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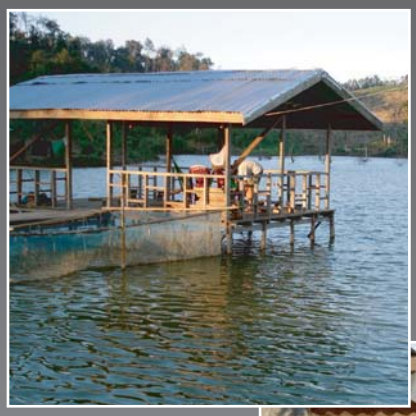
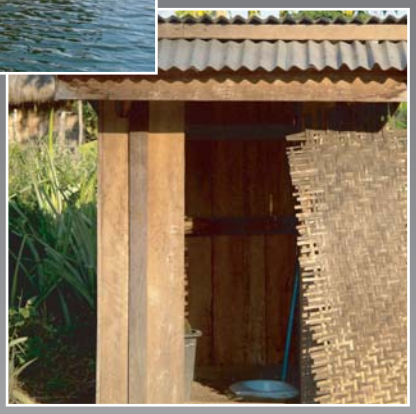
Economic Impacts of Sanitation in Lao PDR

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 48% in 2005, improved sanitation coverage in Lao PDR is below the regional average for Southeast Asian countries of 67%. Nationwide, sanitation coverage increased from 11% in 1990 to 48% in 2005[1], although some of this coverage cannot be considered improved sanitation[2]. This coverage gain still represents significant progress towards the MDG target coverage of 70% in 2015 and the national target coverage of 80% by 2020.

This study shows for the first time that a significant number of people living with unimproved household sanitation imposes a large financial and economic loss on the Lao PDR 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, donor agencies, local authorities, as well as mass organization such as women's or youth groups.

Unimproved sanitation and hygiene have a wide array of impacts, which can be categorized into impacts on: health, water, time use, and tourism. For Lao PDR, 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, Lao PDR lost an estimated LAK 1.9 trillion (USD 193 million) due to poor sanitation and hygiene, equivalent to approximately 5.6% of gross domestic product (GDP). Figure A shows overall economic costs by impact type. To give an indication of the relative impact on the Lao economy, where the average price level is 28% of that of the United States (when prices are compared at market exchange rates), the impact in international dollars is ID 690 million.

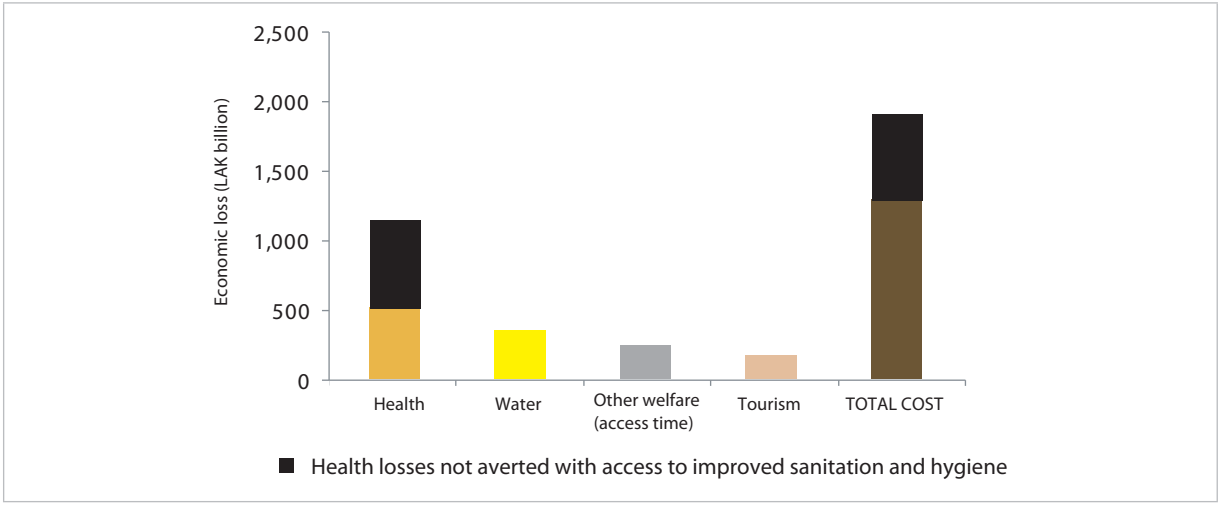
Of the impacts evaluated, health contributes 60% to the overall economic costs estimated in the study, followed by 18% for accessing clean drinking water, 13% for additional time to access unimproved sanitation, and 9% due to tourism losses. These impacts are expected to cause a mixture of direct financial losses as well as indirect or non-monetary economic losses to the Lao population, who have to pay for health services or for accessing clean water supplies, or who may lose income due to poor health.

Poor sanitation, including hygiene, causes at least 3 million disease episodes and 6 thousand premature deaths annually. The resulting economic impact is more than LAK 1.1 trillion (USD 115 million) per year. Poor sanitation also contributes significantly to water pollution, adding to the cost of households accessing safe and clean water supplies. The associated economic costs of polluted water attributed to poor sanitation exceed LAK 350 billion (USD 35 million) per year. This excludes accessing clean water for non-drinking purposes, as well as loss of productive value for fisheries and agriculture due to polluted water. Poor sanitation also contributes LAK 250 billion (USD 25 million) losses per year due to additional time required to access unimproved sanitation, and possibly over LAK 150 billion (USD 17 million) per year in tourism losses.

1 Note that Lao MICS III 2006 reports 45% improved sanitation coverage in Lao PDR.

2 Lao PDR Population and Housing Censuses 1995 and 2005. Note, however, that the census does not distinguish between improved and unimproved sanitation facilities.

Figure A. Economic impacts of poor sanitation and hygiene (2006)



Source: Estimated by the authors.

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 with basic sanitation and improved hygiene[3]. The avertable losses are shown in the lower area of the 'Health' and 'Total cost' bars. Of total costs of LAK 1.9 trillion (USD 193 million) attributed to poor sanitation and hygiene, LAK 1.3 trillion are avertable through universal improved sanitation and hygiene.

A number of impacts of poor sanitation and hygiene were not quantified in this study due to lack of data, but are known to influence population behavior and overall welfare. These include additional health effects (e.g. helminthes), intangible welfare effects (relating to the population's preferences for a safe, convenient and private place to defecate), impact on water withdrawn for other productive purposes, impact on fisheries, impact on land availability and value, and impact on businesses and foreign direct investment. If these were all quantified in the study, the overall impact would be significantly greater than LAK 1.9 trillion, and the avertable losses would be significantly greater than LAK 1.3 trillion.

This is the first study in Lao PDR to compile economic evidence on a range of impacts of poor sanitation and hygiene. The results indicate that poor sanitation and hygiene have significant costs, with major implications for the socio-economic development of Lao PDR 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, and access to safe drinking water.

The study demonstrates that poor sanitation affects everyone, but especially households without improved sanitation, which tend to be the poor and vulnerable. Hence, sanitation should receive greater attention from all levels of Lao PDR 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 access affordable sanitation services.

3 Further mitigation of disease would require better than 'basic' sanitation.

Foreword

In 2006-7 the Lao economy grew at over 7% 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 data sets 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 during 2009, a 'sanitation options' study, which examines 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 Lao PDR, Cambodia, Indonesia, the Philippines and Vietnam. While 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
BOD	Biochemical oxygen demand
EAP	East Asia and the Pacific
ESI	Economics of Sanitation Initiative
GDP	Gross domestic product
GFS	Gravity-fed systems
HRQL	Health-Related Quality of Life
ID	International dollar
JMP	Joint Monitoring Programme (WHO, UNICEF)
LAK	Lao kip
LRHS	Lao Reproductive Health Survey (latest 2005)
MDG	Millennium Development Goal
MICS III	Multiple Indicator Cluster Survey number 3 (latest 2006)
MOH	Ministry of Health
NGO	Non-governmental organization
OECD	Organization of Economic Cooperation and Development
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 five countries: Cambodia, Indonesia, Lao PDR, the Philippines, and Vietnam. 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 two years 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 regional study methodology and provided the figures for malnutrition-related health effects of poor sanitation.

The country team in Lao PDR consisted of the National Economic Research Institute (NERI) led by Leeber Leebouapao (Deputy Director of NERI) and assisted by Saykham Voladet. NERI was supported in data collection and management by Bjorn Larsen, who provided the quantitative estimates. Guy Hutton provided continuous support to the Lao team, and wrote the report. WSP in Lao PDR facilitated the study, with special thanks to Viengsamay Vongkhamsao, Thomas Meadley and Bounthavong Sourisak.

The ESI Lao PDR has been financed by the regional component of the Sustainable Sanitation for East Asia (SUSEA) Program, funded by the Swedish International Development Agency (SIDA). Regional resources of ESI have also been supported by 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.

The Lao PDR report was peer reviewed by Declan O'Leary (SNV), Viengsamay Vongkhamsao and Thomas Meadley. A large number of peer reviewers contributed their valuable time and ideas to the regional ESI study, which contributed to the Lao PDR methodology. Elena Strukova, Caroline van den Berg, Anjali Archarya, and Tracey Hart reviewed the methodology study before its implementation. Peer reviewers of the synthesis draft report were (World Bank staff unless otherwise stated) Eddy Perez, Anjali Acharya, Pete Kolsky, Elena Strukova (consultant), and Peter Feldman (Plan International). Peer reviewers of the Cambodia country draft report were Hilda Winarta (UNICEF), Jan Lam (SNV), Chea Samnang (Ministry of Rural Development), Ruud Corsel (Niras-Scanagri, Vietnam), and Oun Syvibola (Plan International). The Indonesia study was reviewed by Foort Bustraan and Nona Poeroo Utomo (USAID / Environmental Services Program). Peer reviewers of the Philippines country draft report were Jema Sy and Andy Robinson (consultant). Peer reviewers of the Vietnam country draft report were Samuel Leibermann, Doan Hong Quang, Pham Khanh Toan (Ministry of Construction), Nguyen Viet Anh (University of Civil Engineering), Nguyen Kim Thai (University of Civil Engineering), Nguyen Van Thuan (Australian Agency for International Development), and John Collett (Plan International).

Reference for citation:

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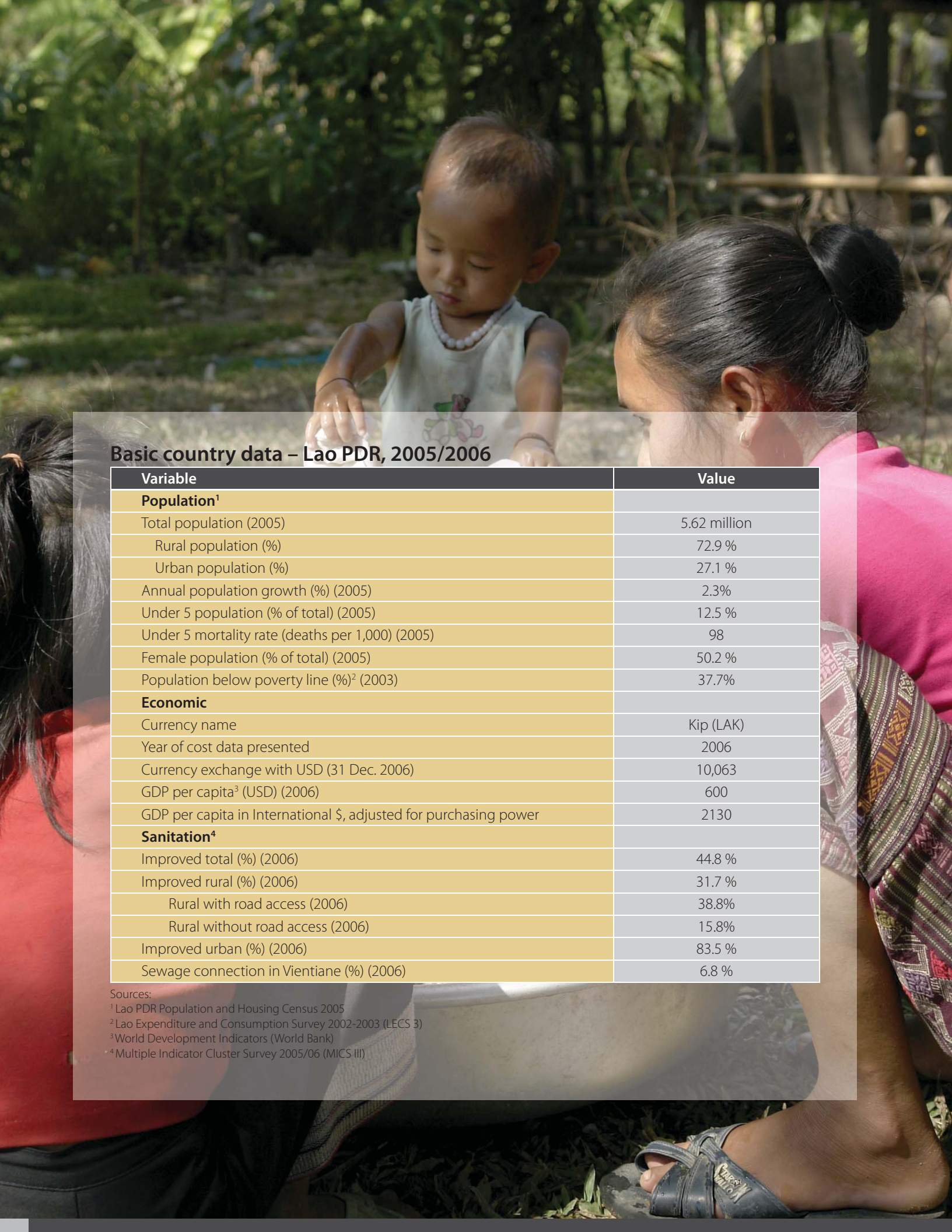


Basic country data – Lao PDR, 2005/2006

Variable	Value
Population[1]	
Total population (2005)	5.62 million
Rural population (%)	72.9 %
Urban population (%)	27.1 %
Annual population growth (%) (2005)	2.3%
Under 5 population (% of total) (2005)	12.5 %
Under 5 mortality rate (deaths per 1,000) (2005)	98
Female population (% of total) (2005)	50.2 %
Population below poverty line (%)[2] (2003)	37.7%
Economic	
Currency name	Kip (LAK)
Year of cost data presented	2006
Currency exchange with USD (31 Dec. 2006)	10,063
GDP per capita[3] (USD) (2006)	600
GDP per capita in International $, adjusted for purchasing power	2130
Sanitation[4]	
Improved total (%) (2006)	44.8 %
Improved rural (%) (2006)	31.7 %
Rural with road access (2006)	38.8%
Rural without road access (2006)	15.8%
Improved urban (%) (2006)	83.5 %
Sewage connection in Vientiane (%) (2006)	6.8 %

Sources:
[1] Lao PDR Population and Housing Census 2005
[2] Lao Expenditure and Consumption Survey 2002-2003 (LECS 3)
[3] World Development Indicators (World Bank)
[4] Multiple Indicator Cluster Survey 2005/06 (MICS III)

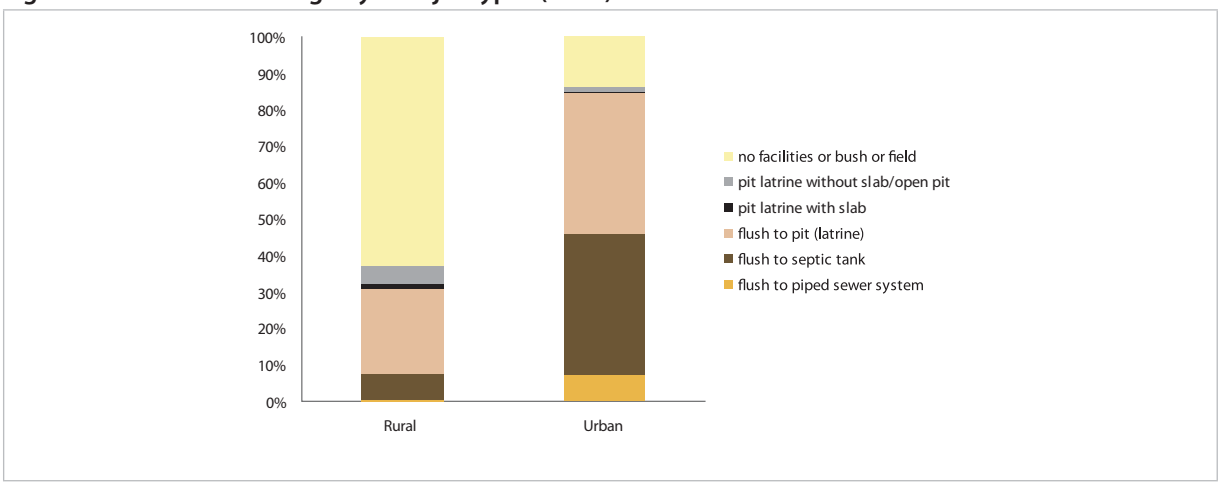
1 Introduction

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 sanitation. Compared with other countries in Southeast Asia, in 2005 Lao PDR was below average in establishing sanitation access. The Multiple Indicator Cluster Survey 2006 (MICS III) showed a coverage of 44.8% with improved sanitation (or 48% cited by the UNICEF/WHO Joint Monitoring Program), compared with an average of 67% for all countries in Southeast Asia.

At least fifty-two percent (52%) of the Lao population live without access to sanitation in 2006, which corresponds to over **three million Laotians living without improved sanitation**, that is, without an easily accessible, private and safe place to urinate and defecate. Data constraints make it difficult to estimate sanitation coverage in the year 1990. An assessment carried out in 2005 estimates sanitation coverage of 11% in 1990[4]. Hence, coverage has increased from 11% to 48% over the 15 year period 1990-2005, reflecting good progress towards the United Nations Lao PDR target of 70% in 2015.

Efforts to increase sanitation coverage must also compete with population growth in Lao PDR, which stands at an estimated 2.3% per annum and is one of the highest in the region. At this rate, an additional 130,000 Laotians will require improved sanitation facilities every year from 2006 until 2015, thus adding to the 3.1 million people currently living without improved sanitation. Furthermore, significant rural-urban and inter-provincial disparities exist, which sanitation improvement efforts must address. Figure 1 shows variations in sanitation coverage between urban and rural areas, with unimproved sanitation coverage ranging from 16.5% in urban to 68.2% in rural areas[5]. Regionally in Lao PDR, lack of improved coverage is 72% in the South, 57% in the North, and 46% in the Center. By household wealth, lack of improved coverage is 93% in the poorest quintile of households, but only 2% in the richest quintile[6].

Figure 1. Sanitation coverage by 6 major types (2006)



Source: Calculated by the authors from the Multiple Indicator Cluster Survey 2006 (MICS III)

The sanitation sub-sector has limited visibility in Lao PDR. Sanitation is not high on the political agenda, either at national or local level. In March 2008, the government established a National Steering Committee for Sanitation

4 UN Lao PDR. United Nations Common Country Assessment Lao PDR. UN Lao PDR Country Team and Lao PDR Government. 2005.
5 Lack of improved, or unimproved sanitation is "pit latrine without slab/open pit" and "no facilities or bush or field."
6 Lao MICS III 2006. Household wealth is estimated by ownership of assets/durable goods, etc.

to oversee the International Year of Sanitation activities, but so far this has not led to increased investment or commitments. That sanitation is low on the list of political priorities is also reflected in the low level of government investment in this sub-sector. Most provision is via household investment or donor projects.

A National Strategy for Rural Water Supply and Environmental Health (commonly known as the RWSS Strategy) was adopted in 1997 and updated in 2004. Both urban and rural sanitation are the responsibility of the Ministry of Public Health (MPH), through the National Centre for Environmental Health (Nam Saat). Implementation of the strategy has been constrained because it is poorly communicated and disseminated, and also because Nam Saat has limited financial resources for implementing policies and limited numbers of staff and capacities at provincial and district level to deliver fully on its mandate. Nam Saat hosts occasional meetings of the national sanitation group, which is essentially an information sharing forum (between those attending), but it does not facilitate sector planning, decision-making processes or resource mobilisation and deployment.

As well as the lack of national level investments by the Lao government or external partners in the sector, opportunities for attracting private sector engagement in the financing and provision of sanitation services have not been adequately developed and exploited, especially the potential for contribution by small-scale entrepreneurs.

Table 1. Lao population by region and by rural/urban location (2005)

Region	Rural ('000)	Urban ('000)	Total ('000)	Provinces
Vientiane Municipality	128.6	569.7	698.3	
North	1,448.7	299.6	1,748.3	Xayabouri, Phongsaly, Oudomxay, Luangnamtha, Luangprabang, Houaphanh, Bokeo
Central	1,711.8	1,033.0	2,744.8	Vientiane, Xiengkhuang, Borikhamxay, Khammuane, Savannakhet
South	939.3	189.5	1,128.8	Attapeu, Champasack, Saravane, Sekong
Total	**4,099.8**	**1,522.1**	**5,621.9**	

Source: Lao PDR Population and Housing Census 2005

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 roles improved water supply and sanitation services can play in the development process. Therefore, evidence is needed to support advocacy for increasing investment in sanitation. Such evidence should not focus exclusively on a single impact such as health impact, but on the full range of impacts such as 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 higher levels of government, 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 Lao PDR with better evidence on the negative economic impacts of poor sanitation and hygiene,
- To provide sanitation stakeholders with a better basis for arguing for increasing investment and for more rational policy making in and for 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 Lao PDR employs a standardized peer-reviewed methodology[7], which was also implemented in four other countries: Cambodia, Indonesia, 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 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 Lao Kip (LAK) 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 presents other aspects of the methodology and selected results.

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, this study recognizes other aspects of sanitation. The management of human excreta, animal excreta, solid waste, agricultural waste, toxic waste, wastewater and food, and associated hygiene practices are all included in a broader definition of sanitation. However, not all of these could be assessed in the Lao PDR study. Table 2 provides an overview of the aspects of sanitation which were included, with the main focus being on the human excreta aspect. In other countries, some but limited consideration was given to disposal of gray water and solid waste disposal.

Table 2. Aspects of sanitation included in the present sanitation impact study

Included	Excluded

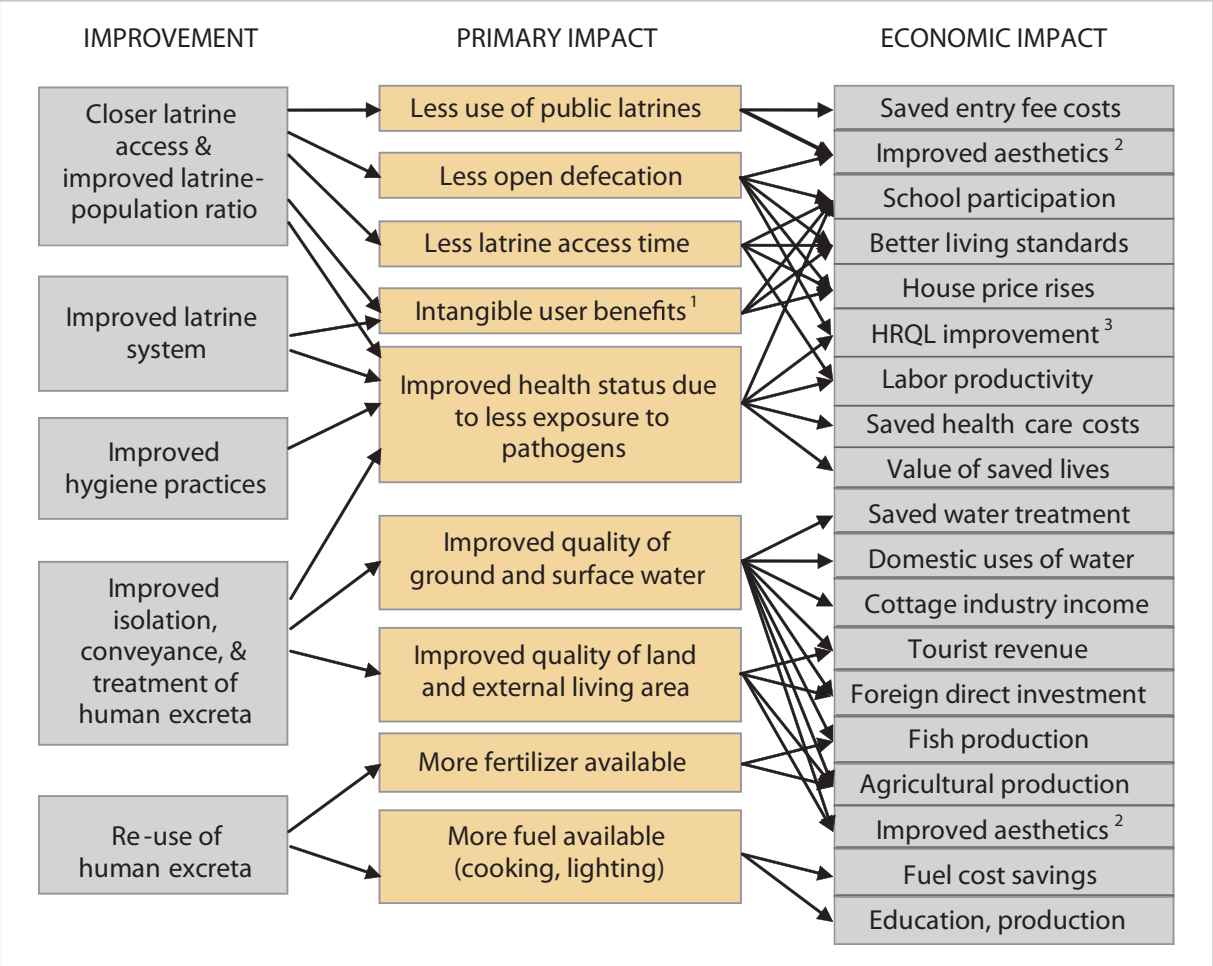
• Practices related to human excreta
  • Quality, safety, and proximity of latrine system
  • Disposal or treatment of excreta and impact on the (inhabited) outdoor environment
  • Hygiene practices (hand washing with soap)
	• Practices related to disposal or treatment of gray water
	• Practices related to disposal or treatment of household solid waste
	• Drainage and general flood control measures
	• Industrial effluents, toxic waste, and medical waste
	• Agricultural waste
	• Broader environmental sanitation
	• Vector control
	• Broader food safety
	• Practices related to use or disposal of animal excreta

7 The full methodology is described in the synthesis report "Economic Impacts of Sanitation in Southeast Asia". Water and Sanitation Program. 2008.

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 2. 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).

Figure 2. Primary impacts and resulting economic impacts associated with improved sanitation options ("disposal of human excreta")



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

Based on this initial assessment of a long list of sanitation impacts, a shortened list of four impacts was selected for evaluation in this present study, based on potential importance and/or measurability. These are

- Health impacts
- Water resource impacts
- Other welfare impacts
- Tourism impacts

Table 3 shows the financial and economic costs quantified in this study. Note that some impacts such as 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 (column 3) are not distinguished in this study, due to difficulties in separating between economic and financial costs with the data available for the study. Other less tangible or quantifiable welfare impacts were assessed but not expressed in monetary units; these along with other non-quantified impacts are listed in Annex Table B1.

Table 3. Financial and economic costs of poor sanitation measured in the study

Impact category	Sub-impacts evaluated	Economic costs attributable to poor sanitation
1. Health	Health care costs	Full costs of health seeking, including formal health care services and traditional healers
	Productivity costs	Welfare or income loss due to adult and child sickness time
	Premature mortality	Discounted lifetime income losses for adult & child death
2. Water resources	Drinking water costs	Water treatment and distribution
3. Other welfare	Time loss	Welfare loss due to adult & child travel time for open defecation
4. Tourism	Tourism costs	Revenue loss from tourism potential not fully exploited

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 four *features* of sanitation improvements shown in Figure 2 (excluding excreta reuse), plus improved sanitation for tourists, as shown in Table 4. 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 costs and benefits of sanitation improvements from field settings in Lao PDR, available from a forthcoming follow-up study.

Table 4. 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)*
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)*
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
Sanitary conditions for tourists	Culturally appropriate improved tourist toilet facilities (hotels, restaurants, tourist attractions) and general environmental sanitation	Avert tourist losses

* Sourced from a meta-analysis of international evidence on water, sanitation and hygiene improvement impacts by Fewtrell et al (2005)[8].

8 Fewtrell L, Kaufmann R, Kay D, Enanoria W, Haller L and Colford JM (2005). Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. Lancet Infectious Diseases, Volume 5:42-52.

3 Results

3.1 Summary of economic impacts of poor sanitation

The overall economic losses from poor sanitation and hygiene amount to LAK 1.9 trillion (USD 193 million) per year (see Table 5). This sum is equivalent to 5.6 % of GDP in 2006, amounting to approximately LAK 346,000 (USD 34.4) per person per year. To give an indication of the relative impact on the Lao economy, where the average price level is 28% of that of the United States (when prices are compared at market exchange rates), the impact in international dollars is ID 690 million[9].

Table 5. Economic losses due to poor sanitation, by impact type (2006)

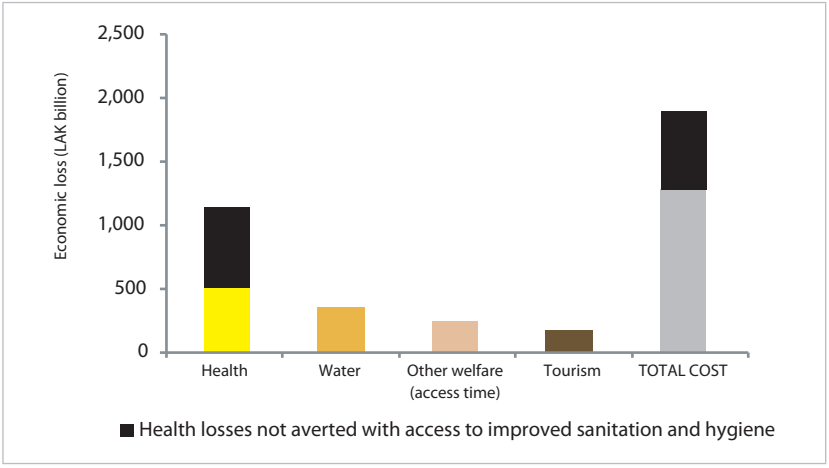
Impact	Total Economic Losses		Per Capita Losses		Share (%)
	LAK (billion)	USD (Million)	LAK	USD	
Health costs	**1,165.6**	**115.8**	**207,335**	**20.60**	**60%**
Health care costs	50.9	*108.9*	9,052	0.90	*3%*
Productivity costs	18.8	*1.9*	3,346	0.33	*1%*
Premature death costs	1,096.9	*5.1*	194,938	19.37	*56%*
Water costs	**354.3**	**35.2**	**63,032**	**6.26**	**18%**
Boiling of drinking water	131.5	*13.1*	23,381	2.32	*7%*
Bottled water consumption	172.5	*17.1*	30,675	3.05	*9%*
Treatment of municipal water	50.4	*5.0*	8,968	0.89	*3%*
Other welfare (time use)	**249.0**	**24.7**	**44,292**	**4.40**	**13%**
Tourist loss	**174.3**	**17.3**	**31,002**	**3.08**	**9%**
TOTAL	**1,943.0**	**193.2**	**345,653**	**34.4**	**100%**

Source: Estimated by the authors.
USD 1 = LAK 10,063.

Out of the LAK 1.9 trillion economic losses, health impacts account for 60% (LAK 1.2 trillion), water impacts 18% (LAK 354 billion), welfare losses 13% (LAK 249 billion), and tourist loss 9% (LAK 174 billion). These figures exclude a whole range of other impacts that were not quantified in this study (see Annex Table B1).

By improving sanitation and hygiene, the majority of negative impacts can be averted, (the lower section of the bar in the 'Total Cost' bar of Figure 3) **equivalent to LAK 1.3 trillion**. With universal sanitation coverage,

Figure 3. Economic losses due to poor sanitation and hygiene, by impact type (LAK billion, 2006)



Source: Estimated by the authors.

9 Purchasing Power Parity (PPP) is a form of exchange rate that takes into account the cost and affordability of common items in different countries, usually expressed in the form of US dollars. The purchasing power exchange rate equalizes the purchasing power of different currencies in their home countries for a given basket of goods. The best-known and most-used purchasing power parity exchange rate is the Geary-Khamis dollar (the "international dollar").

it is envisaged that the majority of higher water access costs attributed to poor sanitation can be averted, as well as all the access time costs, and the tourism losses attributed to poor sanitation. In terms of health costs attributed to poor sanitation and hygiene, improving basic sanitation and hygiene interventions are assumed to have a maximum combined reduction in diarrheal disease and related conditions of 45% (see Footnote 8). Hence, out of the total health economic losses of LAK 1.17 trillion, only 45% of these, or LAK 0.55 trillion, can be averted (see Figure 3).

In conclusion, protecting water resources, averting health impacts, reducing access time and the potentially positive impacts on tourism, are just four potential major benefits of a sanitation program, as quantified in this study. 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 a Lao 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 and time losses associated with disease, and (3) the value associated with premature loss of life.

Poor sanitation and hygiene cause significant burden of disease in Lao PDR through illness and premature death. Given the large number of diseases and health effects due to poor sanitation and hygiene (see Annex Table B2), this study selected only some key health impacts based on their epidemiological and economic importance, and on the availability of data from national statistics and research studies. Table 6 shows the estimated number of episodes attributed to poor sanitation and hygiene for the selected diseases: diarrheal disease, typhoid, hepatitis, dysentery, scabies, and diseases related to malnutrition (acute lower respiratory infection and malaria)[10].

Table 6. Annual disease cases attributed to poor sanitation and hygiene (2006)

Disease	Children <5	Children 5-14	Population 15+	Total
Diarrhea	1,160,720	800,800	898,480	2,860,000
Typhoid	196	1,441		1,637
Hepatitis	18	209		227
Dysentery	110	629		739
Scabies	7,496	283		7,779
Total direct cases	**1,168,540**	**1,701,842**		**2,870,382**
ALRI	64,569	-[1]		64,569
Malaria	14,138	-[1]		14,138
Total indirect cases	**78,707**	-[1]		**78,707**
Total cases	**1,247,247**	**1,701,842**		**2,949,089**

Source: Estimated by the authors based on methodologies applied in ESI and data from Epidemic Control Centre; MICS III (2006); LRHS (2005).
ALRI - acute lower respiratory infection.

Almost three million cases of diarrhea were attributed to poor sanitation and hygiene (Table 6). Annual incidence of diarrhea in children under five was estimated from the average of the prevalence rate in the Multiple Indicator Cluster Surveys III (MICS) conducted in 2006 (12.4% prevalence rate) and the Lao Reproductive Health Survey (LRHS) conducted in 2005 (5.7% prevalence rate). This gives an estimated 1.9 cases per child under five per year. Based

10 Methodology for estimating mortality and morbidity from malnutrition attributable to diarrheal infections from sanitation and hygiene is provided in: World Bank (2008). Environmental health and child survival: epidemiology, economics, experiences, and also in World Bank (2008). Economic impacts of sanitation in Southeast Asia – a four country study conducted in Cambodia, Indonesia, the Philippines and Vietnam under the Economics of Sanitation Initiative (ESI). Water and Sanitation Program.

on the available estimates from WHO for older age groups, children 5-14 years old were estimated to have 0.6 cases of diarrhea per year, and adults 0.3 cases per year. In addition to these, 1.6 thousand cases of typhoid and 7.8 thousand cases of scabies attributed to poor sanitation and hygiene were reported from the national health information system. Counting indirect diseases related to nutritional status, almost 80 thousand cases of acute lower respiratory infection (ALRI) and malaria are estimated to be attributed to poor sanitation and hygiene in the under five age group. Over 80% of these are accounted for by ALRI[11]. 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, or being reported by, a public service provider in Lao PDR.

The total number of deaths attributed to poor sanitation and hygiene exceeds 6,000, of which 3,600 are accounted for by diarrhea and 2,400 by indirect diseases related to malnutrition (Table 7 and Figure 4). Ninety-five percent of these deaths are accounted for by children under five. Due to weak data, especially for the population over five years of age, these figures are likely to underestimate the total deaths.

Table 7. Annual deaths attributed to poor sanitation and hygiene, by age group (2006)

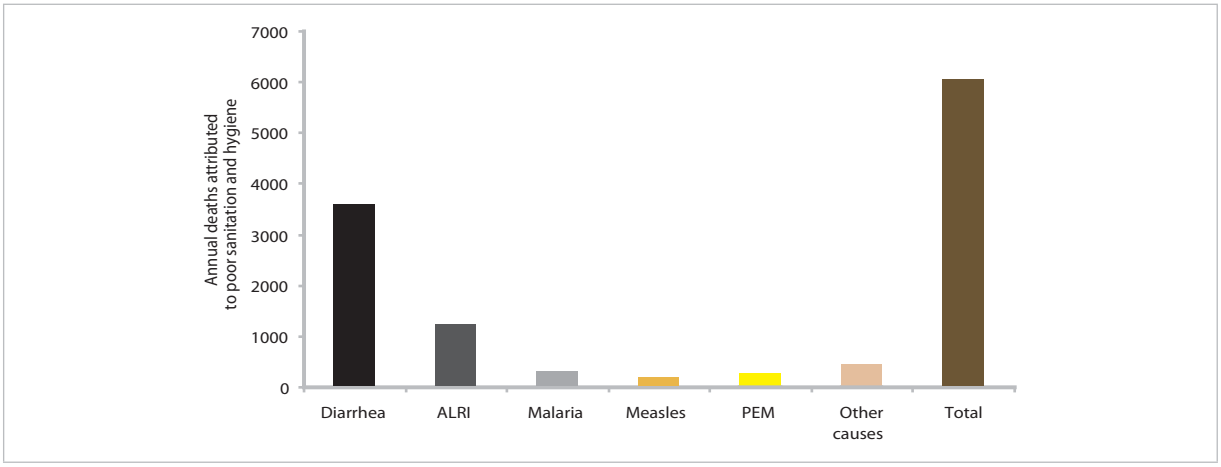
Disease	Children <5	Population 5+	Total
Diarrhea	3,256	352	3,608
Total direct deaths	**3,256**	**352**	**3,608**
Acute lower respiratory infection	1,236	-[1]	1,236
Malaria	330	-[1]	330
Measles	187	-[1]	187
Protein energy malnutrition[2]	264	-[1]	264
Other causes[2]	439	-[1]	439
Total indirect deaths	**2,456**	-[1]	**2,456**
Total direct + indirect deaths	**5,712**	**352**	**6,064**

Source: Estimated by the authors using methodologies applied in ESI and baseline mortality statistics for Lao PDR from WHO, adjusted to a under 5 child mortality rate of 98 per 1000 live births in 2005.

[1] Not available

[2] Not included in economic losses in this study. These consist of deaths from other infectious including tuberculosis, other childhood cluster diseases, meningitis, hepatitis, dengue fever, and tropical cluster diseases.

Figure 4. Annual deaths attributed to poor sanitation and hygiene (2006)



Source: Estimated by the authors.

11 Based on ALRI incidence from WHO Global Burden of Disease and malaria incidence in Korenromp E. (2005): Malaria incidence estimates at country level for the year 2004. World Health Organization. Roll Back Malaria. Geneva, Switzerland.

The group most vulnerable to disease from poor sanitation and hygiene are young children. The risk of children getting disease varies according to a whole range of contextual factors: environment, socio-economic condition, and rural/urban residence. For Lao PDR, these factors remain largely unanalyzed. However, the MICS III survey in Lao PDR collected selected health data on children under five, thus allowing crude comparisons between major risk factors. The survey collected diarrheal prevalence in children under five years of age over the two weeks before the survey, and disaggregated children by sanitation coverage and nutritional status. **Children living in a household with no toilet facility have a clearly higher diarrheal prevalence (2.9 cases per year) than those with toilet facility (2.0 cases per year)**. Likewise, rates of diarrheal disease are lower in urban areas (1.4 cases per year) compared with rural areas (2.8 cases per year). Table 8 shows diarrheal disease is higher in children with worse nutritional status. For example children with severe malnutrition (severe underweight) had a more than two times higher chance of having diarrhea than children with normal weight for age.

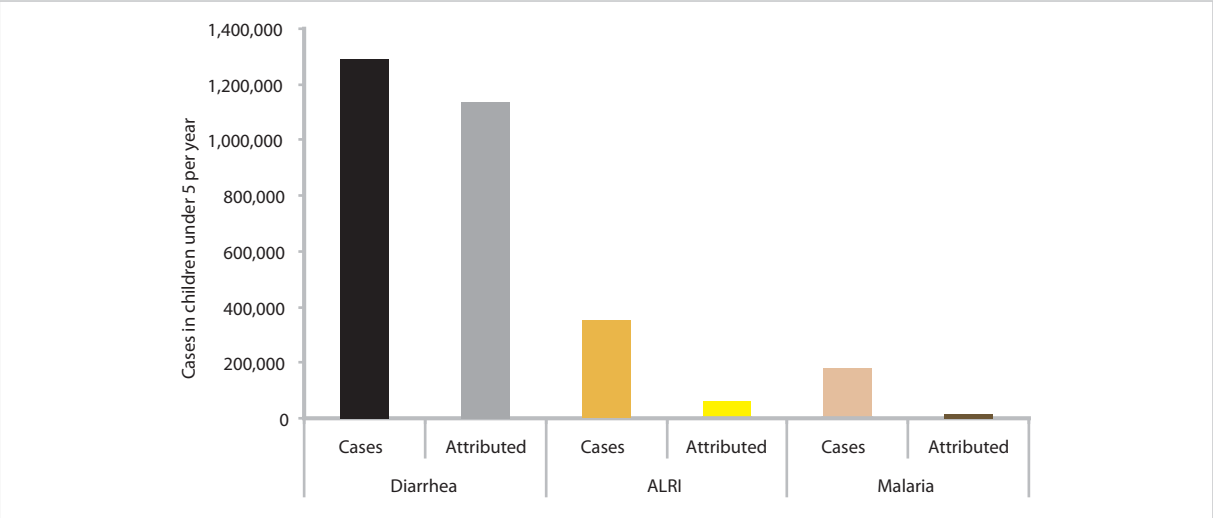
Table 8. Number of cases of diarrhea per year by children's nutritional status (2005)

Age group	Weight for age status				All
	Not underweight	Mild underweight	Moderate underweight	Severe underweight	
Age < 12 months	1.9	3.1	3.4	6.4	2.5
Age 12-59 months	2.0	2.3	2.7	4.5	2.6
Age < 60 months	**2.0**	**2.4**	**2.8**	**4.6**	**2.6**

Source: Estimated from MICS III 2006 for children aged 0-4 years. Note: Mild underweight is weight-for-age z-score (WAZ) of -1 to -2; moderate underweight is WAZ of -2 to -3; and severe underweight is WAZ < -3.

For children under five years of age, Figure 5 shows the estimated total cases from three selected diseases, and the number of cases attributed to poor sanitation and hygiene. From international literature, 88% of diarrheal cases are estimated to be due to poor sanitation and hygiene[12]. In the cases of indirect diseases, ALRI and malaria are linked to poor sanitation through the impact of diarrheal disease on nutritional status, and subsequent vulnerability to other diseases. It is estimated that 21% of ALRI cases and 9% of malaria cases are attributed to poor sanitation and hygiene.

Figure 5. The difference between total cases and cases attributed to poor sanitation and hygiene, in children under five (2006)



Source: Estimated by the authors.

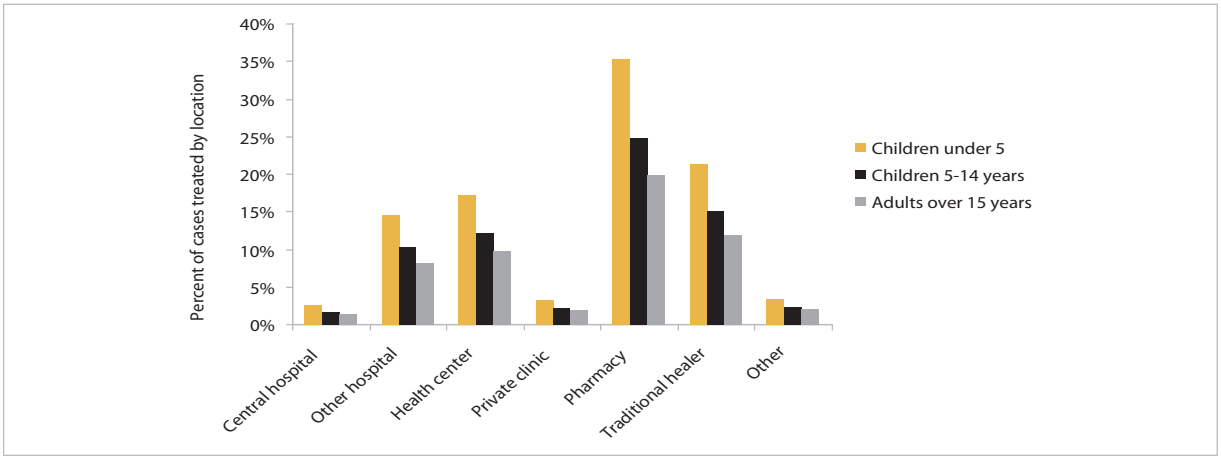
12 This assumes that diarrhea transmitted via water is ultimately caused by poor sanitation and hygiene.

A range of other diseases have not been quantified in this study due to lack of national data. One major disease condition, especially for children, is intestinal helminthes. No studies were found for Lao PDR suggesting the current rates of helminthes infection. However, in East Asia helminthes are cited to have prevalence rates of 36% (roundworm), 28% (whipworm) and 26% (hookworm)[13]. Estimates from the Centre for Malariology, Parasitology and Entomology (CMPE) at the Ministry of Health in Lao PDR suggest 36% prevalence in children under five, and 52% in the over five population. Using these figures, it is estimated that 250,000 of the 700,000 children under 5 years old, and 2.5 million of the 4.9 million population over five years of age, are infected with one or more helminthes. However, these estimates need to be substantiated with field studies from Lao PDR. Annex Table B2 also shows some other health problems caused by poor water and sanitation.

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. According to a national survey (LRHS 2005), 71% of children under five receive treatment for diarrheal disease when sick. The proportions are lower for older children and adults and are estimated to be 50% and 40% respectively, based on international comparative evidence. Figure 6 shows the type of provider sought for cases that are treated for diarrheal disease, by age group. For all age groups, the most commonly reported provider is the pharmacy or drug sellers, followed by traditional healers, these being the most accessible especially in rural areas. Formal health centers and hospitals are chosen by over 30% of under fives treated.

Figure 6. Type of provider sought for treated cases of diarrhea, by age group (2005)

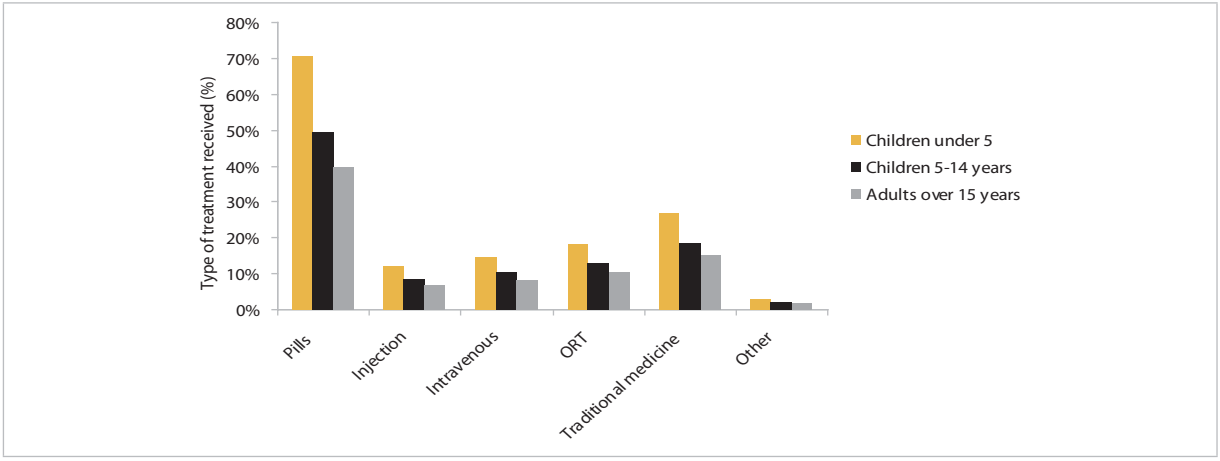


Source: LRHS, 2005 for children under 5. Estimated by the authors for population 5+ years.

For diarrheal disease, the most common type of treatment received is pills, with over 70% of under five year olds reported as receiving pills as part of their treatment (Figure 7). No other type of treatment accounts for more than 30% of cases. As the % cases sum to more than 100%, it is clear that children under five receive more than one type of treatment per disease episode.

13 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.

Figure 7. Type of treatment provided for diarrhea, by age group (2005)



Source: LRHS, 2005 for children under 5. Estimated by the authors for population 5+ years.

To estimate the costs of treatment seeking for diarrheal incidence, health care unit costs were applied country-wide, based on interviews with health staff and pharmacies, as well as using assumptions (Table 9). The cost of treatment at a medical facility, not including medicines, injections or intravenous drip, was estimated at LAK 29,000 (USD 2.88), while the cost of oral rehydration therapy is LAK 5,030 (USD 0.50), medicines LAK 10,063 (USD 1.00), injections or intravenous treatment LAK 20,126 (USD 2.00), traditional medicines LAK 5,030 (USD 0.50), and consultation with traditional healer LAK 10,063 (USD 1.00). Costs of typhoid, dysentery, hepatitis A and scabies were higher at LAK 230,000 (USD 22.9), LAK 324,000 (USD 32.2), LAK 208,000 (USD 20.7) and LAK 34,000 (USD 3.4) per case, respectively.

Unlike diarrheal disease, no comprehensive data sets on treatment rates of ALRI and malaria are available. MICS III reports that 53% of children under five with suspected pneumonia received antibiotics. Treatment rates of 53% for ALRI and 50% for malaria are therefore applied in this study. Treatment cost of ALRI is the cost of consultation plus antibiotics for a 10-day treatment, based on pharmacy prices, giving a total treatment cost of LAK 25,000 to 50,000 (depending on location). Treatment cost of a case of malaria is estimated at LAK 173,000 to 231,500 (depending on location).

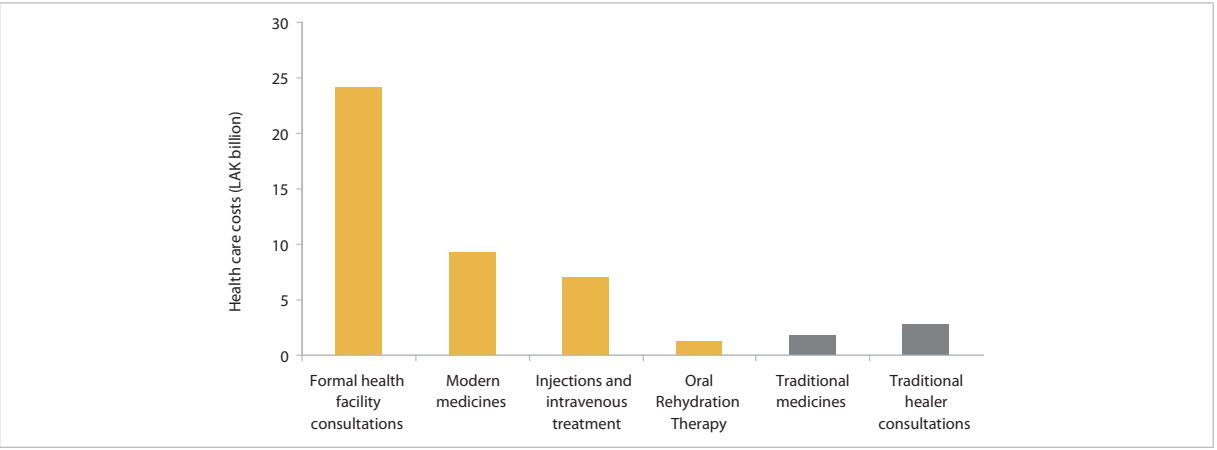
Table 9. Unit treatment costs at formal health centers for major diseases (2006)

Diseases	Rural clinic (LAK)	Urban clinic (LAK)	Rural clinic (USD)	Urban clinic (USD)
Diarrhea	25,157	50,315	2.5	5.0
Typhoid	230,443		22.9	
Dysentery	324,029		32.2	
Hepatitis A	208,304		20.7	
Scabies	34,214		3.4	
ALRI	25,157	50,315	2.5	5.0
Malaria	173,084	231,449	17.2	23.0

Source: Unit costs obtained and estimated by the authors.

Putting together disease rates with treatment seeking and unit costs of care, the total health care costs of treating diseases of poor sanitation and hygiene amount to LAK 46.3 billion (USD 4.6 million). The highest cost is consultations at formal health facilities, mainly public (Figure 8). A smaller proportion of costs (LAK 4.5 billion, or USD 0.46 million) are associated with consulting traditional healers. Hence, a significant proportion of the overall costs would be saved by patients and to government budgets if sanitation and hygiene-related diseases were prevented.

Figure 8. Total health care costs by treatment type (LAK billion)



Source: Estimated by the authors.

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. Economic costs were estimated as the time lost from daily activities, valued for adults at 30% of the national GDP per capita of USD 600, or LAK 3,020 (USD 0.30) per hour, giving LAK 906 (USD 0.09) per hour as the national average value of lost time[14]. Child time was valued at half that of adult time at LAK 453 (USD 0.045) per hour – to account for the time taken off school or other productive activities. Time off daily activities varied by disease – one day for diarrheal disease (two hours per day for four days), seven days for dysentery, ten days for typhoid and scabies, and fifteen days for hepatitis. Total productivity losses are LAK 18.8 billion per year (USD 1.9 million) (Figure 9).

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[15]. As an approximate value of annual income, the average GDP per capita in 2006 of LAK 6 million (USD 600) was applied. This gives an equivalent value of life of LAK 133 million (USD 13,246) for those dying as productive adults (those over 15 years of age, with a median age of 40 years old); LAK 224 million (USD 22,282) for those dying between the ages of 5 and 14 (median age of 10 years old); and LAK 209 million (USD 20,811) 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[16]. Total costs of premature death equal LAK 1.1 trillion (USD 108 million) per year (see Figure 9).

In sensitivity analysis, the VOSL method is used. Due to the absence of studies on VOSL in Lao PDR, an average VOSL of USD 2 million is transferred from OECD country studies. The transfer is made at an income elasticity of 1.0, and adjusted by the difference in GDP per capita between these countries and Lao PDR. The resulting unit economic

14 The average GDP per capita of USD 600 compares with the average income per capita estimated by NERI in urban areas (USD570) and in rural areas (USD 285), and the national average (USD 356). However, the downward adjustment of 30% of GDP per capita leads to a conservative estimate of time value.

15 It is important to note that these values are economic values and do reflect the ethical value of life.

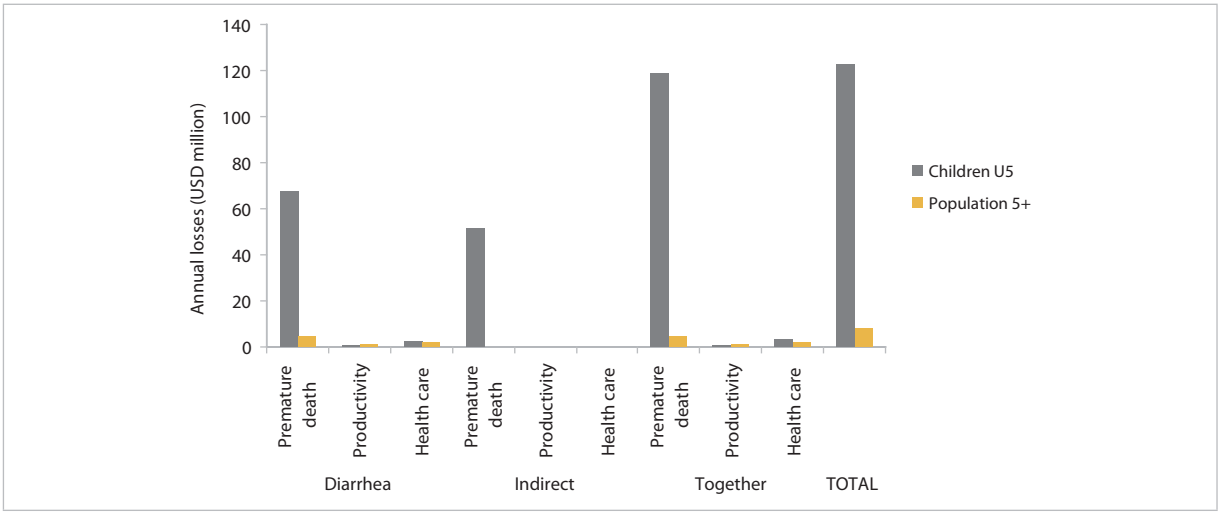
16 The human capital values calculated here are based on a working life from 15 to 65 years, an annual growth in real income of 2%, and an annual discount rate of 3%.

value for premature death valued at VOSL is LAK 403 million (USD 40,000), giving annual premature mortality costs of LAK 2.44 trillion (USD 243 million). In other words, the total cost of mortality is more than twice as high using VOSL approach as when using the human capital approach.

3.2.5 Summary of health-related costs

Figure 9 summarizes the estimated economic cost of the health impacts of poor sanitation and hygiene in Lao PDR (Annex Table B5 provides the figures). The majority of these costs – 93% – are accounted for by premature death.

Figure 9. Health-related costs of poor sanitation and hygiene (2006)



Source: Estimated by the authors. "Indirect" refers to diseases related to nutritional status, which is affected by poor sanitation and hygiene. "Together" sums "Diarrhea, hepatitis and typhoid" combined with "Indirect" cost.

3.3 Water resource impacts

3.3.1 Water resources and water pollution

Lao PDR is well endowed with water resources, with an average surface water volume of 60,307m^3 per person per year compared with 6,020m^3 in the East Asia and Pacific Region. Indeed, water is an essential part of the life and culture of Lao people, and makes an important contribution to the socio-economic development goals of the country. Hydropower is increasingly contributing to the economy. Overall, water demand was roughly 260m^3 per person in the year 2002. Water usage is predominantly agricultural 82%, followed by industrial 10%, and domestic 8%.

Average annual rainfall ranges from 1,300mm per year in the northern valleys to 3,700 mm per year at higher elevations in the south. Nationwide, the seasonal variation in rainfall is about 80% during the rainy season (May-October) and 20% in the dry season (November-April). The total of annual water flow in Lao PDR of 270 billion cubic meters is equivalent to 35% of the average annual flow of the whole Mekong Basin. Annex Table B6 shows the watershed area and annual discharge of eleven major river basins in Lao PDR.

In general, the water quality of rivers within Lao PDR and the Mekong is considered to be good, based on international standards. The level of oxygen is high and the nutrient concentration is low. With the pressure of rapid demographic growth, socio-economic development and urbanization, however, the water quality is increasingly exposed to deterioration. In 1999, it was estimated that 35% of liquid effluent disposal to inland surface waters from all sources was treated. In recent years, some problems have emerged related to waste and polluted surface water in major urban areas from varied community use (residential density, hotels, hospitals and entertainments centers). No urban

centers, including the capital Vientiane, have comprehensive piped sewerage systems or wastewater collection, treatment and disposal systems. At the Mekong River downstream of Vientiane, for example, low concentrations of dissolved oxygen (DO) have been observed. The quality of surface and ground water is sometimes poor, creating many types of diseases in both urban and rural areas and in both the rainy and dry season. The effects of the lack of access to clean water – either surface or ground water – are mainly felt at the local level and particularly affect poor people in remote areas. In urban areas, piped water rates are frequently higher for the poor as they often have secondary connections (often being unable to afford a direct connection) through others, but pay a premium to those others for volumes used.

Lao PDR has water quality standards[17] based on the WHO guidelines. A number of different agencies and institutions have mandates related to water supply and quality: the Department of Irrigation in the Ministry of Agriculture and Forestry is responsible for monitoring ambient water quality; the Water Resources and Environment Administration deals with urban wastewater quality; Water Supply Authority for urban water supply quality; and Ministry of Public Health for drinking water quality. Overall, there appears to be little coordination and very little overall monitoring and systematic reporting on water quality in Lao PDR.

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. For some 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. This study therefore focuses on the costs of assessing clean drinking water only.

3.3.2 Drinking water costs

Due to polluted local and freely-available water sources which impose health risks, households may choose to take one or more of four avertive strategies, which have financial or opportunity costs, or both, attached to them: (1) household water treatment, (2) household piped water from treated sources, (3) travel further to collect cleaner water than the closer but polluted water source, or (4) purchase bottled (treated) water. Obviously, the choice depends on the options available to each household and their costs. Of those treating water themselves, boiling water is still the most common method in Lao PDR. Table 10 shows available data on the proportion of households boiling water in rural and urban areas, varying from an estimated 10% in Vientiane (due to sourcing municipal piped treated water and purchase of bottled drinking water) to 83% in Lamam town in Sekong province. Table 11 shows the types of fuel used for cooking in urban and rural areas, which – to a large extent – indicates the type of fuel use for boiling water. Table 12 shows the proportion of households consuming bottled water as their main drinking water source, ranging from 0% in rural areas without roads to an estimated 80% in Vientiane Municipality, and national average 17%.

Table 10. Proportion of households boiling water

Areas covered by study	Population	%
Lamam (small town), Sekong province	Rural (always or usually)[1]	83%
Phongsaly town (small town), Phongsaly province	Rural (always or usually)[1]	73%
32 rural villages in 4 provinces	Rural (regularly)[1]	68%
Vientiane Urban population	Urban (always or usually)[2]	10%
Other urban areas	Urban (always or usually)[2]	56%

Sources: [1] Poverty Environment Nexus Report, World Bank, 2006; [2] Estimated by the authors based on source of drinking water.

17 MoPH (2005): Decision on the Management of Quality Standards for Drinking Water and Household Water Supply.

Table 11. Fuel used for cooking

Fuel type	Urban	Rural
Electricity[1]	3.8%	0.1%
LPG[2]	2.5%	0.1%
Gas[2]	1.0%	0.0%
Charcoal[1]	34.6%	7.4%
Wood[1]	55.1%	88.5%
Sawdust[1]	0.3%	0.0%
Other[1]	2.7%	3.9%
Total	**100%**	**100%**

Sources: [1] Census, 2005; [2] MICS III, 2006

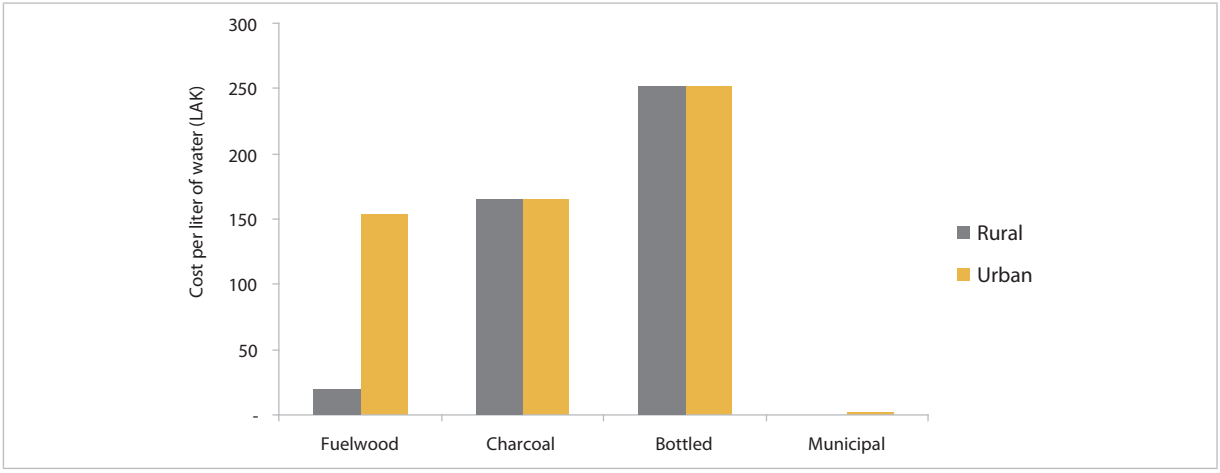
Table 12. Proportion of households consuming bottled water as their main drinking water source (2006)

Location	%
Rural with road	8%
Rural without road	0%
Vientiane Municipality	80%
Other urban areas	34%
Urban Total	**52%**
NATIONAL	**17%**

Sources: MICS III, 2005/06. Note: MICS provides figures for total urban. Estimates for Vientiane and Other urban separately are by the authors.

Unit cost information for various water sources was gathered from several sources. The cost of household water treatment by boiling was estimated based on the two main fuel sources – wood and charcoal – and the purchase price or collection costs of boiling two liters per person per day. The weighted average cost per liter is LAK 20 for fuel wood, which is largely collected, and LAK 165 for charcoal, which is largely purchased. Bottled water purchased in large bottles costs on average LAK 252 per liter, while municipal piped water costs LAK 2.2 per liter (or USD 0.22 per cubic meter). Due to lack of data, it is conservatively assumed that no households walk further to access their water from cleaner sources than the most local and easily accessible.

Figure 10. Cost per liter of clean water sources (2006)



Source: Estimated by the authors.

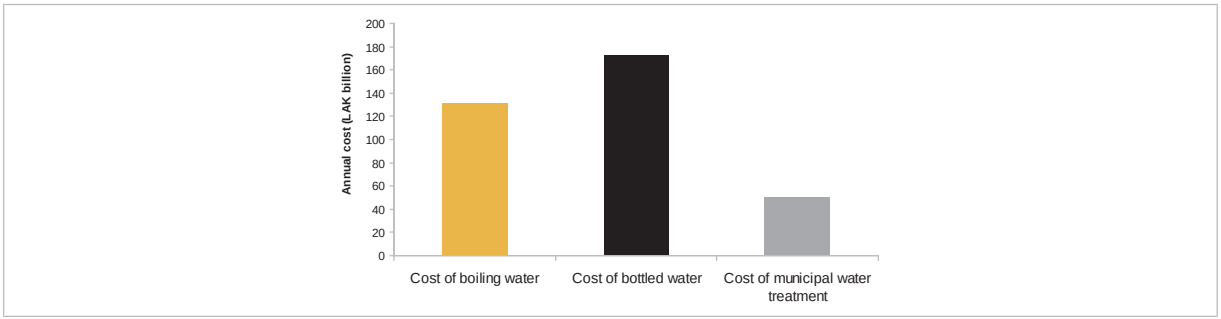
Table 13 and Figure 11 show the total costs attributed to poor sanitation of accessing drinking water, including only the daily needs per capita for drinking water. The economic cost is LAK 354 billion (USD 35.2 million) per year. The largest cost component is for bottled water (49%) and household water treatment (37%). The annual cost in 2006 was 1% of national GDP.

Table 13. Drinking water access costs per year (LAK billion, 2006)

Clean water source	LAK (billion)	USD (million)	%
Cost of boiling water	131	13.1	39%
Cost of bottled water	172	17.1	49%
Cost of municipal water treatment	50	5.0	12%
Total cost	**344**	**34.2**	**100%**

Source: Estimated by the authors.

Figure 11. Drinking water access costs per year (LAK billion)



Source: Estimated by the authors.

It is argued that pollution of some local water sources is directly attributed to poor human and animal sanitation, as well as other sources of pollutants. National data show that in 60% of communities using dug wells as their main source of water, frequent outbreaks of diarrhea and related diseases occurred. Seventy percent of dug wells were found to pose intermediate risks to health, while 20% were considered high risk. This suggests that the source of the disease may be water borne and originate from the dug wells. Many of these wells are not protected (properly covered and partially lined). In comparison, the level of diarrhea and similar diseases in communities using hand-pumps or gravity-fed systems, was much lower: 23% where hand-pumps were used and 16% for communities with gravity-fed systems (usually in remote and less populated areas). Hence it is not unrealistic to argue that a significant proportion of these costs are due to unimproved sanitation.

In addition to the increased cost of accessing water for drinking purposes, poor sanitation also increases water access costs for other purposes such as domestic uses, as well as reducing the productivity of water (see Annex Table B1). As noted already, reduced water quality may affect fish health via pathogen ingestion and compromised dissolved oxygen, thus potentially affecting fish catch. Due to the lack of supporting data and thus high level of uncertainty associated with these impacts, they were not evaluated for the Lao PDR study.

3.4 Other welfare impacts

3.4.1 Aesthetics outside the household

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. 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.

3.4.2 Intangible welfare impacts related directly to latrine-type

Difficulties in quantification aside, no studies at the national level provide information on what is classified in the present study as "intangible welfare" impacts of poor sanitation. The type of sanitation facility a household has will have a range of impacts on population welfare (well-being, living standard). An important but difficult to quantify aspect is the welfare impact on individuals and families that use a sub-standard or 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.

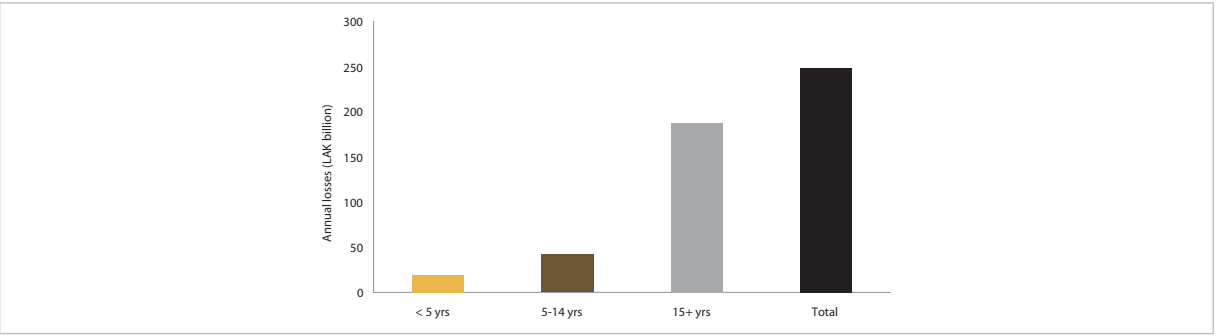
With the high levels of unimproved sanitation in Lao PDR, welfare losses due to a number of 'intangible' aspects of poor sanitation could provide important arguments for sanitation programs. However, to date no studies examining these aspects in Lao PDR have come to light.

- Comfort and 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 off the property 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.

3.4.3 Access time

Welfare loss from increased access time arising from lack of access to improved sanitation. For households practicing open defecation, it is assumed 20 minutes extra are required per day to find a secluded spot for defecation. The economic losses were computed on the basis of forgone income and value of time. In the case of adults, this was assumed to be 30% of the average GDP per capita. The time value of children was assumed to be half the value of adult time. The total economic cost is estimated to be LAK 249 billion (USD 24.7 million) per year (Figure 12). When the access time per day is changed, the resulting economic losses range from LAK 125 billion (for 10 minutes per day) to LAK 373 billion (for 30 minutes per day).

Figure 12. Value of loss of time due to open defecation practices (2006)



Source: Estimated by the authors.

3.4.4 Impact on life decisions and behavior

Running water supply and sanitary latrines in schools are a luxury 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. In Lao PDR, a significant number of schools either do not have toilets, or the toilets are in an unacceptable condition for student use.

3.5 Tourism impacts

Tourism is a key sector in Lao PDR. Providing LAK 1.74 trillion (USD 173 million) in revenue in 2006, tourism is an important source of local government tax income, as well as jobs. In 2006, 1.2 million foreign visitors traveled to Lao PDR (see Table 14). Currently, foreign tourists spend on average LAK 322,000 (USD 32) per day, and stay on average 4.5 days, giving an average revenue per tourist visit of LAK 1.4 million (USD 142). The tourist industry is expected to continue growing at over 4% per annum over the next 10 years[18].

The number of tourists considering Lao PDR 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 both 'higher-value' tourists, that is, those who are willing to pay more for their holiday, and also tap the potential for longer stays and increase the distribution of eco-tourism/community and homestay based tourism favored by the independent traveler.

18 World Travel and Tourism Council, 2008 Report for Lao PDR.

Table 14. Number of tourists and revenue from tourism in Lao PDR, 2001- 2006

Year	Number of tourists, 000'	Average length of stay	Average expenditure per person per day (USD)	Total Revenue (USD million)
2001	674	5.2	30	104
2002	736	4.3	36	113
2003	636	4.0	34	87
2004	895	4.3	31	119
2005	1,096	4.5	30	147
2006	1,215	4.5	32	173
Total/Average	5,252	4.4	33	743
Of which:				
International Tourists	1,453	6.6	51	489
Regional Tourists	3,799	3.6	26	254

Source: estimations based on Laos National Tourism Authority data

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 other countries in the region with higher visit rates, higher daily expenditure and longer average length of stay. The current hotel occupancy is low, but tourist accommodation capacity is increasing. It is expected that within a few years, tourist arrivals to Lao PDR could double – assuming it can attract greater tourist numbers. A doubling would lead to annual revenue gains of at least LAK 1.74 trillion. Assuming that 10% of these revenue gains are attributable to improved sanitation, present poor sanitation conditions are estimated to contribute LAK 174 billion (USD 17.3 million) in losses annually. This corresponds to 9% of the total quantified economic losses due to poor sanitation and hygiene.

4 Recommendations

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

The economic costs of LAK 1.9 trillion (USD 193 million) associated with poor sanitation and hygiene are considerable, totaling 5.6% of national GDP. Hence, the developmental benefits of investing in improved sanitation and improved hygiene practices are potentially huge, leading to averted costs of at least LAK 1.3 trillion. These investments will also contribute to mitigating a number of other impacts not quantified in this study, as well as generating further benefits through excreta reuse 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 half of Lao 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 the urban poor

Losses are incurred in both rural and urban populations where sanitation is unimproved, thus justifying investment to both unserved rural and poor urban areas, and the targeting of financial investment/support and subsidies to the most deserving populations. 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 additional motivation and resources to reach the first rung of the sanitation ladder and beyond. Sanitation programs should aim to achieve comprehensive coverage, including elimination of open defecation, to achieve the greatest reduction in disease rates.

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 there are significant economic losses from poor personal hygiene practices. A simple intervention such as hand washing with soap can lead to substantial economic benefits in the form of lower disease incidence and averted health costs. The 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. Better monitoring and further evaluation of the impact of improved sanitation options in Lao PDR

A systematic and pragmatic water quality surveillance structure incorporating public health risk assessment is needed in Lao PDR in order to realistically analyze the quality of the water (on a regular basis) and be able to communicate how to prevent public health hazards from different pollution sources. A system of health risk evaluation should be created to target the high-risk areas and as a result improve the health status of the population.

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.

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

$$CW = CW\_Drink \quad (3)$$

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

$$CW\_Drink = \sum_{m} CW\_Drink_{m} \tag{12}$$

Cost of accessing clean drinking water per source/treatment method

$$CW\_Drink_{m} = h_{m} \cdot wdrink_{m} \cdot pwater_{m} \cdot \delta \cdot \pi_{m} \tag{13}$$

A4. User preference costs algorithm

Time access cost for unimproved latrine

$$CU\_T = pop\_u \cdot taccess \cdot ptime \cdot 365 \tag{14}$$

A5. Tourism losses

Lost revenues

$$CT\_RL = \varphi \cdot \left(\frac{oc_{O}}{oc_{A}} - 1 \right) \cdot ta \cdot et \tag{15}$$

Tourist health cost and welfare loss

$$CT\_HT = td \cdot \mu \cdot (pahc + pawl) \tag{16}$$

A6. Variable definition summary

Tables A1 to A3 present the subscripts, variables and parameters used in the algorithms in Sections A1 to A5 above.

Table A1. Subscripts used in algorithms

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

[1] Varies by country.

Table A2. Variables used in algorithms

Symbol	Description
C	Total cost of poor sanitation and hygiene
CHC	Health costs of poor sanitation and hygiene
CH_HC	Health care costs of all diseases
CH_HC_i	Health care cost of disease type *i*
CH_P	Productivity costs of diseases
CH_P_i	Productivity cost of disease type *i*
CH_D	Premature death costs of diseases
CT	Tourism losses associated with poor sanitation and hygiene
CT_RL	Revenue losses
CU_T	Time access cost for unimproved latrine
CW	Water-related costs of poor sanitation and hygiene
CW_Drink	Clean water drinking access costs
CW_Drink_m	Clean water drinking access cost for method *m*
$death_{ia}$	Number of premature deaths, by disease type *i* and age group *a*
et	Expenditure per tourist (USD)
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*
$phealth_{ih}$	Unit price of care (per visit or day) for disease type *i* at health facility *h*
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
ta	Actual number of tourists
taccess	Average access time (journey or waiting) per day
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*

Table A3. Parameters used in algorithms

Symbol	Description
α_i	Incidence rate per person of disease type *i*
β_i	Proportion of episodes attributed to poor sanitation for disease type *i*
χ_{ih}	Proportion of cases seeking care for disease type *i* and provider *h*
γ_{ia}	Proportion of deaths attributable to poor sanitation, by disease type *i* and age group *a*
δ	Attributable water pollution to poor sanitation
μ	Proportion of diseases related to poor sanitation
π_m	Importance of averting drinking polluted water in relation to overall benefits of piped water supply; where $\pi_m = 1$ for $m \neq$ piped water

Annex B: National Data Inputs and Results

Table B1. Impacts of poor sanitation not quantified in this study

Impact	Excluded items	Link with poor sanitation
1. Health	Quality of life	Sanitation-related diseases cause pain and suffering beyond the measurable economic effects. Disability-adjusted life-years (DALY), which attempt to capture quality of life loss, indicate that sanitation-related diseases contribute significantly to national disease burden estimates
	Informal treatment-seeking and home treatment	This study 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: 1. Helminthes 2. Malnutrition and the costs of supplemental feeding 3. Reproductive tract infections for women bathing in dirty water 4. Dehydration resulting from low water consumption from lack of access to private latrines (especially women) 5. Specific health problems suffered by those working closely with waste products (sanitation workers, dump scavengers) 6. Health impacts due to flooding (physical, psychological) 7. Impact on education and lifetime income of childhood malnutrition from diarrheal infections 8. Unreported food poisoning due to contaminated fish products 9. Animal and insect vectors of disease (e.g. rodents, mosquitoes) 10. Avian influenza
2. Water resources	Household water use	Household costs and time spent treating water for domestic purposes other than drinking
	Fish production	The study excluded the following: 1. Market value of sale of freshwater fish 2. Nutrient losses from lower fish catch and effect on spending
	Water management	Economic losses associated with flooding from lack of drainage
	Irrigation	Polluted surface water may lead to extraction of scarce groundwater; or use of polluted water for irrigation has implications for agricultural productivity and human health
	Other welfare impacts	1. 'Non-use' value of clean water resources such as 'existence' and 'bequest' values 2. Wildlife use of water resources
3. External environment	Aesthetics	Welfare loss from population exposure to open sewers / defecation
4. Other welfare	Intangible impacts	Welfare loss from lack of comfort, privacy, security, and convenience of unimproved sanitation; effects on status & prestige
	Time loss	Access time for urination in private place, especially women Access time for daytime defecation (when away from household)
	Life decisions and absence from daily activities	Poor sanitation in schools and the workplace affect attendance and drop-out rates, especially of girls and women
5. Other	Foreign direct investment	Companies selecting investment locations may be influenced by, among other factors, the sanitation situation in a country; tangible secondary evidence is, however, very limited.
	Macroeconomic impact	Overall impact on GDP and economic growth of the diverse micro-economic impacts of poor sanitation

Table B2. Diseases linked to poor sanitation and hygiene, and primary transmission routes and vehicles

Disease	Pathogen	Primary transmission route	Vehicle
Diarrheal diseases (gastrointestinal tract infections)			
Rotavirus diarrhea	Virus	Fecal-oral	Water, person-to-person
Typhoid/ paratyphoid	Bacterium	Fecal-oral and urine-oral	Food, water + person-person
Vibrio cholera	Bacterium	Fecal-oral	Water, food
Escherichia Coli	Bacterium	Fecal-oral	Food, water + person-person
Amebiasis (amebic dysentery)	Protozoa [1]	Fecal-oral	Person-person, food, water, animal feces
Giardiasis	Protozoa [1]	Fecal-oral	Person-person, water (animals)
Salmonellosis	Bacterium	Fecal-oral	Food
Shigellosis	Bacterium	Fecal-oral	Person-person +food, water
Campylobacter Enteritis	Bacterium	Fecal-oral	Food, animal feces
Helicobacter pylori	Bacterium	Fecal-oral	Person-person + food, water
Protozoa			
Other viruses [2]	Virus	Fecal-oral	Person-person, food, water
Malnutrition	Caused by diarrheal disease and helminthes		
Helminthes (worms)			
Intestinal nematodes [3]	Roundworm	Fecal-oral	Person-person + soil, raw fish
Digenetic trematodes (e.g. Schistosomiasis Japonicum)	Flukes (parasite)	Fecal/urine-oral; fecal-skin	Water and soil (snails)
Cestodes	Tapeworm	Fecal-oral	Person-person + raw fish
Eye diseases			
Trachoma	Bacterium	Fecal-eye	Person-person, via flies, fomites, coughing
Adenoviruses (conjunctivitis)	Protozoa [1]	Fecal-eye	Person-person
Skin diseases			
Ringworm (Tinea)	Fungus (Ectoparasite)	Touch	Person-person
Scabies	Fungus (Ectoparasite)	Touch	Person-person, sharing bed and clothing
Other diseases			
Hepatitis A	Virus	Fecal-oral	Person-person, food, 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/ and Hunter's Tropical Medicine and Emerging Infectious Diseases. Strickland GT. Eighth Edition ed. 2000. W.B. Saunders Company. 1192 pages

Notes:

[1] There are several other protozoa-based causes of gastro-intestinal tract infection, 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).

[2] Other viruses include adenovirus (respiratory and gastrointestinal infections), astrovirus (gastrointestinal infections), calicivirus (gastrointestinal infections), norwalk viruses (gastrointestinal infections), reovirus (respiratory and gastrointestinal infections)

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

Table B3. Percent of population with sanitation facilities

Toilet facility	Rural	Urban	National	National (age<5 yrs)	Rural w/ road	Rural w/o road
Flush to piped sewer system	0.35	6.8	1.98	1.11	0.4	0.24
Flush to septic tank	6.99	38.57	14.96	10.43	9.63	1.05
Flush to pit	23.22	37.74	26.88	21.02	27.7	13.17
Flush to somewhere else	0.29	0.48	0.33	0.23	0.41	0
Flush to unknown place	0	0.07	0.02	0.05	0	0
Ventilated improved pit latrine	0.04	0.04	0.04	0.05	0.02	0.11
Pit latrine with slab	1.11	0.37	0.92	0.92	1.04	1.26
Pit latrine without slab (open pit)	4.75	1.3	3.88	3.68	4.3	5.77
Hanging toilet or latrine	0.85	1	0.89	0.75	1.09	0.31
No facilities or bush or field	62.38	13.63	50.07	61.73	55.38	78.09
Other	0.02	0	0.02	0.05	0.03	0
Improved sanitation facility	**31.71**	**83.52**	**44.78**	**33.53**	**38.79**	**15.83**
Unimproved sanitation facility	**68.29**	**16.48**	**55.21**	**66.49**	**61.21**	**84.17**

Source: MICS III 2006. Unimproved sanitation is "pit latrine without slab/open pit", "hanging toilet or latrine", "no facilities, bush or field" and "other".

Table B4. Treatment of diarrhea

Treatment	Children <5 years of age	Children 5-14 years of age	Adults 15+ years of age
Percent of cases treated			
Central hospital	2.5%	1.8%	1.4%
Other hospital	14.6%	10.3%	8.2%
Health center	17.2%	12.1%	9.7%
Private clinic	3.2%	2.2%	1.8%
Pharmacy	35.4%	24.9%	19.9%
Traditional healer	21.3%	15.0%	12.0%
Other	3.5%	2.5%	2.0%
Percent of cases treated at formal health facility	**37.5%**	**26.3%**	**21.1%**
Percent of cases treated (any treatment)	**71.2%**	**50.0%**	**40.0%**
Type of treatment (of those treated)			
Pills	70.7%	49.6%	39.7%
Injection	12.1%	8.5%	6.8%
Intravenous	14.6%	10.3%	8.2%
ORT	18.2%	12.8%	10.2%
Traditional medicine	26.8%	18.8%	15.1%
Other	2.9%	2.0%	1.6%

Source: LRHS 2005 for children < 5 years. Authors' estimates for population 5+ years.

Table B5. Health-related economic costs (LAK billion)

Diseases	Cost type	Children U5	Population 5+	Total
Diarrhea, hepatitis and typhoid	Premature death	682	47	729
	Productivity	5	11	16
	Health care	27	20	47
Indirect (related to nutritional status)	Premature death	367	0	367
	Productivity	2	1	3
	Health care	2	1	4
Together	Premature death	1,049	47	1,096
	Productivity	8	11	19
	Health care	29	22	51
TOTAL		1,086	80	1,166

Source: Estimated by the authors

Table B6. River Basin Areas and Annual Runoff of the Major River Basin in Lao PDR

River Basin Name	Watershed area [sq.km.]	Annual discharge [m^3]	Length of main stream [km]
Nam Ou	19,700	12,276,964,800	390
Nam Suang	5,800	3,654,076,320	150
Nam Khane	6,100	29,454,624,000	250
Nam Ngum	16,500	23,021,280,000	1,403
Nam Nhiep	4,270	5,885,248,320	156
Nam Sane	2,230	4,271,235,840	120
Nam Theun/Cading	3,370	7,027,166,880	138
Nam Sebangfay	8,560	13,623,552,000	190
Nam Sebanghieng	19,400	15,673,392,000	370
Nam Sedone	6,170	5,064,681,600	1,574
Nam Sekong	10,500	16,146,432,000	170

Sources: Department of Hydrology and Methodology, 2004