Economic Assessment of Sanitation Interventions in Lao People's Democratic Republic

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

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The Water and Sanitation Program is a multi-donor partnership administered by the World Bank to support poor people in obtaining affordable, safe, and sustainable access to water and sanitation services.

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Executive Summary

A. INTRODUCTION

Access to improved sanitation is a major concern in the Lao People's Democratic Republic (PDR). Recent estimates from the Joint Monitoring Programme for Water Supply and Sanitation (JMP) of the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) show that only 63% of the population of the country had access to improved sanitation facilities in 2010. Sanitation conditions are worse in rural areas, where only 50% of the population had access to improved facilities and about 3 out of 10 people still practice open defecation. Within rural areas, access to improved sanitation also varies widely between those that have and do not have roads. Hutton et al. (2009) cited the Multiple Indicator Cluster Survey (MICS) III, which found that 39% of rural households with access to roads also had access to improved sanitation facilities. This was more than 2 times higher than rural households that did not have roads. There is also a wide discrepancy in access to improved sanitation at the provincial level. Based on the 2011 Lao Social Indicator Survey, fewer than 4 out of 10 people in the provinces of Saravane, Phongsaly, Attapeu and Sekong had access to improved sanitation. This stands in contrast to Vientiane Capital where coverage rates are close to 100%.

The low rate of access to improved sanitation imposes a heavy burden on the Lao economy. A previous phase of the Economics of Sanitation Initiative (ESI) estimated the overall economic cost of poor sanitation in the country to be in the order of US$193 million (at 2006 prices) per year, or the equivalent of 5.6% of gross domestic product (GDP) (Hutton et al., 2009). This translates to about US$34 per person per year, and approximately 60% of these losses were attributable to health-related costs.

Lao PDR has made significant strides in improving access to sanitation facilities in recent years. The JMP reports that the proportion of the population with access to improved sanitation increased by 18% between 2005 and 2010 alone, from 45% to 63%, nationwide, exceeding the MDG target of 54% access to improved sanitation. However, many challenges remain in terms of improving access. Recent studies by Baetings and O'Leary (2010) and Giltner et al. (2010) show that sanitation has received little attention from government and continues to take a low priority compared to water supply. Apart from limited funding, there are also coordination issues among the many government agencies involved in sanitation. The two studies mentioned above assert that the "interface between [government] agencies is not clearly articulated" (Giltner et al., 2010, p. 15) and it is not clear which agency is ultimately responsible for sanitation.

B. STUDY AIMS AND METHODS

This study aims to generate evidence on the costs and benefits of sanitation improvements in different contexts in Lao PDR. Conducted with a view towards identifying the most economically efficient options under different conditions, it seeks to contribute to improved decision making by government, donor agencies, non-government organizations (NGOs) and other institutions.

The study quantified the costs and benefits associated with various sanitation options in different study sites. The benefits included the impacts on health, water sources and water treatment practices, and access time. The costs included both the investment and recurrent costs associated with ensuring sustained delivery of each sanitation option. The costs and benefits of the sanitation options were syn-

thesized using standard indicators of economic efficiency. These indicators included the benefit-cost ratio, net present value, internal rate of the return, and payback period. Cost-effectiveness ratios – cost per disability-adjusted life year (DALY) averted, cost per disease case averted and cost per death averted – were also calculated.

C. DATA SOURCES AND STUDY SITES

The study used primary and secondary sources of data in its analysis. The instruments for the primary data collection included household surveys and focus group discussions (FGD). These surveys were implemented in selected villages and localities of the following sites:

- Site 1: Chantabouly District, Vientiane Capital
- Site 2: Xaythany District, Vientiane Capital
- Site 3: Meun District, Vientiane Province
- Site 4: Nam Bak District, Luang Prabang Province
- Site 5: Nan District, Luang Prabang Province
- Site 6: Champone District, Savannakhet Province

To supplement and triangulate the data collected from field sites, and to fill key gaps in information, further evidence was collected from international and local literature, project and government documents and surveys, and data from various institutions. The opinions of experts in the local sanitation sector were also solicited to validate data, and fill in knowledge gaps from primary or secondary sources.

Table A shows the sanitation interventions that were examined in each of the study sites. In the analysis, the benefits from the interventions were compared against a baseline of open defecation, and different rungs on the sanitation "ladder". It is important to note that there is currently no sewerage system that treats wastewater in Lao PDR. Hence, the economic efficiency of a sewerage system with treated wastewater was modeled for Vientiane Capital using cost data from ESI studies in other countries.

Additional surveys were implemented to explore the impacts of inadequate sanitation outside the community level and the economy as a whole. A tourist survey was conducted at Wattay International Airport in Vientiane and in selected tourist locations in Vientiane Capital in order to explore how international holiday and business visitors were affected by poor sanitation in Lao PDR. A survey of selected firms in Vientiane Capital was also implemented to explore how poor sanitation affects business activity.

D. MAIN ECONOMIC ANALYSIS RESULTS

The key finding of the study is that there are net benefits associated with all of the interventions evaluated. The benefit-cost ratios (BCRs) were greater than one for all interventions (Figure A), suggesting that the monetized gains exceed every kip that is spent on the intervention. For example, dry pit latrines in rural areas had a BCR of 9.0. This means an average return to society of 9 kip for every kip that is invested in dry pit latrines in rural areas. Rural areas (Sites

TABLE A. SANITATION OPTIONS COMPARED IN THE STUDY SITES

Option	Site					
	1	2	3	4	5	6
	Urban	Urban	Rural	Rural	Urban	Rural
Open defecation	✓	✓	✓	✓	✓	✓
Shared: Wet pit[a]	✓	✓	✓			
Shared: Toilet to septic tank[a]	✓	✓				
Dry pit latrine			✓	✓		
Wet pit latrine	✓	✓	✓	✓	✓	✓
Toilet to septic tank	✓	✓			✓	
Toilet to sewer (with treatment)	✓					

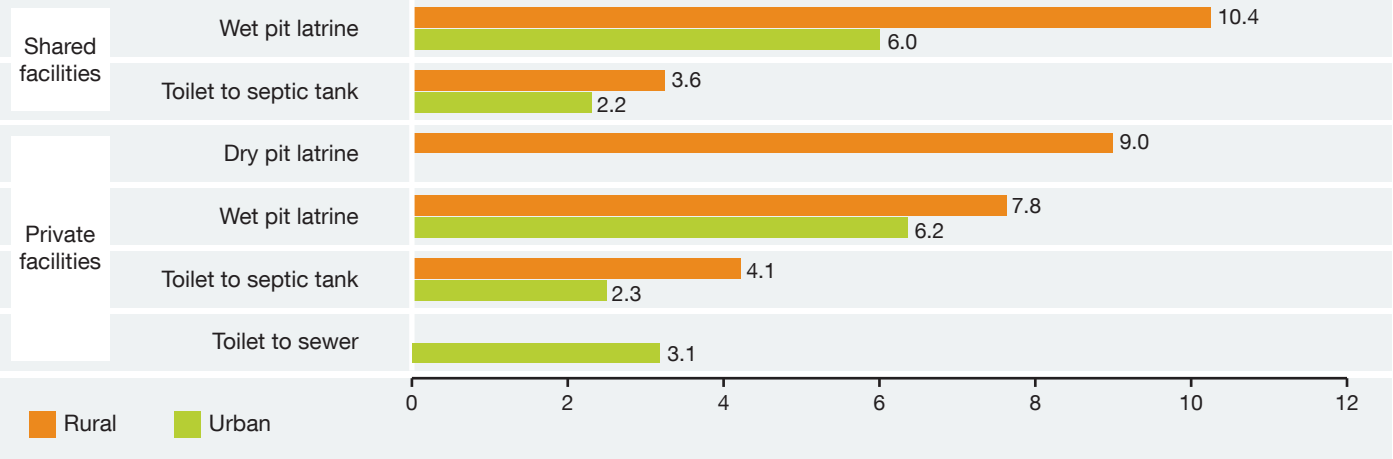
[a] Refers to facilities that are used by two or more households.

2, 3, 4 and 6) with higher BCRs than urban areas showed the most favorable results for wet and dry pit latrines. On the other hand, wet pit latrines showed the most favorable indicators for urban areas (Sites 1 and 5). Toilets with access to septic tanks facilities had the least favorable BCRs for rural and urban areas. The relatively high BCRs for wet and dry pit latrines in rural and urban sites were due to their relatively low investment and recurrent costs.

While it is not shown in Figure A, the findings are sensitive to site-specific conditions. In Site 2, which is classified as rural, the BCR for private wet pit latrines was higher than that for shared wet pit latrines. This pattern is contrary to the average for rural sites (Figure A) where shared wet pit latrines had the highest BCR. The reason for these seemingly contradictory results is that the BCRs for private wet pit latrines were substantially lower in Sites 4 and 6, which reduced the average BCR for such facilities.

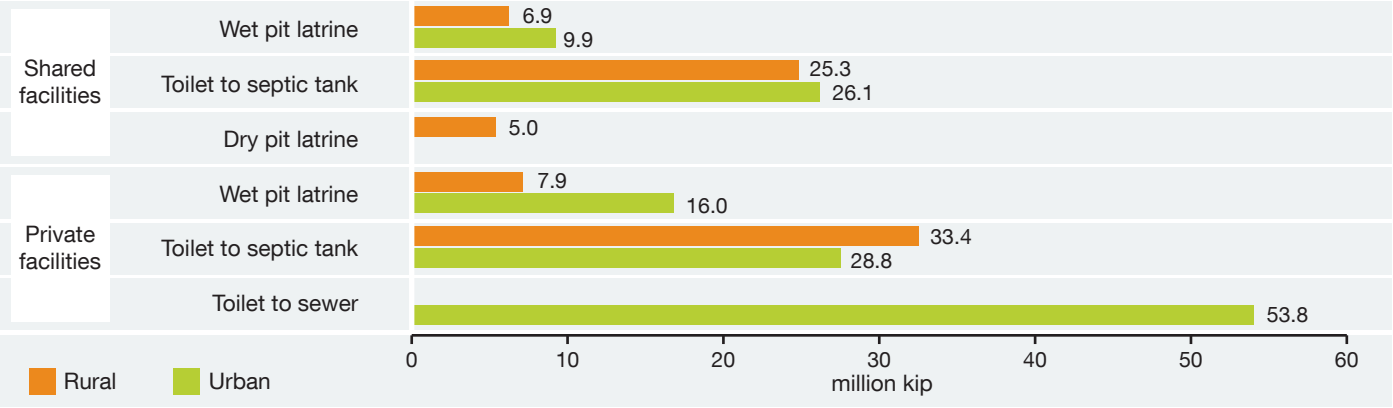
The study also estimated cost-effectiveness ratios, which are focused mainly on the health impacts of the sanitation options. Figure B summarizes the key results using the cost per DALY averted under each option. It indicates that the lowest costs per health unit gained were for dry pit latrines in rural areas (5 million kip or US$607 at the 2010 exchange rate of 8,259 kip per US$), and for wet pit latrines in urban areas (9.9 million kip or US$1,193). Where applicable, cost per DALY was also lower for shared facilities compared to private facilities.

FIGURE A. BENEFIT-COST RATIOS IN THE RURAL AND URBAN SITES, IDEAL SETTING[a]



Note: [a] Dry pit latrines were not evaluated in urban sites, while toilets with access to sewer facilities were not evaluated in rural sites.
Source: Author's calculations.

FIGURE B. COST PER DISABILITY-ADJUSTED LIFE YEAR (DALY) AVERTED IN RURAL AND URBAN SITES, IDEAL SETTING, MILLION KIP PER HOUSEHOLD[a]



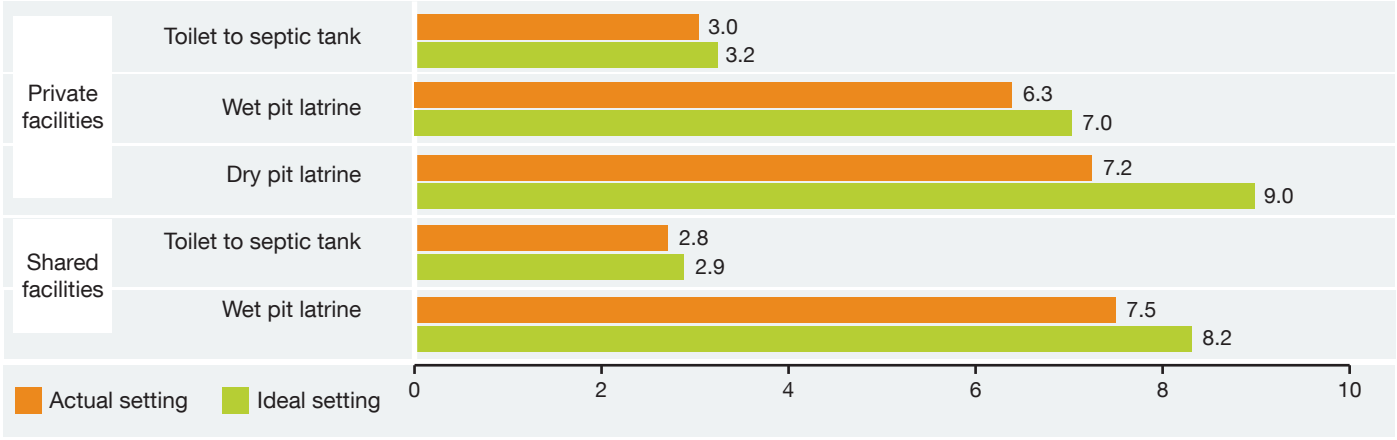
Note: [a] See notes to Figure A.
Source: Author's calculations.

The findings discussed above have several key implications for sanitation decision makers. First, it pays to invest in sanitation improvements. Every intervention at every site showed economic returns that exceeded investment and recurrent costs. Second, low-cost sanitation options (wet and dry pit latrines) deliver relatively high economic benefits for every kip that is invested compared to septic tanks and sewerage with treatment. This finding is especially important to consider in situations where investment funds for sanitation improvements are scarce. Third, cost-effectiveness ratios are also lower for wet and dry pit latrines compared to toilets that have access to septic tanks – hence from a health perspective, the focus should be on ensuring basic access for the entire population before moving populations further up the sanitation ladder (i.e. to septic tanks or sewerage). Fourth, the results reinforce the widely held belief that the viability of a sanitation option is sensitive to site-specific conditions. This is partially supported by the differences between the efficiency indicators across rural and urban areas. Within rural and urban areas, the absolute and relative values of the options also vary by site.

The results presented above reflect ideal conditions. However, the benefits under such conditions may not be fully realized in the absence of changes in hygiene behavior and in the use of the facilities in actual settings. Figure C shows BCRs in actual settings. The lower BCRs for actual settings compared to ideal settings were generally driven by findings in the sites that: (a) not all household members use improved toilets regularly; (b) not all toilet facilities fully isolate water from human excreta; and (c) households continue to practice boiling water despite having access to improved sanitation. The last point captures the fact that poor sanitation and/or the absence of centralized facilities for the treatment of water in some sites are not the only source of water contamination.

It is important to note some limitations of the analysis. First, sites had different types of facilities. This means that some care must be exercised in interpreting averages of results between the two sets of interventions because of inter-site variation. Second, the quantitative analysis did not include a number of benefits associated with improved sanitation. These benefits, which are very difficult to determine in monetary units, include impacts on the environment, tourism, business, and intangible aspects (comfort, prestige, privacy, convenience and safety). While these impacts were analyzed qualitatively, their potential impact on the quantitative estimates should not be ignored. For example, the importance of privacy, convenience and safety are likely to raise the benefits of toilets that are located within or very near the house. Similarly, the ability to quantify the benefits associated with comfort and prestige are likely to raise the net gains associated with toilets that flush to septic tanks. The BCRs associated with toilets that have access to wastewater and treatment facilities may also be higher if their environmental benefits are fully accounted for in the analysis. Such estimates are also likely to become more favorable if the cleaner environment results in higher tourism revenues and lower business costs.

FIGURE C. BENEFIT-COST RATIOS UNDER IDEAL AND ACTUAL SETTINGS, BY INTERVENTION



Source: Author's calculations.

E. DISAGGREGATED RESULTS

The following paragraphs discuss the detailed results of the study. Sub-sections E1 to E4 summarize the key inputs to the cost-benefit analysis. Sub-sections E5 to E8 present the results from the qualitative analysis, and the tourism and business surveys.

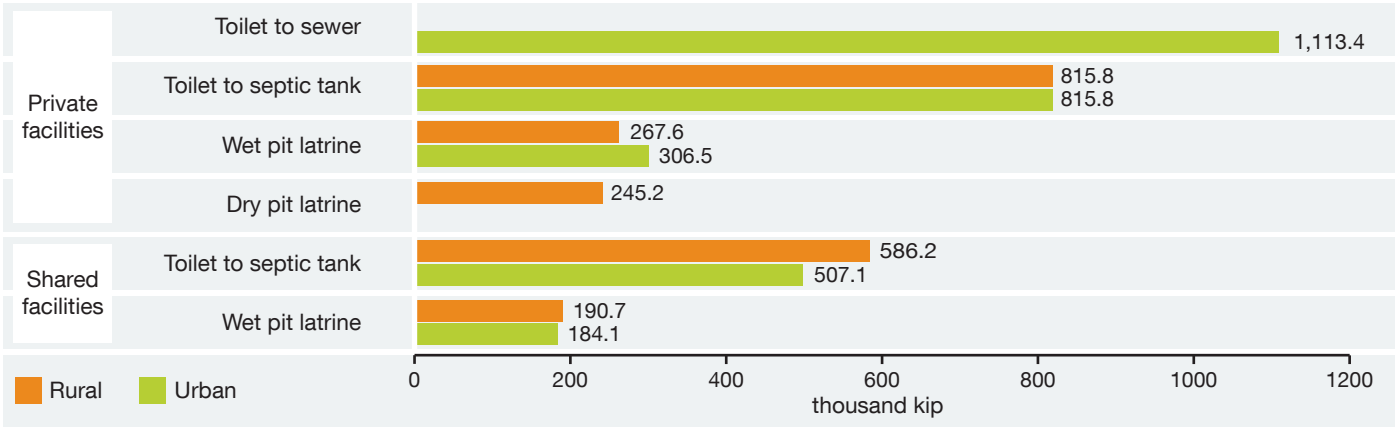
E1. COSTS OF INTERVENTIONS

Data on investment and recurrent costs per household were compiled and estimated for each intervention. Recurrent costs are annual expenditures on the operation and maintenance of the facilities. Investment costs, which were annualized for comparability across interventions and with recurrent cost, represent the expenses involved in constructing and installing the facilities. For toilets that have access to treatment facilities (wastewater treatment, septage treatment and sewers), the costs combine the expenses incurred for the toilet and the treatment facilities. It is important to note that the costs do not include expenses for sanitation software, such as program management and behavior change communication, because of the lack of information available from projects.

Figure D shows the estimated annual costs per household of various sanitation options, with both investment and recurrent costs included. It indicates a wide divergence in the cost of the various options, ranging from 184,000 kip (US$22) for shared wet pit latrines in urban areas to 1.11 million kip (US$134) for toilets with access to sewers in urban areas. There are also cost differences between rural and urban sites for similar types of intervention. For example, private wet pit latrines in rural areas were slightly cheaper than their counterparts in urban areas. Cost differences for a particular technology are accounted for by variations in the materials used for construction and prices across the sites.

Annualized investment costs accounted for a larger proportion of the (annual) total costs in all interventions. The share of investment costs as part of total cost also varies across technologies and sites, and were estimated as follows: shared wet pit latrines (72-73% in rural and urban sites); shared toilets (47% in urban sites and 54% in rural sites); dry pit latrines (100% in rural sites); private wet pit latrines (81-83% in rural and urban sites); toilets with access to septic tanks (67% in rural and urban sites); and toilets with access to sewers (64% in urban site). Most of the costs are shouldered by households.[1] The largest contribution from non-household sources was 16% of the investment cost from donor agencies for private wet pit latrines in rural areas. The rather small average contribution of donor agencies is explained by the fact that most of the households in the sample did not get any support from donor agencies or the government. For households that received toilets through donor programs, the share of household contributions to investment costs was of course much smaller. For example, excluding the value of labor, households that received private wet pit latrines from donors in Site 3 only contributed about 15% of total costs.

FIGURE D. ANNUAL ECONOMIC COST PER HOUSEHOLD OF SANITATION OPTIONS, THOUSAND KIP



Source: Author's calculations.

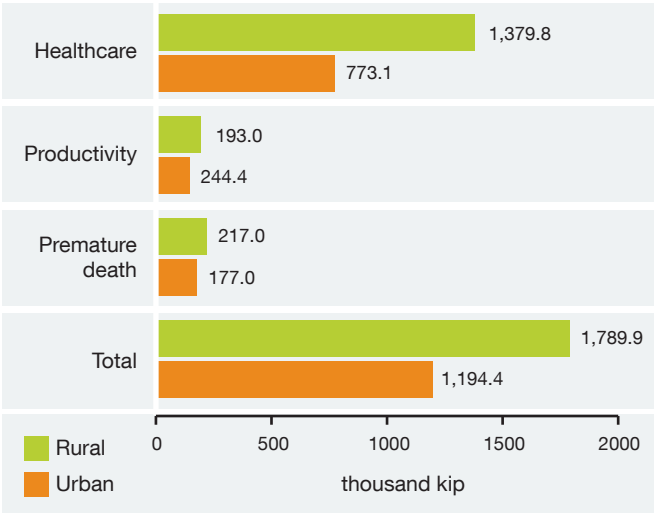
[1] This does not apply to toilets that have access to treated sewers, because there were no households which actually fitted into this category of facilities.

E2. HEALTH BENEFITS

Health benefits are based on the averted costs of diseases associated with poor sanitation. The diseases included in the study were diarrhea, helminths, and malnutrition-related diseases such as malaria, acute lower respiratory infection (ALRI) and measles.[2] Using information from the international literature and survey sites, the study estimated the costs in terms of health care (treatment and medication), productivity (lost productive time for sick people and their carers) and premature death (the value of life approximated using the 'human capital approach' – see methodology in main text). As a whole, annual health-related costs were estimated to be in excess of 1.19 million kip (US$144) per household in both rural and urban sites (Figure E). Losses in rural areas, especially with regard to health care, were generally higher than that in urban areas.

In the study, averted health costs depended on the sanitation option available to households before and after the intervention. For rural households that initially practiced open defecation, the projected gain from an intervention that provides access to basic improved sanitation facilities was slightly more than 720,000 kip (US$87) per household. For urban households that already had access to basic improved sanitation, the provision of access to treatment facilities was estimated to cause benefits that were approximately 23% of the baseline health costs.

FIGURE E. ANNUAL HEALTH COST PER HOUSEHOLD IN RURAL AND URBAN SITES, THOUSAND KIP



Source: Author's calculations.

E3. WATER BENEFITS

Water benefits were based on the premise that poor sanitation contributes to water pollution. Pollution in turn alters the behavior of households by forcing them to obtain water from more expensive sources and to practice water treatment at household level. The cost of obtaining drinking water goes beyond financial costs (e.g. the price paid for bottled water or piped water supply); it also includes hauling costs associated with traveling to more distant sources that are perceived to be cleaner than nearer sources. The household survey provided some support to the asserted link between pollution and household behavior. At least 80% of piped and non-piped protected water users cited quality as one of the main reasons for their choice of water source. Of the respondents relying on water from unprotected sources, about 74% said that the absence of safer alternatives was the reason for their use of such sources.

Water benefits were calculated by assuming that households – once sanitation is considerably improved in their community – might seek less expensive water sources (in terms of both financial and hauling), and/or practice less expensive water treatment, or abandon water treatment. The estimated changes were less significant compared to health benefits. Projected annual savings for more convenient water sources that can be used for drinking water were approximately 21,000 kip (US$3) per household. Savings of 38,000 kip (US$5) were estimated for the lower requirements associated with water treatment.

E4. ACCESS TIME SAVINGS

Households that practice open defecation or only have access to shared toilets incur costs not experienced by those who have access to private and close-at-hand toilets. These costs are the time spent traveling to and from a place for defecation or waiting in a queue before using the toilet in the case of those who use community and shared toilets. Such costs are also incurred by people who accompany children to a place of defecation. The survey confirmed that households recognize the value of the time that is lost by accessing toilets. Almost all (at least 97%) of the respondents who do not have access to private latrines said that proximity is an important argument for having a private toilet. A large proportion (at least 75%) of households who already had access to private

[2] A more detailed explanation of the links between sanitation and these diseases is provided in Annex A of Hutton et al. (2008).

toilets also claimed the proximity of their current facilities was an important reason for getting one.

The amount of time lost in accessing off-plot shared or public toilets or open defecation sites was found to be significant. From the household survey, an adult loses about 21 minutes/day while a child loses about 13 minutes per day. This implies approximately 22 days lost per household per year and translates into annual costs of about 1.08 million kip (US$130) per household in both rural and urban sites. While the estimated losses from rural and urban sites are very close to each other, the sources of these costs are quite different. Annual time losses in rural areas (31 days/household) were found to be close to 2 times as much as in urban areas (18 days/household). However, incomes, and therefore opportunity costs, in urban areas were higher than in rural areas. It is important to note that the estimates are conservative for two reasons. First, the costs only cover losses associated with time spent accessing place of defecation (slightly over once a day on average), and not urination – which requires several trips per day. The extent to which this omission understates the true losses is difficult to determine because there are no existing estimates of the time spent accessing a place to urinate. Second, opportunity costs for adults and children in the entire study were valued at 30% and 15% of estimated province-specific GDP per capita per day, respectively. Estimated losses in terms of accessing toilets, and health-related productivity losses, will be much higher if such costs are valued at the full amount (100%) of GDP per capita per day.

E5. INTANGIBLE BENEFITS OF SANITATION OPTIONS

Information on the intangible aspects of sanitation was generated by a household survey and FGDs. These instruments were used to obtain the perceptions, opinions and preferences of a representative section of the communities covered in the study sites. The process yielded four sets of results: (a) the respondents' understanding of sanitation; (b) reasons for sanitation coverage; (c) satisfaction with the current sanitation option; and (d) for those without a toilet, reasons to get a toilet and the desired characteristics of a toilet.

The FGDs revealed that the most common understanding of sanitation is cleanliness inside and around houses. Another common response, particularly among females in households that have toilets, was the absence of animal excreta in the streets or village.

The most common reasons cited by households for not having toilets were high costs and that the households had never been offered a toilet. The main reason for households having a toilet was that they were provided or supported by projects. These results suggest that apart from reasons of poverty, household decision-makers in the study sites seem to be waiting for interventions from the government and other development partners, rather than investing in sanitation on their own.

The seeming reliance on government and other development partners for access to sanitation facilities may reflect a lack of awareness of the benefits of sanitation and that these benefits can be acquired even with low-cost sanitation options. However, households that do not have access to toilets are aware of some benefits of such facilities. When asked why they may want to get a toilet, respondents cited: (a) proximity; (b) privacy; (c) not needing to share toilets with other households; (d) cleanliness and freedom from unpleasant odors; and (e) a comfortable toilet position as important reasons to acquire toilets. More than half of the respondents without toilets also expressed concerns about safety when their children defecate in the open.

The respondents in the household survey were asked about their level of satisfaction with existing facilities, given a set of attributes to rank between 1 (not satisfied) and 5 (very satisfied). The survey found that households with access to improved sanitation are satisfied, but not very much, with their toilet options, with average satisfaction ratings ranging from 2.9 to 3.3. Households without access to improved sanitation had a lower level of satisfaction, with ratings ranging from 1.9 to 2.5, based on their current "facilities". Differences in the level of satisfaction between households with and without toilets were largest for attributes associated with: (a) avoiding snakes and insects; (b) using the toilet when it is raining; (c) feeling good about inviting guests to the house; (d) pride associated with toilet ownership; (d) proximity of toilets; (e) privacy; (f) cleanliness; and (g) comfort. Most of these attributes are difficult to quantify in monetary terms, suggesting that the BCRs presented in the study are lower than these should be.

E6. EXTERNAL ENVIRONMENT

The external environment refers to the impact of inadequate isolation of excreta on the environment, and is not related to toilet access. It also excludes water pollution, which was covered in a separate component of the study. One objective here is to get a sense of how the respondents perceived the overall state of sanitation in their community. In this regard, the respondents gave the impression that their respective environments were quite good but could still be improved. Households were asked to rank different causes of environmental pollution on a scale of 1 (very high pollution) to 5 (no pollution). For pollution from human excreta, an average rating of 3.6 was given by the respondents to the aspect of smell from sewage/defecation and waste. An overall environmental assessment of 3.7 was given. The poorest environmental rating was for the presence of smoke from burning waste (3.4).

Households with access to improved sanitation also contribute to the pollution of their local communities. The survey found that about 14% of households with access to toilets still practiced open defecation. Moreover, the practice appears more common in rural areas.

E7. TOURISM BENEFITS

Whether or not tourists decide to visit or return to a country might be sensitive to sanitation conditions such as quality of water resources, quality of the environment, food safety, availability of toilets in public places and health risks. While such impacts were not directly quantified, the study conducted a survey of foreign visitors at the departure gate of the international airport and in selected sites in Vientiane Capital. The focus of the exercise was to find out how sanitation in Lao PDR affected the perceptions of tourists and the overall quality of their stay in the country. The results could be significant to Lao PDR in light of the importance of tourist revenues to the economy. To illustrate, the World Travel and Tourism Council (WTTC, 2011) estimated tourism and travel to generate a direct contribution of 2.7 trillion kip (4.3% of GDP) and 105,300 jobs (3.6% of total employment) in 2011.

The survey found that visitors enjoyed their stay in Lao PDR as a whole. This was particularly the case for Luang Prabang and natural sites. However, the respondents assessed that general sanitation conditions can still stand some improvement, especially in Vang Vieng.[3] Toilet availability in public places appears to be a serious concern. Close to half (46%) of the respondents said that, when outside their hotel, they could not find a toilet at a time of need.

About a fifth (19%) of the respondents admitted to having experienced gastrointestinal problems during their stay. On average, affected visitors were incapacitated for about half a day but felt the symptoms for slightly more than two days. This is a cost to tourism. The amount that visitors could have spent during those days of illness represents foregone earnings for the tourism industry.

Despite the incidence of illness and related concerns with respect to sanitation, nearly 9 in 10 visitors (87%) expressed an intention to return to the country. Furthermore, 95% of the respondents said that they would recommend the country as a tourist destination to friends.

E8. BUSINESS BENEFITS

Poor sanitation has the potential to influence the operation of firms and the decisions of businesses to locate in particular areas. These links were assessed through face-to-face interviews with 17 owners/managers of firms in Vientiane Capital. These firms were engaged in activities that are likely to be influenced by sanitation conditions, including food and beverage production, restaurants, hotels, travel agencies and the production of pharmaceutical products.

The business owners and managers were asked to rate different aspects of sanitation in their areas of operation. On a rating scale of 1 (best) to 5 (worst), the most favorable average ratings were given to the water quality of rivers (2.4), air quality from human excreta (2.6) and household coverage with private toilets (2.6). In contrast, the least favorable ratings were given to the presence of toilets in public places (4.2).

None of the respondents said that sanitation-related conditions were a factor in their choice of location. In this regard, the most common responses were on the proximity to target markets and the presence of business opportunities.

[3] Vang Vieng is a small town located between Vientiane and Luang Prabang that is very popular among backpackers and low-budget travelers. It is currently being developed to target visitors from higher-end markets.

While sanitation did not appear to be a serious consideration in the location of firms, the study found evidence that it has an effect on business operations. All respondents cited that poor water quality could have a serious impact on their business, suggesting an indirect link between sanitation and business operations. The importance of clean water to business operations is also reflected in the finding that 7 out of 11 responding firms said that they spent money on water treatment.[4] Water treatment costs, which ranged from US$10 to US$2,000 per month, were heavily influenced by the size of the firms and the scale of their operations.

As a whole, the respondents did not appear to place much importance on the effect of the surrounding environment on their business. When asked to rate the impacts of a poor environment on their customers, current recruitment and stakeholders on a scale of 1 (not important) to 5 (very important), the highest average rating was given by foreign-owned beverage firms (3.5). However, the firms admitted to spending amounts ranging from US$12 to US$1,750 per month on cleaning their surroundings.[5] Among the most common measures taken by firms to deal with poor environmental conditions were the introduction of cleaning procedures and the training of staff in hygiene.

F. RECOMMENDATIONS

The major finding of this study is that all interventions evaluated have benefits that exceed costs, when compared with open defecation. The high net benefits of low-cost sanitation options, such as wet pit latrines in urban areas, and wet and dry pit latrines in rural areas, also suggest that these technologies should be at the center of national plans for sanitation improvements, especially where funds are scarce. The net benefits of sanitation interventions also vary considerably from one site to the next. This suggests a careful consideration of site conditions before interventions are implemented.

While not directly drawn from the study, it is important to emphasize that there is an urgent need to increase access to improved sanitation in Lao PDR. This can be seen clearly from JMP statistics for 2010, which indicate that about 4 in 10 people (37%) in the country did not have access to improved sanitation facilities. This is further supported by evidence that the economic costs of poor sanitation are large.

Based on the findings, the study recommends the following:

1. **Increase access to improved sanitation in rural areas.** Data from the JMP show that access to improved sanitation is lower in these areas. Moreover, about half of the rural population continues to practice open defecation. The stronger emphasis on investment in rural areas is also supported by the finding that the net returns to sanitation investments, at least from the perspective of the BCRs, are higher in these areas compared to those in urban areas. This recommendation does not suggest abandoning efforts to increase access to improved sanitation in urban areas. For one, 11% of the urban population in 2010 did not have access to improved sanitation. However, investment in urban areas may have to go beyond latrines and more into off-site treatment facilities.
2. **Focus on least expensive solutions with highest benefits.** Achieving economic benefits from increased access to improved sanitation does not require expensive toilet facilities. This study found that the highest net returns were for wet and dry pit latrines in rural areas, and wet pit latrines in urban areas. While the study does not provide clear evidence that shared toilets have higher BCRs than private toilets, these facilities should not be disregarded altogether. For one, shared toilets were still found to be economically feasible (their economic benefits exceed investment and recurrent costs) despite the fact that users of these options still incur time losses and are less likely to realize the health benefits, especially when facilities are not maintained very well. Where space and funds are seriously constrainted, these facilities may continue to offer a practical option until private facilities can be made available to households. However, some consideration must be given to the demand of the community for such facilities.

[4] The other six firms did not respond to the question on water treatment practices.
[5] The values were sensitive to firm size and scale of operations.

3. **Promote equitable access to improved sanitation.** The government, donor agencies and other institutions will continue to have an integral role in increasing access to improved sanitation. Information from the World Bank shows that one third of the Lao population lives on less than 1.25 International Dollars per day, and two-thirds live on less than 2 International Dollars per day. Many of the households with no access to improved sanitation facilities are likely to belong to this segment of the population. This argument is further supported by the FGD findings, where respondents cited economic factors (e.g. cost is too high), for not having a toilet. However, some care must be exercised interpreting the perceived high costs, and in the manner in which institutions participate in improving access to improved sanitation. The field research conducted in this study found that respondents in all sites cited "never offered a toilet" as a reason for not having one. This response creates the impression that households seem to be waiting for an intervention rather than trying to address sanitation problems on their own, and are perhaps not aware of the fact that low cost options are as beneficial to them. Along with the finding that only half of the respondents in the survey claimed to have washed their hands after defecating, this underscores the need for evidence-based behavior change approaches that emphasize the potential benefits of improved sanitation.

This study is an initial attempt to generate an economic evidence base in Lao PDR and to examine how evidence can be practically applied to sanitation decision making. A handful of projects and sites were selected for the analysis; hence, it does not provide an exhaustive assessment of the economics of sanitation in the country. Several data inputs were based on non-site specific data, and for some impacts there was limited quantitative assessment and monetization of the benefits. Therefore, further research is needed on the potential impacts of poor sanitation and on the efficiency of sanitation interventions. Such research is needed in:

1. Generating reliable site-specific and age-group-specific incidence and mortality rates for sanitation-related diseases such as diarrhea and helminths. The value of statistical life estimates associated with poor sanitation in Lao PDR will also enhance estimates of the value of premature death.
2. Establishing rigorous and site-specific quantitative links between sanitation and: (a) disease incidence (attribution factors); (b) tourism; (c) water use and access; (d) water quality; and (e) business activity.
3. Establishing stronger evidence on the performance of projects from post-project evaluations, including several years after the project, to assess sustainability. If project managers know that sustainability will be assessed several years after the project has withdrawn, greater attention will be given to promoting different aspects of sustainability (e.g. financial, behavior change, infrastructure quality and maintenance).
4. Making the necessary further attempts to quantify the intangible benefits (e.g. comfort, prestige, dignity and privacy) and environmental benefits of improved sanitation and the importance of these benefits to household or community willingness to pay for sanitation.
5. Selecting between the specific sanitation technologies and software options. Decision makers must know the initial conditions of the target beneficiaries. Such an understanding is essential to increasing the success and sustainability of the option that is chosen. This is supported by the study findings that an option could have divergent efficiency indicators in different sites. From the perspective of project implementers, this underscores the need for pre-project assessments. On the other hand, the government can help project implementers by strengthening information systems in potential project sites.

Foreword

In its recognition of sanitation as a key aspect of human development, Goal 7 of the Millennium Development Goals includes access to safe sanitation: "to reduce by half between 1990 and 2015 the proportion of people without access to improved sanitation." This reflects the fact that access to improved sanitation is a basic need: at home as well as at the workplace or school, people appreciate and value a clean, safe, private and convenient place to urinate and defecate. Good sanitation also contributes importantly to achieving other development goals such as child mortality reduction, school enrollment, improved nutritional status, gender equality, clean drinking water, environmental sustainability and the quality of life of slum dwellers.

Despite its recognized importance, sanitation continues to lose ground to other development targets when it comes to priority setting by governments, households, the private sector and donors. This fact is hardly surprising given that sanitation remains a largely taboo subject; neither is it an "attractive" subject for media or politicians to promote as a worthy cause. Furthermore, limited data exist on the tangible development benefits for decision makers to justify making sanitation a priority in government or private spending plans.

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

Phase 1 of the ESI in 2007-2009 conducted and published "sanitation impact" studies, which estimated the economic and social impacts of unimproved sanitation on the populations and economies of Lao PDR (Hutton et al., 2009) and other countries of Southeast Asia. This study showed that the economic costs of poor sanitation, valued at 2006 prices, are US$193 million per year, or the equivalent of 5.6% of gross domestic product for Lao PDR. These and other results were disseminated to national policy makers, sector partners, and decentralized levels of the country.

The current volume reports the second major activity of ESI, which examines in greater depth the costs and benefits of specific sanitation interventions in a range of field settings in Lao PDR. The purpose is to provide information to decision makers on the impact of their decisions relating to sanitation – to understand the costs and benefits of improved sanitation in selected rural and urban locations, and to enable a better understanding of the overall national level impacts of improving sanitation coverage in Lao PDR. On the cost side, decision makers and stakeholders need to understand more about the timing and size of costs (e.g. investment, operation and maintenance), as well as financial versus non-financial costs, in order to make appropriate investment decisions that increase intervention effectiveness and sustainability. On the benefit side, monetary and non-monetary impacts need to be more fully understood in advocating for improved sanitation as well as making the optimal sanitation choice. For cost-benefit estimation, a sample of sites representing different contexts of Lao PDR was selected to assess efficiency of sanitation interventions, and thus illustrate the range and size of sanitation costs and benefits.

The research under this program is being conducted in Cambodia, Yunnan Province of China, Indonesia, Lao PDR, the Philippines, and Vietnam. Similar studies are also ongoing in selected South Asian, African, and Latin American countries.

While WSP has developed this study, it is an "initiative" in the broadest sense, which includes the active contribution of many people and institutions (see Acknowledgments).

Abbreviations and Acronyms

ADB	Asian Development Bank
AIT	Asian Institute of Technology
ALRI	Acute lower respiratory infection
BCR	Benefit-cost ratio
BOD	Biochemical oxygen demand
CBA	Cost-benefit analysis
CER	Cost-effectiveness ratio
CFU	Colony-forming units
CLTS	Community-Led Total Sanitation
COD	Chemical oxygen demand
CPI	Consumer Price Index
DALY	Disability-Adjusted Life Year
DO	Dissolved oxygen
DPWT	Department of Public Works and Transport
EAP	East Asia and the Pacific
ESI	Economics of Sanitation Initiative
ESUP	Environmental Sanitation Upgrading Project
FGD	Focus group discussion
GDP	Gross domestic product
GIT	Gastro-intestinal tract
HCA	Human capital approach

HHDP	Houaphanh Health Development Program
IRR	Internal rate of return
JMP	Joint Monitoring Programme (WHO, UNICEF)
LECS	Lao Expenditure and Consumption Survey
LNTA	Lao National Tourism Administration
LSIS	Lao Social Indicator Survey
MDG	Millennium Development Goal
Mg/l	Milligrams per liter
MICS	Multiple Indicator Cluster Survey
MOH	Ministry of Health
MPWT	Ministry of Public Works and Transport
Nam Saat	National Center for Environmental Health and Water Supply
NCRWSSSP	Northern and Central Regions Water Supply and Sanitation Sector Project
NGO	Non-governmental organization
NPV	Net present value
NTU	Nephelometic Turbidity Units
OD	Open defecation
OPWT	Office of Public Works and Transport
PBP	Payback period
PHCP2	Primary Health Care Program Phase II
PPHD	Provincial Public Health Department

SNWSP	Strengthening National Water Supply and Sanitation Strategy Program
UDAA	Urban Development and Administration Authorities
UNICEF	United Nations Children's Fund
US$	United States dollar
VIP	Ventilated improved pit
VOSL	Value of a statistical life
WEPA	Water Environment Partnership in Asia
WHO	World Health Organization
WREA	Water Resources and Environment Administration
WREO	Water Resources and Environment Office
WSP	Water and Sanitation Program
WSPMN	Water and Sanitation Projects in Meun and Nan Districts
WTTC	World Travel and Tourism Council

Glossary of Terms

Benefit-cost ratio (BCR): the ratio of the present value of the stream of benefits to the present value of the stream of costs. A higher BCR implies a more efficient intervention.

Cost per case averted: the discounted value of the cost of each case of a disease that is avoided because of an intervention.

Cost per DALY averted: the discounted value of the cost of each DALY that is avoided because of an intervention.

Cost per death averted: the discounted value of the cost of each death that is avoided because of an intervention.

Cost-effectiveness ratio (CER): the ratio of the present value of the future cost to the present value of the future health benefits in non-monetary units (cases, deaths, disability-adjusted life years). The lower the CER the more efficient the intervention.

Disability-Adjusted Life Year (DALY): a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability. One DALY can be thought of as one lost year of "healthy" life (WHO, 2010).

Improved sanitation: the use of the following facilities in home compounds: flush/pour-flush to piped sewer system/septic tank/pit latrine, ventilated improved pit (VIP) latrine, pit latrine with slab, or composting toilet (JMP, 2008).

Shared sanitation facilities: sanitation facilities of an otherwise acceptable type shared between two or more households. Only facilities that are not shared or not public are considered improved (JMP, 2008).

Open defecation: the practice of disposing human feces in fields, forests, bushes, open bodies of water, beaches or other open spaces or disposed of with solid waste (JMP, 2008).

Intangible benefits: benefits of improved sanitation that are difficult to quantify. These include impacts on the quality of life, comfort, security, dignity, and personal and cultural preferences.

Internal rate of return (IRR): the discount rate for which the present value of the stream of net benefits is zero. In other words, the discount rate that makes the BCR equal to unity (1).

Net benefit: the difference between the present value of the stream of benefits and the present value of the stream of costs.

Net present value (NPV): the discounted value of the current and future stream of net benefits from a project.

Payback period (PBP): represents the number of periods (e.g. years) necessary to recover the costs incurred to that time point (investment plus recurrent costs).

Sewage: water-borne human or animal waste removed from residences, buildings, institutions, industrial and commercial establishments together with groundwater, surface water and storm water. Liquid and solid waste carried off in sewers or drains.

Septage: the sludge produced in individual onsite wastewater-disposal systems, principally septic tanks and cesspools. These also represent the contents of septic tanks.

Sewerage: a network of pipelines, ditches and channels, including pumping stations and force mains, and service connections including other devices for the collection, transport and treatment of sewage.

Strategic sanitation: a concept based on the following principles (Rosenweig and Perez, 2002):

- Ensuring that any plan to improve sanitation services is financially sustainable
- Consulting households to understand what sanitation solutions are in use and what expectations people have
- Using a public consultation process with stakeholders to discuss the options
- Including a specific health component to maximize health benefits
- Selecting an appropriate model for managing the provision of sanitation services to ensure sustainability

Unimproved sanitation: the use of the following facilities anywhere: flush/pour flush without isolation or treatment, pit latrine without slab/open pit, bucket, hanging toilet/hanging latrine, use of a public facility or sharing any improved facility, no facilities, bush or field (open defecation) (JMP, 2008).

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Economic assessment of sanitation interventions in Lao PDR. U-Primo Rodriguez, Guy Hutton and Alan Boatman. World Bank, Water and Sanitation Program. 2013.

Other country and synthesis reports:

Economic assessment of sanitation interventions in Cambodia. Sam Sok Heng, Guy Hutton, Poch Kongchheng and Phyrum Kov. World Bank, Water and Sanitation Program. 2012.

Economic assessment of sanitation interventions in Indonesia. Asep Winara, Guy Hutton, Oktarinda, Edi Pumomo, Koderi Hadiwardoyo, Indon Merdykasari, Takdir Numadi, Bert Bruinsma, Dedek Gunawan, Dadang Fadilah and Martin Albrecht. World Bank, Water and Sanitation Program. 2011.

Economic assessment of sanitation interventions in the Philippines. U-Primo Rodriguez, Guy Hutton, Nelissa Jamora, Dieldre Harder, Jeremy Ockelford and Edkarl Galing. World Bank, Water and Sanitation Program. 2011.

Economic assessment of sanitation interventions in Vietnam. Nguyen Viet Anh, Guy Hutton, Hoang Thuy Lan, Phan Dan, Le Thu Hoa and Bui Thi Nhung. World Bank, Water and Sanitation Program. 2012.

Economic assessment of sanitation interventions in Yunnan Province, PR China. Liang Chuan, Guy Hutton, Yang Liqiong, Fang Jinming, Zhang Tiwei, Dong Lin, Zhang Pu and Luo Ronghuai. World Bank, Water and Sanitation Program. 2012.

Economic assessment of sanitation interventions in Southeast Asia. Guy Hutton, U-Primo Rodriguez, Asep Winara, Nguyen Viet Anh, Sam Sok Heng, Kov Phyrum, Liang Chuan, Isabel Blackett, Almud Weitz. World Bank, Water and Sanitation Program. 2012.

Summary reports are available for each country, in both English and in the local languages. All country reports are accessible from http://www.wsp.org/pubs/index.asp

Content

List of Tables

List of Figures

List of Annex Tables

Selected Development Indicators for Lao PDR

Variable (unit; year)	Value
Population	
Total population (millions; 2010)[a]	6.2
Rural population (%; 2009)	68.0
Urban population (%; 2009) [b]	32.0
Annual population growth (%; 2000-2009) [b]	2.0
Under 5 population (% of total; 2009) [b]	12.5
Under 5 mortality rate (deaths per 1,000; 2009)[c]	59.0
Female population (% of total, 2005)[d]	50.2
Population earning less than	
US$1.25/day (% of total, 2008, PPP)[e]	33.9
US$2.00/day (% of total, 2008, PPP)[e]	66.0
Economic	
Currency name	Kip
Year of cost data presented	2010
Exchange rate (kip per US$; 2010)[a]	8,259
GDP per capita (US$; 2010)[e]	1,176.7
GNI per capita, adjusted for purchasing power (International $; 2010)[f]	2,460.0
Sanitation	
Improved total (% of households, 2010)[g]	63.0
Improved rural (% of households, 2010)[g]	50.0
Improved urban (% of households, 2010)[g]	89.0
Sewerage connection (% of households, 2006)[i]	
Rural[h]	0.4
Urban[h]	6.8

Sources:
[a] ADB (2011)
[b] UNICEF (2010)
[c] WHO (2011a)
[d] Lao Statistical Bureau
[e] World Bank (2011b); PPP – purchasing power parity
[f] World Bank (2011c)
[g] JMP (2012)
[h] Multiple Indicator Cluster Survey (MICS) as cited in JMP(2010a)
[i] The majority of wastewater flows untreated to water bodies or to the ground

I. Introduction

1.1 SANITATION COVERAGE AND OVERVIEW OF THE SANITATION SECTOR

Access to improved sanitation facilities is a major concern for the Lao People's Democratic Republic (PDR). Recent estimates from the Joint Monitoring Programme for Water Supply and Sanitation (JMP) of the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) indicate that only 63% of the population of the country had access to improved sanitation facilities in 2010 (Table 1).[6] Sanitation conditions are also worse in rural areas, where 8% of the population only had access to unimproved facilities and about 41% of the population still practiced open defecation.

The lack of information makes it difficult to make solid general statements regarding the progress of the country towards achieving the Millennium Development Goal (MDG) for sanitation; i.e., reducing by half the proportion of its population in 1990 who did not have access to improved sanitation facilities.[7] Using 1995 as the base year, which probably had more favorable coverage statistics compared to 1990 and therefore sets a higher target, it appears that the MDG for sanitation has already been achieved. As of 2010, the proportion of the population that has access to improved sanitation was already about 4% above the estimated target of 59%.

Figure 1 provides information on sanitation coverage in the different regions of Lao PDR, from the most recent Lao Social Indicator Survey. It indicates that households in Vientiane

TABLE 1. SANITATION COVERAGE IN LAO PDR, 1995 - 2010, WITH 2015 TARGET, % OF POPULATION

Region	Private facilities		Shared facilities	Open defecation
	improved	unimproved		
Rural				
1995	8	9	0	83
2000	15	9	0	76
2005	33	7	1	59
2010	50	8	1	41
2015[a]	54[a]		46[a]	
Urban				
1995	58	11	3	28
2000	64	8	4	24
2005	78	6	4	14
2010	89	3	5	3
2015[a]	79[a]		21[a]	
All				
1995	17	9	1	73
2000	26	8	1	65
2005	45	6	2	47
2010	63	7	2	28
2015[a]	59[a]		41[a]	

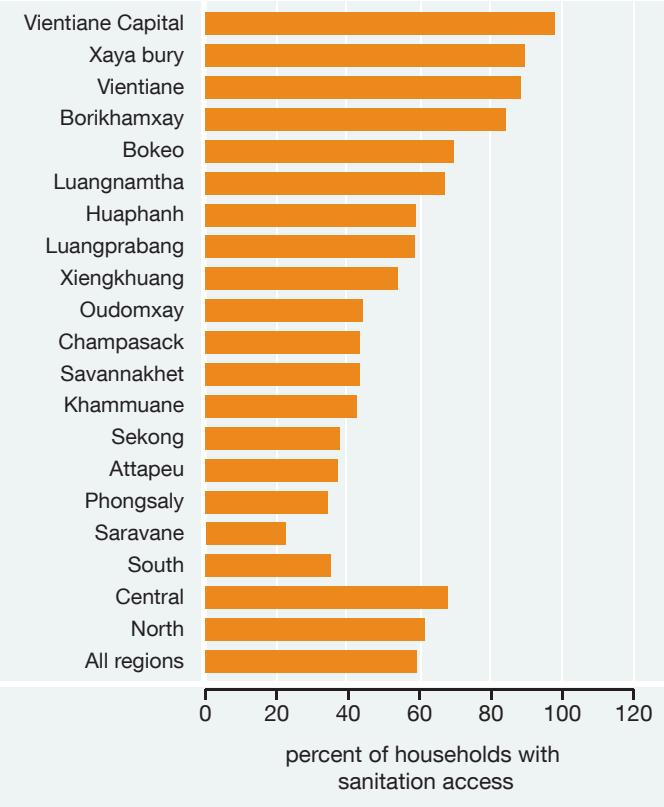
Note: [a] The values for 2015 are targets based on the MDG target applied in Lao PDR. These were calculated by the authors based on the JMP target of reducing by half the proportion of the population that do not have access to improved sanitation facilities in 1990. However, in the absence of 1990 estimates, the authors used 1995 data to calculate the target.
Source: JMP (2012)

[6] The JMP (2008) defines an improved sanitation facility as "one that hygienically separates human excreta from human contact" (p.39). These include flush or pour flush latrines connected to a piped sewer system, septic tank or pit latrine and ventilated improved pit latrine. On the other hand, unimproved facilities include pit latrines without slab or platform, hanging latrines and bucket latrines. Pour-flush toilets that discharge into open drains, ditches or other bodies of water and facilities shared by two or more households are also considered unimproved.
[7] There is no information on sanitation coverage for 1990.

Capital had the highest access to improved facilities, at 97.9%. However, 9 of the 17 provinces had rates of access to improved facilities that were below the national average of 59%. This is most noticeable in Saravane (22.3%), where the proportions of households with access to improved sanitation were only about a quarter of their counterparts in Vientiane.

Two patterns emerge from the analysis of sanitation coverage data. First, there have been significant improvements in sanitation coverage the past decade or so. However, greater effort is needed as nearly 4 out of 10 people (about 2.3 million) in Lao PDR still do not have access to improved sanitation. Second, the gap in terms of access to improved sanitation facilities across regions narrowed from 50% in 1995 to 39% in 2010. Despite this favorable trend, close to 90% of the 2.3 million people with no access to improved sanitation facilities reside in rural areas (about 2 out of every 3 people in the country, based on 2012 JMP estimates, live in rural areas). Moreover, there are indications that differences in sanitation coverage are more pronounced when the examination is conducted at the provincial level. It is also important to note that there is a wide discrepancy in access to improved sanitation in rural areas with and without access to roads. Information from the Multiple Indicator Cluster Survey (MICS) III in 2006 (cited in Hutton et al., 2009) showed that about 39% of rural households with access to roads also had access to improved sanitation facilities. This was more than 2 times higher (16%) than rural households that did not have access to roads.

FIGURE 1. PERCENTAGE OF HOUSEHOLDS WITH ACCESS TO IMPROVED SANITATION FACILITIES, BY PROVINCE, 2011



Note: "Modern facilities" and "normal latrines" were classified as improved sanitation facilities in this study. Modern facilities are defined in the census as latrines that use cistern water flushed to a piped sewer system or septic tank. Normal latrines are pour-flush facilities connected to a piped sewer system or septic tanks, or pit latrines with slab.
Source: Lao Social Indicator Survey 2011

Recent studies by Baetings and O'Leary (2010) and Giltner et al. (2010) review the institutional and legal environment in the Lao sanitation sector. Some of the key findings of these studies are as follows. First, both studies assert that sanitation has received little attention from government and continues to take a second priority to water supply. From a financial perspective, government budget allocations are small. Giltner et al. (2010) estimated the contribution of the government was in the neighborhood of 12.5% of total spending on rural sanitation in 2008/9. This implies that sanitation projects and programs in rural areas are heavily dependent on support from developing partners while households continue to shoulder a large proportion of the investment costs of new sanitation facilities. Specific sanitation-related policies or initiatives have also been slow in coming. Giltner et al. (2010), for example, lament the absence of an overall sanitation strategy for Lao PDR. On the other hand, Baetings and O'Leary (2010) state that the existing legal framework is quite general and provides "limited specific reference to sanitation and wastewater issues" (p.2). Second, there are many government agencies involved in the sanitation sector, with overlapping tasks and the absence of an agency that is ultimately responsible for sanitation. Giltner et al. (2010) also add that the "interface between agencies is not clearly articulated" (p. 15). These two findings suggest that coordination issues among government agencies exacerbate the restrictions imposed by limited funding.

1.2 STUDIES ON THE COSTS AND BENEFITS OF SANITATION IN LAO PDR

The authors have found no studies focusing on evaluating costs against the benefits of sanitation options in Lao PDR. However, some studies have dealt with aspects of sanitation that are relevant to the current exercise.

Hutton et al. (2009) evaluated the economic impacts of poor sanitation in Lao PDR. As a component of the Economics of Sanitation Initiative (ESI), the paper quantifies potential losses arising from poor sanitation. It identifies health, water, access time and tourism as the key sources of quantifiable losses. The study is useful to the current analysis because it provides a framework for evaluating the potential benefits associated with sanitation improvements.

The study found that there are large economic costs associated with poor sanitation. It estimated the overall economic costs of poor sanitation in Lao PDR to be of the order of US$193 million (at 2006 prices) per year, or 5.6% of gross domestic product (GDP) (Hutton et al., 2009). This translates to about US$34 per person per year, and approximately 60% of these losses were attributable to health-related costs.

Baetings and O'Leary (2010), Giltner et al. (2010) and Colins (2011) provide estimates of the costs of various sanitation options in different sites. In addition, these studies provide relevant sanitation-related information for Lao PDR. Baetings and O'Leary (2010) also provides valuable survey-based information from Vientiane Capital on aspects including: access to toilet facilities; location of toilets (outside or inside the house); availability of water in toilets; water sources for anal washing; toilet hygiene and cleanliness; satisfaction of users with toilet facilities; reasons for state of toilets (i.e. clean or dirty); septage storage; pit emptying issues; knowledge about septage emptying; flooding and raising of toilets; toilet construction costs; and operation and maintenance issues. Giltner et al. (2011) describe the sources and uses of financing for hygiene and sanitation in rural areas of the country. The study found that the Lao government made a very small contribution (12.5%) in total expenditure to basic sanitation and hygiene in rural areas. Most spending was accounted for by households (52.2%) and development partners (35.3%).

1.3 ORGANIZATION OF THE STUDY

Cost-benefit analysis (CBA) is a method that can be used to evaluate various sanitation options. The objective of the technique is to generate a monetary measure of the stream of benefits and costs from an investment project or policy. It can estimate: (a) the expected economic return (return per US$ invested); (b) net present value of investments; and (c) the internal rate of return of investments or policy initiatives. It therefore aids decision-makers in identifying whether the net benefits of a project or policy are positive or negative. In the presence of multiple options, a CBA may also provide a valuable input for priority setting.

This analysis is important in order to enhance the chances that scarce resources are efficiently allocated to projects that provide acceptable levels of net benefit. Moreover, it helps evaluate the costs, budget impacts and benefits of sanitation alternatives if additional funds become available to finance further investment in sanitation. Furthermore, CBA provides information that can be used for the advocacy of development interventions, assuming that its findings are favorable.

The remainder of this report is organized as follows: Section 2 describes the overall objectives and aims of the study. It also explains some of the key research questions that will be addressed in subsequent sections. Section 3 discusses the methodology of the study. It describes the costs and benefits to be evaluated and the key indicators used in the analysis of the various options. The section also describes the study sites and data collection methods. Section 4 presents the local or site-specific benefits associated with improved sanitation while Section 5 describes some of the broader benefits to the economy. Section 6 presents the costs associated with various sanitation options. It also describes the costs as a household moves up the sanitation ladder. Section 7 combines the information from Sections 4 to 7 by way of a cost-benefit and cost-effectiveness analysis. It also compares the various efficiency indicators across various sanitation options. Section 8 provides a discussion of the results and Section 9 concludes with the recommendations of the study.

II. Study Aims

2.1 OVERALL PURPOSE

The purpose of the Economics of Sanitation Initiative (ESI) is to promote evidence-based decision making using improved methodologies and data sets, thus increasing the effectiveness and sustainability of public and private sanitation spending.

Better decision making techniques and economic evidence are also expected to stimulate additional spending on sanitation to meet or surpass national coverage targets.

2.2 STUDY AIMS

The aim of this study is to generate robust evidence of the costs and benefits of sanitation improvements in different programmatic and geographic contexts in Lao PDR, leading to the selection of the most efficient and sustainable sanitation interventions and programs.

The evidence is presented in simplified form and distilled into key recommendations to increase uptake by a range of sanitation financiers and implementers, including different levels of government and sanitation sector partners, as well as households and the private sector.

Standard outputs of cost-benefit analysis (CBA) include benefit-cost ratios (BCRs), internal rate of return (IRR), payback period (PBP), and net benefits (see Glossary). Cost-effectiveness measures relevant to health impacts will provide information on the costs of achieving health improvements. In addition, intangible aspects of sanitation not quantified in monetary units are highlighted as being crucial to the optimal choice of sanitation intervention.

2.3 SPECIFIC STUDY USES

By providing hard evidence of the costs and benefits of improved sanitation, the study will:

- Provide **advocacy material** for increased spending on sanitation, and to prompt sector stakeholders to pay greater attention to the efficient implementation and scaling up of improved sanitation.
- Enable the inclusion of **efficiency criteria** in the selection of sanitation options in government and donor strategic planning documents, and in specific sanitation projects and programs.
- Bring greater focus on **appropriate technology** through increased understanding of the marginal costs and benefits of moving up the "sanitation ladder" in different contexts.
- Provide the empirical basis for improved estimates of the total costs and benefits of **meeting sanitation targets** (e.g. MDG targets), and contribute to national strategic plans for meeting and surpassing the MDG targets.

2.4 RESEARCH QUESTIONS

In order to fulfill the overall purpose of the study, research questions were defined that have a direct bearing on sanitation policies and decisions. The questions were formulated to identify overall efficiency (i.e. cost versus benefit) and costs and benefits seperately, distinguished for overall efficiency questions (i.e. cost versus benefit), and for costs and benefits separately.[8]

The major concern in economic evaluation is to understand efficiency – in terms of return on investment and recur-

[8] "Costs" (and "benefits") refer simultaneously to financial and economic costs (and benefits), unless otherwise specified.

rent expenditure. Hence, the focus of economic evaluation is on what it costs to deliver an intervention and what the returns will be. Several different efficiency measures allow examination of the question from different angles, such as the number of times by which benefits exceed costs, the annual equivalent returns, and the time to repay costs and start generating net benefits (see box). As sanitation and hygiene improvement also fall within the health domain, economic arguments can be made for investment in sanitation and hygiene interventions within the health budget, if the health return per unit cost invested is competitive compared with other uses of the same health budget.

BOX 1. RESEARCH QUESTIONS ON SANITATION EFFICIENCY

i. Are benefits greater than the costs of sanitation interventions? By what proportion do benefits exceed costs (benefit-cost ratio – BCR)?
ii. What is the IRR?
iii. How long does it take for a household to recover its initial investment costs (PBP)?
iv. What is the net gain of each sanitation intervention (net present value – NPV)?
v. What is the cost of achieving standard health gains such as averted death, cases and disability-adjusted life years (DALY)?
vi. How does economic performance vary across sanitation options, program approaches, and locations? What factors explain performance?

It is also useful from decision making, planning, and advocacy perspectives to better understand the nature and timing of costs and benefits, as well as how non-economic aspects affect the implementation of sanitation interventions, hence affecting their eventual efficiency (see boxes below). Furthermore, given that several impacts of improved sanitation cannot easily be quantified in monetary terms, this study attempts to give greater emphasis to these impacts in the overall CBA.

In addition, other research questions are crucial to an appropriate interpretation and use of information on sanitation costs and benefits. Most importantly, the full benefit of a sanitation intervention may not be received due to factors in the field that affect uptake and compliance with the intervention. These factors need to be better understood to advise future program design.

BOX 2. RESEARCH QUESTIONS ON SANITATION COSTS

i. What is the range of costs for each technology option in different field settings?
ii. What proportion of costs are capital and recurrent costs, for different interventions?
iii. What are necessary maintenance and repair interventions and costs of extending the life of hardware and increasing sustainability?
iv. What are the incremental costs of moving from one sanitation improvement to another – i.e. moving up the sanitation ladder – for specified populations to meet sanitation targets?

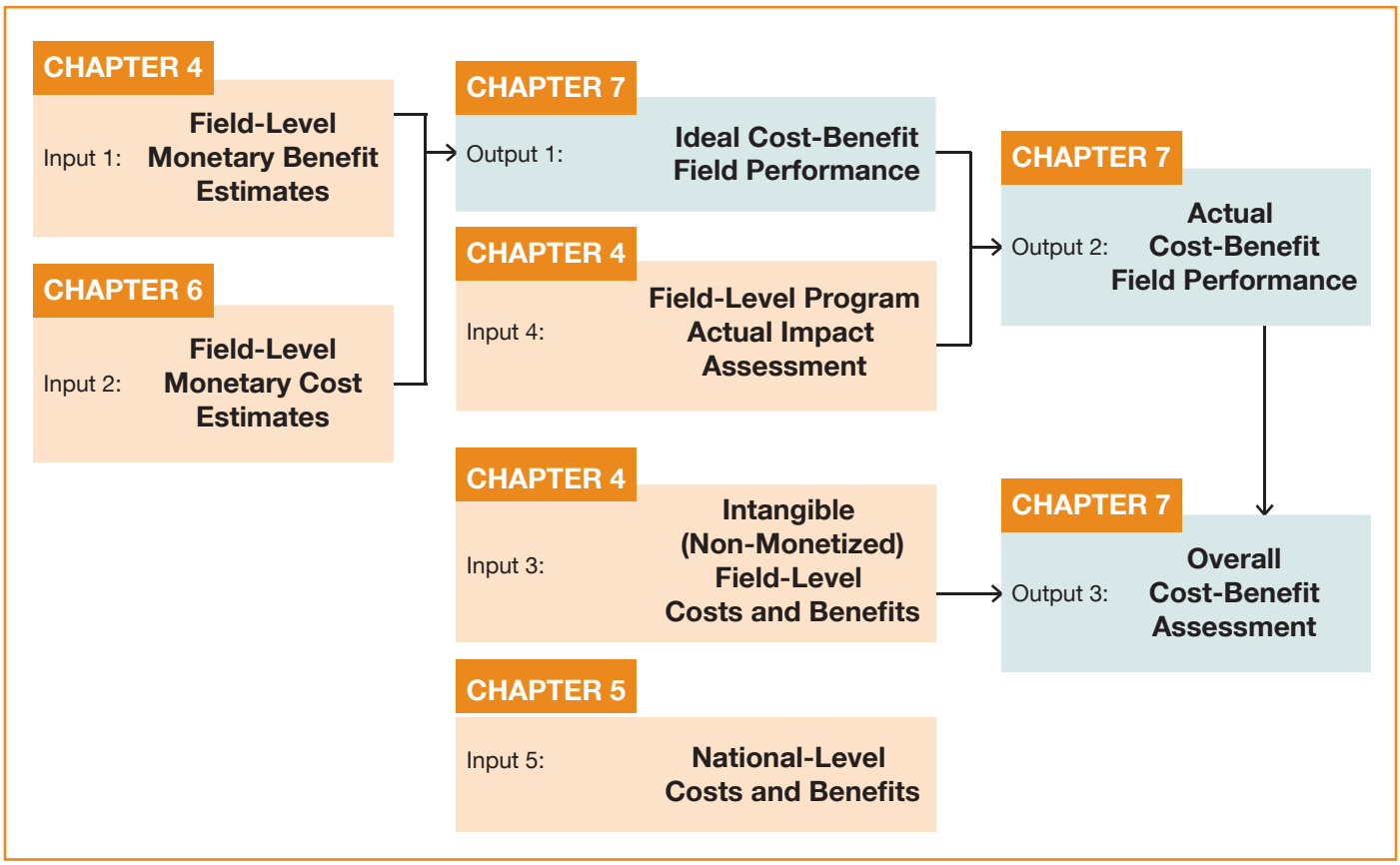
BOX 3. RESEARCH QUESTIONS ON SANITATION BENEFITS

i. What local evidence exists for the links between sanitation and health, water quality and water users, land use, time use, tourism and the business environment?
ii. What is the size of the economic benefit related to health expenditure, health-related productivity and premature mortality; household water uses; time savings; and other welfare impacts?
iii. What is the actual or likely willingness of households and agencies to pay for improved sanitation?
iv. What is "up-front" versus "annual recurrent" willingness to pay?
v. How do benefits accrue or vary over time?

III. Methods

The study methodology in Lao PDR follows standard cost-benefit techniques (Boardman et al., 2006; Gramlich, 1998), which have been adapted to sanitation interventions and the site-specific field studies. As shown in Figure 2, the study consists of a field component that leads to quantitative cost-benefit estimates, and an in-depth study of qualitative aspects of sanitation. Two types of field-level cost-benefit performances are presented. Output 1 reflects ideal performance, which assumes that an intervention is delivered, maintained, and used appropriately, while Output 2 captures actual performance based on observed levels of intervention effectiveness at the field sites. Both of these analyses are incomplete because the intangible impacts of sanitation improvements and other benefits that may accrue outside the sanitation improvement site are excluded in the study. Hence, Output 3 synthesizes the quantitative and qualitative findings to generate a more comprehensive set of conclusions and recommendations.

FIGURE 2. FLOW OF DATA COLLECTED (INPUTS) AND EVENTUAL COST-BENEFIT ASSESSMENTS (OUTPUTS)



3.1 TECHNICAL SANITATION INTERVENTIONS EVALUATED

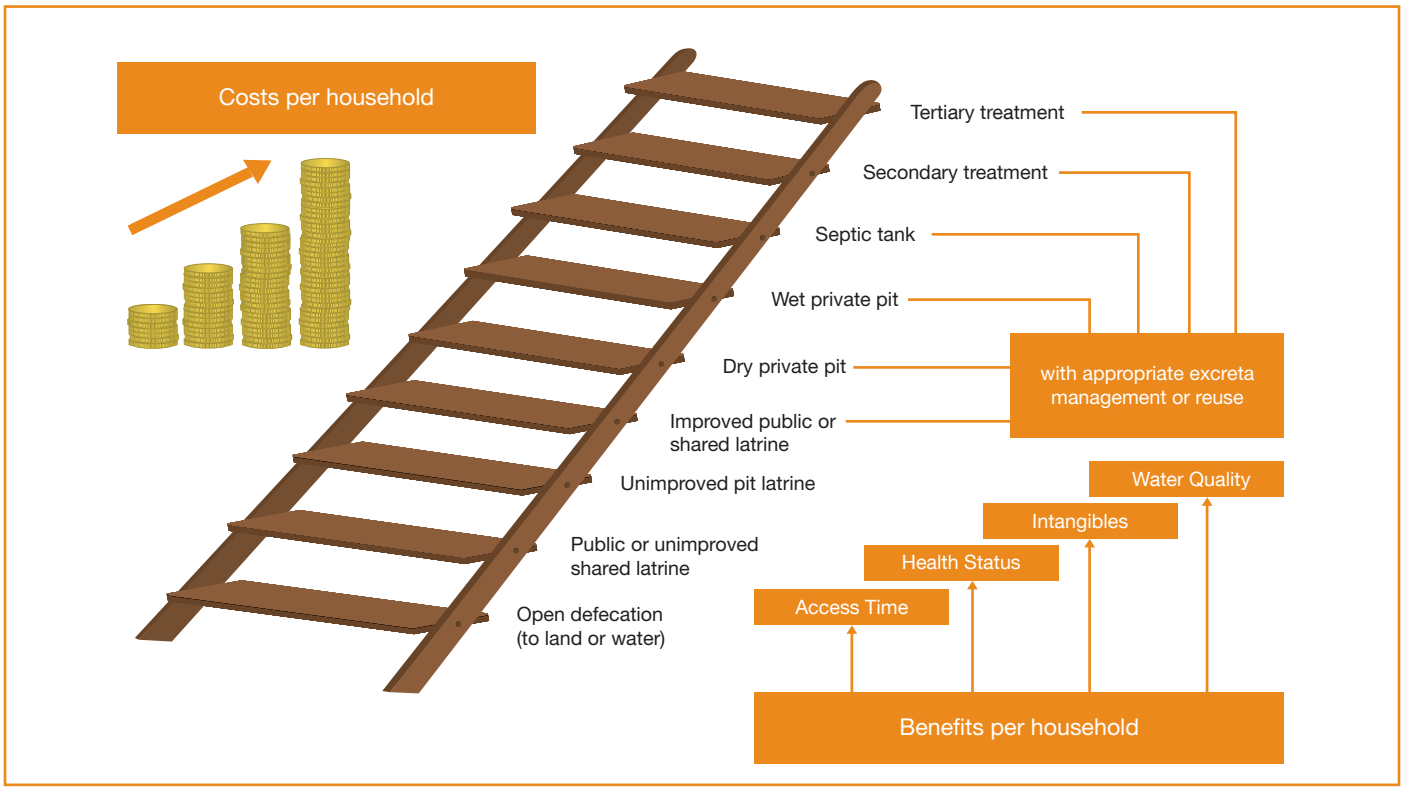
The type of sanitation evaluated in this study is household human excreta management. Interventions to improve human excreta management at household level focus on both onsite and off-site sanitation options. One of the key aims of this study, where possible, is to compare the relative efficiency of different sanitation technologies.

To qualify as an economic evaluation study, a cost-benefit analysis (CBA) compares at least two alternative intervention options. It usually includes comparison with the baseline of "do nothing." However, comparing two sanitation options will rarely be enough since, ideally, the analysis should compare all sanitation options that are feasible for each setting – in terms of affordable, technically feasible, and culturally acceptable options – so that a clear policy recommendation can be made based on the efficiency of a range of sanitation options, among other factors.

Technical sanitation options include all those interventions that move households up the sanitation ladder and thus bring benefits. Figure 3 presents a generalized sanitation ladder. The upward slope of the ladder reflects the assumption of greater benefits as the household climbs the ladder, but (generally) with higher costs. The progression shown in Figure 3 is not necessarily true in all settings and hence needs to be altered based on setting-specific features (e.g. rural or urban, and different physical/climatic environments such as soil type or water scarcity).

While the study proposes to conduct analyses of the costs and benefits of achieving the MDG targets and beyond, sanitation options will not be restricted by "unimproved" and "improved" sanitation as defined by the WHO/UNICEF Joint Monitoring Programme (JMP). For example, some households will be interested in upgrading from one type of improved sanitation to another, such as from VIP to septic tank, or from septic tank to sewerage. Other households need to decide whether to replace a facility that has reached the end of its useful life. Under some program approaches, e.g., Community-Led Total Sanitation (CLTS), households are also encouraged to move up the ladder, even if this does not imply a full move to JMP-defined "improved" sanitation, such as the use of shared or unimproved private latrines.

FIGURE 3. REPRESENTATION OF THE SANITATION "LADDER"



3.2 COSTS AND BENEFITS EVALUATED

Sanitation costs are the denominator in the calculation of benefit-cost ratios, and are thus crucial to the evaluation of sanitation option efficiency. Summary cost measures include total annual and lifetime costs, cost per household and cost per capita. For financing and planning purposes, this study disaggregates costs for each sanitation option by capital and recurrent costs, and by financier. The incremental costs of moving up the sanitation ladder are also assessed.

To maximize the usefulness of an economic analysis for diverse audiences, the benefits of improved sanitation and hygiene are divided into three categories:

1. **Household direct benefits**: These are incurred by households making the sanitation improvement. The actual or perceived benefits will drive the decision by the household to invest in sanitation, and will also guide the type of sanitation improvement chosen. These benefits may include: health impacts related to household sanitation and hygiene; local water resource impacts; access time; and intangible impacts.
2. **Local level external benefits**: These are potentially incurred by all households living in an environment where households improve their sanitation. However, some of the benefits may not be substantial until a critical mass of households has improved their sanitation. These benefits may include: health impacts related to environmental exposure to pathogens (e.g. water sources, open defecation practices); aesthetics of environmental quality; and usability of local water sources for productive activities. Given the challenges in designing studies to distinguish these benefits from household direct benefits, this study classified local level external benefits with household direct benefits.
3. **Wider scale external benefits**: These result from improved sanitation at the macro level. Benefits may include: water quality for productive uses; tourism; local business impact; and foreign direct investment. They can either be linked to coverage in specific areas or zones (e.g. tourist area or industrial zone), or to the country generally (e.g. investment climate). As well as improved management of human excreta, other contributors to environmental improvement such as solid waste management and wastewater treatment need to be considered.

In brief, this study distinguishes between the economic analysis results and local community impacts, where the sanitation and hygiene improvements take place, and national level impacts. Table 2 shows the impacts included in the current study, distinguishing between those expressed in monetary and non-monetary units.

TABLE 2. BENEFITS OF IMPROVED SANITATION INCLUDED IN THIS STUDY

Level	Impact	Socio-economic impacts evaluated in	
		Monetary terms ($ values)	Non-monetary terms (non-$)
Local benefits	Health	• Health care costs • Health-related productivity • Premature death	• Disease and mortality rates • Quality of life impacts
	Domestic water	• Water sourcing • Household treatment	• Linking poor sanitation, water quality & practices
	Access time	• Time use	• Convenience, comfort, privacy, status, security, gender
	Environmental quality		• Aesthetics of household and community environment
Tourism and Business	Tourism		• Sanitation-tourism link: potential impact of poor sanitation on tourist numbers • Income losses associated with loss of tourists • Tourist health costs
	Business		• Sanitation-business link: potential impact of poor sanitation on local businesses

While the focus of this study is on household sanitation, the importance of **institutional sanitation** also needs to be noted. For example, improved school sanitation may affect whether children (especially girls) start or stay in school, and workplace sanitation affects decisions of the workforce (especially women) to take or continue work with a particular employer. These impacts are incremental over and above the three discussed above. However, they are outside the scope of this present study.

3.3 FIELD STUDIES

3.3.1 FIELD SITE SELECTION AND DESCRIPTION

According to good economic evaluation practice, interventions evaluated should reflect the options faced by households, communities and policy makers. Therefore, the locations selected should contain a range of sanitation options that are typically available in Lao PDR, covering both urban and rural sites. By sampling a range of representative locations, study results can be generalized outside study settings, and hence be more useful for national and local-level planning purposes.

The principal criterion for site selection applied to Economics of Sanitation Initiative (ESI) studies is that there has been a sanitation project or program implemented in the past five years, and at some level of scale that allows minimum sample sizes of 30 households to be collected per sanitation option per site. Once the list of projects and programs has been established, a further set of criteria is applied in order to reduce the shortlist to six locations or projects (based on the available budget). These criteria include: (i) logistical feasibility for research; (ii) potential for collaboration with project/program; (iii) being representative of Lao PDR in terms of geophysical, climatic, demographic and socio-economic characteristics.

The study team had difficulty meeting these criteria due to the low population density of the country and the lack of variation in technical sanitation options. Hence, the strategy adopted was to survey about 1,200 households in six sites; which are a mix of urban and rural sites. For the purposes of analysis, the peri-urban site (site 2) was classified as a rural site, as it fitted more rural characteristics (population density). Since priority was given to sites that had a variety of sanitation options available, only three of the sites meet the criteria of having been exposed to sanitation projects or programs within five years of this study. This decision dampened the ability of the study to examine the possible impacts of sanitation projects on the households and communities but allowed the analysis to cover a wider range of sanitation interventions.

The six sites selected for the study were:

- Site 1 (urban): Chantabouly District, Vientiane Capital
- Site 2 (rural): Xaythany District, Vientiane Capital
- Site 3 (rural): Meun District, Vientiane Province
- Site 4 (rural): Nam Bak District, Luang Prabang Province
- Site 5 (urban): Nan District, Luang Prabang Province
- Site 6 (rural): Champone District, Savannakhet Province

The locations of the field sites are indicated in Figure 4.

FIGURE 4. LOCATION OF THE SELECTED FIELD SITES IN LAO PDR

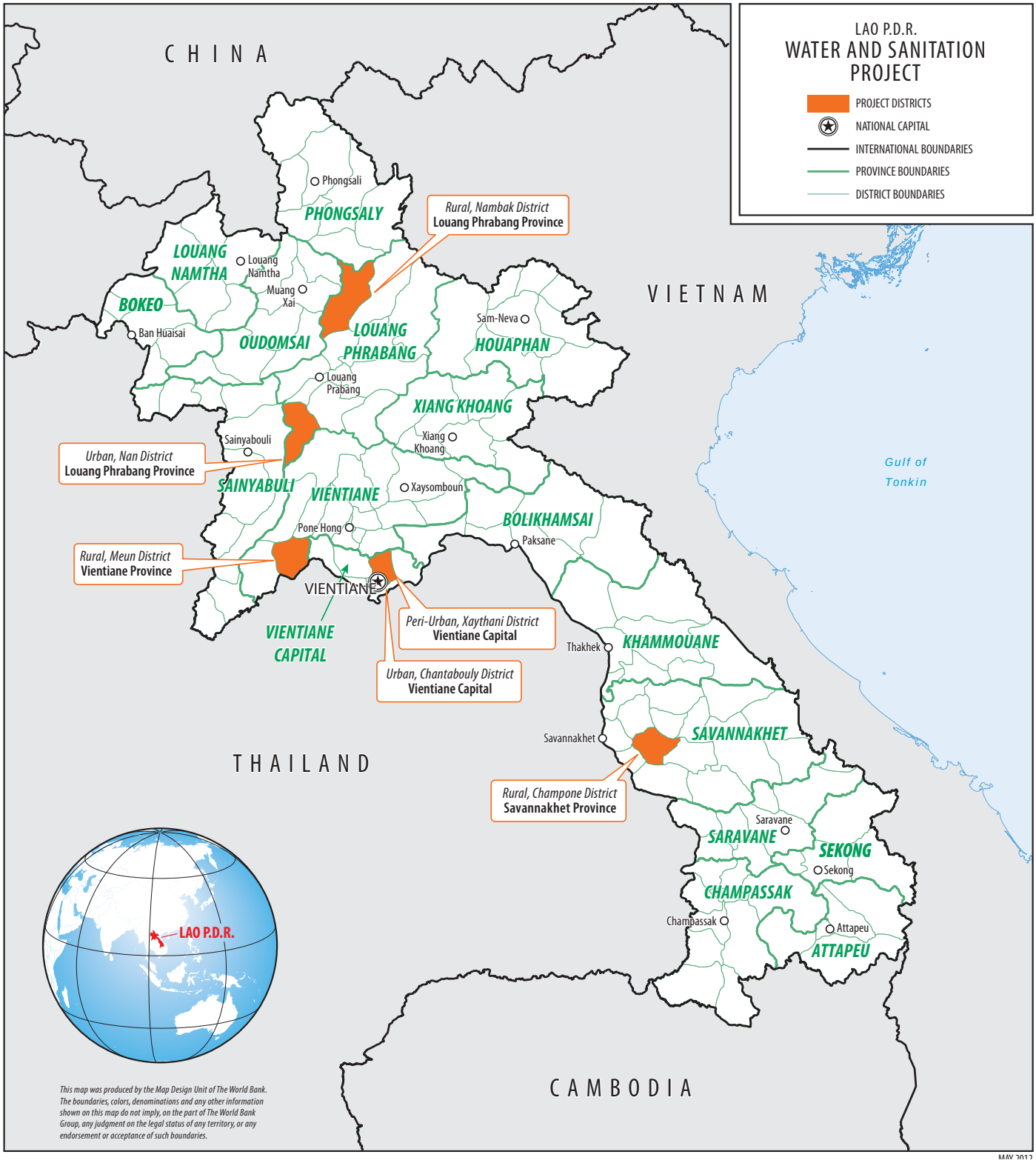


Table 3 provides a brief description of the provinces that contain the six study sites. It indicates that Vientiane and Luang Prabang provinces are very similar in a number of aspects. Incomes measured by GDP per capita are similar in these two provinces, and poverty incidence and demographic indicators are also quite close to the national average.[9] While Savannakhet province is also quite similar to Vientiane and Luang Prabang provinces, a larger proportion of its population resides in urban areas. Sites 1 and 2 in Vientiane Capital have significantly higher levels of economic activity and population densities than the other provinces. GDP per capita in Vientiane Capital is almost 3 times higher than that in the provinces of Vientiane, Luang Prabang and Savannakhet. Population density and the proportion of households living in urban areas in Vientiane Capital are much higher than the national average, and poverty incidence is also about half of the national average.

Table 4 shows the interventions evaluated for each study site. It indicates that the analysis focused mainly on dry pit latrines in rural areas, wet pit latrines in rural and urban areas, and toilets that flush to septic tanks or sewers in urban areas. Shared toilets were evaluated in one urban and two rural sites. In the analysis that follows, only Sites 1 and 5 were treated as urban areas while sites 2, 3, 4 and 6 were treated as rural areas.

It is important to note that there is no sewer system in any of the study sites. Hence, the analysis of a sewer system with sewage treatment in Site 1 was an attempt to get a sense of the net benefits that may arise should such facilities be installed in Vientiane Capital.

TABLE 3. SELECTED INDICATORS FOR KEY PROVINCES IN THE STUDY

Province	Sites	GDP (US$)[a]	Poverty incidence (%)[b]	% of households living in rural areas[c]	Population density (people / sq km)[d]
Vientiane Capital	1 & 2	2,148	15	35	178
Vientiane Province	3	751	28	75	17
Luang Prabang	4 & 5	821	27	77	24
Savannakhet	6	897	29	50	41

Notes: [a] Data taken from Ministry of Planning and Investment (2011). GDP estimates represent the average for 2006-10.; [b] 4th Lao Expenditure and Consumption Survey (LECS4) for 2007/8 as cited in Ministry of Planning and Investment (2011); [c] LECS4 2007/8; [d] Lao Statistical Bureau – data refer to the year 2005.

TABLE 4. SANITATION INTERVENTIONS EVALUATED PER SITE

Option	Site					
	1	2	3	4	5	6
	Urban	Urban	Rural	Rural	Urban	Rural
Open defecation	✓	✓	✓	✓	✓	✓
Shared: Wet pit[a]	✓	✓	✓			
Shared: Toilet to septic tank[a]	✓	✓				
Dry pit latrine			✓	✓		
Wet pit latrine	✓	✓	✓	✓	✓	✓
Toilet to septic tank	✓	✓			✓	
Toilet to sewer (with treatment)	✓					

[a] Refers to facilities that are used by two or more households.

[9] Based on the sources provided in Table 3, the national averages for the proportion of households living in rural areas, poverty incidence and population density are 69%, 28%, and 24 people/sq km, respectively.

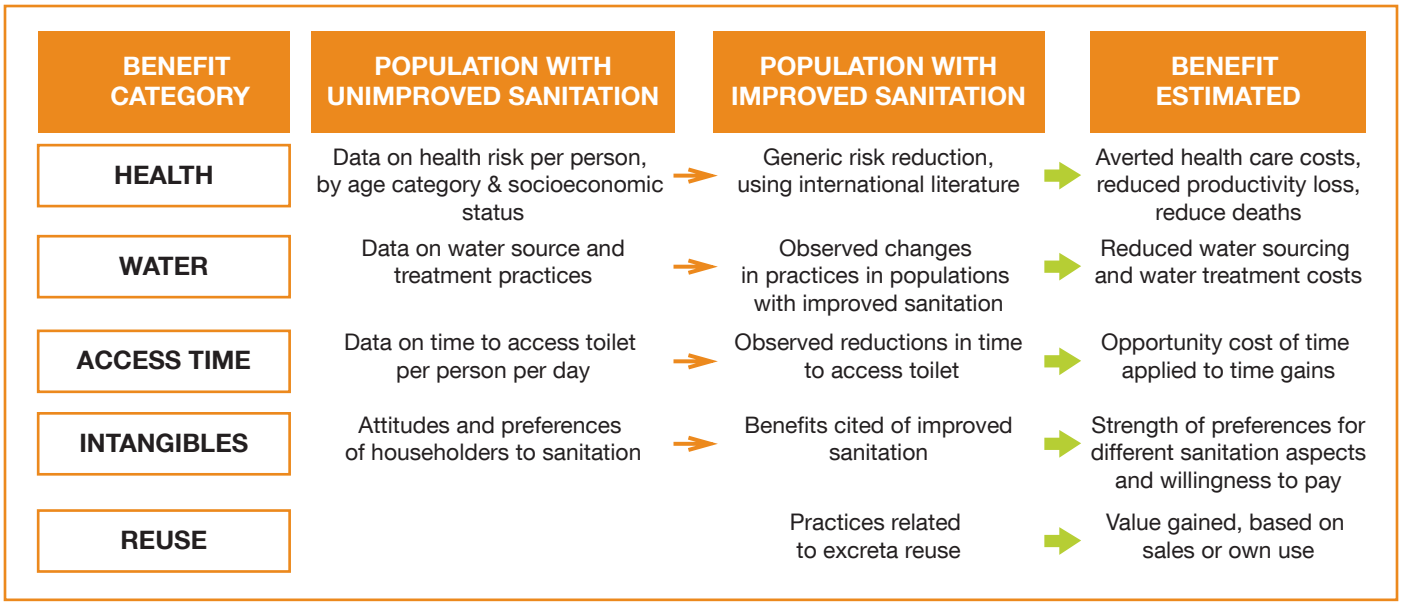
3.3.2 COST ESTIMATION METHODOLOGY

This study estimated the costs of different sanitation options. Cost estimation was based on information from an ESI household questionnaire and the existing literature. Data from these sources were compiled, compared, adjusted and entered into standardized cost tabulation sheets. The annual equivalent costs of different sanitation options were calculated based on annualized investment cost (taking into account the estimated length of life of hardware components) and adding annual maintenance and operational costs. Information from sanitation project and provider documentaion, and market prices was supplemented by interviews with key resource personnel to ensure the correctness of interpretation, and to enable adjustment where necessary.

Key points about estimated costs include:

- **Components of investment costs**. Investment costs represent expenditure on labor and materials for the construction and installation of facilities. In the case of toilets, these include expenditure on constructing the substructure and superstructure, and the installation of toilet bowls. Information on the cost of facilities was taken from recent literature (Collins, 2011 and Giltner et al., 2010). The cost estimates from the different studies were also converted to 2010 prices using the consumer price index (CPI) for non-food items, which was taken from ADB (2011).
- **Recurrent costs**. These refer to expenditure on the maintenance and operation of facilities such as water for flushing toilets, water and materials used to clean facilities and repairs. The values used in the analysis were extracted from the ESI household survey.
- **Toilets with access to sewer facilities**. The absence of a sewer system in Vientiane meant estimates of the cost of such facilities were not available. To address this challenge, the study modeled the cost of sewer facilities. It assumed that the investment and recurrent costs of toilets and sewers are higher or lower than their counterparts for toilets with access to septic tanks by a given factor.[10] The factors, which were extracted from similar ESI study in Indonesia (Winara et al., 2011), used in the analysis were 1.30 (investment costs) and 1.50 (recurrent costs). There are alternative factors from the ESI study in Vietnam (Nguyen et al., 2012) that are much higher than their counterparts for Indonesia.[11] However, these were not used here in an effort to use more conservative estimates of sewer system costs. Further reference to the factors from the ESI study in Vietnam is made in Section 7.4.

FIGURE 5. OVERVIEW OF METHODS OF ESTIMATING FIELD-LEVEL BENEFITS OF IMPROVED SANITATION



[10] Mathematically, the cost of toilets with access to sewer facilities = cost of toilets with access to septic tanks x factor.
[11] The factors from the ESI study in Vietnam are: (a) investment costs = 2.43 and (b) recurrent costs = 2.79.

Apart from the assumptions underlying the cost of access to sewers, there are a number of limitations to the other cost data that will be used in the study. The most significant of these limitations is the absence of information on program management or behavior change communication costs, which suggests that costs as a whole are likely to be underestimated in the study. Differences in the quality of materials used in construction also translate to variations in the cost of a particular sanitation option. Given the presence of multiple cost estimates, a simple average was used for the study. Finally, a tricky issue is the treatment of shared facilities. Compared to private (single household) facilities, shared facilities may have a shorter expected life and higher overall maintenance and operation costs simply because there are more users. However, more users also mean that the investment cost per household is lower. In the analysis, shared latrines were assumed to: (a) last half as long as private latrines; (b) have investment costs per household equal to total investment costs divided by the number of households; (c) have the same maintenance and operational costs as a private latrine. The last assumption ensures that the overall costs, which are equal to the number of users multiplied by the private costs per household, are higher for shared facilities.

3.3.3 BENEFIT ESTIMATION METHODOLOGY

Economic evaluation of sanitation interventions should be based on sufficient evidence of impact, thus giving unbiased estimates of economic efficiency. Hence the appropriate attribution of *causality of impact* is crucial, and requires a robust study design. Annex Table A2 presents alternative study designs for conducting economic evaluation studies, starting at the top with the most valid scientific approaches, down to the least valid at the bottom. Given that the most valid scientific approach (a randomized time-series intervention study) was not possible within the timeframe and resources of this study, the most valid remaining option was to construct an economic model for assessment of the cost-benefit of providing sanitation interventions and of moving from one sanitation coverage category to the next. A range of data was used in this model, reflecting households with and without improved sanitation, to ensure that *before* and *after* intervention scenarios were most appropriately captured. This included capturing the current situation in each type of household (e.g. health status and health seeking, water practices and time use), as well as understanding attitudes towards poor and improved sanitation, and the factors driving household and institutional decisions to invest in sanitation. These data were supplemented with evidence from other local, national and international surveys and data sets on variables that could not be scientifically captured in the field surveys. These included disease incidence and mortality rates, changes in disease rates associated with improvements in sanitation access and economic variables (incomes and discount rates).

Figure 5 presents an overview of the methods of estimating the benefits of moving up the sanitation ladder. The actual size of the benefit will depend on the specific sub-type of sanitation intervention implemented.

The specific methods for calculating the sanitation benefits are described below.

Health: Three types of disease burden are evaluated for the purposes of cost-benefit and cost-effectiveness analysis: numbers of cases (incidence or prevalence); numbers of deaths; and disability-adjusted life years (DALYs). The diseases included are all types of diarrheal disease, helminths and diseases related to malnutrition. Malnutrition is partially caused by environmental factors including poor water, sanitation and hygiene, and the presence of malnutrition increases the risk of, and fatality from, other diseases (e.g. malaria, acute lower respiratory infection and measles) (see Annex Table A3).[12] Health costs averted through improved sanitation are calculated by multiplying overall health costs per household by the relative health risk reduction resulting from improved sanitation measures. Health costs are made up of disease treatment costs, productivity losses and premature mortality losses. For cost-effectiveness analysis, DALYs are calculated by combining the morbidity element (made up of disease rate, disability weight and illness duration) and the mortality element (mortality rate and life expectancy). Standard weights and disease duration are sourced from the Global Burden of Disease study (WHO, 2008), and an average life expectancy for Lao PDR of 63 years is used (WHO, 2011a).

[12] A more detailed explanation of the links between sanitation and these diseases is provided in Annex A of Hutton et al. (2008).

- Rates of morbidity and mortality are sourced from various data sets for three age groups (0-4 years, 5-14 years, 15+ years), and compared and adjusted to reflect local variations in those rates. National disease and mortality rates were adjusted to rates used for the field sites based on the socio-economic characteristics of sampled populations. As not all diarrheal diseases come from fecal-oral transmission, an attribution fraction of 0.88 is applied for these diseases. For helminths, an attribution factor of "unity" was used in the study – i.e. cases are fully attributed to poor sanitation. Methods for the estimation of disease and mortality rates from indirect diseases via malnutrition are provided in the ESI Impact Study report (Hutton et al., 2009).
- Health care costs are calculated by applying treatment-seeking rates for different health care providers to the disease rates per age group. The calculations also take into account hospital admission rates for severe cases. Unit costs of services and patient travel and sundry costs are applied based on treatment seeking.
- Health-related productivity costs are calculated by applying time off work or school to the disease rates, per population age group. The economic cost of time lost due to illness reflects an opportunity cost of time or an actual financial loss for adults with paid work. The unit cost values are based on the average income rates per location. For adults a rate of 30% of the average income is applied, reflecting a conservative estimate of the value of time lost. For children aged 5-14 years, sick time reflects lost time at school, which has an opportunity cost, valued at 15% of the average income. For children under five, the time of the child carer or caregiver is applied at 15% of the average income. Values are provided in Table 5.
- Premature death costs are calculated by multiplying the mortality rate by the unit value of a death. Although premature death imposes many costs on societies, it is difficult to value precisely. The method employed by this study – the human capital approach (HCA) – approximates economic loss by estimating the future discounted income stream from a productive person, from the time of death until the end of (what would have been) their productive life. While this value may undervalue premature loss of life, as there is a value to human life beyond the productive worth of the workforce, the study faced limited alternative sources of value due to a lack of studies (e.g. value-of-a-statistical-life [VOSL]).[13] Values are provided in Table 5, including VOSL adjusted to Lao PDR from developed country studies. This shows that the economic value of lost life is highest for people above 15 years of age.
- Risk reductions of illness and death associated with improved sanitation and hygiene interventions are assessed from previous reviews of the international literature (Esrey et al 1985; Esrey and Habicht 1986; Esrey et al 1991; Prüss and Mariotti, 2000; Fewtrell et al 2005; Waddington et al 2009), and are applied and adjusted to reflect risk reduction in local settings based on baseline health risks and interventions.

Water: While water has many uses that go beyond the household level, the focus of the field study is use for domestic purposes, in particular drinking water. The most specific link between poor management of human excreta and water quality is the safety aspect, which causes communities to take mitigating action to avoid consuming unsafe water. These include reducing reliance on surface water and more use of wells, a treated piped water supply or bottled water. This even involves the need to rely less on shallow dug wells, which are more easily contaminated with pathogens, and to drill deeper wells.

This study measures the actual or potential economic benefits of improving sanitation on two sets of mitigation measures:

[13] VOSL studies attempt to value what individuals are willing to pay to reduce the risk of death (e.g. safety measures) or willing to accept for an increase in the risk of death. These values are extracted either from observations of actual market and individual behavior ("hedonic pricing") or from what individuals stated in relation to their preferences from interviews or written tests ("contingent valuation"). Both of these approaches estimate directly the willingness to pay of individuals, or society, for a reduction in the risk of death, and hence are more closely associated with actual welfare loss compared with the HCA.

TABLE 5. VALUES FOR ECONOMIC COST OF TIME PER DAY AND OF LOSS OF LIFE, 2010

	Value	
	Thousand kip	**US$**
Economic value of a lost life		
Human capital approach[a]		
0-4 years	51,028	6,179
5-14 years	88,767	10,748
15+ years	108,187	13,100
Value of statistical life (VOSL)[b]	400,732	48,522
Economic value of a lost day of adult productive time (8 hours)[c]		
Site 1 (urban)	31.4	3.8
Site 2 (rural)	21.2	2.6
Site 3 (rural)	11.0	1.3
Site 4 (rural)	12.0	1.5
Site 5 (urban)	12.0	1.5
Site 6 (rural)	13.1	1.6

Notes: [a] The estimates assume an annual growth rate of 4.2% for real GDP and an annual discount rate of 12%. The growth rate of real GDP is based on UNICEF (2010) data from 1990-2009 while the discount rate is the real interest rate reported in the World Bank (2011a). [b] The VOSL of US$2 million is transferred to the study countries by adjusting downwards by the ratio of GDP per capita in each country to GDP per capita in the USA. The calculation is made using official exchange rates, assuming an income elasticity of 1.0. Direct exchange from higher to lower income countries implies an income elasticity assumption of 1.0, which may not be true in practice. [c] This was calculated by dividing annual provincial GDP per capita by the number of working days in Lao PDR (246 days). The result was then multiplied by 0.3 to account for the assumption that not all of the lost time will be devoted to productive activities.

- Accessing water from the source. Because households walk further to access water from cleaner sources such as drilled wells, or pay more for piped water, access to improved sanitation would in theory reduce these costs. For example, people may traditionally prefer the taste of water from shallow wells to that from deeper wells, and hence would likely return to use shallow wells or wells closer to their home if they could guarantee cleaner and safer water. In some instances, water access and treatment costs of water utilities may also be lower if they use local and less contaminated water sources. Hence, expected percentage cost reductions are applied to the current costs of clean water access to estimate cost savings of improved sanitation.
- Household treatment of water. Households may treat water due to concerns about its safety and appearance. This is commonly true even for piped treated water supplies. Boiling is the most popular method because it is perceived to guarantee that the water is safe for drinking. However, boiling water can require considerable cash outlay and time to collect fuel. Furthermore, boiling water for drinking purposes is more costly to the environment due to the use of wood, charcoal or electricity, with correspondingly higher CO_2 emissions than other treatment methods. If sanitation is improved and the pathogens in the environment are reduced to low levels, households may feel more ready to use simple and less costly household treatment methods such as filtration or chlorination. If piped sources could be trusted, as in most industrialized countries, households may no longer feel the need to treat water. Hence, the cost savings associated with changes in water treatment practices are calculated based on observations and expected future household treatment practices under a situation of improved sanitation.

Water quality measurement was also conducted in representative field sites in order to get a sense of the impacts of improved sanitation on local water quality (see Annex Table A4).

Access time: Households with access to a private latrine will save time associated with going to the bush or using a shared facility. The time used for each sanitation option will vary from household to household, and from person to person, as children, men, women, and the elderly all have different sanitation preferences and practices. This study calculates the time savings of improved sanitation for different population groups, based on observations of households both with and without improved sanitation. The value of time is based on the same values as health-related time savings (see above).

Intangibles: Intangibles are major determinants of personal and community welfare such as comfort, privacy, convenience, safety, status and prestige. Due to its very private nature, it is difficult to elicit reliable responses from individuals, and these responses may vary considerably from one individual and social group to the next. Intangibles are therefore difficult to quantify and summarize from a population perspective, and are even more difficult to value in monetary terms for a CBA. Economic tools do exist for quantitative assessment of intangible benefits, such as the contingent valuation method, and willingness to pay surveys are commonly used to value environmental goods. However, there are many challenges to the application of these methods in field settings that affect their reliability and validity, and ultimately the appropriate interpretation of quantitative results. Furthermore, willingness to pay often captures not only the intangible variables being examined, but also the preferences that have been valued elsewhere in this study (e.g. health and water benefits). The current study therefore attempts only to understand and measure sanitation knowledge, practices and preferences in terms of ranking scales. This enables a separate set of results to be provided alongside the monetary-based efficiency measures.

External environment: The impacts of poor sanitation practices on the external environment are also difficult to quantify in monetary terms. Hence, this study attempts only to understand and measure practices and preferences in relation to the broader environment, in terms of ranking scales and descriptive presentation. Given that human-related sanitation is only one of several factors in environmental quality, other aspects – sources of water pollution, solid waste management, and animal waste – are also addressed to understand human excreta management within the overall picture of environmental quality.

A summary of the key formulas, variables and data sources used for calculating the monetized benefits is provided in Annex Table A5.

3.3.4 DATA SOURCES

The range of different costs and benefits estimated in this study required the collection of data from a variety of sources such as ESI field surveys, other national surveys, government documents and other research studies. The main reason for conducting the field survey was that data systems such as the health information system are often of poor quality and incomplete, while larger, more reliable nationwide or local surveys may be out of date and may not reflect closely the situation found in the ESI field sites.

Field surveys were implemented under the ESI in 2009 over a period of three months. The field team had five enumerators under the guidance of a field manager. Information gathered by the team leader from the field sites was sent to the study team leader and socio-economist for further decision on sample design. Accurate and up-to-date data on the sites were difficult to find, even with the assistance of village chiefs. This made it necessary to implement a rapid household survey in prospective sites prior to the actual survey. During this process, the field team collected information on the number of households and people in the sites, the type of toilet facilities and water supplies in use, and solid waste management conditions and practices. The rapid household survey also assisted in the formulation and specification of a relevant sample for actual survey. In Site 2, for example, extensive pre-survey work in 36 villages led to the identification and selection of villages that met the relevant criteria for a good sample. For each site, respondents were selected through a two-stage stratified sampling technique. Households were grouped initially into those that received and those that did not receive sanitation intervention. A random sample of households was then selected from each group. The contents of the field tools applied are introduced briefly below.

Field tool 1: Household questionnaire. Household questionnaires consisted of two main parts. The first was for household representatives (the senior male and/or female household member, based on availability at time of interview) while the second was a shorter observational com-

ponent covering mainly the physical water, sanitation and hygiene features of the household. The interview section of the questionnaire consisted of the following:

- Socio-economic and demographic information, and household features
- Current and past household sanitation options and practices, and mode of receipt
- Perceived benefits of sanitation, and preferences related to external environment
- Household water supply sources, treatment and storage practices
- Health events and treatment-seeking behavior
- Hygiene practices
- Household solid waste practices

The household questionnaire was applied to 1,211 households over the six sites, or an average 202 households per site. Annex Table A6 presents the sample sizes per sanitation option and per field site.

Field tool 2: Focus group discussion. The purpose of the focus group discussions (FGD) was to elicit behavior and preferences in relation to water, sanitation and hygiene among different population groups, classified by sanitation coverage (with versus without toilets) and by gender. The topics covered in the FGDs followed a generic template of discussion topics, but the depth of discussion was dictated by the readiness of the participants to discuss them. The added advantage of the FGD approach is to discuss aspects of sanitation and hygiene that may not otherwise be revealed by face-to-face household interviews, and to either arrive at a consensus or otherwise to reflect the diversity of opinions and preferences for sanitation and hygiene among the population.

A total of 21 FGDs, attended by 146 participants, were conducted at the sites (see Annex Table A7). The socio-economist/project coordinator led the FGDs at Sites 1 to 3 and the field manager led the FGDs for Sites 4 to 6. Each session lasted for about 90 minutes.

Field tool 3: Water quality measurement. Because poor sanitation has detrimental impacts on water quality, special attention was paid in this study to identify the relationship between the type and coverage of toilets in the selected field sites and the quality of local water bodies. Given the time scale of the study, it was not possible to measure water quality variables before the project or program was implemented; neither was it possible to compare wet season and dry season measurements. The water quality measurement survey was contracted to Geo-Sys Lao. The study enabled a broader comparison of water quality between study sites with different sanitation coverage levels. Water sources tested at the sites included ground water (wells), standing water (ponds, canals), flowing water (rivers, wastewater channels) and tap water. Annex Table A4 shows the type of test and location per parameter, and the number and type of water sources tested. Parameters measured varied per water source, but generally included E. Coli, Biological Oxygen Demand for 5 days (BOD5), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Nitrates, Ammonia, conductivity, turbidity, pH, and residual chlorine.

Other data sources: In addition to the data collected from the field sites, information was gathered from other sources to support the field-level cost-benefit study, such as reports, interviews, and data sets. These included:

- Local literature and interviews: costs and lifespan of toilet facilities
- International literature and publications: incidence and mortality rates of disease, effectiveness of sanitation and hygiene interventions to avert disease, economic data, and sanitation coverage (JMP data).

3.3.5 DATA ANALYSIS

The types of costs and benefits included in the study are listed in Section 3.2, which describes how costs, benefits and other relevant data are analyzed to arrive at overall cost-benefit estimates.

The field level CBA generates a set of efficiency measures from site-specific field studies, focusing on actual implemented sanitation improvements, including household and community costs and benefits. The costs and benefits are estimated in economic terms for a 20-year period for each field site, using average values based on the field surveys and supplemented with other data or assumptions. Five major efficiency measures are presented:

1. The benefit-cost ratio (BCR) is the present value of the future benefits divided by the present value of the future costs, for the 20-year period. Future costs and benefits (i.e. beyond the first year) were discounted to present value using a rate of 12%. The discount rate is the real interest rate reported for 2010 by the World Bank (2011a). Coincidentally, this is also the same discount rate used by Kwon (2005) and Pholsena et al (2003) in other Lao PDR-based studies.
2. The cost-effectiveness ratio (CER) is the present value of the future health benefits in non-monetary units (cases, deaths, DALY) divided by the present value of the future costs, for the 20-year period. Future costs and health benefits (i.e. beyond the first year) are discounted to present value using a discount rate (see above).
3. The internal rate of return (IRR) is the discount rate at which the present value equals zero – that is, the costs equal the benefits – for the 20-year period. It shows the annual equivalent rate of return of spending on sanitation, and can be compared with other development projects or alternative uses of funds (e.g. earning interest in a bank account).
4. The payback period (PBP) is the time after which benefits have been paid back, assuming initial costs exceed benefits (due to capital cost) and over time benefits exceed costs, thus leading to a break-even point.
5. The net present value (NPV) is the net discounted benefits minus the net discounted costs.

The results are presented by field site and each sanitation improvement option is compared with the "no sanitation" option (i.e. open defecation). In addition, selected steps up the sanitation ladder are presented, such as from shared latrine to private latrine, from dry pit latrine to wet pit latrine, and from wet pit latrine to sewers. The efficiency ratios are presented both under conditions of well-delivered sanitation programs that lead to well-functioning sustainable sanitation systems, and sanitation systems and practices under actual conditions. Given that not all sanitation benefits have been valued in monetary units, these benefits are described and presented in non-monetary units alongside the efficiency measures.

The results described above reflect data on the input variables of the "average" population. Therefore, to assess whether intervention efficiency is higher or lower in different income categories and socio-demographic groups, input values for poor and vulnerable groups without sanitation were entered into the economic model, and compared with the average and high income groups. Information across study sites is likely to differ in terms of household size, value of time, disease and mortality rates, water supply and treatment practices, and the cost per sanitation option.

3.4 NATIONAL STUDIES

National-level studies served two main purposes: (a) to assess the impacts of improved sanitation outside field sites to enable a more comprehensive CBA (tourism, business and sanitation reuse value); and (b) to complement or supplement data collected at field level to enable better assessment of local-level impacts.

3.4.1 TOURIST AND VISITOR SURVEY

There is arguably a link between sanitation and tourism for which very limited data currently exist (Hutton et al, 2009). Poor sanitation and hygiene may affect tourists in two ways:

1. Short-term welfare loss and expenses of tourists who travel to Lao PDR. Tourists can get sick from diarrhea, intestinal worms, hepatitis and other diseases, which have direct healthcare costs. Tourists may also be exposed to poor environmental conditions, including poor sanitation, which can reduce their enjoyment of the holiday.
2. Reduced numbers of tourists selecting Lao PDR as their destination. Tourists may stay away from locations that are deemed unsafe (from a health perspective) and unpleasant (unclean water, smelly environment, lack of proper toilets, etc). Tourists who have visited such locations may decide not to return or not to recommend the location to friends.

This study attempts to explore these two impacts through a survey of non-resident foreign visitors. Aside from holiday tourists, business visitors were also included to get their personal views and to make an important link with the business survey (Section 3.4.2).

Some 235 visitors were interviewed during October 2009. Slightly more than half of the respondents (118 visitors) were interviewed prior to leaving the country at Wattay International Airport. About a third of the respondents (84 visitors) were interviewed in locations that are frequently visited by tourists (including hotels, restaurants, temples and museums) in Vientiane Capital. The remaining respondents were interviewed at the domestic departure area of Wattay Airport.[14]

The survey team was composed of three members and the interviews were conducted over 16 working days. In all cases, visitors were approached by the team members and the purpose of the survey was explained. Visitors agreeing to take part were then interviewed on the spot. The interviews, which were conducted either in English or Thai, lasted for 10 to 30 minutes.

The survey form included questions on the following topics:

- Length of trip, places stayed and price category of hotel
- Level of enjoyment of different locations visited, and reasons
- Sanitary condition of places visited, and availability of toilets
- Water and sanitation-related sicknesses suffered, perceived sources, days of sickness, and type and cost of treatment sought
- Major sources of concern for a holiday stay in Lao PDR
- Intention to return to Laos, recommendation to friends, and reasons

Table 6 shows that most of the respondents (188) were in Lao PDR for a holiday, while the rest were in the country for business purposes. Moreover, the majority of those interviewed (178) were first time visitors. About 54% of the respondents came from Asian countries while the rest were Western visitors. Respondents were predominantly (57%) male.

3.4.2 BUSINESS SURVEY

Poor sanitation also has the potential to affect businesses in two ways:

1. Higher business costs and lost income. Businesses located in areas with poor sanitation may pay higher costs (e.g. having to pay more to access clean water) or lose income (due to customers being unwilling to visit the location). It should be noted, though, that the customer losses are not necessarily absolute losses to the country, as customers may have the choice to go elsewhere – i.e. to other businesses located in other areas.
2. Foreign businesses that decide not to locate in Lao PDR. Sanitation may be one of the many decision variables for locating a business activity in a particular country. There are several pathways through which poor sanitation may affect a business' decision to locate in Lao PDR: (a) health of the workforce, due to actual statistics or business leader perceptions of the poor health of a nation's workers; (b) poor (perceived) quality of water for use by the business, and the related costs; (c) general poor environment

TABLE 6. SAMPLE SIZES FOR TOURIST SURVEY, BY MAIN ORIGIN OF TOURIST

Visitor nationality	Holiday tourists			Business visitors			Visitors total
	First time visitors	Repeat visitors	Total	First time visitors	Repeat visitors	Total	
Asian 1[a]	30	6	36	5	14	19	55
Asian 2[b]	19	0	19	4	3	7	26
Asian 3[c]	31	9	40	3	3	6	46
Westerners[d]	79	14	93	4	11	15	108
Total	159	29	188	16	31	47	235

Notes: [a] Refers to visitors from Indonesia, Malaysia, the Philippines and Thailand. [b] Refers to visitors from China, Myanmar, North Korea and Vietnam. [c] Refers to visitors from Hong Kong, Japan, Singapore, South Korea and Taiwan. [d] Refers to visitors from Australia, New Zealand, Europe and North America

[14] Wattay Airport offers flights to eight domestic destinations.

(solid waste, unsightliness), which affects the ability to do business; and (d) undesirability of foreign staff to be located in Lao PDR due to poor sanitary conditions, among other things.

In order to assess these hypothesized effects, 17 firms located in Vientiane Capital were surveyed through face-to-face interviews and, in some cases, in-depth discussions. Table 7 provides a breakdown of the type of firms interviewed in this exercise. The food and beverage sector had seven respondents, of which five were Lao-owned. These firms are small family enterprises targeting the local market - a slaughter house, a seafood importer, and producers of noodles, meatballs and ice. The owners of the local firms were interviewed for this study. The international firms were composed of a bakery and brewery. The bakery, which only operates in Lao PDR, has several factories and sales outlets. In contrast, the brewery is a global firm that produces for both local and foreign markets. The production managers of the two foreign-owned firms were interviewed.

The tourist sector was represented by three restaurants, three hotels and two travel agencies. Two of the selected restaurants are owned by Lao citizens and their foreign partners. In both cases the Lao owner was interviewed. The third restaurant was owned by two foreigners (westerners) living in Lao PDR, one of whom was interviewed. All three restaurants only operate within Lao PDR, with one of the firms having several branches. All of the hotels were owned by foreigners, and two were part of larger international chains. The respondents from these hotels included a human resource manager and two assistant managers, who were Lao nationals. The two tour agencies were locally owned. One of the agencies mainly operated within Lao PDR (and through the internet), while the other operates within the region and with six globally spread sales offices. The operations manager and a foreign advisor were interviewed for the first travel agency while the owner was interviewed for the second. The two pharmaceutical firms were owned by the Lao government. The respondents were the director of one of the factories and the vice managing director of the other.

These firms were selected based on the hypothesized link between sanitation and their businesses, and the importance of the sector and specific firm to the Lao economy. Naturally, the survey of foreign firms was of those that are already located in Lao PDR, and hence a key category of firm – those that had decided against locating in Lao PDR – were not included in the sample. However, foreign firms were asked about the factors affecting their decision to locate in Lao PDR, and their experiences of the country.

The survey form included questions on the following topics:

- Ownership, sector, activities, employees and location of firm (production, sales, etc.)
- Perceptions of sanitation at company location
- Factors affecting decision to locate in country or area, and intention to relocate
- The production and sales costs related to different aspects of poor sanitation (health, water, environment)
- Potential costs and benefits of improved sanitation related to the business

TABLE 7. SAMPLE SIZE FOR BUSINESS SURVEY, BY MAIN SECTORS OF FIRMS

Main business or sector of firm	Local firm	Foreign firm	Total
Food and beverage producers	**5**	**2**	**7**
Restaurants	2	1	**3**
Hotels	1	2	**3**
Travel agencies/local tour operators	2	0	**2**
Pharmaceutical factories	2	0	**2**
Total	**12**	**5**	**17**

IV. Local Benefits of Improved Sanitation

This section presents the local benefits arising from access to improved sanitation.[15] This includes direct household benefits, which represent actual or perceived gains that motivate households to invest in sanitation. Also covered are local-level external benefits that refer to gains received by all households living in areas where members of the community have improved their access to sanitation. In describing the local benefits of improved sanitation, this section covers the following topics:

- Health (Section 4.1)
- Water (Section 4.2)
- Access time (Section 4.3)
- Intangible sanitation preferences (Section 4.4)
- External environment (Section 4.5)
- Project performance and actual benefits (Section 4.6)
- Summary of local benefits (Section 4.7)

4.1 HEALTH

The succeeding sub-sections discuss the key values and assumptions used in the calculation of health benefits. These also summarize the estimated benefits for the different study sites.

4.1.1 DISEASE BURDEN OF POOR SANITATION

Table 8 shows the disease burden associated with poor sanitation and hygiene among children under the age of five years. It indicates an estimated 5,548 disease cases, 8 deaths and 76 DALYs lost per 1,000 children each year in rural areas. While estimated disease mortality and DALYs are not too different from those in urban areas, incidence rates for children living in rural areas are about 24% (5,549 per 1,000 against 4,479 per 1,000) higher than in urban areas. Diarrheal diseases account for the largest proportion of cases, deaths and DALYs lost among children under the age of five years.

TABLE 8. DISEASE RATES AND DEATHS ATTRIBUTABLE TO POOR SANITATION AND HYGIENE FOR CHILDREN UNDER FIVE YEARS, ANNUAL RATES PER 1,000 PEOPLE, 2010

Disease	Rural Sites			Urban Sites		
	Cases	Deaths	DALYs	Cases	Deaths	DALYs
Direct diseases						
Diarrhea	4,143	3.63	36.05	3,074	3.63	34.51
Helminths	1,000	0.03	6.28	1,000	0.03	6.28
Indirect diseases						
Malnutrition	316	0.35	3.19	316	0.35	3.19
Malaria	4	0.52	4.31	4	0.52	4.31
Acute lower respiratory infection	85	1.62	13.76	85	1.62	13.76
Measles	nr	1.56	12.89	nr	1.56	12.89
Total	5,548	7.72	76.47	4,479	7.72	74.93

Note: nr = not relevant;
Source: Annex Table B1

[15] Please refer to Section 3.2 for a more detailed explanation of the local-level benefits.

Site-specific and age-specific rates used in the study are presented in Annex Table B1.[16] It is important to note that the lack of reliable site-specific information on disease rates means that only rural-urban differences are estimated here.

To some extent, quality of life impacts associated with morbidity are reflected in the DALY calculations above, and in the estimates of health care and productivity costs presented in later sections. However, these estimates still fail to fully capture the pain, suffering and discomfort that come with disease. For example, it is possible that adults continue to report for work even though they are sick. Hence, while there might not be a loss of income for these sick adults, the additional discomfort associated with working at a time of illness is not captured in the analysis.

Figure 6 shows the incidence rates for direct diseases for all age groups and sites. The values reported here are lower than in Table 8 because incidence rates for diarrheal diseases are lower among older age groups.

4.1.2 HEALTHCARE COSTS

Healthcare costs were estimated using information on the number of cases, proportion of illnesses treated by each provider, and unit costs associated with each provider.

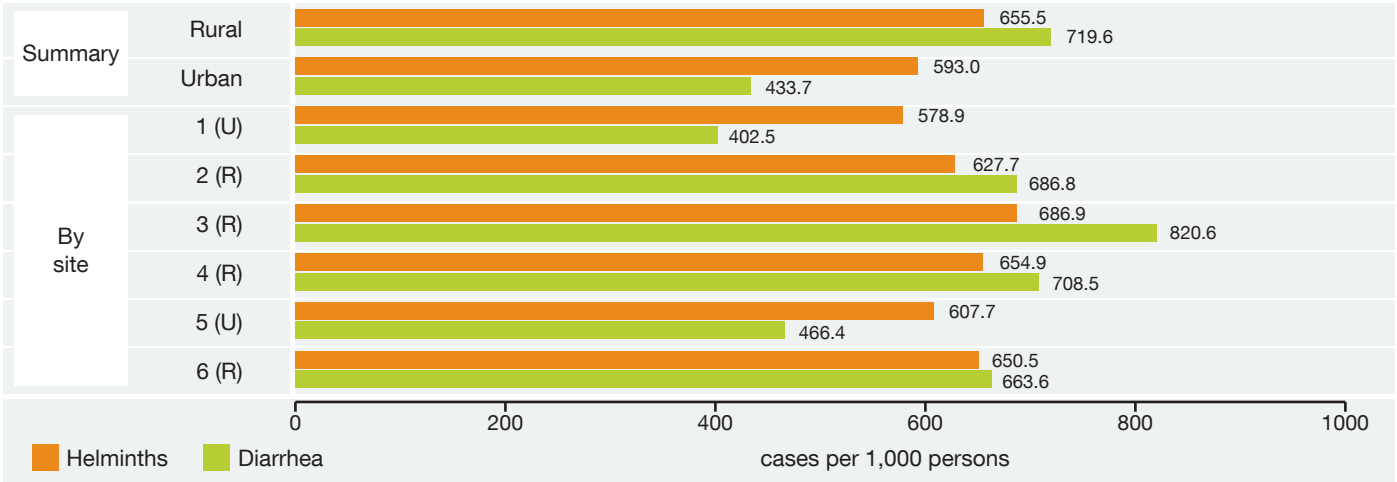
Table 9 summarizes treatment-seeking rates for diarrhea among children aged below five years. Using information from the ESI household survey and WHO (2011b), it indicates that the majority of the respondents went to hospitals and other formal facilities. This practice appears to be more prevalent in urban areas. The use of informal care facilities and other treatment practices is also more common in rural areas. Due to the lack of reliable information, the treatment practices found in Table 9 were also used for the other age groups (i.e., ages 5 years and above) in the analysis.

The ESI household survey found that, among those who went to hospitals, in-patient admission rates varied by disease and location. Given the relatively small number of responses for each of the sites however, the approach was to calculate the in-patient admission rates for the different age groups in the rural and urban sites as a whole, rather than by specific site. The results were in-patient admission rates (as a percentage of all disease cases) with the following ranges:

- Diarrhea: 33% (urban) to 50% (rural)
- ALRI: 33% (rural) to 38% (urban)
- Malaria: 15% (rural) to 50% (urban)

There was no available information on in-patient admission rates for helminths, so an in-patient admission rate of zero was used.[17]

FIGURE 6. COMPARISON OF DIRECT DISEASE RATES FOR ALL AGE GROUPS, PER 1,000 PEOPLE



Notes: R =. rural site; U. = urban site
Source: Annex Table B1

[16] Annex Table B2 contains a list of diseases rates that were initially considered in the study.
[17] This assumption was also adopted in the Philippines (Rodriguez et al., 2011), where doctors interviewed said that people who suffered from helminths were basically out-patient cases.

Unit costs for treating diarrheal disease are provided in Table 10. Outpatient costs of hospital care (public and private hospitals and clinics) are comprised of doctors' fees and payments for medicine in such facilities. These were estimated to be about 162,000 kip (US$20) and 132,000 kip (US$16) per case in rural and urban areas, respectively. In-patient costs for treating diarrhea in the rural sites were about 212,000 kip (US$25) per patient, which is about 25% higher than in urban areas. Incidental expenses capture transport costs associated with traveling to the facility. These costs were found to be quite high for Lao PDR, especially in rural areas. All the costs used in the analysis were drawn from the ESI household survey. Annex Table B4 presents unit costs associated with diarrhea, helminths, ALRI and malaria.

Table 11 shows the estimated annual healthcare costs per person attributed to poor sanitation and hygiene in Lao PDR. The values account for the unit costs of diseases and their respective incidence rates. The table indicates three clear patterns. First, healthcare costs per person were higher as a whole in rural areas than in urban areas. Second, diarrheal diseases accounted for a large proportion of healthcare costs per

TABLE 9. TREATMENT-SEEKING BEHAVIOR FOR DIARRHEA, OF CHILDREN UNDER FIVE YEARS, % OF CASES[a]

Facility	Urban	Rural
Hospitals	42.9	25.7
Other formal facilities	50.0	25.7
Informal care	7.2	45.7
Self-treatment	-	5.3
No treatment	-	9.6

Note: [a] The values may not total 100% due to multiple facilities/practices used by patients. Annex Table B3 shows the treatment-seeking rates that were considered for the different diseases in this study.
Source: WHO (2011b) and ESI survey

TABLE 10. UNIT COSTS ASSOCIATED WITH TREATMENT OF DIARRHEA, THOUSAND KIP, 2010

Health provider	Rural		Urban	
	Health care	Incidentals[a]	Health care	Incidentals[a]
Hospitals (out-patient)	161.7	161.1	132.3	80.6
Hospitals (in-patient)[b]	211.7	161.1	169.5	80.6
Other formal care	170.0	82.8	139.0	6.3
Informal[c]	100.0	-	100.0	-
Self-treatment	11.4	-	-	-

Note: [a] Incidentals = transport costs; [b] Hospital in-patient care = represents costs for the entire duration of stay; [c] no transport costs were available for informal care
Source: Annex Table B4

TABLE 11. AVERAGE HEALTHCARE COST PER PERSON PER YEAR IN FIELD SITES, THOUSAND KIP, 2010

Disease	Rural			Urban		
	0-4 yrs	5-14 yrs	15+ yrs	0-4 yrs	5-14 yrs	15+ yrs
Diarrheal disease	997.0	136.4	68.2	636.0	87.0	43.5
Helminths	149.0	149.0	71.1	87.9	87.9	41.9
Malaria	2.2	nc	nc	4.7	nc	nc
ALRI	23.4	nc	nc	84.5	nc	nc
Total in thousand kip	**1,171.7**	**285.4**	**139.3**	**813.0**	**174.9**	**85.4**
Total in US$	**141.9**	**34.6**	**16.9**	**98.4**	**21.2**	**10.3**

Source: Author's calculations.

person. This is especially the case among children under the age of five where at least 78% of the costs were attributed to diarrheal diseases. Third, healthcare costs of children under the age of five years were substantially higher than in any other age group. In rural areas for example, healthcare costs for this age group amounted to about 1.17 million kip (US$142) per person. This is approximately 4 times larger than the costs for children between the ages of 5 and 14 years, and more than 8 times larger than the costs for adults (over 15 years). While this may be explained mostly by the higher incidence of diarrhea in the under-5 age group, it is important to note that the relative differences across age groups are overstated because malaria and ALRI were not accounted for in the health costs of people over the age of five years.

4.1.3 PRODUCTIVITY COSTS

Two sources of productivity costs are associated with disease. The first is the cost to patients who are unable to perform their regular activities. A second cost, which is often ignored, is that borne by carers who take time away from their regular activities to look after a patient. The study attempts to estimate the productivity losses associated with these two costs.

In valuing productivity losses, respondents were asked about the number of days household members were sick per case of disease. They were also asked about the amount of time spent by carers to look after patients. The survey found that, on average, lost productivity days from diarrheal diseases were about 3.2 (under 5 age group), 4.4 (5-14 age group), and 3.8 (over 15 years). The number of lost productivity days of adults directly associated with the disease (2.7 days per case) was actually lower than the value used in the study. This is because 1.1 days were added to account for the time spent caring for sick children in the case of diarrhea. The ESI household survey also indicates the following number of days lost due to illness as a result of other diseases:[18]

- ALRI: 5.1 days (children under 5 years), 4.0 days (5-14 years), 5.8 days (over 15 years)
- Malaria: 11.6 days (children under 5 years), 9.1 days (5-14 years), 16.2 days (over 15 years)
- Helminths: lost days equal half of values used for diarrhea (assumption)

The value of the lost time can be estimated by the value of the income that patients and carers could have earned during the period of the illness. Recognizing the alternative approaches to the valuation of opportunity costs (e.g. lost income), the study used estimates of provincial GDP per capita as the basis for approximating foregone income.[19] However, the values were scaled down to 15% and 30% of GDP per capita per day for under fives and the other age groups, respectively. The adjustment follows the approach of the ESI Impact Study (Hutton et al., 2009) to account for the possibility that not all of the time lost was spent on productive activities. It was also an attempt to generate more conservative estimates of the impacts.

Table 12 shows the estimated productivity losses per person arising from the assumptions discussed above. It indicates annual losses of approximately 110,000 kip (US$13) and 129,000 kip (US$16) per person for children under the age of five years in rural and urban areas, respectively. This is due mainly to the relatively high incidence of disease, particularly diarrhea, in this age group. Despite relatively low diarrheal incidence rates, productivity costs in urban areas are larger because of higher incomes.

4.1.4 MORTALITY COSTS

Table 13 shows the costs associated with premature death (mortality). The values were computed by multiplying the probability of death and the value of life using the human capital approach (Table 5). There are two clear findings indicated by Table 13. First, the highest costs are reported for children under the age of five years. In rural sites for example, costs for this age group are more than 25 times higher than the costs for the other age groups. This is due to the high diarrheal incidence rate assumed for this age group and the fact that mortality costs associated with malaria and ALRI were not calculated for the other age groups. Second, in the case of children under the age of five years, a large proportion of the costs are due to diarrheal diseases.

[18] Lost adult time includes the number of days allocated to caring for sick children.
[19] There are no up-to-date or 2010-specific estimates of provincial GDP per capita in Lao PDR. These values were approximated by multiplying 2010 GDP per capita at the national level by the ratio of provincial to national GDP from 2006 to 2010. The raw data were taken from the Ministry of Planning and Investment (2011).

TABLE 12. AVERAGE PRODUCTIVITY COST PER PERSON PER YEAR IN FIELD SITES, THOUSAND KIP, 2010

Disease	Rural			Urban		
	0-4 yrs	5-14 yrs	15+ yrs	0-4 yrs	5-14 yrs	15+ yrs
Diarrheal disease	94.9	18.0	15.5	106.8	20.2	17.4
Helminths	11.5	15.9	13.1	17.4	24.0	19.8
Malaria	0.4	nc	nc	0.6	nc	nc
ALRI	3.1	nc	nc	4.7	nc	nc
Total in thousand kip	**109.9**	**33.8**	**28.6**	**129.4**	**44.2**	**37.2**
Total in US$	**13.3**	**4.1**	**3.5**	**15.7**	**5.4**	**4.5**

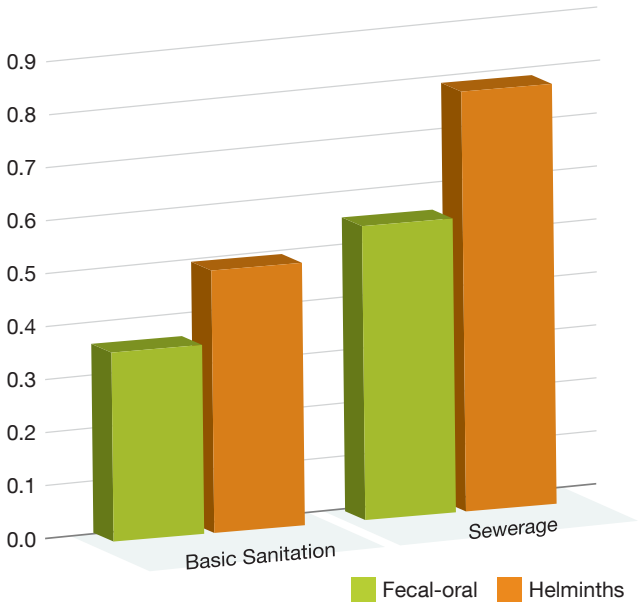
Source: Author's calculations.

TABLE 13. AVERAGE MORTALITY COST PER PERSON PER YEAR IN FIELD SITES, THOUSAND KIP, 2010

Disease	Rural			Urban		
	0-4 yrs	5-14 yrs	15+ yrs	0-4 yrs	5-14 yrs	15+ yrs
Diarrheal disease	185.5	10.7	13.0	185.5	10.7	13.0
Helminths	1.7	-	-	1.7	-	-
Malnutrition	17.7	-	-	17.7	-	-
Malaria	26.5	-	-	26.5	-	-
ALRI	82.9	-	-	82.9	-	-
Total in thousand kip	**332.0**	**10.7**	**13.0**	**332.0**	**10.7**	**13.0**
Total in US$	**40.2**	**1.3**	**1.6**	**40.2**	**1.3**	**1.6**

Source: Author's calculations. '–' not calculated

FIGURE 7. RELATIVE RISK REDUCTION OF FECAL-ORAL DISEASES AND HELMINTHS FROM DIFFERENT SANITATION INTERVENTIONS[a]



Note: [a] See the "Methodology" section for the relevant references, and Hutton et al (2012) for a more detailed discussion of the values.
Source: Author's calculations

4.1.5 AVOIDED HEALTH COSTS

Health effects are central to the arguments for improving sanitation and hygiene. Since limited evidence exists of the actual impact of sanitation or hygiene programs on health outcomes in Lao PDR, this study draws on international evidence. Figure 7 shows the different risk exposure scenarios being compared in this study, and the relative risk of fecal-oral disease and helminths infection associated with each scenario. The left-hand scenarios (basic improved sanitation) are relevant mainly to rural areas, while the right-hand scenarios (moving to treatment of sewage and wastewater) are relevant mainly to urban areas.

The ESI household survey provides some (rather weak) support to the earlier assertion that lower disease incidence is associated with moving up the sanitation ladder. The survey asked respondents whether they observed changes in the diarrheal disease incidence since receiving a new latrine. Their responses suggest that lower incidence was noticed among those receiving access to basic

sanitation facilities (Table 14). For example, about 25% of respondents who recently had access to shared wet pit latrines said that the incidence of diarrheal disease among household members was "probably less" or "a lot less". This value was lower than those who received toilets that flush to septic tanks (private and shared), dry pit latrines and wet pit latrines.

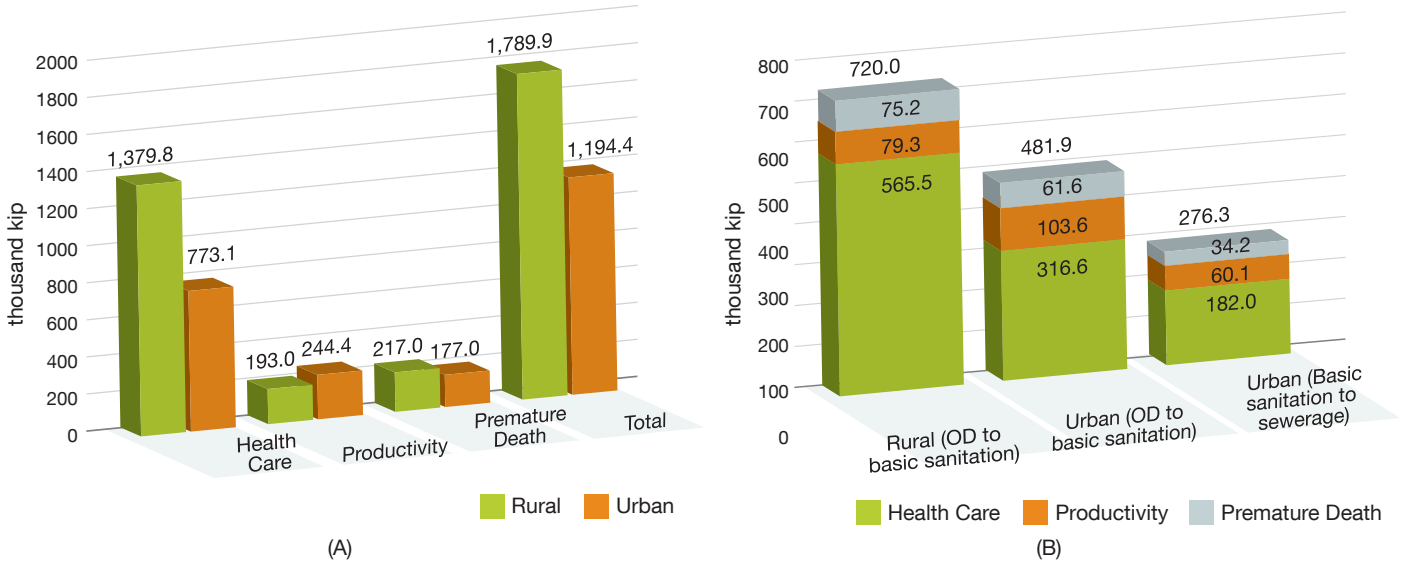
Figure 8 (Panel A) summarizes the estimated total costs per household of poor sanitation and hygiene for the field sites. It shows that the health cost for the average rural household in the sites was about 1.79 million kip (US$216) per year. About 77% of these costs were accounted for by health care. The remainder was divided between productivity and mortality costs. The estimated health cost for the average urban household was 1.19 million kip (US$145) per year. While the costs are still dominated by health care, the proportionate contribution of productivity losses was higher in urban areas because of relatively high incomes. Panel B of Figure 8 shows the estimated costs averted from sanitation improvements. It indicates that health costs fall by 720,000 kip (US$87) as a rural household moves from open defecation to access to basic sanitation. In the case of urban households, a shift from open defecation to basic sanitation access causes a cost reduction of 482,000 kip (US$58). A movement from basic sanitation to sewerage access causes a smaller reduction in health costs. For the typical urban household in the sites, this reduction was estimated at about 276,000 kip (US$33). The results capture diminishing returns in movements up the sanitation ladder.

TABLE 14. PERCEIVED DIFFERENCE IN DIARRHEAL INCIDENCE SINCE IMPROVED SANITATION, AT ALL FIELD SITES

Sanitation coverage after intervention	Number of responses	(% of responses)					
		A lot less	Probably less	No change	Probably more	A lot more	Don't know
Shared wet pit latrine	42	14.3	9.5	57.1	7.1	7.1	4.8
Shared toilet to septic tank	10	10.0	30.0	50.0	-	-	10.0
Dry pit latrine	69	15.9	21.7	42.0	7.2	8.7	4.3
Wet pit latrine	333	20.1	21.3	34.5	9.0	10.2	4.8
Toilet to septic tank	121	16.5	20.7	46.3	8.3	5.0	3.3
All interventions	**582**	**18.3**	**20.5**	**39.8**	**8.3**	**8.5**	**4.5**

Source: ESI survey

FIGURE 8. HEALTH COSTS OF UNIMPROVED SANITATION (A), AND HEALTH COSTS AVERTED OF IMPROVED SANITATION OPTIONS (B)



Source: Author's calculations.

4.2 WATER

Despite being a landlocked country, Lao PDR is well endowed with water resources. This is because the Mekong River, the tenth largest in the world, passes through most of the provinces of the country, including Vientiane Capital. The Water Environment Partnership in Asia (WEPA) website indicates a total annual water flow in the country of about 270 billion m^3, which is approximately a third of the annual water flow of the Mekong River basin (WEPA, undated).

Apart from river systems, other valuable water resources in the country are wetlands such as floodplains, swamps and marshlands. Gerard (2004) notes that Vientiane Capital had an estimated 1,500 km^2 of wetlands in the mid-1990s and that the largest of the wetland in the region is That Luang Marsh, which has an area of 20 km^2.

The quality of the water in rivers and wetlands is without a doubt important in terms of rural and urban water supplies, fisheries, power, irrigation and transport. On the basis of the high oxygen levels and low nutrient concentration, the WEPA (undated) asserts that the quality of water in river systems in Laos is "good". However, it also states that sedimentation is the primary source of pollution in rivers, with loads varying from 41 to 345 tons/km^2/year. It also adds that demographic and economic developments pose risks to the quality of inland surface water.

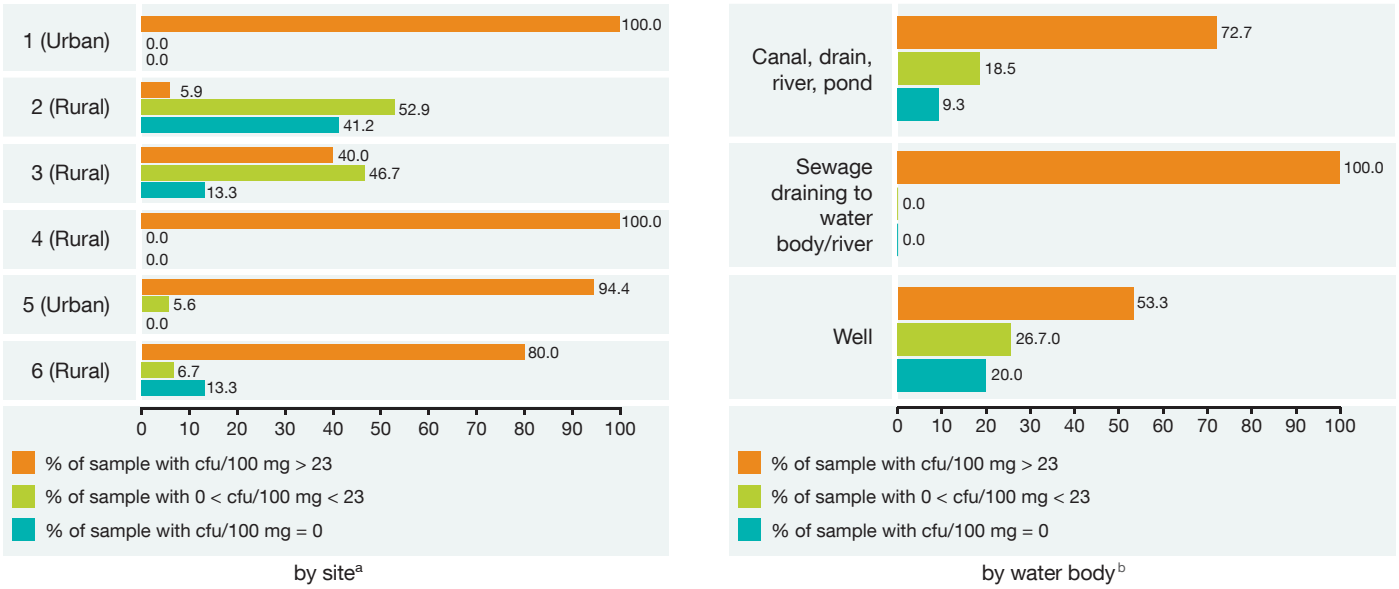
There is also some evidence of groundwater contamination in Vientiane Capital. Baetings and O'Leary (2010) cite that thermo-tolerant coliforms were found in 31 of 33 test samples taken from sources around the city. The study concluded that these findings suggest an "intermediate" threat to health if the water is consumed by humans.

Pollutants would be diluted naturally and natural bacteriological processes would reduce the pollution load in areas with small populations and abundant water resources. While population densities in Lao PDR are small compared to other countries in Asia, its growing population, especially in urban centers, along with poor sanitation and wastewater disposal facilities pose a threat to water quality.

4.2.1 WATER QUALITY AND ITS DETERMINANTS

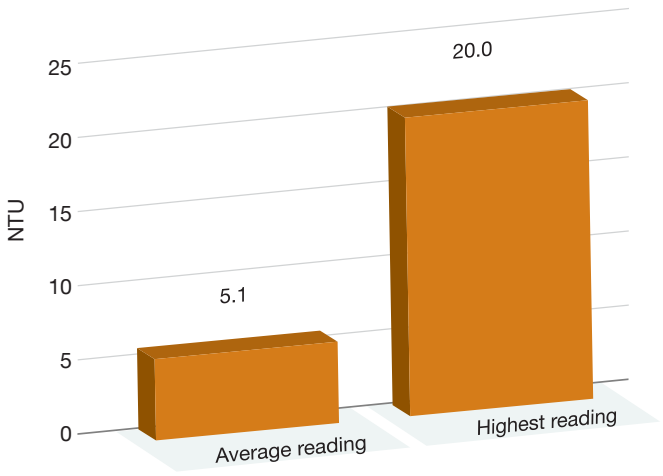
A water quality survey was implemented at the study sites in order to triangulate water quality readings with household practices and perceptions with sanitation practices. This section discusses selected findings while Annex Table C1 provides the full results of the survey.

FIGURE 9. TEST RESULTS FOR E-COLI BY SITE (A) AND WATER SOURCE (B)



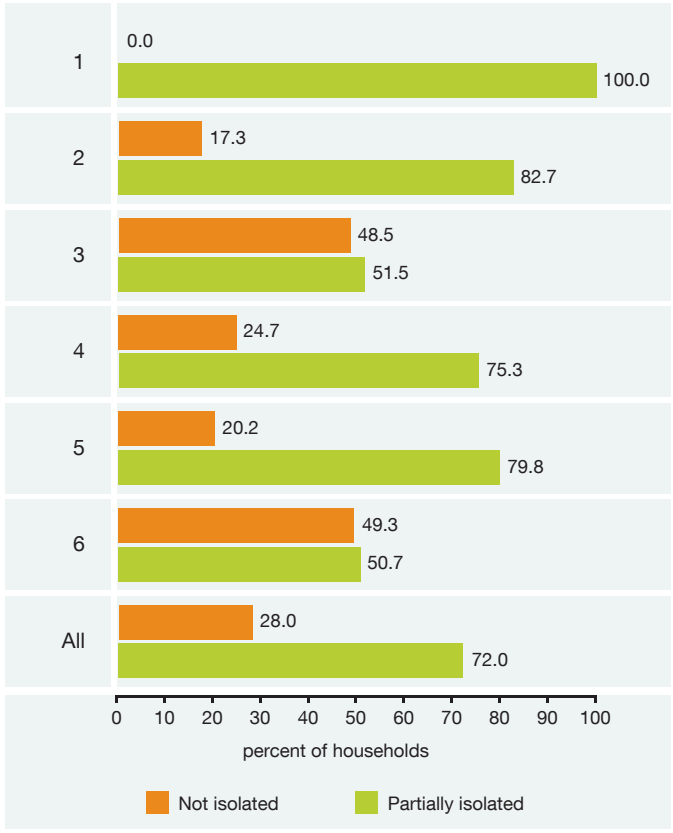
[a] The sample sizes (in parentheses) are as follows: Site 1 (11); Site 2 (17); Site 3 (15); Site 4 (14); Site 5 (18); and Site 6 (15). [b] The samples sizes (in parentheses) are: canals; drains; rivers; ponds (54); sewage draining to water body/river (6); and wells (30).
Source: ESI survey

FIGURE 10. TURBIDITY READINGS AT FIELD SITES, NTU



Source: ESI survev

FIGURE 11. EXTENT OF ISOLATION OF HUMAN EXCRETA IN FIELD SITES, % OF RESPONDENTS



Source: ESI survey

Figure 9 (Panel A) summarizes the results of tests for E. Coli in 90 wells, surface waters and sewer drains at the study sites.[20] It suggests that 88% (79 of 90) of the water bodies/sources tested positive for the presence of E. Coli. Moreover, about two-thirds (61 out of 90) of the water bodies/sources had readings in excess of 23 colony-forming units (CFU)/100 ml. A more serious concern however is that 20 of the 22 drinking water sources tested positive for E. Coli; of which, 15 sources had readings in excess of 23 CFU/100 ml. Figure 9 (Panel B) also shows that, as expected, all sewage that drains to water bodies or rivers failed the test for E.Coli. More than half of the wells tested had the same results.

The water quality survey also tested for turbidity (the cloudiness of the water caused by small suspended particles). Measured in terms of Nephelometic Turbidity Units (NTU), high turbidity levels suggest a heavy concentration of small suspended particles. Figure 10 summarizes the results of the turbidity tests for 21 drinking water sources (wells) at the sites. The average reading of 5.1 NTU is within the drinking water standard of less than 10 NTU.[21] However, three of the wells tested (two in Site 6 and one in Site 4) had readings above the standard. Two wells (one each for Sites 4 and 6) were estimated at 20 NTU, which is about 2 times as much as the standard.

The test results presented above suggest that there is significant room for improvement in the quality of water at the study sites. This is underscored by the finding that a large proportion of the water sources, especially those sources used for drinking water, tested positive for E. Coli. This is somewhat supported by the high turbidity readings for some of the wells that are used as drinking water sources.

Figure 11 shows the proportion of households in the ESI household survey with sanitation facilities that are likely to contribute to water pollution. It indicates that about 72% of the households at the sites have facilities that partially isolate contaminants that contribute to water pollution while the remainder provide no isolation.[22] These findings appear consistent with earlier results, where a large proportion of the water sources tested positive for E Coli. The unimpressive findings

[20] E. Coli is a species of coliform whose presence may be indicative of pollution from human or animal waste.
[21] Appendix 17 of Baetings and O'Leary (2010) shows that the standard for turbidity in drinking water sources is less than 10 NTU.
[22] Households with toilets that flush to treated sewers or septic tanks that are desludged and treated at an off-site facility are assumed to have full isolation in the ideal analysis. Open defecation to water bodies represents no isolation. All other practices or facilities are assumed to only partially isolate contaminants that contribute to water pollution.

of the water quality survey could also be indicative of poorly built facilities and poor waste disposal practices.

4.2.2 HOUSEHOLD WATER ACCESS AND TREATMENT COSTS

One of the major consequences of polluted water in wells, springs, rivers and lakes is that populations and water supply agencies have to treat water, or treat water more intensively, for safe human use. Alternatively, households can access cleaner water from different and more distant sources, thus increasing access costs. Those who do not take precautionary measures are exposed to a higher risk of infectious disease, or poisoning from chemical content. Table 15 shows the household water sources for drinking water and the average monthly water source costs per household. It indicates that the largest sources of water for all sites were bottled water (41% of respondents) and other non-piped protected sources (30%). The heavy use of bottled water is influenced by the high proportion of users in urban sites (61%). In contrast, rural respondents were the primary reason for the rather large proportion of users of other non-piped water sources at all sites. On average, the economic cost of drinking water at all sites was 602,000 kip (US$73) per household per year. Close to half of these costs (49%) are due to the time spent by respondents in accessing water from outside their houses and yards. The share of water access costs are also significantly higher in the rural sites because a larger proportion of households source their water from non-piped sources and a smaller proportion use bottled water. Site-specific data on water access are presented in Annex Table C2.

TABLE 15. WATER ACCESS AND COSTS PER HOUSEHOLD AT THE SURVEY SITES

Water source	Item	Rural	Urban	All sites
Piped water	% Access	5.6	19.0	9.9
	Costs (thousand kip)	18.9	85.7	40.0
	% Access cost[a]	83.9	27.9	66.2
Non-piped protected				
Bottled water	% Access	31.9	60.7	41.0
	Costs (thousand kip)	174.0	388.4	241.6
	% Access cost[a]	-	-	-
Others	% Access	38.3	12.0	30.0
	Costs (thousand kip)	230.5	66.4	178.7
	% Access cost[a]	79.5	47.7	69.4
Unprotected	% Access	24.1	8.3	19.1
	Costs (thousand kip)	186.4	43.0	141.2
	% Access cost[a]	98.6	100.0	99.0
All sources	% Access	100.0	100.0	100.0
	Costs (thousand kip)	609.9	583.5	601.6
	% Access cost[a]	60.3	23.0	48.5

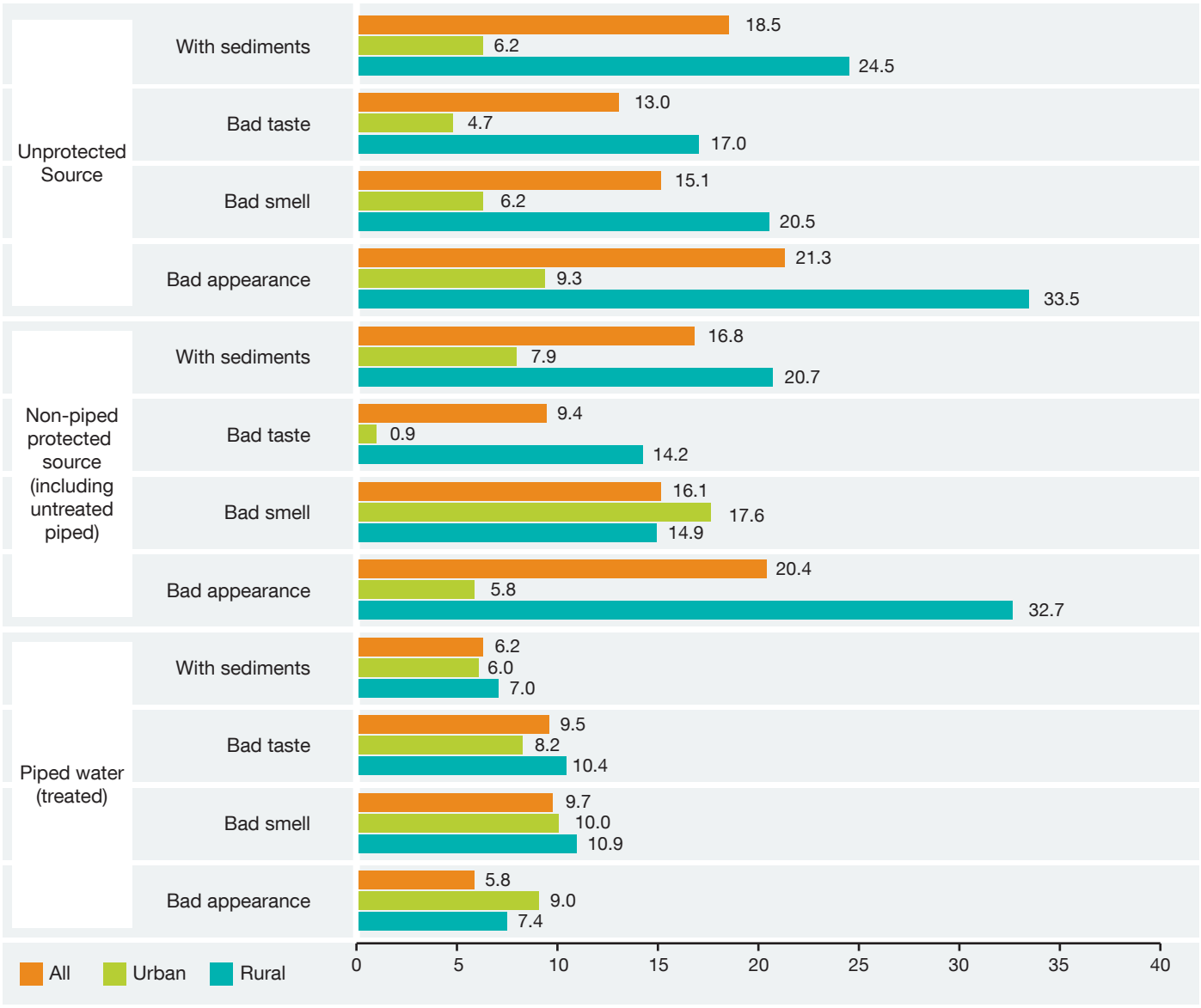
[a] This represents the share of the economic cost of accessing water sources among total costs. It therefore excludes the contribution of water treatment costs. In the case of piped water sources, access costs arise from the use of public standpipes.
Source: Annex Table C2

Figure 12 summarizes the data for householders' responses to the question on characteristics of poor quality water. It provides a comparison between rural and urban areas, and between three major water sources. For households that use unprotected and non-piped protected water sources, the most common complaint is the bad appearance of the water. However, bad smell was the major complaint among users of non-piped protected water sources in urban areas. In the case of households that use piped water, the highest number of complaints were for bad smell and bad taste.

4.2.3 HOUSEHOLD RESPONSE TO CONTAMINATED WATER AND RELATED COSTS

Households may respond to traditional water sources they know to be polluted in one or more ways: changing purchased source; walking farther to haul free water; or water treatment. They may connect to a piped water source (if available and affordable), harvest rainwater, purchase bottled water or bring in a tanker (more in urban areas). Figure 13 shows the reasons cited by all respondents for their choice of

FIGURE 12. HOUSEHOLDS CITING POOR WATER QUALITY FROM THEIR PRINCIPAL DRINKING WATER SOURCE, % OF RESPONDENTS

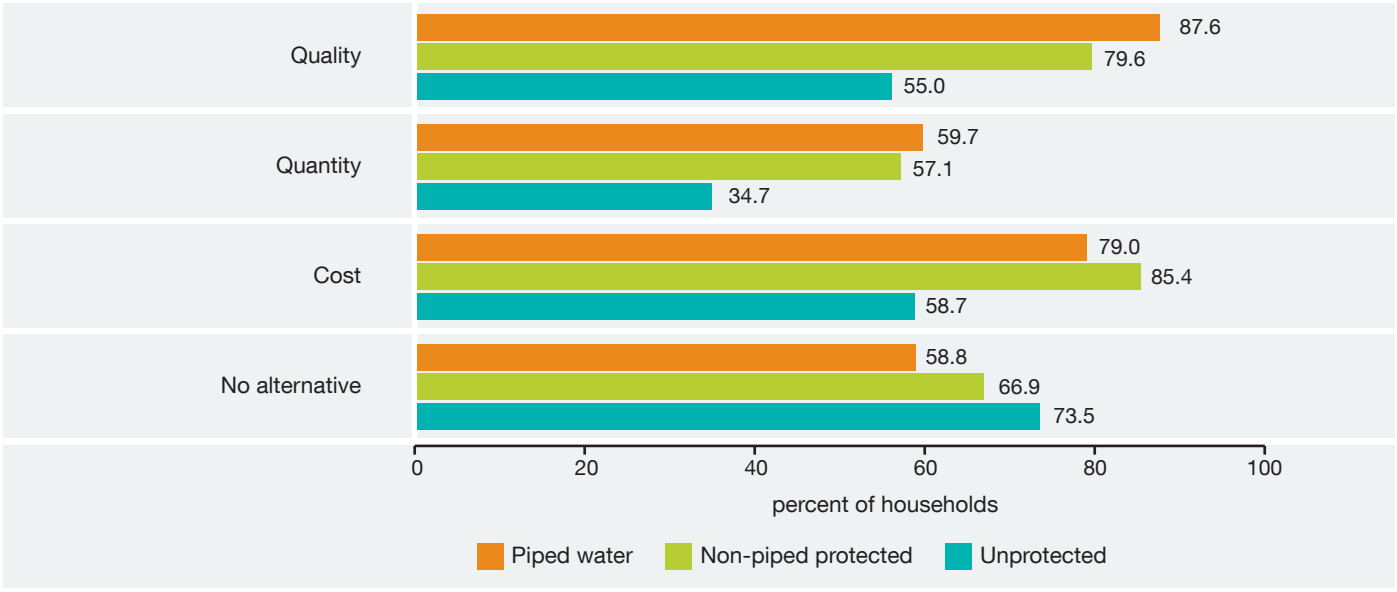


Source: Annex Table C3.

water source. The reasons vary by water source. The primary reason for piped water users was the quality of the water. This is consistent with findings in Figure 12, where a relatively small proportion of piped water users complained of bad appearance, bad smell, bad taste and the presence of sediment. On the other hand, cost was the dominant reason for users of non-piped protected water sources. This is because this group includes users of water sources for which there were no or very low financial (i.e., excluding time for accessing water) costs. Water quality was also an important reason because the group includes users of bottled water. Finally, the absence of alternatives was the main reason for households that use unprotected water sources. Annex Table C4 presents information from the different study sites.

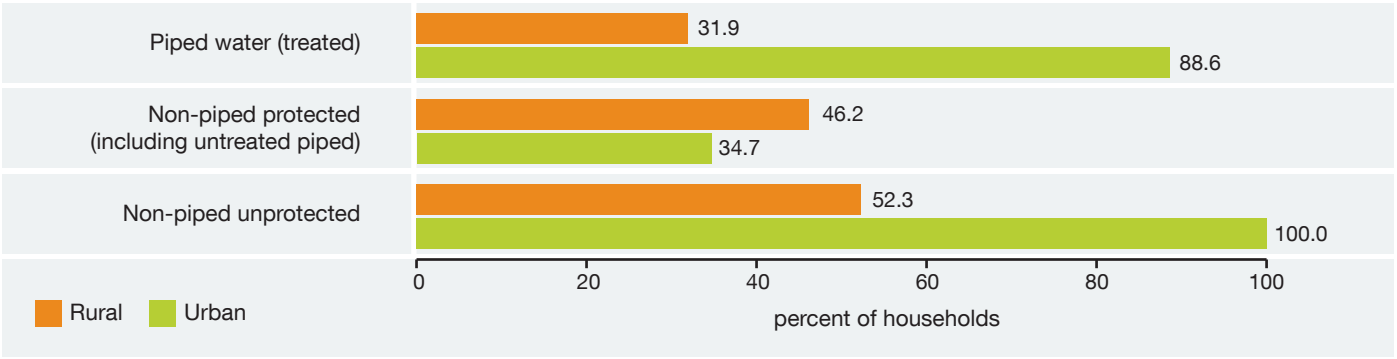
Households may also treat drinking water at home in response to water pollution. The survey found that about 48% of the households treat drinking water (see Annex Table C5 for details). Moreover, the most common method is boiling water, with about 39% of households adopting the practice. Figure 14 shows that water treatment varies by location and water source. It indicates that water treatment is more common in urban than rural areas. The practice is also more common among users of water from unprotected sources. The extreme case is the practice of water treatment for all users of water from unprotected sources in urban areas. However, the previous statement must be treated with caution because the finding is confined to households in Site 5 (see Annex C5).

FIGURE 13. REASONS FOR USING WATER SOURCES – RURAL VERSUS URBAN, % OF RESPONSES



Source: Annex Table C4 .

FIGURE 14. HOUSEHOLDS TREATING DRINKING WATER, % OF RESPONSES



Source: Annex Table C5 .

Figure 15 shows the annual household costs reported for boiling water in the different sites.[23] It indicates an annual cost of about 277,000 kip (US$34) for the average rural household in the survey. This is about 58,000 kip (US$7) more than the cost for the average urban household.

Changes in access to sanitation facilities and water supplies could affect household water treatment practices. In the household survey, the respondents were asked whether their treatment practices had changed two years after they received a new latrine or had access to improved water sources. Figure 16 reports the results of the survey. The major finding is that only a small proportion of the households changed their treatment practice. In the case of households that received new latrines, only about 8% of the respondents said that their treatment practices changed. About the same percentage of households said that their treatment practices changed after having access to improved water supplies. It is interesting to note that rural households appear to be slightly more responsive to changes in sanitation access and improvements in water supply. For example, 9% of the rural respondents said that their treatment practice changed after receiving a new latrine. This is about 2% higher than urban households. In all, the main implication of these findings is that improvements in sanitation will have limited impacts on water treatment practices. At the very least, one cannot expect all households to change their water treatment practices following an improvement in sanitation and/or water supply access. This is likely to be due to a mixture of entrenched habits, and the fact that household wastewater is only one of several sources of contamination of water bodies.

4.2.4 HOUSEHOLD WATER COSTS AVERTED FROM IMPROVED SANITATION

Table 16 summarizes the averted annual costs of an average household in terms of accessing water and water treatment. The averted cost calculations assume that the reduction in water pollution arising from improved sanitation will alter the behavior of households with respect to where they access water supplies and water treatment. Water source and treatment savings were based on a careful comparison of water sources for those with improved and unimproved sanitation.

The values in Table 16 indicate that the savings from improvements in sanitation are quite small. The estimated annual savings from water access and treatment costs averaged across all sites were 21,000 kip (US$3) and 38,000 kip (US$5) per household, respectively. These values capture the point that it is impossible for all costs to be averted following an improvement in sanitation. Since sanitation is not the only source of water pollution. In relation to this, water treatment practices are also likely to be a function of perceptions regarding water quality. This is in part supported by the earlier finding that water treatment practices do not change much following an improvement in sanitation and water supply (Figure 16). Another reason is that a shift towards lower cost treatment practices and water sources still entails a cost, be it financial or the opportunity cost of collecting water.

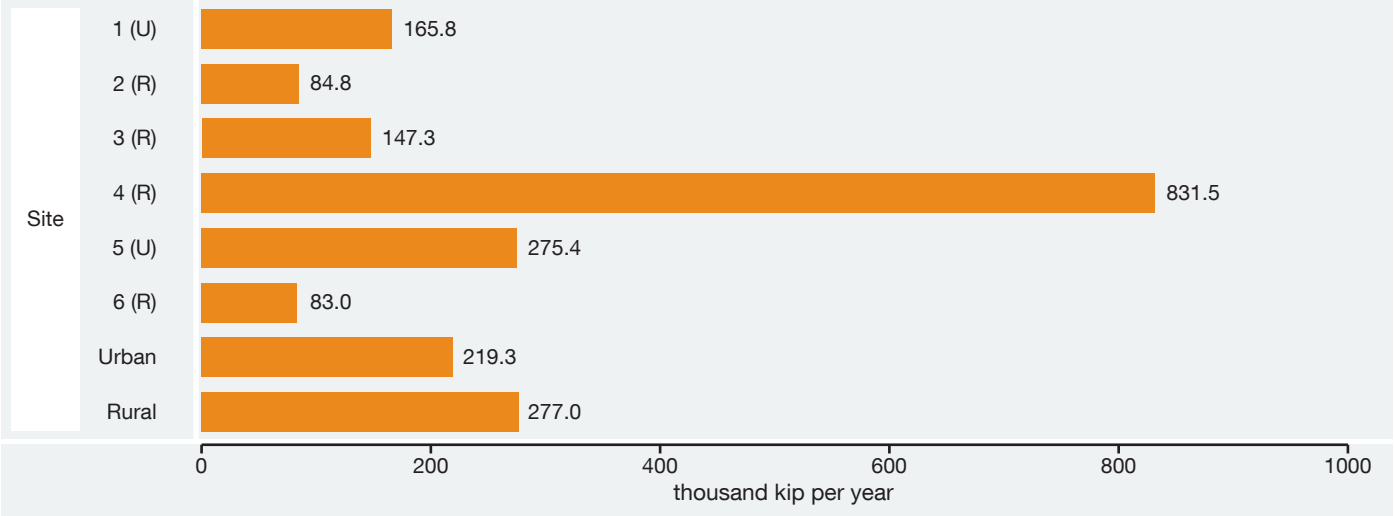
TABLE 16. HOUSEHOLD WATER ACCESS AND WATER TREATMENT COSTS AVERTED AS A RESULT OF IMPROVED SANITATION, THOUSAND KIP

Site	Annual average costs per household			Annual average savings per household following 100% sanitation coverage		
	Water source access	Water treatment	Total	Water source access	Water treatment	Total
Rural	610.5	277.3	887.9	26.7	42.5	69.2
Urban	592.8	211.7	804.5	7.2	25.6	2.7
All sites	605.5	258.8	864.3	21.2	37.7	58.9
All sites in US$	73.3	31.3	104.7	2.6	4.6	7.1

Source: Annex Table C6.

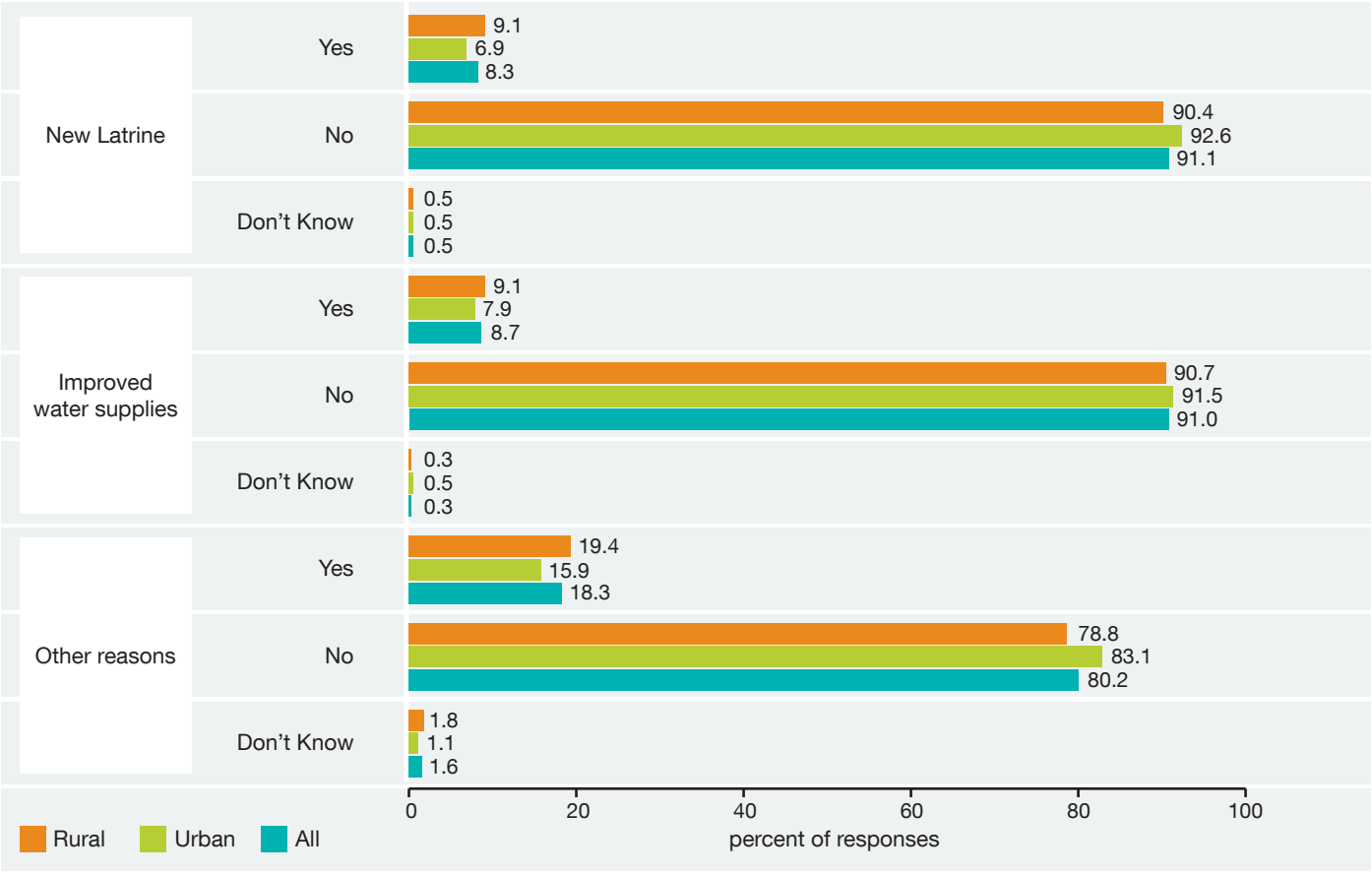
[23] The ESI survey did not provide costs associated with other treatment practices.

FIGURE 15. AVERAGE HOUSEHOLD COSTS FOR BOILING WATER, THOUSAND KIP



Notes: R. = rural; U. = urban
Source: ESI survey

FIGURE 16. DID YOUR WATER TREATMENT PRACTICES CHANGE AFTER RECEIVING (A) A NEW LATRINE OR (B) IMPROVED WATER SUPPLIES OR (C) OTHER REASONS? % OF RESPONSES



Source: ESI Survey.

4.3 ACCESS TIME

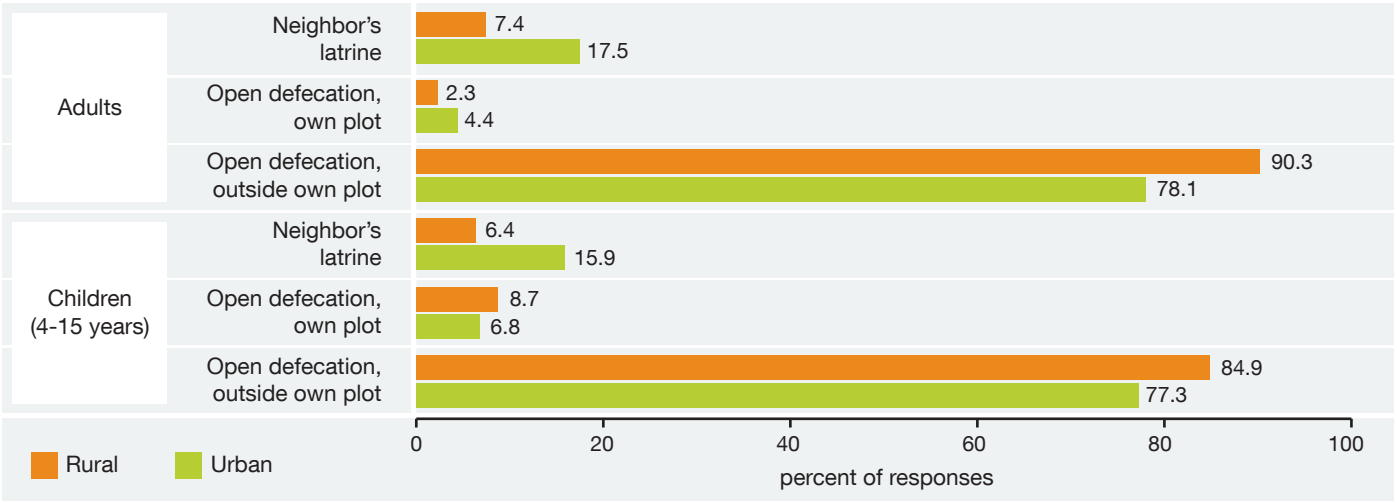
4.3.1 ACCESS TIME AND TIME SAVED

The survey found that a large majority of households without a toilet travel to and from a place outside the immediate vicinity of their houses to defecate. Figure 17 shows that this is practiced by at least 90% of adults in rural areas, and 78% in urban areas.

Figure 18 shows that a considerable amount of time is spent traveling to a place of defecation and/or waiting to access toilets. At rural sites, the travel and waiting time among adults averaged 14 minutes per trip, with trips made 1.6 times a day, amounting to about 23 minutes per day. These values were found to be less for adults in urban areas. For children, travel and waiting times are longer in urban areas. It is important to note that the values shown in Figure 18 underestimate the amount of time spent accessing toilets, because the estimates focus on defecation, and exclude urination.

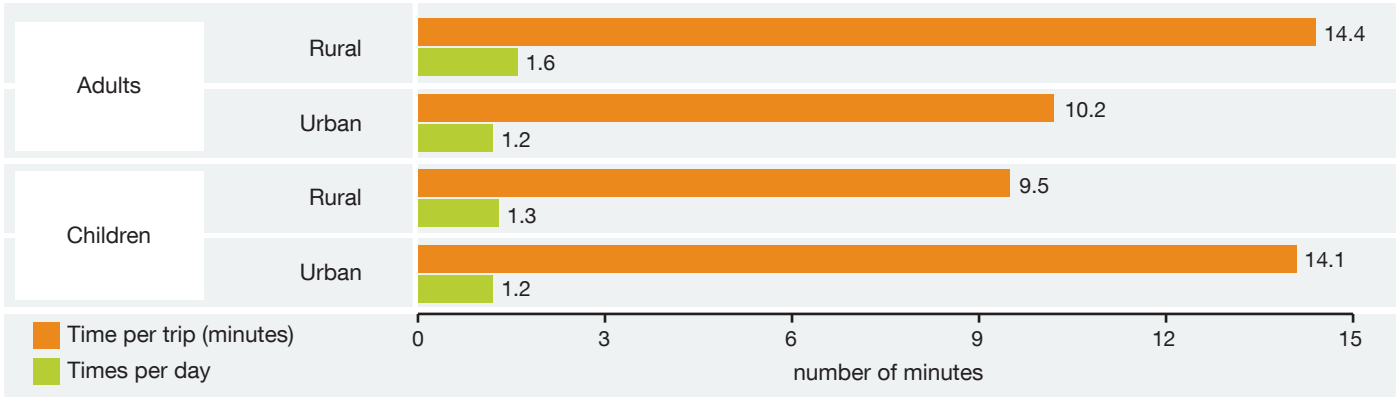
There is an additional time loss in the case of children under the age of five. Figure 19 shows that about 23% of the households surveyed said that young children were accompanied to their place of defecation. This means a time loss not only for the child but also for the person accompanying the child. In addition, there is some evidence that children under the age of five tend to visit the toilet more often. The survey results showed that young children in urban areas visited their place of defecation at an average 1.6 times in a day (Annex Table D3); which is about 23% higher than the average for adults (Annex Table D2).

FIGURE 17. PLACE OF DEFECATION OF HOUSEHOLDS WITHOUT A TOILET, % OF RESPONSES



Source: Annex Table D1.

FIGURE 18. DAILY TIME SPENT ACCESSING TOILET OUTSIDE OWN PLOT FOR THOSE WITH NO TOILET



Source: Annex Table D2.

4.3.2 TIME-SAVING PREFERENCES AND UNIT VALUES OF TIME

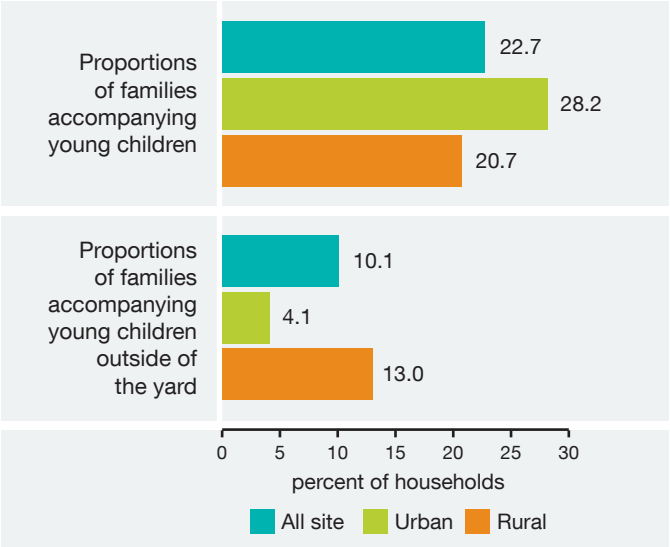
There is evidence that households appreciate the value of time associated with having a private toilet. Figure 20 shows that at least 97% of households without a toilet cited proximity as an important characteristic of having one. About the same proportion of these households agreed that having a private toilet saves time.

The importance of proximity was also revealed in the survey results for households that already have a toilet. Figure 20 shows that 75% of rural and 82% of urban households with private toilets said they were satisfied or very satisfied with the proximity of their toilets. The proportion of households satisfied or very satisfied with the proximity of their toilet was lower for those that only have access to shared/community toilets.

Table 17 provides average rankings of toilet preferences with respect to convenience, based on FGDs conducted in the six study sites. The highest ranked response related to having a latrine near or in the house. This result is consistent for men and women at all survey sites. Another highly ranked response is the ability to use the toilet as the need arises.

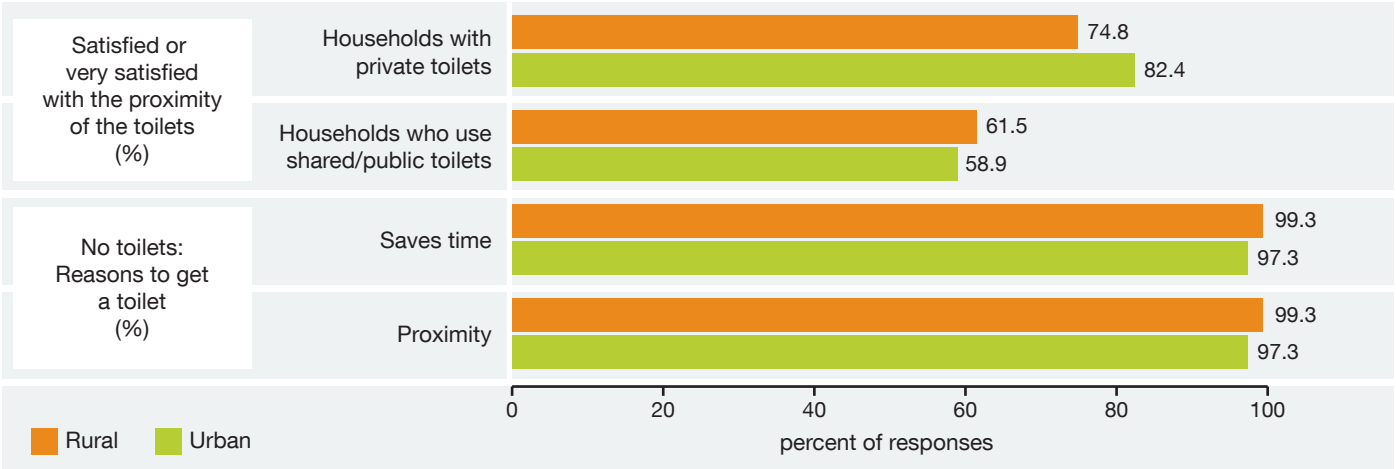
The household questionnaire also asked respondents to choose from three options ("not more", "somewhat more" and "much more") for nine activities they could do if they saved some time in a day. Figure 21 shows the proportion of households for the two activities – leisure and working – which received the highest number of "somewhat more" and "much more" responses. These findings tend to support the earlier decision to use a value for time that is lower than provincial GDP per person – i.e., 30% of provincial GDP per capita for adults and 15% of provincial GDP per capita for children. While it can be argued that the proportions used for scaling down GDP are somewhat arbitrary, it captures the point that not all of the time gained is used for income generating activities.

FIGURE 19. PRACTICES RELATED TO YOUNG CHILDREN, % OF HOUSEHOLDS



Source: Annex Table D3.

FIGURE 20. PREFERENCES RELATED TO TOILET CONVENIENCE, % OF RESPONSES



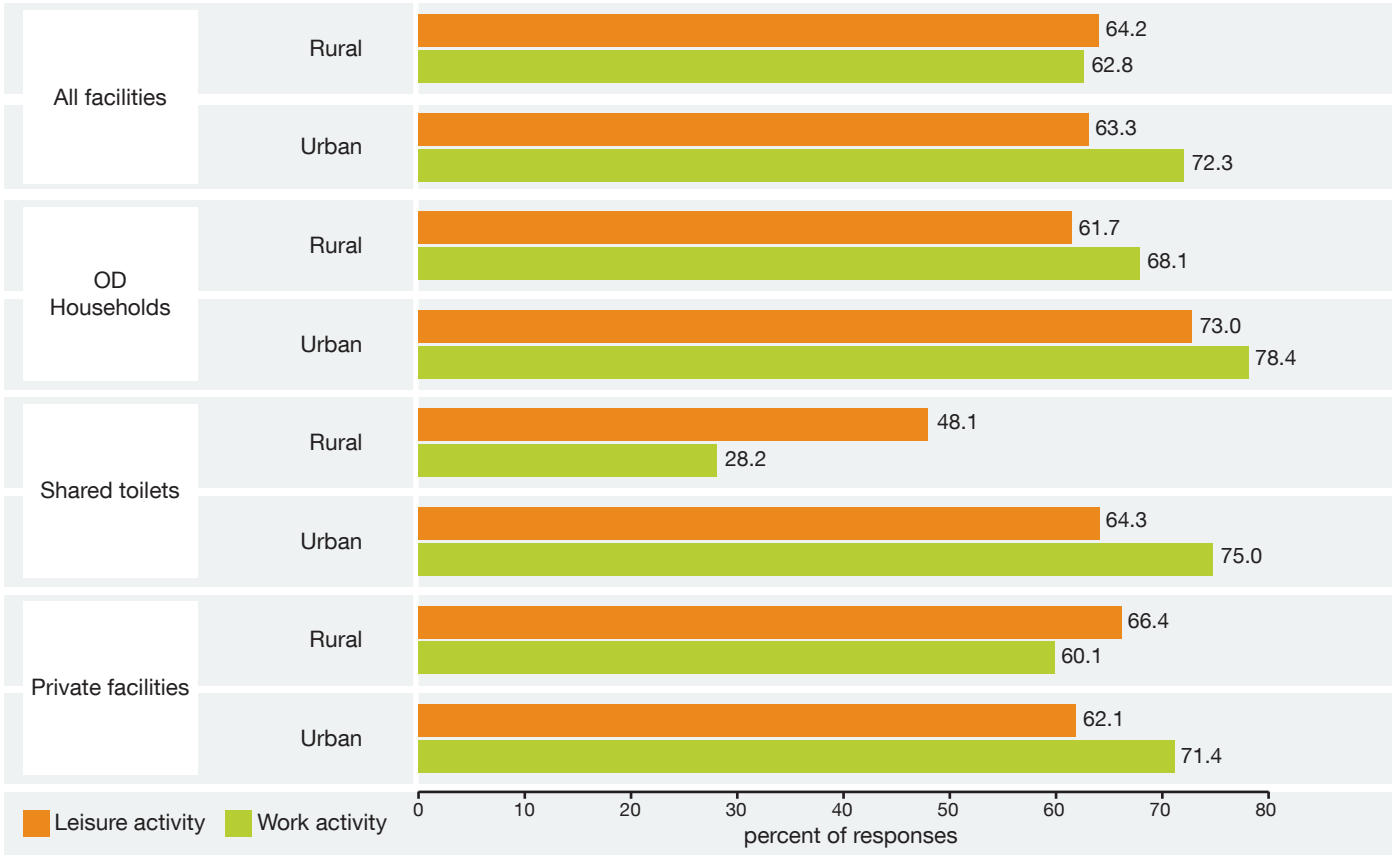
Source: Annex Table D4.

TABLE 17. PREFERENCES RELATED TO TOILET CONVENIENCE, VERY IMPORTANT (1) TO NOT IMPORTANT (5)

Site	Latrine is near or in the house	Not having to wait in a line	Ability to use the toilet as the need arises	Saving time which can be used for other activities
		Males		
1 (urban)	1	-	1	3
2 (rural)	1	-	-	-
3 (rural)	1	-	2	3
4 (rural)	1	2	3	3
5 (urban)	1	3	3	3
6 (rural)	1	3	2	3
		Females		
1 (urban)	1	-	1	3
2 (rural)	1	-	2	3
3 (rural)	1	-	2	2
4 (rural)	1	3	2	3
5 (urban)	1	3	3	3
6 (rural)	1	3	1	2

Note: - = not relevant. Source: FGDs.

FIGURE 21. OPPORTUNITY COST OF TIME: WHAT RESPONDENTS WOULD DO WITH EXTRA TIME - % SAYING 'LEISURE' OR 'WORK' ACTIVITIES[a]



Note: [a] The respondents were asked: "If you could save some time every day, would you like to spend more time for: (a) sleeping, (b) leisure, (c) eating, (d) working/helping with earning income, (e) going to the market, (f) cooking or helping with cooking, (g) washing and cleaning, (h) bathing, and (i) other". This graphic shows the results from two main categories - leisure and working. Multiple responses were possible per respondent. Hence the sum of these may be more than 100%. Source: ESI Survey

4.3.3 TOTAL VALUE OF TIME SAVED

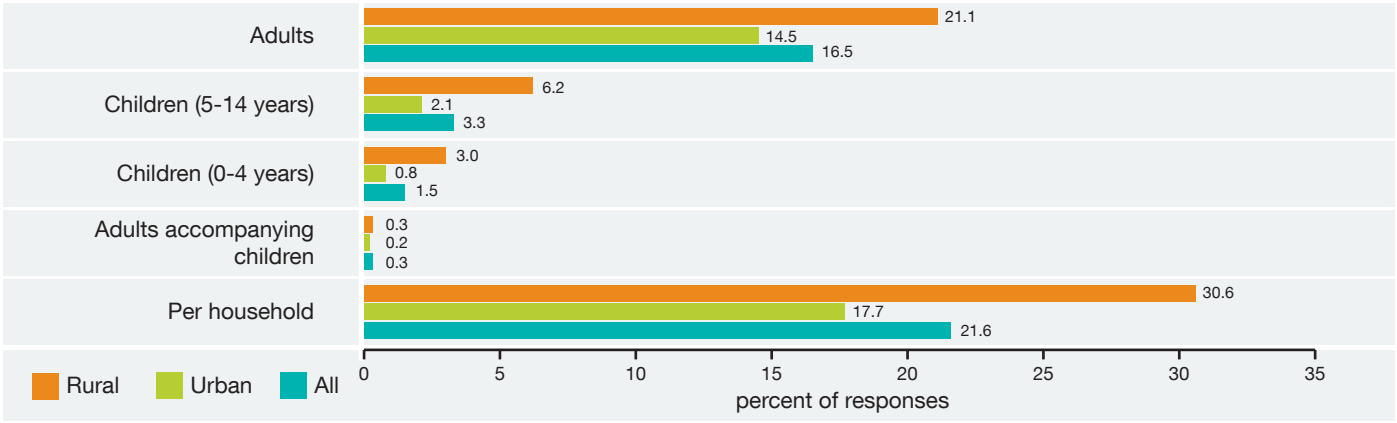
Using the values presented in Section 4.3.2, Figure 22 shows that an average of about 22 days a year could be saved by a household from having access to a toilet. Moreover, the savings for the average household in the rural sites (31 days) were larger than for households at urban sites. In the case of the rural sites, the highest potential savings come from the time of adults.

Given the results shown in Figure 22 and the assumptions about the value of time, Figure 23 shows that a typical household at the survey sites could gain a welfare value of about 1.08 million kip (US$130) a year by getting a private toilet. Time savings in rural and urban areas are almost the same and derive mostly from adult time. It is also important to reiterate that the calculations presented are likely to underestimate the value of lost time, because these do not account for the time spent looking for a place to urinate.

4.4 INTANGIBLE SANITATION PREFERENCES

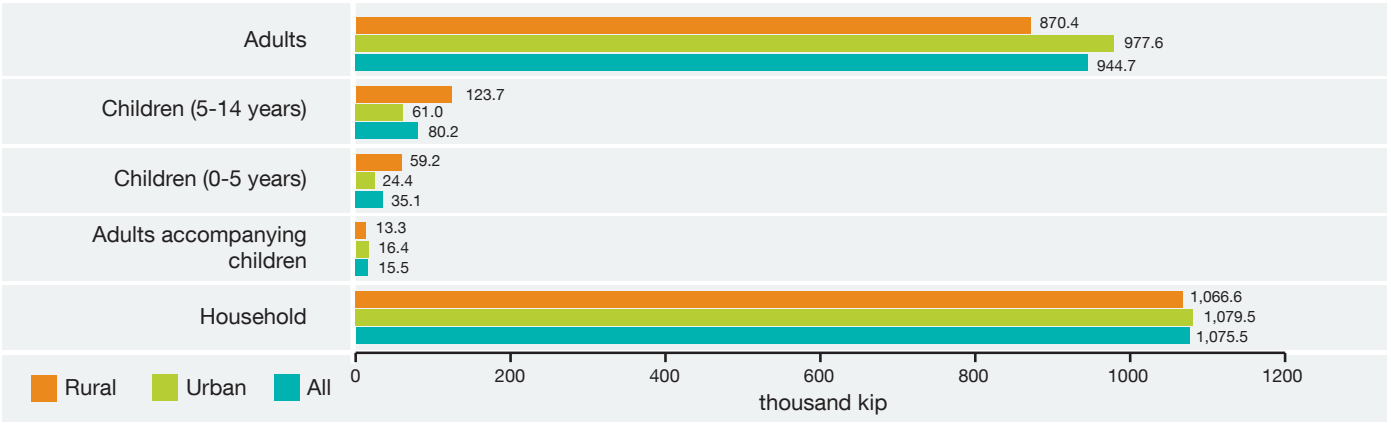
Due to a lack of studies examining the intangible aspects of sanitation, the data presented here are based entirely on ESI fieldwork.[24] The data come from two main sources: a close ended household questionnaire applied to the most senior available household member, and FGDs, held for groups of men and women. These two surveys collected perceptions, opinions and preferences from a representative section of the communities (see Section 3.3 for a description of the methods). Four sets of results are described here: (a) understanding of sanitation; (b) reason for sanitation coverage; (c) satisfaction with the current sanitation option; (d) for those without a toilet, reasons to get one and its desired characteristics.

FIGURE 22. AVERAGE NUMBER OF DAYS SAVED PER YEAR PER HOUSEHOLD MEMBER FROM IMPROVED SANITATION



Source: Annex Table D5.

FIGURE 23. AVERAGE ANNUAL VALUE OF TIME SAVED PER HOUSEHOLD MEMBER FROM IMPROVED SANITATION, THOUSAND KIP



Source: Annex Table D6.

[24] Interested readers may also consult Baetings and O'Leary (2011).

The FGD attempted to elicit how the respondents understand the meaning of sanitation. The process generated many responses which can be divided into action-related and conditions-related understanding of sanitation (Table 18). The responses were dominated by the latter, particularly by the understanding that good sanitation refers to cleanliness inside and around houses. Another common response, particularly among females in households with toilets, was the absence of animal excreta in the streets or village.

TABLE 18. RESPONDENTS' UNDERSTANDING OF SANITATION, NUMBERS REFER TO THE SITE WHERE EACH REASON WAS GIVEN AS ONE OF THE TOP-RANKED RESPONSES [a]

Understanding	Households with toilets		Households that practice open defecation	
	Male	Female	Male	Female
Clean inside and around the houses	3/4/5	1/3/5/6	2/3/4/5/6	2/3/5/6
Absence of animal excreta in the streets/village	4/6	1/2/4/5/6	6	4/6
Clean food or eating clean food			2/3	2
Good management of gray water and/or stagnant water	5	5	4/5	
Availability of toilets				5/6
Clean people		6		5
Clean village	1			2
Clean living area inside the house		4		4
Protection from human diseases	6			
No foul smell from drainage		1		
Absence of waste in the streets	1			
No flooding due to poor sewage/drainage	1			
No foul smell from chicken raising		2		
Good management of wastewater		2		
Clean toilets and no more open defecation			2	
Availability of clean water and soap		3		
Clean toilets (wet pit latrines)		3		
Clean toilets and water	3			
Absence of human excreta in the streets/village	4			
Good water supply				3
People in good health				3
Clean water			3	
Good management of solid waste		4		
No garbage around the house				4
Sufficient water			4	
Clean community lands (canals, wells, riverside, etc.)	5			
Defecate in a hole in the ground			5	
No open defecation	6			
Hand washing	3			
Building wet pit latrines in the village			6	

[a]Values refer to the sites in which the statement was provided.
Source: FGDs

TABLE 19. REASONS FOR CURRENT SANITATION COVERAGE – TOP RESPONSES

Item	Males, by each site						Females, by each site					
	1	2	3	4	5	6	1	2	3	4	5	6
Reasons why households do not have toilets												
Cost is too high		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Never offered a toilet		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Not the first priority		✓										
No space and no time to build			✓									
Not yet permanent in the village									✓			
Not enough water for pit				✓						✓		
Reasons why households have toilets												
Provided/supported by project			✓		✓	✓			✓		✓	✓
Clean and convenient			✓	✓								✓
Not expensive	✓								✓			✓
Clean and no smell					✓	✓					✓	
Convenient						✓						
Easy to install	✓						✓					
Clean	✓						✓					
Easy to use	✓						✓					
Advised by district			✓						✓			
Previous toilet was full					✓						✓	
Clean with water	✓											
No smell								✓				
Comfort				✓								
Safer to use toilet in the house				✓								

Note: All the respondents in Site 1 have toilets.
Source: FGD

Table 19 shows the reasons for the current sanitation coverage of households cited by men and women in the FGDs. It indicates that the main reasons respondents had no toilet were high costs and the fact that households had not been offered one. The main reasons for having a toilet is that they were provided or supported by projects. Other common reasons were associated with cleanliness and convenience.

The respondents were asked about their level of satisfaction with their existing facilities.They were given a set of attributes to rank between 1 (not satisfied) and 5 (very satisfied). The findings are presented in Figure 24, which indicates that households with access to improved sanitation are satisfied, but not very much, with their toilet option, with average ratings ranging from 2.9 to 3.3. Households

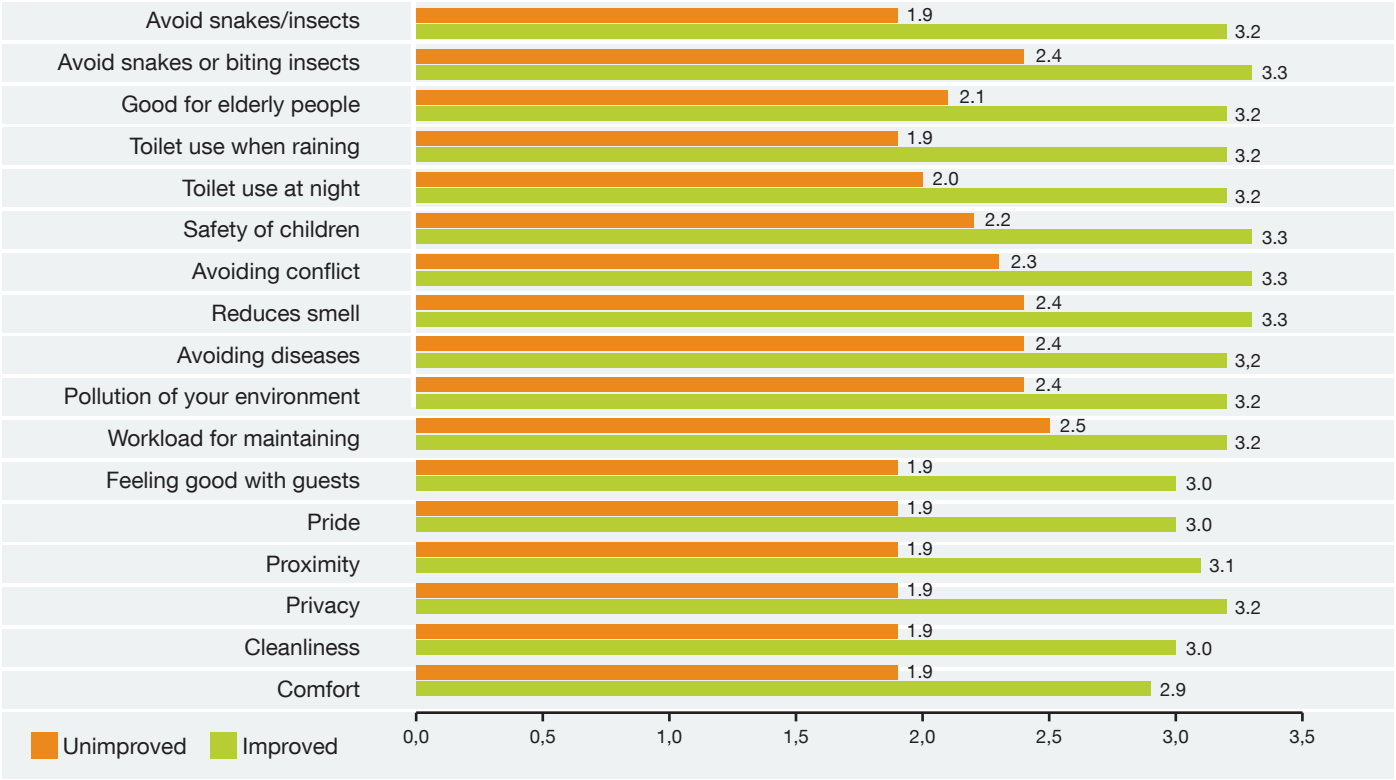
with no access to improved sanitation had a lower level of satisfaction with their current level of "facilities".

The survey asked households without toilets to rate possible reasons for acquiring one. Figure 25 shows that all of the choices were deemed equally important.

The survey results also revealed that respondents with no toilet are willing to pay an average of about 964,000 kip (US$116) for an improved toilet (Annex Table E1).[25] This value is very low and is not sufficient to finance the construction of a pour-flush toilet, which was the overwhelming choice of respondents.[26]

Table 20 indicates some of the concerns of households practicing open defecation (OD), showing that the highest concern was for the safety of children. This result supports the finding in Figure 24, where the households with no access to improved sanitation indicated a lower level of satisfaction in terms of allowing children to use toilets without supervision.

FIGURE 24. LEVEL OF SATISFACTION WITH CURRENT TOILET OPTION, IMPROVED VERSUS UNIMPROVED, NOT SATISFIED (1) TO VERY SATISFIED (5)



Source: Annex Table E2.

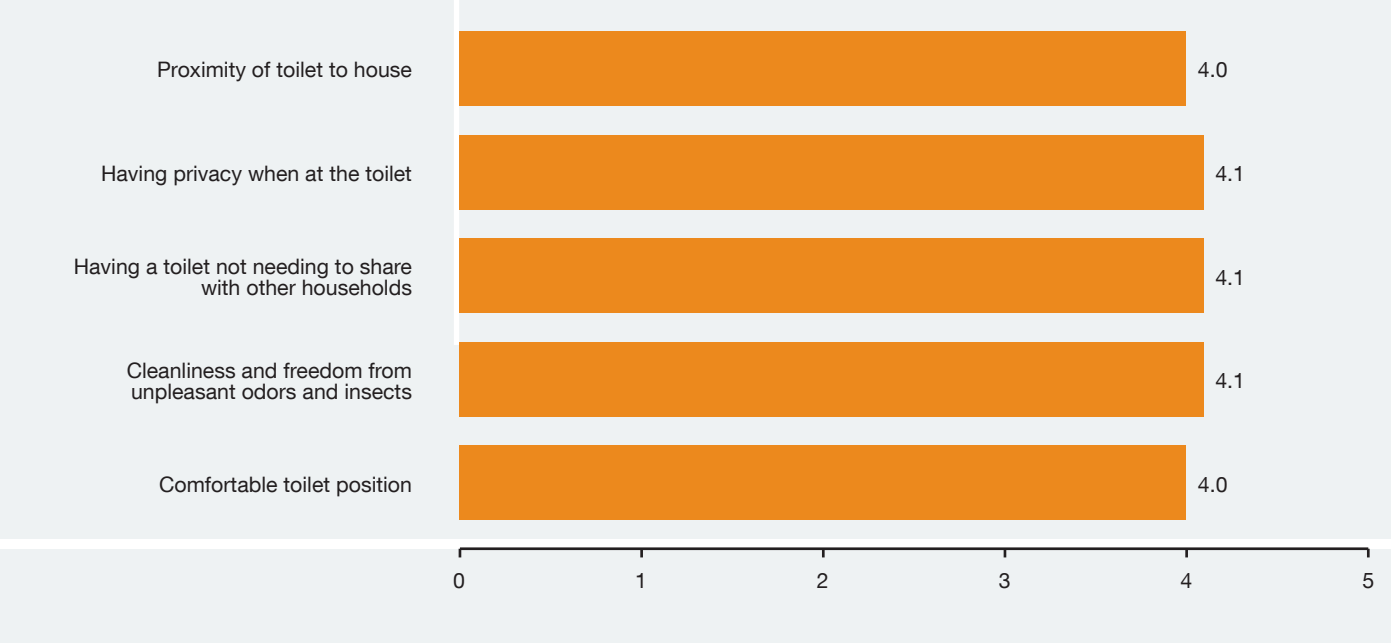
TABLE 20. CONCERNS OF THOSE PRACTICING OPEN DEFECATION

Concern	Number of households responding	Responses (%)		
		Never or rarely	Sometimes	Often or Always
Have you felt in danger when practicing OD?	336	41.4	18.5	40.2
Are you worried about the safety of your children?	279	25.4	19.4	55.2
Have you heard about someone being attacked by animals?	336	86.3	9.5	4.2

Source: ESI survey

[25] This value was obtained by simply asking the respondents about how much they were willing to pay for a toilet. A more rigorous approach estimating willingness to pay for sanitation services was conducted by Harder et al. (2011) for the Philippines.
[26] Estimates of toilet costs are presented in Section 6.

FIGURE 25. REASONS TO GET A TOILET FOR THOSE CURRENTLY WITHOUT TOILET ACCESS, AVERAGE SCORE, NOT IMPORTANT (1) TO VERY IMPORTANT (5)



Source: Annex Table E2.

4.5 EXTERNAL ENVIRONMENT

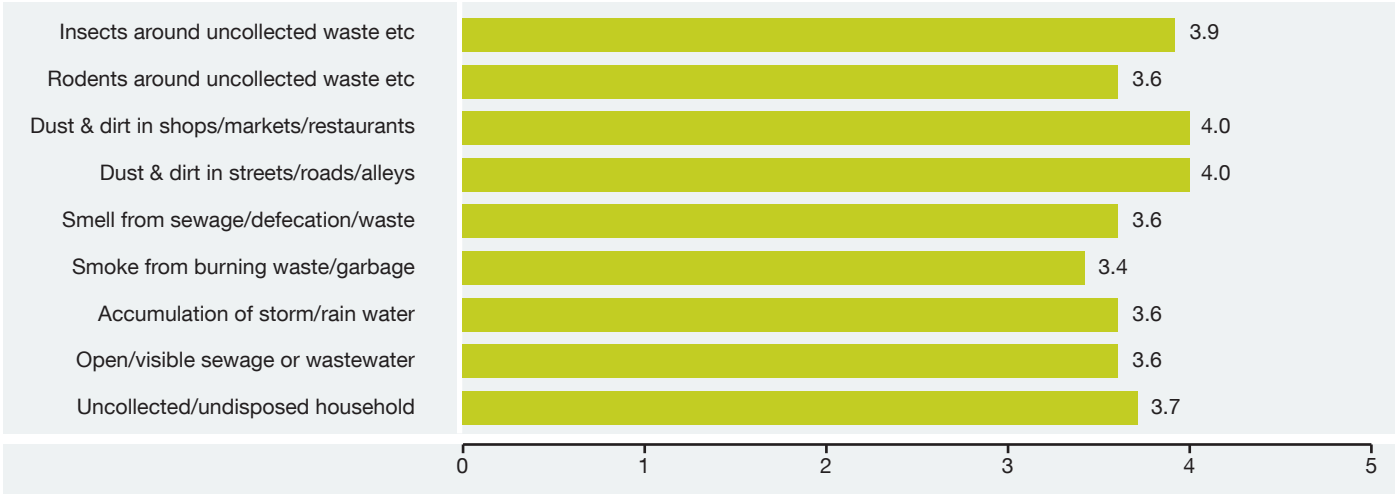
The "external" environment refers to the area outside the toilet itself and is not related to toilet-going. It can include a living area, public area, and private land, which can all be affected by OD practices and unimproved toilet options. The consequences of water pollution will not be discussed here because it has already been covered in Section 4.2. The sources of data are mainly the ESI surveys: household interviews and FGDs. Given that the external environment is also spoiled by other sources of poor sanitation – mainly inadequate solid waste management practices – these have also been assessed to understand the contribution of each, and relative preferences regarding their improvement.

Figure 26 shows scores attributed to the quality of environmental sanitation. It indicates that the respondents are aware that flooding does not occur often at the sites and that OD occurs in their neighborhood sometimes (values close to 2). The respondents also seem to suggest that the state of sanitation in their neighborhood is quite good because the lowest average rating given to a specific characteristic was 3.4 out of a maximum possible 5 (very good). The lowest rating was given to smoke from burning waste/ garbage (3.4) while the best ratings were for dust and dirt in shops/markets/ restaurants or in the streets/roads.

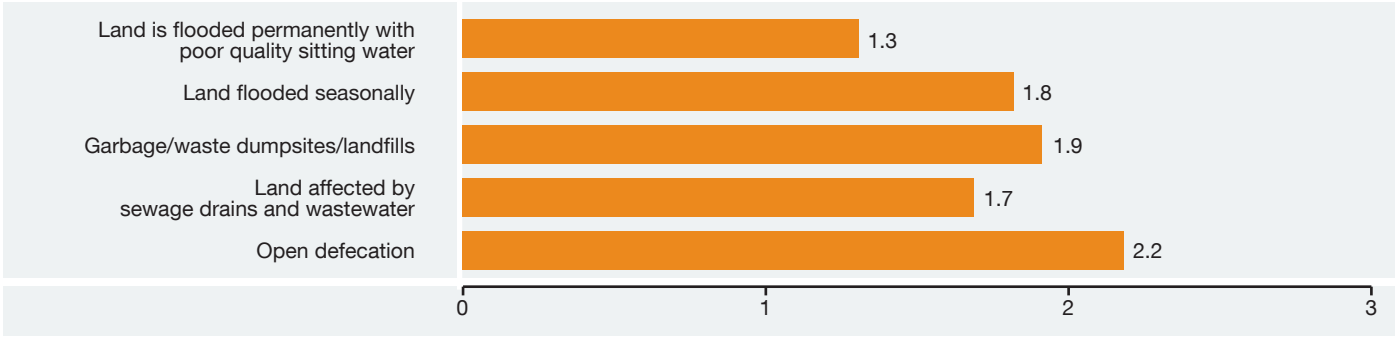
To attempt an overall picture of the state of sanitation at the sites, a simple average of the scores is presented in Figure 27. It suggests that the state of sanitation, as rated by the respondents, is quite good but can still be improved. Moreover, the ratings of rural households were higher those of their urban counterparts. Among the study sites, the highest ratings were for Site 2. While indicative of the state of sanitation, it is difficult to read too much into these findings because the values were based on a subjective assessment of the respondents.

It is important to note that households with access to improved sanitation facilities may still contribute to pollution in the environment. Figure 28 summarizes some findings for households with access to toilets and pit latrines. Among this group, about 14% and 17% defecate in the open or saw children defecating in the yard, respectively. Moreover, such a practice appears to be more common at rural sites.

FIGURE 26. SCORING OF DIFFERENT TYPES OF LIVING AREA



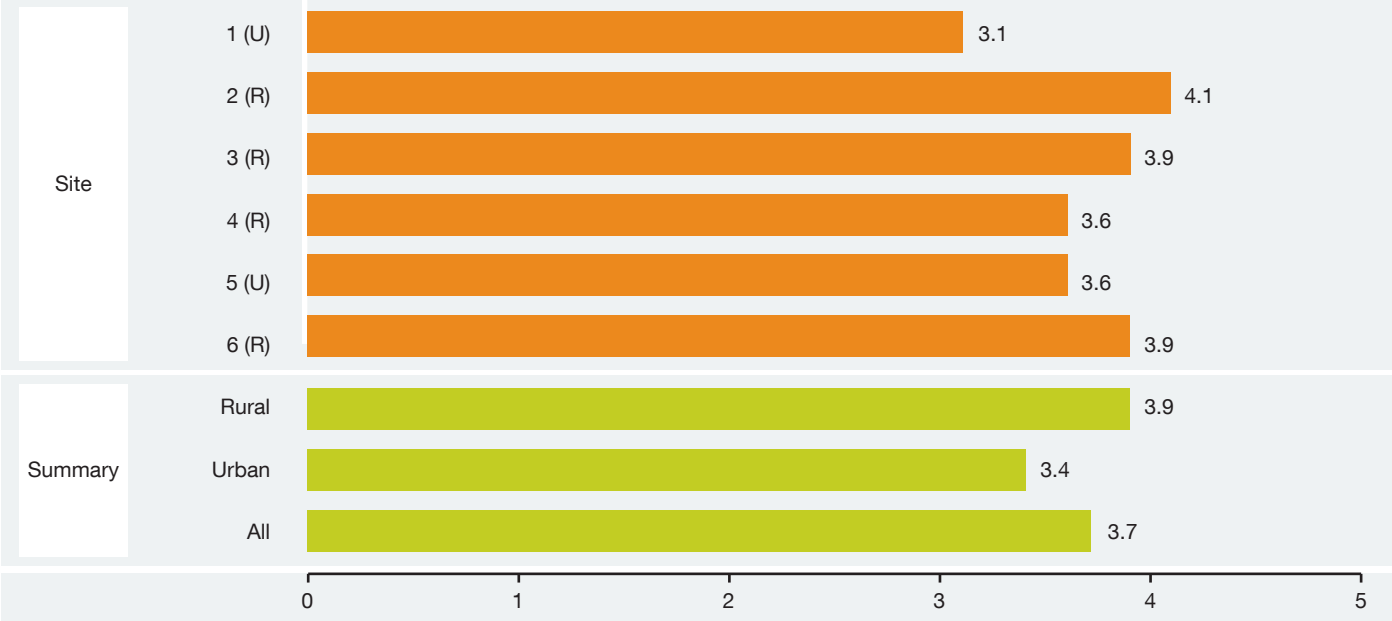
(A) State of sanitation in the neighborhood, very bad (1) to very good (5)



(B) To what extent do the following activities occur in your neighborhood, never (1) to pervasive (5)

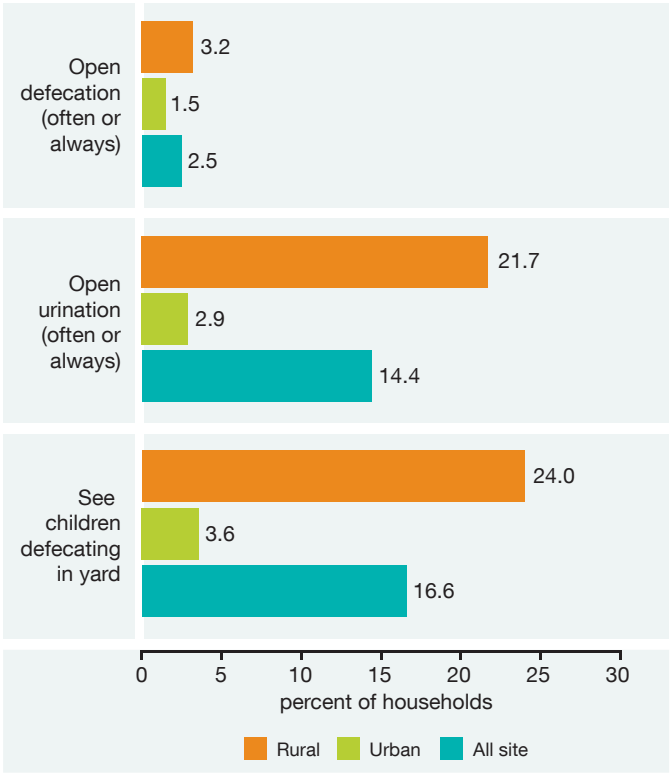
Source: Annex Table F1.

FIGURE 27. OVERALL STATE OF SANITATION AT THE STUDY SITES, VERY POOR (1) TO VERY GOOD (5)

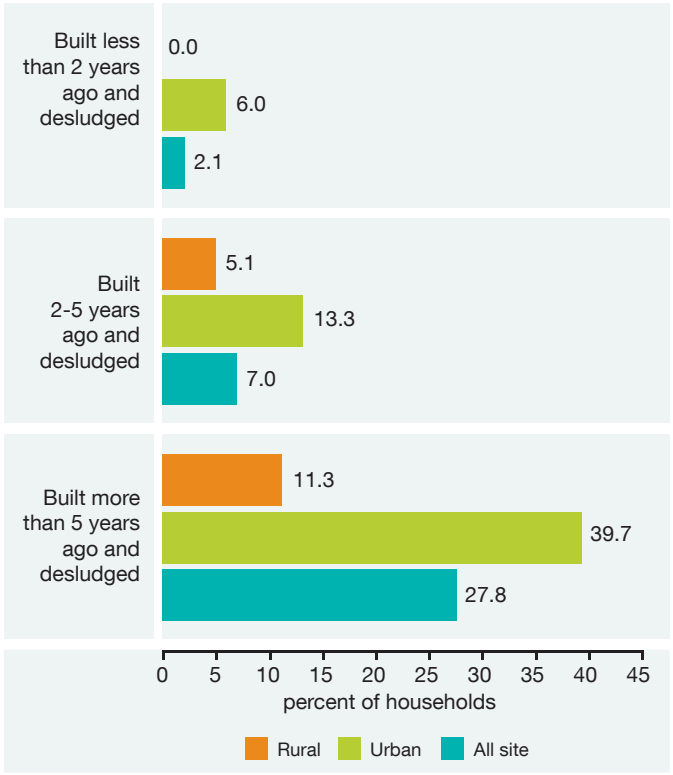


Note: R. = rural; U. = urban
Source: Annex Table F1.

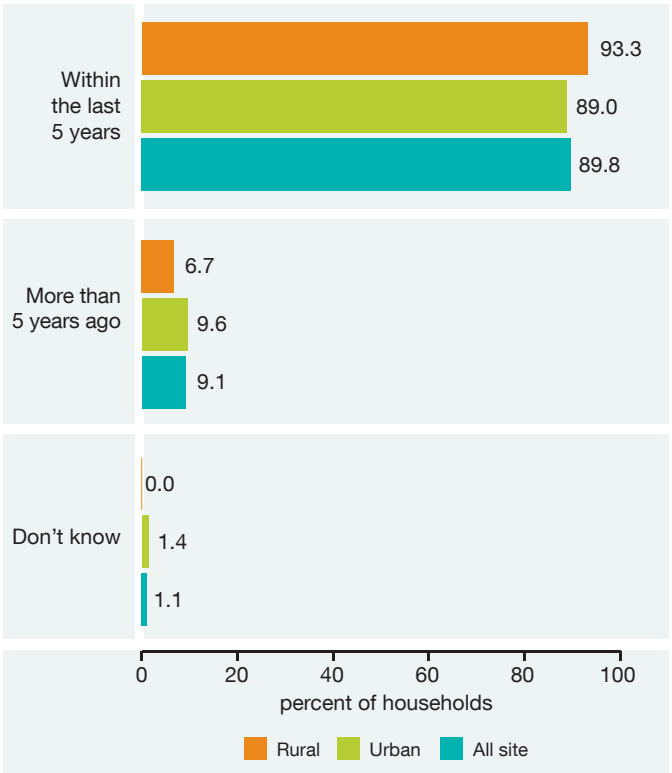
FIGURE 28. PROPORTION OF HOUSEHOLDS WITH UNIMPROVED SANITATION PRACTICES, %



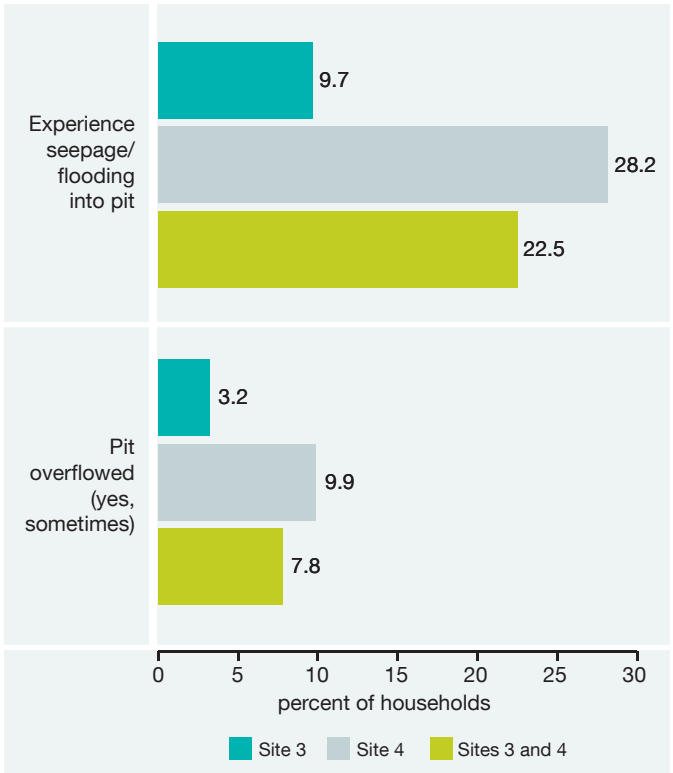
(A) Households with access to toilets



(B) Households with septic tanks



(C) Last time septic tank was desludged
(for septic tanks aged five years and over)



(D) Households with pit latrines (sites 3 and 4 only)

Source: Annex Table F2

Septic tank management practices also require improvement. Among households with facilities over five years old, only about 28% emptied their septic tanks. Of these households, about 9% did so more than five years from the date of the survey. This implies that about three quarters of the households with septic tanks have emptied their facility within the recommended period. In the case of pit latrines, about 23% of respondents said that their pits have experienced seepage or flooding. A smaller proportion said that their pit sometimes overflowed.

The respondents were also asked about the perceived benefits of improved sanitation in terms of reducing pollution in the neighborhood or community and in reducing smell around the house. Figure 29 presents the responses for households with different sanitation facilities, indicating noticeable differences across toilet facilities in both rural and urban areas. Owners of wet pit latrines were satisfied with the way their facilities reduce pollution in the neighborhood or community and smell around the house. However, owners of dry pit latrines and those without toilets were generally unsatisfied.

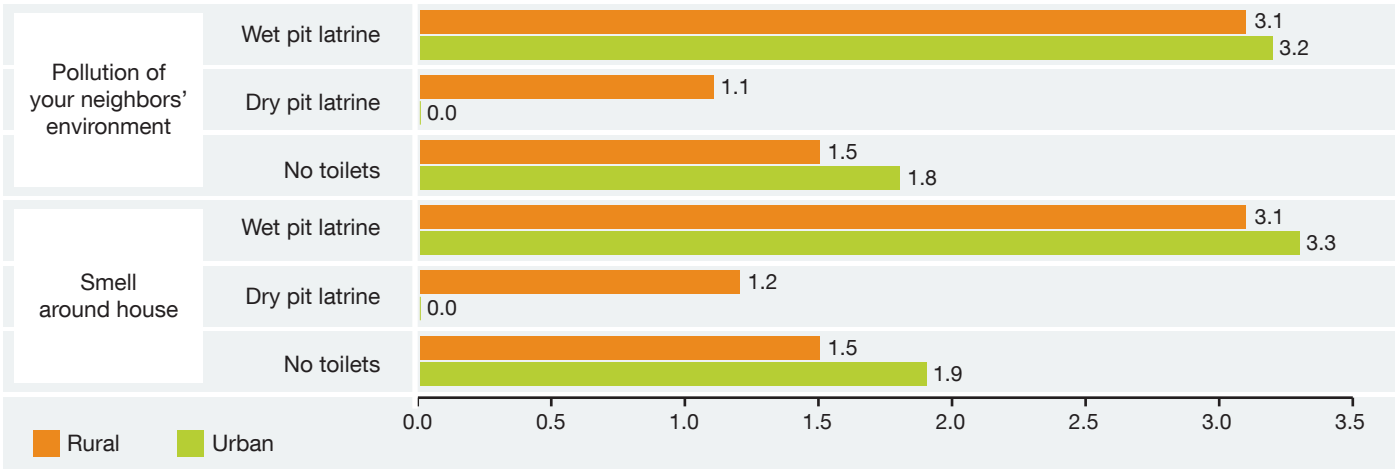
The previous paragraphs described the state of sanitation at the sites by examining the evaluation of the respondents of the various aspects of sanitation. The general implication of the findings was that more work needs to be done in order to achieve satisfactory sanitary conditions. Crucial to understanding why these conditions occur and perhaps the willingness of the respondents to address them is how important they perceive improved sanitation conditions to be. Respondents were asked to give a score of 1 (not important) to 5 (very important) for different aspects of sanitation (Figure 30). The results indicate that they place the highest level of importance on the dust and dirt in shops, markets and restaurants (3.8 for dirt inside), and dust and dirt in streets, roads or alleys (3.7 for dirt outside). It seems that the level of importance assigned to the other aspects, while lower than those mentioned above, were similar because their average values were still 3 or higher. The importance of these aspects was also deemed higher in rural than urban sites. Finally, cross-tabulating these results with the assessment of sanitation conditions (Figure 26) suggests that the aspects on which the respondents put the highest importance were generally those receiving the most positive evaluation.

4.6 PROJECT PERFORMANCE AND ACTUAL BENEFITS AT THE FIELD SITES

4.6.1 PROJECT COVERAGE

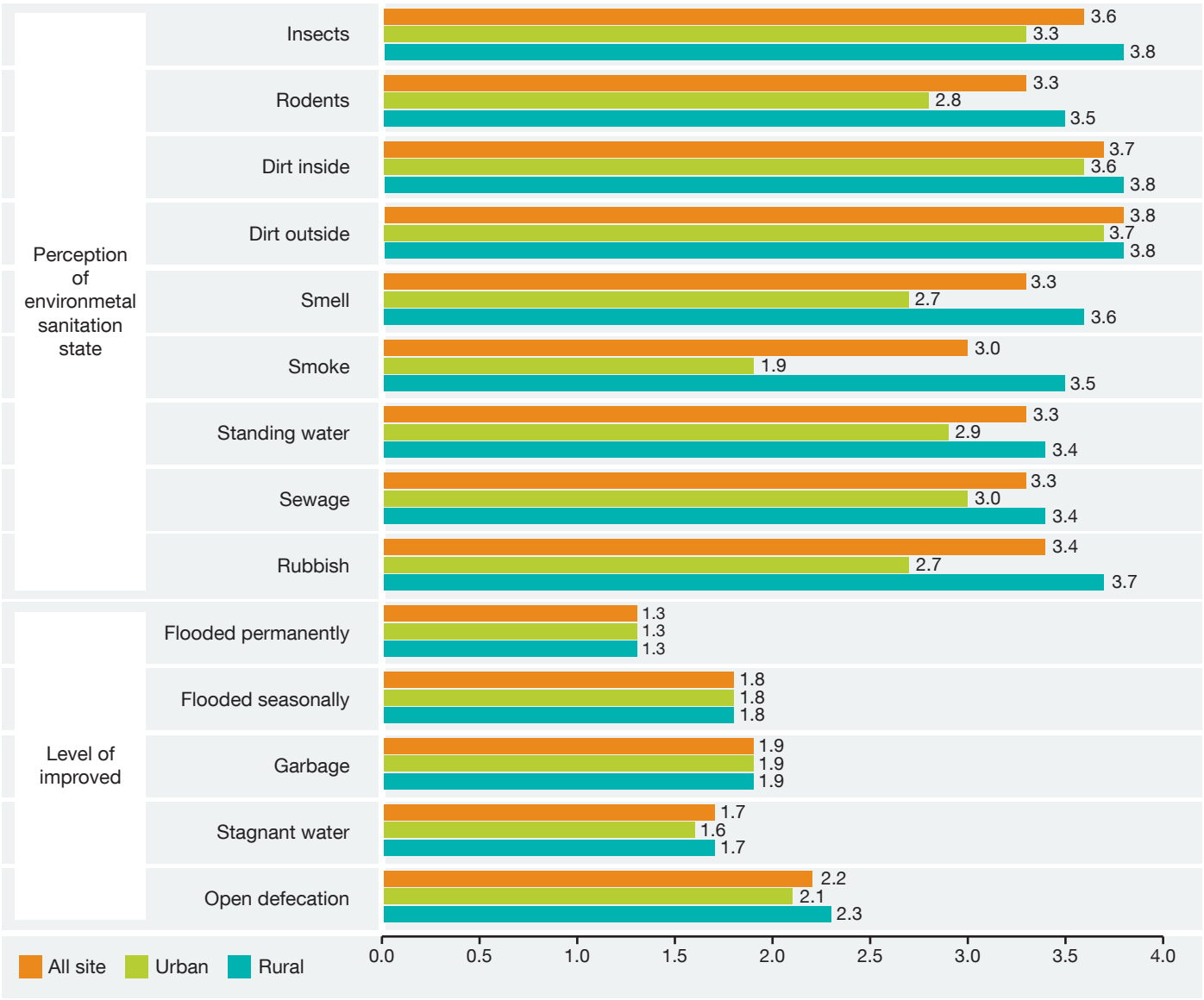
Based on respondents' answers, households in only three field sites received facilities, particularly wet pit latrines, through projects initiated and/or implemented by the government, donor agencies, private firms or NGOs (Table 21). These beneficiaries represent about 44% (126 of 294) of the households with access to wet pit latrines in the three sites (Annex Table F6). Many of the beneficiaries did not or cannot specify the institution that provided the facilities but a majority of the relevant respondents at Site 3 stated that the Red Cross was instrumental in the provision of wet pit latrines.

FIGURE 29. IMPLICATION OF CURRENT TOILET OPTION FOR EXTERNAL ENVIRONMENT, NOT SATISFIED (1) TO VERY SATISFIED (5)



Source: Annex Table F3.

FIGURE 30. IMPORTANCE OF ENVIRONMENTAL SANITATION STATE, BY OPTION TYPE, VERY BAD (1) TO VERY GOOD (5)



Source: Annex Table F4.

TABLE 21. SANITATION COVERAGE INFORMATION PER FIELD SITE[a]

Item	Site		
	3	5	6
Setting	**Rural**	**Urban**	**Rural**
Intervention received by households in survey	Wet pit latrine	Wet pit latrine	Wet pit latrine
Beneficiaries interviewed in the ESI Survey by Institution, no. of households			
Red Cross[b]	28	-	-
Red Cross (unspecified)	-	4	1
Government	1	2	1
Not specified by respondents	9	31	51

[a] Only households in Sites 3, 5, 6 claimed to have received intervention from a project; [b] Water and Sanitation Project in Meun and Nan Districts
Source: Annex Table F6

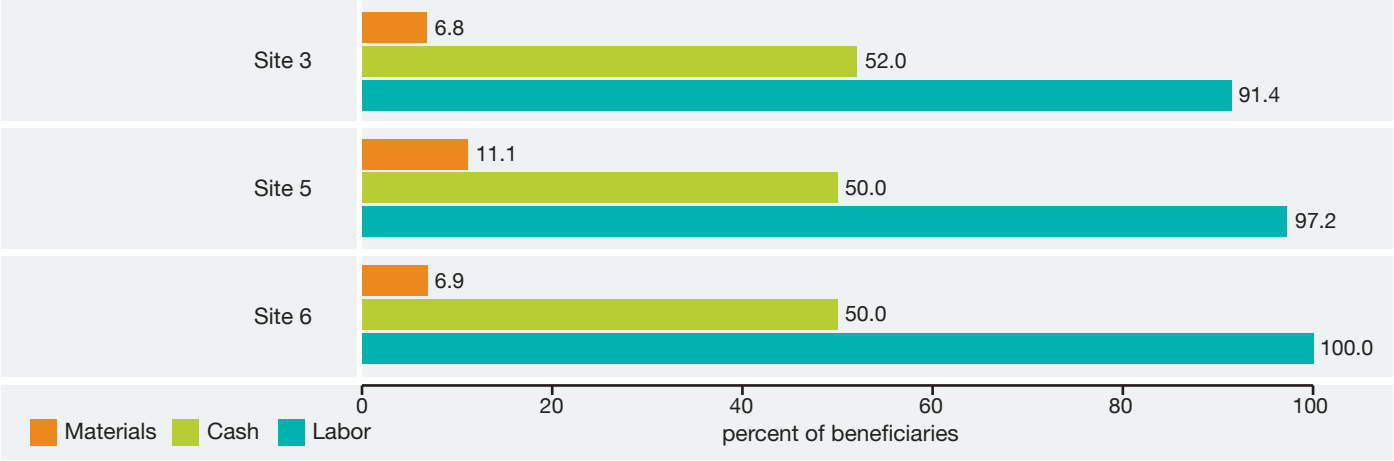
Most of the beneficiaries at the three sites made some form of contribution to the project. Figure 31 shows that about half of all the respondents contributed cash to the project and almost all beneficiaries contributed labor. Annex Table F6 provides more details of the estimated contribution of beneficiaries.

Based on the household survey, Figure 32 summarizes other selected features of these projects. It indicates that majority of the households were given a choice of whether to participate in the project. However, a smaller proportion of the households said that they were given a choice of different toilet options. About half of the beneficiaries said that a hygiene awareness program was provided by the project. The highest proportion is found at Site 3, where 69% of the beneficiaries said that such an activity was provided by the project. A very small proportion of the beneficiaries said that some form of water intervention was provided.

4.6.2 APPROPRIATENESS OF TECHNOLOGY

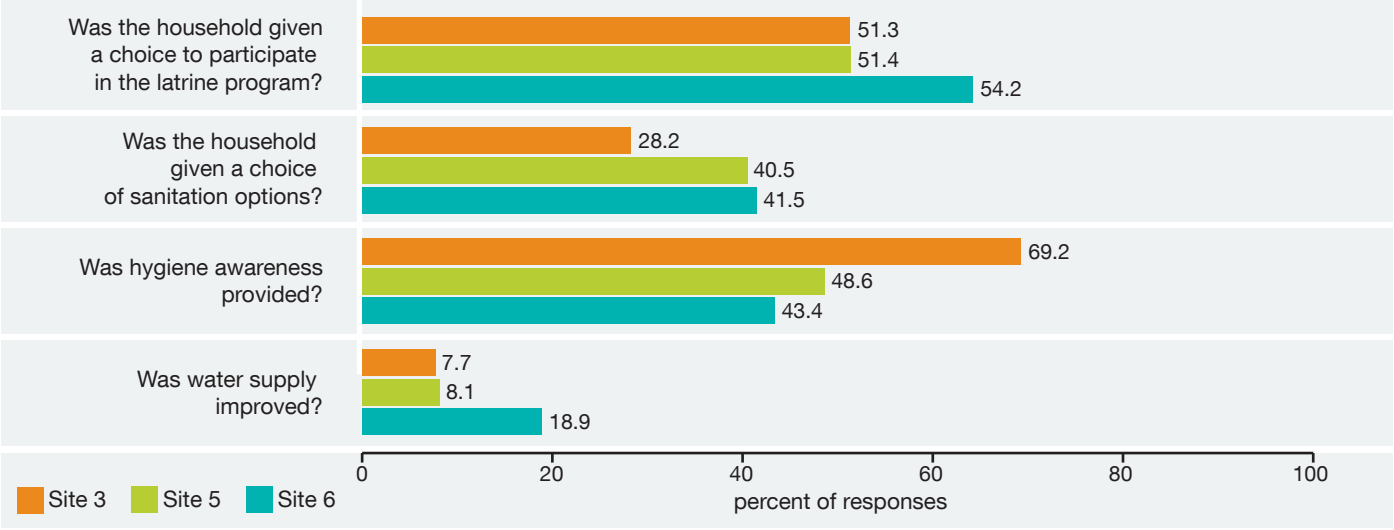
Figure 33 summarizes a few indicators related to the appropriateness of the technologies at the survey sites. It indicates that 7% of the respondents with toilets often did not have sufficient water for flushing. An additional 26% said that this problem occurs sometimes. Flooding and overflowing of dry pit latrines appears to be a problem for only a few of the respondents.

FIGURE 31. CONTRIBUTION OF HOUSEHOLDS, % OF BENEFICIARIES



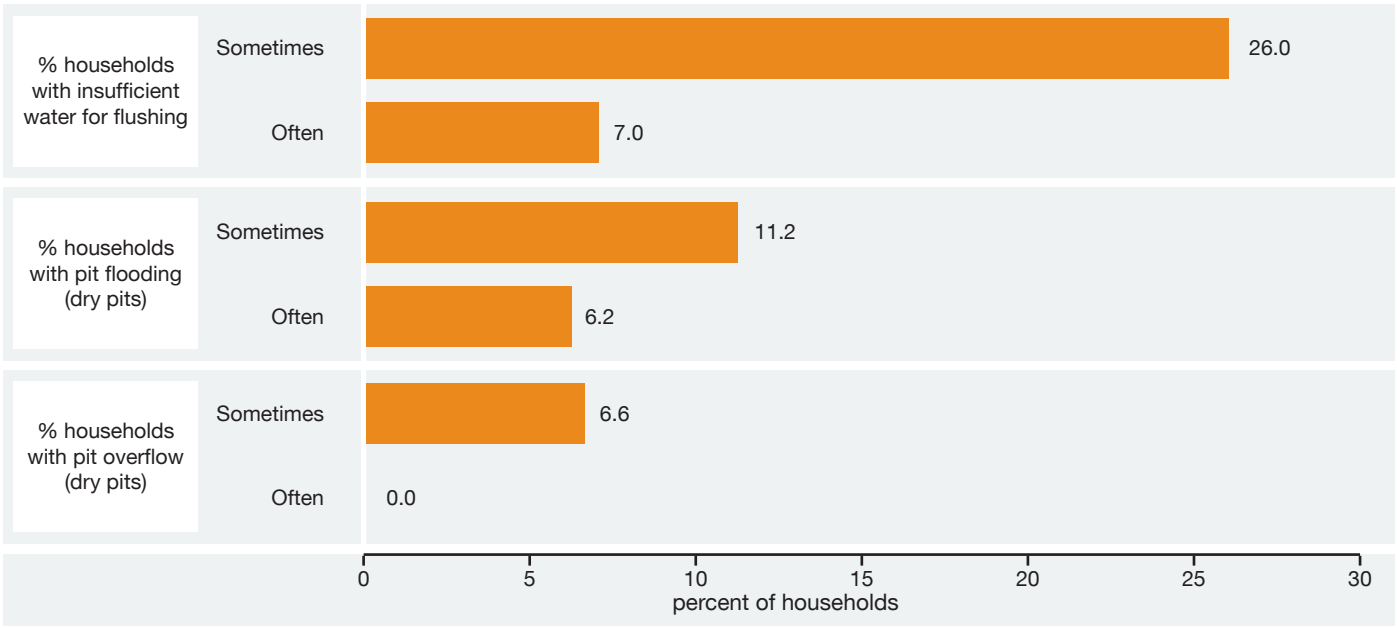
Source: Annex Table F6.

FIGURE 32. HOUSEHOLDS PROVIDING A POSITIVE ("YES") RESPONSE TO SELECTED QUESTIONS, % OF RESPONSES[a]



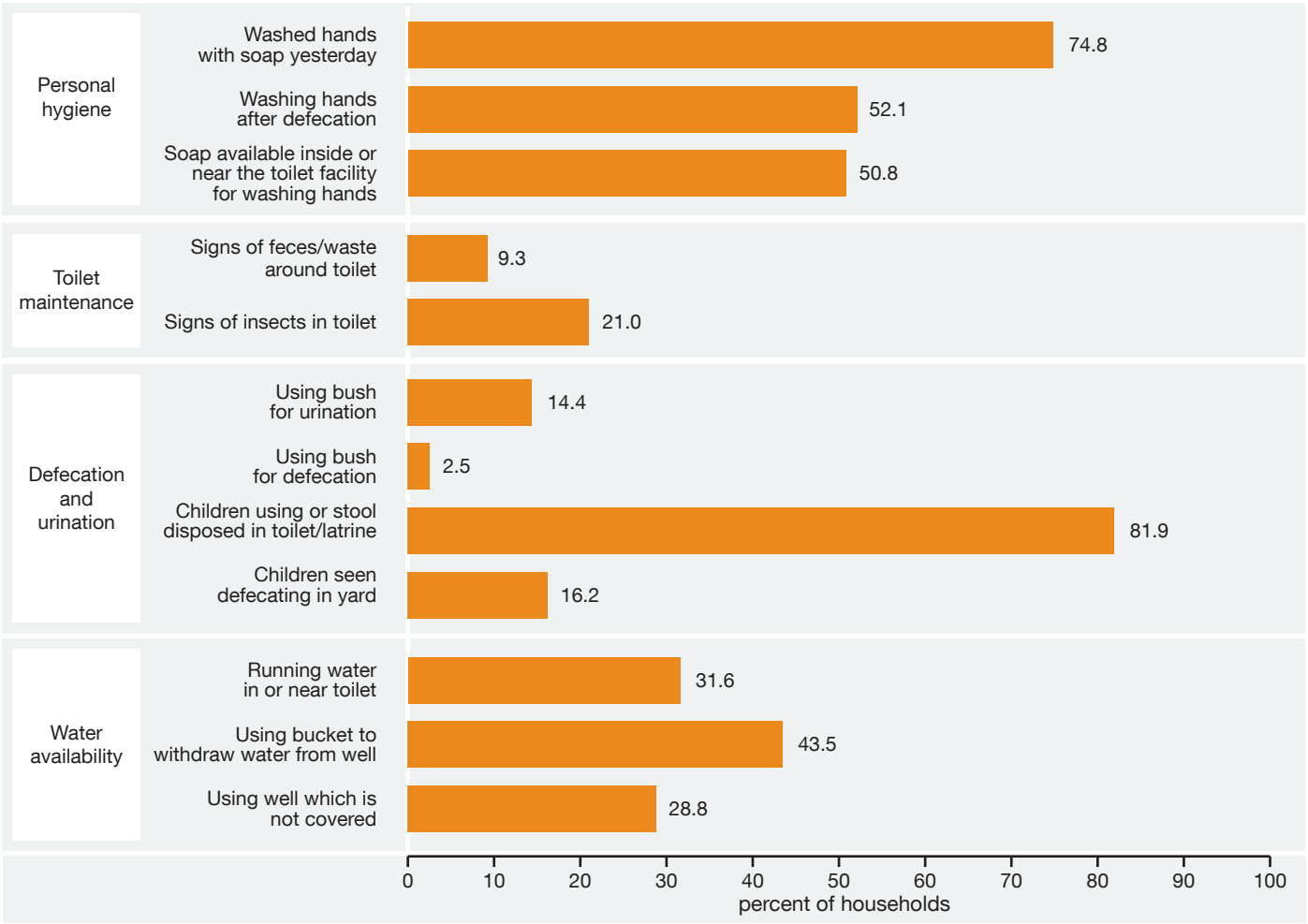
[a] The other responses were "no" and "not applicable".
Source: Annex Table F7.

FIGURE 33. APPROPRIATE TECHNOLOGY



Source: Annex Table F8

FIGURE 34. INDICATORS FOR HOUSEHOLDS WITH ACCESS TO TOILET FACILITIES, %



Source: Annex Table F9

4.6.3 SELECTED IMPACTS ON TARGET BENEFICIARIES

Initiatives to implement sanitation improvements may be assessed in different ways. In the case of projects, it is possible to compare the quantity and quality of interventions against the project targets. Another way would be to examine the impact on the target beneficiaries after project completion. Figure 34 focuses on the latter. It summarizes selected performance indicators for all interventions, regardless of the presence of projects at all of the field sites. The indicators represent the (a) behavior of the survey respondents with respect to hygiene, toilet maintenance, defecation and urination; and (b) water availability. The information was drawn from the household questionnaire and the details for the specific sites are presented in Annex Table F9.

Figure 34 shows that there is considerable room for improvement in terms of hygiene practices. Only 75% of the respondents said that they washed their hands on the day prior to the survey. Moreover, only about half of the same respondents claimed to have washed their hands after defecation.[27] Toilet maintenance and design could be improved as the survey enumerators observed that 9% of facilities showed signs of feces or waste around the toilet. Such findings are likely to be related to the finding that running water is only available in or near the toilet in 32% of households.

Despite the availability of toilets, there is still evidence that households continue to defecate and/or urinate in the open. This appears to be a more serious problem at Site 3, where about 3 out of 10 respondents with access to toilets still urinate in the open (Figure 35).

4.6.4 IDEAL VERSUS ACTUAL BENEFITS

There are a number of factors that may prevent the full realization of the benefits of a sanitation intervention. For example, the extent to which the health benefits of an improved sanitation option are realized depends on whether the facility is used by the beneficiary. If very few of the beneficiaries actually use a sanitation facility, the likelihood of getting diseases will be similar to those who practice OD or use inferior options. The health gains from having access to improved sanitation options might be reduced if the beneficiaries do not wash their hands after defecating. Hence, it is important to check if these practices are common among the beneficiaries. Similar arguments can be related to the other benefits of improved sanitation – water source, water treatment, and access time.

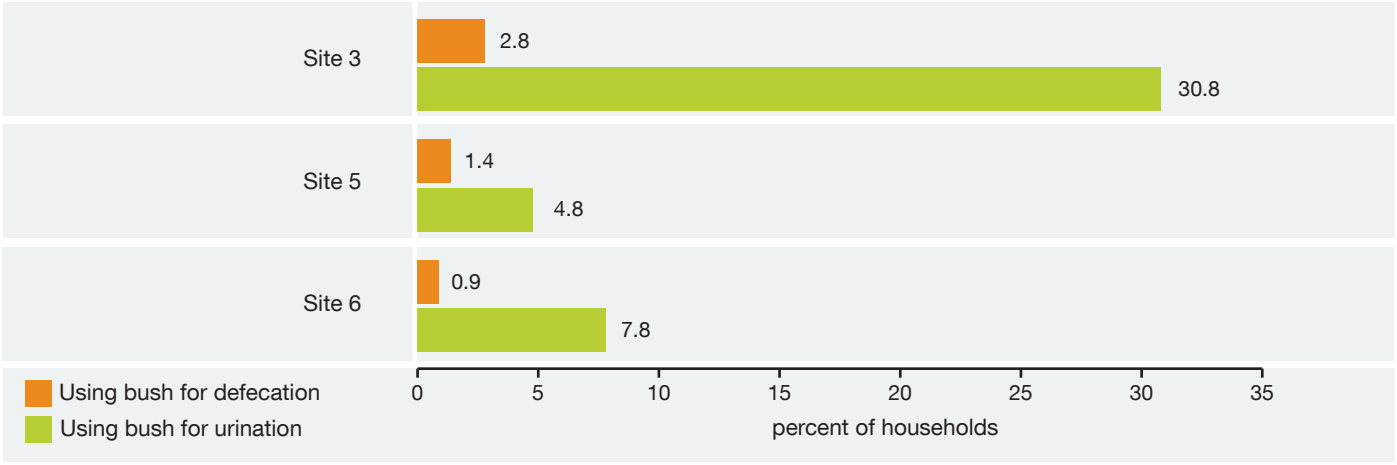
This study made an attempt to capture the inability to fully realize the benefits of an intervention by making a distinction between ideal and actual benefits as follows. First, the benefits quantified in Sections 4.1 to 4.3 are treated as gains occurring under ideal conditions – i.e., where sanitation facilities are used at optimal levels, maintained properly, and complemented with appropriate hygiene practices. Second, the benefits are adjusted with the aid of selected indicators from the field sites. The adjusted values are called "actual benefits" in the analysis. The actual and ideal benefits are used to generate two sets of efficiency measures – ideal and actual conditions – in Section 7.

Figure 36 shows selected indicators for the field sites. It indicates that at least 90% of the households in four of the six sites use their (improved) toilets regularly. This implies a high likelihood that the health benefits from improved sanitation are going to be realized at these sites. At Sites 3 and 6, however only about two thirds of households use their improved toilets regularly. The proportion of household members using off-plot options represents the potential for realizing the gains associated with access time. While the proportion of households using off-plot options is quite low, Figure 36 indicates that the beneficiaries from Site 4 are the least likely to obtain the full benefits. The full set of indicators for the field sites is presented in Annex Table F10. These values will be used to estimate the actual efficiency of sanitation interventions.

[27] These are likely to be over-estimates. Curtis et al. (2009) cite that self-reporting with respect to handwashing, which was the case in the ESI surveys, has "poor validity" (p. 656). The paper also summarized the results of studies in 11 countries, including Vietnam and selected provinces of China, which suggest that only 17% of mothers and caregivers wash their hands with soap and water after using the toilet.

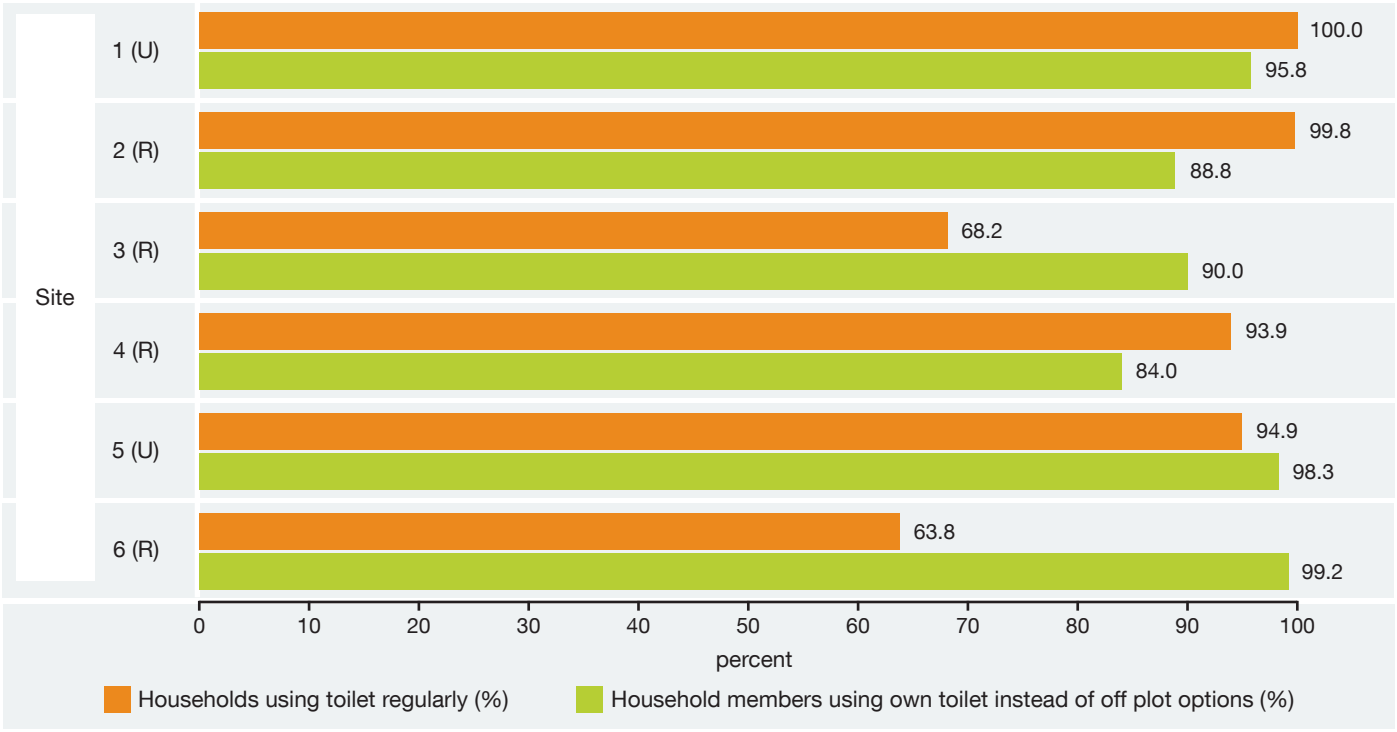
The values presented in Figure 36 should be seen as an initial step in developing a set of measures for evaluating actual benefits. Some of the indicators may be refined further with more available information. For example, the proportion of people who wash their hands after defecation may be augmented with information on the frequency with which they do so. People who wash their hands after defecating are less likely to become sick. Some of the indicators might also have to be combined with other measures to generate a more accurate assessment of actual practices. For example, handwashing may be combined with information on the cleanliness of the toilet bowl or the cubicle itself, or even food preparation. However, the development of such indicators and how they will be used to adjust the benefits is the subject of further studies. Despite its limitations, the indicators presented in this study highlight the point that the full benefits of improved sanitation may not be realized in the absence of changes in hygiene behavior and use of toilet facilities.

FIGURE 35. OPEN DEFECATION AND URINATION IN THE PROJECT SITES, % OF HOUSEHOLDS



Source: Annex Table F9

FIGURE 36. SELECTED ADJUSTMENT VARIABLES FOR BENEFITS, % OF RESPONSES



Note: R. = rural; U. = urban
Source: Annex Table F10.

4.7 SUMMARY OF LOCAL BENEFITS

Table 22 summarizes the local benefits associated with access to improved sanitation under ideal conditions. It presents the quantitative benefits for the rural and urban study sites and represents the estimated gains per household on an annual basis. The table also reports the qualitative benefits that were not quantified in the analysis. The majority of these benefits were sourced from the surveys and FGDs at the study sites.

The quantified benefits suggest that gains associated with access time are likely to be a significant source of benefits for rural and urban households. In the case of rural households, these gains were estimated to be 1.07 million kip (US$129) per household per year. This benefit is about 48% larger than the total averted health costs associated with a movement from open defecation to basic sanitation facilities (720,000 kip or US$87). However, gains associated with having access to private facilities were slightly smaller than the potential benefits of providing a rural household with access to sewer facilities (1.13 million kip or US$137). In the case of urban households, gains associated with access time were the largest source of benefits.

The benefits accrued have been conservatively valued under the methodology of the study. In the case of health, the monetary gains fail to account for the pain and discomfort associated with illness. This could be significant as an average of 28 DALYs per 1,000 people per year could be averted if households in the study sites were to move from open defecation to basic sanitation. It is also important to note that the estimates do not account for costs associated with sanitation-related cases of hepatitis and trachoma.[28] Neither were selected attributes of water quality monetized in the study. For example, the most common complaint among households that use unprotected or non-piped protected water sources was the bad appearance of the water. Users of piped water sources also complained of water that had a bad smell or taste. For access time, the monetized benefits only reflect gains associated with access to private toilets for defecation. These do not account for access time for urination, which could be significant especially among women.

Other benefits that go beyond the health-related, water-related and time-related aspects are very difficult to monetize. For example, the household survey found that the level of satisfaction of households with access to toilets was higher than for those with no toilets. Among households with toilets, satisfaction was highest with respect to: (a) avoiding snakes and biting insects; (b) children's safety; (c) avoiding conflict with neighbors; and (d) the reduction in foul smell.

[28] A more comprehensive list of sanitation-related diseases is presented in Annex Table A3.

TABLE 22. SUMMARY OF LOCAL IMPACTS OF SANITATION IMPROVEMENT[a]

Concern	Benefits of improved sanitation		
	Quantitative benefit (thousand kip/household, annual)		Qualitative benefit
	Rural	Urban	
Health			
Healthcare cost averted			• Health burden/quality of life: Avoided pain and discomfort because of illness: An average of 28 DALYs per 1,000 people are averted for the study sites as households move from OD to basic sanitation. In moving from OD to facilities that have access to wastewater management, DALYs averted rise to 44 per 1,000 people. • Diseases excluded: There are avoided income losses from diseases that are not quantified in this study.
OD to Basic Sanitation	565.5	316.6	
OD to Sewerage	890.6	498.6	
Productivity cost averted			
OD to Basic Sanitation	79.3	103.8	
OD to Sewerage	124.9	163.9	
Mortality cost averted			
OD to Basic Sanitation	75.2	61.6	
OD to Sewerage	117.0	95.8	
Total health costs averted[b]			
OD to Basic Sanitation	720.0	481.9	
OD to Sewerage	1,132.5	758.3	
Water			
Savings from access costs	26.7	7.2	• Improved water quality (smell, appearance, lower contaminants, etc.) for drinking, domestic purposes, recreation and other purposes. The bad appearance of the water was most common complaint among households that use unprotected or non-piped protected sources. Users of water from piped protected sources mostly complained of bad smell and bad taste.
Savings from treatment costs	42.5	25.6	
Access time	1,066.6	1,079.5	• Toilet preferences: Respondents in the FGDs consistently provided the highest ranking to having a "latrine that is near the house." The importance of proximity was reinforced by the finding that the second highest ranked attribute is "ability to use the toilet as the need arises." • Time loses associated with urination were not accounted for in the quantitative analysis. This could be significant because people urinate more often than they defecate in a day.
Intangibles	nc	nc	• Based on many possible benefits of latrines (see Figure 24), the ESI household survey found that the level of satisfaction among households with access to toilets is higher than among those who do not have facilities. While the scores for different attributes were not too different, households that have access to toilets indicated the highest levels of satisfaction for: (a) avoiding snakes or biting insects; (b) safety of children; (c) avoiding conflict; and (d) reducing smell.
External environment	nc	nc	• The responses to the ESI household survey showed that the state of the environment at the study sites seems to be quite good. With scores ranging from 1 (very bad) to 5 (very good), the poorest score was given to smell from burning waste/garbage (3.4). In contrast, the highest ratings were for dust and dirt in shops/markets/restaurants (4.0) and dust and dirt in streets/roads/alleys (4.0)

Notes: [a] nc - not calculated; OD - Open Defecation. [b] This is the sum of averted health care, productivity and mortality costs. The benefits are also measured under ideal conditions.
Source: Author's calculations

V. National Benefits of Improved Sanitation

This section discusses the national impact of improvements in sanitation. In particular, it presents the results on:

- Tourism (Section 5.1)
- Sanitation and business activity (Section 5.2)
- Health (Section 5.3)
- Summary of benefits (Section 5.4)

5.1 TOURISM

Tourism is one of the most dynamic economic activities in Lao PDR. The Lao National Tourism Administration (LNTA, 2010) reports that tourist arrivals expanded at an average annual rate of 20.5% between 1990 and 2009. About 9 in 10 of the more than 2 million visitors in 2009 were from the Asia-Pacific region, most especially Thailand (close to two-thirds of all visitors). In the same year, foreign visitors stayed for an average of 4.5 days and spent about US$45/day.

With the rapid growth of visitor arrivals, it is not surprising that tourism has emerged as an important economic activity, offering significant income and employment opportunities for Lao PDR. For example, the World Travel and Tourism Council (WTTC, 2011) expects that tourism and travel will generate a direct contribution of 2.7 trillion kip (4.3% of GDP) and 105,300 jobs (3.6% of total employment) in 2011. These projections are higher than both their values for 2010 and the relative contributions of travel and tourism in better known tourist destinations. For example, the WTTC (2011) estimated that travel and tourism only had a direct contribution of 103,200 jobs in 2010. The same source also indicates that the expected direct contribution of travel and tourism to GDP in Lao PDR for 2011 is higher compared to Vietnam (3.5%), the Philippines (3.4%) and Indonesia (3.2%).

The choice of tourist destination can be influenced by sanitation conditions including: the quality of water resources (for drinking water and recreation); quality of the environment (smell and appearance); food safety (hygiene and food preparation); the general availability of toilets in public places; and health risks. Disease epidemics, whether influenced by sanitation conditions or not, are also likely to discourage tourists from visiting a site.

While it is difficult to quantify monetary impact, this study attempted to assess the relationships between selected aspects of sanitation and tourism. The analysis is based on a survey of 235 visitors at the international and domestic terminals of the airport at Vientiane, and at strategic sites visited by tourists. The respondents were almost evenly divided among Asians and westerners (Table 23) visiting the country for tourism (80%) or business (20%) purposes. More than 70% of these visitors stayed in hotels or other accommodation costing less US$60 per day, and they stayed in the country for an average of 8 days.

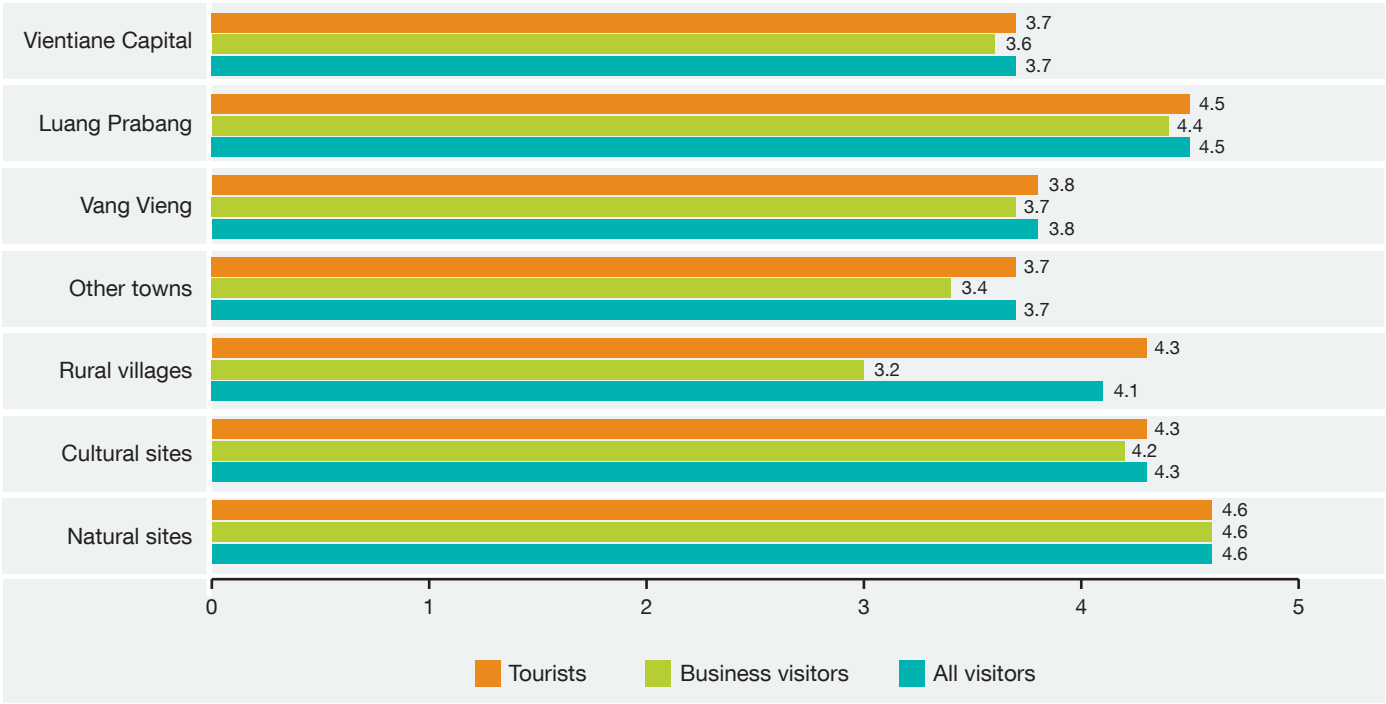
The visitors were asked to rate how much they enjoyed selected sites in the country. A value of 5 was assigned if the site was enjoyed "very much" while a value of 1 was assigned if the visitor did not enjoy the site ("not at all"). The results are shown in Figure 37. The survey findings indicate that the visitors enjoyed their visits to natural sites and Luang Prabang the most. The average rating for the capital (Vientiane) was fairly positive but among the lowest of the choices provided in the survey.

TABLE 23. BACKGROUND CHARACTERISTICS OF RESPONDENTS

Variable		Asian 1[a]	Asian 2[b]	Asian 3[c]	Western[d]	Total
No. of tourists interviewed		55	26	46	108	235
Gender (%)	Male	55	54	57	58	57
	Female	45	46	43	42	43
Average no. of previous trips to country		8	4	4	5	6
Average length of stay of this trip (days)		6	8	5	11	8
Purpose of visit (%)	Tourist	65	73	87	86	80
	Business	35	27	13	14	20
Cost of accommodation for tourists (% of respondents)	Hotel Tariff (US$)					
	Free (stay with friends)	13	4	4	6	7
	1-14	8	23	15	23	18
	15-29	20	31	35	20	24
	30-59	38	15	17	32	29
	60-89	13	23	11	6	10
	90-119	4	4	9	7	6
	120-149	5	-	7	3	4
	150 +	-	-	2	2	1

Notes: [a] Refers to visitors from Indonesia, Malaysia, the Philippines and Thailand. [b] Refers to visitors from China, Myanmar, North Korea and Vietnam. [c] Refers to visitors from Hong Kong, Japan, Singapore, South Korea and Taiwan. [d] Refers to visitors from Australia, New Zealand, Europe and North America.
Source: ESI tourist survey

FIGURE 37. PLACES VISITED AND ENJOYMENT OF STAY, NOT AT ALL (1) TO VERY MUCH (5)[a]



Note: [a] Luang Prabang is a UNESCO World Heritage Site. Vang Vieng is a small town located between Vientiane and Luang Prabang, which was very popular among backpackers and low budget travelers. It is currently being developed to target higher-end visitors .
Source: Annex Table G1.

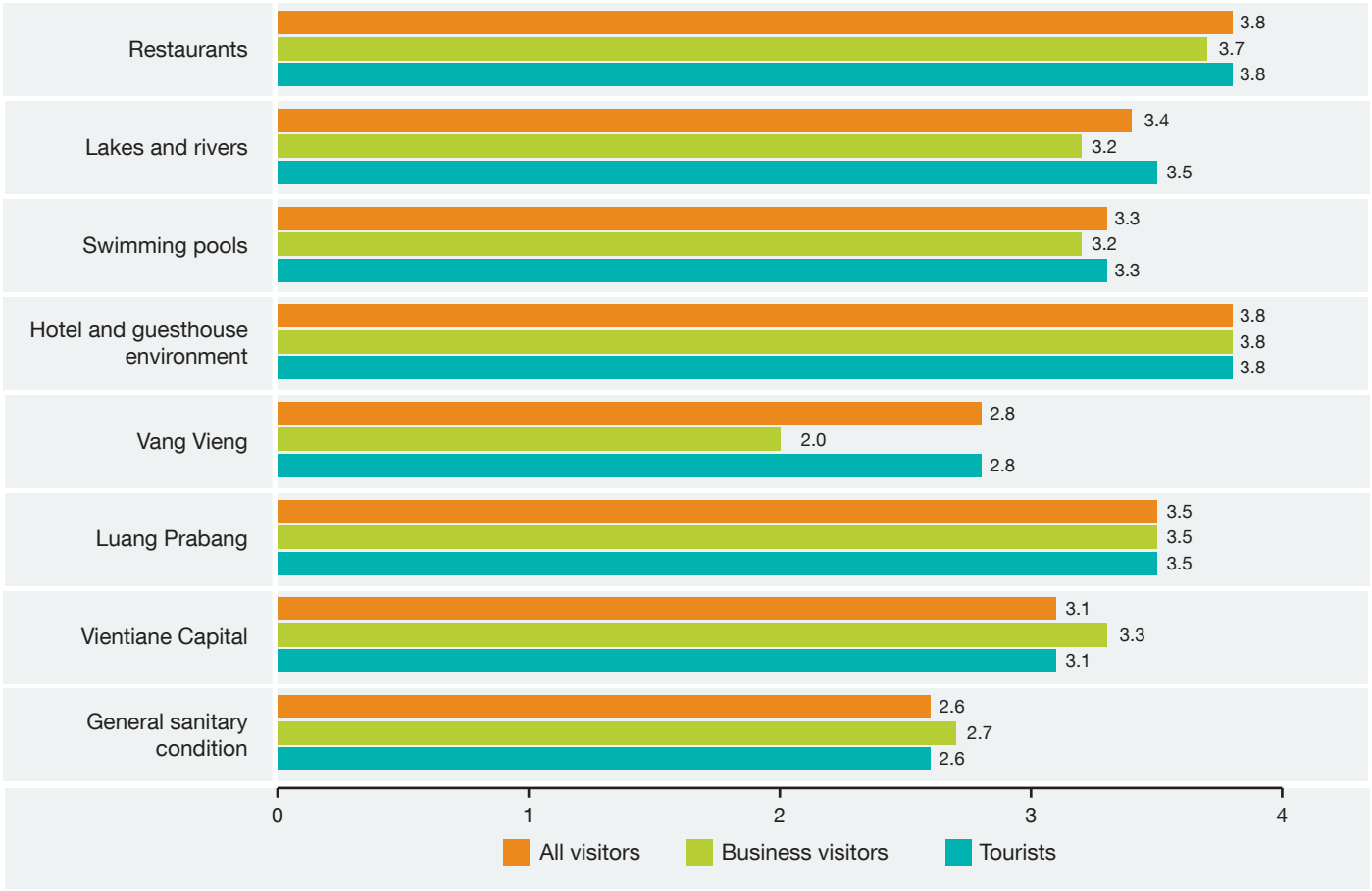
The visitors were also asked to rate sanitary conditions in general and at selected locations in the country on a scale of 1 to 5, with 5 suggesting that sanitary conditions are "very good". As a whole, the average rating for general sanitation conditions was 2.6 (Figure 38). While perceptions of general sanitation conditions were not really impressive, the assessments of specific locations were slightly better. For example, the survey found that the ratings were somewhere between "fair" to "good" for restaurants (3.8) and hotels (3.8). Figure 38 also suggests that the perceptions among tourists and business travelers do not appear to differ much.

Table 24 provides more specific information on sanitation conditions as perceived or experienced by foreign visitors. The respondents were asked to rate the condition of toilets in hotels, restaurants, airports, bus stations, and public toilets around the cities visited. These locations were ranked on a scale of 1("very poor") to 5 ("very good"). The highest ratings were received by hotels and airports. In contrast, the lowest average rating was for bus stations (1.9) and the city (2.0).

There is clearly a need to increase the availability of toilets as a whole. Almost half of foreign visitors (46%) stated that they were not able to find a toilet at a time of need. Such a situation might be a serious cause for concern because over two-thirds (68%) of the visitors providing a "yes" response to this question said that this had an impact on their stay.

Tourists were also asked to state their experience with respect to the availability of soap and water for handwashing in restaurants, bus stations and public toilets (see Table 24). The responses presented to them were on a scale of 1 ("never") to 5 ("always"). About 81% of the visitors said that soap and water was available sometimes to always in restaurants. The assessment for bus stations and the city as a whole was considerably less favorable.

FIGURE 38. GENERAL SANITARY EXPERIENCE, VERY POOR (1) TO VERY GOOD (5)



Source: Annex Table G2

The respondents were also asked to identify 3 of 8 risk factors that concerned them the most during their stay in Lao PDR. Figure 39 summarizes the results of this question and Annex Table G4 provides the details. The greatest concern was for food safety, cited by about 43% of respondents. Not far behind were concerns over public toilets (40%) and tap water (39%).

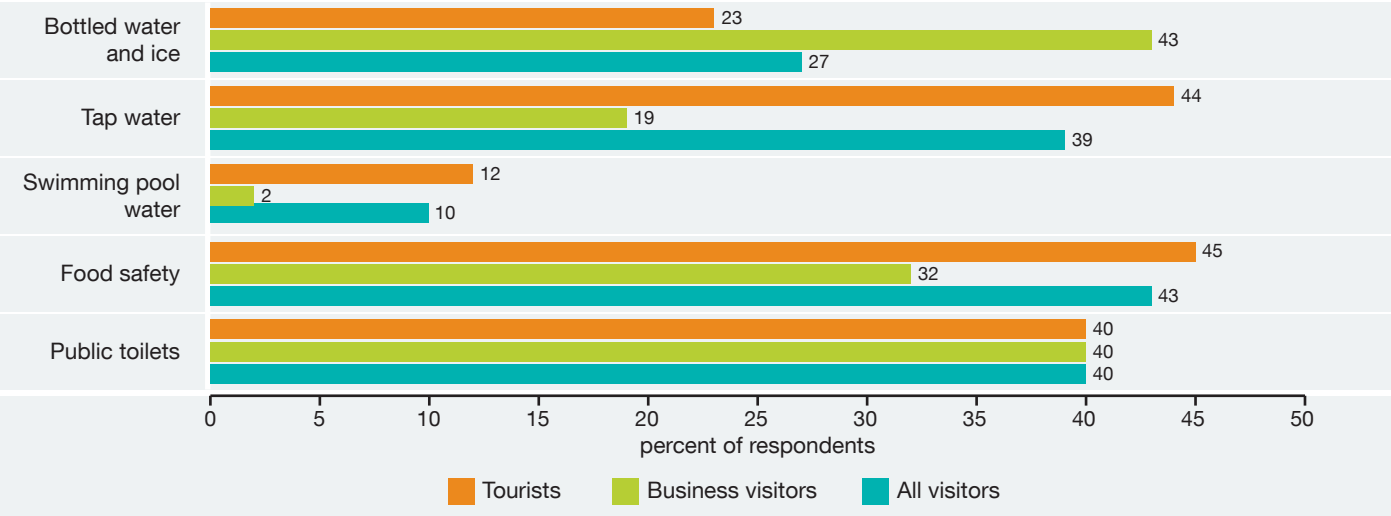
Apart from impressions of sanitation conditions, actual health problems experienced by the visitors could also affect decisions to re-visit the country or to recommend it as a destination to friends and relatives. Table 25 shows selected statistics on the gastro-intestinal tract (GIT) problems experienced by the visitors during their stay in the country. It indicates that about a fifth of the respondents experienced gastro-intestinal problems, with the incidence rate among tourists (20%) slightly higher than that among business travelers (17%). On average, visitors felt the symptoms for slightly more than 2 days and were incapacitated for about half a day. While most of the visitors (64%) did not seek attention for the illness, those that did spent an average of about US$6 on treatment.

TABLE 24. SANITARY EXPERIENCE IN RELATION TO TOILETS AND HAND WASHING

Feature	Tourists	Business visitors	All visitors
Quality of toilets in (1= very poor to 5 = very good)			
Hotel	3.7	3.9	3.7
Restaurants	3.3	3.2	3.2
Airports	3.7	3.7	3.7
Bus stations	1.9	2.3	1.9
City	2.0	2.3	2.0
Toilet availability			
% could not find when needed	46.0	45.0	46.0
% affected stay adversely	64.0	81.0	68.0
Water and soap for hand washing (1 = never to 5 = always)			
Hotel	3.7	3.7	3.7
Restaurants	3.2	3.2	3.2
Airports	3.8	3.8	3.8
Bus stations	1.6	1.0	1.5
City	1.8	1.6	1.8

Source: Annex Table G3

FIGURE 39. FACTORS OF MOST CONCERN TO TOURISTS, %[a]



Note: [a] A respondent can identify up to three factors; Source: Annex Table G4.

TABLE 25. HEALTH TROUBLES EXPERIENCED BY VISITORS

Item	Tourists	Business visitors	All visitors
Visitors with GIT infection (% of total)	20.0	17.0	19.0
Perceived causes (% of infected persons, multiple responses allowed)			
Drinking water	30.0	38.0	31.0
Food	76.0	86.0	78.0
Dirty environment	16.0	13.0	16.0
Hot weather	8.0	13.0	9.0
Average number of days:			
Symptoms were felt	2.1	2.8	2.2
Incapacitated due to illness	0.6	0.9	0.6
Treatment sought (%)			
None	68.0	50.0	64.0
Medical practitioner: out-patient	5.0	13.0	7.0
Other: out-patient	3.0	0.0	2.0
Self-treatment	24.0	38.0	27.0
Average cost of treatment (US$)	5.6	6.0	5.7

Source: Annex Table G5

Despite the less than positive assessment of sanitation conditions, concerns and disease episodes experienced by tourists, about 87% of visitors intend to return to Lao PDR (Figure 40). In addition, 95% of the visitors said that they would recommend the country to friends.

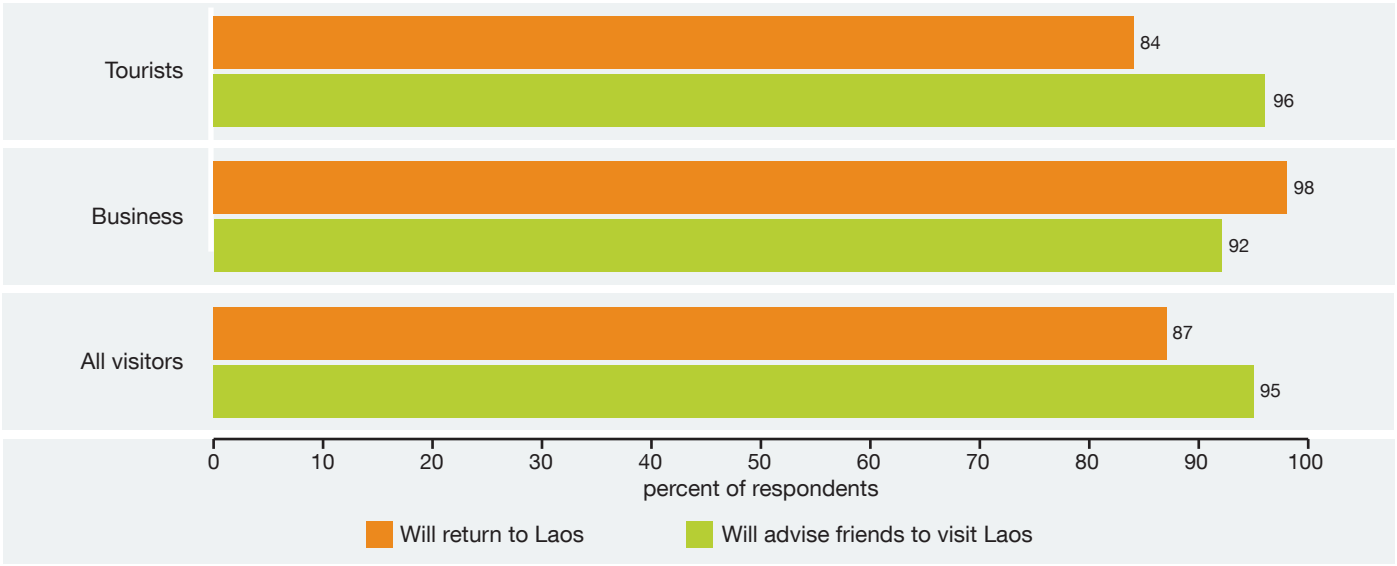
Figure 41 shows key factors that caused respondents to hesitate to return to the country. All respondents were asked this question, irrespective of whether they said they intended to return. The survey reveals no reason that is clearly dominant, perhaps reflecting the previous finding that many of the visitors intend to return to the country. Nonetheless, the most common reasons cited were the impression among visitors that they have seen everything there is to see in the country (5%) and poor sanitation (4%). Among the contributory reasons (Annex Table G7), poor sanitation and poor service emerged as the top factors that make visitors hesitate to return.

The discussion above provides qualitative information on the possible effects of sanitation on tourism. While the available data are not sufficient to calculate the monetary impact, tourism lost due to poor sanitation could be significant. Hutton et al. (2009) estimate these losses to be of the order of 174 billion kip (US$17.3 million) per year at 2006 prices. This was calculated by assuming that 10% of the revenue gains from improved sanitation are lost as a result of poor sanitation conditions.

5.2 SANITATION AND BUSINESS ACTIVITY

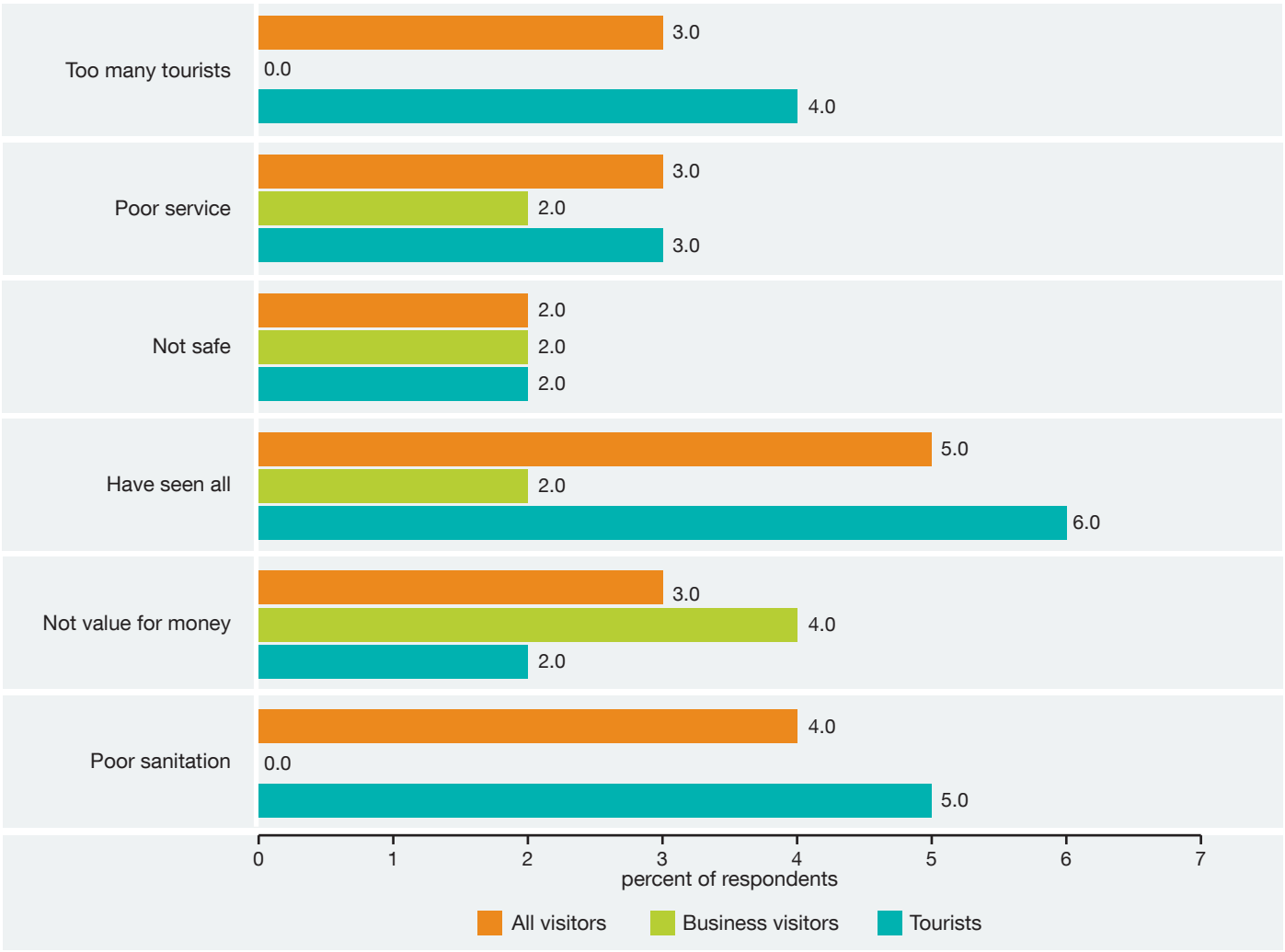
Section 3.4.2 explained that poor sanitation has the potential to influence the operation of firms and the decisions of businesses to locate in a particular area. In order to assess these hypothesized effects, a total of 17 businesses were surveyed through face-to-face interviews and in-depth discussions. These firms were selected based on the potential link between sanitation and their business, and the importance of the sector and specific firm to the economy of Lao PDR. Naturally, the survey of foreign firms was of those that have already located in Lao PDR, and hence a key category of firms – those that had decided against locating there – did not form part of the sample. Foreign firms were asked about the factors affecting their decision to locate in Lao PDR, and their experiences in the country.

FIGURE 40. INTENTION OF FOREIGN VISITORS TO RETURN TO LAO PDR, %



Source: Annex Table G6

FIGURE 41. REASONS FOR HESITANCY OF FOREIGN VISITORS TO RETURN TO LAO PDR, %



Source: Annex Table G7

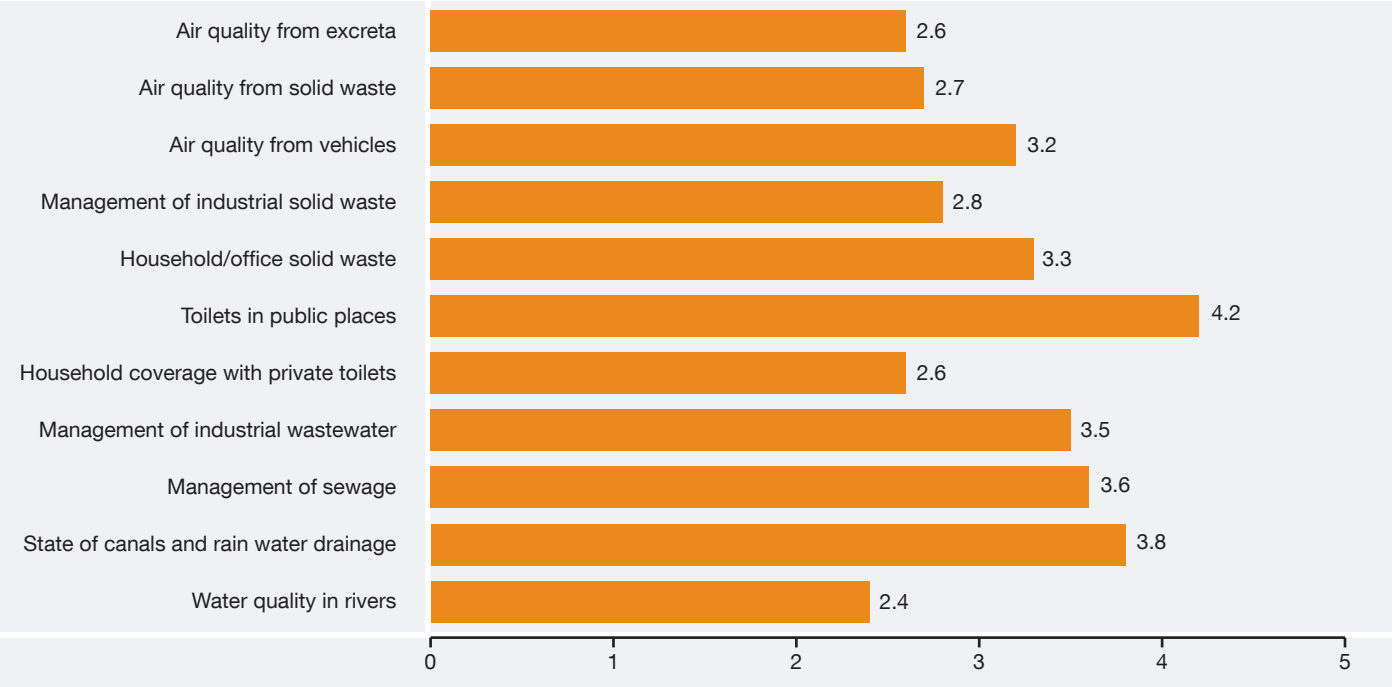
Business owners were asked to rate their perception of sanitation in the location of their establishments on a scale of 1 (best) to 5 (worst). Figure 42 summarizes the respondents' answers to the different aspects of sanitation. The most favorable rating was given to water quality in rivers (2.4), closely followed by air quality affected by poor sanitation (2.6) and household coverage of private toilets (2.6). In contrast, the least favorable rating was given to toilets in public places (4.2).

Table 26 shows the reasons cited by the firms for locating in their current place of business. The results were mixed, which makes it difficult to make strong generalizations. However, it is important to note that none of the firms mentioned sanitation-related conditions as a factor for their choice of location.

Table 27 shows the factors that affect the operation of the firms interviewed for this study. Notwithstanding the small sample size, business owners provided some evidence that poor workforce health affects their businesses. This was particularly important to locally-owned food and beverage producers and pharmaceutical factories. The respondents also mentioned that the actual impact of workforce health on their business is positive as a whole. The foreign business owners/managers, in particular, considered the Lao workforce to be very stable compared to workers in other countries. One foreign restaurant owner mentioned that when he opened his business about eight years prior to the interview, his employees were often sick and this had a negative impact on his business operations. He added however that the health of his employees has improved and attributed this to better living standards in Vientiane Capital.

All the respondents stated that poor water quality could have a serious negative effect on business. In fact, the majority of respondents mentioned access to clean water as the most important aspect of sanitation. This is reflected in Table 27, where the respondents gave an average rating of 4 to the item "Poor water quality affects business." The respondents also felt the quantity of water in Lao PDR is adequate for their production most of the year. It is only in the rainy season (3 months from July to September) that problems related to water arise. For example, one business owner stated that he occasionally had to close his restaurant for a day or two during the rainy season because of lack of water. Even though this restaurant uses bottled water for production, public water supply is still needed for cleaning purposes and for customers bathrooms.

FIGURE 42. RATING OF ENVIRONMENTAL SANITATION CONDITIONS IN THE LOCATION OF THE BUSINESS SURVEY INTERVIEW, BEST (1) TO WORST (5)



Source: Annex Table H1

TABLE 26. REASONS FOR BUSINESSES SELECTING THEIR CURRENT LOCATION

Reason	Food and beverage producers (Local)	Food and beverage producers (International)	Restaurants (Local/ International)	Hotels (International)	Travel agencies/ tour operators (Local)	Pharmaceutical factories (Local Government)
Opportunity to spread brand		✓		✓		
Central location			✓		✓	
Business opportunity			✓	✓		
Have location already	✓			✓		
Close to market	✓					
Close to similar businesses	✓					
New market		✓				
Location is "out-of-town"						✓
Government property						✓

TABLE 27. THE IMPACT OF SANITATION-RELATED FACTORS ON BUSINESSES

Variable: Firms who say that…	No. of responses	Sectors			
		Food and beverage producers (Local)	Food and beverage producers (International)	Restaurants (Local/ International)	Pharmaceutical factories (Local Government)
Health					
Poor workforce health affects their business (% respondents)	11	50.0	-	33.0	50.0
Water					
Water quality is not adequate (% respondents)	11	-	-	-	-
Poor water quality affects their business (1 = unimportant; 5 = important)	11	4.0	4.0	4.0	4.0
They treat their own water (% respondents)	11	75.0	50.0	33.0	100.0
Average monthly cost of water treatment (US$)	6	10.0	2,000.0	10.0	625.0
Poor local environment (1 = unimportant; 5 = important)					
Affects customers	11	1.0	3.5	1.7	1.0
Affects current workers	11	1.0	3.5	1.0	1.0
Affects staff recruitment	10	1.0	3.0	1.0	1.0
Affects suppliers	9	1.0	1.5	1.0	1.0
Affects other company stakeholders	9	1.0	3.0	1.0	1.0
Average monthly cost of environment clean-up (US$)	8	12.0	1,750.0	12.0	500.0
Other aspects	0				
Loss of business days due to local environmental factors (% respondents)	10	-	-	33.0	-
Fines paid for poor environment (% respondents)	9	-	-	-	-
Considered relocating firms (no of firms)	16	1	1		2

Source: ESI survey

The fact that the interviewed business owners/managers found the water quantity to be adequate has to be seen in the light of the use of a mix of water sources. One business, a slaughterhouse located in the outskirts of Vientiane Capital has its own well, and uses the water from this well directly for cleaning purposes. Other local food and beverage produces as well as the Lao-owned restaurants, the pharmaceutical factories and the international brewery mainly use water from the public water supply but filter it themselves.

Four of 11 interviewed businesses do not treat the water (note, 6 non-responses to this question). In two cases, the bakery and the foreign-owned restaurant, this must be interpreted with care because these firms use bottled water in production. The slaughterhouse does not treat the water because it is mainly used for cleaning purposes and not directly in production. Only one firm, a Lao-owned restaurant, uses water directly from the public water supply without further treatment for production.

As shown Table 27, the cost of treatment ranges from US$10/month for the small local family industries to US$2,000/month for the international brewery. While the cost variations across the firms are likely to be explained by the scale and nature of their operations, it is important to note that such costs were considered low by the respondents. This was especially the case for the foreign respondents who find the price of water in Lao PDR to be low relative to other countries.

The local business owners and managers place little importance on the effect of the surrounding environment on their business. Table 27 shows that only the foreign-owned food and beverage firms seem to lend some degree of importance (average score = 3.5) to the effects of the environment on customers, current workers, recruitment and stakeholders. The average amount spent on cleaning surroundings ranges from US$12/month for the small local family industries to US$1,750/month for the international brewery. Such a large variance is of course likely to be explained by the nature of the activities and scale of operations of the firms.

Only one of the local small-scale food and beverage producers had considered moving to another location. However, the owner seemed to be more intent on moving her place of residence, which is in the same building as the factory of the firm, rather than the firm itself. Of the two foreign-owned food and beverage producers, only the bakery which is located in the central area of Vientiane Capital also considered moving to another location. However, this was motivated mainly by the desire to get more space. The two pharmaceutical firms had also considered moving to a different location. Both are government-owned enterprises that want and originally had factories that are away from the city. However, the expansion of the city meant that the existing factories are now within city limits. Efforts to move the factories have been constrained by an inability to find a suitable location that can be easily accessed by its current workforce.

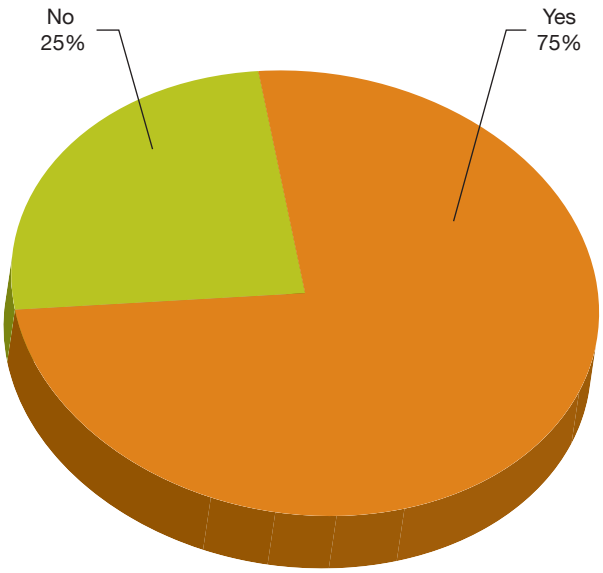
Table 28 shows measures related to cleaning surrounding areas and the training of staff on proper hygiene practices that were implemented by firms to deal with poor environmental conditions.

TABLE 28. SANITATION AND BUSINESS COSTS: MAIN MEASURES TAKEN TO DEAL WITH A POOR ENVIRONMENT

Responses	Sectors				
	Food and beverage producers (Local)	Food and beverage producers (International)	Restaurants	Hotels	Pharmaceutical factories
Paid local authorities to clean streets				✓	
Introduced cleaning procedures		✓		✓	✓
Staff cleaned areas outside the establishment	✓		✓		
Trained staff in hygiene		✓		✓	✓

Source: ESI survey

FIGURE 43. IF SANITATION IMPROVES CONSIDERABLY, DO YOU ENVISAGE EXPANDING YOUR OPERATIONS HERE?, % OF RESPONDENTS



Source: ESI survey

While it seems that sanitation was not a serious factor in locating business operations, the interviews conducted for this study suggest that it does matter. Figure 43 shows that 75% (or 9 out of 12) of the respondents envisaged expanding their operations should there be significant improvements in sanitation. Their impression was that improved sanitation conditions are associated with generally better living standards, which in turn leads to more business opportunities.

5.3 HEALTH

The national health benefits from sanitation improvements depend on the cost of sanitation per household, the reduction in relative risks associated with sanitation options and the sanitation coverage in the country. Information on the first two variables was discussed in Section 4.1 while the third was presented in Section 1.1.

Table 29 presents the estimated health costs associated with sanitation and the potential benefits of sanitation improvement. It indicates that the health-related costs of the existing sanitation access in the country amount to about 1,313 billion kip (US$158 million) per year. The estimated costs for rural areas are higher because there are more households in these regions and health costs per household are higher compared to urban areas. Households that practice open defecation (OD) account for the highest proportion of the health costs. It is also worth noting that the current estimates are higher than the health-related costs in the ESI Impact Study (US$115 million).[29] This is due to changes in economic and demographic conditions between 2006 and 2010, sanitation coverage, refinements in the methodology and improved data sources.

The estimated benefits of sanitation improvement depend on the groups that will receive the interventions as well as the options made available to them. Scenario 1 in Table 29 illustrates the case in which all households have access to sewers. It indicates that the projected gains amount to about 668 billion kip (US$81 million) per year or approximately half of the estimated health costs. However, the cost of pursuing such an objective is likely to be very high and the suitability of having sewers in all parts of the country is also suspect. Without providing a specific option, Scenario 2 shows the benefits associated with having improved sanitation access (not sewers) to households that currently do not have access to such facilities. The estimated benefits amount to just over 228 billion kip (US$28 million).

5.4 SUMMARY OF BENEFITS

Sections 5.1 to 5.3 examined the broader benefits o improved sanitation in Lao PDR. It provided a range of annual health benefits for two scenarios. The first can be treated as an upper limit as it represents a situation in which all the households in the country have access to sewers. The second scenario, which is a more achievable but still a challenging target in the medium term, captures the provision of access to improved sanitation (not necessarily access to sewers) for the population that currently have unimproved access. While the gains to business and tourism were not quantified in this study, the benefits of improved sanitation could also be significant. The ESI Impact Study (Hutton et al., 2009), for example, estimated the tourism losses from poor sanitation to be of the order of 150 billion kip (US$17 million) per year at 2006 prices.

[29] At 2006 prices, Hutton et al. (2009) report that the health-related costs associated with poor sanitation are about 1,165.6 billion kip. This is about 1,260.7 billion kip when valued at 2010 prices.

TABLE 29. NATIONAL HEALTH IMPACTS OF POOR SANITATION

National health impacts of poor sanitation			
Item	**Rural**	**Urban**	**National**
Sanitation Access (% households, year 2010)			
Open defecation [a]	41.0	3.0	28.0
Unimproved (includes shared) [a]	9.0	8.0	9.0
Improved (not sewers)[b]	50.0	89.0	63.0
Improved (sewers)[c]	6.8	0.4	nc[i]
No. of households (thousands, year 2010)			
Open defecation	310.7	10.1	320.8
Unimproved (includes shared)	68.2	26.8	95.0
Improved (not sewers)	378.9	298.3	677.2
Improved (sewers)	51.5	1.3	52.9
Total[d]	757.9	335.1	1,093.0
Health cost per household (thousand kip)			
Open defecation[e]	1,789.9	1,194.4	1,572.6
Unimproved (includes shared) [e]	1,069.9	712.5	939.5
Improved (not sewers) [e]	1,069.9	712.5	939.5
Improved (sewers)[f]	657.5	436.1	576.7
Estimated national health costs (billion kip)[g]			
Open defecation	556.2	12.0	568.2
Unimproved (includes shared)	73.0	19.1	92.1
Improved (not sewers)	405.5	212.5	617.9
Improved (sewers)	33.9	0.6	34.5
Total	1,068.5	244.2	1,312.7
Heath cost savings with improved sanitation (billion kip)[h]			
Scenario 1: All households have access to sewer facilities	570.2	98.0	668.3
Scenario 2: OD and unimproved get access to improved sanitation	223.7	4.8	228.6

Notes: [a] JMP (2012); [b] JMP (2012) less proportion of households with access to sewers; [c] Multiple Indicator Cluster Survey 2006 (as cited in JMP 2010a); [d] combines information from the 4th Lao Expenditure and Consumption Survey (LECS4) and the ADB (2011); [e] costs less averted costs from OD to basic (no wastewater treatment); [f] costs less averted costs of OD to sanitation with wastewater treatment; [g] Number of households multiplied by the cost/household, converted into billions; [h] health costs in base less health costs in scenario; [i] nc . = not calculated

VI. Costs of Improved Sanitation

This section presents the costs of sanitation options. It also describes the costs from different perspectives – investment/recurrent and payer. In Section 6.3, the marginal costs of moving up the sanitation ladder are provided.

6.1 COST SUMMARIES

This section summarizes the costs of various sanitation options. It provides information on investment and recurrent costs, and the expected useful life of the different facilities.[30] Investment costs were annualized to permit a comparison between the sanitation options. Site-specific information on costs is provided in Annex Tables I1 to I6.

There are wide differences in cost across the various sanitation options. Table 30 shows that the annual costs at the rural sites range from 191,000 kip (US$23) per household for shared wet pit latrines to 816,000 kip (US$98) per household for toilets that flush to septic tanks. There is also a wide variation in the expected useful life of the sanitation options, from dry pit latrines, which are expected to last for about a year, to toilets that flush to a septic tank, which are projected to last for 25 years. It is important to note that the expected lives of some toilet options were adjusted downwards to account for the frequency of use. This was the case for shared facilities which were assumed to last half as long as private counterparts.

There is also a wide disparity in the costs and expected lives of the technologies examined in the urban sites. Table 31 shows that the annual costs per household in the urban sites range from 184,000 kip (US$22) for shared wet pit latrines to 1.11 million kip (US$134) for toilets that have access to sewers. There is also a wide variation in the expected useful life of the sanitation options. Shared wet pit latrines are expected to last for about three years while toilets that flush to septic tanks are projected to last about 8 times longer.

TABLE 30. COST OF DIFFERENT SANITATION OPTIONS FOR RURAL HOUSEHOLDS, 2010

Intervention	Lump sum investment costs (thousand kip/household)	Total costs (annualized, thousand kip household)[a]	Estimated life (years)[b]	Sites
Shared: Wet pit latrine	344.4	190.7	3.0	2 & 3
Shared: Toilet to septic tank	1,993.7	586.2	12.5	2
Private dry latrine	218.9	245.2	1.0	3 & 4
Private wet latrine	889.1	267.6	6.0	2,3,4 & 6
Toilet to septic tank	4,272.3	815.8	25.0	2

Note: [a]Total costs per facility per year are the sum of capital (annualized) and recurrent (maintenance and operation) costs. [b] Refers to the expected life of the facility before full replacement.
Source: Annex Tables I1 to I6

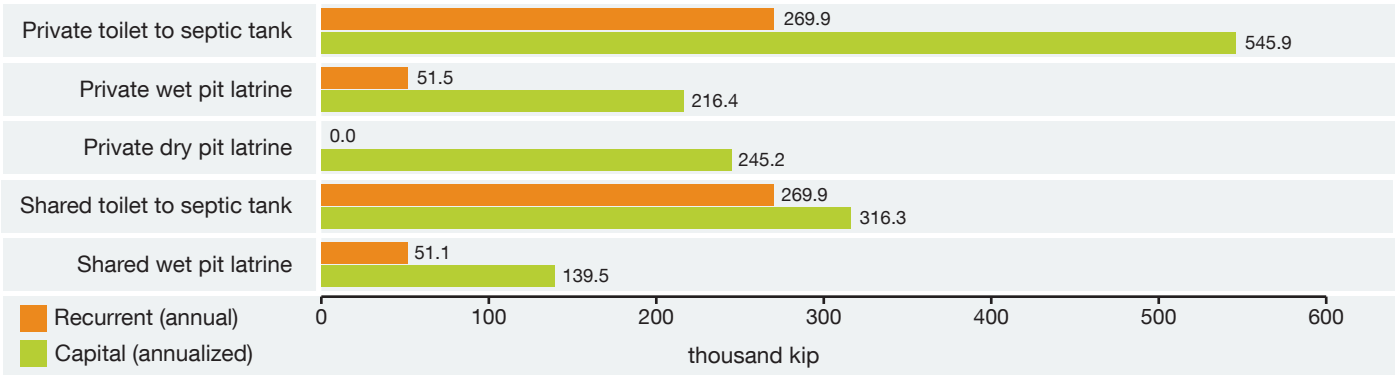
[30] Program costs, which represent expenditure on software (promotion, education, monitoring) were not included in the analysis because of the lack of information from the sites.

TABLE 31. TOTAL COST OF DIFFERENT SANITATION OPTIONS FOR URBAN HOUSEHOLDS, 2010

Intervention	Lump sum investment costs (thousand kip / household)	Total costs (annualized, thousand kip household)[a]	Estimated life (years)[b]	Sites
Shared: Wet pit latrine	319.3	184.1	3.0	1
Shared: Toilet to septic tank	1,495.3	507.1	12.5	1
Private wet latrine	1,049.2	306.5	6.0	1 & 5
Toilet to septic tanks	4,272.3	815.8	25.0	1 & 5
Toilet to sewers	5,545.9	1,113.4	25.0	1

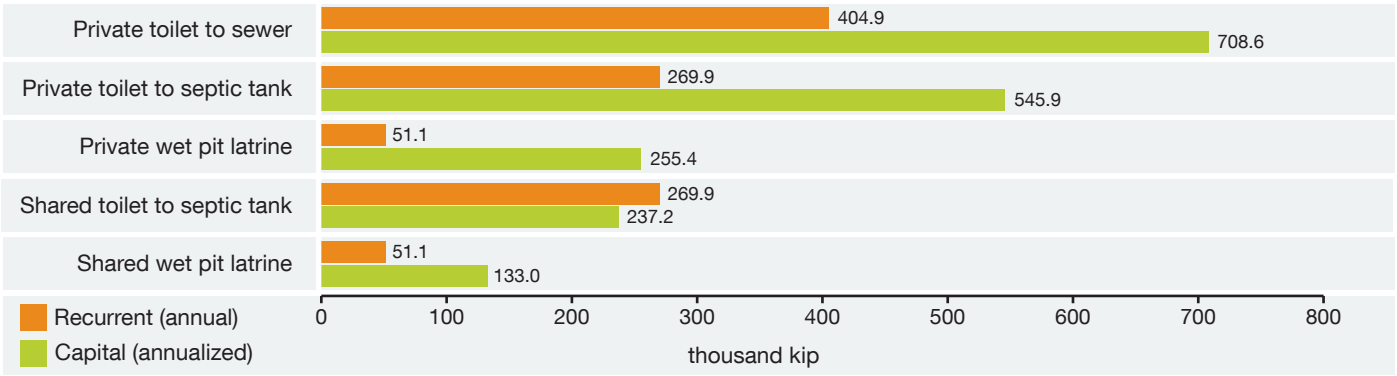
Note: [a]Total costs per facility per year are the sum of capital (annualized) and recurrent (maintenance and operation) costs.[b] Refers to the expected life of the facility before full replacement.
Source: Annex Tables I1 to I6

FIGURE 44. COMPONENTS OF COSTS PER RURAL HOUSEHOLD, THOUSAND KIP, 2010[a]



Note: [a] Total costs per facility per year are the sum of capital (annualized) and recurrent (maintenance and operation) costs.
Source: Annex Tables I1 to I6

FIGURE 45. COMPONENTS OF COSTS PER URBAN HOUSEHOLD, THOUSAND KIP, 2010[a]



Note: [a] Total costs per facility per year are the sum of capital (annualized) and recurrent (maintenance and operation) costs.
Source: Annex Tables I1 to I6

Figure 44 illustrates the main contributors to cost in rural areas. It indicates that annualized investment costs per household range from 140,000 kip (US$17) for shared wet pit latrines to 546,000 kip (US$66) for toilets that flush to septic tanks. Recurrent costs per household also vary across facilities, with the highest being 270,000 kip (US$33) per year for toilets that flush to septic tanks. Annualized investment costs account for the majority of the costs of the technologies.

Figure 45 illustrates the main contributors to cost in urban areas. It indicates that annualized investment costs per household range from 133,000 kip (US$16) for shared wet pit latrines to 709,000 kip (US$85) for toilets that have access to sewers. Recurrent costs range from 51,000 kip (US$6) to 405,000 kip (US$49) per year. As with rural areas, annualized investment costs tend to dominate the costs of the facilities.

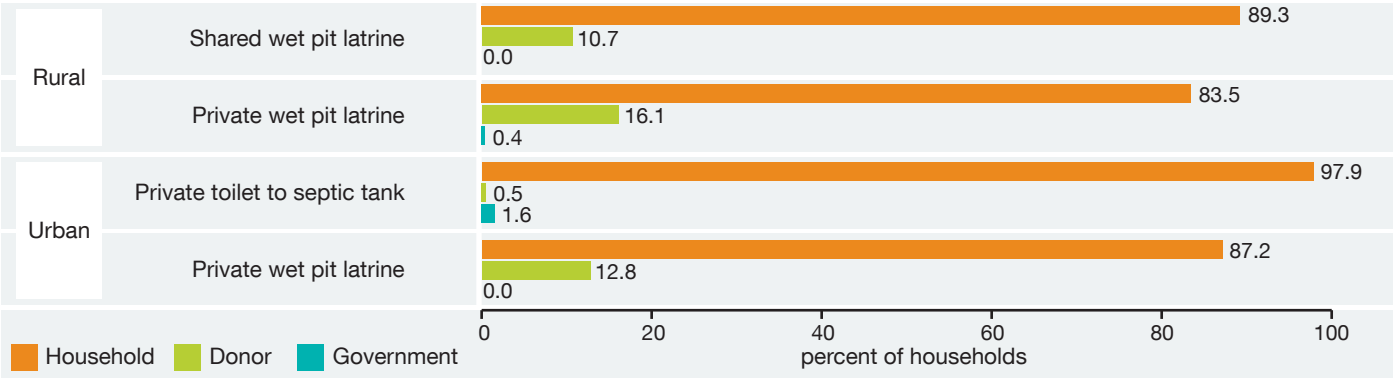
6.2 FINANCING SANITATION

This section discusses the various groups that finance sanitation options. At the outset, it is important to note two points regarding the values presented in this section. First, the contributions of government, donor agencies, NGOs and perhaps the private sector are underestimated here. This is because program costs, which are more likely to be attributed to these stakeholders, are excluded in the analysis because of lack of data. Second, costs attributed to households that received support from other institutions are also underestimated. The sources of funds are based on a household survey, where respondents who acquired toilets with the aid of other institutions were asked the number days of labor that they contributed. These days cannot be readily converted to values because the time period, and hence the appropriate wage rate to use, in which the toilets were acquired are not available. Third, very few respondents claimed to have received assistance in acquiring their toilets and these are limited to a subset of sanitation options at the sites. Only 89 out of the 834 rural respondents mentioned that they received some form of support and these were limited to respondents that use private and shared wet pit latrines. Only 37 out of the 379 urban respondents admitted to having received support. This is broken down among households that use private wet pit latrines (31 respondents), shared wet pit latrines (2 respondents) and toilets that flush to septic tanks (4 respondents).

Figure 46 shows the sources of funding for the various options at rural and urban sites. It indicates that most of the costs are shouldered by households (proportion of costs not financed by government and donors). The largest contribution made by donor agencies was for private wet pit latrines in rural areas (16%). The rather small contribution of donor agencies is explained by the fact that most of the households in the sample financed their toilets. For households that received toilets through donor programs, the shares of household beneficiaries in costs are actually much smaller than those implied by Figure 46. For example, excluding the value of labor, households that received private wet pit latrines from donors at Site 3 only contributed about 15% of total costs.

Despite the rather limited sample in the analysis, the conclusion that households are primarily responsible for acquiring sanitation facilities is realistic. For the period 2008/9, Giltner et al. (2010) estimated that households accounted for 52.2% of total expenditures for basic sanitation and hygiene in rural areas. The remainder was attributed to development partners (35.3%) and the government (12.5%). The paper also showed that 73.7% of these expenditures were for hardware and the rest were for software costs such as project management and behavior change communication.[31] Expenditure on sanitation hardware was also only attributed to households and development partners. All household expenditures was on hardware only, while 61% of donor expenditure was on hardware. Total expenditure for the period was US$5.9 million. This implies that total expenditure on hardware (73.7% of the total) was US$4.4 million. It also suggests that the expenditure of households (52.2% of the total) was US$3.1 million. Hence, households contributed roughly 70.5% of hardware costs.

FIGURE 46. PROPORTION OF SANITATION COSTS FINANCED FROM DIFFERENT SOURCES, %[a]



Note: [a] The values represent the shares of government and donors in hardware costs only. Hardware costs include investment and recurrent costs.
Source: ESI survey.

[31] Giltner et al. (2010) defined hardware as costs for latrine construction, including the labor supplied by the household.

6.3 COSTS OF MOVING UP THE SANITATION LADDER

Table 32 shows the costs of moving up the sanitation ladder for all field sites. In most cases, incremental costs are positive as a household moves up the sanitation ladder. This reflects the point that more advanced sanitation options tend to be more expensive because of investment costs. However, one instance in which costs per household decline is in the movement from shared toilets that flush to septic tanks to private dry and wet pit latrines. This reflects the point that toilets flushing to septic tanks are much more expensive than other facilities. However, this could easily change if there are many households using a particular facility.

The observed pattern for all sites is also generally reflected for rural sites (Figure 47). The incremental cost of moving from shared toilets that flush to septic tanks to dry pit latrines is negative for rural sites. Moreover, the increase in costs of moving from dry pit latrines to wet pit latrines is quite small. Large increases in cost are estimated when households move from private wet pit latrines to private toilets that have access to septic tanks. The observed pattern for the urban sites is similar to that for the rural sites.

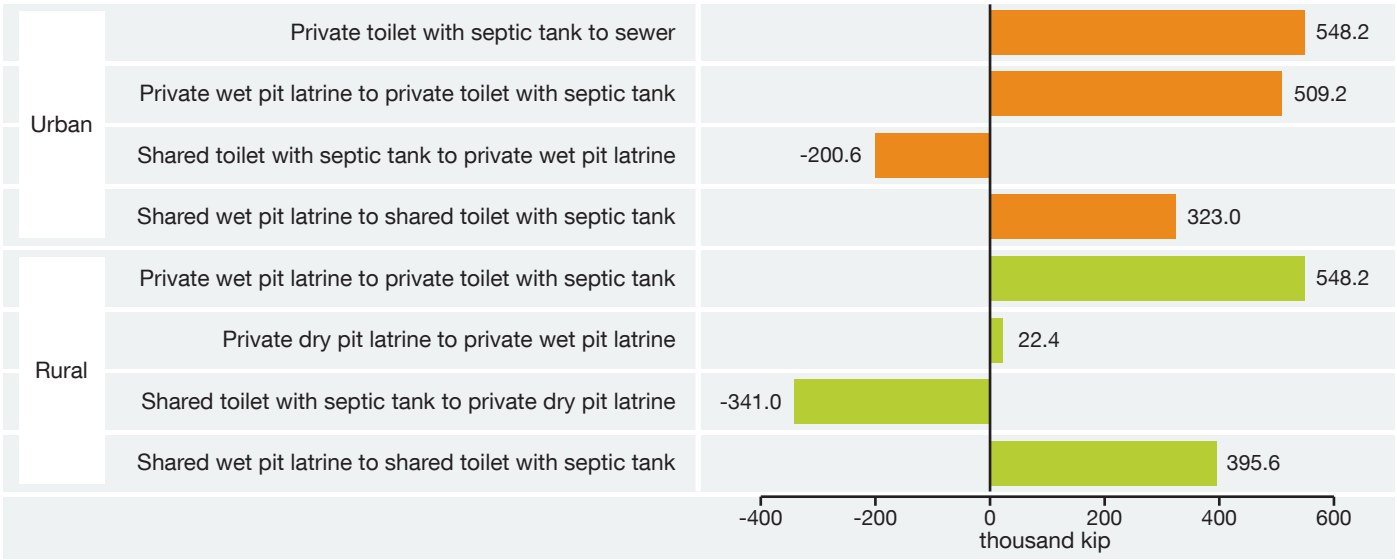
Some care must be exercised in interpreting the results in this section. This is because the costs per household with shared facilities are sensitive to the number of households that use the facility. That is, costs per household are likely to decline for shared toilets if more households are using the facility. However, if the analysis focuses on private facilities only, dry pit latrines are clearly the cheapest and toilets that flush to septic tanks are the most expensive.

TABLE 32. INCREMENTAL COSTS OF MOVING UP THE SANITATION LADDER, ALL SITES, THOUSAND KIP, 2010

	Facility	To				
		Shared toilet to septic tank	Private dry pit latrine	Private wet pit latrine	Private	Sites
From	Shared wet pit latrine	348.1	55.4	91.4	625.9	923.6
	Shared toilet to septic tank		-292.7	-256.6	277.9	575.5
	Private dry pit latrine			36.1	570.6	868.2
	Private wet pit latrine				534.5	832.2
	Private toilet to septic tank					297.7

Source: Annex Table I7. A minus figure means that the option in left column ('from') costs less than the option in the right hand row ('to')

FIGURE 47. INCREMENTAL COSTS OF MOVING UP THE SANITATION LADDER, THOUSAND KIP PER HOUSEHOLD, 2010



Source: Annex Table I7

VII. Efficiency of Improved Sanitation

This section synthesizes the information from Sections 4 to 6 to present the efficiency of sanitation options under ideal and actual conditions. It also discusses the non-quantified impacts alongside the quantitative cost-benefit and cost-effectiveness ratios. It consists of five sub-sections:

- Efficiency of sanitation interventions, compared with no facility (Section 7.1)
- Efficiency of alternatives for moving up the sanitation ladder (Section 7.2)
- Qualitative analysis of the efficiency indicators (Section 7.3)
- Cost variations and the efficiency estimates (Section 7.4)
- Scaling up the results for national policy making (Section 7.5)

7.1 EFFICIENCY OF SANITATION IMPROVEMENTS COMPARED TO NO FACILITY

Economic analysis combines evidence of the cost and benefits of sanitation improvements. All the indicators presented here were calculated by estimating costs and benefits over a planning horizon of 20 years, and discounting future costs and benefits to the present day using a discount rate of 12%. Efficiency indicators are introduced in Section 3 and defined in the Glossary.

Table 33 summarizes the results for the rural sites under ideal and actual settings. Under ideal settings, the efficiency indicators show that all the sanitation options yield positive net benefits. The benefit-cost ratios (BCRs) were all greater than unity and the net present values (NPVs) for all the options were positive. All of the interventions also had short pay-back periods (of two years or less).

Among the various sanitation options, the most favorable BCR estimates were found for shared wet pit latrines (10.4) and private dry pit latrines (9.0). However, the finding that the private toilets with access to septic tanks had the highest NPVs (17.39 million kip or US$2,095) but a relatively low BCR (4.1) highlights the point that this is a relatively expensive option that yields a high return. The cost-effectiveness measures, which are focused more on targets associated with human health, were also most favorable to dry pit latrines, followed by wet pit latrines (shared and private). For example, cost per disability-adjusted life-year (DALY) averted for dry pit latrines was about 5.01 million kip (US$607), which is the lowest among the options considered.

The efficiency indicators discussed above were under ideal conditions. As argued in Section 4.6.4, benefits under actual conditions may be lower for reasons including poor hygiene practices and non-extensive use of the facilities that are made available to the beneficiaries. Table 33 shows that the differences were most noticeable for dry and wet pit latrines, where the BCR under actual conditions was lower than under ideal conditions by 20% and 15%, respectively.

Figure 48 illustrates the site-specific BCRs for the sanitation options at the rural sites. The graph shows that all interventions yield benefits that are higher than costs under ideal conditions. It also indicates that the highest BCR under ideal conditions is for private wet pit latrines at Site 2 (10.9). However, the BCR for shared wet pit latrines at the same site (10.7) and private dry pit latrines at Site 3 (10.4) are not very different. This suggests that the averages shown in Table 33, which favor shared wet pit latrines, are considerably influenced by inter-site differences. That is, the low estimate for private wet pit latrines compared to shared wet pit latrines is due to substantially lower BCR estimates for private wet pit latrines in Sites 4 and 6.

The findings above suggest two clear points. First, relatively high BCRs suggest that there is merit in offering low-cost technologies (i.e. dry and wet pit latrines) in rural areas. This is especially important when funds are scarce. When more funds are available however, it would be unwise to overlook toilets that have access to septic tanks. For one, the returns (4.1 in the case of Site 2) are still higher than every dollar invested. Moreover, these facilities have a high NPV. For example, the NPV for such facilities in Site 2 is slightly more than 2.5 times higher than for private wet pit latrines (see Annex Table J2). Second, site-specific conditions, even within rural areas, should be carefully examined when recommending sanitation options. This is clear from the wide range of BCRs found at the sites. It is not clear whether private facilities are superior to shared facilities. In the case of wet pit latrines at Site 2, the BCR of private facilities was higher than for shared facilities. However, the reverse is was found at Site 3.

Table 34 summarizes the results for the urban sites. Under ideal settings, the estimated BCRs and NPVs show that all the sanitation options yield net benefits. Among the various sanitation options, the most favorable and least favorable estimates were for private wet pit latrines and shared toilets with access to septic tanks, respectively. Cost effectiveness ratios were also favorable to wet pit latrines. For example, the cost per DALY averted for shared wet pits was 9.85 million kips (US$1,193), which is substantially lower than the option with the second lowest cost effectiveness ratio (private wet pit). Unlike the BCR and cost-effectiveness measures, the highest NPV was estimated for toilets that have access to sewers. This finding reflects high returns for these relatively expensive facilities.

The efficiency indicators under actual conditions were also less favorable than the estimates under ideal conditions. However, the differences are generally small, with the largest discrepancy in BCRs being about 5% for wet pit latrines.

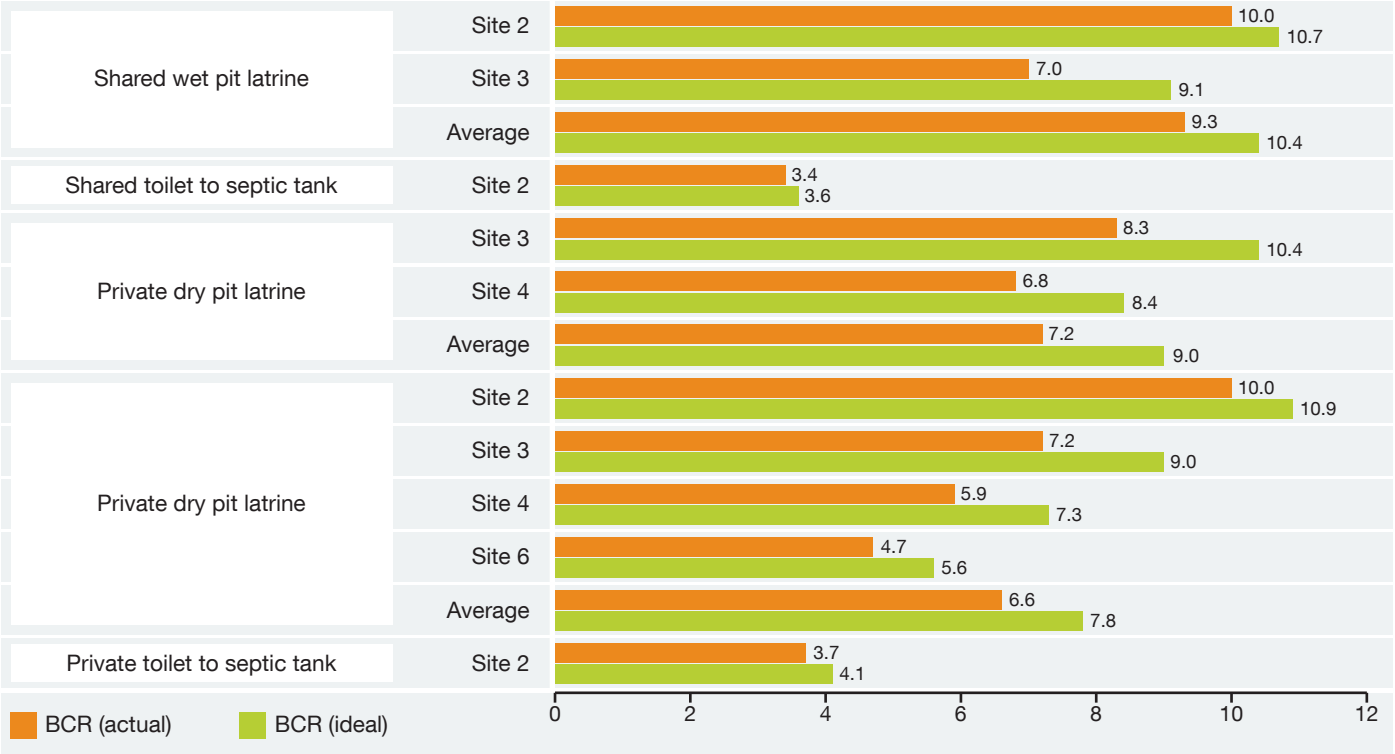
Figure 49 shows the site-specific BCRs for all sanitation options at all of the urban sites. It indicates that all interventions yield benefits that are higher than costs, and shows that private wet pit latrines at Site 1 had the most favorable BCR.

TABLE 33. RURAL AREA EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARED TO "NO TOILET"

Item	Scenario	Shared wet pit latrine	Shared toilet to septic tank	Dry pit latrine	Wet pit latrine	Toilet to septic tank
Sites		2 & 3	2	3 & 4	2,3,4 & 6	2
No of households		47	7	101	312	48
COST-BENEFIT MEASURES (WEIGHTED AVERAGE FOR SITES)						
Benefit per kip of input (kip)	Ideal	10.4	3.6	9.0	7.8	4.1
	Actual	9.3	3.4	7.2	6.6	3.7
Internal rate of return (%)	Ideal	>100	>100	>100	>100	93
	Actual	>100	>100	>100	>100	>100
Pay-back period (years)	Ideal	1	1	1	1	2
	Actual	1	2	1	2	2
Net present value (thousand kip)	Ideal	13,807	11,306	14,588	14,428	17,389
	Actual	12,174	10,175	11,385	11,885	15,426
COST-EFFECTIVENESS MEASURES (WEIGHTED AVERAGE FOR SITES)						
Cost per DALY averted (thousand kip)	Ideal	6,882	25,345	5,011	7,872	33,382
	Actual	7,050	25,400	5,534	9,935	33,454
Cost per case averted (thousand kip)	Ideal	55	186	43	62	246
	Actual	58	187	50	80	246
Cost per death averted (thousand kip)	Ideal	150,965	447,173	104,291	155,324	588,980
	Actual	151,291	448,139	120,105	199,530	590,252

Source: Annex Tables J1 to J6.

FIGURE 48. BENEFIT-COST RATIO, ALL SANITATION OPTIONS AT ALL RURAL SITES



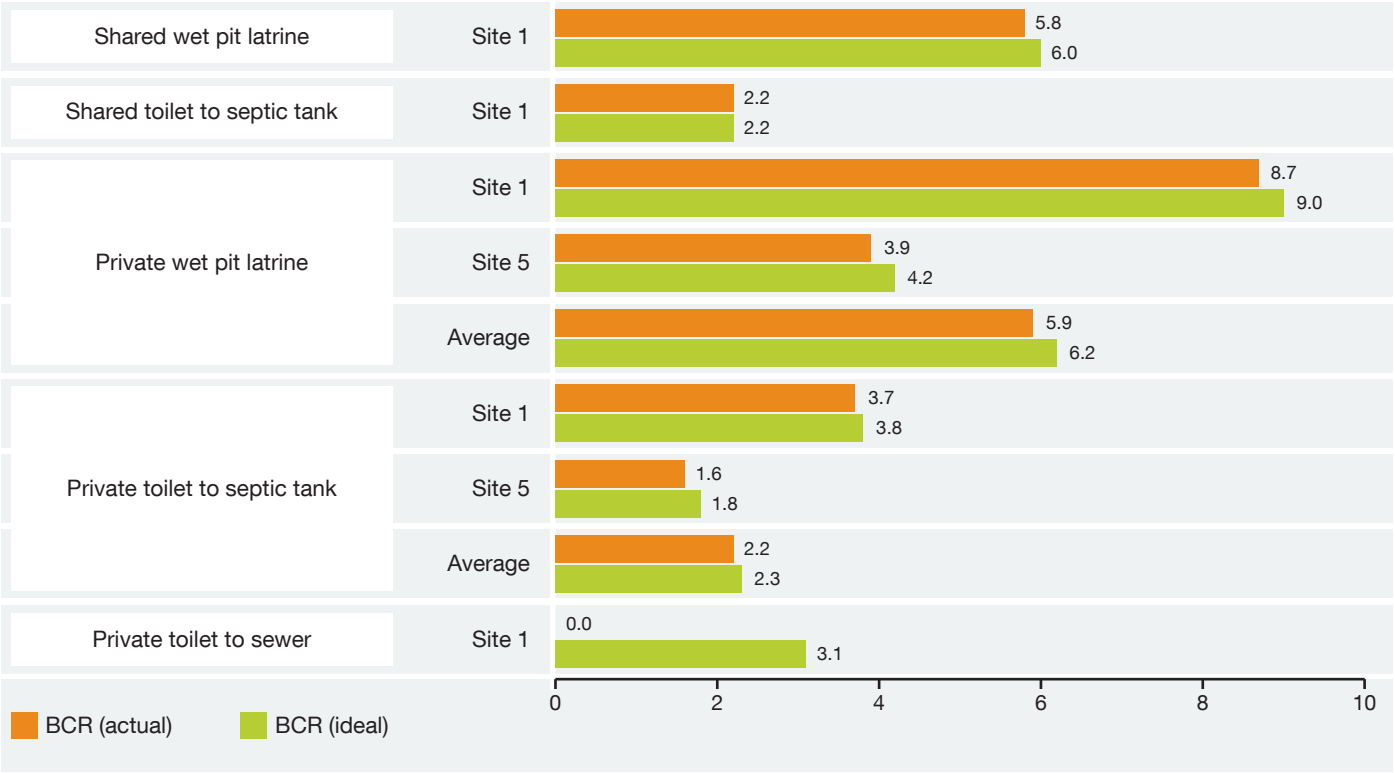
Source: Annex Tables J1 to J6.

TABLE 34. URBAN AREA EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARED TO "NO TOILET"

Item	Scenario	Shared wet pit latrine	Shared toilet to septic tank	Dry pit latrine	Wet pit latrine	Toilet to septic tank
Sites		1	1	1&5	1&5	1
No of households		7	11	169	127	12
COST-BENEFIT MEASURES (WEIGHTED AVERAGE FOR SITES)						
Benefit per kip of input (kip)	Ideal	6.0	2.2	6.2	2.3	3.1
	Actual	5.8	2.2	5.9	2.2	na
Internal rate of return (%)	Ideal	>100	>100	>100	>100	>100
	Actual	>100	>100	>100	>100	na
Pay-back period (years)	Ideal	1	2	1	2	2
	Actual	1	2	1	3	na
Net present value (thousand kip)	Ideal	7,084	4,721	12,559	9,034	16,168
	Actual	6,895	4,533	11,815	8,477	na
COST-EFFECTIVENESS MEASURES (WEIGHTED AVERAGE FOR SITES)						
Cost per DALY averted (thousand kip)	Ideal	9,852	26,120	16,028	28,751	53,832
	Actual	9,852	26,120	16,508	29,252	na
Cost per case averted (thousand kip)	Ideal	74	196	124	220	405
	Actual	74	196	128	224	na
Cost per death averted (thousand kip)	Ideal	195,511	518,317	302,279	554,087	1,068,236
	Actual	195,511	518,317	310,962	563,143	na

Note: 'na' = not applicable, because sewerage option was modeled, with no field observations
Source: Annex Tables J1 to J6.

FIGURE 49. BENEFIT-COST RATIO, ALL SANITATION OPTIONS AT URBAN SITES



Source: Annex Tables J1 to J6.

The estimates in Figure 49 suggest that differences across sites may have a significant influence on aggregate or summary results. For example, it was earlier found that toilets with access to sewers had more favorable BCRs than toilets with access to septic tanks. However, a closer examination of the values in Figure 49 suggests the contrary. It indicates that the relatively low BCR for septic tanks was influenced by the estimates for Site 5, which does not have a sewer system. When the two facilities are compared in a common location (Site 1), the BCRs are slightly more favorable to septic tanks.

A number of observations can be made from the efficiency estimates of various sanitation options in the rural and urban sites. The clearest result is the relatively high BCR for low-cost options (i.e. wet and dry pit latrines). However, this does not suggest that options higher-up the sanitation ladder (i.e. toilets with access to septic tanks or sewers), which have high NPVs, should be ignored. In addition, these findings must be treated with care because of noticeable differences in results for similar sanitation options across sites.

7.2 EFFICIENCY OF ALTERNATIVES FOR MOVING UP THE SANITATION LADDER

This section discusses the incremental net benefits of moving up the sanitation ladder. This is important for decision makers considering investments in more advanced sanitation options. The analysis is relevant to Lao PDR because there are households that already have access to sanitation options other than OD. Hence, in many cases, the key question might be to upgrade from a low cost option (e.g. dry and wet pit latrines) to more expensive technologies (e.g. toilets with septic tanks).

Table 35 presents performance indicators as rural households move up the sanitation ladder. The results vary from one improvement to the next. Based on the BCRs, the movement from shared wet pit latrines to improved facilities will generate net losses (BCR < 1). A similar conclusion can be found in the movement from private dry pit latrines to private wet pit latrines and from private toilets to septic

tanks. Such a reduction in efficiency measures, which is also observed at specific sites, is due to the relatively large increase in the costs of facilities. In contrast, the results show that a movement from shared toilets that flush to septic tanks to private facilities is likely to generate a small net gain.

Table 36 presents performance indicators associated with moving up the sanitation ladder at urban sites. While results are also mixed, these are similar to those of the rural sites in the sense that there are likely to be net losses as households move from wet pit latrines to toilets that flush to septic tanks.

TABLE 35. RURAL AREA EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER, IDEAL SETTING

From	To			
	Shared toilet to septic tank	Dry pit latrine	Wet pit latrine	Toilet to septic tank
BENEFITS PER KIP OF INPUT (IDEAL)				
Shared wet pit latrine	0.4	0.9	0.8	0.4
Shared toilet to septic tank		2.5	2.2	1.1
Dry pit latrine			0.9	0.5
Wet pit latrine				0.5
PAYBACK PERIOD (YEARS, IDEAL)				
Shared wet pit latrine	0	0	0	1
Shared toilet to septic tank		0	0	1
Dry pit latrine			0	1
Wet pit latrine				1
COST PER DALY AVERTED (THOUSAND KIP, IDEAL)				
Shared wet pit latrine	18,463	(1,871)	990	26,500
Shared toilet to septic tank		(20,333)	(17,472)	8,037
Dry pit latrine			2,861	28,371
Wet pit latrine				25,510
COST PER CASE AVERTED (THOUSAND KIP, IDEAL)				
Shared wet pit latrine	131	(12)	7	191
Shared toilet to septic tank		(143)	(124)	59
Dry pit latrine			19	203
Wet pit latrine				183
COST PER DEATH AVERTED (THOUSAND KIP, IDEAL)				
Shared wet pit latrine	316,416	(26,466)	24,567	458,223
Shared toilet to septic tank		(342,882)	(291,849)	141,807
Dry pit latrine			51,033	484,689
Wet pit latrine				433,656

Source: Annex Tables K1 to K5.

TABLE 36. URBAN AREA EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

From	To			
	Shared toilet to septic tank	Wet pit latrine	Toilet to septic tank	Toilet to sewers
BENEFITS PER KIP OF INPUT (IDEAL)				
Shared wet pit latrine	0.4	1.0	0.4	0.5
Shared toilet to septic tank		2.8	1.0	1.4
Wet pit latrine			0.4	0.5
Toilet to septic tank				1.3
PAYBACK PERIOD (YEARS, IDEAL)				
Shared wet pit latrine	1	0	1	1
Shared toilet to septic tank		(1)	0	0
Wet pit latrine			1	1
Toilet to septic tank				(0)
COST PER DALY AVERTED (THOUSAND KIP, IDEAL)				
Shared wet pit latrine	16,267	6,175	18,899	43,980
Shared toilet to septic tank		(10,092)	2,631	27,712
Wet pit latrine			12,724	37,804
Toilet to septic tank				25,081
COST PER CASE AVERTED (THOUSAND KIP, IDEAL)				
Shared wet pit latrine	122	50	145	331
Shared toilet to septic tank		(73)	23	208
Wet pit latrine			96	281
Toilet to septic tank				185
COST PER DEATH AVERTED (THOUSAND KIP, IDEAL)				
Shared wet pit latrine	322,806	106,768	358,576	872,726
Shared toilet to septic tank		(216,038)	35,771	549,920
Wet pit latrine			251,808	765,957
Toilet to septic tank				514,149

Source: Annex Tables K1 to K5.

7.3 QUALITATIVE ANALYSIS OF THE EFFICIENCY INDICATORS

The results discussed in Sections 7.1 and 7.2 should be treated with care. On the cost side, these only capture sanitation hardware; i.e. sanitation facilities. The analysis ignores program costs, which would reflect sanitation and hygiene programs, and the costs of delivering the facilities to households.

From the perspective of sanitation hardware, the results should also be interpreted as conservative estimates of net benefits, because a number of on- and off-site benefits were not included in the analysis.

The most obvious of the omitted on-site benefits are the other diseases associated with poor sanitation such as hepatitis and parasitic diseases. While these diseases on their own may not be as significant as diarrheal diseases,

their collective impact might be substantial. Neither did the analysis value the pain and suffering experienced by people who are inflicted with diseases. In the case of time savings, the quantitative analysis was confined to defecation. Time losses associated with urination among households that do not have access to sanitation facilities is an on-site benefit that was not incorporated in the analysis. More favorable efficiency estimates are also likely to be obtained if it is possible to quantify the intangibles such as comfort, prestige, privacy, cleanliness, and the safety of women and children. This can be seen from the discussion in Section 4, which showed that households with access to toilets had a higher level of satisfaction than those without.

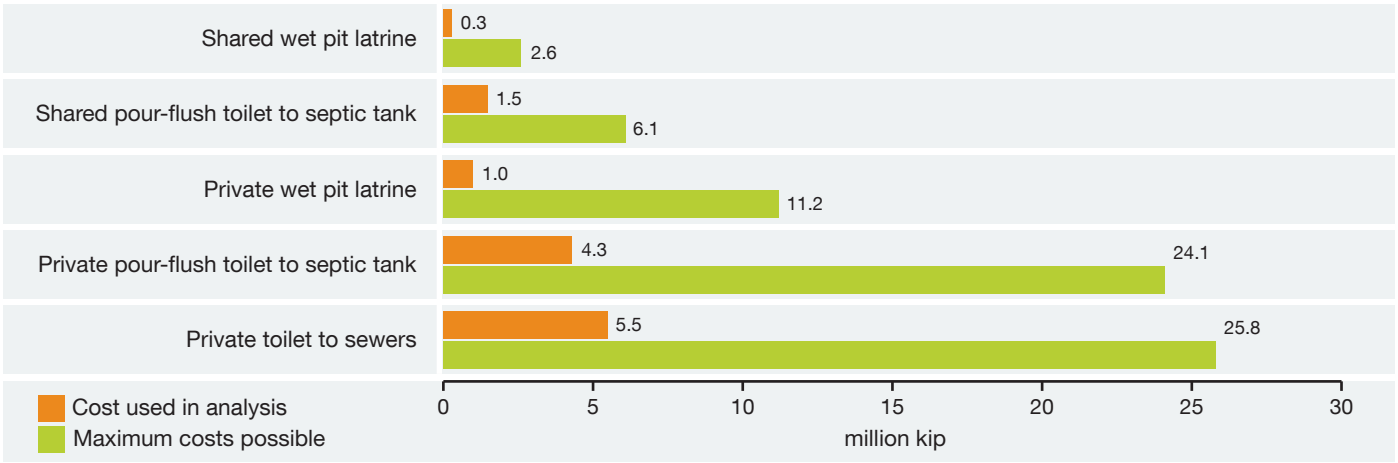
Off-site benefits include the impacts on tourism, business and aesthetics (external environment). The impacts of reduced water pollution on fisheries and the recreational uses of water are also potentially important considerations that were not quantified in this analysis. The omission of off-site benefits may have implications for the net benefits of moving up the sanitation ladder. The quantitative analysis in the previous sections indicates that toilets with access to septic tanks or sewers have net benefits that are lower than those associated with dry pit latrines and wet pit latrines. This is of course driven mostly by the fact that toilets with access to septic tanks or sewers are more expensive. However, the extent to which septic tanks are better than pits in terms of reducing pollution loads suggests that the net benefits of the former are likely to be higher.

7.4 COST VARIATIONS AND THE EFFICIENCY ESTIMATES

Costs could vary significantly within a particular technology. This could be due to differences in materials used in construction and the size of the facility itself. With a view towards identifying the upper limit for these costs, Figure 50 illustrates the economically feasible investment costs for different sanitation options at Site 1. In the case of shared toilets with access to septic tanks, for example, the present values of costs and benefits are equal to each other when investment costs are 6.1 million kip. This is about four times higher than the investment costs used in the analysis (1.5 million kip). The largest proportionate difference between the "maximum" and "actual" investment costs is for private wet pit latrines.

At this stage, it is also important to recall that investment costs per household for toilets with access to sewers were modeled rather than estimated from a field setting in Lao PDR. Specifically, the methodology used the ratio of investment costs for sewerage to septic tanks in Indonesia, where the cost of toilets with access to sewers was 1.3 times larger than the cost of toilets with access to septic tanks. In the case of the ESI study for Vietnam (Nguyen et al., 2012), this ratio was about 2.4. Applying the ratio from Vietnam to the current study suggests that investment costs for toilets with access to sewers would be about 13.3 million kip (= 4.3 million kip x 2.4). Such an assumption would still have generated a favorable BCR because the experiment here shows that investment costs for such a facility could rise up to 25.8 million kip before the BCR becomes equal to unity.

FIGURE 50. INVESTMENT COSTS THAT WILL MAKE THE BENEFIT-COST RATIO EQUAL TO UNITY AT SITE 1, MILLION KIP PER HOUSEHOLD



Source: Author's calculations

For all facilities illustrated in Figure 50, the investment costs that will make the BCRs equal to unity are larger than the values used in the analysis. Costs and quality are likely to be, other things equal, positively related, suggesting that households can continue to reap net benefits if they use more durable materials in the construction of their toilet facilities. The conclusions above are of course illustrative and simply apply to Site 1. However, the finding that the NPVs for the other sites are also positive suggests that more expensive, or larger facilities, could still be built at the other sites without reversing the conclusions about economic feasibility.

7.5 SCALING UP RESULTS FOR NATIONAL POLICY MAKING

The aim of this study goes beyond the assessment of the improvements in sanitation options at the field sites. The ultimate objective is to use the results from the sites in the formulation of national policies related to improvements in sanitation access. Field sites were carefully selected so that the results could be applied to various locations and population groups in the country.

Formulating a national policy on sanitation options is a difficult task. Limited financial resources in the light of potentially large investment in sanitation options cannot be ignored. The sustainability of such investment in terms of maintenance and operation over time should also be considered. Moreover, it is unlikely that a single sanitation option fits all settings.

An important finding of this study is that low-cost sanitation options yield net benefits and have relatively short payback periods. This is exemplified by the findings for dry pit latrines at Sites 3 and 4. In Site 2 and all the urban sites, where dry pit latrines were not evaluated, wet pit latrines had the most favorable net benefits. These examples suggest that sanitation interventions do not necessarily have to be for expensive options. This point becomes very important when taken in the context of the limited budgets of the government, donor agencies and civil society.

Low-cost facilities clearly offer a viable option to meet short-term needs in the face of scarce resources. However, longer-term solutions such as wastewater and septage treatment facilities should not be ruled out altogether. While these facilities were not evaluated in the study, their capacity to reduce pollution, especially in urban areas, could result in benefits that go beyond the households themselves. For example, the potential reduction in the amount of untreated waste flowing directly into water bodies could improve the ability of these resources to provide services (e.g., recreation and fishing).

7.6 SUMMARY

As a whole, the study found that there were net benefits for all the interventions considered at the sites. These were shown by BCRs that are greater than unity and positive NPVs. Net benefits were generally higher for low-cost technologies, particularly dry and wet pit latrines in rural areas and wet pit latrines in urban areas. Low-cost sanitation options also tend to have lower costs associated with given health targets (cost-effectiveness ratios) and faster payback periods. However, the NPVs were in many cases larger for technologies located higher up in the sanitation ladder (septic tanks and sewers). Efficiency indicators under actual settings also tend to be less favorable than under ideal settings.

There are of course many sources of uncertainty. The net benefits calculated in the study might actually be underestimated. Intangible benefits such as comfort, prestige and the personal safety of women and children were not quantified in the analysis. Benefits that accrue outside the household (national benefits) such as aesthetics, tourism, business and water (fisheries and other uses of inland waters) were also excluded from the quantitative analysis. Since these benefits might be more significant to sanitation options at the top of the ladder the net gains from such interventions are higher than the values estimated here. It is also important to note that the omission of program costs from the analysis suggests that the results apply strictly to sanitation facilities. They do not cover the costs of delivering such facilities to the beneficiaries.

VIII. Discussion

8.1 STUDY MESSAGES AND INTERPRETATION

8.1.1 MAIN MESSAGES

The key finding of the study is that there are net benefits associated with all of the interventions evaluated. The benefit-cost ratios (BCRs) were greater than one for all interventions, ranging from 2.2 (shared toilets that flush to septic tanks in urban areas) to 10.4 (shared wet pit latrines in rural areas). In most cases, net benefits are less favorable as households move up the sanitation ladder. In general, this is explained by higher incremental costs compared to incremental benefits. However, some care must be exercised in interpreting the results because of differences in site-specific conditions (e.g. incomes and initial disease rates). In addition, benefits not included in the study could have made the results for sanitation interventions more favorable. These include intangible benefits (e.g. comfort, prestige, privacy status and safety), environmental benefits and impacts on tourism and business.

It is important to note that many of the quantified benefits are not financial (i.e., they go beyond a reduction in out-of-pocket expenses due to poor sanitation). Gains in terms of averted health-related productivity and mortality loses, and lost productive time due to accessing toilets are largely non-financial in nature. The only clear financial gains are the potential for reduced healthcare expenditure (treatment and medication) and savings on water treatment and purchased water. These savings will vary depending on environmental and socio-economic contexts, and hence on whether reductions in environmental pollution affects water sourcing behavior.

Improved sanitation generates benefits to society that go beyond potential healthcare savings to households and the government. The contribution of sanitation investment to a cleaner environment, particularly water resources, benefits society as a whole. The gains come in the form of lower clean-up costs and the potential increase in the use of water resources for activities such as fishing and recreation. Even larger benefits to the community and to the country as a whole could arise if the cleaner environment and water resources contribute to higher tourist revenues and lower business costs. All of this suggests the importance of the participation of the government and NGOs in addressing the problem of sanitation. Such participation is not limited to funding sanitation projects but also includes campaigns to increase awareness of the importance of proper sanitation and hygiene.

8.1.2 ROBUSTNESS OF RESULTS

There are uncertainties surrounding the value of the inputs used in the quantitative analysis. The main sources of uncertainty include (text in parentheses indicates the basis for the actual values used in the analysis):

- Value of productive time (estimated provincial GDP per capita)
- Value of premature death (human capital approach)
- Proportion of productive time lost per day due to poor sanitation (30% of hourly value of GDP per capita for adults and 15% for children under the age of five years)
- Disease incidence and mortality rates (WHO estimates)
- Cost of sanitation options (literature search, expert opinion, surveys)
- Discount rate (World Bank and literature search)

Uncertainties arise because of the presence of alternative values that could have been used in the analysis. This is the case for productive time and premature death. Another reason is the absence of rigorous studies to support the values used in the analysis – proportion of productive time used per day. There might also be instances in which the values are available but not precise or specific enough in terms of the study sites (provincial GDP and WHO disease rate) and the period of analysis being different from the availability of secondary data (WHO disease rates). Finally, there are estimates that by nature exhibit wide variance – e.g. cost of sanitation options. Some of these uncertainties are partially addressed by the estimation of costs and benefits at six different sites, and under ideal and actual scenarios. However, it is useful to examine how sensitive the results are to changes in these variables.

Table 37 illustrates the impacts on the BCRs of different sanitation options at Site 1 under alternative scenarios. The procedure involves changing an assumption in the analysis and recalculating the BCR. Site 1 was chosen because it has the widest range of sanitation options evaluated in the study.

Three experiments are expected to have a negative impact (i.e., to reduce the BCR), on the economic feasibility of the different options in Site 1. These are: (a) using national GDP estimates; (b) increases in investment and/or recurrent costs; and (c) increases in the discount rate. For example, the use of national GDP reduced the benefit-cost ratio of shared wet pit latrines at Site 1 from 6.0 to 3.6. This represents an approximate 40% decline in the returns for wet pit latrines for each kip invested in the facility. It is important to note that the negative impact of using national GDP is confined to Site 1 and other locations with GDPs that are higher than the national average.[32] For sites with a provincial GDP of lower than the national average, one could expect a rise in the BCRs of all the facilities.

TABLE 37. BENEFIT-COST RATIOS OF INTERVENTIONS IN SITE 1 UNDER ALTERNATIVE ASSUMPTIONS, BENEFITS PER KIP INVESTED[a]

Scenario	Shared		Private		
	Wet pit latrine	Toilet to septic tank	Wet pit latrine	Toilet to septic tank	Toilet to sewer
Baseline	6.0	2.2	9.0	3.8	3.1
Scenario					
Using national GDP instead of "provincial GDP"	3.6	1.3	4.2	1.8	1.5
100% of time for adults and 50% of time for children (people under 15 years)	14.9	5.6	26.9	11.4	8.8
10% increase in diarrheal incidence rates	6.1	2.3	9.0	3.8	3.1
10% increase in incidence rates of all diseases	6.2	2.3	9.1	3.9	3.1
10% increase in diarrheal mortality rates at same incidence rates	6.0	2.3	9.0	3.8	3.1
50% increase in investment costs	4.4	1.9	6.4	2.9	1.8
50% increase in recurrent costs	5.2	1.7	8.2	3.2	2.0
50% increase in investment and recurrent costs	4.0	1.5	6.0	2.5	1.4
Discount rate is half	7.1	2.8	10.1	5.0	4.1
Discount rate is double	5.4	1.9	7.6	2.7	2.2

[a] Annex Table K6 provides estimates of the net present values for the different scenarios

[32] In the current study, Site 3 (Vientiane Province) had an estimated provincial per capita GDP of about 93% of the national average. The other sites (2, 4, 5, and 6) had a provincial GDP per capita that was slightly above the national average.

Table 37 shows that none of the alternative scenarios caused the BCRs to be less than one. In other words, the sanitation options continue to be favorable. However, there are some areas that require closer inspection. One is the sensitivity of the values to changes in the income estimates. For example, the 62% drop in the opportunity cost of time due to the use of the national GDP estimate caused a 54% decline (from 3.8 in the baseline to 1.8 in the scenario) in the BCR of toilets to septic tank. Recurrent and investment costs were also relevant for toilets to sewers. For such facilities, a 50% increase in recurrent and investment costs led to a 56% decline (from 3.1 in the baseline to 1.4 in the scenario) in the BCR of the facility.

The simulations also highlight the importance of properly valuing the time of adults and children. The current analysis assumes that adult time is valued at 30% of their income while the time of children is about half of adult time. Valuing adult time at 100% of their income will raise the BCRs of the different options by at least 150% (for shared wet pit latrines). This finding highlights the point that current income assumptions are conservative.

8.2 UTILIZATION OF RESULTS IN DECISION MAKING

8.2.1 POTENTIAL USES OF RESULTS

The results of the study have many uses in the decision-making processes in the sanitation sector. These can be used as a source for advocacy in sanitation improvements. In particular, these can be used to emphasize the benefits associated with improved sanitation and the net benefits associated with various sanitation options. Such advocacy can target households in terms of investing in toilets. Equally important is convincing government, donors, and other institutions of the importance of investment in basic sanitation facilities and off-site treatment facilities, and in designing programs to promote behavior change.

The findings and study approach can also be used in selecting the appropriate sanitation interventions for various sites. This is particularly important in identifying the technologies that will yield the highest net returns in the long term. Where funds are scarce, the study shows that there are net benefits from investment in low-cost sanitation technologies. However, since many of these low-cost technologies have shorter estimated useful lives, it must be emphasized that such choices are likely to be more suitable to meeting short-term considerations.

The results of this study provide valuable inputs for a national analysis of sanitation options and the formulation of plans to meet national targets. As inputs for a national analysis, the results could be used to evaluate and select between options in various settings. The framework and, to a limited extent, the assumptions and data used here could also be adopted for settings or technologies that were not covered in the study.

8.2.2 TRANSLATING EVIDENCE INTO ACTION

The results of this study are useful to various groups. Stakeholders in the water and sanitation sector can use them for strategic plans and the formulation of budgets. The results of the cost-benefit and cost-effectiveness analyses can assist in deciding on the appropriate technologies for different settings in the country. The cost estimates can also provide valuable inputs to the formulation of budgets.

The results can be used by government agencies involved in making plans for the sector and in implementing sanitation projects. These agencies include: the Water Resources and Environment Administration (WREA); Water Resources and Environment Office; Ministry of Public Works and Transport (MPWT); Public Works and Transport Institute of MPWT; Provincial Department of Public Works and Transport; District Office of Public Works and Transport; Provincial Nam Papas (a state-owned urban service provider); Urban Development and Administration Authorities; Ministry of Health; Provincial Public Health Department; and National Center for Environmental Health and Water Supply (Nam Saat). The study results can assist donors and NGOs in their collaboration with national government agencies and local government units, to the extent that they are consulted in the planning process. The results are also highly relevant in the selection and design of projects of these donors and NGOs.

The results of the study can also be used to sensitize other institutions like the media about the impact of sanitation improvements and the various sanitation options. This helps in advocacy, which may eventually increase the awareness of households of the costs and benefits of sanitation improvements.

8.2.3 INTEGRATING ECONOMIC CONSIDERATIONS INTO A DECISION MAKING PROCESS

In real life, many factors influence decisions. Some are evidence-based while others are related to political decision making. The study shows how economic analysis, in terms of quantifying costs and benefits and eventually calculating net benefits, can be used to generate decision-making aids. The analysis could be extended for a broader analysis of options. As in multi-criteria analysis, such an exercise may require an extensive set of criteria. These criteria may include the availability of resources, selection of the appropriate implementation and financing approaches, environmental factors, and the acceptability and willingness of the target beneficiaries of sanitation programs.

8.3 DELIVERING SANITATION IMPROVEMENTS TO TARGET BENEFICIARIES

8.3.1 KEY APPROACHES IN THE DELIVERY OF SANITATION IMPROVEMENTS

There are many instances in which improvements in sanitation facilities can only be made available through projects or programs implemented by the government (national and local), donor agencies, private firms and NGOs. The households without latrines or toilets are likely to be poor and will have difficulty in paying for such facilities. Off-site treatment facilities often require investment outlays that are beyond the means of households in the community. In addition, the fact that these facilities benefit communities rather than just one household raises questions about how the investment outlays will be financed or distributed among the potential beneficiaries.

There are many ways in which access to improved sanitation facilities has been delivered to households and communities. There are two important dimensions in this process – financial and implementation approaches.

Financial approaches refer to the manner in which funds are provided. These include direct payments for the provision of software and hardware, leveraging funds from other sources, and the use of subsidies to encourage the beneficiaries to contribute to the investment. A discussion of these subsidies is provided in Evans et al (2009).[33]

Implementation approaches are concerned with the way in which projects and programs facilitate the delivery of sanitation interventions to target beneficiaries. These approaches can be classified as: (a) Community-Led Total Sanitation (CLTS); (b) sanitation marketing; (c) informed choice; (d) supply-driven approach; and (e) strategic urban sanitation.[34] Implementation approaches may also be accompanied by measures that motivate hygiene behavior change. It is important to note that a specific project or program may include a mix of the elements of the aforementioned approaches.

Sanitation programs and projects may also involve partnerships, or agreements between two or more stakeholders to share knowledge, skills and responsibilities. Such partnerships may be at the level of implementation and financing, and may involve collaboration between the government and the private sector or different levels of government. For example, it is possible to have a financing partnership in which one group provides funding while another implements the project.

8.3.2 PROGRAM APPROACHES IN LAO PDR

This study initially considered reviewing 17 of the many programs in Lao PDR, dating back as far as 1996. However, this was reduced to six because of the lack of available information. The programs reviewed for this study are:[35]

- Northern and Central Regions Water Supply and Sanitation Sector Project (NCRWSSSP)
- Houaphanh Health Development Program (HHDP)
- Primary Health Care Program Phase II (PHCP2)
- Water and Sanitation Projects in Meun and Nan Districts (WSPMN)
- Environmental Sanitation Upgrading Project (ESUP)
- Strengthening National Water Supply and Sanitation Strategy Program (SNWSP)

[33] The subsidies are also summarized in Rodriguez et al. (2011).
[34] A short description of these approaches is provided in Annex 1 of Rodriguez et al. (2011).
[35] Annex Table K7 provides basic information about these projects. Some of the acronyms used in this study were supplied by the authors.

Four of these projects were implemented in villages or districts or provinces relevant to the study sites. These were the WSPMN (Sites 3 and 5), ESUP (Hatsady Tai village in Site 1), SNWSP (Site 6) and NCRWSSSP (multiple locations including Site 5). However, many of the households in the ESI survey were unaware that they were beneficiaries of these projects.

The oldest of the above projects (SNWSP and PHCP2) began in 2003, while the most recent (WSPMN) started in 2009. Most of the projects have finished (as late as 2010 for NCRWSSSP and ESUP, while the HHDP was scheduled for completion in 2012). These projects were funded externally. Five were funded by donor agencies while one (ESUP) received funding support from the Asian Institute of Technology. The projects were implemented by government agencies, which in four cases involved staff from the Center for Environmental Health and Water Supply (Nam Saat) of the Ministry of Health. However, government agency implementation of projects was generally supported by the funding agencies.

All of these projects had water supply and/or sanitation components. With the exception of the HHDP, the projects provided hardware (Annex Table K7). PHCP2 and ESUP also provided software.

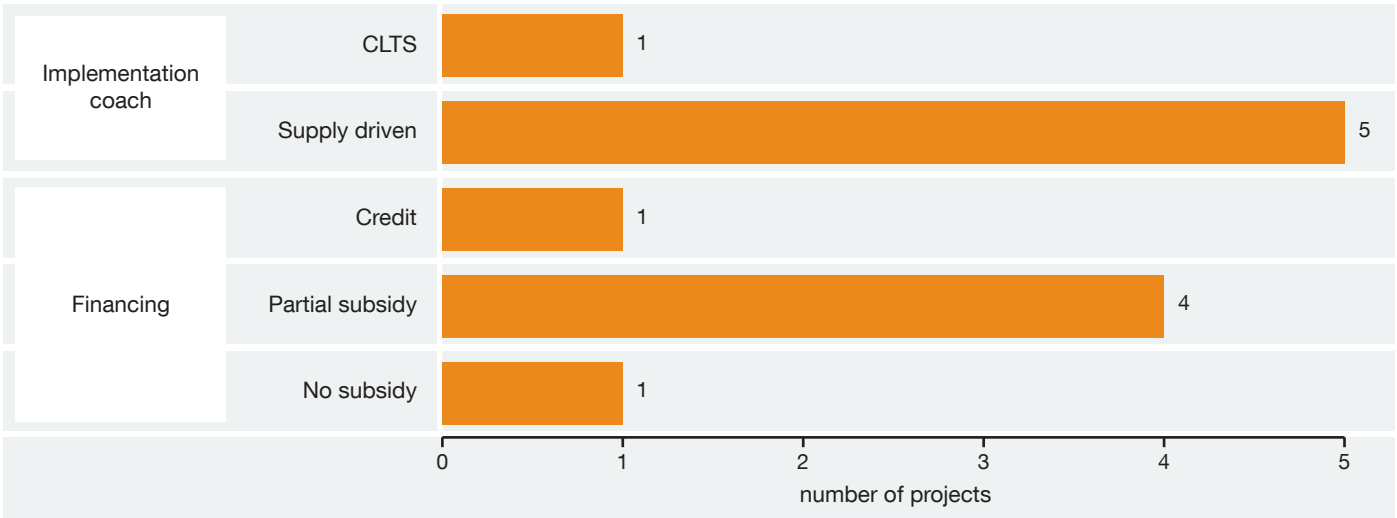
Figure 51 summarizes the implementation and financing approaches and partnerships involved in the projects reviewed in the study. It indicates that the supply-driven implementation approach was the most common practice. Only HHDP used the CLTS approach in the implementation of the project. Most projects also provided partial subsidies.

8.3.3 A CALL FOR A MORE THOROUGH ASSESSMENT OF APPROACHES

A thorough assessment of the program approaches has been very difficult to conduct in Lao PDR due to a lack of project documentation evaluating implementation and impact, especially after project completion. In addition, very few projects were examined here, which restricts the ability of this study to make reliable inferences. Without a doubt, evaluating the effectiveness of the approaches is important in order to ensure that the target beneficiaries get the most from programs. It is also essential to avoiding mistakes committed in previous projects.

Given this lack of program evaluation, this paper makes a call for further studies in the evaluation of the various implementation and financing approaches in the sanitation sector of Lao PDR. Such studies could include developing a clear and robust framework and indicators with which the approaches could be evaluated and compared.

FIGURE 51. IMPLEMENTATION APPROACHES AND PARTNERSHIPS IN THE SELECTED PROJECTS



Source: Annex Table K7

IX. Recommendations

This section outlines the key recommendations of the study. Many of these recommendations are not new to stakeholders in Lao PDR; however, they are reiterated on the strength of the findings of the current study. While not directly drawn from the study, it is important to emphasize that there is an urgent need to increase access to improved sanitation in Lao PDR. This can be seen clearly from JMP statistics for 2010 which indicate that about 4 in 10 people (37%) in the country did not have access to improved sanitation facilities. This is further supported by evidence that the economic costs of poor sanitation are substantial.[36]

Recommendation 1: The sanitation options made available to the population should focus on affordability

Accomplishing increased access to improved sanitation does not require expensive toilet facilities. This study found that the highest net returns were for wet and dry pit latrines in rural areas, and wet pit latrines in urban areas.

Shared toilets can also provide improved access for families, compared with the alternative – open defecation. From an economic perspective, shared toilets are also economically attractive. In locations where space and funds are a constraint, these facilities may continue to offer a practical alternative to a private toilet (one toilet per household).

Recommendation 2: The country's efforts should be focused on increasing access to improved sanitation in rural areas

As of 2010, only about half of the people living in rural areas had access to improved sanitation. Open defecation was also rampant, practiced by about 4 in 10 people in rural areas. If current trends continue, about 2 out 3 people in these areas will have access to improved sanitation by 2015.

Allocating scarce resources to rural areas is essential for a number of reasons. First, access to improved sanitation in urban areas is already quite high. Second, rural areas are home to nearly 70% of all households in the country. Third, the estimates in Section 7 show that the benefit-cost ratios (BCRs) for specific sanitation options in rural areas were higher than their counterparts in urban areas. This was due to a combination of poorer health (and hence greater capacity to benefit), and because on average, the sanitation options were less expensive. Fourth, as indicated in Recommendation 1, sanitation investment in rural areas does not have to be focused on expensive options.

The first two of these reasons suggest that there is little room for improving access to sanitation in urban areas, and that increases in sanitation coverage in rural areas are likely to have a larger impact at national level. The third reason is based on the finding that, from a purely economic perspective, the return on every dollar invested in rural areas

[36] Estimates made by Hutton et al. (2009) showed that annual costs of poor sanitation in the country amounted to about US$193 million or 5.6% of GDP in 2006. Since the estimates were based on sanitation coverage rates for 2006, when only 45% of households had access to improved sanitation, it can be asserted that improvements in sanitation coverage through 2010 mean that the economic impacts could already be significantly lower. While this statement may be true, it is still very likely that the costs are quite large. Estimates in Section 5.3 show that the health-related costs associated with the 2010 sanitation coverage rates were 1,312 billion kip (US$157 million). This is still about 2.4% of 2010 GDP and ignores other impacts included in the study by Hutton et al. (2009).

is higher than in urban areas. The fourth reason implies that, given a constrained national budget, more households could be provided with access to improved facilities in rural areas than in urban areas.

These points do not suggest that investment in urban areas should be abandoned altogether. For one thing, 11% of the urban population still does not have access to improved sanitation. However, investment in urban areas may have to go beyond latrines and more into off-site treatment facilities. These facilities, according to Baetings and O'Leary (2010), are still in short supply even in cities such as Vientiane. However, due to higher average incomes in urban areas, household as well as private sector investment should be sought before resorting to government budgets.

Recommendation 3: The government, donor agencies and other institutions will continue to have an integral role in increasing access to improved sanitation.

Information from the World Bank shows that one-third of the Lao population lives on less than 1.25 international dollars a day, and two-thirds of the population live on less than 2 international dollars a day. As the households with no access to improved sanitation facilities are likely to belong to this segment of the population, the government, donor agencies and other institutions will continue to play an important role in increasing access to improved sanitation. The role of these institutions could be in funding and implementing large scale behavior change programs, and in assisting and/or funding innovative market-based instruments that can facilitate the provision of such facilities to the poorest populations.

This argument is further supported by the findings from the focus group discussions (FGDs) where respondents cited economic reason for not having a toilet. However, some care must be exercised in the manner in which institutions participate in increasing access to improved sanitation. The FGDs and household survey in the current study found that respondents at all sites cited "never offered a toilet" as a reason for not having such a facility. This response creates the impression that households seem to be waiting for an intervention rather than trying to address sanitation problems on their own. Along with the finding that only half of the respondents in the survey claimed to have washed their hands after defecating, this underscores the need for evidence-based behavior change approaches that emphasize the potential benefits that can be realized through improved sanitation. While the results of this study can feed into such advocacy efforts, further research is needed to understand the demand side of sanitation. Such research could include studies of household preferences, motivations and challenges with respect to the acquisition of different sanitation options.

Recommendation 4: Further research and evidence on the impact of poor sanitation

Following the limitations cited in Section 8, there is clearly a need for more research in the sanitation sector. These studies could include:

- Generating more specific information on access to sanitation facilities. The current practice involves collecting information on the facilities available to households. There is no national information on the state of existing facilities (i.e., whether these facilities are functioning properly, and the actual service levels they provide). There is also very little information on whether the design of such facilities conforms to pre-determined specifications, as might be the case with septic tanks.
- Generating reliable site-specific and age-group-specific incidence and mortality rates for sanitation-related diseases such as diarrhea and helminths. Value of statistical life estimates for Lao PDR will also enhance estimates of the value of premature death associated with poor sanitation.
- Establishing rigorous and site-specific or at least country-specific quantitative links between sanitation and: (a) disease incidence (attribution factors); (b) tourism; (c) water use and access; (d) water quality; (e) environment; and (f) business activity. This involves identifying a rigorous methodology and estimates for establishing the magnitude of the benefits associated with improved sanitation, and if possible, with specific sanitation options. This can be relevant especially in the case of treatment systems that are likely to cause an improvement in the

quality of bodies of water and the environment as a whole. The improvements associated with these resources could in turn translate into a clearer understanding of the benefits to tourism and business activities.

- Establishing stronger evidence of the performance of projects in actual settings, and the various implementation and financial approaches of such activities. A critical first step in this exercise is the proper recording and compilation of the documents from such projects. This documentation should be limited to project completion reports and also monitoring the impact of the project well beyond its completion.
- In selecting between the specific options, decision makers must be cognizant of the initial conditions of the target beneficiaries. This understanding is essential to increasing the success and sustainability of the option chosen. This is supported by the finding of the study that an option could have divergent efficiency indicators in different sites. For example, the BCRs from shared wet pit latrines were found to be higher than for private wet pit latrines in rural areas. However, the reverse was true for urban areas. From the perspective of project implementers, this highlights the need for pre-project assessment. On the other hand, the government can help project implementers by strengthening information systems at potential project sites.

References

ADB [Asian Development Bank]. 2011. *Key Indicators for Asia and the Pacific 2011: Lao People's Democratic Republic*. Downloaded on 17 December 2011 from www.adb.org/statistics.

Baetings, E. and D. O'Leary. 2010. *Rapid Assessment of Household Sanitation Services: Vientiane, Lao PDR*. Water and Sanitation Program, World Bank, December.

Boardman, A. D. Greenberg, A. Vining and D. Weimer. 2006. *Cost-Benefit Analysis: Concepts and Practice*. 3rd ed., Prentice-Hall, New Jersey.

Brooker, S., P. Singhasivanon, J. Waikagul, S. Supavej, S. Kojima, T. Takeuchi, T. Luong and S. Looareesuwan. 2003. Mapping soil-transmitted helminthes in Southeast Asia and implications for parasite control. *Southeast Asian Journal of Tropical Medicine and Public Health*. 34(1): 24-36.

Colins, J. 2011. *Scaling Up Rural Sanitation Project, Piloting CLTS in Southern PDR: Lessons and Prospects*. Unpublished manuscript. August.

Conlan, J., B. Khamlome, K. Vongxay, A. Elliot, L. Pallant, B. Scripa, S. Blacksell, S. Fenwick and A. Thompson. 2012. Soil-transmitted helminthiasis in Laos: A community-wide cross-sectional study of humans and dogs in a mass drug administration environment. *American Journal of Tropical Medicine and Hygiene*. 86(4): 624-634.

Curtis, V., L. Danguah and R. Aunger. 2009. Planned, motivated and habitual hygiene behavior: an eleven country review. *Health Education Research*. 24(4): 655-673.

Esrey, S. A. and J.-E. Habicht. 1986. Epidemiologic evidence for health benefits from improved water and sanitation in developing countries. *Epidemiology Review*. 8:117-28.

Esrey, S. A., R. Feachem and J. Hughes. 1985. Interventions for the control of diarrheal diseases among young children: Improving water supplies and excreta disposal facilities. *Bulletin of the World Health Organization*. 63(4):757- 772.

Esrey. S. A., J. B. Potash. L. Roberts and C. Shiff. 1991. Effects of improved water supply and sanitation on ascariasis, diarrhea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bulletin of the World Health Organization*. 69(5):609-21.

Evans. B., C. van der Voorden and A. Peal. 2009. *Public Funding for Sanitation: The Many Faces of Sanitation Subsidies*. Water Supply and Sanitation Collaborative Council, Geneva, Switzerland.

Fewtrell. L., R. B. Kaufmann, D. Kay, W. Enanoria, L. Haller and J. M. Colford. 2005. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: A systematic review and meta-analysis. *Lancet Infectious Diseases*. 5(1):42-52.

Gerard, P. 2004. *Integrating Wetland Ecosystem Values into Urban Planning: The Case of That Luang March, Vientiane, Lao PDR*. The World Conservation Union Asia Regional Environmental Programme and World Wildlife Fund Lao Country Office, Vientiane.

Giltner, S., P. Dutton and P. Kouangpalath. 2010. *Lao PDR Sanitation and Hygiene Financing Study*. Water and Sanitation Programme, World Bank.

Gramlich, E. 1998. *A Guide to Benefit-Cost Analysis*. 2nd edition. Prentice Hall (re-issued by Waveland Press), New Jersey.

Hortez, P., D. Bundy, K. Beegle, S. Brooker, L. Drake, N. de Silva, A. Montressor, D. Engels, M. Jukes, L. Chitsulo, J. Chow, R. Laxminarayan, C. Michaud, J. Bethony, R. Correa-Oliviera, X. Shuhua, A. Fenwick and L. Savioli. 2006. Helminth infections: Soil transmitted heminth infections and schistosomiasis. Chapter 24 in D. Jamison, J. Breman, A. Measam and others (editors). *Disease Control Priorities in Development Countries*. World Bank, Washington D.C.

Hortez, P., N. de Silva, S. Brooker and J. Bethony. 2003. *Soil Transmitted Helminth Infections: The Nature, Causes and Burden of the Condition*. Disease Control Priorities (DCCP) Working Paper No. 3, Fogarty International Center, National Institute of Health, Maryland.

Hutton, G., U. Rodriguez, A. Winara, A. Nguyen, S. Heng, P. Kov, L. Chuan, I. Blackett, A. Weitz. 2012. *Economic assessment of sanitation interventions in Southeast Asia*. World Bank, Water and Sanitation Program.

Hutton, G., B. Larsen, L. Leebouapao and S. Voladet. 2009. *Economic Impacts of Sanitation in Lao PDR*. Water and Sanitation Program, World Bank.

Hutton, G., U. Rodriguez, L. Napitupulu, P. Thang and P. Kov. 2008. *Economic Impacts of Sanitation in Southeast Asia*. Water and Sanitation Program. World Bank.

JMP [Joint Monitoring Programme]. 2008. *Progress on Sanitation and Drinking-Water 2008 update*. WHO and UNICEF.

JMP. 2010a. *Estimates for the Use of Improved Sanitation Facilities: Lao People's Democratic Republic*. wssinfo.org

JMP. 2010b. *Progress on Sanitation and Drinking-Water 2010 update*. WHO and UNICEF.

JMP. 2012. *Progress on Sanitation and Drinking-Water 2012 update*. WHO and UNICEF.

Kwon, K. 2005. *Financial Feasibility of Composting Market Waste in Vientiane, Lao PDR*. Master's Thesis, Department of Civil Engineering, University of Toronto.

Lao Statistical Bureau. Undated-a. *Population Census 2005*. Downloaded on 26 November 2011 from http://www.nsc.gov.la/index.php?option=com_content&view=article&id=18&Itemid= 19&showall=1

Lao Statistical Bureau. Undated-b. *Population Census 2005*. Downloaded on 24 May 2012 from http://www.nsc.gov.la/index.php?option=com_content&view=article&id=37:population &catid=6&Itemid=38

LNTA. 2010. *2009 Statistical Report on Tourism in Laos*. Lao National Tourism Administration, Vientiane, Lao PDR.

Nguyen, V.A., G. Hutton, H.T. Lan, P. Dan, L.T. Hoa and B. T. Nhung. 2012. *Economic Assessment of Sanitation Interventions in Vietnam*. Water and Sanitation Program, World Bank.

Pholsena, S., K. Yasui, R. Jogo and M. Fukuda. 2003. Project evaluation method of study on improvement of roads in the southern region of Lao PDR. *Journal of the Eastern Asia Society for Transportation Studies*. 5(October): 3000-3014.

Prüss A. and S. Mariotti. 2000. Preventing trachoma through environmental sanitation: a review of the evidence base. *Bulletin of the World Health Organization*. 78:258-66.

Rodriguez U., G. Hutton, N. Jamora, D. Harder, J. Ockelford and E. Galing. 2011. *Economic assessment of sanitation interventions in the Philippines*. Water and Sanitation Program, World Bank.

UNICEF. 2010. *At a Glance: Lao People's Democratic Republic*. United Nations Children's Fund. Downloaded 26 November 2011 from http://www.unicef.org/infobycountry/laopdr_ statistics.html.

Waddington. H, B. Snilstveit, H. White, and L. Fewtrell. 2009. *Water, Sanitation and Hygiene Interventions to Combat Childhood Diarrhoea in Developing Countries*. The International Initiative for Impact Evaluation (3ie). Synthetic Review 001, August.

WEPA. Undated. *State of Water Environment, Water-related Issues and Policies*. Water Environment Partnership in Asia. Downloaded 14 March 2012 from http://www.wepa-db.net/policies/state/laos/overview.htm.

WHO. 2008. *The Global Burden of Disease: 2004 Update*. World Health Organization, Geneva.

WHO. 2011a. *World Health Statistics*. World Health Organization, Geneva.

WHO. 2011b. *World Health Survey: Report of Lao People's Democratic Republic*. Downloaded on 19 December 2011 from http://www.who.int/healthinfo/survey/whsresults/en/index6.html

Winara, A., G. Hutton, Oktarinda, E. Pumomo, K. Hadiwardoyo, I. Merdykasari, T. Numadi, B. Bruinsma, D. Gunawan, D. Fadilah and M. Albrecht. 2011. *Economic assessment of sanitation interventions in Indonesia*. Water and Sanitation Program, World Bank.

World Bank. 2011a. *World Development Indicators: Real interest rate (%)*. Downloaded on 17 December 2011 from http://data.worldbank.org/indicator/FR.INR.RINR.

World Bank. 2011b. *World Development Indicators: GDP per capita (current US$)*. Downloaded on 17 December 2011 from http://data.worldbank.org/indicator/ NY.GDP.PCAP.CD.

World Bank. 2011c. *World Development Indicators: Poverty headcount ratio at $1.25 a day (PPP) (% of population)*. Downloaded on 17 December 2011 from http://data.worldbank.org/indicator/ SI.POV.2DAY.

WTTC. 2011. *Travel and Tourism Economic Impact 2011: Laos*. World Travel and Tourism Council, London, U.K.

ANNEX A

TABLE A1: SANITATION COVERAGE BY REGION, % OF HOUSEHOLDS, 2011

Province	Improved toilet	Unimproved toilet	No toilet (open defecation)
NORTH	**61.3**	**5.1**	**33.6**
Phongsaly	34.1	4.1	61.8
Luang Namtha	67.3	0.1	32.6
Oudomxay	44.2	8.9	46.9
Bokeo	69.3	0.2	30.5
Luang Prabang	58.6	2.1	39.3
CENTER	**67.8**	**1.8**	**30.4**
Huaphanh	58.8	12.5	28.7
Sayaboury	89.7	3.5	6.8
Xiengkhuang	54.1	12.6	33.3
Vientiane	88.2	1.7	10.1
Vientiane Capital	97.9	0.7	1.4
Bolikhamxay	84.0	0.4	15.6
Khammuane	42.1	0.9	57.0
SOUTH	**34.8**	**2.0**	**63.2**
Savannakhet	43.0	0.4	56.5
Saravane	22.3	0.2	77.5
Sekong	37.7	10.1	52.1
Champasak	43.2	1.0	55.8
Attapeu	37.2	5.1	57.6
TOTAL	**59.2**	**2.9**	**37.9**
RESIDENCE			
Urban	91.3	1.0	7.7
Rural	48.2	3.6	48.2
Rural with road	51.2	3.7	45.0
Rural without road	22.5	2.3	75.2

Source: 2011 Lao Social Indicator Survey

TABLE A2: ASSESSMENT OF ADVANTAGES AND LIMITATIONS OF DIFFERENT DESIGN OPTIONS

No	Design	Advantages	Limitations
DESIGNS INVOLVING FIELD DATA COLLECTION			
1	Economic study designed entirely for research purposes, including matching and randomization of comparison groups	• Addresses the specific questions of the research • Highly scientific design	• Expensive and lengthy period • May not capture health impact • Limited generalisability
2	Economic research attached to other research studies (e.g. randomized clinical trials)	• Captures health impact with degree of precision • Can conduct additional research on other impacts • Add-on research cost is small • Statistical analysis possible	• Expensive and lengthy period • Few ongoing clinic trials • Requires collaboration from start • Trials may not reflect real conditions • Limited comparison options
3	Economic research attached to pilot study, with or without randomization	• Add-on research cost is small • Options are policy relevant • Matched case-control possible • Can start research in mid-pilot	• Few pilot programs available • Pilots often not designed with scientific evaluation in mind (e.g. before vs. after surveys) • Pilot conditions not real life • Limited comparison options
4	Economic research attached to routine government or NGO/donor programs, without randomization	• Reflects real life conditions (e.g. uptake and practices) • Research addresses key policy questions • Matched case-control possible	• No research infrastructure • No scientific design • Limited comparison options
DESIGNS INVOLVING SECONDARY DATA COLLECTION			
5	Collection of data from a variety of local sources to conduct a modeling study	• Relatively low cost • Short time frame feasible • Can compare several options and settings in research model • Can mix locally available and non-local data	• Results imprecise and uncertain • Actual real-life implementation issues not addressed
6	Extraction of results from previous economic studies	• Low cost • Results available rapidly • Gives overview from various interventions and settings	• Limited relevance and results not trusted by policy makers • Published results themselves may not be precise

TABLE A3: 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 (especially shellfish), water
Hepatitis E	Virus	Fecal-oral	Water
Poliomyelitis	Virus	Fecal-oral, oral-oral	Person-person
Leptospirosis	Bacterium	Animal urine-oral	Water and soil - swamps, rice fields, mud

Sources: WHO http://www.who.int/water_sanitation_health/en/ and [75, 76]

[1] There are several other protozoa-based causes of GIT, including
- Balantidium coli – dysentery, intestinal ulcers
- Cryptosporidium parvum - gastrointestinal infections
- Cyclospora cayetanensis - gastrointestinal infections
- Dientamoeba fragilis – mild diarrhea
- Isospora belli/hominus – intestinal parasites, gastrointestinal infections

[2] Other viruses include:
- Adenovirus – respiratory and gastrointestinal infections
- Astrovirus – gastrointestinal infections
- Calicivirus – gastrointestinal infections
- Norwalk viruses – gastrointestinal infections
- Reovirus – respiratory and gastrointestinal infections

[3] Intestinal nematodes include:
- Ascariasis (roundworm - soil)
- Trichuriasis trichiura (whipworm)
- Ancylostoma duodenale/Necator americanus (hookworm)

TABLE A4: WATER QUALITY MEASUREMENT PARAMETERS PER LOCATION, AND TEST METHOD

Parameter	Unit	Location	Number of samples taken			
			Canal, drain, river, pond	Sewage draining to water/river	Well	Tap
Thermotolorant coliforms/E-coli (TTC)	cfu/100 ml	Laboratory	54	6	30	-
Biological Oxygen Demand (BOD5)	mg/L	Laboratory	45	6	-	-
Chemical Oxygen Demand (COD)	mg/L	Laboratory	54	6	-	-
Dissolved Oxygen (DO)	mg/L	Laboratory	54	6	-	-
Nitrate (NO3)	mg/L	Laboratory	54	-	12	-
Ammonia (NH4)	mg/L	Laboratory	54	6	30	-
Conductivity (µS/cm)	µS/cm	Laboratory	54	6	30	-
Turbidity (NTU)	NTU	Laboratory	54	6	30	-
pH - value		Laboratory	54	6	-	-
Residual chlorine	mg/L	Laboratory	-	-	-	12
Temperature	Celsius	Field	54	6	30	6

TABLE A5. KEY FORMULAS, VARIABLES AND DATA SOURCES FOR CALCULATING MONETIZED BENEFITS

Impacts included	Variable	Data sources
1. HEALTH *(All calculations are made using disaggregated data inputs on disease and age grouping: 0-4 years, 5-14 years, 15+ years)*		
1.1 Health care savings *Calculation:* *[Prevalence or incidence X Attribution to poor sanitation X ((% seeking outpatient care X visits per case X unit cost per visit (medical and patient)) + (Inpatient admission rate X days per case X unit cost per day (medical and patient))] X* *Proportion of disease cases averted*	Diarrheal disease incidence (0-4 years)	WHO statistics
	Diarrheal disease incidence (over 5 years)	
	Helminthes prevalence	Global review
	Indirect diseases incidence (malaria, ALRI)	WHO statistics
	Malnutrition prevalence	UNICEF/WHO statistics
	Attribution of fecal-oral diseases to poor sanitation	WHO. Value = 88%
	Attribution of helminthes to poor sanitation	Global review. Value = 100%
	% disease cases seeking health care	ESI household survey
	Outpatient visits per patient	
	Inpatient admission rate	
	Inpatient days per admission	
	Health service unit costs	
	Other patient costs (transport, food)	
	% disease cases averted	International literature review
1.2 Health morbidity-related productivity gains *Calculation:* *[Prevalence X Attribution to poor sanitation X Days off productive activities X Value of time] X Proportion of disease cases averted*	Days off productive activities	ESI household survey
	Basis of time value: GDP per capita	National economic data World Bank data Average product per capita (at sub-national level, where available) - 30% for adults, 15% for children
1.3 Premature mortality savings *Calculation:* *[Mortality rate X Attribution to poor sanitation X Value of life] X Proportion of disease cases averted*	Mortality rate (all diseases)	WHO statistics
	Basis of time value: GDP per capita	National economic data World Bank data Annual value of lost production of working adults (human capital approach), from the time of death until the end of (what would have been) their product life.
	Discount rate for future earnings	Government cost of capital estimate (8%)
	Long-term economic growth	Assumption
	Value-of-statistical-life	Meta-analyses from developed country studies
1.4 Disability-adjusted life-years (DALY) averted *Calculation:* *DALY = YLD+YLL* *YLD: discounted disability based on weight and years equivalent time* *YLL: discounted future years of healthy life lost*	Duration of disability	ESI household survey
	Disability weighting	WHO burden of disease project
	Healthy life expectancy	WHO statistics
	Discount rate for future disease burdens	Literature search (12%)
	Morbidity and mortality rates	Various: see 1.1 and 1.3 (above)

TABLE A5. KEY FORMULAS, VARIABLES AND DATA SOURCES FOR CALCULATING MONETIZED BENEFITS (CONTINUED)

Impacts included	Variable	Data sources
2. WATER (for household use) *(weighted average costs were estimated for each water source and for each household water treatment method)*		
2.1 Household water access savings *Calculation:* *Annual costs X % costs reduced, per water source*	Drinking water sources (%) in wet and dry seasons	ESI household survey
	Annual financial cost per household, per water source	
	Annual non-financial cost per household, per water source	
	Proportion of access cost reduction under scenario of 100% improved sanitation, per water source	ESI household survey; assumption
2.2 Household water treatment savings *Calculation:* *(% households treating water per method X annual cost) X % households who stop treating*	Proportion of households treating their water, by method	ESI household survey
	Full annual cost per water treatment method	
	Proportion of households currently treating who stop treating under scenario of 100% improved sanitation	ESI household survey; assumption: as well as stopping treatment, households may switch to an alternative – cheaper – treatment method if the cleaner water sources enable different water purification methods
3. ACCESS TIME SAVINGS *(weighted average costs estimated for each age category and gender – young children, children and male and female adults)*		
Calculation: *% household members using OD X Time saved per trip due to private toilet X average trips per day X value of time*	Household composition (demographics)	ESI household survey
	Sanitation practice, by age group	
	Average round trip time to access site of open defecation	
	Average number of round trips to defecation site per day	
	Basis of time value: GDP per capita	National economic data World Bank data Average product per capita (at sub-national level, where available) – 30% for adults, 15% for children

TABLE A6: HOUSEHOLDS SAMPLED VERSUS TOTAL HOUSEHOLDS PER VILLAGE/COMMUNITY

Item	Improved				Unimproved				Total
	Dry pit	Wet pit	Septic tanks	Others	Shared wet pit	Shared septic tank	Shared others	OD	
	Numbers of households								
ACTUAL SAMPLE									
Site 1	-	72	84	16	7	11	4	-	194
Site 2	-	67	48	-	36	7	1	33	192
Site 3	30	65	1	-	11	1	2	102	212
Site 4	71	72	4	-	-	-	-	50	197
Site 5	-	97	43	2	5	1	-	37	185
Site 6	-	108	-	-	8	1	-	114	231
Total	101	481	180	18	67	21	7	336	1,211
PLANNED SAMPLE									
Site 1	-	101	99	-	-	-	-	-	200
Site 2	-	64	49	-	40	-	47	200	
Site 3	31	66	-	-	10	-	93	200	
Site 4	80	80	-	-	-	-	-	40	200
Site 5	30	70	60	-	-	-	-	40	200
Site 6	30	80	50	-	-	-	-	40	200

TABLE A7: SAMPLE SIZES OF OTHER SURVEYS AT STUDY SITES

Site	Focus Group Discussion			Water Quality Measurement			
	No. of sessions	Male	Female	Canal, drain, river, pond	Sewage draining to water body/river	Well	Tap
1 (urban)	2	6	8	6	8	6	6
2 (rural)	3	6	13	6	6	6	-
3 (rural)	4	12	13	8	-	6	-
4 (rural)	4	12	15	8	-	6	-
5 (urban)	4	14	17	6	6	6	6
6 (rural)	4	17	13	8	-	6	-
All sites	21	67	79	42	20	36	12

ANNEX B

TABLE B1: HEALTH RATES FOR DISEASES, BY SITE, VALUES PER 1,000 PEOPLE

	Average rural sites	Average urban sites	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Number of cases per 1,000 people (all age groups)								
DIRECT DISEASES								
Diarrhea	719.6	433.7	402.5	686.8	820.6	708.5	466.4	663.6
Helminths	655.5	593.0	578.9	627.7	686.9	654.9	607.7	650.5
Number of cases per 1,000 people (Under the age of 5 years)								
DIRECT DISEASES								
Diarrhea	4,143.4	3,074.2	3,074.2	4,143.4	4,143.4	4,143.4	3,074.2	4,143.4
Helminths	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0
INDIRECT DISEASES								
Malnutrition	316.0	316.0	316.0	316.0	316.0	316.0	316.0	316.0
Malaria	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
ALRI	84.8	84.8	84.8	84.8	84.8	84.8	84.8	84.8
Total (under 5s)	**5,548.7**	**4,479.4**	**4,479.4**	**5,548.7**	**5,548.7**	**5,548.7**	**4,479.4**	**5,548.7**
Number of deaths per 1,000 people (All age groups)								
DIRECT DISEASES								
Diarrhea	0.5	0.4	0.3	0.4	0.5	0.4	0.4	0.4
Helminths	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Number of deaths per 1,000 people (Under the age of 5 years)								
DIRECT DISEASES								
Diarrhea	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Helminths	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INDIRECT DISEASES								
Malnutrition	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Malaria	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
ALRI	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Measles	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Total (under 5s)	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**	**7.7**
Disability Life Years per 1,000 people (DALYs): All age groups								
DIRECT DISEASES								
Diarrhea	11.0	3.5	3.2	4.6	30.1	4.7	3.9	4.2
Helminths	4.0	3.6	3.5	3.8	4.2	4.0	3.7	3.9
Disability Life Years per 1,000 people (DALYs): Under the age of 5 years								
DIRECT DISEASES								
Diarrhea	36.0	34.5	34.5	36.0	36.0	36.0	34.5	36.0
Helminths	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
INDIRECT DISEASES								
Malnutrition	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Malaria	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
ALRI	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
Measles	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
Total (under 5s)	**76.5**	**74.9**	**74.9**	**76.5**	**76.5**	**76.5**	**74.9**	**76.5**

TABLE B2: COMPARISON OF DATA SOURCES FOR SELECTED DISEASES

Disease	Age	Data Source	Cases/1,000 people	
			Rural	Urban
Diarrhea	Under 5	ESI Survey	25.9	20.8
		WHO (World Health Survey 2011)	468.00	284.00
		WHO (2005)	3,801.3	3,801.3
		WHO rates (used in ESI Impacts study)	2,012.4	1,154.4
	Age 5-14	ESI Survey	10.1	26.90
		WHO (2005)	520.0	520.0
	Age 15+	ESI Survey	31.60	15.9
		WHO (2005)	260.00	260.00
Helminths	Under 5	Brooker et al. (2003), Conlan et al. (2012), Hortez et al. (2006 and 2003)	1,000.00	1,000.00
	Age 5-14		1,000.00	1,000.00
	Age 15+		477.4	477.4
Malnutrition				
Underweight	Under 5	WHO (World Health Statistics 2011)	316.0	316.0
Stunted	Under 5	WHO (World Health Statistics 2011)	476.0	476.0
Malaria	Under 5	ESI Survey	2.5	80.0
	Under 5	Larsen (2007)	4.4	4.4
	Age 15+	FHSIS		
ALRI	Under 5	Larsen (2007)	84.8	84.8
		World Health Survey (2011)	536.00	568.00

TABLE B3: EVIDENCE ON TREATMENT-SEEKING BEHAVIOR FOR OTHER DISEASES

Data source by disease, rural/urban and year	Observations	% seeking treatment from					No treatment (%)
		Hospitals	Other formal facilities	Private informal care	Pharmacy	Self-treatment	
DIARRHEA							
WHO (0-4 years)							
Urban	na		92.9	7.1	na	na	-
Rural	na		51.3	45.7	na	na	9.6
National	na		59.9	37.8	na	na	7.8
ESI Impacts study (2005, national)							
0-4 years	na		37.5	21.3	21.3	na	28.8
5-14 years	na		26.3	15.0	15.0		50.0
15 and over	na		21.1	12.0	12.0		60.0
ESI Sites (2009, urban)							
all age groups	13	46.2	53.8	-	-	30.8	-
ESI Sites (2009, rural)							
all age groups	41	29.3	29.3	2.4	-	36.6	29.3
SYMPTOMS OF ALRI							
WHO (0-4 years)							
Urban	na	34.8	22.0	41.0	na	na	10.9
Rural	na	38.1	24.0	36.1	na	na	9.7
National	na	-	-	-	na	na	-
ESI Sites (2009, urban)							
all age groups	5	80.0	-	-	-	20.0	20.0
ESI Sites (2009, rural)							
all age groups	23	56.5	34.8	-	-	26.1	4.3
ESI Sites (2009, all sites)							
all age groups	28	60.7	28.6	-	-	25.0	7.1
MALARIA							
ESI Sites (2009, urban)							
all age groups	18	66.7	16.7	-	-	5.6	16.7
ESI Sites (2009, rural)							
all age groups	67	74.6	16.4	-	-	40.3	6.0
ESI Sites (2009, all sites)							
all age groups	85	72.9	16.5	-	-	32.9	8.2

TABLE B4: UNIT COSTS ASSOCIATED WITH TREATMENT OF DISEASES

Health provider	Rural (thousand kip)		Urban (thousand kip)	
	Health care	Incidentals[a]	Health care	Incidentals[a]
Diarrhea				
Hospitals (out-patient)	161.7	161.1	132.3	80.6
Hospitals (in-patient)[b]	211.7	161.1	169.5	80.6
Other formal care	170.0	82.8	139.0	6.3
Informal care	100.0	-	100.0	-
Self-treatment	11.4	-	-	-
Helminths				
Hospitals (out-patient)	132.7	161.1	78.3	80.6
Hospitals (in-patient) [b]	-	-	-	-
Other formal care	23.9	82.8	18.8	6.3
Informal care	100.0	-	100.0	-
Self-treatment	11.4	-	-	-
ALRI				
Hospitals (out-patient)	300.0	161.1	1,575.0	80.6
Hospitals (in-patient) [b]	212.5	-	-	-
Other formal care	160.2	-	(37.0)	-
Informal care	-	-	-	-
Self-treatment	100.0	-	100.0	-
Malaria				
Hospitals (out-patient)	1,088.5	161.1	2,333.3	80.6
Hospitals (in-patient) [b]	214.4	-	135.0	-
Other formal care	89.4	-	10.0	-
Informal care	100.0	-	100.0	-
Self-treatment	105.6	-	105.6	-

[a] Incidentals only represent transport costs; [b] Hospital in-patient care represents costs of the entire duration of stay in the facility.

ANNEX C

TABLE C1: FULL WATER QUALITY MEASUREMENT RESULTS

Source description	(cfu/ 100ml)	BODs (mg/l)	COD (mg/l)	DO (mg/l)	NO3 (mg/l)	NH4 (mg/l)	Conduc- tivity	Tur- bidity	pH	Residual Chlorine	Tempe- rature	Uses
Brown water and mix up with gray	>23	7.5	189.8	2.6	0.4	10	602	11	7.7	-	31	NI
Gray water in the open drain	>23	37.4	184.1	2.7	0.5	8	610	13	7.4	-	33	NI
Gray water flow into community	>23	19.7	197.4	1.7	0.3	6	689	16	7.7	-	31	NI
Gray water in drain	>23	10.7	186	1.4	0.6	4	579	13	7.6	-	31	NI
Brown and gray water collected	>23	12.2	60.8	3.5	1	3	451	20	7.1	-	31	NI
Gray water collected	>23	13.8	56.2	2.7	2.7	0.8	390	10	7.7	-	36	NI
Open drain and gray water	>23	42.1	205.2	1.5	1.9	0.6	520	15	7.8	-	30	NI
Gray water in community drainage	>23	36.9	235.4	1.3	2.1	2	890	16	7.6	-	31	NI
Gray water in open drain	>23	12.7	216.3	1.1	3.7	0.6	521	11	7.3	-	31	NI
Gray water collected from open drain	>23	3.2	182.2	1.9	0.9	1	493	2	7.8	-	36.2	NI
Gray water in open drain	>23	44.2	260.1	2.4	1.1	0.4	151	20	7.1	-	32	NI
Tap water inside the house	-	-	-	-	-	-	-	-	-	0.1		B
Tap water inside the house	-	-	-	-	-	-	-	-	-	0.05		BC
Tap water	-	-	-	-	-	-	-	-	-	0.04	31,5	B
Tap water inside the house	-	-	-	-	-	-	-	-	-	0.05		B
Tap water outside the house	-	-	-	-	-	-	-	-	-	0.05		BC
Tap water	-	-	-	-	-	-	-	-	-	0.06	31	B
Canal water after village	0	4.4	16	8.9	<0.25	0.1	89	23	6.9	-	41	I
Irrigation canal water at the end of downstream village	2.2	18.7	20	9.1	<0.25	0.3	96	9	7	-	40,5	I
A fish pond close to the house in the village	5.1	12.5	22	8.6	0.8	0.2	96	46	6.8	-	36	F
Gray water from household use close to the well	2.2	19.8	50	4.3	0.9	0.3	303	47	7.1	-	39	NI
Water collection in the middle of village	16	10.8	16	8.9	<0.25	0.4	93	42	7	-	36,8	NI
A pond in the village	0	15.8	34	6	0.3	0.5	180	10	7.4	-	36	F
Water collection upstream	0	9.9	4	8.2	0.7	0.2	114	49	7.1	-	36,5	I
A pond close to village	5.1	9.9	12	12.1	0.7	0.3	118	20	7.1	-	40	CB
Drain water	2.2	8.6	10	6.7	<0.25	0.4	271	53	8.1	-	40,8	NI
A pond in the village	0	10.1	10	7.1	<0.25	0.2	316	6	7.4	-	37,2	F

TABLE C1: FULL WATER QUALITY MEASUREMENT RESULTS (CONTINUED)

Source description	(cfu/ 100ml)	BODs (mg/l)	COD (mg/l)	DO (mg/l)	NO3 (mg/l)	NH4 (mg/l)	Conduc- tivity	Tur- bidity	pH	Residual Chlorine	Tempe- rature	Uses
A small pool by the road	5.1	10.5	12.2	8.2	0.4	0.3	127	23	7.2	-	40	F
A bore hole with electrical	0	-	-	-	-	0.1	691	0	-	-	30	CB
A protected dug well	0	-	-	-	-	0.2	101	9	-	-	28	CB
A protected dug well with cover	>23	-	-	-	-	0.1	53	4	-	-	31	CBD
A protected dug well with roofing	9.2	-	-	-	-	0.1	68	31	-	-	30	CB
A protected dug well with concrete rings and cover	9.2	-	-	-	-	0.3	121	1	-	-	28	CBD
Private bore hole used for bathing	0	-	-	-	-	0.3	858	0	-	-	32	CB
Fish pond	5.1	1.6	15.2	1	5.1	0.5	329	11	6.9	-	28	F
Canal water	>23	4.3	14.8	1.9	55.1	0.6	315	26	6.9	-	27	I
Middle of stream	16	6.8	15.8	1.2	0.4	0.6	342	215	8.1	-	28	G
Drain	>23	16.6	225.9	1.3	5.2	2.5	395	1820	7.6	-	34	NI
Upstream water	16	6.6	144.3	14.2	2.4	0.2	311	8	8.3	-	28	CB
Downstream river	>23	3.2	157.6	16	3.4	0.4	274	336	8.3	-	28	G
Drain	>23	32.3	265.8	3.3	1.8	0.5	1372	354	7.3	-	32	NI
Fish Pond	>23	11.1	166	4.1	3.8	1	275	3900	7.5	-	31	F
Protected dug well	9.2	-	-	-	5	0.4	328	3	-	-	29	CD
Well	>23	-	-	-	50.1	0.5	317	6	-	-	27	CBD
Middle stream well	16	-	-	-	0.4	0.5	341	2	-	-	28	CD
Protected dug well	5.1	-	-	-	3.2	0.4	587	3	-	-	29	CB
Protected dug well	9.2	-	-	-	5.4	0.6	373	0	-	-	29	CBD
Upstream well	0	-	-	-	1.2	0.5	363	0	-	-	28,2	G
Small pond with lotus	>23	0.8	15.2	4.4	0.6	0.1	241	42	7.2	-	28	F
Small river upstream from village	>23	1.3	15.2	5.1	0.7	0.2	181	34	7.7	-	29	B
Small stream	>23	6.9	18.9	5	1.1	0.05	213	68	7.2	-	27	NI
River upstream	>23	0.4	15.2	4.7	1.8	0.08	320	28	7.6	-	31	B
Fish pond	>23	4.2	15.2	5.4	0.5	0.17	132	62	7.2	-	29	F
River down stream	>23	0.9	3.8	5.1	1.6	0.29	178	45	7.6	-	30.5	BG
River center of village	>23	2.9	3.8	7.3	1.4	0.14	185	41	7.8	-	31	B
River down stream	>23	2.9	7.6	5.5	1.2	0.12	181	40	8	-	31.5	BCG
Communal tap	>23	-	-	-	-	0.23	335	2	-	-	28.5	BCD
Communal tap only water in the morning	>23	-	-	-	-	0.13	366	3	-	-	28	CD
Communal tap	>23	-	-	-	-	0.13	391	8	-	-	29	BCD
Communal tap	>23	-	-	-	-	0.19	389	20	-	-	28	BCD
Private water connection	>23	-	-	-	-	0.11	420	2	-	-	28.5	BCD
Communal tap	>23	-	-	-	-	0.14	429	0.6	-	-	28	BCD
River center of village	>23	0.7	9.5	12	1	0.2	304	7	8.1	-	28.2	G
Fish pond	>23	4.2	55	11	1.6	0.2	696	95	7.8	-	28	F
Pond end of village	>23	0.6	22	11	0.5	0.26	328	12	7.7	-	30	F

TABLE C1: FULL WATER QUALITY MEASUREMENT RESULTS (CONTINUED)

Source description	(cfu/ 100ml)	BODs (mg/l)	COD (mg/l)	DO (mg/l)	NO3 (mg/l)	NH4 (mg/l)	Conduc-tivity	Tur-bidity	pH	Residual Chlorine	Tempe-rature	Uses
River upstream	>23	3.5	13.3	14	1.1	0.15	299	4	8.1	-	28	G
Nan river	>23	10.7	41	12	1.2	0.17	297	27	8.2	-	27	BG
Nan river	>23	6.9	18.2	14	1.4	0.16	312	30	8	-	27	BG
Large stream through village	>23	25.8	24.7	12	-	3.5	609	55	7.3	-	28	G
Drain through village	>23	50.8	55	12	-	3	792	90	7.5	-	29.2	NI
Drain under road	>23	34.3	26.6	13	-	0.4	645	135	7.1	-	29	NI
Stream/drain from paddy	>23	7	3.8	14	-	0.16	309	9	8	-	29	NI
Drain	>23	58.8	41.8	12	-	3.6	658	51	7.4	-	29	NI
Drain at center of village	>23	27.1	30.4	10	-	0.2	1001	34	7.5	-	29	NI
stream well	>23	-	-	-	-	0.18	447	1.8	-	-	28	D
Well	>23	-	-	-	-	0.12	576	0.8	-	-	28	B
Well	>23	-	-	-	-	0.2	382	0.7	-	-	29	CD
Well	16	-	-	-	-	0.14	590	0.9	-	-	27.5	D
Well	>23	-	-	-	-	0.21	791	8.6	-	-	29	B
Well	>23	-	-	-	-	0.22	450	0.4	-	-	29.5	BCD
Tap	-	-	-	-	-	-	-	-	-	0.05	-	BCD
Tap	-	-	-	-	-	-	-	-	-	0.10	-	BCD
Tap	-	-	-	-	-	-	-	-	-	0.40	-	BC
Tap	-	-	-	-	-	-	-	-	-	0.60	-	BC
Tap	-	-	-	-	-	-	-	-	-	0.80	-	BCD
Tap	-	-	-	-	-	-	-	-	-	0.70	-	BCD
Natural pond	>23	-	1044	1.19	1.1	4.4	130	1120	6.5	-	30	NP
Natural pond	>23	-	76	1.8	3.9	4.8	217	939	7.3	-	36	NP
Fish pond	>23	-	104	1.76	3.4	3.4	227	1600	7.1	-	32	F
Fish pond	>23	-	57	1.59	7.4	3	766	2540	6.9	-	33	F
Fish pond	>23	-	104	2.06	3.6	2.6	186	1720	7.1	-	33	F
Canal	>23	-	104	2.52	0.9	2.2	917	49	7.2	-	30	NI
Fish pond	>23	-	133	3.52	1	1	1188	284	7.3	-	30	F
River	>23	-	76	7.92	0.6	0.27	1578	14	7.9	-	32	BD
Fish pond	>23	-	95	6.37	0.06	0.15	300	67	7.3	-	29	F
Well	>23	-	-	-	0.5	0.17	90.1	9	-	-	29	BCD
Well	0	-	-	-	0.5	0.4	55.7	13	-	-	32	D
Well	>23	-	-	-	73.6	0.6	1302	8	-	-	29	BCD
Well	>23	-	-	-	55.1	2	1320	2	-	-	29	BD
Well	16	-	-	-	27.3	0.5	892	0	-	-	28	CB
Well	0	-	-	-	3.5	0.4	124.1	20	-	-	30	CBD

Source Type: A = canal, drain, river, pond; B = sewage draining to water/river; C = well; D = Tap
Uses: C = Cooking, B = bathing, D = drinking, F = fish source, I = irrigation, G = water for gardening, NI = not indicated, NP = natural pond
Location code: HT = Hatsady Tai, HN = Hatsady Neua, K = Khoknoy, LN = Lao Nat, N = Nasala, NF = Na Fai, NI = Nong Ing, NNN = Nam Nga North to bridge, NP = Napapai, P = Pakchan, PC = Phon Chaleun, PN = Phonkham Neua, PS = Phon Sai, PT = Phonkham Tai, S = Sailom, SMK = Si Moung Khoun, T = Thongloum,
- .. not available or not tested

TABLE C2: WATER ACCESS AND TREATMENT PRACTICES AND RELATED COST PER SITE

Water source	Item	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Rural	Urban	All sites
Piped water	% Access	11.1	-	0.5	4.1	27.4	16.6	5.6	19.0	9.9
	Costs[a]	60.7	-	7.4	34.1	112.4	32.7	18.9	85.7	40.0
	% Access cost	-	na	100.0	100.0	57.5	55.0	83.9	27.9	66.2
Non-piped protected										
Bottled water	% Access	82.3	85.1	7.1	22.3	37.6	17.9	31.9	60.7	41.0
	Costs	548.1	456.8	35.8	110.3	218.4	115.9	174.0	388.4	241.6
	% Access cost	-	-	-	-	-	-	-	-	-
Others	% Access	6.6	13.8	23.4	68.3	17.7	47.3	38.3	12.0	30.0
	Costs (thousand kip)	43.6	35.1	197.5	468.8	90.8	222.6	230.5	66.4	178.7
	% Access cost	-	28.4	99.9	94.8	98.4	90.9	79.5	47.7	69.4
Unprotected	% Access	-	1.1	69.0	5.3	17.2	18.2	24.1	8.3	19.1
	Costs	-	0.0	627.2	60.2	88.7	45.7	186.4	43.0	141.2
	% Access cost	na	100.0	94.4	100.0	100.0	100.0	98.6	100.0	99.0
All sources	% Access	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Costs	652.4	491.9	867.8	673.4	510.2	416.8	609.9	583.5	601.6
	% Access cost	-	2.0	91.8	80.0	47.6	63.8	60.3	23.0	48.5

[a] Costs are in thousand kip per household per year

TABLE C3: HOUSEHOLDS CITING POOR WATER QUALITY BY SITE, % OF WATER USERS PER OPTION

Water source	Characteristic	Site						Summary		
		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Rural	Urban	All
Piped water (treated)	Bad appearance	6.5	7.1	4.3	3.9	11.4	13.6	7.4	9.0	5.8
	Bad smell	12.4	11.2	16.4	9.9	7.6	6.5	10.9	10.0	9.7
	Bad taste	1.8	11.6	20.7	6.2	14.4	3.7	10.4	8.2	9.5
	With sediment	3.6	12.3	4.3	7.7	8.4	4.3	7.0	6.0	6.2
Non-piped protected source (including untreated piped)	Bad appearance	-	35.7	24.3	51.4	11.4	21.6	32.7	5.8	20.4
	Bad smell	20.0	20.4	13.2	26.8	15.2	1.6	14.9	17.6	16.1
	Bad taste	-	20.2	11.8	23.1	1.7	3.8	14.2	0.9	9.4
	With sediment	-	22.9	19.5	42.7	15.6	1.1	20.7	7.9	16.8
Non-protected sources	Bad appearance	-	11.5	34.6	65.0	18.4	23.9	33.5	9.3	21.3
	Bad smell	-	5.8	28.7	44.9	12.3	4.5	20.5	6.2	15.1
	Bad taste	-	5.8	24.4	39.9	9.2	-	17.0	4.7	13.0
	With sediment	-	5.8	30.8	65.0	12.3	-	24.5	6.2	18.5

TABLE C4: CITED REASONS FOR USING WATER SOURCES BY SITE,% OF WATER USERS FOR EACH OPTION

Water source	Reason	Rural	Urban	All	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Piped water (treated)	Quality	89.2	83.9	87.6	89.3	98.7	95.7	88.7	78.6	75.6
	Quantity	58.7	62.0	59.7	63.9	71.6	62.1	51.5	60.2	51.0
	Cost	78.6	79.8	79.0	71.6	75.3	82.8	80.6	87.7	75.8
	No alternative	66.3	41.9	58.8	13.0	68.6	61.4	51.7	70.2	81.4
Non-piped protected source	Quality	76.9	85.7	79.6	100.0	66.5	78.5	67.4	71.7	92.4
	Quantity	44.2	86.1	57.1	100.0	41.1	43.7	46.0	72.6	45.6
	Cost	84.3	87.8	85.4	100.0	87.2	75.0	94.9	75.9	81.1
	No alternative	76.6	45.0	66.9	0.0	76.9	72.9	85.3	89.0	72.4
Non-piped unprotected source	Quality	74.5	14.1	56.0	0.0	100.0	64.5	44.9	27.9	87.5
	Quantity	40.4	21.9	34.7	0.0	47.1	32.9	35.0	43.3	46.4
	Cost	72.0	28.7	58.7	0.0	58.6	73.7	70.0	56.7	83.3
	No alternative	85.8	45.9	73.5	0.0	58.6	96.5	100.0	90.8	86.8

TABLE C5: TREATMENT PRACTICES BY SITE

Water source	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Rural	Urban	All sites
NUMBER OF HOUSEHOLDS USING									
Piped sources	21	0	1	8	49	38	47	70	117
Non-piped protected source	171	187	65	180	103	150	582	274	856
Non-piped unprotected source	0	5	142	8	32	40	195	32	227
Total	192	192	208	196	184	228	824	376	1200
PERCENTAGE OF HOUSEHOLDS USING THE SOURCE									
Piped water sources									
Households treating water	76.2	na	100.0	87.5	93.9	18.4	31.9	88.6	65.8
Boiling	52.4	na	100.0	87.5	93.9	18.4	31.9	81.4	61.5
Chlorine	4.8	na	-	-	-	-	-	1.4	0.9
Filter (mechanical)	23.8	na	-	-	-	-	-	7.1	4.3
Filter (home-made)	4.8	na	-	-	-	-	-	1.4	0.9
Stand & Settle	4.8	na	-	-	-	-	-	1.4	0.9
Other	-	na	-	-	6.1	2.6	2.1	4.3	3.4
Non-piped protected sources									
Households treating water	31.0	28.3	40.0	77.2	40.8	34.0	46.2	34.7	42.5
Boiling	18.1	15.0	33.8	73.9	35.0	22.0	37.1	24.5	33.1
Chlorine	-	-	-	-	-	-	-	-	-
Filter (mechanical)	6.4	1.1	-	0.6	-	2.0	1.0	4.0	2.0
Filter (home-made)	1.2	-	1.5	1.7	-	6.0	2.2	0.7	1.8
Stand & Settle	1.2	-	7.7	-	-	-	0.9	0.7	0.8
Other	0.6	1.1	1.5	2.2	3.9	2.0	1.7	1.8	1.8
Non-piped unprotected sources									
Households treating water	na	80.0	51.4	87.5	100.0	45.0	52.3	100.0	59.0
Boiling	na	60.0	41.5	87.5	100.0	37.5	43.1	100.0	51.1
Chlorine	na	-	-	-	-	-	-	-	-
Filter (mechanical)	na	-	-	-	-	-	-	-	-
Filter (home-made)	na	-	0.7	-	-	-	0.5	-	0.4
Stand & Settle	na	-	5.6	-	-	-	4.1	-	3.5
Other	na	-	0.7	-	-	-	0.5	-	0.4
Average for all sources									
Households treating water	35.9	29.7	48.1	78.1	65.2	33.3	46.8	50.3	47.9
Boiling	21.9	16.1	39.4	75.0	62.0	24.1	38.2	41.5	39.3
Chlorine	0.5	-	-	-	-	-	-	0.3	0.1
Filter (mechanical)	8.3	1.0	-	0.5	-	1.3	0.7	4.3	1.8
Filter (home-made)	1.6	-	1.0	1.5	-	3.9	1.7	0.8	1.4
Stand & Settle	1.6	-	6.3	-	-	-	1.6	0.8	1.3
Other	0.5	1.0	1.0	2.0	3.8	1.8	1.5	2.1	1.7

TABLE C6: WATER ACCESS AND HOUSEHOLD TREATMENT COSTS AVERTED, THOUSAND KIP

Site	Annual average cost per household			Annual average cost saved per household following 100% sanitation coverage		
	Water source access	Water treatment	Total	Water source access	Water treatment	Total
1 (urban)	652.4	165.8	818.2	8.1	1.7	9.8
2 (rural)	491.9	84.8	576.8	0.5	3.1	3.6
3 (rural)	867.8	147.3	1,015.1	7.8	17.6	25.4
4 (rural)	673.4	831.5	1,504.9	90.4	152.0	242.4
5 (urban)	510.2	275.4	785.6	5.9	58.6	64.5
6 (rural)	416.8	83.0	499.8	11.7	4.6	16.3
Average rural	**610.5**	**277.3**	**887.9**	**26.7**	**42.5**	**69.2**
Average urban	**592.8**	**211.7**	**804.5**	**7.2**	**25.6**	**32.7**
Average all households	**605.5**	**258.8**	**864.3**	**21.2**	**37.7**	**58.9**

ANNEX D

TABLE D1: PLACE OF DEFECATION OF HOUSEHOLDS WITH NO "OWN" TOILET

	Adult				Children (aged 5-14 years)			
	N	Neighbor (%)	Own plot (%)	Outside plot (%)	N	Neighbor (%)	Own plot (%)	Outside plot (%)
1 (urban)	16	100.0	-	-	5	100.0	-	-
2 (rural)	151	35.1	-	64.9	55	32.7	9.1	58.2
3 (rural)	340	4.7	3.5	91.8	169	6.5	10.1	83.4
4 (rural)	141	-	2.8	97.2	90	-	-	100.0
5 (urban)	121	6.6	5.0	88.4	39	5.1	7.7	87.2
6 (rural)	298	-	1.7	98.3	136	-	12.5	87.5
Summary								
Rural	930	7.4	2.3	90.3	450	6.4	8.7	84.9
Urban	137	17.5	4.4	78.1	44	15.9	6.8	77.3
All	1067	8.7	2.5	88.8	494	7.3	8.5	84.2

TABLE D2: DAILY TIME SPENT ACCESSING TOILET FOR THOSE WITH NO TOILET

	Adult[a]		Children (aged 5-14 years)	
	Time per trip and waiting (minutes)	No. of times per day	Time per trip and waiting (minutes)	No. of times per day
1 (urban)	7.00	1.17	11.88	1.24
2 (rural)	11.88	1.67	15.16	1.45
3 (rural)	15.16	1.74	14.42	1.39
4 (rural)	14.42	1.83	11.90	1.36
5 (urban)	11.90	1.17	15.20	1.24
6 (rural)	15.20	1.32	0.00	1.21
Summary				
Rural	14.38	1.60	9.46	1.34
Urban	10.24	1.17	14.08	1.24
All sites	13.75	1.53	10.16	1.33

[a] Accounts for time spent accompanying children to a place of defecation.

TABLE D3: PRACTICES RELATED TO YOUNG CHILDREN

Site	No. of responses	Parents accompanying young children		Parents accompanying their children outside the yard	Average number of times visited in the day prior to the survey
		Number saying 'Yes'	%	%	
1 (urban)	98	40	40.8	-	1.7
2 (rural)	118	22	18.6	6.2	1.8
3 (rural)	162	44	27.2	21.0	1.9
4 (rural)	146	22	15.1	9.0	1.5
5 (urban)	118	21	17.8	11.9	1.5
6 (rural)	183	38	20.8	9.8	1.5
Summary					
Rural	609	126	20.7	13.0	1.7
Urban	216	61	28.2	4.1	1.6
All sites	825	187	22.7	10.1	1.6

TABLE D4: PREFERENCES RELATED TO TOILET CONVENIENCE, FROM HOUSEHOLDS

Site	Perceived benefits of sanitation (B6.1): proximity cited as satisfied or very satisfied (%)		Those without toilet: reasons to get a toilet (%)	
	Those with toilet	Those without toilet	Saves time (B7.16)	Proximity is an important characteristic (B7.17)
1 (urban)	83.8	na	na	na
2 (rural)	84.2	62.1	100.0	100.0
3 (rural)	68.9	63.0	98.0	98.0
4 (rural)	55.2	61.1	100.0	100.0
5 (urban)	80.6	58.9	97.3	97.3
6 (rural)	92.1	60.1	100.0	100.0
Summary				
Rural	74.8	61.5	99.3	99.3
Urban	82.4	58.9	97.3	97.3

TABLE D5: AVERAGE TIME SAVED PER PERSON OR HOUSEHOLD PER YEAR (DAYS)

Site	Adults[a]	Children 5-14 years	Children under 5 years	Adult time with young children	Average per person	Average per household
1 (urban)	15.3	1.6	0.6	0.3	3.4	17.7
2 (rural)	18.5	4.2	2.2	0.2	5.2	25.1
3 (rural)	29.2	9.4	4.9	0.5	7.1	43.9
4 (rural)	20.3	6.1	3.1	0.3	6.0	29.8
5 (urban)	13.8	2.6	1.1	0.2	3.6	17.6
6 (rural)	16.5	5.1	1.8	0.3	5.4	23.7
Summary						
Rural	21.1	6.2	3.0	0.3	5.9	30.6
Urban	14.5	2.1	0.8	0.2	3.5	17.7
All sites	16.5	3.3	1.5	0.3	4.3	21.6

a Does not include the time spent accompanying children to a place of defecation

TABLE D6: VALUE OF TIME PER PERSON/HOUSEHOLD PER YEAR (THOUSAND KIP)

Site	Adults	Children 5-14 years	Children under 5 years	Adult time with young children	Average per household
1 (urban)	1,438	74	29	27	1,568
2 (rural)	1,179	132	69	14	1,394
3 (rural)	961	154	81	16	1,212
4 (rural)	732	110	55	11	908
5 (urban)	495	47	20	6	567
6 (rural)	649	100	35	12	796
Summary					
Rural	870	124	59	13	1,067
Urban	978	61	24	16	1,079
All sites	945	80	35	15	1,076

[a] Does not include the time spent accompanying children to a place of defecation

ANNEX E

TABLE E1: IMPORTANT CHARACTERISTICS OF A TOILET FOR THOSE CURRENTLY WITHOUT

Characteristic	No. responses	Average score (1 = not important; 5 = very important)
Comfortable toilet position	332	4.0
Cleanliness and freedom from unpleasant odours and insects	332	4.1
Not needing to share with other households	332	4.1
Having privacy when at the toilet	332	4.1
Proximity of toilet to house	332	4.0
Pour-flush toilet compared to dry pit latrine	332	4.2
Having a toilet disposal system that does not require emptying (piped sewer versus septic tank)	332	3.8
Having a toilet disposal system that does not pollute your own, your neighbors', or your community's environment	332	4.1
Willingness to pay for improved toilet?	215	963,200 Kip
Type of toilet they would get (%)		
Pour-flush toilet	330	99.7
Pit latrine	0	0.3

TABLE E2: LEVEL OF SATISFACTION WITH CURRENT TOILET OPTION

Characteristic	Improved sanitation			Unimproved sanitation		
	Flush toilets	Dry pit latrine	Average	Open defecation	Shared latrines	Average
Comfort	3.2	1.5	2.9	1.7	2.6	1.9
Cleanliness	3.3	1.4	3.0	1.7	2.9	1.9
Privacy	3.5	1.9	3.2	1.7	2.6	1.9
Proximity	3.3	1.7	3.1	1.7	2.5	1.9
Pride	3.3	1.5	3.0	1.7	2.6	1.9
Feeling good with guests	3.3	1.5	3.0	1.7	2.5	1.9
Workload for maintaining	3.3	2.0	3.2	2.4	2.8	2.5
Pollution of your environment	3.4	1.8	3.2	2.2	3.0	2.4
Avoiding diseases	3.4	1.9	3.2	2.3	2.9	2.4
Reduces smell	3.5	1.9	3.3	2.2	3.0	2.4
Avoiding conflict	3.4	2.4	3.3	2.2	2.9	2.3
Safety of children	3.5	2.2	3.3	2.1	2.8	2.2
Toilet use at night	3.5	1.7	3.2	1.8	2.6	2.0
Toilet use when raining	3.5	1.7	3.2	1.8	2.6	1.9
Good for elderly people	3.4	1.6	3.2	1.9	3.1	2.1
Avoid snakes and biting insects	3.5	2.0	3.3	2.2	3.1	2.4
Avoid snakes/insects	3.5	1.7	3.2	1.8	2.6	1.9

ANNEX F

TABLE F1: SCORING OF DIFFERENT TYPES OF LIVING AREA

Item	Site						Averages		
	1	2	3	4	5	6	Rural	Urban	All
State of sanitation in the neighborhood very bad (1) to very good (5)									
Uncollected/undisposed household waste/garbage	3.2	4.2	4.2	3.6	3.1	3.7	3.9	3.1	3.7
Open/visible sewage or wastewater	3.3	4.2	3.7	3.6	3.5	3.4	3.7	3.4	3.6
Accumulation of storm/rain water	3.1	4.2	3.7	3.5	3.5	3.5	3.7	3.3	3.6
Smoke from burning waste/garbage	2.0	3.9	3.6	3.5	3.0	4.1	3.8	2.5	3.4
Smell from sewage/defecation/waste	3.0	4.0	4.0	3.5	3.5	3.9	3.8	3.2	3.6
Dust & dirt in streets/roads/alleys	3.4	4.2	4.0	3.4	4.5	4.3	4.0	4.0	4.0
Dust & dirt in shops/markets/restaurants	3.4	4.2	4.0	3.5	4.4	4.3	4.0	3.9	4.0
Rodents around uncollected waste etc.	3.2	4.0	4.0	3.5	3.3	3.7	3.8	3.3	3.6
Insects around uncollected waste etc.	3.4	4.4	4.0	3.9	3.8	3.9	4.0	3.6	3.9
Simple average	**3.1**	**4.1**	**3.9**	**3.6**	**3.6**	**3.9**	**3.9**	**3.4**	**3.7**
To what extent do the following activities occur in your neighborhood Never (1) to Pervasive (4)									
Open defecation	1.1	2.4	3.1	2.3	1.7	2.5	2.6	1.4	2.2
Land affected by sewage drains and wastewater	1.6	2.1	1.8	1.7	1.5	1.5	1.7	1.6	1.7
Garbage/waste dumpsites/landfills	1.4	2.1	2.3	2.0	1.5	2.0	2.1	1.5	1.9
Land flooded seasonally	1.8	2.2	1.9	1.8	1.7	1.4	1.8	1.7	1.8
Land is flooded permanently with poor quality sitting water	1.1	1.4	1.3	1.3	1.3	1.4	1.3	1.2	1.3
Simple average	**1.4**	**2.0**	**2.1**	**1.8**	**1.5**	**1.8**	**1.9**	**1.5**	**1.8**

TABLE F2: PROPORTION OF HOUSEHOLDS WITH AND WITHOUT TOILET WHO HAVE UNIMPROVED SANITATION PRACTICE

Item	Site						Averages		
	1	2	3	4	5	6	Rural	Urban	All
Households with access to toilet % of responses saying often or always									
Open defecation	1.6	0.6	2.8	8.2	1.4	0.9	3.2	1.5	2.5
Open urination	1.6	15.7	30.8	32.7	4.8	7.8	21.7	2.9	14.4
See children defecating in yard	4.9	22.0	35.8	25.6	2.3	14.5	24.0	3.6	16.6
Septic tanks % of total responses									
Built less than 2 years ago and desludged	18.8	-	-	-	-	-	-	6.0	2.1
Built 2-5 years ago and desludged	33.3	12.7	5.0	-	2.6	1.4	5.1	13.3	7.0
Built more than 5 years ago and desludged	60.0	15.3	-	5.6	5.8	7.3	11.3	39.7	27.8
Last time septic tanks were desludged % of responses for septic tanks aged 5 years and above									
Within the last 5 years	88.4	90.9	na	100.0	100.0	100.0	93.3	89.0	89.8
More than 5 years ago	10.1	9.1	na	-	-	-	6.7	9.6	9.1
Don't know	1.4	-	na	-	-	-	-	1.4	1.1
Households with pit latrines % of responses									
Experienced seepage/flooding into pit (sometimes or often in rainy season)	na	na	9.7	28.2	na	na	22.5	na	22.5
Pit overflowed (yes)	na	na	3.2	9.9	na	na	7.8	na	7.8

TABLE F3: IMPLICATION OF CURRENT TOILET OPTION FOR EXTERNAL ENVIRONMENT

Characteristic	Improved sanitation			Unimproved sanitation
	Wet pit latrine	Dry latrine	Average	No toilet
Pollution of your or neighbors' environment (question B6.1)				
Site1 (urban)	2.6	na	2.6	na
Site 2 (rural)	2.9	na	2.9	1.6
Site 3 (rural)	3.2	0.8	2.4	1.4
Site 4 (rural)	3.1	1.2	2.2	1.6
Site 5 (urban)	2.8	na	2.8	1.8
Site 6 (rural)	3.3	na	3.3	1.5
Summary				
Rural	3.1	1.1	2.6	1.5
Urban	3.2	na	3.2	1.8
All	3.2	1.1	2.8	1.5
Smell around house (question B6.1)				
Site1 (urban)	2.9	na	2.9	na
Site 2 (rural)	3.0	na	3.0	1.9
Site 3 (rural)	3.0	1.2	2.5	1.5
Site 4 (rural)	3.1	1.2	2.2	1.6
Site 5 (urban)	2.8	na	2.8	1.9
Site 6 (rural)	3.3	na	3.3	1.4
Summary				
Rural	3.1	1.2	2.7	1.5
Urban	3.3	na	3.3	1.9
All	3.2	1.2	2.9	1.6

TABLE F4: PERCEPTIONS OF ENVIRONMENTAL SANITATION STATE, BY OPTION TYPE

Site	Intervention/ Control	Are you aware of any of the following? 1 (none/never) to 5 (pervasive)					Perception of environmental sanitation state 1 (very bad) to 5 (very good)								
		Open defecation	Stagnant water	Garbage	Flooded seasonally	Flooded permanently	Rubbish	Sewage	Standing water	Smoke	Smell	Dirt outside	Direct inside	Rodents	Insects
1 (urban)	Intervention	2.1	1.5	1.7	1.7	1.3	2.7	2.8	2.6	1.2	2.4	3.1	3.0	2.7	3.0
2 (rural)	Intervention	1.3	1.6	1.5	1.9	1.2	4.1	3.9	3.9	3.8	3.8	4.0	4.0	3.7	4.2
	Control	1.2	1.6	1.4	1.6	1.0	4.0	4.2	4.1	3.4	3.8	4.3	4.3	3.8	4.2
3 (rural)	Intervention	3.0	1.7	2.1	1.8	1.2	3.9	3.3	3.3	3.2	3.6	3.8	3.7	3.7	3.6
	Control	3.0	1.7	2.2	1.5	1.4	4.3	3.9	3.8	3.5	4.1	3.9	3.9	4.0	3.9
4 (rural)	Intervention	2.8	2.2	2.3	2.3	1.4	3.3	3.2	3.1	3.2	3.1	2.9	3.0	3.2	3.6
	Control	2.0	1.8	2.1	1.7	1.3	3.4	3.2	3.2	3.2	3.4	3.4	3.4	3.1	3.8
5 (urban)	Intervention	2.2	1.8	2.2	1.9	1.4	2.7	3.2	3.1	2.4	2.9	4.3	4.2	2.8	3.5
	Control	2.2	1.6	2.0	1.7	1.3	2.6	3.1	3.4	2.7	3.8	4.5	4.4	3.1	3.5
6 (rural)	Intervention	1.8	1.5	1.6	1.6	1.3	3.4	3.0	3.1	3.8	3.5	4.1	4.1	3.3	3.7
	Control	2.5	1.5	2.0	1.5	1.3	3.4	3.0	3.2	4.0	3.7	4.1	4.1	3.5	3.6
Summary															
Rural		2.3	1.7	1.9	1.8	1.3	3.7	3.4	3.4	3.5	3.6	3.8	3.8	3.5	3.8
Urban		2.1	1.6	1.9	1.8	1.3	2.7	3.0	2.9	1.9	2.7	3.7	3.6	2.8	3.3
All		2.2	1.7	1.9	1.8	1.3	3.4	3.3	3.3	3.0	3.3	3.8	3.7	3.3	3.6

TABLE F5: RANKING IMPORTANCE OF ENVIRONMENTAL SANITATION, BY OPTION TYPE

Site	Intervention/ Control	Importance of environmental sanitation management (Q I.2)								
		Rubbish	Sewage	Standing water	Smoke	Smell	Dirt outside	Direct inside	Rodents	Insects
1 (urban)	Intervention	3.9	3.8	3.6	3.6	3.7	3.7	3.7	3.5	3.5
2 (rural)	Intervention	4.2	4.2	4.2	4.1	4.2	4.2	4.1	4.1	4.1
	Control	3.8	3.7	3.8	3.6	3.7	3.8	3.8	3.8	3.7
3 (rural)	Intervention	3.9	3.7	3.6	3.7	3.7	3.7	3.6	3.5	3.5
	Control	4.0	3.9	3.7	3.7	3.9	3.7	3.8	3.5	3.4
4 (rural)	Intervention	3.8	3.8	3.8	3.8	3.8	3.9	3.9	3.8	3.9
	Control	4.0	4.0	3.9	3.9	3.9	4.0	3.9	4.0	4.0
5 (urban)	Intervention	3.9	3.9	3.9	3.9	3.9	4.0	4.1	3.9	3.9
	Control	4.0	3.9	4.0	3.8	3.8	4.0	4.0	4.0	3.9
6 (rural)	Intervention	3.9	3.8	3.8	3.8	3.8	3.9	3.9	3.9	3.9
	Control	3.8	3.7	3.7	3.8	3.8	3.8	3.8	3.8	3.8
Summary										
Rural		3.9	3.9	3.8	3.8	3.9	3.9	3.9	3.8	3.8
Urban		3.9	3.9	3.8	3.7	3.8	3.8	3.9	3.7	3.7
All		3.9	3.9	3.8	3.8	3.9	3.9	3.9	3.8	3.8

TABLE F6: FINANCING FROM HOUSEHOLD AND PROJECT SOURCES

Item	Site		
	3	5	6
Rural/Urban	Rural	Urban	Rural
Facilities received	Wet pit latrine	Wet pit latrine	Wet pit latrine
Sample size	76	102	116
Households with sanitation from the program, of which	38	37	53
Government	1	2	1
ADB	0	0	0
Red Cross	28	4	1
Others	0	1	2
Not known	9	30	49
Households contributing (% of beneficiaries)			
Cash	52%	50%	50%
Materials	7%	11%	7%
Labor	91%	97%	100%
Value of household inputs per beneficiary (thousand kip)			
Cash	140	143	357
Materials	311	157	415
Labor contribution per beneficiary (hours)	37	22	39
Value of project input per household (thousand kip)	383	466	174

TABLE F7: HOUSEHOLD CHOICES AND OTHER INTERVENTIONS

	Site			
	3	**5**	**6**	**All sites**
Rural/Urban	206	183	227	
Number of households receiving intervention	39	37	53	129
Was household given a choice to participate? (%)				
Yes, voluntary	51.3	51.4	64.2	56.6
No, not voluntary	43.6	43.2	34.0	90.1
Not applicable	5.1	5.4	1.9	5.5
Was household given a choice of options? (%)				
Yes, choice available	28.2	40.5	41.5	865.2
No, choice not available	71.8	56.8	43.4	8.3
Not applicable	0.0	2.7	15.1	108.1
Hygiene awareness (%) - Did the program/community provide hygiene awareness at the same time?				
Yes	69.2	48.6	43.4	62.9
No	28.2	35.1	34.0	66.8
Not applicable	2.6	16.2	22.6	28.4
Water intervention offered (%) - Did the program/community provide water services to your household?				
Yes	7.7	8.1	18.9	56.3
No	92.3	86.5	77.4	193.8
Not applicable	0.0	5.4	3.8	2.1

TABLE F8: APPROPRIATE TECHNOLOGY

Site	Rural/ urban	Number of households interviewed	% households with insufficient water for flushing[a]		% households with pit flooding[b]		% households with pit overflow[b]	
			Sometimes	**Often**	**Sometimes**	**Often**	**Sometimes**	**Often**
1	urban	179	23.5	11.8	na	na	na	na
2	rural	191	20.5	-	na	na	na	na
3	rural	206	33.3	8.3	6.9	-	3.5	-
4	rural	194	nc	nc	15.7	12.9	10.0	-
5	urban	183	16.7	16.7	na	na	na	na
6	rural	227	33.3	-	na	na	na	na
All sites		**1,180**	**26.0**	**7.0**	**11.2**	**6.2**	**6.6**	**0.0**

[a]Applies to wet pit latrines and pour-flush toilets only; [b]applies to dry pit latrines only

TABLE F9: ACTUAL PROGRAM PERFORMANCE IN RELATION TO KEY SELECTED INDICATORS FOR PROGRAM EFFECTIVENESS, RURAL SITES ONLY

Variable	Site						
	1	2	3	4	5	6	All
Rural/Urban	Urban	Rural	Rural	Rural	Urban	Rural	
Households with access to toilets	194	159	110	147	148	117	875
Number of toilets provided by government, NGOs, donors and other institutions	-	-	38	-	37	53	128
% of households, with members who often or always:							
Use bush for defecation	1.6	0.6	2.8	8.2	1.4	0.9	2.5
Use bush for urination	1.6	15.7	30.8	32.7	4.8	7.8	14.4
Children seen defecating in yard	4.9	22.0	35.8	25.6	2.3	14.5	16.2
% of households, with members who often or always:							
Children using or stool disposed in toilet/latrine	85.7	85.5	69.6	70.7	88.4	88.5	81.9
Wash hands with soap yesterday	67.7	97.5	66.4	72.8	67.3	75.9	74.8
Wash hands after defecation	47.9	70.9	40.2	49.7	49.0	51.7	52.1
% of households, with members who often or always:							
Using well which is not covered	64.9	na	-	46.7	23.1	20.0	28.8
Using bucket to withdraw water from well	40.4	na	60.0	46.7	19.2	60.0	43.5
Signs of feces on the floor inside the toilet	4.6	6.9	12.0	6.0	22.6	4.8	9.3
Signs of insects inside the toilet	15.0	10.6	25.6	18.1	40.5	19.7	21.0
Running water in or near toilet	27.5	77.7	17.9	20.7	8.3	32.0	31.6
Soap available inside or near the toilet facility for washing hands	42.5	76.6	33.3	61.2	31.5	57.1	50.8

TABLE F10: ACTUAL PROGRAM PERFORMANCE IN RELATION TO KEY SELECTED INDICATORS FOR PROGRAM EFFECTIVENESS

Impact	Indicator	Site					
		1	2	3	4	5	6
		Urban	Rural	Rural	Rural	Urban	Rural
Health improvement (basic sanitation)	% household members using improved toilet regularly	100.0	99.8	68.2	93.9	94.9	63.8
Health (hygiene intervention)	% households washing hands after defecation	47.9	73.3	37.5	50.5	49.5	49.1
Water source	% of households with facilities that partially of fully isolate water from human excreta	100.0	82.7	51.5	75.3	79.8	50.7
Water treatment	% households using non-boiling household water treatment methods	42.4	11.4	19.8	4.1	6.8	29.2
Access time	% household members using own toilet instead of off-plot options	95.8	88.8	90.0	84.0	98.3	99.2
	Men	95.4	90.1	90.9	85.8	98.4	99.4
	Women	97.0	88.5	90.0	83.3	98.2	98.9
	Children 5-14	93.8	87.0	88.9	85.8	98.3	99.1
	Children 0-4	94.4	88.9	90.8	74.5	98.1	100.0

ANNEX G

TABLE G1: PLACES VISITED (% RESPONDENTS) AND ENJOYMENT OF STAY (1 = NOT AT ALL TO 5 = VERY MUCH)

Category	Hotel tariff	N	Vientiane		Luang Prabang		Vang Vieng		Other towns		Rural Villages		Cultural sites		Natural sites		Service Level	
			%	Score	%	Score	%	Score	%	Score	%	Score	%	Score	%	Score	%	Score
Tourist	Free	7	86.0	3.5	14.0	5.0	14.0	4.0	29.0	4.5	29.0	4.00	71.00	3.60	29.00	4.00	100.00	3.90
	1-14	41	93.0	3.6	63.0	4.6	56.0	4.0	29.0	3.8	22.0	4.40	80.00	4.20	66.00	4.60	98.00	4.00
	15-29	52	100.0	3.7	52.0	4.6	54.0	3.8	31.0	3.4	33.0	4.20	92.00	4.50	63.00	4.80	100.00	3.90
	30-59	52	100.0	3.8	46.0	4.2	38.0	3.7	17.0	3.6	35.0	4.40	96.00	4.30	52.00	4.60	100.00	4.00
	60-89	19	95.0	3.5	58.0	4.3	26.0	3.8	16.0	4	32.0	3.50	74.00	4.10	47.00	4.60	89.00	3.60
	90-119	8	100.0	4.5	38.0	5.0	13.0	1.0	13.0	4	38.0	4.70	100.00	4.60	50.00	4.80	100.00	4.50
	120-149	6	100.0	3.8	17.0	4.0	0.0	-	17.0	5	17.0	4.00	83.00	4.00	50.00	3.70	100.00	4.30
	150+	3	100.0	3.3	67.0	5.0	33.0	4.0	33.0	5	33.0	5.00	100.00	5.00	33.00	5.00	100.00	4.30
	Sub-total	188	97.0	3.7	51.0	4.5	42.0	3.8	24.0	3.7	30.0	4.30	88.00	4.30	56.00	4.60	98.00	4.00
Business	Free	10	90.0	3.8	0.0	-	0.0	-	30.0	4.3	10.0	4.00	40.00	4.20	20.00	4.50	100.00	4.00
	1-14	1	100.0	3	0.0	-	0.0	-	0.0	-	100.0	3.00	100.00	4.00	-	-	100.00	4.00
	15-29	5	100.0	3.4	80.0	4.3	40.0	3.5	40.0	3.1	20.0	5.00	60.00	4.70	40.00	4.50	100.00	3.80
	30-59	16	100.0	3.8	0.0	-	6.0	4.0	13.0	4.5	19.0	3.30	56.00	4.30	25.00	4.80	100.00	4.30
	60-89	5	100.0	3.4	0.0	-	0.0	-	20.0	2	40.0	3.50	60.00	4.00	20.00	4.00	100.00	4.00
	90-119	7	100.0	4.1	0.0	-	0.0	-	0.0	-	-	-	57.00	3.80	-	-	86.00	4.00
	120-149	3	100.0	2.7	33.0	5.0	0.0	-	67.0	1.5	67.0	1.50	67.00	4.50	-	-	100.00	4.00
	150+	0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	Sub-total	47	98.0	3.6	11.0	4.4	6.0	3.7	21.0	3.4	21.0	3.20	55.00	4.20	19.00	4.60	98.00	4.10
TOTAL		**235**	**98.0**	**3.7**	**43.0**	**4.5**	**35.0**	**3.8**	**23.0**	**3.7**	**29.0**	**4.10**	**82.00**	**4.30**	**49.00**	**4.60**	**98.00**	**4.00**

TABLE G2: GENERAL SANITARY EXPERIENCE (1 = VERY POOR TO 5 = VERY GOOD)

Category	Hotel tariff	N	General sanitary condition	Vientiane Capital	Luang Pra-bang	Vang Vieng	Hotel and Guesthouse Environ-ment	Swimming Pools	Lakes and Rivers	Restaurants
Tourist	Free	7	3.00	3.20	4.00	na	4.20	na	2.70	3.10
	1-14	41	2.60	2.90	3.60	2.60	3.70	3.70	3.90	3.90
	15-29	52	2.40	3.00	3.60	2.80	3.50	3.00	3.30	3.80
	30-59	52	2.60	3.10	3.40	3.10	3.80	2.80	3.30	3.80
	60-89	19	2.50	3.10	2.80	2.80	3.90	3.00	3.40	3.70
	90-119	8	3.00	4.00	4.50	1.00	4.40	4.50	4.30	4.20
	120-149	6	3.50	3.20	4.00	na	4.40	4.00	3.00	4.20
	150+	3	3.00	4.00	4.50	4.00	5.00	5.00	4.50	4.70
	Sub-total	188	2.60	3.10	3.50	2.80	3.80	3.30	3.50	3.80
Business	Free	10	3.30	3.50	na	na	4.30	3.00	3.60	4.00
	1-14	1	3.00	3.00	na	na	5.00	5.00	4.00	5.00
	15-29	5	2.20	3.40	3.50	2.00	3.00	2.00	4.00	3.00
	30-59	16	2.70	3.10	na	2.00	3.80	2.00	2.90	3.70
	60-89	5	2.40	3.60	na	na	4.00	4.00	3.00	3.80
	90-119	7	3.00	3.40	na	na	3.60	3.00	3.30	3.80
	120-149	3	1.70	3.30	na	na	4.00	3.50	2.50	3.00
	150+	0	na	na	na	na	na	na	na	na
	Sub-total	47	2.70	3.30	3.50	2.00	3.80	3.20	3.20	3.70
TOTAL		**235**	**2.60**	**3.10**	**3.50**	**2.80**	**3.80**	**3.30**	**3.40**	**3.80**

TABLE G3: SANITARY EXPERIENCE IN RELATION TO TOILETS AND HAND WASHING

Category	Hotel tariff	N	Quality of toilets (1= very poor to 5 = very good)					Toilet availability		Water and soap for hand washing (1 = never to 5 = always)				
			Hotel	Restaurants	Airports	Bus stations	City	% could not find when needed	% impact on stay	Hotel	Restaurants	Airports	Bus stations	City
Tourist	Free	7	4.2	3.4	4.4	1.0	3.5	57.0	50.0	4.0	3.2	4.0	1.0	2.3
	1-14	41	3.3	2.9	3.9	2.3	2.1	54.0	59.0	3.6	3.2	3.8	1.4	1.7
	15-29	52	3.5	3.2	3.8	1.4	1.5	52.0	67.0	3.7	2.9	3.9	1.6	1.6
	30-59	52	3.8	3.4	3.5	2.0	2.0	40.0	67.0	3.8	3.3	3.8	1.7	1.8
	60-89	19	3.6	3.2	3.6	1.8	1.3	53.0	70.0	3.7	3.5	3.7	2.0	1.4
	90-119	8	4.4	4.0	4.0	na	na	na	na	3.5	3.3	2.0	na	na
	120-149	6	3.8	3.8	3.8	2.0	5.0	17.0	100.0	4.0	3.3	3.3	2.0	4.0
	150+	3	5.0	4.5	4.0	na	na	67.0	50.0	4.0	4.0	4.0	na	na
	Sub-total	188	3.7	3.3	3.7	1.9	2.0	46.0	64.0	3.7	3.2	3.8	1.6	1.8
Business	Free	10	4.0	3.4	3.9	1.3	2.0	50.0	100.0	4.0	3.6	4.0	1.0	1.0
	1-14	1	5.0	4.0	4.0	3.0	3.0	na	na	na	na	4.0	1.0	3.0
	15-29	5	2.8	2.2	3.8	na	2.0	80.0	100.0	3.3	3.0	4.0	na	na
	30-59	16	3.8	3.1	3.6	4.0	2.0	50.0	50.0	3.6	3.1	3.8	1.0	na
	60-89	5	3.8	3.6	3.4	3.0	na	na	na	4.0	3.2	3.3	na	na
	90-119	7	4.4	3.8	3.6	na	3.0	29.0	100.0	4.0	3.6	4.0	na	1.0
	120-149	3	3.7	3.3	3.0	1.0	1.0	67.0	100.0	4.0	2.7	4.0	1.0	1.5
	150+	0	na	na	na	na	na	na	na	na	na	na	na	na
	Sub-total	47	3.9	3.2	3.7	2.3	2.3	45.0	81.0	3.7	3.2	3.8	1.0	1.6
TOTAL		**235**	**3.7**	**3.2**	**3.7**	**1.9**	**2.0**	**46.0**	**68.0**	**3.7**	**3.2**	**3.8**	**1.5**	**1.8**

TABLE G4: WHAT FACTORS WERE OF MOST CONCERN? (% OF RESPONDENTS)

Category	Hotel tariff	N	Bottled water and ice	Tap water	Swimming pool water	Food safety	Public toilets	Unsanitary toilets	Shaking hands	Currency notes
Tourist	Free	7	14.0	14.0	0.0	57.0	14.0	14.0	14.0	14.0
	1-14	41	24.0	56.0	10.0	44.0	34.0	5.0	5.0	10.0
	15-29	52	23.0	42.0	12.0	48.0	50.0	4.0	4.0	6.0
	30-59	52	21.0	42.0	17.0	44.0	40.0	8.0	8.0	8.0
	60-89	19	21.0	53.0	33.0	42.0	53.0	11.0	11.0	5.0
	90-119	8	25.0	13.0	0.0	38.0	25.0	na	na	13.0
	120-149	6	50.0	17.0	0.0	57.0	14.0	na	na	14.0
	150+	3	33.0	67.0	0.0	33.0	na	na	na	33.0
	Sub-total	188	23.0	44.0	12.0	45.0	40.0	6.0	6.0	8.0
Business	Free	10	60.0	20.0	0.0	30.0	40.0	na	na	30.0
	1-14	1	0.0	100.0	0.0	0.0	100.0	na	na	na
	15-29	5	20.0	0.0	20.0	60.0	20.0	na	na	na
	30-59	16	31.0	25.0	0.0	19.0	38.0	na	na	13.0
	60-89	5	60.0	0.0	0.0	40.0	60.0	na	na	20.0
	90-119	7	57.0	29.0	0.0	29.0	14.0	na	na	29.0
	120-149	3	33.0	0.0	0.0	67.0	100.0	na	na	na
	150+	0	na	na	na	na	na	na	na	na
	Sub-total	47	43.0	19.0	2.0	32.0	40.0	na	na	17.0
TOTAL		**235**	**27.0**	**39.0**	**10.0**	**43.0**	**40.0**	**5.0**	**5.0**	**10.0**

TABLE G5: HEALTH PROBLEMS EXPERIENCED BY FOREIGN VISITORS

Category	Hotel tariff	N	Gastro-intestinal tract (GIT) infections		Suspected source of GIT infections (% of sick persons, multiple responses possible)				Average number of days of:		Medical care (%)				
			Visitors with infection	% of respondents	Drinking water or ice	Food	Dirty environment	Hot weather	Symptoms	Incapacitation	None	Medical practitioner: outpatient	Other practitioner: outpatient	Self-medication	Average Cost paid by patient (US$)
Tourist	Free	7	1	14.0	100.0	-	-	-	1.0	0.0	100.0	-	-	-	-
	1-14	41	8	20.0	-	100.0	13.0	-	2.1	0.1	63.0	-	-	38.0	4.0
	15-29	52	12	23.0	42.0	58.0	8.0	8.0	2.1	0.9	83.0	8.0	-	8.0	12.5
	30-59	52	7	13.0	43.0	86.0	29.0	14.0	2.1	0.5	71.0	14.0	14.0	-	2.5
	60-89	19	6	32.0	17.0	83.0	33.0	17.0	2.7	0.7	33.0	-	-	67.0	3.8
	90-119	8	2	25.0	-	50.0	-	-	1.5	0.5	100.0	-	-	-	-
	120-149	6	1	17.0	100.0	100.0	-	-	1.0	1.0	-	-	-	100.0	10.0
	150+	3	0	-	na	na	na	na	na	na	na	na	na	na	na
	Sub-total	188	37	20.0	30.0	76.0	16.0	8.0	2.1	0.6	68.0	5.0	3.0	24.0	5.6
Business	Free	10	2	20.0	50.0	100.0	-	50.0	5.0	1.0	-	-	-	100.0	3.0
	1-14	1	0	-	na	na	na	na	na	na	na	na	na	na	na
	15-29	5	1	20.0	100.0	100.0	100.0	-	2.0	1.0	100.0	-	-	-	-
	30-59	16	2	13.0	50.0	50.0	-	-	1.5	1.0	50.0	-	-	50.0	-
	60-89	5	0	-	na	na	na	na	na	na	na	na	na	na	na
	90-119	7	2	29.0	-	100.0	-	-	1.0	0.0	100.0	-	-	-	-
	120-149	3	1	33.0	-	100.0	-	-	5.0	2.0	-	100.0	-	-	18.0
	150+	0	0	na	na	na	na	na	na	na	na	na	na	na	na
	Sub-total	47	8	17.0	38.0	86.0	13.0	13.0	2.8	0.9	50.0	13.0	-	38.0	6.0
TOTAL		**235**	**45**	**19.0**	**31.0**	**78.0**	**16.0**	**9.0**	**2.2**	**0.6**	**64.0**	**7.0**	**2.0**	**27.0**	**5.7**

TABLE G6: INTENTION TO RETURN OF FOREIGN VISITORS

Category	Hotel tariff	N	Return to Lao PDR? (%)			Advise friends to visit Lao PDR? (%)		
			Yes	No	May be	Yes	No	May be
Tourist	Free	7	71	0	29	100	0	0
	1-14	41	85	5	10	100	0	0
	15-29	52	85	0	15	98	0	2
	30-59	52	83	4	13	96	0	4
	60-89	19	74	5	21	84	5	11
	90-119	8	100	0	0	100	0	0
	120-149	6	100	0	0	100	0	0
	150+	3	100	0	0	67	33	0
	Sub-total	188	84	3	13	96	1	3
Business	Free	10	100	0	0	90	0	10
	1-14	1	100	0	0	100	0	0
	15-29	5	100	0	0	80	20	0
	30-59	16	100	0	0	94	0	6
	60-89	5	80	0	20	100	0	0
	90-119	7	100	0	0	100	0	0
	120-149	3	100	0	0	67	0	33
	150+	0	0	0	0	0	0	0
	Sub-total	47	98	0	2	92	2	6
TOTAL		**235**	**87**	**2**	**11**	**95**	**1**	**4**

TABLE G7: REASONS FOR FOREIGN VISITORS HESITATING TO RETURN TO LAO PDR

Category	Hotel tariff	N	Reasons for hesitancy in returning (% cited)											
			Main						Contributory					
			Poor sanitation	Not value for money	Have seen all	Not safe	Poor service	Too many tourists	Poor sanitation	Not value for money	Have seen all	Not safe	Poor service	Too many tourists
Tourist	Free	7	14	-	-	-	-	-	-	14	-	-	14	-
	1-14	41	2	2	7	-	-	2	10	12	7	5	22	20
	15-29	52	6	2	4	2	8	2	15	8	17	8	13	2
	30-59	52	6	2	8	2	2	6	13	6	17	-	15	2
	60-89	19	11	5	-	5	-	11	37	21	26	-	26	5
	90-119	8	-	-	13	-	-	13	-	-	-	-	-	-
	120-149	6	-	-	17	17	-	-	33	33	-	17	17	-
	150+	3	-	-	-	-	-	-	-	-	-	-	-	-
	Sub-total	188	5	2	6	2	3	4	15	10	14	4	16	6
Business	Free	10	-	-	-	-	-	-	-	-	-	-	-	10
	1-14	1	-	-	-	-	-	-	-	-	-	-	-	-
	15-29	5	-	20	-	-	-	-	-	-	-	-	-	-
	30-59	16	-	-	-	-	-	-	13	-	6	13	13	13
	60-89	5	-	-	-	-	-	-	-	-	-	-	-	20
	90-119	7	-	14	-	14	-	-	14	-	-	-	14	14
	120-149	3	-	-	33	-	33	-	-	33	-	33	-	33
	150+	0	na	na	na	na	na	na	na	na	na	na	na	na
	Sub-total	47	-	4	2	2	2	-	6	2	2	6	6	13
TOTAL		**235**	**4**	**3**	**5**	**2**	**3**	**3**	**13**	**9**	**11**	**4**	**14**	**7**

ANNEX H

TABLE H1: RATING OF ENVIRONMENTAL SANITATION CONDITIONS IN THE LOCATION OF THE BUSINESS SURVEY INTERVIEW (1= BEST; 5 = WORST)

Variable	Food and beverage producers (Local)	Food and beverage producers (International)	Restaurants (Local/ International)	Hotels (International)	Travel agencies/ tour operators (Local)	Pharmaceutical factories (Local/ government)	All
Water quality in rivers	2.0	3.5	1.0	3.3	2.5	2.0	2.4
State of canals and rainwater drainage	3.2	4.5	4.0	4.3	4.0	3.0	3.8
Management of sewage	2.4	4.5	4.3	3.7	4.5	3.5	3.6
Management of industrial wastewater	3.0	4.5	nr	4.0	nr	3.0	3.5
Household coverage of private toilets	1.6	4.0	2.5	3.0	3.5	2.5	2.6
Toilets in public places	3.4	5.0	5.0	4.3	5.0	3.5	4.2
Household/office solid waste	3.2	4.5	1.0	4.0	3.5	3.0	3.3
Management of industrial solid waste	2.0	4.0	0.0	3.0	2.5	3.5	2.8
Air quality related to vehicles emissions	2.6	3.0	3.7	3.3	3.5	4.0	3.2
Air quality related to solid waste	2.2	3.5	1.5	2.7	3.5	3.5	2.7
Air quality related to poor excreta management	2.0	3.0	2.5	3.0	3.5	3.5	2.6
Number of companies	**5**	**2**	**3**	**3**	**2**	**2**	**17**
Number of responses	**5**	**2**	**3**	**3**	**2**	**2**	**17**

nr = no responses

ANNEX I

TABLE I1: SITE 1 AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION OPTIONS, USING FULL (ECONOMIC) COST (THOUSAND KIP, YEAR 2010)

Cost Item	Shared wet pit latrine	Shared toilet to septic tank	Private wet pit latrine	Toilet to septic tank	Toilet to sewer
Investment costs: Initial one-off spending (annualized)[a]	133.0	237.2	255.4	545.9	708.6
Recurrent costs: Average annual spending[b]	51.1	269.9	51.1	269.9	404.9
Average annual cost calculations					
Expected life (years)	3.0	12.5	6.0	25.0	25.0
Cost/household	184.1	507.1	306.5	815.8	1,113.4
Cost/capita	35.2	97.0	58.7	156.1	213.1
Of which:					
% capital	72%	47%	83%	67%	64%
% recurrent	28%	53%	17%	33%	36%
Number of households	7	11	72	84	12

[a] Program costs excluded. [b] Only represents cost of maintenance and operations. Program costs excluded.

TABLE I2: SITE 2 AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION OPTIONS, USING FULL (ECONOMIC) COST (THOUSAND KIP, YEAR 2010)

Cost Item	Shared wet pit latrine	Shared toilet to septic tank	Private wet pit latrine	Toilet to septic tank
Investment costs: Initial one-off spending (annualized)[a]	136.1	316.3	216.4	545.9
Recurrent costs: Average annual spending[b]	51.1	269.9	51.1	269.9
Average annual cost calculations				
Expected life (years)	3.0	12.5	6.0	25.0
Cost/household	187.2	586.2	267.6	815.8
Cost/capita	38.9	121.8	55.6	169.4
Of which:				
% capital	73%	54%	81%	67%
% recurrent	27%	46%	19%	33%
Number of households	36	7	67	48

[a] Program costs excluded. [b] Only represents cost of maintenance and operations. Program costs excluded.

TABLE I3: SITE 3 AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION OPTIONS, USING FULL (ECONOMIC) COST (THOUSAND KIP, YEAR 2010)

Cost Item	Shared wet pit latrine	Private dry pit latrine	Private wet pit latrine
Investment costs: Initial one-off spending (annualized)[a]	150.9	245.2	216.4
Recurrent costs: Average annual spending[b]	51.1	-	51.1
Average annual cost calculations			
Expected life (years)	3.0	1.0	6.0
Cost/household	202.0	245.2	267.6
Cost/capita	32.7	39.6	43.2
Of which:			
% capital	75%	100%	81%
% recurrent	25%	0%	19%
Number of households	11	30	65

[a] Program costs excluded. [b] Only represents cost of maintenance and operations. Program costs excluded.

TABLE I4: SITE 4 AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION OPTIONS, USING FULL (ECONOMIC) COST (THOUSAND KIP, YEAR 2010)

Cost Item	Private dry pit latrine	Private wet pit latrine
Investment costs: Initial one-off spending (annualized)[a]	245.2	216.4
Recurrent costs: Average annual spending[b]	-	51.1
Average annual cost calculations		
Expected life (years)	1.0	6.0
Cost/household	245.2	267.6
Cost/capita	49.5	54.0
Of which:		
% capital	100%	81%
% recurrent	0%	19%
Number of households	71	72

[a] Program costs excluded. [b] Only represents cost of maintenance and operations. Program costs excluded.

TABLE I5: SITE 5 AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION OPTIONS, USING FULL (ECONOMIC) COST (THOUSAND KIP, YEAR 2010)

Cost Item	Private wet pit latrine	Toilet to septic tank
Investment costs: Initial one-off spending (annualized)[a]	255.4	545.9
Recurrent costs: Average annual spending[b]	51.1	269.9
Average annual cost calculations		
Expected life (years)	6.0	25.0
Cost/household	306.5	815.8
Cost/capita	63.1	167.9
Of which:		
% capital	83%	67%
% recurrent	17%	33%
Number of households	97	43

[a] Program costs excluded. [b] Only represents cost of maintenance and operations. Program costs excluded.

TABLE I6: SITE 6 AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION OPTIONS, USING FULL (ECONOMIC) COST (THOUSAND KIP, YEAR 2010)

Cost Item	Private wet pit latrine
Investment costs: Initial one-off spending (annualized)[a]	216.4
Recurrent costs: Average annual spending[b]	51.1
Average annual cost calculations	
Expected life (years)	6.0
Cost/household	267.6
Cost/capita	61.4
Of which:	
% capital	81%
% recurrent	19%
Number of households	108

[a] Program costs excluded. [b] Only represents cost of maintenance and operations. Program costs excluded.

TABLE I7: INCREMENTAL COSTS OF MOVING UP THE SANITATION LADDER

	Facility	TO				
		Shared toilet to septic tank	Private dry pit latrine	Private wet pit latrine	Private toilet to septic tank	Private toilet to sewer
FROM	*SITE 1*					
	Shared wet pit latrine	323.0		122.4	631.6	929.3
	Shared toilet to septic tank			(200.6)	308.6	606.3
	Private wet pit latrine				509.2	806.9
	Private Toilet to septic tank					297.7
	SITE 2					
	Shared wet pit latrine	399.0		80.4	628.6	
	Shared toilet to septic tank			(318.6)	229.5	
	Private wet pit latrine				548.2	
	SITE 3					
	Shared wet pit latrine		43.2	65.5		
	Private dry pit latrine			22.4		
	SITE 4					
	Private dry pit latrine			22.4		
	SITE 5					
	Private wet pit latrine				509.2	
	SITE 6 (NOT APPLICABLE, ONE FACILITY ONLY)					
	Rural sites (uses average of costs in relevant sites)					
	Shared wet pit latrine	395.6	54.5	76.9	625.1	
	Shared toilet to septic tank		(341.0)	(318.6)	229.5	
	Private dry pit latrine			22.4	570.6	
	Private wet pit latrine				548.2	
	Urban sites (uses average of costs in relevant sites)					
	Shared wet pit latrine	323.0		122.4	631.6	929.3
	Shared toilet to septic tank			(200.6)	308.6	606.3
	Private wet pit latrine				509.2	806.9
	Private Toilet to septic tank					297.7
	All sites (uses average of costs in sites)					
	Shared wet pit latrine	348.1	55.4	91.4	625.9	923.6
	Shared toilet to septic tank		(292.7)	(256.6)	277.9	575.5
	Private dry pit latrine			36.1	570.6	868.2
	Private wet pit latrine				534.5	832.2
	Private toilet to septic tank					297.7

ANNEX J

TABLE J1: SITE 1 (URBAN), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARED TO "NO TOILET"

Item	Scenario	Shared wet pit latrine	Shared toilet to septic tank	Private wet pit latrine	Private toilet to septic tank	Private toilet to sewer
Number of observations		7	11	72	84	na
Cost-benefit measures						
Benefits per kip of input (kip)	Ideal	6.0	2.2	9.0	3.8	3.1
	Actual	5.8	2.2	8.7	3.7	na
Internal rate of return (%)	Ideal	>100	>100	>100	>100	>100
	Actual	>100	>100	>100	>100	na
Pay-back period (years)	Ideal	1	2	1	2	2
	Actual	1	2	1	2	na
Net present value (thousand kip)	Ideal	7,084	4,721	19,200	15,939	16,168
	Actual	6,895	4,533	18,462	15,201	na
Cost-effectiveness measures						
Cost per DALY averted (thousand kip)	Ideal	9,852	26,120	16,601	39,056	53,832
	Actual	9,852	26,120	16,601	39,056	na
Cost per case averted (thousand kip)	Ideal	74	196	125	294	405
	Actual	74	196	125	294	na
Cost per death averted (thousand kip)	Ideal	195,511	518,317	329,434	775,014	1,068,236
	Actual	195,511	518,317	329,434	775,014	na

TABLE J2: SITE 2 (RURAL), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARED TO "NO TOILET"

Item	Scenario	Shared wet pit latrine	Shared toilet to septic tank	Private wet pit latrine	Private toilet to septic tank
Number of observations		36	7	67	48
Cost-benefit measures					
Benefits per kip of input (kip)	Ideal	10.7	3.6	10.9	4.1
	Actual	10.0	3.4	10.0	3.7
Internal rate of return (%)	Ideal	>100	>100	>100	93.4
	Actual	>100	>100	>100	>100
Pay-back period (years)	Ideal	1	1	1	2
	Actual	1	2	1	2
Net present value (thousand kip)	Ideal	14,158	11,306	20,952	17,389
	Actual	13,028	10,175	18,990	15,426
Cost-effectiveness measures					
Cost per DALY averted (thousand kip)	Ideal	8,556	25,345	12,409	33,382
	Actual	8,575	25,400	12,435	33,454
Cost per case averted (thousand kip)	Ideal	63	186	91	246
	Actual	63	187	92	246
Cost per death averted (thousand kip)	Ideal	150,965	447,173	218,930	588,980
	Actual	151,291	448,139	219,403	590,252

TABLE J3: SITE 3 (RURAL), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARED TO "NO TOILET"

Item	Scenario	Shared wet pitlatrine	Private dry pitlatrine	Private wet pitlatrine
Number of observations		11	30	65
Cost-benefit measures				
Benefits per kip of input (kip)	Ideal	9.1	10.4	9.0
	Actual	7.0	8.3	7.2
Internal rate of return (%)	Ideal	>100	>100	>100
	Actual	>100	>100	>100
Pay-back period (years)	Ideal	1	1	1
	Actual	1	1	1
Net present value (thousand kip)	Ideal	12,656	17,154	16,874
	Actual	9,381	13,406	13,125
Cost-effectiveness measures				
Cost per DALY averted (thousand kip)	Ideal	1,403	1,638	1,889
	Actual	2,058	2,403	2,771
Cost per case averted (thousand kip)	Ideal	29	34	39
	Actual	43	50	58
Cost per death averted (thousand kip)	Ideal	64,621	75,438	87,011
	Actual	94,785	110,651	127,626

TABLE J4: SITE 4 (RURAL), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARED TO "NO TOILET"

Item	Scenario	Shared wet pit latrine	Shared toilet to septic tank
Number of observations		71	72
Cost-benefit measures			
Benefits per kip of input (kip)	Ideal	8.4	7.3
	Actual	6.8	5.9
Internal rate of return (%)	Ideal	>100	>100
	Actual	>100	>100
Pay-back period (years)	Ideal	1	1
	Actual	1	2
Net present value (thousand kip)	Ideal	13,504	13,224
	Actual	10,532	10,252
Cost-effectiveness measures			
Cost per DALY averted (thousand kip)	Ideal	6,437	7,424
	Actual	6,858	7,910
Cost per case averted (thousand kip)	Ideal	47	54
	Actual	50	58
Cost per death averted (thousand kip)	Ideal	116,482	134,352
	Actual	124,100	143,139

TABLE J5: SITE 5 (URBAN), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARED TO "NO TOILET"

Item	Scenario	Shared wet pit latrine	Shared toilet to septic tank
Number of observations		97	43
Cost-benefit measures			
Benefits per kip of input (kip)	Ideal	4.2	1.8
	Actual	3.9	1.6
Internal rate of return (%)	Ideal	>100	37.4
	Actual	>100	32.6
Pay-back period (years)	Ideal	1	5
	Actual	1	6
Net present value (thousand kip)	Ideal	7,629	4,368
	Actual	6,881	3,620
Cost-effectiveness measures			
Cost per DALY averted (thousand kip)	Ideal	15,602	36,704
	Actual	16,438	38,672
Cost per case averted (thousand kip)	Ideal	123	289
	Actual	130	305
Cost per death averted (thousand kip)	Ideal	282,122	663,710
	Actual	297,251	699,300

TABLE J6: SITE 6 (RURAL), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARED TO "NO TOILET"

Item	Scenario	Shared wet pit latrine
Number of observations		108
Cost-benefit measures		
Benefits per kip of input (kip)	Ideal	5.6
	Actual	4.7
Internal rate of return (%)	Ideal	>100
	Actual	>100
Pay-back period (years)	Ideal	1
	Actual	2
Net present value (thousand kip)	Ideal	9,711
	Actual	7,819
Cost-effectiveness measures		
Cost per DALY averted (thousand kip)	Ideal	8,958
	Actual	14,046
Cost per case averted (thousand kip)	Ideal	64
	Actual	100
Cost per death averted (thousand kip)	Ideal	170,960
	Actual	268,071

ANNEX K

TABLE K1: SITE 1 (RURAL), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Item	Scenario	From/to									
		Shared wet pit latrine to:				Shared toilet to septic tank to:			Private wet pit latrine to:		Private toilet to septic tank to:
		Shared toilet to septic tank	Private wet pit latrine	Private toilet to septic tank	Private toilet to sewer	Private wet pit latrine	Private toilet to septic tank	Private toilet to sewer	Private toilet to septic tank	Private toilet to sewer	Private toilet to sewer
Cost-benefit measures											
Benefits per kip of input (kip)	Ideal	0.4	1.5	0.6	0.5	4.0	1.7	1.4	0.4	0.3	0.8
	Actual	0.4	1.5	0.6	0.5	3.9	1.7	1.4	0.4	0.3	na
Pay-back period (years)	Ideal	1	-	1	1	(1)[1]	-	-	1	1	-
	Actual	1	-	1	1	(1)[1]	-	-	1	1	na
Net present value (thousand kip)	Ideal	(2,363)[1]	12,116	8,855	9,084	14,478	11,217	11,447	(3,261)[1]	(3,032)[1]	229
	Actual	(2,363)[1]	11,567	8,306	8,535	13,929	10,668	10,898	(3,261)[1]	(3,032)[1]	na
Cost-effectiveness measures											
Cost per DALY averted (thousand kip)	Ideal	16,267	6,749	29,203	43,980	(9,518)[1]	12,936	27,712	22,454	37,231	14,776
	Actual	16,267	6,749	29,203	43,980	(9,518)[1]	12,936	27,712	22,454	37,231	na
Cost per case averted (thousand kip)	Ideal	122	51	220	331	(72)[1]	97	208	169	280	111
	Actual	122	51	220	331	(72)[1]	97	208	169	280	na
Cost per death averted (thousand kip)	Ideal	322,806	133,924	579,503	872,726	(188,882)[1]	256,698	549,920	445,580	738,802	293,222
	Actual	322,806	133,924	579,503	(96,222)	(188,882)[1]	256,698	(419,028)	445,580	(230,146)[1]	na

[1]Parentheses denotes negative number

TABLE K2: SITE 2 (RURAL), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Item	Scenario	From/to					
		Shared wet pit latrine			Shared toilet to septic tank		Private toilet to septic tank
		Shared toilet to septic tank	Private wet pit latrine	Private toilet to septic tank	Private wet pit latrine	Private toilet to septic tank	Private toilet to septic tank
Cost-benefit measures							
Benefits per kip of input (kip)	Ideal	0.3	1.0	0.4	3.0	1.1	0.4
	Actual	0.3	1.0	0.4	3.0	1.1	0.4
Pay-back period (years)	Ideal	-	-	1	-	1	1
	Actual	1	-	1	(1)	-	1
Net present value (thousand kip)	Ideal	(2,853)	6,794	3,230	9,647	6,083	(3,564)
	Actual	(2,853)	5,962	2,398	8,815	5,251	(3,564)
Cost-effectiveness measures							
Cost per DALY averted (thousand kip)	Ideal	16,788	3,852	24,826	(12,936)	8,037	20,974
	Actual	16,825	3,860	24,879	(12,964)	8,055	21,019
Cost per case averted (thousand kip)	Ideal	124	28	183	(95)	59	154
	Actual	124	28	183	(95)	59	155
Cost per death averted (thousand kip)	Ideal	296,207	67,965	438,015	(228,243)	141,807	370,050
	Actual	296,847	68,112	438,961	(228,736)	142,114	370,849

TABLE K3: SITE 3 (RURAL), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Item	Scenario	From/to		
		Shared wet pit latrine		Private dry pit latrine
		Private dry pit latrine	Private wet pit latrine	Private wet pit latrine
Cost-benefit measures				
Benefits per kip of input (kip)	Ideal	1.1	1.0	0.9
	Actual	1.2	1.0	0.9
Pay-back period (years)	Ideal	-	-	-
	Actual	-	-	-
Net present value (thousand kip)	Ideal	4,499	4,218	(280)
	Actual	4,025	3,744	(280)
Cost-effectiveness measures				
Cost per DALY averted (thousand kip)	Ideal	(12,936)	8,037	20,974
	Actual	(12,964)	8,055	21,019
Cost per case averted (thousand kip)	Ideal	(95)	59	154
	Actual	(95)	59	155
Cost per death averted (thousand kip)	Ideal	(228,243)	141,807	370,050
	Actual	(228,736)	142,114	370,849

TABLE K4: SITE 4 (RURAL), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Item	Scenario	From private dry pit latrine to private wet pit latrine
Cost-benefit measures		
Benefits per kip of input (kip)	Ideal	0.9
	Actual	0.9
Pay-back period (years)	Ideal	-
	Actual	1
Net present value (thousand kip)	Ideal	(280)
	Actual	(280)
Cost-effectiveness measures		
Cost per DALY averted (thousand kip)	Ideal	987
	Actual	1,052
Cost per case averted (thousand kip)	Ideal	7
	Actual	8
Cost per death averted (thousand kip)	Ideal	17,870
	Actual	19,039

TABLE K5: SITE 5 (URBAN), EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Item	Scenario	From private wet pit latrine to private toilet to septic tank
Cost-benefit measures		
Benefits per kip of input (kip)	Ideal	0.4
	Actual	0.4
Pay-back period (years)	Ideal	4
	Actual	5
Net present value (thousand kip)	Ideal	(3,261)
	Actual	(3,261)
Cost-effectiveness measures		
Cost per DALY averted (thousand kip)	Ideal	21,102
	Actual	22,234
Cost per case averted (thousand kip)	Ideal	166
	Actual	175
Cost per death averted (thousand kip)	Ideal	381,587
	Actual	402,049

TABLE K6: SENSITIVITY ANALYSIS: NET PRESENT VALUES (IDEAL SETTING, THOUSAND KIP, SITE 1)

Experiment[a]	Shared wet pit latrine	Shared toilet to septic tank	Private wet pit latrine	Private toilet to septic tank	Private toilet to sewer
Baseline	7,084	4,721	19,200	15,939	16,168
1	3,680	1,318	7,642	4,381	4,183
2	19,840	17,477	62,513	59,252	61,054
3	7,267	4,904	19,383	16,122	16,446
4	7,450	5,088	19,566	16,305	16,740
5	7,119	4,757	19,235	15,974	16,217
6	6,582	3,952	18,208	14,230	10,608
7	6,870	3,594	18,986	14,811	11,935
8	6,368	2,825	17,994	13,103	6,381
9	12,361	9,282	30,132	26,733	28,636
10	4,046	2,288	11,248	8,155	7,769

a The experiments in the analysis are as follows: (1) Using national GDP instead of "provincial GDP"; (2) 100% of time for adults and 50% of time for children (people under 15 years); (3) 10% increase in diarrhea incidence rates; (4) 10% increase in incidence rates of all diseases; (5) 10% increase in diarrheal mortality rates at same incidence rates; (6) 50% increase in investment costs; (7) 50% increase in recurrent costs; (8) 50% increase in investment and recurrent costs; (9) discount rate is half the value in the baseline; (10) discount rate is double the value in the baseline

TABLE K7: BASIC FEATURES OF SANITATION PROGRAMS

No.	Project Name	Sites	Funding source	Start year	End year	Implementing agency(ies)	Output	Implementing approach
1	Northern and Central Regions Water Supply and Sanitation Project (WSSSP)	Multiple sites including Nan District (Luang Prabang Province).[a]	ADB	2005	2010	Government Ministry of Public Works and Transport (MPWT) -Department of Housing and Urban Planning (DHUP) with support from the Asian Development Bank (ADB)	Water and sanitation hardware	Supply driven
2	Houaphanh Health Development Program.	Houaphanh	Concern Worldwide	2007	2012	Lao Ministry of Health's Center for Environmental Health and Water Supply (NAM SAAT) staff with support from Concern Worldwide	Water and sanitation software	Community-led total sanitation and demand driven
3	Primary Health Care Programme - Phase II.	Houaphanh	DRC and Lao Red Cross (LRC)	2003	2008	NAM SAAT staff with support from Danish Red Cross (DRC)	Water and sanitation hardware and software	Supply driven
4	Water and Sanitation project in Meun and Nan districts (3 villages)	Meun and Nan Districts	Lao Red Cross - International Committee of the Red Cross (ICRC)	2009		LRC staff with support from NAM SAAT	Water and sanitation hardware	Supply driven
5	Environmental Sanitation Upgrading project	Hatsady Tai village, Vientiane Capital	Asian Institute of Technology (AIT), Bangkok	2007	2010	National Public Works Institute (NPWI)	Water and sanitation hardware and hardware	Supply driven
6	Strengthening National Water Supply and Sanitation Strategy Program	Champone District, Savannakhet Province	Belgian Technical Cooperation (BTC)	2003	2006	NAM SAAT	Sanitation hardware	Supply driven

a The other sites are Kenethao (Sayaboury Province), Houn (Oudomxay Province), Keo Oudom (Vientiane Province), Xanakham (Vientiane Province) Khoun (Xiengkhouang Province), Xamtai (Houaphanh Province), Sing (Luang Namtha Province), Ngoi (Luang Prabang province), Namor (Oudomxai province), Namkeung (Bokeo province) and Old Namtha (Luang Namtha Province).

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