wide variation in these estimates at the provincial level.

### 3.3.2 Water quality indicators

Water quality monitoring in Indonesia is mainly conducted by the government, at national, provincial and local levels. Some major government monitoring activities include (1) the Clean River Program (PROKASIH), which measures water quality in the most heavily polluted rivers, including industrial wastewater discharge; (2) the Clean City Award Program (ADIPURA), which includes water quality as one of the evaluated categories; and (3) a national government-supported program monitoring one river in each province since 2002. The Ministry of Environment compiles river water monitoring results from several provinces and publishes them in the annual 'State of the Environment' report. Selected river quality indicators from this report are presented in Annex Table C13. In addition to government activities, water companies also conduct water quality monitoring on their sources of water supply.

Different organizations measure different water quality indicators. Parameters routinely recorded are temperature, pH, conductivity, turbidity, biochemical oxygen demand, dissolved oxygen and nutrients (ammonia and orthophosphate). Indicator monitoring is done mainly for regulatory enforcement at the provincial level. More recently, the general public has been able to access several indicators updated daily via the website of the river management agency. Although monitoring is conducted at many sites throughout the country, results are not widely disseminated and the available data are indicative (e.g. the low and high values) rather than complete. Second, when interpreting the results it should be borne in mind that the water quality monitoring schedule is somewhat erratic and produces some results which do not appear robust when cross-temporal or cross-site comparisons are made.

Table 12 presents a summary of the pollution levels of selected rivers. Annex Table C13 provides the data supporting these assessments, covering pH, dissolved oxygen, BOD, dissolved solids, and suspended solids. Given the large volumes of pollution load presented in section 3.3.1, it is not surprising that the quality of river water is poor. Most BOD readings are above the national standard of 2 mg/l, while at downstream locations dissolved oxygen levels are routinely below 5 mg/l (an approximate threshold below which compromises the ability of water to support fish). For 30 provinces, all rivers at some time do not fulfill the Class I quality standard as a source of raw water for drinking. In 2005 only three rivers fulfilled the Class I criteria at locations upstream. Similarly, for locations mid- and downstream, only three rivers were able, at a specific point in time (not all the time), to fulfill the Class II criteria (water quality suitable for other uses such as recreation and fish farming/aquaculture). Even rivers in low density areas such as Papua have mildly polluted water and do not meet the required drinking water standard.

**Table 12. Quality of major rivers based on national standards, 2005**

| Province                  | River         | Pollution level by location <sup>1</sup> |                      |
|---------------------------|---------------|--|----------------------|
|                           |               | Upstream                                 | Mid- or downstream   |
| NAD                       | Krueng Aceh   | Mild to medium                           | Mild to medium       |
| North Sumatra             | Deli          | Mild to medium                           | Mild to medium       |
| West Sumatra              | Batang Agam   | Satisfactory to mild                     | Mild                 |
| Riau                      | Kampar        | Mild to heavy                            | Mild to medium       |
| Jambi                     | Batang Hari   | Mild to medium                           | Mild to medium       |
| South Sumatra             | Musi          | Mild to medium                           | Mild to medium       |
| Bengkulu                  | Air Bengkulu  | Mild to medium                           | Mild                 |
| Lampung                   | Way Sekampung | Medium                                   | Mild to medium       |
| Bangka Belitung           | Rangkui       | Mild to heavy                            | Mild to heavy        |
| Jakarta                   | Kali Angke    | Mild to heavy                            | Mild to medium       |
| West Java and Jakarta     | Ciliwung      | Mild to heavy                            | Medium to heavy      |
| West Java                 | Citarum       | Mild to heavy                            | Medium to heavy      |
| Central Java - Yogyakarta | Progo         | Satisfactory to mild                     | Mild to heavy        |
| East Java                 | Brantas       | Mild to medium                           | Satisfactory to mild |
| West Java - Banten        | Cisadane      | Mild to heavy                            | Mild to medium       |
| Bali                      | Tukad Badung  | Mild                                     | Mild                 |
| West Nusa Tenggara        | Jangkok       | Mild to medium                           | Medium               |
| East Nusa Tenggara        | Kali Dendeng  | Mild                                     | Satisfactory to mild |
| West Kalimantan           | Kapuas        | Satisfactory to mild                     | Mild to heavy        |
| Central Kalimantan        | Kahayan       | Heavy                                    | Mild to heavy        |
| South Kalimantan          | Martapura     | Mild to heavy                            | Medium               |
| East Kalimantan           | Mahakam       | Mild                                     | Mild to medium       |
| North Sulawesi            | Tondano       | Mild                                     | Mild                 |
| Central Sulawesi          | Palu          | Mild to medium                           | Mild to medium       |
| South Sulawesi            | Tallo         | Mild                                     | Mild to heavy        |
| South Sulawesi            | Jeneberang    | Mild                                     | Mild to heavy        |
| Southeast Sulawesi        | Konawehea     | Mild                                     | Mild                 |
| North Maluku              | Tabobo        | Mild                                     | Satisfactory to mild |
| Papua                     | Anafere       | Mild                                     | Medium               |

Source: Indonesia State of the Environment, 2005

<sup>1</sup> Water quality evaluated based on Government Regulation No 82/2001 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).

It is noteworthy that while rivers may exhibit a higher capacity to assimilate waste during the rainy season, water quality indicators are not necessarily better. For example, monitoring at the Brantas River Basin in East Java showed that during the rainy season, suspended solid loads rise to 70-500 mg/l compared to 20-150 mg/l in dry season, above the Indonesian standard of 50 mg/l. Furthermore, BOD at Brantas river ranges from 5-12 mg/l during the dry season, and from 6-15 mg/l during the wet season, which is significantly higher than the Indonesian standard of 2 mg/l. One of the most polluted river sections exhibited BOD values ranging from 10 to 20 mg/l.

### 3.3.3 Drinking water

Due to the many pollutants released into water in Indonesia, leading to poor quality surface water, few surface water sources are safe to drink from. This leads to households switching to water sources that are less convenient to access, more costly to access, or less safe, or all three. Annex Table B7 shows selected drinking water quality standards in Indonesia.

As a consequence of poor quality surface water or, equally, concerns about the quality of groundwater, many households in Indonesia choose to consume treated water from water treatment plants (18%), bottled water (4%), and/or they treat water themselves (at least 7 in 10 households). Many households have little choice but to continue to consume unsafe water, such as from an unprotected well or spring (14%), or surface water such as rivers (3%). Table 13 presents access to various drinking water sources, and definitions of 'improved' versus 'unimproved' (Annex Table C14 presents drinking water sources by province and rural/urban area).

**Table 13. Access to various drinking water sources**

| Source                                  | Rural  | Urban  | Total  |
|---|--------|--------|--------|
| 1. Piped from plant                     | 9.03   | 30.80  | 18.34  |
| 2. Ground water (tubewell or borehole)  | 9.23   | 19.47  | 13.61  |
| 3. Protected well (dug well)            | 38.15  | 29.98  | 34.66  |
| 4. Protected spring                     | 12.85  | 3.14   | 8.70   |
| 5. Rainwater                            | 3.41   | 1.35   | 2.53   |
| 6. Packaged water                       | 1.02   | 8.95   | 4.41   |
| 7. Unprotected well                     | 14.26  | 4.77   | 10.20  |
| 8. Unprotected spring                   | 6.89   | 0.60   | 4.20   |
| 9. Rivers                               | 4.78   | 0.61   | 3.00   |
| 10. Others                              | 0.38   | 0.33   | 0.36   |
| Total                                   | 100.00 | 100.00 | 100.00 |
| <b>JMP definition</b>                   |        |        |        |
| Improved (1,2,3,4,5)                    | 72.67  | 84.74  | 77.83  |
| Unimproved (6,7,8,9,10)                 | 27.33  | 15.26  | 22.17  |
| <b>'Safe' water (includes packaged)</b> |        |        |        |
| Improved (1,2,3,4,5,6)                  | 73.69  | 93.69  | 82.24  |
| Unimproved (7,8,9,10)                   | 26.31  | 6.31   | 17.76  |

Source: Susenas, 2006. See Annex Table C14 for provincial breakdown.

In 2006, 39% of urban households and 23% of rural households obtained their drinking water from a source that is located less than 10 meters from the nearest septic tank or other waste disposal site, where the risk of contamination is relatively high. In Jakarta, more than 60% of wells sampled in 2004 were contaminated with E. coli in excess of the regulated drinking water level, despite the majority of these being classified as protected wells. Furthermore, in 2006 the Jakarta Environmental Monitoring Agency (BPLHD Jakarta) estimated that 80% of deep wells were contaminated with E. coli. Hence the actual access to improved drinking water sources may be different from the estimates provided in Table 13.

Table 14 shows the proportion of households that pay for their drinking water compared with those that obtain their drinking water free of charge, by water source. According to the Susenas survey, 78% of households obtain their water nominally free of charge; but in fact there may be capital, maintenance or access costs (especially for piped

water or well water) that are paid for by community groups, government agencies or other organizations. Some households purchase water that has been accessed from surface or ground sources but not treated.

**Table 14. Households purchasing or accessing free drinking water, by source**

| Source                             | Purchased (%) | Free (%)    | Total (%)    |
|------------------------------------|---------------|-------------|--------------|
| Packaged                           | 100.0         | 0.0         | 100.0        |
| Piped from plant                   | 69.7          | 30.3        | 100.0        |
| Groundwater (tubewell or borehole) | 11.5          | 88.5        | 100.0        |
| Well (dug well)                    | 3.8           | 96.2        | 100.0        |
| Spring                             | 9.4           | 90.6        | 100.0        |
| River                              | 2.3           | 97.7        | 100.0        |
| Rainwater                          | 5.5           | 94.5        | 100.0        |
| Other                              | 37.4          | 62.6        | 100.0        |
| <b>Total</b>                       | <b>21.6</b>   | <b>78.4</b> | <b>100.0</b> |

Source: Susenas, 2006

Due to lack of nationally representative data on the proportion of households that treat their drinking water themselves, available local studies and interviews were used. The study assumes that 90% of all households treat their water, where their main drinking water source is not package/bottled water. In the less-developed and poorer provinces of West Nusa Tenggara, East Nusa Tenggara, West Papua and Papua, it is assumed that 70% of households treat their drinking water. The majority – over 95% – of household treatment, is done by boiling, as shown in a 6-province study.

Unit cost information for various water sources was gathered from several sources:

- Water piped from treatment plant: the average price for non-commercial customers in 2004 was IDR 1,500 (USD 0.17) per m<sup>3</sup>, varying by province from IDR 700 (USD 0.08) per m<sup>3</sup> to IDR 2,400 (USD 0.27) per m<sup>3</sup>, inflated to reflect 2006 prices. Financial cost was estimated to be 80% of economic cost, given that water companies are subsidized (80% reflects the average level of cost recovery for water companies).
- Water piped from other sources: assumed to cost IDR 21,200 (USD 2.4) per m<sup>3</sup>. Financial cost equals economic cost. It is assumed that households choose piped water for two reasons: quality concerns and convenience. Quality concerns (related to poor sanitation) are attributed 50% of the piped water costs.
- Other purchased water: IDR 47,700 (USD 5.4) per m<sup>3</sup> from water vendors selling by the jerry can, and IDR 326,600 (USD 37) per m<sup>3</sup> for packaged water based on an average of small sized bottled water and refillable 19-liter containers (locally called a 'galon'). Financial cost is equal to economic cost.
- Cost of household water treatment (boiling): the study uses an economic cost of IDR 2,000 (USD 0.21) to boil a liter of water, representing a weighted average of the economic cost of kerosene<sup>11</sup> and an opportunity cost for firewood collection (the two main fuel sources for boiling water). The financial cost is calculated using the subsidized kerosene prices, which reflects the amount households actually pay<sup>12</sup>.
- Hauled water: nationally, 64% of households hauling their water require 5 minutes or less daily to obtain their water; 29% require 5-29 minutes; 5% require 30-59 minutes, and 3% require more than one hour. Part of the time costs, valued at average compensation to employees, are allocated to poor water quality, as households have to travel further to access adequately clean water. This is only an economic cost, with no financial cost.

11 The financial cost of boiling water using kerosene (*Action research on point of use drinking water treatment alternatives as appropriate for underprivileged households in Jakarta*. M Weimer. Environmental Services Program: Jakarta. 2006) was adjusted by the government subsidy on kerosene to estimate the full economic cost.

12 The subsidy provided by the government is not included as financial cost given that the costs are not a direct financial contribution by the government, but rather the lower sales volume of oil on the international market.

The total costs of accessing cleaner drinking water due to water pollution are adjusted to reflect the contribution of poor sanitation to overall water pollution, using the proportions by province shown in Annex Table C14.

Table 15 shows the total costs attributed to poor sanitation of accessing drinking water, including only the daily needs per capita for drinking water. The largest cost component is for drinking water treatment, since most Indonesians boil their water (even piped water from formal treatment plants are not directly potable). The financial cost is IDR 7.1 trillion (USD 803 million) per year, while the economic cost is IDR 12 trillion (USD 1,364) per year. The majority of costs – 85% – are attributed to household water treatment. Since most households use kerosene as cooking fuel, the economic cost is higher than the financial cost to households because the price of kerosene is heavily subsidized by the government.

**Table 15. Drinking water access costs (IDR billion)**

| Water source                     | Financial    |              | Economic      |              |
|----------------------------------|--------------|--------------|---------------|--------------|
|                                  | Total        | %            | Total         | %            |
| <b>Purchased piped water</b>     | <b>132</b>   | <b>1.8</b>   | <b>203</b>    | <b>1.7</b>   |
| Rural                            | 62           | 0.9          | 97            | 0.8          |
| Urban                            | 62           | 0.9          | 106           | 0.9          |
| <b>Purchased non-piped water</b> | <b>945</b>   | <b>13.3</b>  | <b>971</b>    | <b>8.1</b>   |
| Rural                            | 450          | 6.4          | 468           | 3.9          |
| Urban                            | 494          | 6.9          | 503           | 4.2          |
| <b>Household water treatment</b> | <b>6,012</b> | <b>84.9</b>  | <b>10,196</b> | <b>84.7</b>  |
| Rural                            | 3,461        | 48.9         | 5,835         | 48.5         |
| Urban                            | 2,551        | 36.0         | 4,361         | 36.2         |
| <b>Hauled water</b>              | <b>0</b>     | <b>0</b>     | <b>671</b>    | <b>5.6</b>   |
| Rural                            | 0            | 0            | 494           | 4.1          |
| Urban                            | 0            | 0            | 177           | 1.5          |
| <b>Total</b>                     | <b>7,089</b> | <b>100.0</b> | <b>12,041</b> | <b>100.0</b> |
| Rural                            | 3,973        | 56.0         | 6,895         | 57.3         |
| Urban                            | 3,107        | 44.0         | 5,156         | 42.8         |

### 3.3.4 Other domestic uses of water

In addition to the uses of surface and groundwater sources for drinking, water is a resource for many other human and nonhuman activities. While it is not possible to conduct an exhaustive analysis of all the uses of water, this study assessed the relevance of non-commercial household (domestic) activities, such as the use of water for cooking, washing, and bathing.

Table 16 shows the costs attributed to poor sanitation as a result of accessing water from improved water sources. The estimated economic impact amounts to IDR 1.2 trillion (USD 131 million) per year. Nearly 90% of these costs are accounted for by households that purchase piped water. Although the same strict requirements for water quality do not apply as for drinking water, households may still walk further for improved water and willingly pay companies to deliver or pipe water for non-drinking domestic uses.

**Table 16. Water access costs for other domestic uses (IDR billion)**

| Water source                 | Financial  |              | Economic     |              |
|------------------------------|------------|--------------|--------------|--------------|
|                              | Total      | %            | Total        | %            |
| <b>Purchased piped water</b> | <b>932</b> | <b>100.0</b> | <b>1,021</b> | <b>88.1</b>  |
| Rural                        | 263        | 28.2         | 310          | 30.4         |
| Urban                        | 669        | 71.8         | 712          | 69.4         |
| <b>Hauled water</b>          | <b>0</b>   | <b>0.0</b>   | <b>139</b>   | <b>11.9</b>  |
| Rural                        | 0          | 0.0          | 97           | 69.8         |
| Urban                        | 0          | 0.0          | 41           | 30.2         |
| <b>Total</b>                 | <b>932</b> | <b>100.0</b> | <b>1,160</b> | <b>100.0</b> |
| Rural                        | 263        | 28.2         | 406          | 35.0         |
| Urban                        | 669        | 71.8         | 753          | 65.0         |

### 3.3.5 Fish production

The fisheries sub-sector in Indonesia employs more than 4.5 million people (4.7% of the workforce) in both wild capture fisheries and aquaculture. In 2005, fisheries contributed USD 6.8 billion to the national product, equivalent to 2.2% of GDP. In 2005, fresh fish and shrimp exports totaled USD 1.5 billion, or about 2% of all exports .

Given the lack of empirical evidence linking water quality and fish production in Southeast Asia, this study used innovative methods to examine the likely effect of sewage on fish production. While the impact of micro-bacteria in surface water affects both fish health and the health of the Indonesian people who live off fish, the lack of data on these makes it difficult to evaluate quantitatively. A second link is examined, which is the impact of BOD from sewage and wastewater on dissolved oxygen levels in rivers, lakes and ponds and hence fish reproduction and survival. The methodology used is described in full in the 4-country regional report (see Acknowledgments for citation).

It is estimated that the negative impact of poor sanitation on the dissolved oxygen content of freshwater in Indonesia causes a loss to fish production equivalent to IDR 812 billion (USD 92 million) per annum, of which 17% is accounted for by South Sumatra, 15% by West Kalimantan and 12% by South Kalimantan (Annex Table C15 provides the full provincial breakdown).

### 3.3.6 Summary of water-related costs

Table 21 shows the total costs from the three evaluated impacts of water pollution in Indonesia. The majority of financial and economic losses – over 85% – are accounted for by drinking water quality impact. Fifty-eight percent of the costs are accounted for by rural areas and 42% by urban areas. These costs are an underestimate of the total water-related costs of poor sanitation, as a number of other potential impacts were not evaluated (see Annex Table B2).

**Table 17. Summary of total costs due to polluted water sources (IDR billion)**

| Impact              | Location     | Financial    |             | Economic      |             |
|---------------------|--------------|--------------|-------------|---------------|-------------|
|                     |              | Total        | %           | Total         | %           |
| Drinking water      | Rural        | 3,973        | 49.6        | 6,895         | 49.2        |
|                     | Urban        | 3,107        | 38.8        | 5,156         | 36.8        |
|                     | <b>Total</b> | <b>7,089</b> | <b>88.4</b> | <b>12,041</b> | <b>85.9</b> |
| Fish production     | Rural        | 0            | 0           | 812           | 5.8         |
|                     | Urban        | 0            | 0           | 0             | 0           |
|                     | <b>Total</b> | <b>0</b>     | <b>0</b>    | <b>812</b>    | <b>5.8</b>  |
| Domestic water uses | Rural        | 265          | 3.3         | 406           | 2.9         |
|                     | Urban        | 671          | 8.3         | 750           | 5.4         |
|                     | <b>Total</b> | <b>936</b>   | <b>11.6</b> | <b>1,156</b>  | <b>8.3</b>  |
| <b>Total</b>        | Rural        | 4,237        | 52.9        | 8,113         | 57.9        |
|                     | Urban        | 3,778        | 47.1        | 5,906         | 42.1        |
|                     | <b>Total</b> | <b>8,016</b> | <b>100</b>  | <b>14,019</b> | <b>100</b>  |

## 3.4 Environment

### 3.4.1 Aesthetics

Aesthetics is not strongly related to productivity or income. Economic studies do not usually quantify aesthetics, such as smell and sight, in economic terms. Studies assessing user preferences for sanitation options, including willingness to pay studies, tend to limit the focus to the physical boundaries of the household, and hence not the broader environment where people spend their time, such as rural paths and roads, city streets, market places, fields, and so on. In Indonesia, the housing module in Susenas collects information on the type of environmental pollution suffered by households, covering different sources of smoke, odor and noise. The Susenas 2004 survey found that more than 10 million people are exposed to open sewers, more than 43 million people exposed to open defecation, and more than 8 million people exposed to open dumping of solid waste (Table 18). Although difficult to quantify in monetary terms, the impact of exposure to sub-standard practices of waste disposal may impact directly on consumption and production activities of households, yielding lower level of welfare and quality of life. The real condition of reduced quality of life can be reflected by one example, where in 2005 residents living close to an open dumping site Bantargebang in Bekasi were awarded IDR 50,000 (USD 5.70) per month per household as compensation for the smell they have to endure ('smell compensation').

**Table 18. Households exposed to sub-standard practices of waste disposal**

| Location     | Improved sanitation (%)   |                       | Exposed population (million) |                                  |  |
|--------------|---------------------------|-----------------------|------------------------------|----------------------------------|--|
|              | Enclosed defecation sites | Solid waste collected | Exposed to open sewers       | Exposed to open defecation sites | Exposed to open dumping of solid waste |
| Rural        | 72%                       | 1%                    | 3.78                         | 35.97                            | 3.47                                   |
| Urban        | 92%                       | 41%                   | 6.90                         | 7.87                             | 5.33                                   |
| <b>Total</b> | <b>80%</b>                | <b>18%</b>            | <b>10.68</b>                 | <b>43.84</b>                     | <b>8.80</b>                            |

Source: Susenas, 2004.



### 3.4.2 Land quality

Land that is used for improper, unofficial disposal of solid waste and open defecation will be unusable for other more productive uses, and hence will cause an economic loss to society. Collection rates of solid waste are low, especially in poor urban and rural areas in Indonesia. Even when 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; only a small proportion of solid waste is recycled or properly disposed in controlled dumping sites or sanitary landfills. Hence the price of land close to solid waste disposal areas can be highly depressed, as in the case of Bantargebang in the city of Bekasi, Banten Province, where the average price of land close to the disposal site (IDR 20,000 to IDR 30,000 per m<sup>2</sup>) was about 10% of the average price in northern Bekasi (IDR 300,000 per m<sup>2</sup>).

Table 17 shows that the total economic loss is estimated at IDR 245 billion (USD 27.8 million) due to open defecation practices, and IDR 604 billion (USD 68.5 million) due to poor solid waste disposal practices (see Annex Table C17 for provincial and rural/urban breakdown).

**Table 19. Economic loss due to degraded and unavailable land**

| Location     | Land mass (m <sup>2</sup> million) |             | Average land value (IDR/m <sup>2</sup> ) | Total land value loss (IDR. billion) |              |
|--------------|------------------------------------|-------------|--|--------------------------------------|--------------|
|              | Human waste                        | Solid waste |  | Human waste                          | Solid waste  |
| Rural        | 41.5                               | 20.9        | 2470-10,000                              | - <sup>1</sup>                       | 137.7        |
| Urban        | 7.9                                | 29.5        | 5030-20,040                              | 245.5                                | 466.7        |
| <b>Total</b> | <b>49.5</b>                        | <b>50.4</b> |  | <b>245.5</b>                         | <b>604.4</b> |

<sup>1</sup> Not calculated

## 3.5 Other welfare impacts

Difficulties in quantification aside, no studies at the national level provide information on what is classified in the present study as “other welfare” impacts of poor sanitation. 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 that use a sub-standard, uncomfortable latrine or have no latrine at all. Except for the disease impact (covered elsewhere), these less tangible aspects of human welfare have limited direct financial implications, but can be quantified as welfare losses using conventional economic techniques. More tangible impacts of using sub-standard latrines or having no facilities are time impacts due to journeying time or waiting due to insufficient shared or public latrines per head of population, as well as life decisions such as schooling or choice of employment, which may be linked to the presence of sub-standard latrines or absence of latrines in schools and workplaces.

### 3.5.1 Access time

Welfare loss from increased access time arising from having to use unimproved sanitation can be due to journey time for open defecation or waiting time for shared latrines. Table 20 presents the population experiencing sub-optimal access (Annex Table C19 presents the provincial and rural/urban breakdown). For 75% of households, comprising households using private toilets, and a proportion of those using shared and common latrines (50%) and those practicing open defecation (25%), access time is already minimized. The remaining population – 10% using shared and 15% practicing open defecation, equaling 25% of households – are assumed to experience sub-optimal access time. For these households, open defecation is assumed to require 15 minutes per day extra to find a secluded spot for defecation, while for shared latrines the extra time queuing varies from 15 minutes in rural areas to 30 minutes in urban areas. Access time is relatively high because in urban areas in Indonesia access time can be

longer because toilets are shared with many people, and because it is common for people to wash themselves while in the latrines, thus prolonging queuing time. For example, in the public toilets being built by BEST in urban areas of Banten Province, the 6-7 latrines are shared by 100 families. Assuming 4 people per family, that makes a ratio of 57 people per latrine. In other towns, dormitories catering to blue collar workers were found to provide only 2 latrines for 20-40 people, who often have to queue for more than half an hour to use the latrine. Hence, queuing is one of the main complaints regarding shared public latrines.

The economic losses were computed on the basis of forgone income. In the case of adults, this was assumed to be 30% of the average daily compensation of employees. The time value of children was assumed to be half the value of adult time.

**Table 20. Toilet access, by geographical location sub-type (by region)**

| Location     | Population with access time already minimized (%) | Population experiencing sub-optimal access |                     | Average time access per day for those with sub-optimal access |                       |
|--------------|---|--|---------------------|---|-----------------------|
|              |   | Shared latrines (%)                        | Open defecation (%) | Shared latrines (hrs)   | Open defecation (hrs) |
| Rural        | 68.78   | 10.08                                      | 21.14               | 0.25  | 0.25                  |
| Urban        | 83.90   | 9.83                                       | 6.29                | 0.50  | 0.25                  |
| <b>Total</b> | <b>75.27</b>                                      | <b>9.98</b>                                | <b>14.75</b>        | <b>0.25-0.50</b>  | <b>0.25</b>           |

Source: Authors' estimate

Latrine access time also makes up an important component of the cost of unimproved sanitation. Fifty-five million people experience sub-standard access time daily, with more than 4 billion hours of access time needed annually (Table 21). Annual economic losses are estimated at IDR 10.8 trillion, or USD 1.22 billion (Annex Table C19 presents provincial and rural/urban breakdowns).

**Table 21. Time used and costs of accessing shared latrine or open defecation site**

| Establishment | Time spent accessing facility (million hours) |                 | Economic cost (IDR billion) |             |
|---------------|---|-----------------|-----------------------------|-------------|
|               | Shared latrines                               | Open defecation | Total                       | %           |
| Rural         | 781   | 1,613           | 6,261                       | 58%         |
| Urban         | 1,301   | 413             | 4,512                       | 42%         |
| <b>Total</b>  | <b>2,083</b>                                  | <b>2,026</b>    | <b>10,773</b>               | <b>100%</b> |

### 3.5.2 Intangible aspects

With high levels of unimproved sanitation in Indonesia, welfare losses due to a number of 'intangible' aspects of poor sanitation could provide important arguments for sanitation programs. However, to date no studies examining these aspects in Indonesia have come to light.

- Comfort & acceptability– the ease to perform personal hygiene functions; 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; not being limited to toilet-going in the hours of darkness; or being seen walking to access toilet facilities, especially women.
- Security – the location of the latrine within or near to the home means that excursions to the outdoors do not need to be made for toilet-going needs, in particular at night, when there may be dangers (theft, attack, rape, and injuries sustained from snakes or other dangerous animals).
- Conflict – on-plot sanitation can avoid conflict with neighbors or the community, where tensions exist concerning shared facilities, or fields and rivers for open defecation.

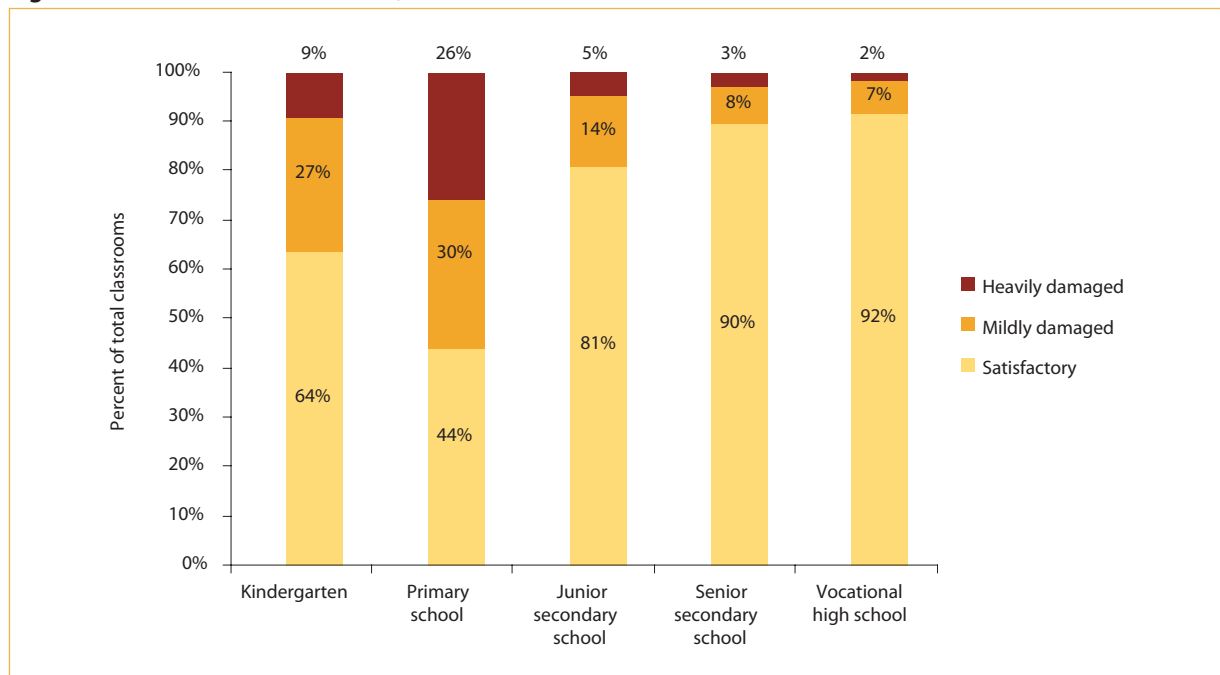
- Status and prestige – when visitors come to the house, it gives prestige to the household to be able to offer their guests a clean and convenient toilet to use. Families may hold more social events at their house if they have a clean latrine.

### 3.5.3 Impact on life decisions and behavior

Running water supply and sanitary latrines in schools are rare in most of the developing world. In many workplaces, latrines are unhygienic, poorly maintained, and do not cater to the special needs of women. The presence of hygienic and private sanitation facilities in schools has been shown to affect enrollment and attendance, especially for girls. Good latrine access at the workplace has implications for female participation in traditionally male-dominated employment areas. Furthermore, sanitary and adequate latrines in schools and at workplaces not only affect participation rates but improve the welfare of all pupils and employees using them.

Given the complex web of causative factors and eventual life decisions, and the many factors determining absenteeism from school or the workplace, it is difficult to quantify the exact relationship between poor sanitation conditions, education and work decisions, and eventual economic outcomes. In terms of education, the poor quality of education is still a challenge, including poor quality of infrastructure. Official reports have in recent years provided snapshots of the condition of classrooms and other school facilities in Indonesia (Figure 9). Available data suggest that a significant number of kindergarten and primary classrooms are not in an acceptable condition (>35%), while a lower proportion of secondary school classrooms are in a damaged state (<20%). At the primary school level, less than half of all classrooms are in satisfactory condition, and about a quarter are badly damaged. If classrooms are damaged, it is probable that water and sanitation facilities at these schools are in a similar or worse condition. Indeed, it is highly likely that the toilet condition in the majority of schools is significantly worse than the classroom condition.

**Figure 9. Classroom condition, 2005-06**



Source: Ministry of Education Summary Data 2005/06

There are no data on toilet or clean water access at schools in Indonesia. Some anecdotal information is available, such as the report of consultants on the Indonesia School Improvement Grants Program (SIGP) who, visiting 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 inadequate in number to cater for the number of students using them. On average there were 2 toilets per school. Lack of clean water access was also observed, with students at many schools being forced to use streams or fish ponds near the school for toilet needs, posing particular problems during the rainy season.

In spite of poor classroom conditions, however, official statistics show primary school enrollment rates in Indonesia to be relatively high, with no difference in enrollment between boys and girls (93% for both girls and boys in 2005). A higher proportion of boys complete primary school, however, and there is higher drop out rate for girls than for boys. On the other hand, despite relatively better quality of classrooms and facilities, enrolment rates at junior (65%) and senior secondary (42%) school are significantly lower than at primary school. This drop-out can be attributed to various contributing factors; but note that, at these older ages, toilet availability and condition become relatively more important for children, especially girls.

A survey in 1999 indicated sickness, having to work/earn money, having to help with household chores, and having been punished as the main reasons for missing schools days. The reasons for dropping out or not attending school include parents' low income, student laziness, having to work, having had enough education, and the school being too far away. The condition of school facilities was not cited among the main reasons for missing school days or dropping out of school, although poor water and sanitation is unlikely to have been provided as a response option in school surveys.

Lack of data is also encountered in terms of work participation, and this study did not explore this issue further.

### 3.6 Tourism impacts

Tourism is a key sector in Indonesia, providing IDR 39.7 trillion (USD 4.5 billion) in revenue in 2006, an important source of local government tax income, as well as jobs for 6.1 million Indonesians (7% of total jobs). In 2006, almost 5 million foreign visitors traveled to Indonesia, 57% for holidays, 38% for business, and 5% for other purposes. The tourist industry is expected to grow by 3.6% in 2007, increasing to 6.4% per annum from 2008 to 2015.

The number of tourists choosing Indonesia for their holidays is related, among other things, to the general sanitary conditions of the country, such as the quality of water resources; quality of outdoor environment (smell, sightliness); food safety (hygiene in food preparation); general availability of toilets offering comfort and privacy in hotels, restaurants, and bus stations; and the related health risks of all the above. Better sanitary conditions will attract 'high-value' tourists, that is, those who are willing to pay more for their holiday. Currently, foreign tourists spend on average IDR 882,800 (USD 100) per day, and stay on average 9 days, giving an average revenue per tourist visit of IDR 7.9 million (USD 900).

Economic losses are reflected by the gap between current tourist revenues and the tourist revenues that would be possible at significantly higher tourist visit numbers, such as those experienced by neighboring countries with higher visit rates. The current hotel occupancy rate of 45% is low, and is assumed, therefore, in the mid-term, to grow to 80%. The analysis conservatively assumes constant hotel capacity over the same time period. Assuming that 5% of these revenue gains are attributable to improved sanitation, present poor sanitation conditions are estimated to contribute IDR 1,465 billion (USD 166 million) in losses annually (Annex Table C20 provides provincial breakdown).

### 3.7 Sanitation Markets

In addition to averted losses, improved sanitation and hygiene means a shift in demand for hygiene-related products such as latrines, soap and toilet paper. Improved toilet systems leads to an increase in demand for construction materials, and improved treatment and disposal leads to increased demand for sludge removal services.

Table 22 shows the potential market size for sanitation inputs for the construction of latrines. The analysis assumes sanitation improvement in some 2.1 million rural households and 170,000 urban households annually to meet the MDG target in 2015, with the majority constructing latrines with septic tanks (soak pits). Using these assumptions, the value of demand for materials is worth at least IDR 2.4 trillion (USD 274 million) annually.

**Table 22. Sanitation input market values, construction (IDR billion)**

| Areas receiving improvement            | Simple pit latrine | VIP          | Septic tank    | Simple EcoSan | Piped sewer connection | Total          |
|--|--------------------|--------------|----------------|---------------|------------------------|----------------|
| <b>Coverage received (% of total)</b>  |                    |              |                |               |                        |                |
| Rural households (of 2.1 million/year) | 20%                | 10%          | 60%            | 5%            | 5%                     | 100%           |
| Urban households (of 170,000/year)     | 5%                 | 10%          | 75%            | 5%            | 5%                     | 100%           |
| <b>Value (IDR billion)</b>             |                    |              |                |               |                        |                |
| Rural                                  | 155.4              | 173.0        | 1,277.4        | 21.2          | 21.2                   | 1,650.8        |
| Urban                                  | 15.9               | 60.9         | 678.0          | 7.9           | 7.9                    | 768.0          |
| <b>Total</b>                           | <b>171.3</b>       | <b>233.9</b> | <b>1,955.4</b> | <b>29.1</b>   | <b>29.1</b>            | <b>2,418.9</b> |

Improvement in hygiene means an increase in the use of hygienic products, including soap and toilet paper. An increase of 40% in the use of soap by rural households and 20% by urban households results in an increase in demand for soap worth IDR 630 billion (USD 71 million) annually (Table 23). A 25% increase in households using toilet paper could yield an additional IDR 313 billion (USD 24 million) demand for toilet paper annually. Proper handling of pits and septic tanks requires sludge to be removed at least every two years; leading to market growth of IDR 2 trillion (USD 227 million) per year in sludge removal services.

**Table 23. Sanitation input market values, hygiene products and improved treatment**

| Areas receiving improvement | Soap         | Toilet paper | Sludge removal | Total          |
|-----------------------------|--------------|--------------|----------------|----------------|
| <b>Coverage</b>             |              |              |                |                |
| % rural households          | 40%          | 0%           | 25%            | 65%            |
| % urban households          | 20%          | 25%          | 25%            | 75%            |
| <b>Value (IDR billion)</b>  |              |              |                |                |
| Rural                       | 459.1        | 0.0          | 538.5          | 997.6          |
| Urban                       | 167.7        | 211.9        | 1,465.4        | 1,853.9        |
| <b>Total</b>                | <b>626.8</b> | <b>211.9</b> | <b>2,004.0</b> | <b>2,842.6</b> |

In addition to expanding the market for sanitation inputs, improved sanitation includes re-use of waste. The reuse of human waste for fertilizer or biogas production cannot be assumed to be population-wide, given cultural attitudes towards handling and re-use of human waste, and low practical feasibility in many locations. Success often depends on local perceptions of the expected returns on re-using of human waste, whether it be for biogas or fertilizer. The

number of establishments or households using human fecal waste for fertilizer is not yet significant in Indonesia. Fecal waste processing has so far largely focused on using animal waste, with the Ministry of Agriculture promoting small-scale biogas processing. The Ministry of Agriculture has estimated that a biogas digester using excreta from livestock can yield the equivalent of 2.5 liters of kerosene per day, valued at USD 1.42 per day or USD 517 annually.



In terms of processing human fecal waste into biogas, information was obtained from the Bina Ekonomi Sosial Terpadu (BEST) organization, which has been working with communities and other stakeholders to construct sanitation facilities in urban communities. Each of the facilities serves about 100 households (350 to 500 people). Some of these facilities are fitted with a system for generating biogas. Human waste from a facility used by 100 households can generate enough biogas to power 3 stoves for 24 hours. The stoves are located on site; some are used by households for daily cooking, and some are allotted to small scale food vendors. Based on these parameters, this study conservatively estimates that each stove runs continuously for 12 hours per day, and that each hour of cooking is equivalent to the use of one liter of kerosene at the cost of IDR 5,000 (USD 0.57). In total,

each stove can yield USD 6.80 worth of cooking energy per day per stove, or IDR 68 million (USD 7,442) per year for three stoves. If we assume that all households sharing the sanitation facilities have equal access to the stoves, the estimated benefit for 100 households is IDR 650,000 (USD 74) annually per household. Assuming 198,000 rural households and 710,000 urban households adopt biogas, the potential value of waste conversion into biogas is at least IDR 132 billion (USD 15 million) per year in rural areas and IDR 467 billion (USD 53 million) in urban areas, totaling IDR 600 billion (USD 67 million) annually.

# 4 Recommendations



### **Recommendation 1. Give greater priority to investments in sanitation and hygiene promotion**

Economic losses due to poor sanitation and hygiene of IDR 56 trillion are considerable, totaling 2.3% of national GDP. Hence the developmental benefits of investing in improved sanitation are potentially huge, leading to averted costs of IDR 40 trillion. These investments will also mitigate a number of other impacts not quantified in this study, as well as generating further benefits through excreta re-use and sanitation input market value. Improving sanitation also contributes to the attainment of other development targets, including some of the key MDGs. With at least one third of the Indonesian households without improved sanitation, it is evident that more investments are needed in this sector.

### **Recommendation 2. Target investments to rural areas as well as to urban slums**

Losses are incurred in both rural and urban populations where sanitation is unimproved, thus justifying balanced investment to both unserved rural and urban areas, and targeting of subsidies to the most deserving populations.

Per capita losses were marginally higher in urban areas, while a larger proportion of the unserved population resides in rural areas. Sanitation programs should in particular target families with young children, as this population group is more vulnerable to health impacts of unimproved sanitation. Rural areas where households practice subsistence farming and have limited cash income and spending power will need motivation to reach the first rung of the sanitation ladder.

Another priority is supporting sanitation development in poor urban areas where land or house ownership is low and households cannot easily improve sanitation individually but need a community response. These areas have high population densities and are more exposed to the negative impacts of poor sanitation. In such confined spaces, human excreta that is not properly disposed or treated will pollute water resources, drains, rivers and canals and increase health risks among the people living in the vicinity.

### **Recommendation 3. Strengthen promotion and information campaigns to improve personal hygiene practices, focusing on hand washing with soap**

The study showed that hand washing with soap can lead to substantial economic benefits in the form of lower disease incidence and averted health costs, particularly from reduced incidence of diarrheal and infectious skin diseases, and the implications for nutritional status in infants and children. The documented low levels of improved hygiene practices, the relatively low per capita costs of hygiene promotion and the associated benefits, justify greater attention by public policy makers and the private sector to improving hygiene practices and availability of hygiene products. As well as stand-alone hand washing with soap campaigns, hygiene promotion can be efficiently built into all water and sanitation programs and other health campaigns, to reach a greater audience and at lower unit cost.

### **Recommendation 4. Further evaluate available sanitation technology and program options for improving sanitation in Indonesia**

The estimated national economic benefits from improving sanitation will provide useful information for sanitation advocacy and policy making, but sanitation program selection needs to be made based on more precise information on the costs and benefits of specific sanitation options. The various public/private and financial/economic costs and benefits need to be better understood in specific contexts to inform policy making, program design, community engagement and financing options. Future work conducted under the Economics of Sanitation Initiative will help fill the information gap.



# Annexes

## Annex A: Algorithms

### A1. 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

$$CT = CT_{RL} \quad (5)$$

### A2. 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

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

### A3. Water-related costs associated with poor sanitation and hygiene

Total cost associated with accessing clean drinking water

$$CW\_Drink = \sum_m CW\_Drink_m \quad (12)$$

Cost of accessing clean drinking water per source/treatment method

$$CW\_Drink_m = h_m \cdot wdrink_m \cdot pwater_m \cdot \delta \cdot \pi_m \quad (13)$$

Total domestic water access cost (excl. drinking water)

$$CW\_Domestic = \sum_m CW\_Domestic_m \quad (14)$$

Domestic water access cost by source/method

$$CW\_Domestic_m = h_m \cdot wdom_m \cdot pwater_m \cdot \delta \cdot \theta_m \quad (15)$$

Fisheries loss

$$CW\_Fish = AFP - PFP \quad (16)$$

Potential fish production level

$$PFP = \frac{AFP}{\varepsilon} \quad (17)$$

### A4. Land costs

$$CL = ql \cdot pland \quad (18)$$

### A5. User preference costs algorithm

Time access cost for unimproved latrine

$$CU\_T = pop\_u \cdot taccess \cdot ptime \cdot 365 \quad (19)$$

Cost of days absent from school

$$CU\_AS = egirls \cdot \phi \cdot das \cdot ptime \quad (20)$$

Cost of days absent from work

$$CU\_AW = ewomen \cdot \eta \cdot daw \cdot ptime \quad (21)$$

### A6. Tourism losses

Lost revenues

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

Tourist health cost and welfare loss

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

## A7. Variable definition summary

Tables A1 to A3 present the subscripts, variables and parameters used in the algorithms in Sections A1 to A6 above.

**Table A1. Subscripts used in algorithms**

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

**Table A2. Variables used in algorithms**

| Symbol  | Description   |
|---|---|
| <i>C</i>  | Total cost of poor sanitation and hygiene                                   |
| <i>CHC</i>                                      | Health costs of poor sanitation and hygiene                                 |
| <i>CH<sub>HC</sub></i>                          | Health care costs of all diseases   |
| <i>CH<sub>HC</sub><sub><i>i</i></sub></i>       | Health care cost of disease type <i>i</i>                                   |
| <i>CH<sub>P</sub></i>                           | Productivity costs of diseases  |
| <i>CH<sub>P</sub><sub><i>i</i></sub></i>        | Productivity cost of disease type <i>i</i>                                  |
| <i>CH<sub>D</sub></i>                           | Premature death costs of diseases   |
| <i>CL</i>                                       | Land cost   |
| <i>CT</i>                                       | Tourism losses associated with poor sanitation and hygiene                  |
| <i>CT<sub>RL</sub></i>                          | Revenue losses  |
| <i>CT<sub>HT</sub></i>                          | Tourist health and welfare losses   |
| <i>CU</i>                                       | User preference losses associated with poor sanitation and hygiene          |
| <i>CU<sub>T</sub></i>                           | Time access cost for unimproved latrine                                     |
| <i>CU<sub>AS</sub></i>                          | Cost of days absent from school   |
| <i>CU<sub>AW</sub></i>                          | Cost of days absent from work   |
| <i>CW</i>                                       | Water-related costs of poor sanitation and hygiene                          |
| <i>CW<sub>Drink</sub></i>                       | Clean water drinking access costs   |
| <i>CW<sub>Drink</sub><sub><i>m</i></sub></i>    | Clean water drinking access cost for method <i>m</i>                        |
| <i>CW<sub>Domestic</sub></i>                    | Domestic water access costs   |
| <i>CW<sub>Domestic</sub><sub><i>m</i></sub></i> | Domestic water access cost for method <i>m</i>                              |
| <i>CW<sub>Fish</sub></i>                        | Fisheries production loss   |
| <i>death<sub><i>ia</i></sub></i>                | Number of premature deaths, by disease type <i>i</i> and age group <i>a</i> |
| <i>dh<sub><i>i</i></sub></i>                    | Number of days taken off work or daily activities due to disease <i>i</i>   |
| <i>das</i>                                      | Days per girl per year taken off school due to poor sanitation              |
| <i>daw</i>                                      | Days per woman per year taken off work due to poor sanitation               |
| <i>egirls</i>                                   | Number of adolescent girls enrolled in school                               |
| <i>et</i>                                       | Expenditure per tourist (USD)   |
| <i>ewomen</i>                                   | Number of women in paid employment  |

| Symbol         | Description  |
|----------------|--|
| $h_m$          | 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 A3. Parameters used in algorithms**

| Symbol        | Description   |
|---------------|---|
| $\alpha_i$    | Incidence rate per person of disease type $i$   |
| $\beta_i$     | Proportion of episodes attributed to poor sanitation for disease type $i$   |
| $\chi_{ih}$   | Proportion of cases seeking care for disease type $i$ and provider $h$  |
| $\gamma_{ia}$ | Proportion of deaths attributable to poor sanitation, by disease type $i$ and age group $a$   |
| $\delta$      | Attributable water pollution to poor sanitation   |
| $\varepsilon$ | Ratio of the fish production at the current DO level to fish production at the optimal DO level   |
| $\phi$        | Proportion of schools with inadequate sanitation facilities   |
| $\eta$        | Proportion of work places with inadequate sanitation facilities   |
| $\mu$         | Proportion of diseases related to poor sanitation   |
| $\pi_m$       | Importance of averting drinking polluted water in relation to overall benefits of piped water supply; where $\pi_m = 1$ for $m \neq$ piped water                        |
| $\theta_m$    | 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 B: National Data Inputs and Results

Table B1. Comparison of sanitation coverage (%) measured in national surveys in Indonesia

| Survey  | Improved sanitation (%)         |                                    |             |       | Unimproved sanitation (%) |             |                 |       |       |
|---|---------------------------------|------------------------------------|-------------|-------|---------------------------|-------------|-----------------|-------|-------|
|   | Private toilet with septic tank | Private toilet without septic tank | Pit latrine | Total | Public toilet             | Pit latrine | Open defecation | Other | Total |
| <b>National Demographic and Health Survey 2002-2003</b> |                                 |                                    |             |       |                           |             |                 |       |       |
| Rural   | 27                              | 10                                 | 8           | 45    | 6                         | 8           | 34              | 7     | 55    |
| Urban   | 65                              | 9                                  | 2           | 75    | 9                         | 2           | 12              | 3     | 25    |
| Total   | 44                              | 10                                 | 5           | 59    | 8                         | 5           | 24              | 5     | 42    |
| <b>National Socio-Economic Survey 2004</b>              |                                 |                                    |             |       |                           |             |                 |       |       |
| Rural   | 26                              | -                                  | 17          | 45    | -                         | 17          | 40              | 3     | 55    |
| Urban   | 66                              | -                                  | 8           | 74    | -                         | 8           | 17              | 1     | 26    |
| Total   | 43                              | -                                  | 12          | 55    | -                         | 12          | 31              | 2     | 45    |
| <b>National Inter-Censal Survey 2005</b>                |                                 |                                    |             |       |                           |             |                 |       |       |
| Rural   | 29                              | 16                                 | 6           | 52    | 11                        | 6           | 26              | 5     | 48    |
| Urban   | 64                              | 12                                 | 1           | 77    | 13                        | 1           | 8               | 1     | 23    |
| Total   | 44                              | 14                                 | 4           | 63    | 12                        | 4           | 18              | 3     | 37    |
| <b>National Socio-Economic Survey 2006</b>              |                                 |                                    |             |       |                           |             |                 |       |       |
| Rural   | 24                              | -                                  | 18          | 42    | -                         | 18          | 37              | 3     | 58    |
| Urban   | 62                              | -                                  | 10          | 72    | -                         | 10          | 17              | 1     | 28    |
| Total   | 41                              | -                                  | 14          | 55    | -                         | 14          | 29              | 2     | 45    |

Source: Statistics Indonesia (BPS)

**Table B2. Impacts of poor sanitation not quantified in this study**

| Impact                         | Excluded items                                   | Link with poor sanitation  |
|--------------------------------|--|--|
| <b>1. Health</b>               | 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 excludes the large proportion of disease cases – especially for mild diseases – 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: <ol style="list-style-type: none"> <li>1. Helminthes and skin diseases (Cambodia, Philippines)</li> <li>2. Malnutrition and the costs of supplemental feeding</li> <li>3. Reproductive tract infections for women bathing in dirty water</li> <li>4. Dehydration resulting from low water consumption from lack of access to private latrines (especially women)</li> <li>5. Specific health problems suffered by those working closely with waste products (sanitation workers, dump scavengers)</li> <li>6. Health impacts due to flooding (physical, psychological)</li> <li>7. Impact on education of childhood malnutrition</li> <li>8. Unreported food poisoning due to contaminated fish products</li> <li>9. Animal and insect vectors of disease (e.g. rodents, mosquitoes)</li> <li>10. Avian influenza</li> </ol> |
| <b>2. Water resources</b>      | 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: <ol style="list-style-type: none"> <li>1. Non-recorded marketed freshwater fish</li> <li>2. Farmed freshwater fish (Indonesia)</li> <li>3. Marine fish</li> <li>4. Subsistence fishing losses</li> <li>5. Nutrient losses from lower fish catch and effect on spending</li> </ol>  |
|                                | 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                            | <ol style="list-style-type: none"> <li>1. 'Non-use' value of clean water resources such as 'existence' and 'bequest' values</li> <li>2. Wildlife use of water resources</li> </ol>   |
| <b>3. External environment</b> | Aesthetics                                       | Welfare loss from population exposure to open sewers / defecation  |
| <b>4. Other welfare</b>        | 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<br>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 and drop-out rates, especially of girls and women   |
| <b>5. Other</b>                | 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   |



**Table B3. Diseases linked to poor sanitation and hygiene, and primary transmission routes and vehicles**

| Disease   | Pathogen                                   | Primary transmission route   | Vehicle                                     |
|---|--|------------------------------|---|
| <b>Diarrheal diseases (gastrointestinal tract infections)</b> |  |                              |   |
| 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 <sup>1</sup>                      | Fecal-oral                   | Person-person, food, water, animal feces    |
| Giardiasis  | Protozoa <sup>1</sup>                      | 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 <sup>2</sup>                                    | Virus                                      | Fecal-oral                   | Person-person, food, water                  |
| Malnutrition  | Caused by diarrheal disease and helminthes |                              |   |
| <b>Helminthes (worms)</b>                                     |  |                              |   |
| Intestinal nematodes <sup>3</sup>                             | 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                    |
| <b>Eye diseases</b>   |  |                              |   |
| Trachoma  | Bacterium                                  | Fecal-eye                    | Person-person, via flies, fomites, coughing |
| Adenoviruses (conjunctivitis)                                 | Protozoa <sup>1</sup>                      | Fecal-eye                    | Person-person                               |
| <b>Skin diseases</b>  |  |                              |   |
| Ringworm (Tinea)  | Fungus (Ectoparasite)                      | Touch                        | Person-person                               |
| Scabies   | Fungus (Ectoparasite)                      | Touch                        | Person-person, sharing bed and clothing     |
| <b>Other diseases</b>   |  |                              |   |
| Hepatitis A   | Virus                                      | Fecal-oral                   | Person-person, food, 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: World Health Organization [http://www.who.int/water\\_sanitation\\_health/en/](http://www.who.int/water_sanitation_health/en/) and Hunter's Tropical Medicine and Emerging Infectious Diseases. Strickland GT. Eighth Edition ed. 2000. W.B. Saunders Company. 1192 pages

Notes:

<sup>1</sup> 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), and isospora belli / hominus (intestinal parasites, gastrointestinal infections).

<sup>2</sup> Other viruses include adenovirus (respiratory and gastrointestinal infections), astrovirus (gastrointestinal infections), calicivirus (gastrointestinal infections), norwalk viruses (gastrointestinal infections), reovirus (respiratory and gastrointestinal infections)

<sup>3</sup> Intestinal nematodes include ascariasis (roundworm - soil), trichuriasis trichiura (whipworm), ancylostoma duodenale / Necator americanus (hookworm), and intestinal Capillariasis (raw freshwater fish).

**Table B4. Outpatients seeking treatment by provider type, all diseases**

| Location     | Public hospital | Private hospital | Private practice | Government health center | Para-medical | Traditional healer | Mid-wife   | Other      | Total        |
|--------------|-----------------|------------------|------------------|--------------------------|--------------|--------------------|------------|------------|--------------|
| Rural        | 6.2             | 2.5              | 17.1             | 42.7                     | 23.6         | 2.3                | 0.7        | 4.8        | 100.0        |
| Urban        | 10.1            | 6.5              | 30.8             | 34.6                     | 11.9         | 1.8                | 0.5        | 3.8        | 100.0        |
| <b>Total</b> | <b>8.0</b>      | <b>4.3</b>       | <b>23.1</b>      | <b>39.2</b>              | <b>18.5</b>  | <b>2.1</b>         | <b>0.6</b> | <b>4.3</b> | <b>100.0</b> |

Source: Susenas 2006

**Table B5. Disease treatment cost studies**

| Study (study year)  | Health service level or type        | Currency | Unit costs |           |           |
|---|-------------------------------------|----------|------------|-----------|-----------|
|   |                                     |          | Low        | Mid       | High      |
| <b>Diarrheal diseases</b>   |                                     |          |            |           |           |
| <b>Simanjuntak et al (2001)</b><br>Outpatient visits, North Jakarta                             | Primary (public)                    | IDR      | 4,414      |           | 17,656    |
|   |                                     | USD      | 0.50       |           | 2.00      |
|   | Primary (private)                   | IDR      | 8,828      |           | 88,280    |
|   |                                     | USD      | 1.00       |           | 10.00     |
| <b>Karyana (2003)</b> Outpatient visits,<br>Tugu Selatan Primary (public health center)         | Informal health care                | IDR      |            | 5,000     |           |
|   |                                     | USD      |            | 0.57      |           |
|   | Self treatment                      | IDR      | 250        | 1,620     | 10,000    |
|   |                                     | USD      | 0.03       | 0.18      | 1.13      |
|   | Transport cost                      | IDR      | 500        | 3,000     | 8,000     |
|   |                                     | USD      | 0.06       | 0.34      | 0.91      |
|   |                                     | IDR      | 24,060     | 36,375    | 56,970    |
|   |                                     | USD      | 2.73       | 4.12      | 6.45      |
| <b>Soeharno (2001)</b> Outpatient visits<br>Sidoarjo, East Java Primary (public health center)  | Medicine                            | IDR      | 25,116     | 43,933    | 76,752    |
|   |                                     | USD      | 2.85       | 4.98      | 8.69      |
|   | ORS, 2 days                         | IDR      |            | 593       | 1,281     |
|   |                                     | USD      |            | 0.07      | 0.15      |
|   | ORS, 5 days                         | IDR      |            | 1,443     |           |
|   |                                     | USD      |            | 0.16      |           |
|   | Antibiotics                         | IDR      |            | 1,463     |           |
|   |                                     | USD      |            | 0.17      |           |
| <b>Supomo (2001)</b> Outpatient visits<br>Sidoarjo, Central Java Primary (public health center) | Patient cost diarrhea               | IDR      |            | 644       | 1,085     |
|   |                                     | USD      |            | 0.07      | 0.12      |
|   | Patient cost pneumonia              | IDR      |            | 527       | 802       |
|   |                                     | USD      |            | 0.06      | 0.09      |
|   | Full treatment cost diarrhea        | IDR      |            | 5,661     | 38,208    |
|   |                                     | USD      |            | 0.64      | 4.33      |
|   | Full treatment cost pneumonia       | IDR      |            | 5,275     | 35,354    |
|   |                                     | USD      |            | 0.60      | 4.00      |
| <b>Surahman (2001)</b><br>Inpatient cost (private hospital)                                     | Total out of pocket cost            | IDR      |            | 4,204,852 |           |
|   |                                     | USD      |            | 476.31    |           |
| <b>Sofyan (2004)</b> Outpatient cost, Serang, Banten Primary (public health center)             |                                     | IDR      | 8,516      |           | 15,315    |
|   |                                     | USD      | 0.96       |           | 1.73      |
| <b>Ermawati, 2005 (2004)</b><br>Inpatient cost, Tangerang, Banten (public hospital)             | Severe (with complications)         | IDR      | 827,195    | 1,288,158 | 1,827,038 |
|   |                                     | USD      | 93.70      | 145.92    | 206.96    |
|   | Non-severe (with/out complications) | IDR      | 454,401    | 454,401   | 800,344   |
|   |                                     | USD      | 51.47      | 51.47     | 90.66     |

| Study (study year)  | Health service level or type  | Currency  | Unit costs |           |           |  |
|---|---|-----------|------------|-----------|-----------|--|
|   |   |           | Low        | Mid       | High      |  |
| <b>Typhoid</b>  |   |           |            |           |           |  |
| <b>Wahyuni, 2004 (2004)</b><br>Inpatient cost, Jakarta (public hospital)                          | With complications  | IDR       | 1,522,148  | 3,281,210 | 7,033,503 |  |
|   |   | USD       | 172.42     | 371.68    | 796.73    |  |
|   | No complications  | IDR       | 1,041,560  | 1,736,953 | 3,439,027 |  |
|   |   | USD       | 117.98     | 196.75    | 389.56    |  |
| <b>Hadiwiardjo, 2006 (2006)</b> Outpatient cost, Tangerang, Banten (public health center)         |   | IDR       |            | 94,377    | 129,864   |  |
|   |   | USD       |            | 10.69     | 14.71     |  |
| <b>Tuberculosis</b>   |   |           |            |           |           |  |
| <b>Baroroh, 2004 (2004)</b><br>Purbalingga, West Java (public health center)                      | Government subsidy  | IDR       |            | 499,526   |           |  |
|   |   | USD       |            | 56.58     |           |  |
|   | Patient out of pocket cost  | IDR       |            | 77,540    |           |  |
|   |   | USD       |            | 8.78      |           |  |
| <b>Malaria</b>  |   |           |            |           |           |  |
| <b>Yanuar, 2004 (2003)</b> Sungailiat, Bangka (public hospital)                                   | Outpatient  | IDR       | 3,500      | 28,310    | 120,000   |  |
|   |   | USD       | 0.40       | 3.21      | 13.59     |  |
|   | Inpatient   | IDR       | 93,500     | 351,985   | 1,438,000 |  |
|   |   | USD       | 10.59      | 39.87     | 162.89    |  |
|   | Self treatment  | IDR       | 1,000      | 2,510     | 11,800    |  |
|   |   | USD       | 0.11       | 0.28      | 1.34      |  |
|   | Traditional treatment   | IDR       | 1,500      | 2,350     | 4,000     |  |
|   |   | USD       | 0.17       | 0.27      | 0.45      |  |
|   | Other out of pocket costs   | IDR       | 12,500     | 97,355    | 289,000   |  |
|   |   | USD       | 1.42       | 11.03     | 32.74     |  |
|   | <b>Cost comparison</b> Inpatient Sukabumi, West Java Primary (public health center) | Full cost | IDR        |           | 4,459     |  |
|   |   |           | USD        |           | 0.51      |  |
| Patient tariff  |   | IDR       |            | 2,000     |           |  |
|   |   | USD       |            | 0.23      |           |  |
| <b>Hartono (2000)</b> Inpatient cost Jakarta (type C low, type B high)                            | Public hospital   | IDR       | 208,039    |           | 444,336   |  |
|   |   | USD       | 23.57      |           | 50.33     |  |
|   | Private hospital  | IDR       | 1,020,651  |           | 1,366,212 |  |
|   |   | USD       | 115.62     |           | 154.76    |  |
| <b>Malnutrition</b>   |   |           |            |           |           |  |
| <b>Friedman et al (2004)</b> Outpatient cost Various (public health centers supplemental feeding) | Marginal cost   | IDR       | 175,455    | 204,843   | 219,108   |  |
|   |   | USD       | 19.87      | 23.20     | 24.82     |  |
|   | Total (full cost)   | IDR       | 183,264    | 207,521   | 221,882   |  |
|   |   | USD       | 20.76      | 23.51     | 25.13     |  |
|   | <b>Therapeutic feeding</b>  |           |            |           |           |  |
|   | Marginal cost   | IDR       | 188,868    | 241,240   | 402,774   |  |
|   |   | USD       | 21.39      | 27.33     | 45.62     |  |
|   | Total (full cost)   | IDR       | 191,452    | 257,049   | 408,234   |  |
|   |   | USD       | 21.69      | 29.12     | 46.24     |  |
|   | <b>Vitamin A supplement</b>   |           |            |           |           |  |
|   | Marginal cost   | IDR       | 710        | 1,450     | 1,948     |  |
|   |   | USD       | 0.08       | 0.16      | 0.22      |  |
| Total (full cost)   | IDR   | 1,317     | 2,057      | 2,513     |           |  |
|   | USD   | 0.15      | 0.23       | 0.28      |           |  |

**Table B6. Total health-related costs (IDR billion)**

| Disease                | Total financial costs |               |                 |              | Total economic costs |               |                 |               |
|------------------------|-----------------------|---------------|-----------------|--------------|----------------------|---------------|-----------------|---------------|
|                        | Health care           | Prod-uctivity | Premature death | Total        | Health care          | Prod-uctivity | Premature death | Total         |
| Diarrheal diseases     | 388                   | 821           | 433             | 1,642        | 503                  | 2,595         | 14,875          | 17,983        |
| Helminths              | 26                    | 9             | 0               | 35           | 44                   | 18            | 0               | 62            |
| Skin diseases          | 530                   | 194           | 9               | 733          | 706                  | 424           | 194             | 1,333         |
| Trachoma               | 9                     | 0             | 0               | 9            | 9                    | 9             | 0               | 18            |
| Hepatitis A            | 18                    | 9             | 0               | 26           | 18                   | 18            | 79              | 124           |
| Hepatitis E            | 1                     | 0             | 0               | 0            | 0                    | 0             | 9               | 9             |
| Malnutrition, direct   | 238                   | 0             | 0               | 238          | 327                  | 26            | 9,614           | 9,967         |
| Malnutrition, indirect | 26                    | 0             | 0               | 26           | 35                   | 0             | 0               | 35            |
| <b>Total</b>           | <b>1,236</b>          | <b>1,033</b>  | <b>441</b>      | <b>2,719</b> | <b>1,642</b>         | <b>3,090</b>  | <b>24,780</b>   | <b>29,512</b> |

**Table B7. Selected drinking water quality standards in Indonesia**

| Indicator                | Unit | Indonesia standard |
|--------------------------|------|--------------------|
| pH value                 | Unit | 6-9                |
| Suspended solids         | Mg/L | 50                 |
| Total dissolved solids   | Mg/L | 1000               |
| Dissolved oxygen         | Mg/L | 6                  |
| Biological oxygen demand | Mg/L | 2                  |
| COD                      | Mg/L | 10                 |
| Phosphate                | mg/L | 0.2                |
| NO <sub>3</sub>          | mg/L | 10                 |
| NH <sub>3</sub> -N       | mg/L | 0.5                |
| Arsenic                  | mg/L | 0.05               |
| Cobalt                   | mg/L | 0.2                |
| Barium                   | mg/L | 1                  |
| Boron                    | mg/L | 1                  |
| Selenium                 | mg/L | 0.01               |
| Cadmium                  | mg/L | 0.01               |
| Chrome (IV)              | mg/L | 0.05               |
| Copper                   | mg/L | 0.02               |
| Iron                     | mg/L | 0.3                |

Source: Government Regulation No 82/2001

## Annex C: Provincial Data Inputs and Results

Table C1. Population size by province and region in Indonesia, 2006

| Province                | Population         |                   |                    | Households          |                   |
|-------------------------|--------------------|-------------------|--------------------|---------------------|-------------------|
|                         | Rural              | Urban             | Total              | Average size (2005) | Total             |
| <b>Sumatra</b>          |                    |                   |                    |                     |                   |
| NAD                     | 3,028,642          | 1,023,912         | 4,052,553          | 3.8                 | 1,055,058         |
| North Sumatra           | 6,832,531          | 5,786,468         | 12,618,998         | 4.3                 | 2,962,612         |
| West Sumatra            | 3,247,684          | 1,386,478         | 4,634,161          | 4.0                 | 1,151,036         |
| Riau                    | 3,021,262          | 1,743,415         | 4,764,677          | 3.9                 | 1,236,319         |
| Jambi                   | 1,954,587          | 729,883           | 2,684,470          | 3.9                 | 693,092           |
| South Sumatra           | 4,588,790          | 2,314,275         | 6,903,065          | 3.9                 | 1,763,500         |
| Bengkulu                | 1,122,646          | 446,148           | 1,568,794          | 3.8                 | 411,678           |
| Lampung                 | 5,701,178          | 1,513,202         | 7,214,380          | 3.9                 | 1,832,252         |
| Bangka Belitung         | 635,011            | 440,270           | 1,075,281          | 4.0                 | 265,636           |
| Riau Archipelago        | 275,917            | 1,062,546         | 1,338,463          | 3.9                 | 347,299           |
| <b>Java-Bali</b>        |                    |                   |                    |                     |                   |
| Jakarta                 | 0                  | 8,966,706         | 8,966,706          | 3.5                 | 2,529,972         |
| West Java               | 19,203,877         | 20,443,459        | 39,647,335         | 3.3                 | 12,029,882        |
| Central Java            | 19,132,359         | 12,999,103        | 32,131,462         | 3.7                 | 8,705,992         |
| Yogyakarta              | 1,385,132          | 2,004,996         | 3,390,128          | 3.2                 | 1,052,353         |
| East Java               | 21,656,344         | 14,950,066        | 36,606,411         | 3.5                 | 10,602,134        |
| Banten                  | 4,359,731          | 4,867,719         | 9,227,450          | 3.7                 | 2,481,957         |
| Bali                    | 1,692,353          | 1,740,619         | 3,432,972          | 3.7                 | 921,483           |
| <b>Nusa Tenggara</b>    |                    |                   |                    |                     |                   |
| West Nusa Tenggara      | 2,731,237          | 1,489,160         | 4,220,397          | 3.3                 | 1,262,645         |
| East Nusa Tenggara      | 3,677,128          | 679,875           | 4,357,003          | 4.6                 | 942,879           |
| <b>Kalimantan</b>       |                    |                   |                    |                     |                   |
| West Kalimantan         | 2,966,742          | 1,092,898         | 4,059,639          | 4.1                 | 980,675           |
| Central Kalimantan      | 1,369,853          | 557,111           | 1,926,964          | 3.6                 | 541,895           |
| South Kalimantan        | 2,072,930          | 1,274,374         | 3,347,305          | 3.6                 | 918,978           |
| East Kalimantan         | 1,279,230          | 1,658,451         | 2,937,680          | 3.7                 | 783,433           |
| <b>Sulawesi</b>         |                    |                   |                    |                     |                   |
| North Sulawesi          | 1,350,493          | 804,897           | 2,155,390          | 3.4                 | 632,735           |
| Central Sulawesi        | 1,856,156          | 463,240           | 2,319,396          | 4.0                 | 582,941           |
| South Sulawesi          | 5,295,299          | 2,286,499         | 7,581,797          | 4.1                 | 1,829,339         |
| Southeast Sulawesi      | 1,566,367          | 436,311           | 2,002,678          | 4.1                 | 488,319           |
| Gorontalo               | 696,586            | 245,232           | 941,818            | 3.4                 | 274,752           |
| West Sulawesi           | 783,258            | 195,477           | 978,736            | 4.1                 | 236,150           |
| <b>Maluku and Papua</b> |                    |                   |                    |                     |                   |
| Maluku                  | 906,338            | 365,226           | 1,271,564          | 5.0                 | 256,632           |
| North Maluku            | 678,544            | 220,098           | 898,642            | 5.5                 | 163,528           |
| West Papua              | 485,518            | 171,448           | 656,965            | 3.6                 | 184,936           |
| Papua                   | 1,416,045          | 500,039           | 1,916,084          | 3.6                 | 539,379           |
| <b>National</b>         | <b>126,969,767</b> | <b>94,859,597</b> | <b>221,829,364</b> | <b>3.7</b>          | <b>60,661,472</b> |

Source: Authors' projection for 2006, based on 2005 Intercensal Survey (Statistics Indonesia), adjusted by average population growth 2000-2005 by province from Indonesia Yearly Statistics (Statistics Indonesia) 2005/2006.

**Table C2. Sanitation coverage by province and rural/urban grouping**

| Province         | Location | Improved sanitation % |             |       | Unimproved sanitation %         |             |       |       | All % |
|------------------|----------|-----------------------|-------------|-------|---------------------------------|-------------|-------|-------|-------|
|                  |          | Septic tank           | Pit latrine | Total | Water body garden, field, beach | Pit latrine | Other | Total |       |
| NAD              | Rural    | 24.8                  | 15.5        | 40.3  | 39.4                            | 15.5        | 4.7   | 59.7  | 100.0 |
|                  | Urban    | 68.5                  | 9.4         | 78.0  | 11.6                            | 9.4         | 1.0   | 22.1  | 100.0 |
|                  | Total    | 34.3                  | 14.2        | 48.5  | 33.4                            | 14.2        | 3.9   | 51.5  | 100.0 |
| North Sumatra    | Rural    | 28.5                  | 18.9        | 47.4  | 27.4                            | 18.9        | 6.2   | 52.6  | 100.0 |
|                  | Urban    | 71.5                  | 9.3         | 80.8  | 7.5                             | 9.3         | 2.4   | 19.2  | 100.0 |
|                  | Total    | 47.2                  | 14.7        | 62.0  | 18.8                            | 14.7        | 4.5   | 38.0  | 100.0 |
| West Sumatra     | Rural    | 19.7                  | 8.7         | 28.4  | 59.6                            | 8.7         | 3.3   | 71.6  | 100.0 |
|                  | Urban    | 63.7                  | 7.2         | 70.9  | 20.0                            | 7.2         | 1.9   | 29.1  | 100.0 |
|                  | Total    | 33.4                  | 8.2         | 41.6  | 47.3                            | 8.2         | 2.9   | 58.4  | 100.0 |
| Riau             | Rural    | 1.1                   | 35.5        | 36.6  | 24.1                            | 35.5        | 3.8   | 63.4  | 100.0 |
|                  | Urban    | 70.9                  | 11.7        | 82.6  | 5.5                             | 11.7        | 0.2   | 17.4  | 100.0 |
|                  | Total    | 36.0                  | 23.6        | 59.6  | 14.8                            | 23.6        | 2.0   | 40.4  | 100.0 |
| Jambi            | Rural    | 19.5                  | 16.6        | 36.1  | 45.1                            | 16.6        | 2.2   | 63.9  | 100.0 |
|                  | Urban    | 65.4                  | 8.6         | 74.1  | 16.2                            | 8.6         | 1.1   | 25.9  | 100.0 |
|                  | Total    | 32.0                  | 14.5        | 46.4  | 37.2                            | 14.5        | 1.9   | 53.6  | 100.0 |
| South Sumatra    | Rural    | 18.0                  | 20.7        | 38.7  | 38.9                            | 20.7        | 1.8   | 61.3  | 100.0 |
|                  | Urban    | 64.9                  | 12.3        | 77.2  | 9.8                             | 12.3        | 0.7   | 22.8  | 100.0 |
|                  | Total    | 33.2                  | 18.0        | 51.1  | 29.5                            | 18.0        | 1.4   | 48.9  | 100.0 |
| Bengkulu         | Rural    | 16.4                  | 22.0        | 38.4  | 36.4                            | 22.0        | 3.2   | 61.6  | 100.0 |
|                  | Urban    | 56.2                  | 16.1        | 72.3  | 5.2                             | 16.1        | 6.3   | 27.7  | 100.0 |
|                  | Total    | 27.1                  | 20.4        | 47.5  | 28.0                            | 20.4        | 4.1   | 52.5  | 100.0 |
| Lampung          | Rural    | 20.6                  | 31.2        | 51.7  | 16.0                            | 31.2        | 1.1   | 48.3  | 100.0 |
|                  | Urban    | 56.6                  | 15.0        | 71.6  | 11.5                            | 15.0        | 1.9   | 28.4  | 100.0 |
|                  | Total    | 28.1                  | 27.8        | 55.9  | 15.1                            | 27.8        | 1.3   | 44.1  | 100.0 |
| Bangka Belitung  | Rural    | 37.1                  | 8.7         | 45.9  | 37.6                            | 8.7         | 7.9   | 54.2  | 100.0 |
|                  | Urban    | 65.4                  | 10.4        | 75.8  | 10.5                            | 10.4        | 3.4   | 24.2  | 100.0 |
|                  | Total    | 48.6                  | 9.4         | 58.0  | 26.6                            | 9.4         | 6.1   | 42.0  | 100.0 |
| Riau Archipelago | Rural    | 16.2                  | 9.1         | 25.3  | 62.0                            | 9.1         | 3.6   | 74.7  | 100.0 |
|                  | Urban    | 53.8                  | 16.1        | 69.9  | 13.4                            | 16.1        | 0.5   | 30.1  | 100.0 |
|                  | Total    | 46.4                  | 14.8        | 61.2  | 23.0                            | 14.8        | 1.1   | 38.8  | 100.0 |
| Jakarta          | Total    | 82.3                  | 5.7         | 88.0  | 5.9                             | 5.7         | 0.3   | 12.0  | 100.0 |
| West Java        | Rural    | 28.1                  | 11.2        | 39.2  | 47.9                            | 11.2        | 1.7   | 60.8  | 100.0 |
|                  | Urban    | 56.6                  | 7.4         | 64.0  | 27.2                            | 7.4         | 1.4   | 36.0  | 100.0 |
|                  | Total    | 42.6                  | 9.2         | 51.8  | 37.4                            | 9.2         | 1.6   | 48.2  | 100.0 |
| Central Java     | Rural    | 30.2                  | 17.5        | 47.7  | 33.4                            | 17.5        | 1.4   | 52.3  | 100.0 |
|                  | Urban    | 61.9                  | 7.4         | 69.2  | 22.7                            | 7.4         | 0.8   | 30.8  | 100.0 |
|                  | Total    | 43.1                  | 13.4        | 56.5  | 29.0                            | 13.4        | 1.1   | 43.5  | 100.0 |
| Yogyakarta       | Rural    | 32.3                  | 29.9        | 62.1  | 6.4                             | 29.9        | 1.6   | 37.9  | 100.0 |
|                  | Urban    | 79.5                  | 5.1         | 84.6  | 8.4                             | 5.1         | 1.9   | 15.4  | 100.0 |
|                  | Total    | 60.4                  | 15.1        | 75.5  | 7.6                             | 15.1        | 1.8   | 24.5  | 100.0 |
| East Java        | Rural    | 22.7                  | 21.5        | 44.2  | 33.1                            | 21.5        | 1.2   | 55.8  | 100.0 |
|                  | Urban    | 56.8                  | 12.7        | 69.5  | 17.2                            | 12.7        | 0.6   | 30.5  | 100.0 |
|                  | Total    | 36.8                  | 17.8        | 54.6  | 26.6                            | 17.8        | 1.0   | 45.4  | 100.0 |

| Province           | Location | Improved sanitation % |             |       | Unimproved sanitation %         |             |       |       | All % |
|--------------------|----------|-----------------------|-------------|-------|---------------------------------|-------------|-------|-------|-------|
|                    |          | Septic tank           | Pit latrine | Total | Water body garden, field, beach | Pit latrine | Other | Total |       |
| Banten             | Rural    | 22.7                  | 11.2        | 33.9  | 52.5                            | 11.2        | 2.4   | 66.1  | 100.0 |
|                    | Urban    | 65.8                  | 11.1        | 76.9  | 11.5                            | 11.1        | 0.5   | 23.1  | 100.0 |
|                    | Total    | 46.8                  | 11.1        | 57.9  | 29.7                            | 11.1        | 1.3   | 42.1  | 100.0 |
| B a l i            | Rural    | 48.6                  | 9.5         | 58.1  | 28.6                            | 9.5         | 3.8   | 41.9  | 100.0 |
|                    | Urban    | 76.9                  | 7.2         | 84.1  | 7.8                             | 7.2         | 1.0   | 15.9  | 100.0 |
|                    | Total    | 63.8                  | 8.2         | 72.0  | 17.5                            | 8.2         | 2.3   | 28.0  | 100.0 |
| West Nusa Tenggara | Rural    | 17.1                  | 10.5        | 27.6  | 58.3                            | 10.5        | 3.7   | 72.4  | 100.0 |
|                    | Urban    | 31.2                  | 14.7        | 45.9  | 37.1                            | 14.7        | 2.3   | 54.1  | 100.0 |
|                    | Total    | 22.2                  | 12.0        | 34.2  | 50.6                            | 12.0        | 3.2   | 65.8  | 100.0 |
| East Nusa Tenggara | Rural    | 7.8                   | 28.3        | 36.1  | 24.1                            | 28.3        | 11.6  | 63.9  | 100.0 |
|                    | Urban    | 34.3                  | 29.4        | 63.7  | 5.9                             | 29.4        | 1.0   | 36.3  | 100.0 |
|                    | Total    | 11.9                  | 28.5        | 40.4  | 21.2                            | 28.5        | 9.9   | 59.6  | 100.0 |
| West Kalimantan    | Rural    | 15.3                  | 18.4        | 33.7  | 43.1                            | 18.4        | 4.9   | 66.3  | 100.0 |
|                    | Urban    | 64.8                  | 11.6        | 76.4  | 10.3                            | 11.6        | 1.8   | 23.6  | 100.0 |
|                    | Total    | 28.3                  | 16.6        | 44.9  | 34.4                            | 16.6        | 4.0   | 55.1  | 100.0 |
| Central Kalimantan | Rural    | 8.4                   | 16.1        | 24.4  | 58.5                            | 16.1        | 1.1   | 75.6  | 100.0 |
|                    | Urban    | 43.3                  | 18.3        | 61.6  | 19.9                            | 18.3        | 0.3   | 38.5  | 100.0 |
|                    | Total    | 18.6                  | 16.7        | 35.3  | 47.1                            | 16.7        | 0.9   | 64.7  | 100.0 |
| South Kalimantan   | Rural    | 16.6                  | 20.5        | 37.1  | 41.6                            | 20.5        | 0.8   | 62.9  | 100.0 |
|                    | Urban    | 42.1                  | 19.6        | 61.8  | 17.8                            | 19.6        | 0.8   | 38.2  | 100.0 |
|                    | Total    | 26.1                  | 20.2        | 46.3  | 32.8                            | 20.2        | 0.8   | 53.7  | 100.0 |
| East Kalimantan    | Rural    | 25.9                  | 22.5        | 48.3  | 27.2                            | 22.5        | 2.0   | 51.7  | 100.0 |
|                    | Urban    | 61.7                  | 13.3        | 74.9  | 11.7                            | 13.3        | 0.2   | 25.1  | 100.0 |
|                    | Total    | 45.3                  | 17.5        | 62.8  | 18.8                            | 17.5        | 1.0   | 37.2  | 100.0 |
| North Sulawesi     | Rural    | 41.7                  | 18.1        | 59.8  | 19.0                            | 18.1        | 3.0   | 40.2  | 100.0 |
|                    | Urban    | 54.0                  | 20.1        | 74.1  | 4.2                             | 20.1        | 1.7   | 25.9  | 100.0 |
|                    | Total    | 46.4                  | 18.9        | 65.3  | 13.4                            | 18.9        | 2.5   | 34.8  | 100.0 |
| Central Sulawesi   | Rural    | 23.5                  | 12.5        | 36.0  | 43.6                            | 12.5        | 7.9   | 64.0  | 100.0 |
|                    | Urban    | 67.4                  | 10.4        | 77.8  | 10.1                            | 10.4        | 1.7   | 22.2  | 100.0 |
|                    | Total    | 32.3                  | 12.1        | 44.4  | 36.9                            | 12.1        | 6.6   | 55.6  | 100.0 |
| South Sulawesi     | Rural    | 29.9                  | 16.0        | 45.9  | 36.1                            | 16.0        | 2.0   | 54.1  | 100.0 |
|                    | Urban    | 71.2                  | 8.9         | 80.1  | 10.0                            | 8.9         | 1.1   | 19.9  | 100.0 |
|                    | Total    | 43.0                  | 13.7        | 56.8  | 27.8                            | 13.7        | 1.7   | 43.3  | 100.0 |
| Southeast Sulawesi | Rural    | 22.5                  | 20.0        | 42.5  | 33.8                            | 20.0        | 3.7   | 57.5  | 100.0 |
|                    | Urban    | 62.2                  | 13.1        | 75.3  | 10.9                            | 13.1        | 0.8   | 24.7  | 100.0 |
|                    | Total    | 31.2                  | 18.5        | 49.7  | 28.8                            | 18.5        | 3.0   | 50.3  | 100.0 |
| Gorontalo          | Rural    | 16.8                  | 12.4        | 29.2  | 52.2                            | 12.4        | 6.2   | 70.8  | 100.0 |
|                    | Urban    | 44.4                  | 17.9        | 62.4  | 17.4                            | 17.9        | 2.4   | 37.6  | 100.0 |
|                    | Total    | 24.3                  | 13.9        | 38.1  | 42.8                            | 13.9        | 5.2   | 61.9  | 100.0 |
| West Sulawesi      | Rural    | 16.5                  | 13.7        | 30.1  | 53.1                            | 13.7        | 3.1   | 69.9  | 100.0 |
|                    | Urban    | 42.4                  | 13.2        | 55.6  | 30.5                            | 13.2        | 0.7   | 44.4  | 100.0 |
|                    | Total    | 20.3                  | 13.6        | 33.9  | 49.8                            | 13.6        | 2.8   | 66.1  | 100.0 |
| Maluku             | Rural    | 15.7                  | 12.0        | 27.7  | 54.9                            | 12.0        | 5.3   | 72.3  | 100.0 |
|                    | Urban    | 63.2                  | 9.5         | 72.7  | 17.4                            | 9.5         | 0.5   | 27.4  | 100.0 |
|                    | Total    | 29.3                  | 11.3        | 40.7  | 44.1                            | 11.3        | 3.9   | 59.4  | 100.0 |

| Province               | Location     | Improved sanitation % |             |             | Unimproved sanitation %         |             |            |             | All %        |
|------------------------|--------------|-----------------------|-------------|-------------|---------------------------------|-------------|------------|-------------|--------------|
|                        |              | Septic tank           | Pit latrine | Total       | Water body garden, field, beach | Pit latrine | Other      | Total       |              |
| North Maluku           | Rural        | 29.3                  | 10.1        | 39.4        | 47.1                            | 10.1        | 3.4        | 60.6        | 100.0        |
|                        | Urban        | 69.5                  | 7.9         | 77.4        | 13.9                            | 7.9         | 0.8        | 22.6        | 100.0        |
|                        | Total        | 39.2                  | 9.6         | 48.8        | 39.0                            | 9.6         | 2.7        | 51.2        | 100.0        |
| West Papua             | Rural        | 16.9                  | 10.1        | 27.0        | 59.8                            | 10.1        | 3.3        | 73.1        | 100.0        |
|                        | Urban        | 66.0                  | 5.6         | 71.6        | 21.5                            | 5.6         | 1.2        | 28.4        | 100.0        |
|                        | Total        | 33.8                  | 8.6         | 42.4        | 46.5                            | 8.6         | 2.6        | 57.6        | 100.0        |
| Papua                  | Rural        | 10.7                  | 16.8        | 27.6        | 37.4                            | 16.8        | 18.3       | 72.4        | 100.0        |
|                        | Urban        | 56.9                  | 16.0        | 72.9        | 10.3                            | 16.0        | 0.9        | 27.1        | 100.0        |
|                        | Total        | 21.5                  | 16.6        | 38.1        | 31.1                            | 16.6        | 14.2       | 61.9        | 100.0        |
| <b>Indonesia Total</b> | <b>Rural</b> | <b>24.4</b>           | <b>17.8</b> | <b>42.2</b> | <b>37.3</b>                     | <b>17.8</b> | <b>2.8</b> | <b>57.9</b> | <b>100.0</b> |
|                        | <b>Urban</b> | <b>62.3</b>           | <b>9.7</b>  | <b>72.0</b> | <b>17.2</b>                     | <b>9.7</b>  | <b>1.0</b> | <b>28.0</b> | <b>100.0</b> |
|                        | <b>Total</b> | <b>40.7</b>           | <b>14.3</b> | <b>55.0</b> | <b>28.7</b>                     | <b>14.3</b> | <b>2.0</b> | <b>45.0</b> | <b>100.0</b> |

Source: Susenas 2006

**Table C3. Annual incidence of diarrheal disease for children under five years, by province**

| Province                 | Diarrheal incidence | Province           | Diarrheal incidence |
|--------------------------|---------------------|--------------------|---------------------|
| Nanggroe Aceh Darussalam | 2.3232              | West Nusa Tenggara | 2.8512              |
| North Sumatra            | 2.5978              | East Nusa Tenggara | 2.7245              |
| West Sumatra             | 3.0202              | West Kalimantan    | 1.7530              |
| R i a u                  | 1.2883              | Central Kalimantan | 0.5069              |
| J a m b i                | 1.7107              | South Kalimantan   | 2.0909              |
| South Sumatra            | 0.6970              | East Kalimantan    | 2.3443              |
| Bengkulu                 | 1.7318              | North Sulawesi     | 2.0064              |
| Lampung                  | 1.9430              | Central Sulawesi   | 1.3517              |
| Bangka Belitung          | 1.9853              | South Sulawesi     | 3.2736              |
| Riau Archipelago         | 1.2883              | Southeast Sulawesi | 1.9008              |
| Jakarta                  | 1.6474              | Gorontalo          | 2.5766              |
| West Java                | 3.1891              | West Sulawesi      | 3.2736              |
| Central Java             | 1.6685              | Maluku             | 2.3232              |
| Yogyakarta               | 1.0982              | North Maluku       | 2.3232              |
| East Java                | 2.0698              | West Papua         | 2.3232              |
| Banten                   | 2.6400              | Papua              | 2.3232              |
| B a l i                  | 2.5133              | <b>National</b>    | <b>2.3232</b>       |

Source: Indonesia Demographic and Health Survey 2002-3



Table C4. Treatment seeking behavior by province and rural/urban grouping

| Province         | Location | % Seeking outpatient treatment |                   |       | % Self treatment | Total |
|------------------|----------|--------------------------------|-------------------|-------|------------------|-------|
|                  |          | Formal provider                | Informal provider | Total |                  |       |
| NAD              | Rural    | 29                             | 9                 | 38    | 62               | 100   |
|                  | Urban    | 33                             | 8                 | 41    | 59               | 100   |
|                  | Total    | 30                             | 9                 | 38    | 62               | 100   |
| North Sumatra    | Rural    | 17                             | 11                | 27    | 73               | 100   |
|                  | Urban    | 25                             | 7                 | 32    | 68               | 100   |
|                  | Total    | 21                             | 9                 | 29    | 71               | 100   |
| West Sumatra     | Rural    | 22                             | 16                | 38    | 62               | 100   |
|                  | Urban    | 32                             | 12                | 43    | 57               | 100   |
|                  | Total    | 24                             | 15                | 39    | 61               | 100   |
| R i a u          | Rural    | 14                             | 4                 | 18    | 82               | 100   |
|                  | Urban    | 28                             | 3                 | 30    | 70               | 100   |
|                  | Total    | 19                             | 3                 | 22    | 78               | 100   |
| J a m b i        | Rural    | 19                             | 3                 | 22    | 78               | 100   |
|                  | Urban    | 38                             | 6                 | 44    | 56               | 100   |
|                  | Total    | 25                             | 4                 | 29    | 71               | 100   |
| South Sumatra    | Rural    | 20                             | 6                 | 26    | 74               | 100   |
|                  | Urban    | 29                             | 2                 | 31    | 69               | 100   |
|                  | Total    | 23                             | 5                 | 28    | 72               | 100   |
| Bengkulu         | Rural    | 18                             | 8                 | 26    | 74               | 100   |
|                  | Urban    | 30                             | 7                 | 36    | 64               | 100   |
|                  | Total    | 21                             | 8                 | 29    | 71               | 100   |
| Lampung          | Rural    | 17                             | 12                | 29    | 71               | 100   |
|                  | Urban    | 24                             | 9                 | 34    | 66               | 100   |
|                  | Total    | 19                             | 11                | 30    | 70               | 100   |
| Bangka Belitung  | Rural    | 22                             | 7                 | 27    | 73               | 100   |
|                  | Urban    | 32                             | 8                 | 40    | 60               | 100   |
|                  | Total    | 25                             | 7                 | 32    | 68               | 100   |
| Riau Archipelago | Rural    | 31                             | 6                 | 37    | 63               | 100   |
|                  | Urban    | 29                             | 5                 | 33    | 67               | 100   |
|                  | Total    | 29                             | 5                 | 34    | 66               | 100   |
| Jakarta          | Total    | 36                             | 3                 | 39    | 61               | 100   |
| West Java        | Rural    | 26                             | 13                | 33    | 67               | 100   |
|                  | Urban    | 39                             | 11                | 40    | 60               | 100   |
|                  | Total    | 32                             | 12                | 36    | 64               | 100   |
| Central Java     | Rural    | 24                             | 14                | 38    | 62               | 100   |
|                  | Urban    | 33                             | 8                 | 41    | 59               | 100   |
|                  | Total    | 28                             | 11                | 39    | 61               | 100   |

| Province           | Location | % Seeking outpatient treatment |                   |       | % Self treatment | Total |
|--------------------|----------|--------------------------------|-------------------|-------|------------------|-------|
|                    |          | Formal provider                | Informal provider | Total |                  |       |
| Yogyakarta         | Rural    | 32                             | 8                 | 40    | 60               | 100   |
|                    | Urban    | 32                             | 4                 | 36    | 64               | 100   |
|                    | Total    | 32                             | 6                 | 38    | 62               | 100   |
| East Java          | Rural    | 19                             | 13                | 33    | 67               | 100   |
|                    | Urban    | 27                             | 9                 | 36    | 64               | 100   |
|                    | Total    | 23                             | 11                | 34    | 66               | 100   |
| Banten             | Rural    | 17                             | 6                 | 23    | 77               | 100   |
|                    | Urban    | 26                             | 4                 | 30    | 70               | 100   |
|                    | Total    | 22                             | 5                 | 27    | 73               | 100   |
| B a l i            | Rural    | 36                             | 14                | 50    | 50               | 100   |
|                    | Urban    | 38                             | 6                 | 44    | 56               | 100   |
|                    | Total    | 37                             | 10                | 47    | 53               | 100   |
| West Nusa Tenggara | Rural    | 27                             | 10                | 36    | 64               | 100   |
|                    | Urban    | 27                             | 7                 | 34    | 66               | 100   |
|                    | Total    | 27                             | 9                 | 35    | 65               | 100   |
| East Nusa Tenggara | Rural    | 37                             | 8                 | 45    | 55               | 100   |
|                    | Urban    | 45                             | 2                 | 48    | 52               | 100   |
|                    | Total    | 38                             | 7                 | 46    | 54               | 100   |
| West Kalimantan    | Rural    | 20                             | 8                 | 28    | 72               | 100   |
|                    | Urban    | 24                             | 6                 | 30    | 70               | 100   |
|                    | Total    | 22                             | 7                 | 29    | 71               | 100   |
| Central Kalimantan | Rural    | 20                             | 4                 | 24    | 76               | 100   |
|                    | Urban    | 24                             | 7                 | 30    | 70               | 100   |
|                    | Total    | 21                             | 5                 | 26    | 74               | 100   |
| South Kalimantan   | Rural    | 17                             | 10                | 27    | 73               | 100   |
|                    | Urban    | 22                             | 5                 | 27    | 73               | 100   |
|                    | Total    | 19                             | 8                 | 27    | 73               | 100   |
| East Kalimantan    | Rural    | 28                             | 8                 | 30    | 70               | 100   |
|                    | Urban    | 34                             | 4                 | 37    | 63               | 100   |
|                    | Total    | 31                             | 6                 | 34    | 66               | 100   |
| North Sulawesi     | Rural    | 25                             | 7                 | 31    | 69               | 100   |
|                    | Urban    | 31                             | 3                 | 34    | 66               | 100   |
|                    | Total    | 27                             | 5                 | 32    | 68               | 100   |

| Province           | Location | % Seeking outpatient treatment |                   |       | % Self treatment | Total |
|--------------------|----------|--------------------------------|-------------------|-------|------------------|-------|
|                    |          | Formal provider                | Informal provider | Total |                  |       |
| Central Sulawesi   | Rural    | 18                             | 7                 | 26    | 74               | 100   |
|                    | Urban    | 32                             | 5                 | 37    | 63               | 100   |
|                    | Total    | 21                             | 7                 | 28    | 72               | 100   |
| South Sulawesi     | Rural    | 21                             | 6                 | 27    | 73               | 100   |
|                    | Urban    | 27                             | 4                 | 30    | 70               | 100   |
|                    | Total    | 23                             | 5                 | 28    | 72               | 100   |
| Southeast Sulawesi | Rural    | 19                             | 4                 | 23    | 77               | 100   |
|                    | Urban    | 20                             | 2                 | 22    | 78               | 100   |
|                    | Total    | 19                             | 4                 | 23    | 77               | 100   |
| Gorontalo          | Rural    | 21                             | 7                 | 29    | 71               | 100   |
|                    | Urban    | 30                             | 10                | 40    | 60               | 100   |
|                    | Total    | 24                             | 8                 | 32    | 68               | 100   |
| West Sulawesi      | Rural    | 17                             | 3                 | 20    | 80               | 100   |
|                    | Urban    | 26                             | 4                 | 30    | 70               | 100   |
|                    | Total    | 18                             | 3                 | 21    | 79               | 100   |
| Maluku             | Rural    | 23                             | 4                 | 27    | 73               | 100   |
|                    | Urban    | 25                             | 2                 | 27    | 73               | 100   |
|                    | Total    | 17                             | 3                 | 19    | 81               | 100   |
| North Maluku       | Rural    | 20                             | 6                 | 26    | 74               | 100   |
|                    | Urban    | 34                             | 7                 | 41    | 59               | 100   |
|                    | Total    | 23                             | 6                 | 29    | 71               | 100   |
| West Papua         | Rural    | 30                             | 1                 | 31    | 69               | 100   |
|                    | Urban    | 19                             | 12                | 31    | 69               | 100   |
|                    | Total    | 22                             | 9                 | 31    | 69               | 100   |
| Papua              | Rural    | 28                             | 3                 | 31    | 69               | 100   |
|                    | Urban    | 26                             | 2                 | 28    | 72               | 100   |
|                    | Total    | 27                             | 3                 | 30    | 70               | 100   |
| Indonesia Total    | Rural    | 23                             | 10                | 32    | 68               | 100   |
|                    | Urban    | 32                             | 7                 | 37    | 63               | 100   |
|                    | Total    | 33                             | 2                 | 34    | 66               | 100   |

Source: Susenas 2006

**Table C5. Comparison of alternative sources of time value**

| Province            | GDP per capita                   |                   | Average compensation to employees |                   | Minimum wage                     |                   | Average wage                     |                   |
|---------------------|----------------------------------|-------------------|-----------------------------------|-------------------|----------------------------------|-------------------|----------------------------------|-------------------|
|                     | Year <sup>1</sup><br>(IDR mill.) | Hour<br>(IDR th.) | Year <sup>1</sup><br>(IDR mill.)  | Hour<br>(IDR th.) | Year <sup>1</sup><br>(IDR mill.) | Hour<br>(IDR th.) | Year <sup>1</sup><br>(IDR mill.) | Hour<br>(IDR th.) |
| NAD                 | 8.3                              | 4.1               | 17.2                              | 8.5               | 9.8                              | 4.9               | 11.0                             | 5.5               |
| North Sumatra       | 11.6                             | 5.7               | 24.1                              | 12.0              | 8.9                              | 4.4               | 9.5                              | 4.8               |
| West Sumatra        | 10.4                             | 5.2               | 21.7                              | 10.8              | 7.8                              | 3.9               | 9.6                              | 4.8               |
| Riau                | 18.4                             | 9.1               | 38.2                              | 19.0              | 9.1                              | 4.5               | 11.5                             | 5.7               |
| Jambi               | 7.4                              | 3.7               | 15.4                              | 7.7               | 6.8                              | 3.4               | 11.1                             | 5.5               |
| South Sumatra       | 8.3                              | 4.1               | 17.2                              | 8.6               | 7.2                              | 3.6               | 9.2                              | 4.6               |
| Bengkulu            | 6.9                              | 3.4               | 14.3                              | 7.1               | 6.2                              | 3.1               | 9.8                              | 4.9               |
| Lampung             | 5.8                              | 2.9               | 12.1                              | 6.0               | 6.1                              | 3.0               | 6.9                              | 3.4               |
| Bangka Belitung Is. | 13.0                             | 6.4               | 27.1                              | 13.4              | 13.0                             | 6.4               | 11.2                             | 5.6               |
| Riau Archipelago    | 31.3                             | 15.5              | 64.9                              | 32.2              | 7.3                              | 3.6               | 14.8                             | 7.3               |
| DKI Jakarta         | 52.3                             | 26.0              | 108.5                             | 53.8              | 9.8                              | 4.9               | 14.7                             | 7.3               |
| West Java           | 10.1                             | 5.0               | 20.9                              | 10.4              | 5.4                              | 2.6               | 9.0                              | 4.4               |
| Central Java        | 6.7                              | 3.4               | 13.9                              | 6.9               | 5.4                              | 2.6               | 7.0                              | 3.4               |
| DI Yogyakarta       | 8.1                              | 4.0               | 16.7                              | 8.3               | 5.5                              | 2.7               | 8.7                              | 4.3               |
| East Java           | 11.8                             | 5.8               | 24.5                              | 12.2              | 4.7                              | 2.3               | 7.2                              | 3.5               |
| Banten              | 10.0                             | 4.9               | 20.7                              | 10.3              | 7.0                              | 3.4               | 11.2                             | 5.6               |
| Bali                | 10.7                             | 5.3               | 22.2                              | 11.0              | 6.1                              | 3.0               | 10.1                             | 5.0               |
| West Nusa Tenggara  | 6.6                              | 3.3               | 13.6                              | 6.7               | 6.6                              | 3.3               | 6.2                              | 3.1               |
| East Nusa Tenggara  | 3.7                              | 1.9               | 7.6                               | 3.8               | 6.6                              | 3.3               | 8.5                              | 4.2               |
| West Kalimantan     | 8.9                              | 4.4               | 18.4                              | 9.2               | 6.1                              | 3.1               | 9.8                              | 4.9               |
| Central Kalimantan  | 11.7                             | 5.8               | 24.3                              | 12.0              | 7.6                              | 3.8               | 11.6                             | 5.7               |
| South Kalimantan    | 9.2                              | 4.6               | 19.2                              | 9.5               | 7.5                              | 3.7               | 10.0                             | 4.9               |
| East Kalimantan     | 24.8                             | 12.3              | 51.5                              | 25.5              | 8.2                              | 4.1               | 17.7                             | 8.8               |
| North Sulawesi      | 8.9                              | 4.4               | 18.5                              | 9.2               | 6.9                              | 3.4               | 10.8                             | 5.4               |
| Central Sulawesi    | 7.9                              | 4.0               | 16.5                              | 8.2               | 6.9                              | 3.4               | 8.6                              | 4.2               |
| South Sulawesi      | 7.4                              | 3.6               | 15.3                              | 7.6               | 7.3                              | 3.6               | 10.1                             | 5.0               |
| Southeast Sulawesi  | 7.1                              | 3.5               | 14.6                              | 7.2               | 7.3                              | 3.6               | 9.5                              | 4.7               |
| Gorontalo           | 3.9                              | 1.9               | 8.1                               | 4.1               | 6.3                              | 3.2               | 10.0                             | 4.9               |
| West Sulawesi       | 4.9                              | 2.4               | 10.1                              | 5.0               | 7.3                              | 3.6               | 8.8                              | 4.3               |
| Maluku              | 3.9                              | 1.9               | 8.1                               | 4.0               | 6.9                              | 3.4               | 11.0                             | 5.5               |
| North Maluku        | 3.1                              | 1.5               | 6.5                               | 3.2               | 6.3                              | 3.2               | 11.2                             | 5.6               |
| West Papua          | 9.0                              | 4.4               | 18.6                              | 9.3               | 9.9                              | 4.9               | 13.7                             | 6.8               |
| Papua               | 24.8                             | 12.3              | 51.5                              | 25.5              | 9.9                              | 4.9               | 19.1                             | 9.4               |
| <b>National</b>     | <b>11.8</b>                      | <b>5.8</b>        | <b>24.5</b>                       | <b>12.2</b>       | <b>7.2</b>                       | <b>3.6</b>        | <b>9.1</b>                       | <b>4.5</b>        |

Source: Statistics Indonesia. Annual values in IDR million. Hourly valued in IDR thousand.

<sup>1</sup> Annual value converted to hourly value, assuming 8 working hours/day, and 252 working days/year.

**Table C6. Value of human life using human capital approach (IDR million)**

| Province                | Annual compensation to employees | Value of human life |              |                 |              |                |              |
|-------------------------|----------------------------------|---------------------|--------------|-----------------|--------------|----------------|--------------|
|                         |                                  | Low value           |              | Base Case Value |              | High value     |              |
|                         |                                  | 0-15 years          | 15+ years    | 0-15 years      | 15+ years    | 0-15 years     | 15+ years    |
| NAD                     | 17.2                             | 438.6               | 220.8        | 518.2           | 238.2        | 742.2          | 278.2        |
| North Sumatra           | 24.1                             | 617.4               | 310.7        | 729.4           | 335.3        | 1,044.5        | 391.6        |
| West Sumatra            | 21.7                             | 553.6               | 278.6        | 654.1           | 300.7        | 936.7          | 351.2        |
| Riau                    | 38.2                             | 976.9               | 491.6        | 1,154.1         | 530.5        | 1,652.8        | 619.7        |
| Jambi                   | 15.4                             | 395.1               | 198.8        | 466.8           | 214.5        | 668.4          | 250.6        |
| South Sumatra           | 17.2                             | 439.9               | 221.4        | 519.7           | 238.9        | 744.3          | 279.0        |
| Bengkulu                | 14.3                             | 365.5               | 184.0        | 431.9           | 198.5        | 618.5          | 231.9        |
| Lampung                 | 12.1                             | 309.0               | 155.5        | 365.1           | 167.8        | 522.8          | 196.0        |
| Bangka Belitung Is.     | 27.1                             | 692.3               | 348.4        | 817.9           | 375.9        | 1,171.3        | 439.1        |
| Riau Archipelago        | 64.9                             | 1,660.7             | 835.8        | 1,962.0         | 901.9        | 2,809.8        | 1,053.4      |
| DKI Jakarta             | 108.5                            | 2,773.6             | 1,395.8      | 3,276.8         | 1,506.2      | 4,692.7        | 1,759.3      |
| West Java               | 20.9                             | 535.6               | 269.5        | 632.8           | 290.8        | 906.2          | 339.7        |
| Central Java            | 13.9                             | 356.1               | 179.2        | 420.7           | 193.4        | 602.5          | 225.9        |
| DI Yogyakarta           | 16.7                             | 427.3               | 215.0        | 504.8           | 232.0        | 722.9          | 271.0        |
| East Java               | 24.5                             | 627.5               | 315.8        | 741.4           | 340.8        | 1,061.7        | 398.1        |
| Banten                  | 20.7                             | 530.4               | 266.9        | 626.6           | 288.0        | 897.3          | 336.4        |
| Bali                    | 22.2                             | 567.7               | 285.7        | 670.7           | 308.3        | 960.5          | 360.1        |
| West Nusa Tenggara      | 18.4                             | 471.2               | 237.1        | 556.7           | 255.9        | 797.2          | 298.9        |
| East Nusa Tenggara      | 24.3                             | 621.1               | 312.6        | 733.8           | 337.3        | 1,050.8        | 394.0        |
| West Kalimantan         | 19.2                             | 490.3               | 246.7        | 579.2           | 266.3        | 829.5          | 311.0        |
| Central Kalimantan      | 51.5                             | 1,315.8             | 662.2        | 1,554.5         | 714.6        | 2,226.3        | 834.6        |
| South Kalimantan        | 18.5                             | 473.0               | 238.1        | 558.9           | 256.9        | 800.4          | 300.1        |
| East Kalimantan         | 16.5                             | 421.4               | 212.1        | 497.8           | 228.8        | 712.9          | 267.3        |
| North Sulawesi          | 15.3                             | 391.2               | 196.9        | 462.1           | 212.4        | 661.8          | 248.1        |
| Central Sulawesi        | 14.6                             | 374.2               | 188.3        | 442.1           | 203.2        | 633.1          | 237.4        |
| South Sulawesi          | 8.1                              | 207.8               | 104.6        | 245.5           | 112.9        | 351.6          | 131.8        |
| Southeast Sulawesi      | 10.1                             | 258.2               | 129.9        | 305.0           | 140.2        | 436.8          | 163.8        |
| Gorontalo               | 13.6                             | 348.1               | 175.2        | 411.2           | 189.0        | 588.9          | 220.8        |
| West Sulawesi           | 7.6                              | 193.9               | 97.6         | 229.1           | 105.3        | 328.1          | 123.0        |
| Maluku                  | 8.1                              | 205.8               | 103.6        | 243.1           | 111.8        | 348.2          | 130.5        |
| North Maluku            | 6.5                              | 165.2               | 83.1         | 195.2           | 89.7         | 279.5          | 104.8        |
| West Papua              | 18.6                             | 476.7               | 239.9        | 563.2           | 258.9        | 806.6          | 302.4        |
| Papua                   | 51.5                             | 1,316.7             | 662.6        | 1,555.6         | 715.0        | 2,227.7        | 835.2        |
| <b>National average</b> | <b>24.5</b>                      | <b>626.6</b>        | <b>315.3</b> | <b>740.2</b>    | <b>340.3</b> | <b>1,060.1</b> | <b>397.4</b> |

Source: Authors' estimates

**Table C7. Main rivers in Indonesia**

| Province           | River            | River basin area (km <sup>2</sup> ) | Flow (m <sup>3</sup> /second) |         |
|--------------------|------------------|-------------------------------------|-------------------------------|---------|
|                    |                  |                                     | Maximum                       | Minimum |
| North Sumatra      | Asahan           | 4,669                               | 481                           | 15      |
|                    | Gambus           | 1,013                               | 299                           | 30      |
| West Sumatra       | Batang Hari      | 4,952                               | 4,800                         | 35      |
|                    | Batang Kuantan   | 2,215                               | 808                           | 3       |
|                    | Batang Pasaman   | 1,395                               | 1,446                         | 27      |
| Lampung            | W. Tulang Bawang | 3,427                               | 862                           | 5       |
|                    | W. Sekampung     | 1,696                               | 1,276                         | 3       |
|                    | W Seputih        | 1,648                               | 302                           | 0       |
|                    | Kali Pemali      | 1,111                               | 701                           | -       |
| Yogyakarta         | Kali Progo       | 3,388                               | 2,500                         | 0       |
| East Java          | Bengawan Solo    | 62,986                              | 13,497                        | 14      |
|                    | Kali Brantas     | 70,167                              | 34,507                        | 72      |
| Banten             | Ciujung          | 4,549                               | 4,183                         | 20      |
|                    | Cisadane         | 1,146                               | 350                           | -       |
| West Nusa Tenggara | Parado           |                                     | 1,499                         | 441     |
|                    | Tiu Kulit        |                                     | 1,047                         | 308     |
| East Nusa Tenggara | Babak            |                                     | 587                           | 274     |
|                    | Meninting        |                                     | 440                           | 169     |
| Central Kalimantan | Barito           | 32,067                              | 5,663                         | 63      |
|                    | Kahayan          | 14,175                              | 2,267                         | 101     |
|                    | Katingan         | 11,929                              | 3,902                         | 51      |
| Central Sulawesi   | Tambalako        | 1,353                               | 976                           | 1       |
|                    | Buol             | 1,413                               | 421                           | 31      |
| South Sulawesi     | Cenranae         | 11,866                              | 6,963                         | 30      |

Table C8. Main lakes in Indonesia

| Province           | Lake       | Surface area km <sup>2</sup> | Volume m <sup>3</sup> |
|--------------------|------------|------------------------------|-----------------------|
| NAD                | Lhok Gajah | 10                           | 400,000               |
|                    | Paya Sikam | 77                           | 1,170,000             |
| North Sumatra      | Aek Natona | 9                            | 800,000               |
|                    | Hasang     | 3                            | 350,000               |
| West Sumatra       | Telaga Bir | 5                            | 850,000               |
|                    | Telaga Kay | 2                            | 600,000               |
| R i a u            | Guntung    | 2                            | 50,000                |
|                    | Sekanak    | 7                            | 171,000               |
| South Sumatra      | Kolong Kac | 100                          | 3,000,000             |
|                    | Air Siku   | 200                          | 12,000,000            |
| Lampung            | Way Tengko | 3                            | 470,000               |
|                    | Way Sido M | 2                            | 490,000               |
|                    | Way Batu L | 5                            | 640,817               |
| West Java          | Tonjong    | 1                            | 730,000               |
| Central Java       | Wonosari   | 2                            | 50,000                |
|                    | Sumber Agu | 1                            | 75,000                |
| Yogyakarta         | Mejing     | 3                            | 51,000                |
|                    | Kalen      | 1                            | 24,000                |
| North Sulawesi     | Karuyan    | 2                            | 50,000                |
|                    | Sidodadi   | 3                            | 50,000                |
| South Sulawesi     | Tonjong    | 1                            | 730,000               |
|                    | Palaguna   | 86                           | 1,300,000             |
|                    | Sabulakoa  | 32                           | 356,400               |
| Southeast Sulawesi | Lakara     | 34                           | 181,300               |

**Table C9. Proportion of untreated sewage discharged to water bodies<sup>1</sup>**

| Province         | Location | % sewage discharged directly into water body | % open defecation in water courses | Septic tanks not managed properly |                   | Leaking pit latrine |                   | Total |
|------------------|----------|--|------------------------------------|-----------------------------------|-------------------|---------------------|-------------------|-------|
|                  |          |  |                                    | Total %                           | % to ground water | Total %             | % to ground water |       |
| NAD              | Rural    | 31.49  | 11.79                              | 12.40                             | 6.20              | 15.54               | 7.77              | 57.25 |
|                  | Urban    | 22.91  | 3.95                               | 34.27                             | 17.14             | 9.41                | 4.71              | 48.69 |
|                  | Total    | 29.63  | 10.09                              | 17.14                             | 8.57              | 14.21               | 7.10              | 55.39 |
| North Sumatra    | Rural    | 24.68  | 11.16                              | 14.26                             | 7.13              | 18.93               | 9.47              | 52.43 |
|                  | Urban    | 23.71  | 3.19                               | 35.75                             | 17.88             | 9.32                | 4.66              | 49.43 |
|                  | Total    | 24.26  | 7.69                               | 23.62                             | 11.81             | 14.75               | 7.37              | 51.13 |
| West Sumatra     | Rural    | 41.73  | 14.74                              | 9.86                              | 4.93              | 8.67                | 4.33              | 65.73 |
|                  | Urban    | 26.74  | 6.51                               | 31.87                             | 15.94             | 7.18                | 3.59              | 52.77 |
|                  | Total    | 37.08  | 12.19                              | 16.69                             | 8.34              | 8.20                | 4.10              | 61.72 |
| Riau             | Rural    | 16.96  | 7.47                               | 0.54                              | 0.27              | 35.52               | 17.76             | 42.46 |
|                  | Urban    | 21.77  | 0.96                               | 35.47                             | 17.74             | 11.67               | 5.83              | 46.29 |
|                  | Total    | 19.36  | 4.22                               | 18.01                             | 9.00              | 23.59               | 11.80             | 44.38 |
| Jambi            | Rural    | 43.84  | 5.25                               | 9.76                              | 4.88              | 16.62               | 8.31              | 62.27 |
|                  | Urban    | 28.93  | 2.92                               | 32.72                             | 16.36             | 8.63                | 4.32              | 52.52 |
|                  | Total    | 39.80  | 4.61                               | 15.98                             | 7.99              | 14.46               | 7.23              | 59.63 |
| South Sumatra    | Rural    | 37.75  | 4.59                               | 9.01                              | 4.51              | 20.66               | 10.33             | 57.17 |
|                  | Urban    | 23.55  | 1.92                               | 32.46                             | 16.23             | 12.30               | 6.15              | 47.85 |
|                  | Total    | 33.16  | 3.72                               | 16.59                             | 8.30              | 17.96               | 8.98              | 54.15 |
| Bengkulu         | Rural    | 29.58  | 8.69                               | 8.20                              | 4.10              | 22.00               | 11.00             | 53.36 |
|                  | Urban    | 16.56  | 7.68                               | 28.08                             | 14.04             | 16.15               | 8.07              | 46.35 |
|                  | Total    | 26.07  | 8.42                               | 13.56                             | 6.78              | 20.42               | 10.21             | 51.48 |
| Lampung          | Rural    | 15.14  | 4.09                               | 10.29                             | 5.14              | 31.18               | 15.59             | 39.96 |
|                  | Urban    | 22.75  | 3.32                               | 28.30                             | 14.15             | 15.03               | 7.52              | 47.73 |
|                  | Total    | 16.73  | 3.92                               | 14.05                             | 7.02              | 27.81               | 13.90             | 41.58 |
| Bangka Belitung  | Rural    | 12.59  | 25.02                              | 18.57                             | 9.29              | 8.71                | 4.36              | 51.24 |
|                  | Urban    | 19.14  | 7.21                               | 32.72                             | 16.36             | 10.36               | 5.18              | 47.89 |
|                  | Total    | 15.24  | 17.80                              | 24.31                             | 12.15             | 9.38                | 4.69              | 49.88 |
| Riau Archipelago | Rural    | 46.37  | 13.47                              | 8.12                              | 4.06              | 9.06                | 4.53              | 68.43 |
|                  | Urban    | 23.92  | 1.98                               | 26.89                             | 13.45             | 16.15               | 8.07              | 47.41 |
|                  | Total    | 28.32  | 4.23                               | 23.22                             | 11.61             | 14.76               | 7.38              | 51.53 |
| Jakarta          | Total    | 4.14   | 2.08                               | 41.15                             | 41.15             | 5.75                | 5.75              | 53.11 |
| West Java        | Rural    | 34.63  | 15.38                              | 28.05                             | 14.03             | 11.17               | 5.58              | 69.61 |
|                  | Urban    | 34.90  | 4.61                               | 28.32                             | 14.16             | 7.39                | 3.69              | 57.36 |
|                  | Total    | 31.32  | 9.90                               | 21.30                             | 10.65             | 9.24                | 4.62              | 56.49 |



| Province           | Location | % sewage discharged directly into water body | % open defecation in water courses | Septic tanks not managed properly |                   | Leaking pit latrine |                   | Total |
|--------------------|----------|--|------------------------------------|-----------------------------------|-------------------|---------------------|-------------------|-------|
|                    |          |  |                                    | Total %                           | % to ground water | Total %             | % to ground water |       |
| Central Java       | Rural    | 30.52  | 6.62                               | 15.09                             | 7.55              | 17.51               | 8.76              | 53.44 |
|                    | Urban    | 34.03  | 2.81                               | 30.95                             | 15.47             | 7.35                | 3.68              | 55.99 |
|                    | Total    | 31.95  | 5.06                               | 21.55                             | 10.78             | 13.37               | 6.69              | 54.47 |
| Yogyakarta         | Rural    | 12.41  | 2.62                               | 16.14                             | 8.07              | 29.86               | 14.93             | 38.02 |
|                    | Urban    | 25.50  | 3.32                               | 39.73                             | 19.87             | 5.10                | 2.55              | 51.23 |
|                    | Total    | 20.21  | 3.05                               | 30.19                             | 15.10             | 15.11               | 7.56              | 45.90 |
| East Java          | Rural    | 30.03  | 5.61                               | 11.35                             | 5.67              | 21.49               | 10.74             | 52.05 |
|                    | Urban    | 29.51  | 1.59                               | 28.41                             | 14.20             | 12.67               | 6.34              | 51.64 |
|                    | Total    | 29.82  | 3.95                               | 18.40                             | 9.20              | 17.84               | 8.92              | 51.89 |
| Banten             | Rural    | 21.35  | 20.85                              | 11.36                             | 5.68              | 11.18               | 5.59              | 53.47 |
|                    | Urban    | 19.39  | 4.76                               | 32.92                             | 16.46             | 11.09               | 5.55              | 46.15 |
|                    | Total    | 20.25  | 11.88                              | 23.38                             | 11.69             | 11.13               | 5.57              | 49.38 |
| B a l i            | Rural    | 20.15  | 14.11                              | 24.31                             | 12.16             | 9.48                | 4.74              | 51.14 |
|                    | Urban    | 23.04  | 2.94                               | 38.46                             | 19.23             | 7.18                | 3.59              | 48.80 |
|                    | Total    | 21.69  | 8.13                               | 31.89                             | 15.94             | 8.25                | 4.12              | 49.88 |
| West Nusa Tenggara | Rural    | 33.01  | 18.44                              | 8.55                              | 4.28              | 10.47               | 5.24              | 60.96 |
|                    | Urban    | 36.62  | 6.44                               | 15.60                             | 7.80              | 14.72               | 7.36              | 58.21 |
|                    | Total    | 34.31  | 14.10                              | 11.10                             | 5.55              | 12.01               | 6.01              | 59.96 |
| East Nusa Tenggara | Rural    | 3.02   | 23.06                              | 3.89                              | 1.94              | 28.31               | 14.15             | 42.17 |
|                    | Urban    | 9.60   | 3.46                               | 17.15                             | 8.57              | 29.39               | 14.69             | 36.33 |
|                    | Total    | 4.05   | 19.99                              | 5.96                              | 2.98              | 28.47               | 14.24             | 41.25 |
| West Kalimantan    | Rural    | 31.39  | 12.61                              | 7.64                              | 3.82              | 18.40               | 9.20              | 57.01 |
|                    | Urban    | 22.40  | 3.81                               | 32.38                             | 16.19             | 11.61               | 5.80              | 48.20 |
|                    | Total    | 29.02  | 10.29                              | 14.16                             | 7.08              | 16.61               | 8.31              | 54.69 |
| Central Kalimantan | Rural    | 57.91  | 2.42                               | 4.18                              | 2.09              | 16.05               | 8.03              | 70.44 |
|                    | Urban    | 28.97  | 1.15                               | 21.64                             | 10.82             | 18.28               | 9.14              | 50.07 |
|                    | Total    | 49.41  | 2.04                               | 9.31                              | 4.65              | 16.71               | 8.35              | 64.46 |
| South Kalimantan   | Rural    | 41.99  | 2.70                               | 8.30                              | 4.15              | 20.49               | 10.25             | 59.08 |
|                    | Urban    | 27.10  | 1.42                               | 21.07                             | 10.54             | 19.63               | 9.82              | 48.86 |
|                    | Total    | 36.45  | 2.22                               | 13.05                             | 6.53              | 20.17               | 10.09             | 55.27 |
| East Kalimantan    | Rural    | 28.66  | 4.50                               | 12.94                             | 6.47              | 22.47               | 11.24             | 50.86 |
|                    | Urban    | 25.40  | 1.01                               | 30.83                             | 15.41             | 13.25               | 6.63              | 48.45 |
|                    | Total    | 26.89  | 2.60                               | 22.67                             | 11.34             | 17.46               | 8.73              | 49.54 |

| Province               | Location     | % sewage discharged directly into water body | % open defecation in water courses | Septic tanks not managed properly |                   | Leaking pit latrine |                   | Total        |
|------------------------|--------------|--|------------------------------------|-----------------------------------|-------------------|---------------------|-------------------|--------------|
|                        |              |  |                                    | Total %                           | % to ground water | Total %             | % to ground water |              |
| North Sulawesi         | Rural        | 24.38  | 5.58                               | 20.84                             | 10.42             | 18.12               | 9.06              | 49.44        |
|                        | Urban        | 15.43  | 2.81                               | 27.02                             | 13.51             | 20.06               | 10.03             | 41.77        |
|                        | Total        | 20.97  | 4.53                               | 23.20                             | 11.60             | 18.86               | 9.43              | 46.52        |
| Central Sulawesi       | Rural        | 29.77  | 17.71                              | 11.75                             | 5.87              | 12.52               | 6.26              | 59.61        |
|                        | Urban        | 24.13  | 3.09                               | 33.70                             | 16.85             | 10.42               | 5.21              | 49.28        |
|                        | Total        | 28.64  | 14.78                              | 16.16                             | 8.08              | 12.10               | 6.05              | 57.54        |
| South Sulawesi         | Rural        | 17.10  | 15.27                              | 14.95                             | 7.47              | 16.00               | 8.00              | 47.84        |
|                        | Urban        | 22.72  | 3.58                               | 35.58                             | 17.79             | 8.92                | 4.46              | 48.54        |
|                        | Total        | 18.89  | 11.56                              | 21.51                             | 10.75             | 13.75               | 6.87              | 48.07        |
| Southeast Sulawesi     | Rural        | 14.20  | 16.26                              | 11.24                             | 5.62              | 20.05               | 10.02             | 46.10        |
|                        | Urban        | 20.76  | 3.59                               | 31.08                             | 15.54             | 13.11               | 6.56              | 46.44        |
|                        | Total        | 15.64  | 13.49                              | 15.59                             | 7.80              | 18.53               | 9.26              | 46.18        |
| Gorontalo              | Rural        | 24.81  | 22.03                              | 8.41                              | 4.21              | 12.38               | 6.19              | 57.23        |
|                        | Urban        | 18.77  | 7.20                               | 22.22                             | 11.11             | 17.94               | 8.97              | 46.04        |
|                        | Total        | 23.18  | 18.03                              | 12.14                             | 6.07              | 13.88               | 6.94              | 54.21        |
| West Sulawesi          | Rural        | 28.39  | 17.52                              | 8.23                              | 4.11              | 13.69               | 6.84              | 56.87        |
|                        | Urban        | 24.73  | 8.91                               | 21.20                             | 10.60             | 13.19               | 6.60              | 50.83        |
|                        | Total        | 27.85  | 16.25                              | 10.13                             | 5.07              | 13.61               | 6.81              | 55.96        |
| Maluku                 | Rural        | 20.14  | 24.68                              | 7.85                              | 3.93              | 12.04               | 6.02              | 54.75        |
|                        | Urban        | 22.79  | 5.65                               | 31.58                             | 15.79             | 9.51                | 4.76              | 48.98        |
|                        | Total        | 20.90  | 19.21                              | 14.67                             | 7.34              | 11.31               | 5.66              | 53.09        |
| North Maluku           | Rural        | 17.78  | 21.72                              | 14.66                             | 7.33              | 10.09               | 5.04              | 51.87        |
|                        | Urban        | 18.34  | 7.25                               | 34.75                             | 17.37             | 7.91                | 3.96              | 46.92        |
|                        | Total        | 17.92  | 18.15                              | 19.62                             | 9.81              | 9.55                | 4.78              | 50.65        |
| West Papua             | Rural        | 32.74  | 18.87                              | 8.45                              | 4.22              | 10.06               | 5.03              | 60.86        |
|                        | Urban        | 25.32  | 7.58                               | 33.02                             | 16.51             | 5.61                | 2.81              | 52.21        |
|                        | Total        | 30.12  | 14.95                              | 16.88                             | 8.44              | 8.62                | 4.31              | 57.81        |
| Papua                  | Rural        | 12.89  | 31.85                              | 5.37                              | 2.69              | 16.82               | 8.41              | 55.82        |
|                        | Urban        | 17.49  | 4.40                               | 28.47                             | 14.23             | 15.96               | 7.98              | 44.10        |
|                        | Total        | 13.96  | 25.47                              | 10.74                             | 5.37              | 16.62               | 8.31              | 53.10        |
| <b>Indonesia Total</b> | <b>Rural</b> | <b>27.57</b>                                 | <b>10.67</b>                       | <b>12.19</b>                      | <b>6.09</b>       | <b>17.80</b>        | <b>8.90</b>       | <b>53.23</b> |
|                        | <b>Urban</b> | <b>28.58</b>                                 | <b>3.12</b>                        | <b>31.15</b>                      | <b>15.57</b>      | <b>9.75</b>         | <b>4.87</b>       | <b>52.15</b> |
|                        | <b>Total</b> | <b>27.99</b>                                 | <b>7.43</b>                        | <b>20.34</b>                      | <b>10.17</b>      | <b>14.34</b>        | <b>7.17</b>       | <b>52.75</b> |

Source: Authors' estimates. <sup>1</sup> All figures presented as % of entire rural, urban or total population

Table C10. Total release of domestic polluting substances to water bodies

| Province               | Total release per day |                         |                                | Polluting substances (tons per year) |                |               |                  |                                    |
|------------------------|-----------------------|-------------------------|--------------------------------|--------------------------------------|----------------|---------------|------------------|------------------------------------|
|                        | Feces ('000 kg)       | Urine (m <sup>3</sup> ) | Gray (million m <sup>3</sup> ) | BOD                                  | N              | P             | TSS              | Coliform count (10 <sup>15</sup> ) |
| NAD                    | 336.7                 | 3,367                   | 44.9                           | 40,964                               | 7,374          | 1,884         | 55,711           | 90,763                             |
| North Sumatra          | 967.8                 | 9,678                   | 129.0                          | 117,745                              | 21,194         | 5,416         | 160,133          | 240,818                            |
| West Sumatra           | 429.0                 | 4,290                   | 57.2                           | 52,195                               | 9,395          | 2,401         | 70,985           | 128,857                            |
| R i a u                | 317.1                 | 3,171                   | 42.3                           | 38,586                               | 6,946          | 1,775         | 52,478           | 68,496                             |
| J a m b i              | 240.1                 | 2,401                   | 32.0                           | 29,212                               | 5,258          | 1,344         | 39,729           | 69,680                             |
| South Sumatra          | 560.7                 | 5,606                   | 74.8                           | 68,212                               | 12,278         | 3,138         | 92,769           | 147,745                            |
| Bengkulu               | 121.1                 | 1,211                   | 16.2                           | 14,738                               | 2,653          | 678           | 20,044           | 30,350                             |
| Lampung                | 449.9                 | 4,499                   | 60.0                           | 54,742                               | 9,854          | 2,518         | 74,449           | 91,048                             |
| Bangka Belitung        | 80.5                  | 805                     | 10.7                           | 9,789                                | 1,762          | 450           | 13,313           | 19,533                             |
| Riau Archipelago       | 103.5                 | 1,035                   | 13.8                           | 12,588                               | 2,266          | 579           | 17,119           | 25,949                             |
| Jakarta                | 714.3                 | 7,143                   | 95.2                           | 86,910                               | 15,644         | 3,998         | 118,198          | 184,646                            |
| West Java              | 3359.5                | 33,595                  | 447.9                          | 408,741                              | 73,573         | 18,802        | 555,888          | 923,661                            |
| Central Java           | 2625.1                | 26,251                  | 350.0                          | 319,382                              | 57,489         | 14,692        | 434,360          | 695,859                            |
| Yogyakarta             | 233.4                 | 2,334                   | 31.1                           | 28,398                               | 5,112          | 1,306         | 38,622           | 52,143                             |
| East Java              | 2849.0                | 28,490                  | 379.9                          | 346,627                              | 62,393         | 15,945        | 471,412          | 719,443                            |
| Banten                 | 683.5                 | 6,835                   | 91.1                           | 83,156                               | 14,968         | 3,825         | 113,093          | 164,263                            |
| B a l i                | 256.9                 | 2,569                   | 34.2                           | 31,252                               | 5,625          | 1,438         | 42,503           | 62,362                             |
| West Nusa Tenggara     | 379.6                 | 3,796                   | 50.6                           | 46,183                               | 8,313          | 2,124         | 62,808           | 110,773                            |
| East Nusa Tenggara     | 269.6                 | 2,696                   | 35.9                           | 32,800                               | 5,904          | 1,509         | 44,608           | 54,124                             |
| West Kalimantan        | 333.0                 | 3,330                   | 44.4                           | 40,519                               | 7,293          | 1,864         | 55,106           | 88,646                             |
| Central Kalimantan     | 186.3                 | 1,863                   | 24.8                           | 22,668                               | 4,080          | 1,043         | 30,828           | 58,449                             |
| South Kalimantan       | 277.5                 | 2,775                   | 37.0                           | 33,764                               | 6,077          | 1,553         | 45,918           | 74,650                             |
| East Kalimantan        | 218.3                 | 2,183                   | 29.1                           | 26,561                               | 4,781          | 1,222         | 36,123           | 52,640                             |
| North Sulawesi         | 150.4                 | 1,504                   | 20.1                           | 18,299                               | 3,294          | 842           | 24,887           | 34,053                             |
| Central Sulawesi       | 200.2                 | 2,002                   | 26.7                           | 24,355                               | 4,384          | 1,120         | 33,123           | 56,057                             |
| South Sulawesi         | 546.7                 | 5,467                   | 72.9                           | 66,517                               | 11,973         | 3,060         | 90,463           | 127,915                            |
| Southeast Sulawesi     | 138.7                 | 1,387                   | 18.5                           | 16,877                               | 3,038          | 776           | 22,953           | 31,177                             |
| Gorontalo              | 76.6                  | 766                     | 10.2                           | 9,317                                | 1,677          | 429           | 12,672           | 20,204                             |
| West Sulawesi          | 82.2                  | 822                     | 11.0                           | 9,996                                | 1,799          | 460           | 13,594           | 22,376                             |
| Maluku                 | 101.3                 | 1,013                   | 13.5                           | 12,320                               | 2,218          | 567           | 16,755           | 26,165                             |
| North Maluku           | 68.3                  | 683                     | 9.1                            | 8,307                                | 1,495          | 382           | 11,297           | 16,831                             |
| West Papua             | 55.8                  | 558                     | 7.4                            | 6,784                                | 1,221          | 312           | 9,227            | 15,690                             |
| Papua                  | 152.6                 | 1,526                   | 20.3                           | 18,569                               | 3,342          | 854           | 25,254           | 39,446                             |
| <b>Indonesia Total</b> | <b>17565</b>          | <b>175,503</b>          | <b>2340.0</b>                  | <b>2,135,288</b>                     | <b>384,352</b> | <b>98,223</b> | <b>2,903,992</b> | <b>4,505,582</b>                   |

Source: Authors' estimates

**Table C11. Industrial pollution load in Jakarta, 2004**

| Industry sub-sector             | Volume of waste  |               | Polluting substances |               |            |               |                |               |
|---------------------------------|------------------|---------------|----------------------|---------------|------------|---------------|----------------|---------------|
|                                 |                  |               | BOD                  |               | N          |               | TSS            |               |
|                                 | m <sup>3</sup>   | %             | tons                 | %             | tons       | %             | tons           | %             |
| Agro industry                   | 20               | 0.0           | 2,776                | 0.3           | 121        | 61.1          | 3,072          | 0.3           |
| Food processing                 | 158,742          | 5.1           | 473,839              | 49.7          | 38         | 19.2          | 51,012         | 5.6           |
| Drinks                          | 320              | 0.0           | 142                  | 0.0           | 0          | 0.0           | 86             | 0.0           |
| Textile                         | 564,310          | 18.0          | 380,025              | 39.9          | 0          | 0.0           | 215,879        | 23.5          |
| Leather                         | 26               | 0.0           | 45                   | 0.0           | 8          | 4.0           | 69             | 0.0           |
| Wood processing                 | 439              | 0.0           | 64,200               | 6.7           | 26         | 13.1          | 118            | 0.0           |
| Basic chemicals                 | 12,533           | 0.4           | 22,038               | 2.3           | 5          | 2.5           | 12,650         | 1.4           |
| Non-metallic mineral processing | 2,065,500        | 65.7          | 0                    | 0.0           | 0          | 0.0           | 31,500         | 3.4           |
| Basic metals                    | 52,200           | 1.7           | 0                    | 0.0           | 0          | 0.0           | 1,543          | 0.2           |
| Metal processing                | 16,775           | 0.5           | 5,887                | 0.6           | 0          | 0.0           | 2,532          | 0.3           |
| Electricity and gas             | 270,900          | 8.6           | 4,620                | 0.5           | 0          | 0.0           | 600,600        | 65.3          |
| <b>Total</b>                    | <b>3,141,765</b> | <b>100.00</b> | <b>953,572</b>       | <b>100.00</b> | <b>198</b> | <b>100.00</b> | <b>919,061</b> | <b>100.00</b> |

Source: Ministry of Environment. Status Lingkungan Hidup Indonesia 2005. Jakarta, 2006.

Table C12. Contribution of domestic sources to overall water pollution (% of BOD)

| Province               | Industry        |           | Agriculture     |          | Domestic        |           | Total           |            |
|------------------------|-----------------|-----------|-----------------|----------|-----------------|-----------|-----------------|------------|
|                        | BOD ('000 tons) | %         | BOD ('000 tons) | %        | BOD ('000 tons) | %         | BOD ('000 tons) | %          |
| NAD                    | 156             | 73        | 16              | 8        | 41              | 19        | 213             | 100        |
| North Sumatra          | 477             | 73        | 59              | 9        | 118             | 18        | 654             | 100        |
| West Sumatra           | 73              | 51        | 18              | 12       | 52              | 37        | 142             | 100        |
| R i a u                | 378             | 88        | 12              | 3        | 39              | 9         | 429             | 100        |
| J a m b i              | 36              | 49        | 9               | 11       | 29              | 39        | 74              | 100        |
| South Sumatra          | 218             | 70        | 26              | 8        | 68              | 22        | 312             | 100        |
| Bengkulu               | 6               | 24        | 3               | 15       | 15              | 62        | 24              | 100        |
| Lampung                | 72              | 47        | 26              | 17       | 55              | 36        | 152             | 100        |
| Bangka Belitung        | 43              | 80        | 1               | 2        | 10              | 18        | 54              | 100        |
| Riau Archipelago       | 358             | 94        | 12              | 3        | 13              | 3         | 382             | 100        |
| Jakarta                | 954             | 92        | 0               | 0        | 87              | 8         | 1,041           | 100        |
| West Java              | 2,077           | 75        | 276             | 10       | 409             | 15        | 2,762           | 100        |
| Central Java           | 1,006           | 72        | 67              | 5        | 319             | 23        | 1,393           | 100        |
| Yogyakarta             | 53              | 55        | 16              | 16       | 28              | 29        | 97              | 100        |
| East Java              | 1,608           | 76        | 149             | 7        | 347             | 16        | 2,103           | 100        |
| Banten                 | 589             | 86        | 12              | 2        | 83              | 12        | 684             | 100        |
| B a l i                | 42              | 51        | 8               | 10       | 31              | 38        | 82              | 100        |
| West Nusa Tenggara     | 12              | 18        | 9               | 13       | 46              | 69        | 67              | 100        |
| East Nusa Tenggara     | 4               | 8         | 8               | 19       | 33              | 73        | 45              | 100        |
| West Kalimantan        | 94              | 63        | 15              | 10       | 41              | 27        | 149             | 100        |
| Central Kalimantan     | 26              | 48        | 5               | 10       | 23              | 42        | 54              | 100        |
| South Kalimantan       | 63              | 54        | 21              | 17       | 34              | 29        | 118             | 100        |
| East Kalimantan        | 781             | 95        | 17              | 2        | 27              | 3         | 825             | 100        |
| North Sulawesi         | 23              | 53        | 3               | 6        | 18              | 41        | 44              | 100        |
| Central Sulawesi       | 18              | 39        | 3               | 8        | 24              | 54        | 46              | 100        |
| South Sulawesi         | 52              | 40        | 11              | 8        | 67              | 51        | 129             | 100        |
| Southeast Sulawesi     | 10              | 31        | 6               | 17       | 17              | 52        | 33              | 100        |
| Gorontalo              | 4               | 26        | 1               | 8        | 9               | 66        | 14              | 100        |
| West Sulawesi          | 52              | 72        | 11              | 15       | 10              | 14        | 73              | 100        |
| Maluku                 | 3               | 17        | 1               | 7        | 12              | 75        | 16              | 100        |
| North Maluku           | 6               | 38        | 1               | 5        | 8               | 57        | 15              | 100        |
| West Irian Jaya        | 20              | 73        | 1               | 2        | 7               | 25        | 27              | 100        |
| Papua                  | 10              | 35        | 1               | 2        | 19              | 63        | 29              | 100        |
| <b>Indonesia Total</b> | <b>9,321</b>    | <b>76</b> | <b>821</b>      | <b>7</b> | <b>2,137</b>    | <b>17</b> | <b>2,279</b>    | <b>100</b> |

Source: Authors' estimates

Table C13. Selected river quality indicators, 2003

| Province<br>River                      | Location        | Batch | pH  | DO (mg/l) | BOD (mg/l) | TSS (mg/l) | TDS (mg/l) | DO (2005) |
|--|-----------------|-------|-----|-----------|------------|------------|------------|-----------|
| <b>NAD</b><br>Krueng<br>Tamiang        | Up-<br>stream   | I     | 7.0 | 6.7       | 0.6        | -          | 250.0      | 6.2 - 9   |
|  |                 | II    | 7.2 | 7.0       | 0.7        | -          | 500.0      |           |
|  | Down-<br>stream | I     | 6.0 | 6.0       | 3.3        | -          | 580.0      |           |
|  |                 | II    | 6.5 | 6.6       | 2.5        | -          | 1700.0     |           |
| <b>North Sumatra</b><br>Deli           | Up-<br>stream   | I     | 8.7 | 5.7       | 3.2        | 36.0       | -          | 0.7 - 7.7 |
|  |                 | II    | 7.3 | 8.4       | 4.1        | 36.0       | -          |           |
|  | Down-<br>stream | I     | 6.6 | 2.4       | 6.5        | 20.0       | -          |           |
|  |                 | II    | 6.8 | 2.4       | 7.7        | 104.0      | -          |           |
| <b>West Sumatra</b><br>Batang Agam     |                 |       |     |           |            |            | 5.2 - 7    |           |
| <b>Riau</b><br>Kampar                  |                 |       |     |           |            |            |            | 1.2 - 7.8 |
| <b>Jambi</b> Batang<br>Hari            | Up-<br>stream   | I     | 7.5 | 5.7       | 4.0        | 206.0      | 59.0       | 3 - 6.5   |
|  |                 | II    | 6.9 | 5.9       | 1.0        | 72.0       | 76.0       |           |
|  | Down-<br>stream | I     | 5.8 | 5.3       | 1.4        | 4.0        | 74.0       |           |
|  |                 | II    | 6.0 | 5.7       | 4.0        | 76.0       | 104.0      |           |
| <b>South Sumatra</b><br>Musi           | Up-<br>stream   | I     | 6.1 | 3.2       | 8.0        | 24.0       | -          | 1.8 - 7.9 |
|  |                 | II    | 7.4 | 3.2       | 1.7        | 33.7       | -          |           |
|  | Down-<br>stream | I     | 6.0 | 4.2       | 8.7        | 25.0       | -          |           |
|  |                 | II    | 8.0 | 3.0       | 1.8        | 32.2       | -          |           |
| <b>Bengkulu</b><br>Air Bengkulu        | Up-<br>stream   | I     | 6.8 | 4.1       | 1.0        | 24.2       | 30.0       | 1.1 - 3.8 |
|  |                 | II    | 6.6 | 2.9       | 20.0       | 95.2       | 90.0       |           |
|  | Down-<br>stream | I     | -   | -         | -          | -          | -          |           |
|  |                 | II    | 6.0 | 3.8       | 3.4        | 156.0      | 20.0       |           |
| <b>Lampung</b><br>Way Sekampung        |                 |       |     |           |            |            |            | 1.9 - 4   |
| <b>Bangka-<br/>Belitung</b><br>Rangkui | Up-<br>stream   | I     | 5.9 | 1.6       | 12.0       | -          | 68.2       | 1.6 - 7.5 |
|  |                 | II    | 5.7 | 7.4       | 4.5        | -          | 87.4       |           |
|  | Down-<br>stream | I     | 6.8 | 2.1       | 6.0        | -          | 11.4       |           |
|  |                 | II    | 8.0 | 8.8       | 5.2        | -          | 15.7       |           |
| <b>Jakarta</b><br>Ciliwung             | Up-<br>stream   | I     | 7.6 | 2.7       | 0.8        | 7.0        | -          | 0 - 5.8   |
|  |                 | II    | 7.5 | 4.1       | 5.1        | 10.0       | -          |           |
|  | Down-<br>stream | I     | 7.0 | 0.4       | 20.8       | 30.0       | -          |           |
|  |                 | II    | 7.3 | 2.1       | 47.1       | 59.0       | -          |           |
| <b>West Java</b><br>Citarum            | Up-<br>stream   | I     | 9.5 | 0.8       | 34.0       | 98.0       | 667.0      | 0 - 5.9   |
|  |                 | II    | 7.2 | 3.9       | 8.2        | 800.0      | 170.0      |           |
|  | Down-<br>stream | I     | 7.4 | 3.1       | 12.0       | 75.0       | 310.0      |           |
|  |                 | II    | 7.1 | 2.6       | 17.2       | 3220.0     | 134.0      |           |

| Province<br>River                          | Location          | Batch | pH  | DO (mg/l) | BOD (mg/l) | TSS (mg/l) | TDS (mg/l) | DO (2005)            |
|--|-------------------|-------|-----|-----------|------------|------------|------------|----------------------|
| <b>Banten</b><br>Cisadane                  | Up-<br>stream     | I     | 8.0 | 7.0       | 3.4        | 38.0       | -          | 5.1 - 6.3            |
|  |                   | II    | 8.0 | 7.6       | 2.7        | 47.0       | -          |                      |
|  | Down-<br>stream   | I     | 7.0 | 3.4       | 3.9        | 24.0       | -          |                      |
|  |                   | II    | 7.4 | 0.2       | 16.9       | 14.0       | -          |                      |
| <b>Central Java</b><br>Yogyakarta<br>Progo | Up-<br>stream     | I     | 7.5 | 7.7       | 2.8        | 28.0       | 180.0      | 6.3-8.0 <sup>a</sup> |
|  |                   | II    | 7.4 | 7.7       | 1.1        | 18.0       | 212.0      | 4.9-6.5 <sup>b</sup> |
|  | Down-<br>stream   | I     | 8.1 | 6.8       | 6.8        | -          | 126.0      |                      |
|  |                   | II    | 8.2 | 7.3       | 7.8        | -          | 171.0      |                      |
| <b>East Java</b><br>Brantas                | Up-<br>stream     | I     | 7.7 | -         | 110.0      | 28.0       | -          | 0 - 8.3              |
|  |                   | II    | 7.0 | -         | 268.0      | 98.0       | -          |                      |
|  | Down-<br>stream   | I     | 3.5 | -         | 139.0      | 98.0       | -          |                      |
|  |                   | II    | 7.2 | -         | 177.0      | 20.0       | -          |                      |
| <b>Bali</b><br>Tukad Badung                | Up-<br>stream     | I     | 7.4 | 5.1       | 1.9        | 10.0       | -          | 2.8 - 5              |
|  |                   | II    | 7.0 | 6.8       | 1.9        | 16.0       | -          |                      |
|  | Down-<br>stream   | I     | 6.9 | 7.1       | 4.6        | 20.0       | -          |                      |
|  |                   | II    | 7.0 | 6.9       | 2.5        | 21.0       | -          |                      |
| <b>West Nusa Tenggara</b>                  | Jangkok           |       |     |           |            |            |            | 4 - 7.4              |
| <b>East Nusa Tenggara</b>                  | Kali Dendeng      |       |     |           |            |            |            | 1.1 - 3.5            |
| <b>West Kalimantan</b>                     | Kapuas            |       |     |           |            |            |            | 2.5 - 5              |
| <b>Central Kalimantan</b>                  | Kahayan           |       |     |           |            |            |            | 5.1 - 6              |
| <b>East Kalimantan</b>                     | Mahakam           |       |     |           |            |            |            | 3.1 - 5.7            |
| <b>North Sulawesi</b>                      | Tondano           |       |     |           |            |            |            | 6.7 - 9              |
| <b>Central Sulawesi</b>                    | Palu              |       |     |           |            |            |            | 3 - 7.8              |
| <b>South Sulawesi</b>                      | Jeneberang, Tallo |       |     |           |            |            |            | 4 - 9                |
| <b>Southeast Sulawesi</b><br>Konawehea     | Up-<br>stream     | I     | 6.0 | 5.0       | 3.5        | 2.8        | 60.0       | 1.1 - 9              |
|  |                   | II    | 7.5 | 5.0       | 3.1        | 2.8        | 50.0       |                      |
|  | Down-<br>stream   | I     | 7.4 | 6.0       | 4.0        | 10.5       | 136.0      |                      |
|  |                   | II    | 7.4 | 6.2       | 4.0        | 10.5       | 136.0      |                      |
| <b>Gorontalo</b><br>Bone                   | Up-<br>stream     | I     | 7.1 | 7.4       | 2.0        | 1.7        | 34.5       | 5.3 - 7.8            |
|  |                   | II    | -   | -         | -          | -          | -          |                      |
|  | Down-<br>stream   | I     | 7.2 | 6.9       | 4.2        | 3.4        | 27.2       |                      |
|  |                   | II    | -   | -         | -          | -          | -          |                      |
| <b>North Maluku</b>                        | Tabobo            |       |     |           |            |            |            | 4.8 - 5.4            |
| <b>Papua</b>                               | Anafre            |       |     |           |            |            |            | 3.3 - 7              |

Source: Status of the Environment 2003 and 2005.

Table C14. Main sources of household drinking water

| Province         | Location | Pack-aged water | Piped from plant | Ground water | Well      |             | Spring    |             | River | Rain water | Others | Total |
|------------------|----------|-----------------|------------------|--------------|-----------|-------------|-----------|-------------|-------|------------|--------|-------|
|                  |          |                 |                  |              | Protected | Unprotected | Protected | Unprotected |       |            |        |       |
| NAD              | Rural    | 1.33            | 6.14             | 2.45         | 44.92     | 27.03       | 5.23      | 3.74        | 6.98  | 1.77       | 0.41   | 100   |
|                  | Urban    | 15.60           | 28.27            | 5.78         | 37.15     | 7.22        | 2.67      | 0.65        | 0.39  | 1.04       | 1.22   | 100   |
|                  | Total    | 4.42            | 10.93            | 3.17         | 43.24     | 22.74       | 4.68      | 3.07        | 5.55  | 1.61       | 0.58   | 100   |
| North Sumatra    | Rural    | 0.67            | 8.89             | 11.54        | 31.30     | 17.21       | 10.83     | 9.98        | 5.38  | 3.53       | 0.67   | 100   |
|                  | Urban    | 4.07            | 47.93            | 9.14         | 29.62     | 4.93        | 2.56      | 0.52        | 0.53  | 0.60       | 0.10   | 100   |
|                  | Total    | 2.15            | 25.89            | 10.49        | 30.57     | 11.87       | 7.23      | 5.86        | 3.27  | 2.25       | 0.42   | 100   |
| West Sumatra     | Rural    | 0.51            | 13.74            | 1.76         | 31.32     | 19.05       | 10.83     | 13.82       | 5.14  | 3.63       | 0.21   | 100   |
|                  | Urban    | 4.68            | 43.77            | 6.23         | 32.61     | 5.81        | 4.12      | 2.04        | 0.05  | 0.49       | 0.20   | 100   |
|                  | Total    | 1.80            | 23.05            | 3.14         | 31.72     | 14.95       | 8.75      | 10.17       | 3.56  | 2.65       | 0.21   | 100   |
| Riau             | Rural    | 0.91            | 2.04             | 0.99         | 33.44     | 25.13       | 0.50      | 1.30        | 3.25  | 32.38      | 0.07   | 100   |
|                  | Urban    | 13.24           | 3.83             | 6.81         | 41.32     | 9.78        | 4.89      | 0.35        | 0.35  | 19.29      | 0.14   | 100   |
|                  | Total    | 5.19            | 2.66             | 3.01         | 36.17     | 19.80       | 2.03      | 0.97        | 2.24  | 27.84      | 0.09   | 100   |
| Jambi            | Rural    | 1.16            | 9.57             | 0.92         | 33.40     | 24.09       | 1.87      | 2.04        | 15.14 | 11.74      | 0.07   | 100   |
|                  | Urban    | 4.40            | 36.09            | 1.90         | 29.87     | 8.62        | 0.29      | 0.19        | 1.74  | 16.71      | 0.19   | 100   |
|                  | Total    | 2.03            | 16.76            | 1.19         | 32.44     | 19.90       | 1.44      | 1.54        | 11.51 | 13.09      | 0.11   | 100   |
| South Sumatra    | Rural    | 0.89            | 5.27             | 1.17         | 43.70     | 20.73       | 2.45      | 2.16        | 13.45 | 9.61       | 0.57   | 100   |
|                  | Urban    | 5.12            | 47.81            | 0.74         | 30.40     | 8.59        | 0.80      | 0.21        | 5.00  | 1.02       | 0.32   | 100   |
|                  | Total    | 2.26            | 19.02            | 1.03         | 39.40     | 16.81       | 1.92      | 1.53        | 10.72 | 6.83       | 0.48   | 100   |
| Bengkulu         | Rural    | 0.80            | 7.58             | 1.13         | 35.84     | 37.79       | 6.00      | 6.15        | 4.48  | 0.05       | 0.18   | 100   |
|                  | Urban    | 2.79            | 27.64            | 7.21         | 48.86     | 11.92       | 0.63      | 0.87        | 0.04  | -          | 0.04   | 100   |
|                  | Total    | 1.34            | 13.00            | 2.77         | 39.36     | 30.80       | 4.55      | 4.72        | 3.28  | 0.04       | 0.14   | 100   |
| Lampung          | Rural    | 0.63            | 2.60             | 0.93         | 58.30     | 24.99       | 3.39      | 4.24        | 2.23  | 2.01       | 0.68   | 100   |
|                  | Urban    | 4.75            | 13.79            | 7.86         | 61.42     | 9.82        | 0.87      | 0.66        | 0.40  | -          | 0.44   | 100   |
|                  | Total    | 1.49            | 4.93             | 2.38         | 58.95     | 21.82       | 2.86      | 3.50        | 1.85  | 1.59       | 0.63   | 100   |
| Bangka Belitung  | Rural    | 1.59            | 2.16             | 2.98         | 49.84     | 36.38       | 1.05      | 3.25        | 2.58  | -          | 0.18   | 100   |
|                  | Urban    | 7.77            | 6.99             | 8.90         | 50.12     | 22.51       | 3.03      | 0.34        | -     | -          | 0.34   | 100   |
|                  | Total    | 4.09            | 4.12             | 5.38         | 49.96     | 30.76       | 1.85      | 2.07        | 1.53  | -          | 0.24   | 100   |
| Riau Archipelago | Rural    | 0.20            | 2.98             | 0.49         | 26.99     | 34.78       | 11.19     | 11.74       | 4.95  | 6.29       | 0.40   | 100   |
|                  | Urban    | 8.99            | 46.44            | 1.29         | 28.48     | 6.25        | 1.73      | 0.43        | 0.42  | 3.68       | 2.28   | 100   |
|                  | Total    | 7.27            | 37.93            | 1.13         | 28.19     | 11.84       | 3.59      | 2.64        | 1.31  | 4.19       | 1.92   | 100   |
| Jakarta          | Total    | 20.80           | 39.73            | 33.20        | 4.85      | 0.30        | 0.70      | -           | 0.04  | 0.16       | 0.22   | 100   |
|                  | Rural    | 1.33            | 7.44             | 16.51        | 35.57     | 10.90       | 17.01     | 10.12       | 1.04  | 0.06       | 0.02   | 100   |
| West Java        | Urban    | 7.29            | 17.95            | 31.58        | 33.61     | 4.65        | 3.53      | 0.97        | 0.06  | -          | 0.37   | 100   |
|                  | Total    | 4.37            | 12.79            | 24.18        | 34.57     | 7.72        | 10.15     | 5.46        | 0.54  | 0.03       | 0.20   | 100   |



| Province           | Location | Packaged water | Piped from plant | Ground water | Well      |             | Spring    |             | River | Rain water | Others | Total |
|--------------------|----------|----------------|------------------|--------------|-----------|-------------|-----------|-------------|-------|------------|--------|-------|
|                    |          |                |                  |              | Protected | Unprotected | Protected | Unprotected |       |            |        |       |
| Central Java       | Rural    | 0.49           | 8.54             | 8.55         | 44.72     | 10.83       | 18.48     | 6.86        | 0.90  | 0.51       | 0.13   | 100   |
|                    | Urban    | 3.27           | 28.74            | 13.65        | 42.84     | 6.34        | 4.06      | 0.38        | 0.40  |            | 0.32   | 100   |
|                    | Total    | 1.63           | 16.77            | 10.62        | 43.95     | 9.00        | 12.60     | 4.22        | 0.70  | 0.30       | 0.21   | 100   |
| Yogyakarta         | Rural    | 0.58           | 15.49            | 2.89         | 37.71     | 13.57       | 8.11      | 8.71        | 0.35  | 11.55      | 1.05   | 100   |
|                    | Urban    | 14.30          | 13.28            | 8.84         | 58.35     | 4.31        | 0.54      | 0.34        | -     | -          | 0.05   | 100   |
|                    | Total    | 8.75           | 14.17            | 6.44         | 50.00     | 8.05        | 3.60      | 3.72        | 0.14  | 4.67       | 0.45   | 100   |
| East Java          | Rural    | 1.66           | 8.68             | 13.98        | 45.67     | 8.85        | 14.86     | 3.91        | 0.65  | 0.85       | 0.88   | 100   |
|                    | Urban    | 10.50          | 30.69            | 16.99        | 31.66     | 4.20        | 4.29      | 0.67        | 0.48  | 0.13       | 0.40   | 100   |
|                    | Total    | 5.32           | 17.78            | 15.23        | 39.88     | 6.92        | 10.49     | 2.57        | 0.58  | 0.56       | 0.68   | 100   |
| Banten             | Rural    | 1.56           | 4.44             | 16.27        | 39.28     | 17.02       | 7.54      | 6.14        | 5.93  | 0.77       | 1.04   | 100   |
|                    | Urban    | 12.43          | 19.64            | 46.98        | 14.56     | 2.85        | 2.54      | 0.25        | 0.10  | 0.35       | 0.29   | 100   |
|                    | Total    | 7.62           | 12.92            | 33.39        | 25.50     | 9.12        | 4.75      | 2.86        | 2.68  | 0.54       | 0.62   | 100   |
| Bali               | Rural    | 1.87           | 37.12            | 3.89         | 17.03     | 1.95        | 21.82     | 5.34        | 2.54  | 7.45       | 0.98   | 100   |
|                    | Urban    | 26.88          | 39.27            | 8.48         | 17.20     | 1.48        | 5.58      | 0.78        | 0.23  | 0.04       | 0.07   | 100   |
|                    | Total    | 15.27          | 38.27            | 6.35         | 17.12     | 1.70        | 13.12     | 2.90        | 1.30  | 3.48       | 0.49   | 100   |
| West Nusa Tenggara | Rural    | 2.06           | 13.17            | 8.33         | 44.80     | 13.25       | 12.94     | 3.14        | 2.26  | -          | 0.06   | 100   |
|                    | Urban    | 7.02           | 22.67            | 6.71         | 48.61     | 7.28        | 6.17      | 1.39        | -     | -          | 0.14   | 100   |
|                    | Total    | 3.86           | 16.61            | 7.75         | 46.18     | 11.09       | 10.49     | 2.50        | 1.44  | -          | 0.09   | 100   |
| East Nusa Tenggara | Rural    | 0.24           | 13.37            | 0.92         | 17.32     | 9.89        | 28.42     | 21.32       | 5.67  | 2.79       | 0.05   | 100   |
|                    | Urban    | 2.96           | 57.92            | 0.82         | 25.23     | 5.98        | 1.90      | 1.79        | 2.41  | 0.05       | 0.93   | 100   |
|                    | Total    | 0.67           | 20.33            | 0.90         | 18.56     | 9.28        | 24.28     | 18.27       | 5.16  | 2.36       | 0.19   | 100   |
| West Kalimantan    | Rural    | 0.41           | 7.16             | 1.46         | 6.77      | 12.68       | 5.21      | 3.62        | 30.51 | 32.13      | 0.04   | 100   |
|                    | Urban    | 8.05           | 15.16            | 0.19         | 9.16      | 4.20        | 2.19      | 0.40        | 4.37  | 56.04      | 0.25   | 100   |
|                    | Total    | 2.43           | 9.27             | 1.13         | 7.40      | 10.45       | 4.42      | 2.77        | 23.62 | 38.43      | 0.10   | 100   |
| Central Kalimantan | Rural    | 0.28           | 7.63             | 4.61         | 21.43     | 9.31        | 0.84      | 0.56        | 48.80 | 6.42       | 0.13   | 100   |
|                    | Urban    | 3.03           | 39.60            | 24.86        | 15.51     | 3.22        | 0.33      | 0.55        | 10.52 | 2.28       | 0.10   | 100   |
|                    | Total    | 1.09           | 17.01            | 10.55        | 19.69     | 7.52        | 0.69      | 0.56        | 37.56 | 5.20       | 0.12   | 100   |
| South Kalimantan   | Rural    | 0.44           | 15.35            | 16.45        | 16.73     | 18.15       | 0.79      | 1.54        | 26.49 | 3.70       | 0.37   | 100   |
|                    | Urban    | 5.54           | 67.42            | 3.01         | 16.14     | 4.13        | 0.02      | -           | 3.28  | -          | 0.46   | 100   |
|                    | Total    | 2.34           | 34.72            | 11.45        | 16.51     | 12.93       | 0.51      | 0.97        | 17.86 | 2.32       | 0.40   | 100   |
| East Kalimantan    | Rural    | 1.72           | 19.49            | 3.64         | 20.05     | 18.33       | 3.91      | 1.74        | 21.67 | 8.97       | 0.47   | 100   |
|                    | Urban    | 5.36           | 72.40            | 2.70         | 5.03      | 2.25        | 1.85      | 0.41        | 4.55  | 5.13       | 0.32   | 100   |
|                    | Total    | 3.70           | 48.29            | 3.13         | 11.88     | 9.58        | 2.79      | 1.01        | 12.35 | 6.88       | 0.39   | 100   |

| Province           | Location | Pack-<br>aged<br>water | Piped<br>from<br>plant | Ground<br>water | Well      |             | Spring    |             | River | Rain<br>water | Others | Total |
|--------------------|----------|------------------------|------------------------|-----------------|-----------|-------------|-----------|-------------|-------|---------------|--------|-------|
|                    |          |                        |                        |                 | Protected | Unprotected | Protected | Unprotected |       |               |        |       |
| North Sulawesi     | Rural    | 1.45                   | 22.57                  | 1.78            | 40.35     | 8.50        | 19.32     | 3.96        | 0.28  | 1.75          | 0.03   | 100   |
|                    | Urban    | 6.70                   | 38.70                  | 10.84           | 31.65     | 6.98        | 3.85      | 0.68        | 0.47  | -             | 0.13   | 100   |
|                    | Total    | 3.45                   | 28.72                  | 5.24            | 37.03     | 7.92        | 13.43     | 2.71        | 0.35  | 1.09          | 0.07   | 100   |
| Central Sulawesi   | Rural    | 0.50                   | 12.41                  | 10.02           | 29.91     | 15.00       | 18.83     | 4.14        | 7.69  | 1.41          | 0.11   | 100   |
|                    | Urban    | 11.64                  | 40.86                  | 28.01           | 8.80      | 0.40        | 9.18      | 0.41        | 0.18  | -             | 0.52   | 100   |
|                    | Total    | 2.73                   | 18.12                  | 13.63           | 25.67     | 12.07       | 16.89     | 3.39        | 6.18  | 1.13          | 0.19   | 100   |
| South Sulawesi     | Rural    | 0.42                   | 9.78                   | 11.78           | 36.87     | 19.61       | 11.60     | 6.66        | 2.31  | 0.86          | 0.13   | 100   |
|                    | Urban    | 4.19                   | 59.23                  | 7.19            | 20.98     | 5.03        | 1.53      | 0.75        | 0.97  | 0.03          | 0.08   | 100   |
|                    | Total    | 1.62                   | 25.50                  | 10.32           | 31.81     | 14.97       | 8.40      | 4.78        | 1.88  | 0.59          | 0.11   | 100   |
| Southeast Sulawesi | Rural    | 0.33                   | 19.49                  | 1.64            | 36.20     | 19.60       | 12.31     | 5.53        | 2.44  | 2.14          | 0.33   | 100   |
|                    | Urban    | 2.65                   | 58.74                  | 5.50            | 20.66     | 6.29        | 4.93      | 0.83        | 0.29  | 0.03          | 0.08   | 100   |
|                    | Total    | 0.84                   | 28.09                  | 2.49            | 32.79     | 16.68       | 10.69     | 4.50        | 1.97  | 1.68          | 0.27   | 100   |
| Gorontalo          | Rural    | 0.75                   | 9.33                   | 0.71            | 53.55     | 20.10       | 5.51      | 1.59        | 7.38  | 0.11          | 0.96   | 100   |
|                    | Urban    | 1.07                   | 34.12                  | 4.76            | 52.43     | 7.12        | 0.49      | -           | -     | -             | -      | 100   |
|                    | Total    | 0.84                   | 16.02                  | 1.81            | 53.25     | 16.60       | 4.15      | 1.16        | 5.39  | 0.08          | 0.70   | 100   |
| West Sulawesi      | Rural    | 0.37                   | 8.32                   | 2.95            | 30.90     | 17.02       | 11.75     | 15.67       | 10.87 | 1.70          | 0.45   | 100   |
|                    | Urban    | 3.37                   | 38.73                  | 9.70            | 34.90     | 5.95        | 5.70      | -           | 0.14  | -             | 1.51   | 100   |
|                    | Total    | 0.81                   | 12.80                  | 3.94            | 31.49     | 15.39       | 10.86     | 13.37       | 9.29  | 1.45          | 0.60   | 100   |
| Maluku             | Rural    | 0.05                   | 14.43                  | 1.14            | 39.42     | 13.93       | 23.12     | 5.75        | 1.60  | 0.42          | 0.13   | 100   |
|                    | Urban    | 1.89                   | 46.98                  | 4.74            | 25.03     | 6.46        | 6.86      | 0.36        | 1.43  | 4.85          | 1.39   | 100   |
|                    | Total    | 0.58                   | 23.79                  | 2.17            | 35.28     | 11.78       | 18.45     | 4.20        | 1.55  | 1.70          | 0.49   | 100   |
| North Maluku       | Rural    | 0.36                   | 9.02                   | 0.96            | 42.52     | 29.38       | 6.80      | 4.69        | 3.66  | 2.56          | 0.05   | 100   |
|                    | Urban    | 0.84                   | 63.65                  | 1.65            | 17.35     | 11.55       | 0.76      | -           | -     | 4.20          | -      | 100   |
|                    | Total    | 0.48                   | 22.50                  | 1.13            | 36.31     | 24.98       | 5.31      | 3.53        | 2.76  | 2.97          | 0.04   | 100   |
| West Papua         | Rural    | 0.44                   | 11.00                  | 1.09            | 10.84     | 10.40       | 7.96      | 27.13       | 18.67 | 12.30         | 0.17   | 100   |
|                    | Urban    | 13.27                  | 45.82                  | 2.44            | 11.33     | 14.26       | 2.05      | 1.86        | 1.60  | 7.38          | -      | 100   |
|                    | Total    | 4.89                   | 23.09                  | 1.56            | 11.01     | 11.74       | 5.91      | 18.36       | 12.75 | 10.59         | 0.11   | 100   |
| Papua              | Rural    | 1.80                   | 5.17                   | 0.61            | 7.22      | 9.73        | 10.31     | 35.30       | 17.28 | 12.43         | 0.14   | 100   |
|                    | Urban    | 8.67                   | 42.48                  | 9.21            | 19.37     | 5.75        | 6.08      | 0.34        | 0.25  | 7.37          | 0.48   | 100   |
|                    | Total    | 3.40                   | 13.84                  | 2.61            | 10.04     | 8.80        | 9.32      | 27.18       | 13.33 | 11.26         | 0.22   | 100   |
| Indonesia Total    | Rural    | 1.02                   | 9.03                   | 9.23            | 38.15     | 14.26       | 12.85     | 6.89        | 4.78  | 3.41          | 0.38   | 100   |
|                    | Urban    | 8.95                   | 30.80                  | 19.47           | 29.98     | 4.77        | 3.14      | 0.60        | 0.61  | 1.35          | 0.33   | 100   |
|                    | Total    | 4.41                   | 18.34                  | 13.61           | 34.66     | 10.20       | 8.70      | 4.20        | 3.00  | 2.53          | 0.36   | 100   |

Source: Susenas 2006

Table C15. Fish catch value, actual catch and estimated loss due to poor sanitation

| Province                | Dissolved oxygen levels in major rivers |             | Actual fish catch as % of optimum (base case) | Domestic sanitation as % water pollution | Loss of fish catch due to poor domestic sanitation |             |
|-------------------------|---|-------------|---|--|--|-------------|
|                         | Range                                   | Median      |   |  | IDR million  | USD million |
| NAD                     | 6.2 - 9                                 | 7.6         | 100%  | 19%                                      | -  | -           |
| North Sumatra           | 0.7 - 7.7                               | 4.2         | 32%   | 18%                                      | 37,428   | 4.24        |
| West Sumatra            | 5.2 - 7                                 | 6.1         | 71%   | 37%                                      | 14,357   | 1.63        |
| Riau                    | 1.2 - 7.8                               | 4.5         | 40%   | 9%                                       | 72,032   | 8.16        |
| Jambi                   | 3 - 6.5                                 | 4.8         | 36%   | 39%                                      | 45,540   | 5.16        |
| South Sumatra           | 1.8 - 7.9                               | 4.9         | 36%   | 22%                                      | 138,926  | 15.74       |
| Bengkulu                | 1.1 - 3.8                               | 2.5         | 30%   | 62%                                      | 8,682  | 0.98        |
| Lampung                 | 1.9 - 4                                 | 3.0         | 30%   | 36%                                      | 56,158   | 6.36        |
| Bangka Belitung         | 1.6 - 7.5                               | 4.6         | 34%   | 18%                                      | n.a.   | n.a.        |
| Riau Archipelago        | 1.2 - 7.8                               | 4.5         | 40%   | 3%                                       | n.a.   | n.a.        |
| Jakarta                 | 0 - 5.8                                 | 2.9         | 30%   | 8%                                       | n.a.   | n.a.        |
| West Java               | 0 - 5.9                                 | 3.0         | 30%   | 15%                                      | 18,375   | 2.08        |
| Central Java            | 6.3 - 8                                 | 7.2         | 92%   | 23%                                      | 2,227  | 0.25        |
| Yogyakarta              | 4.9 - 6.5                               | 5.7         | 62%   | 29%                                      | 1,725  | 0.20        |
| East Java               | 0 - 8.3                                 | 4.2         | 31%   | 16%                                      | 23,253   | 2.63        |
| Banten                  | 5.1 - 6.3                               | 5.7         | 62%   | 12%                                      | 241  | 0.03        |
| Bali                    | 2.8 - 5                                 | 3.9         | 29%   | 38%                                      | 5,477  | 0.62        |
| West Nusa Tenggara      | 4 - 7.4                                 | 5.7         | 62%   | 69%                                      | 10,040   | 1.14        |
| East Nusa Tenggara      | 1.1 - 3.5                               | 2.3         | n.a.  | 73%                                      | n.a.   | n.a.        |
| West Kalimantan         | 2.5 - 5                                 | 3.8         | 28%   | 27%                                      | 119,951  | 13.59       |
| Central Kalimantan      | 5.1 - 6                                 | 5.6         | 61%   | 42%                                      | 90,057   | 10.20       |
| South Kalimantan        | 5.1 - 6                                 | 5.5         | 60%   | 29%                                      | 100,807  | 11.42       |
| East Kalimantan         | 3.1 - 5.7                               | 4.4         | 39%   | 3%                                       | 8,028  | 2.04        |
| North Sulawesi          | 6.7 - 9                                 | 7.9         | 100%  | 41%                                      | -  | -           |
| Central Sulawesi        | 3 - 7.8                                 | 5.4         | 59%   | 54%                                      | 505  | 0.06        |
| South Sulawesi          | 4 - 9                                   | 6.5         | 80%   | 51%                                      | 5,011  | 0.57        |
| Southeast Sulawesi      | 1.1 - 9                                 | 5.1         | 51%   | 52%                                      | 31,566   | 3.58        |
| Gorontalo               | 5.3 - 7.8                               | 6.6         | 81%   | 66%                                      | 960  | 0.11        |
| West Sulawesi           | 4 - 9                                   | 6.5         | 80%   | 14%                                      | 21   | 0.00        |
| Maluku                  | 4.8 - 5.4                               | 5.1         | 51%   | 75%                                      | 903  | 0.10        |
| North Maluku            | 4.8 - 5.4                               | 5.1         | 51%   | 57%                                      | 682  | 0.08        |
| West Papua              | 3.3 - 7                                 | 5.2         | 52%   | 25%                                      | 10,008   | 1.13        |
| Papua                   | 3.3 - 7                                 | 5.2         | 52%   | 63%                                      | 25,099   | 2.84        |
| <b>Indonesia Total</b>  |   |             |   |  | <b>812,961</b>                                     | <b>92</b>   |
| <b>Province average</b> |   | <b>4.98</b> | <b>53%</b>                                    | <b>34%</b>                               | <b>30,654</b>                                      | <b>3.47</b> |

Source: Authors' estimates. n.a. – not available.

**Table C16. Population experiencing sub-optimal latrine access time, by province**

| Province           | Location | Population with access time already minimized (%) | Adult population > 15 year | Population experiencing sub-optimal access (proximity, waiting time) |                              | Adult population experiencing sub-optimal access (proximity, waiting time) |                          |
|--------------------|----------|---|----------------------------|--|------------------------------|--|--------------------------|
|                    |          |   |                            | Shared latrines (proportion)   | Open defecation (proportion) | Shared latrines (number)   | Open defecation (number) |
| NAD                | Rural    | 0.63  | 1,284,723                  | 0.15   | 0.23                         | 187,248  | 289,544                  |
|                    | Urban    | 0.86  | 1,684,430                  | 0.09   | 0.05                         | 149,240  | 81,105                   |
| North Sumatra      | Rural    | 0.76  | 4,427,901                  | 0.09   | 0.16                         | 381,242  | 690,753                  |
|                    | Urban    | 0.91  | 3,940,904                  | 0.06   | 0.02                         | 246,701  | 95,468                   |
| West Sumatra       | Rural    | 0.59  | 2,172,334                  | 0.14   | 0.27                         | 294,894  | 589,952                  |
|                    | Urban    | 0.82  | 971,255                    | 0.11   | 0.07                         | 103,342  | 68,401                   |
| Riau               | Rural    | 0.86  | 2,013,579                  | 0.06   | 0.09                         | 117,090  | 171,255                  |
|                    | Urban    | 0.94  | 1,188,266                  | 0.06   | 0.00                         | 65,771   | 4,991                    |
| Jambi              | Rural    | 0.71  | 1,335,719                  | 0.10   | 0.19                         | 135,175  | 256,458                  |
|                    | Urban    | 0.90  | 510,799                    | 0.06   | 0.04                         | 29,090   | 22,679                   |
| South Sumatra      | Rural    | 0.72  | 3,151,469                  | 0.07   | 0.21                         | 229,427  | 658,736                  |
|                    | Urban    | 0.89  | 1,664,243                  | 0.08   | 0.03                         | 137,134  | 47,681                   |
| Bengkulu           | Rural    | 0.68  | 761,271                    | 0.06   | 0.26                         | 45,296   | 197,264                  |
|                    | Urban    | 0.90  | 308,655                    | 0.07   | 0.03                         | 21,807   | 8,172                    |
| Lampung            | Rural    | 0.84  | 3,958,375                  | 0.07   | 0.09                         | 289,555  | 354,473                  |
|                    | Urban    | 0.86  | 1,064,745                  | 0.09   | 0.05                         | 93,485   | 56,458                   |
| Bangka Belitung    | Rural    | 0.64  | 432,667                    | 0.04   | 0.32                         | 17,220   | 138,270                  |
|                    | Urban    | 0.88  | 326,007                    | 0.04   | 0.08                         | 12,307   | 27,434                   |
| Riau Archipelago   | Rural    | 0.75  | 192,789                    | 0.06   | 0.19                         | 11,384   | 36,365                   |
|                    | Urban    | 0.87  | 782,162                    | 0.12   | 0.01                         | 93,742   | 8,506                    |
| Jakarta            | Urban    | 0.87  | 6,775,989                  | 0.12   | 0.00                         | 838,190  | 26,426                   |
| West Java          | Rural    | 0.69  | 13,335,108                 | 0.17   | 0.15                         | 2,201,626  | 1,950,260                |
|                    | Urban    | 0.85  | 14,641,471                 | 0.11   | 0.04                         | 1,557,853  | 621,530                  |
| Central Java       | Rural    | 0.70  | 13,847,786                 | 0.10   | 0.20                         | 1,333,542  | 2,777,173                |
|                    | Urban    | 0.79  | 9,610,228                  | 0.08   | 0.12                         | 786,117  | 1,184,220                |
| Yogyakarta         | Rural    | 0.89  | 1,068,656                  | 0.07   | 0.04                         | 78,333   | 40,075                   |
|                    | Urban    | 0.78  | 1,598,470                  | 0.18   | 0.04                         | 290,442  | 56,826                   |
| East Java          | Rural    | 0.68  | 16,262,127                 | 0.09   | 0.23                         | 1,487,985  | 3,765,089                |
|                    | Urban    | 0.81  | 11,370,357                 | 0.09   | 0.10                         | 1,034,703  | 1,112,874                |
| Banten             | Rural    | 0.57  | 2,867,753                  | 0.11   | 0.32                         | 313,876  | 905,278                  |
|                    | Urban    | 0.85  | 3,420,838                  | 0.11   | 0.05                         | 360,556  | 158,043                  |
| Bali               | Rural    | 0.68  | 1,292,705                  | 0.09   | 0.23                         | 114,146  | 295,028                  |
|                    | Urban    | 0.82  | 1,250,906                  | 0.13   | 0.05                         | 159,053  | 61,451                   |
| West Nusa Tenggara | Rural    | 0.49  | 1,803,200                  | 0.06   | 0.45                         | 113,962  | 807,247                  |
|                    | Urban    | 0.63  | 1,010,130                  | 0.10   | 0.27                         | 101,973  | 269,250                  |

| Province           | Location | Population with access time already minimized (%) | Adult population > 15 year | Population experiencing sub-optimal access (proximity, waiting time) |                              | Adult population experiencing sub-optimal access (proximity, waiting time) |                          |
|--------------------|----------|---|----------------------------|--|------------------------------|--|--------------------------|
|                    |          |   |                            | Shared latrines (proportion)   | Open defecation (proportion) | Shared latrines (number)   | Open defecation (number) |
| East Nusa Tenggara | Rural    | 0.74  | 2,264,310                  | 0.06   | 0.21                         | 131,217  | 466,504                  |
|                    | Urban    | 0.85  | 457,375                    | 0.12   | 0.03                         | 56,143   | 13,413                   |
| West Kalimantan    | Rural    | 0.67  | 1,987,646                  | 0.06   | 0.28                         | 112,401  | 552,019                  |
|                    | Urban    | 0.92  | 773,794                    | 0.04   | 0.04                         | 30,681   | 34,415                   |
| Central Kalimantan | Rural    | 0.61  | 910,164                    | 0.12   | 0.27                         | 112,997  | 242,263                  |
|                    | Urban    | 0.84  | 385,810                    | 0.09   | 0.07                         | 34,761   | 25,869                   |
| South Kalimantan   | Rural    | 0.69  | 1,430,181                  | 0.12   | 0.19                         | 176,699  | 265,370                  |
|                    | Urban    | 0.85  | 914,511                    | 0.11   | 0.04                         | 99,270   | 37,518                   |
| East Kalimantan    | Rural    | 0.80  | 867,659                    | 0.09   | 0.11                         | 79,391   | 91,104                   |
|                    | Urban    | 0.90  | 1,169,353                  | 0.08   | 0.02                         | 97,466   | 19,382                   |
| North Sulawesi     | Rural    | 0.76  | 975,574                    | 0.10   | 0.14                         | 98,045   | 132,654                  |
|                    | Urban    | 0.84  | 591,135                    | 0.14   | 0.02                         | 81,045   | 13,478                   |
| Central Sulawesi   | Rural    | 0.59  | 1,217,258                  | 0.06   | 0.35                         | 78,270   | 426,527                  |
|                    | Total    | 0.63  | 330,067                    | 0.07   | 0.29                         | 23,781   | 96,767                   |
| South Sulawesi     | Rural    | 0.66  | 1,601,740                  | 0.05   | 0.28                         | 86,574   | 450,489                  |
|                    | Urban    | 0.84  | 3,578,691                  | 0.10   | 0.06                         | 356,438  | 211,769                  |
| Southeast Sulawesi | Rural    | 0.67  | 992,751                    | 0.06   | 0.26                         | 61,948   | 262,235                  |
|                    | Urban    | 0.82  | 298,292                    | 0.11   | 0.07                         | 32,588   | 19,777                   |
| Gorontalo          | Rural    | 0.47  | 456,520                    | 0.12   | 0.42                         | 52,591   | 190,916                  |
|                    | Urban    | 0.71  | 171,111                    | 0.18   | 0.10                         | 31,596   | 17,415                   |
| West Sulawesi      | Rural    | 0.54  | 206,769                    | 0.06   | 0.40                         | 12,520   | 82,966                   |
|                    | Urban    | 0.74  | 461,974                    | 0.09   | 0.17                         | 40,030   | 78,512                   |
| Maluku             | Rural    | 0.55  | 584,610                    | 0.12   | 0.34                         | 69,422   | 195,991                  |
|                    | Urban    | 0.81  | 251,628                    | 0.09   | 0.09                         | 23,389   | 23,779                   |
| North Maluku       | Rural    | 0.54  | 429,424                    | 0.15   | 0.32                         | 62,288   | 135,301                  |
|                    | Urban    | 0.83  | 148,961                    | 0.10   | 0.08                         | 14,479   | 11,228                   |
| West Irian Jaya    | Rural    | 0.51  | 310,602                    | 0.11   | 0.37                         | 34,508   | 116,359                  |
|                    | Urban    | 0.82  | 113,069                    | 0.16   | 0.02                         | 17,644   | 2,637                    |
| Papua              | Rural    | 0.56  | 423,671                    | 0.09   | 0.35                         | 39,126   | 147,056                  |
|                    | Urban    | 0.87  | 905,891                    | 0.12   | 0.01                         | 110,564  | 8,832                    |
| Indonesia Total    | Rural    | 0.69  | 84,867,042                 | 0.10   | 0.21                         | 8,559,997  | 17,680,974               |
|                    | Urban    | 0.84  | 72,671,521                 | 0.10   | 0.06                         | 7,131,377  | 4,526,305                |
|                    | Total    | 0.75  | 157,538,564                | 0.10   | 0.15                         | 15,691,374   | 22,207,279               |

Source: Authors' estimates

**Table C17. Economic loss due to degraded and unavailable land**

| Province           | Location | Size of degraded land (m <sup>2</sup> ) |             | Average land value (IDR/m <sup>2</sup> ) | Total loss of land value (IDR million) |             |
|--------------------|----------|---|-------------|--|--|-------------|
|                    |          | Human waste                             | Solid waste |  | Human waste                            | Solid waste |
| NAD                | Rural    | 854,077                                 | 323,658     | 2,472                                    | -                                      | 809         |
|                    | Urban    | 119,798                                 | 242,644     | 5,032                                    | 1,198                                  | 1,213       |
| North Sumatra      | Rural    | 1,347,375                               | 924,103     | 2,472                                    | -                                      | 2,310       |
|                    | Urban    | 194,425                                 | 1,350,337   | 5,032                                    | 1,944                                  | 6,752       |
| West Sumatra       | Rural    | 1,482,243                               | 262,486     | 2,472                                    | -                                      | 656         |
|                    | Urban    | 255,112                                 | 345,194     | 5,032                                    | 2,551                                  | 1,726       |
| Riau               | Rural    | 1,191,586                               | 422,756     | 2,472                                    | -                                      | 1,057       |
|                    | Urban    | 51,605                                  | 390,244     | 5,032                                    | 516                                    | 1,951       |
| Jambi              | Rural    | 238,069                                 | 214,052     | 2,472                                    | -                                      | 535         |
|                    | Urban    | 52,989                                  | 182,423     | 5,032                                    | 530                                    | 912         |
| South Sumatra      | Rural    | 518,533                                 | 549,063     | 2,472                                    | -                                      | 1,373       |
|                    | Urban    | 116,639                                 | 683,891     | 5,032                                    | 1,166                                  | 3,419       |
| Bengkulu           | Rural    | 244,961                                 | 130,086     | 2,472                                    | -                                      | 325         |
|                    | Urban    | 24,092                                  | 120,016     | 5,032                                    | 241                                    | 600         |
| Lampung            | Rural    | 683,001                                 | 722,732     | 2,472                                    | -                                      | 1,807       |
|                    | Urban    | 87,463                                  | 492,283     | 5,032                                    | 875                                    | 2,461       |
| Bangka Belitung    | Rural    | 434,983                                 | 127,928     | 2,472                                    | -                                      | 320         |
|                    | Urban    | 67,978                                  | 70,795      | 5,032                                    | 680                                    | 354         |
| Riau Archipelago   | Rural    | 108,821                                 | 38,608      | 2,472                                    | -                                      | 97          |
|                    | Urban    | 62,903                                  | 237,839     | 5,032                                    | 629                                    | 1,189       |
| Jakarta            | Urban    | 315,628                                 | 4,751,680   | 20,040                                   | 12,625                                 | 95,034      |
| West Java          | Rural    | 10,477,635                              | 2,952,320   | 9,976                                    | -                                      | 29,523      |
|                    | Urban    | 2,653,561                               | 6,267,958   | 20,040                                   | 106,142                                | 125,359     |
| Central Java       | Rural    | 3,987,184                               | 3,866,681   | 9,976                                    | -                                      | 38,667      |
|                    | Urban    | 1,063,327                               | 3,625,169   | 20,040                                   | 42,533                                 | 72,503      |
| Yogyakarta         | Rural    | 58,176                                  | 239,540     | 9,976                                    | -                                      | 2,395       |
|                    | Urban    | 111,478                                 | 718,760     | 20,040                                   | 4,459                                  | 14,375      |
| East Java          | Rural    | 3,798,523                               | 3,360,341   | 9,976                                    | -                                      | 33,603      |
|                    | Urban    | 571,093                                 | 4,407,293   | 20,040                                   | 22,844                                 | 88,146      |
| Banten             | Rural    | 3,210,506                               | 990,255     | 9,976                                    | -                                      | 9,903       |
|                    | Urban    | 836,274                                 | 1,501,591   | 20,040                                   | 33,451                                 | 30,032      |
| Bali               | Rural    | 698,942                                 | 251,435     | 2,472                                    | -                                      | 629         |
|                    | Urban    | 137,857                                 | 472,616     | 5,032                                    | 1,379                                  | 2,363       |
| West Nusa Tenggara | Rural    | 1,615,800                               | 486,577     | 2,472                                    | -                                      | 1,216       |
|                    | Urban    | 245,414                                 | 347,900     | 5,032                                    | 2,454                                  | 1,739       |

| Province               | Location     | Size of degraded land (m <sup>2</sup> ) |             | Average land value (IDR/m <sup>2</sup> ) | Total loss of land value (IDR million) |                |
|------------------------|--------------|---|-------------|--|--|----------------|
|                        |              | Human waste                             | Solid waste |  | Human waste                            | Solid waste    |
| East Nusa Tenggara     | Rural        | 1,690,743                               | 777,379     | 2,472                                    | -                                      | 1,943          |
|                        | Urban        | 66,628                                  | 163,821     | 5,032                                    | 666                                    | 819            |
| West Kalimantan        | Rural        | 920,283                                 | 613,747     | 2,472                                    | -                                      | 1,534          |
|                        | Urban        | 88,525                                  | 203,745     | 5,032                                    | 885                                    | 1,019          |
| Central Kalimantan     | Rural        | 72,054                                  | 158,160     | 2,472                                    | -                                      | 395            |
|                        | Urban        | 19,499                                  | 115,604     | 5,032                                    | 195                                    | 578            |
| South Kalimantan       | Rural        | 156,299                                 | 445,801     | 2,472                                    | -                                      | 1,114          |
|                        | Urban        | 31,859                                  | 435,748     | 5,032                                    | 319                                    | 2,179          |
| East Kalimantan        | Rural        | 127,667                                 | 192,270     | 2,472                                    | -                                      | 481            |
|                        | Urban        | 56,719                                  | 625,445     | 5,032                                    | 567                                    | 3,127          |
| North Sulawesi         | Rural        | 136,940                                 | 186,177     | 2,472                                    | -                                      | 465            |
|                        | Urban        | 36,542                                  | 202,564     | 5,032                                    | 365                                    | 1,013          |
| Central Sulawesi       | Rural        | 732,068                                 | 246,820     | 2,472                                    | -                                      | 617            |
|                        | Total        | 25,756                                  | 133,077     | 5,032                                    | 258                                    | 665            |
| South Sulawesi         | Rural        | 2,801,213                               | 1,150,645   | 2,472                                    | -                                      | 2,877          |
|                        | Urban        | 230,936                                 | 815,153     | 5,032                                    | 2,309                                  | 4,076          |
| Southeast Sulawesi     | Rural        | 789,136                                 | 277,392     | 2,472                                    | -                                      | 693            |
|                        | Urban        | 49,216                                  | 139,582     | 5,032                                    | 492                                    | 698            |
| Gorontalo              | Rural        | 440,242                                 | 43,926      | 2,472                                    | -                                      | 110            |
|                        | Urban        | 47,526                                  | 22,331      | 5,032                                    | 475                                    | 112            |
| West Sulawesi          | Rural        | 451,157                                 | 170,199     | 2,472                                    | -                                      | 426            |
|                        | Urban        | 64,077                                  | 69,689      | 5,032                                    | 641                                    | 348            |
| Maluku                 | Rural        | 701,687                                 | 226,206     | 2,472                                    | -                                      | 566            |
|                        | Urban        | 75,821                                  | 69,710      | 5,032                                    | 758                                    | 349            |
| North Maluku           | Rural        | 497,916                                 | 143,512     | 2,472                                    | -                                      | 359            |
|                        | Urban        | 57,049                                  | 50,143      | 5,032                                    | 570                                    | 251            |
| West Irian Jaya        | Rural        | 303,254                                 | 114,018     | 2,472                                    | -                                      | 285            |
|                        | Urban        | 43,548                                  | 54,745      | 5,032                                    | 435                                    | 274            |
| Papua                  | Rural        | 769,479                                 | 332,541     | 2,472                                    | -                                      | 831            |
|                        | Urban        | 70,306                                  | 159,667     | 5,032                                    | 703                                    | 798            |
| <b>Indonesia Total</b> | <b>Rural</b> | <b>41.5</b>                             | <b>20.9</b> | <b>2,470-10,000</b>                      | <b>-</b>                               | <b>137,717</b> |
|                        | <b>Urban</b> | <b>7.9</b>                              | <b>29.5</b> | <b>5,030-20,040</b>                      | <b>245,418</b>                         | <b>466,118</b> |
|                        | <b>Total</b> | <b>49.5</b>                             | <b>50.4</b> | <b>2,470-20,040</b>                      | <b>245,418</b>                         | <b>604,718</b> |

Source: Authors' estimates

**Table C18. Population exposed to sub-standard practices of waste disposal**

| Province           | Location | Improved sanitation (proportion) |                       | Exposed population (numbers) |                                  |  |
|--------------------|----------|----------------------------------|-----------------------|------------------------------|----------------------------------|--|
|                    |          | Enclosed defecation sites        | Solid waste collected | Exposed to open sewers       | Exposed to open defecation sites | Exposed to open dumping of solid waste |
| NAD                | Rural    | 0.70                             | 0.01                  | 163,850                      | 910,107                          | 114,786                                |
|                    | Urban    | 0.94                             | 0.29                  | 113,552                      | 65,735                           | 18,328                                 |
| North Sumatra      | Rural    | 0.79                             | 0.01                  | 362,807                      | 1,421,166                        | 296,532                                |
|                    | Urban    | 0.97                             | 0.34                  | 576,911                      | 186,903                          | 462,339                                |
| West Sumatra       | Rural    | 0.64                             | 0.01                  | 53,262                       | 1,175,986                        | 85,414                                 |
|                    | Urban    | 0.91                             | 0.37                  | 64,887                       | 130,190                          | 28,839                                 |
| Riau               | Rural    | 0.89                             | 0.00                  | 67,072                       | 342,611                          | 107,859                                |
|                    | Urban    | 0.99                             | 0.35                  | 233,095                      | 9,763                            | 177,480                                |
| Jambi              | Rural    | 0.74                             | 0.01                  | 203,668                      | 500,374                          | 162,817                                |
|                    | Urban    | 0.94                             | 0.32                  | 117,292                      | 43,209                           | 106,417                                |
| South Sumatra      | Rural    | 0.72                             | 0.02                  | 96,823                       | 1,278,896                        | 69,750                                 |
|                    | Urban    | 0.96                             | 0.38                  | 232,122                      | 88,405                           | 170,562                                |
| Bengkulu           | Rural    | 0.65                             | 0.01                  | 3,143                        | 387,874                          | 3,143                                  |
|                    | Urban    | 0.96                             | 0.43                  | 26,501                       | 15,749                           | 23,735                                 |
| Lampung            | Rural    | 0.88                             | 0.02                  | 117,444                      | 680,721                          | 45,039                                 |
|                    | Urban    | 0.93                             | 0.41                  | 100,477                      | 106,983                          | 29,507                                 |
| Bangka Belitung    | Rural    | 0.57                             | 0.01                  | 8,509                        | 270,578                          | 15,558                                 |
|                    | Urban    | 0.89                             | 0.11                  | 35,045                       | 49,398                           | 38,832                                 |
| Riau Archipelago   | Rural    | 0.75                             | 0.00                  | 6,125                        | 69,393                           | 9,850                                  |
|                    | Urban    | 0.99                             | 0.35                  | 142,062                      | 15,407                           | 108,167                                |
| Jakarta            | Urban    | 0.99                             | 0.83                  | 1,072,418                    | 46,627                           | 892,187                                |
| West Java          | Rural    | 0.81                             | 0.02                  | 589,559                      | 3,744,756                        | 553,072                                |
|                    | Urban    | 0.94                             | 0.43                  | 1,318,603                    | 1,157,100                        | 1,063,060                              |
| Central Java       | Rural    | 0.73                             | 0.01                  | 403,693                      | 5,115,993                        | 210,456                                |
|                    | Urban    | 0.84                             | 0.25                  | 513,465                      | 2,135,753                        | 323,678                                |
| Yogyakarta         | Rural    | 0.95                             | 0.01                  | 21,193                       | 69,257                           | 40,723                                 |
|                    | Urban    | 0.95                             | 0.47                  | 127,718                      | 95,037                           | 135,538                                |
| East Java          | Rural    | 0.69                             | 0.01                  | 322,680                      | 6,685,314                        | 547,906                                |
|                    | Urban    | 0.87                             | 0.40                  | 663,783                      | 1,950,984                        | 675,743                                |
| Banten             | Rural    | 0.58                             | 0.03                  | 127,740                      | 1,835,011                        | 127,740                                |
|                    | Urban    | 0.94                             | 0.38                  | 454,645                      | 299,851                          | 337,820                                |
| Bali               | Rural    | 0.70                             | 0.06                  | 6,431                        | 514,983                          | 6,431                                  |
|                    | Urban    | 0.93                             | 0.38                  | 56,744                       | 114,011                          | 53,611                                 |
| West Nusa Tenggara | Rural    | 0.40                             | -                     | 58,995                       | 1,630,275                        | 126,456                                |
|                    | Urban    | 0.64                             | 0.14                  | 125,238                      | 529,247                          | 93,073                                 |



| Province               | Location     | Improved sanitation (proportion) |                       | Exposed population (numbers) |                                  |  |
|------------------------|--------------|----------------------------------|-----------------------|------------------------------|----------------------------------|--|
|                        |              | Enclosed defecation sites        | Solid waste collected | Exposed to open sewers       | Exposed to open defecation sites | Exposed to open dumping of solid waste |
| East Nusa Tenggara     | Rural        | 0.73                             | 0.00                  | 86,413                       | 1,010,107                        | 140,834                                |
|                        | Urban        | 0.96                             | 0.28                  | 42,492                       | 26,583                           | 24,611                                 |
| West Kalimantan        | Rural        | 0.63                             | 0.01                  | 316,551                      | 1,098,584                        | 168,808                                |
|                        | Urban        | 0.94                             | 0.22                  | 46,885                       | 64,809                           | 34,098                                 |
| Central Kalimantan     | Rural        | 0.65                             | 0.02                  | 57,671                       | 486,161                          | 34,931                                 |
|                        | Urban        | 0.91                             | 0.23                  | 9,081                        | 49,806                           | 9,081                                  |
| South Kalimantan       | Rural        | 0.75                             | 0.01                  | 44,568                       | 512,843                          | 75,455                                 |
|                        | Urban        | 0.95                             | 0.37                  | 120,428                      | 69,708                           | 64,738                                 |
| East Kalimantan        | Rural        | 0.86                             | 0.03                  | 52,448                       | 179,092                          | 57,437                                 |
|                        | Urban        | 0.98                             | 0.56                  | 152,909                      | 36,652                           | 132,179                                |
| North Sulawesi         | Rural        | 0.82                             | 0.03                  | 84,271                       | 244,844                          | 47,267                                 |
|                        | Urban        | 0.97                             | 0.34                  | 34,047                       | 24,469                           | 9,739                                  |
| Central Sulawesi       | Rural        | 0.53                             | 0.01                  | 102,274                      | 867,196                          | 70,163                                 |
|                        | Total        | 0.61                             | 0.39                  | 44,564                       | 181,080                          | 13,341                                 |
| South Sulawesi         | Rural        | 0.63                             | 0.00                  | 214,460                      | 1,985,737                        | 164,154                                |
|                        | Urban        | 0.92                             | 0.55                  | 174,917                      | 180,405                          | 124,157                                |
| Southeast Sulawesi     | Rural        | 0.65                             | 0.01                  | 27,881                       | 551,674                          | 15,664                                 |
|                        | Urban        | 0.91                             | 0.39                  | 102,228                      | 38,570                           | 93,720                                 |
| Gorontalo              | Rural        | 0.44                             | 0.00                  | 16,927                       | 388,416                          | 13,305                                 |
|                        | Urban        | 0.86                             | 0.12                  | 30,605                       | 33,278                           | 18,589                                 |
| West Sulawesi          | Rural        | 0.47                             | 0.00                  | 16,840                       | 419,043                          | 28,511                                 |
|                        | Urban        | 0.77                             | 0.55                  | 18,473                       | 44,295                           | 9,930                                  |
| Maluku                 | Rural        | 0.55                             | 0.00                  | 55,105                       | 405,133                          | 58,278                                 |
|                        | Urban        | 0.87                             | 0.16                  | 49,086                       | 46,018                           | 22,900                                 |
| North Maluku           | Rural        | 0.58                             | 0.00                  | 31,281                       | 285,056                          | 15,607                                 |
|                        | Urban        | 0.90                             | 0.25                  | 31,716                       | 22,120                           | 25,355                                 |
| West Irian Jaya        | Rural        | 0.50                             | 0.03                  | 14,517                       | 242,516                          | 13,206                                 |
|                        | Urban        | 0.97                             | 0.38                  | 18,122                       | 5,332                            | 3,292                                  |
| Papua                  | Rural        | 0.54                             | 0.03                  | 42,340                       | 655,345                          | 38,516                                 |
|                        | Urban        | 0.99                             | 0.38                  | 52,854                       | 6,501                            | 9,601                                  |
| <b>Indonesia Total</b> | <b>Rural</b> | <b>0.72</b>                      | <b>0.01</b>           | <b>3,776,541.2</b>           | <b>35,965,044.9</b>              | <b>3,465,666.0</b>                     |
|                        | <b>Urban</b> | <b>0.92</b>                      | <b>0.41</b>           | <b>6,902,966.0</b>           | <b>7,869,978.1</b>               | <b>5,334,245.2</b>                     |
|                        | <b>Total</b> | <b>0.80</b>                      | <b>0.18</b>           | <b>10,679,507.2</b>          | <b>43,835,023.0</b>              | <b>8,799,911.2</b>                     |

Source: Authors' estimates

**Table C19. Time used accessing latrines**

| Province           | Location | Total time spent accessing (million hours) |                 | Value (IDR billion) |                 |
|--------------------|----------|--|-----------------|---------------------|-----------------|
|                    |          | Shared latrines                            | Open defecation | Shared latrines     | Open defecation |
| NAD                | Rural    | 17   | 26              | 17                  | 27              |
|                    | Urban    | 27   | 7               | 28                  | 8               |
| North Sumatra      | Rural    | 35   | 63              | 50                  | 91              |
|                    | Urban    | 45   | 9               | 65                  | 13              |
| West Sumatra       | Rural    | 27   | 54              | 35                  | 70              |
|                    | Urban    | 19   | 6               | 24                  | 8               |
| Riau               | Rural    | 11   | 16              | 14                  | 20              |
|                    | Urban    | 12   | 0               | 27                  | 1               |
| Jambi              | Rural    | 12   | 23              | 28                  | 53              |
|                    | Urban    | 5  | 2               | 12                  | 5               |
| South Sumatra      | Rural    | 21   | 60              | 19                  | 55              |
|                    | Urban    | 25   | 4               | 23                  | 4               |
| Bengkulu           | Rural    | 4  | 18              | 4                   | 17              |
|                    | Urban    | 4  | 1               | 4                   | 1               |
| Lampung            | Rural    | 26   | 32              | 27                  | 33              |
|                    | Urban    | 17   | 5               | 18                  | 5               |
| Bangka Belitung    | Rural    | 2  | 13              | 1                   | 11              |
|                    | Urban    | 2  | 3               | 2                   | 2               |
| Riau Archipelago   | Rural    | 1  | 3               | 1                   | 3               |
|                    | Urban    | 17   | 1               | 12                  | 1               |
| Jakarta            | Urban    | 153  | 2               | 110                 | 2               |
| West Java          | Rural    | 201  | 178             | 324                 | 287             |
|                    | Urban    | 284  | 57              | 459                 | 92              |
| Central Java       | Rural    | 122  | 253             | 196                 | 409             |
|                    | Urban    | 143  | 108             | 556                 | 419             |
| Yogyakarta         | Rural    | 7  | 4               | 28                  | 14              |
|                    | Urban    | 53   | 5               | 205                 | 20              |
| East Java          | Rural    | 136  | 344             | 878                 | 2,222           |
|                    | Urban    | 189  | 102             | 1,221               | 657             |
| Banten             | Rural    | 29   | 83              | 185                 | 534             |
|                    | Urban    | 66   | 14              | 82                  | 18              |
| Bali               | Rural    | 10   | 27              | 13                  | 34              |
|                    | Urban    | 29   | 6               | 36                  | 7               |
| West Nusa Tenggara | Rural    | 10   | 74              | 9                   | 61              |
|                    | Urban    | 19   | 25              | 15                  | 20              |

| Province               | Location     | Total time spent accessing (million hours) |                 | Value (IDR billion) |                 |
|------------------------|--------------|--|-----------------|---------------------|-----------------|
|                        |              | Shared latrines                            | Open defecation | Shared latrines     | Open defecation |
| East Nusa Tenggara     | Rural        | 12   | 43              | 10                  | 35              |
|                        | Urban        | 10   | 1               | 10                  | 1               |
| West Kalimantan        | Rural        | 10   | 50              | 10                  | 50              |
|                        | Urban        | 6  | 3               | 6                   | 3               |
| Central Kalimantan     | Rural        | 10   | 22              | 15                  | 32              |
|                        | Urban        | 6  | 2               | 9                   | 3               |
| South Kalimantan       | Rural        | 16   | 24              | 24                  | 35              |
|                        | Urban        | 18   | 3               | 22                  | 4               |
| East Kalimantan        | Rural        | 7  | 8               | 9                   | 10              |
|                        | Urban        | 18   | 2               | 22                  | 2               |
| North Sulawesi         | Rural        | 9  | 12              | 12                  | 16              |
|                        | Urban        | 15   | 1               | 20                  | 2               |
| Central Sulawesi       | Rural        | 7  | 39              | 9                   | 52              |
|                        | Total        | 4  | 9               | 4                   | 7               |
| South Sulawesi         | Rural        | 8  | 41              | 6                   | 33              |
|                        | Urban        | 65   | 19              | 53                  | 16              |
| Southeast Sulawesi     | Rural        | 6  | 24              | 3                   | 11              |
|                        | Urban        | 6  | 2               | 3                   | 1               |
| Gorontalo              | Rural        | 5  | 17              | 2                   | 8               |
|                        | Urban        | 6  | 2               | 6                   | 2               |
| West Sulawesi          | Rural        | 1  | 8               | 1                   | 8               |
|                        | Urban        | 7  | 7               | 8                   | 8               |
| Maluku                 | Rural        | 6  | 18              | 9                   | 26              |
|                        | Urban        | 4  | 2               | 6                   | 3               |
| North Maluku           | Rural        | 6  | 12              | 8                   | 18              |
|                        | Urban        | 3  | 1               | 3                   | 1               |
| West Irian Jaya        | Rural        | 3  | 11              | 4                   | 12              |
|                        | Urban        | 3  | 0               | 4                   | 0               |
| Papua                  | Rural        | 4  | 13              | 11                  | 41              |
|                        | Urban        | 20   | 1               | 62                  | 2               |
| <b>Indonesia Total</b> | <b>Rural</b> | <b>781</b>                                 | <b>1,613</b>    | <b>1,963</b>        | <b>4,330</b>    |
|                        | <b>Urban</b> | <b>1,302</b>                               | <b>413</b>      | <b>3,137</b>        | <b>1,337</b>    |
|                        | <b>Total</b> | <b>2,083</b>                               | <b>2,026</b>    | <b>5,102</b>        | <b>5,667</b>    |

Source: Authors' estimates

**Table C20. Economic impact of lower foreign tourist numbers, 2006**

| Province               | Current tourism value <sup>1</sup> (IDR billion) | Current hotel occupancy rate (%) | Future potential value <sup>2</sup> (IDR billion) | Annual economic loss <sup>3</sup> (IDR billion) |
|------------------------|--|----------------------------------|---|---|
| NAD                    | 6  | 48.7                             | 10  | 0   |
| North Sumatra          | 657  | 37.4                             | 1,405   | 37  |
| West Sumatra           | 158  | 40.2                             | 315   | 8   |
| R i a u                | 188  | 42.1                             | 358   | 8   |
| J a m b i              | 14   | 34.8                             | 32  | 1   |
| South Sumatra          | 34   | 36.7                             | 74  | 2   |
| Bengkulu               | 2  | 21.8                             | 7   | 0   |
| Lampung                | 22   | 45.6                             | 39  | 1   |
| Bangka Belitung        | 8  | 38.1                             | 17  | 0   |
| Riau Archipelago       | 5,673  | 42.1                             | 10,780  | 255   |
| Jakarta                | 5,938  | 51.1                             | 9,299   | 168   |
| West Java              | 1,160  | 37.8                             | 2,458   | 65  |
| Central Java           | 519  | 43.2                             | 961   | 22  |
| Yogyakarta             | 621  | 45.6                             | 1,089   | 23  |
| East Java              | 1,228  | 48.3                             | 2,035   | 40  |
| Banten                 | 435  | 33.3                             | 1,046   | 31  |
| B a l i                | 20,574   | 47.8                             | 34,434  | 693   |
| West Nusa Tenggara     | 916  | 32.5                             | 2,251   | 67  |
| East Nusa Tenggara     | 98   | 43.9                             | 179   | 4   |
| West Kalimantan        | 172  | 40.5                             | 341   | 8   |
| Central Kalimantan     | 6  | 42.7                             | 11  | 0   |
| South Kalimantan       | 44   | 47.0                             | 75  | 2   |
| East Kalimantan        | 232  | 54.5                             | 341   | 5   |
| North Sulawesi         | 148  | 51.9                             | 228   | 4   |
| Central Sulawesi       | 14   | 52.9                             | 21  | 0   |
| South Sulawesi         | 293  | 38.2                             | 613   | 16  |
| Southeast Sulawesi     | 6  | 43.6                             | 11  | 0   |
| Gorontalo              | 4  | 51.9                             | 6   | 0   |
| West Sulawesi          | 2  | 38.2                             | 4   | 0   |
| Maluku                 | 28   | 48.1                             | 47  | 1   |
| North Maluku           | 2  | 48.1                             | 3   | 0   |
| West Papua             | 8  | 23.5                             | 27  | 1   |
| Papua                  | 54   | 34.8                             | 124   | 4   |
| <b>Indonesia Total</b> | <b>39,267</b>                                    | <b>45.0</b>                      | <b>68,643</b>                                     | <b>1,465</b>                                    |

<sup>1</sup> Ministry of Culture and Tourism. Statistical report on visitor arrivals to Indonesia 2006. Jakarta: Data and Information Center. 2007.

<sup>2</sup> Calculated as the revenue from tourists, assuming 80% occupancy of existing (foreign) tourist hotels.

<sup>3</sup> Calculated as the gap between current and potential value, multiplied by 5% attribution to sanitation.



