Economic Assessment of Sanitation Interventions in Vietnam

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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water and sanitation program

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

Economic growth in Vietnam remains impressive. In less than a decade, Vietnam has lifted around 20 million people out of poverty. However, Vietnam is still in the bottom half of countries in terms of GDP per capita. The productivity and well being of its population remain well below their potential.

The Government of Vietnam is making considerable efforts to improve the country's infrastructure, which provides the foundation for adequate living conditions and socio-economic development. Successful sanitation projects that significantly improve urban and rural environmental sanitation are now recognized in Hanoi, Hai Phong, Dak Lak, Quang Ninh, Quang Nam, Quang Ngai, Vinh Long and many other locations. Lessons for improving national policies and designing new projects are to be gathered from those schemes.

However, the water supply and sanitation sector in Vietnam still faces a number of challenges that can only be overcome through enhanced effort. For instance the sector lacks a mechanism for regular sector assessments that addresses critical issues such as the different institutional, managerial and operational aspects of the sector and their links to health, well being and economic development. The institutional arrangement for urban and rural water supply and sanitation also prevents synergy, information exchange and coordination.

Vietnam is already widely recognized for its rapid and very impressive progress towards the Millennium Development Goals (MDGs). While considerable investments have been made in the water and sanitation sector, the country still faces many challenges. According to the Joint Monitoring Programme (JMP) run by the World Health Organization and UNICEF, the population of Vietnam has enjoyed increased access to water sources, from 57% in 1990 to 95% in 2010, and increased sanitation access from 37% in 1990 to 76% in 2010 (JMP, 2012). However, the JMP and national definitions differ. According to the National Target Programme, only 40% of the rural population had access to clean domestic water sources in 2010, and only 55% of rural families have access to hygienic toilets. Many challenges remain to providing unserved populations with the basic minimum of services according to national standards, and also to moving populations further up the water supply and sanitation ladder to enjoy full access. A lack of universal coverage of basic sanitation and drinking water facilities continues to have a series of negative effects on the population. Phase 1 of the Economics of Sanitation Initiative (ESI) study showed that water- and sanitation-related diseases were responsible for 34% of the US$780 million annual economic impact of poor sanitation in Vietnam (Thang et al, 2007). The remaining 66% was contributed by the pollution of water resources (US$287 million), impact on land use value (US$118 million), time lost to finding a location for excretion (US$41.6 million) and the potential economic impact of lost tourism (US$69 million).

B. STUDY AIMS AND METHODS

The aim of the study was to generate robust evidence of the costs and benefits of sanitation improvement in different programmatic and geographic contexts in Vietnam, leading to policy recommendations to help the selection of the most efficient and sustainable sanitation interventions and programs. Basic hygiene aspects are also included, insofar as they affect health outcomes. Selected aspects of sanitation such as technology choice, project management, user acceptance and willingness to pay in on-site, cluster and centralized sanitation systems were assessed in this study.

The types of sanitation assessed in the Vietnam study included on-site and off-site management of human excreta, urban and rural wastewater management, domestic solid waste management, and animal waste from farms.

The study estimated the costs of different sanitation options, including program management, on-site and off-site costs. The study evaluated the following benefits of improved sanitation: health; water quality; access time; excreta and wastewater reuse; 'intangible' impacts; and improved external environment. A range of data sources was used in the study, collected from both households with and without improved sanitation, to ensure that before versus after intervention scenarios were 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 both poor and improved sanitation, and the factors driving sanitation decisions. These data were supplemented with evidence from other local, national and international surveys and data sets on variables that could not be adequately captured in the field surveys.

The study methodology in Vietnam follows a standard methodology developed at regional level reflecting established cost-benefit techniques, which have been adapted to sanitation interventions and the Vietnam field study based on specific research needs and opportunities.

The study consists of a field component, which leads to quantitative benefit-cost ratio (BCR) estimates as well as in-depth examination of qualitative aspects of sanitation.

Economic evaluation of sanitation interventions should be based on sufficient evidence of impact, thus giving unbiased estimates of economic efficiency. Annual equivalent costs were calculated based on annualized investment cost (taking into account the estimated length of life of hardware and software components) and adding annual maintenance and operational costs. Financial costs were distinguished from non-financial costs, and broken down by financing source.

Benefits of improved sanitation and hygiene in this study included both direct household and external local level benefits (health impacts related to household sanitation and hygiene, local water resource impacts, access time, intangible impacts, house prices, and the value of human excreta reuse, and wider scale, external macro-level benefits). Macro-level benefits included water quality for productive uses, tourism, local business impact and foreign direct investment. As well as improved management of human excreta, other contributors to environmental improvement such as solid waste management and wastewater treatment were considered. In this study, the selected evaluation approach was to construct an economic model to assess the cost-benefit of providing sanitation interventions and of moving from one sanitation coverage category to the next. Two types of field-level cost-benefit performance are presented for sanitation programs:

- Type 1 reflects ideal performance assuming the intervention is delivered, maintained and used appropriately.
- Type 2 reflects actual performance based on observed levels of intervention effectiveness in the field sites.

Overall cost-benefit assessment also takes into account the intangible benefits of sanitation improvements and other benefits that may accrue outside the sanitation improvement site. Furthermore, program and project approaches were evaluated to obtain lessons on how to efficiently implement sanitation interventions in practice.

C. DATA SOURCES AND STUDY SITES

Given the range of costs and benefits estimated in this study, a number of different data sources were defined including up-to-date evidence from the field sites and evidence from other databases and studies. Data collection at field sites was conducted using different tools, including: a household survey; focus group discussion; stakeholder interviews; a market survey; a water quality survey; and information collection from available reports.

Seventeen locations were selected for the field surveys – eight urban and nine rural – in order to represent a range of sanitation program case studies covering Northern, Central and Southern regions of the country. Selection of study sites was also based on different technical options applied at different scales, including household level, community level (village, farm), and whole urban and rural area level (city, town). Summary information of selected sites is given in Tables A and B, respectively.

TABLE A: SELECTED STUDY SITES IN URBAN AREAS

Project Name	Sanitation aspects covered			
	Household toilet	Community sewerage and drainage	Solid waste management	Animal waste
Environmental Sanitation project in Sa Dec town, Dong Thap province	✓	✓	✓	
Expanding Benefits for the Poor through Urban Environmental Improvements in Tam Ky, Quang Nam	✓	✓	✓	
Sanitation project in Hai Phong	✓	✓	✓	
Sanitation project in Ha Long city: Bai Chay area		✓	✓	
Environmental Sanitation project for Buon Ma Thuot city	✓	✓		
Private water supply and solid waste management model in Hiep Hoa district, Bac Giang province			✓	
3R project in Hanoi city (reduce, reuse, recycle)			✓	
Solid waste management improvement project for Cua Lo town, Nghe An province			✓	

TABLE B: SELECTED STUDY SITES IN RURAL AREAS

Project Name	Sanitation aspects covered			
	Household toilet	Community sewerage and drainage	Solid waste management	Animal waste
R1. Biogas program for animal husbandry in Binh Tan village, Xuan Phu commune, Xuan Loc district, Dong Nai province	✓			✓
R2. Rural WSS improvement in Binh Thanh and Binh Hoa Bac communes, Vinh Long province (Cuu Long delta Rural WSS Project)	✓			
R3. Hygiene and Sanitation Improvement in Tinh Dong commune, Son Tinh district, Quang Ngai province	✓			
R4. Installation of household biogas digesters in 16 communes, Tan Lap, Dan Phuong, Ha Tay (Hanoi)	✓			✓
R5. Sanitation Marketing project in Tam Dan commune, Tam Ky district, Quang Nam province	✓			
R6. Private solid waste management model in Hong Giang commune, Luc Ngan, Bac Giang			✓	
R7. Waste management project in Lai Xa, Hanoi (formerly Ha Tay)	✓	✓	✓	
R8. Biogas and use for electricity generation: Live-stock breeding farm in Thieu Duong, Thieu Hoa district, Thanh Hoa				✓
R9. Expanded environmental sanitation project in Phu Loc district, Thua Thien – Hue province	✓			

National level studies were also conducted covering tourism, business and sanitation markets. These studies served two main purposes:

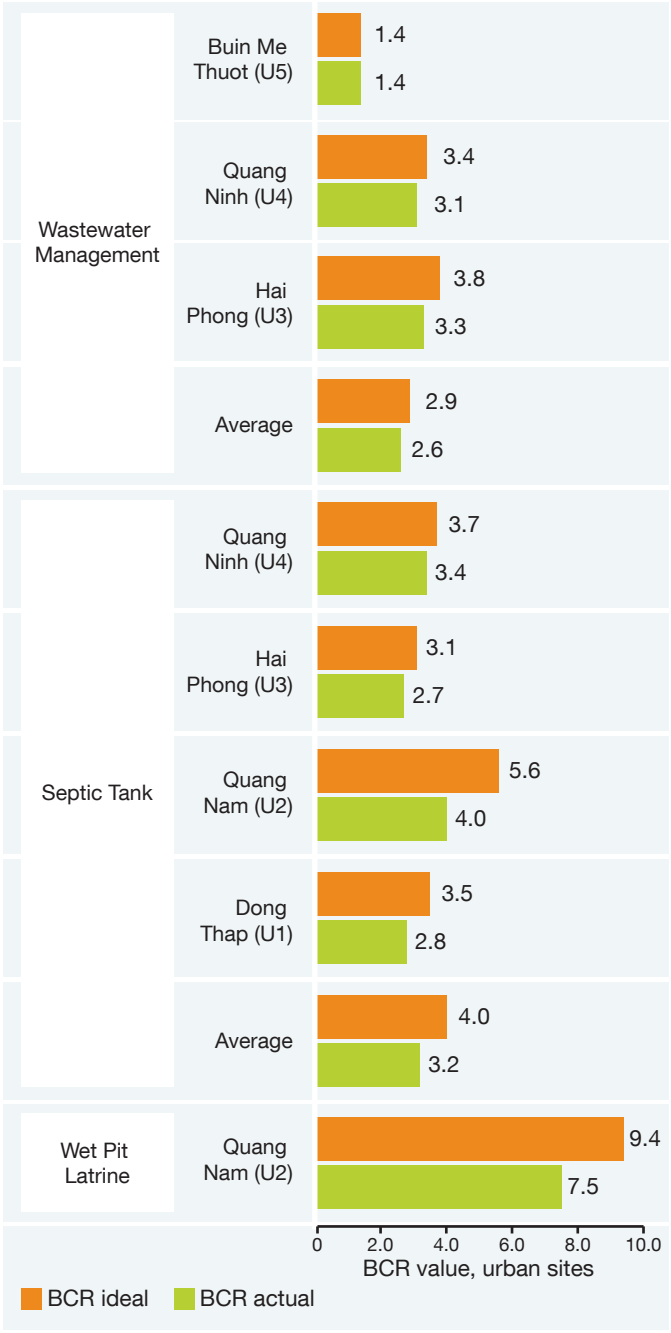
- To assess impacts of improved sanitation outside field sites to enable a more comprehensive cost-benefit assessment; and
- To complement or supplement data collected at field level to enable better assessment of local level impacts, such as on health and water resources.

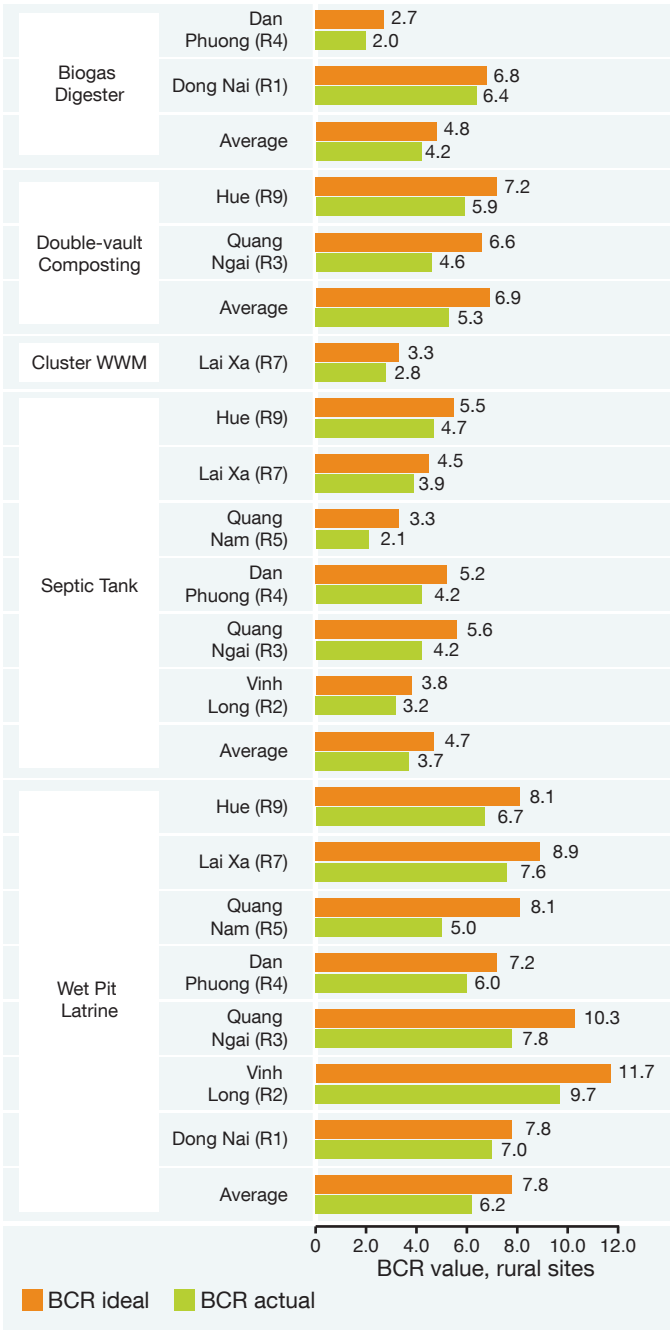
D. MAIN ECONOMIC ANALYSIS RESULTS

D1. EXCRETA MANAGEMENT

A summary of the results per field site and per sanitation option, with the average benefit-cost ratios (BCRs) per technology is shown in Figure A. For all sites, all sanitation interventions have brought positive results. All BCR values are more than 1, ranging for the options in urban sites from 1.4 to 7.5 (actual values) and from 1.4 to 9.4

FIGURE A: BENEFIT-COST RATIOS FOR ALL SURVEY SITES IN URBAN AND RURAL AREAS





(ideal values). In rural sites, the actual BCR values range from 2.0 to 9.7, and the ideal values are from 2.7 to 11.7. In both urban and rural areas, on-site sanitation facility of pit latrines brings the highest BCR, thanks to the lower relative cost of rural sanitation technologies. Centralized wastewater treatment plants require the highest investment, operation and maintenance costs compared with on-site sanitation facilities. Hygiene interventions added to health benefits with a low cost per household covered, giving higher BCRs than with sanitation interventions alone. The reuse of treatment wastewater and sludge also adds economic value at relatively low cost.

The average payback period of investment in urban sites ranged from less than 1 year (moving up from open defecation [OD] to pit latrine) to 5 years (from OD to centralized wastewater treatment system). The average payback period in rural areas ranged from under 1 year (moving up from OD to pit latrine) to 2 years (from OD to biogas digester).

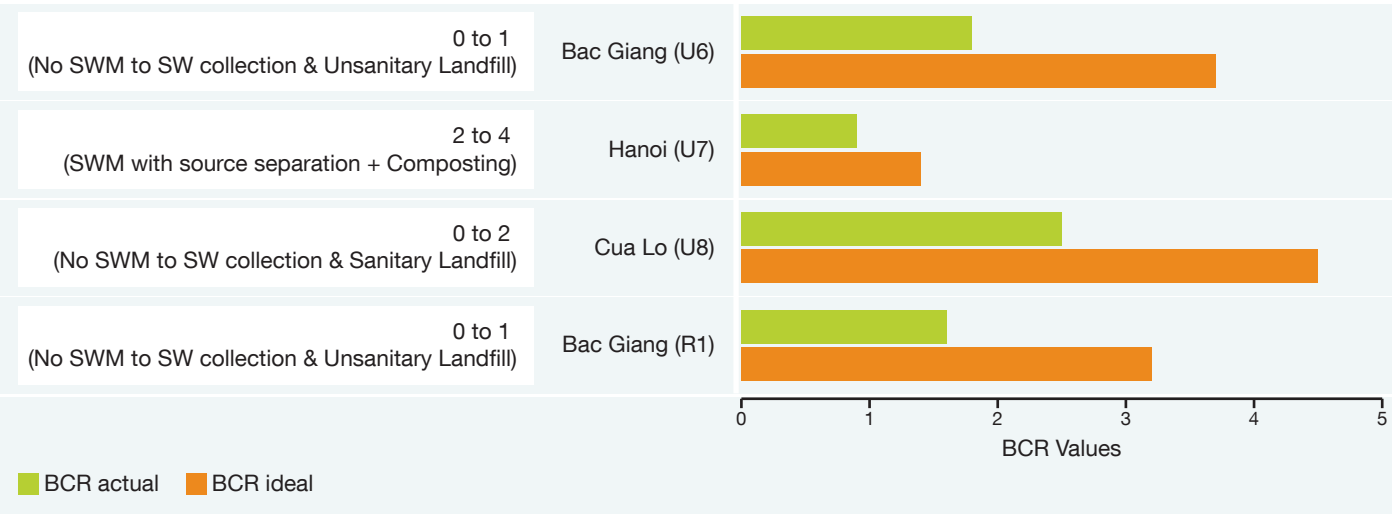
Different internal rates of return (IRR) have been found. IRR of over 100% were found in all technologies except wastewater management at both rural and urban sites. Such rates of return are significantly higher than the return on many other investments such as interest rates available from the banks or government bonds, showing the possibilities of mobilizing different financial sources to invest in sanitation. For urban wastewater management, rates of return averaging 50% were found, which is still a highly favorable return for the use of public investment funds.

In both urban and rural areas, the economic benefits realized by populations beginning with no or unimproved sanitation exceed the economic benefits seen by populations moving up from one improved sanitation option to another. This is because populations already using improved sanitation have already seen some benefit, so moving them up the ladder leads to fewer marginal benefits. For example, urban populations with a toilet and septic tank already enjoy time savings and some health benefits provided by that option, and therefore the improved management of wastewater (such as that provided by a centralized wastewater treatment system) provides fewer marginal health benefits and no access time savings. However, the quantitative analysis does not capture fully some of the key arguments for investing in improved wastewater management, such as intangible benefits, environmental and averted water pollution benefits. Furthermore, when current sanitation options become dysfunctional or costly to maintain and therefore need replacement, the policy maker should compare the economic performance of alternative sanitation options to OD, because if the current systems cease to function, their benefits will also be removed.

D2. SOLID WASTE MANAGEMENT

Figure B presents BCR from projects supporting improved solid waste management. The actual BCR values range from 0.9 to 2.5, while ideal BCR values range from 1.4 to 4.5. Ideal values are 49% to 61% higher than actual values due to the low participation rates of households in projects. Sanitary landfill increases the value of BCR from both reduced water treatment costs and increased

FIGURE B: BENEFIT-COST RATIOS FOR SOLID WASTE MANAGEMENT IMPROVEMENT PROJECTS



land values. Other non-valued aesthetic benefits are also increased due to improved solid waste management practices. While moving up from (1) conventional solid waste collection and sanitary land filling to (2) source separation and composting of organic fraction of solid waste, the BCR value can be less than 1 (the actual value of BCR of the Hanoi 3R pilot project is 0.9) or more than 1 (the ideal BCR value is 1.4). The higher BCR value would be achieved when the service coverage and community participation is assured. Compost production, reductions in transportation and less space devoted to landfill, and improved environment around landfill sites are all major benefits of sustainable approaches to solid waste management. Further benefits may be also gained, if resources are recovered by anaerobic digestion of organic waste and capturing biogas from landfill sites under the UN Clean Development Mechanism.

E. DISAGGREGATED RESULTS

E1. COSTS

Table C presents the average costs of all sanitation options considered in the 12 surveyed sites including excreta management options, with urban and rural results shown separately

In urban areas, there is a clear increase in the cost of moving up the ladder. With big investment in collection sewers and drains, and wastewater and sludge treatment facilities, the centralized wastewater treatment option in urban areas has the highest cost compared with the other locations where only on-site household sanitation improvement can take place. In rural areas, biogas digester construction, community wastewater collection and treatment systems require the highest investment.

TABLE C: SUMMARY OF AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND '000, 2009. 1 US$= 17,400 VND)

Sanitation options	Urban wet pit latrine	Urban septic tank	Urban centralized WWT	Rural wet pit latrine	Rural septic tank	Rural cluster w/w treatment	Rural double-vault composting	Rural biogas digester
Investment costs: Initial one-off spending								
1. Capital	1,584	4,920	11,970	1,706	4,872	8,567	2,914	10,416
2. Program	29	65	2,954	40	165	406	139	420
SUB-TOTAL	1,613	4,985	14,924	1,746	5,037	8,972	3,053	10,836
Recurrent costs: Average annual spending								
1. Operation	98	198	703	69	148	52	120	202
2. Maintenance	84	200	403	61	93	232	150	196
3. Program	0	0	69	14	17	0	50	0
SUB-TOTAL	182	398	1,174	144	258	284	320	398
Average annual cost calculations								
Duration[1]	7	10	20	7	10	10	10	15
Cost/household	366	766	1,323	357	677	1,088	520	950
Cost/capita	96	202	349	94	179	287	137	251
Breakdown (%)								
% capital	62	64	45	68	72	79	56	73
% program	1	1	11	2	2	4	3	3
% recurrent	37	35	44	30	26	18	41	24
Observations[2]	29	246	201	82	501	97	125	59

[1] Refers to length of life of hardware before full replacement
[2] Number of households surveyed

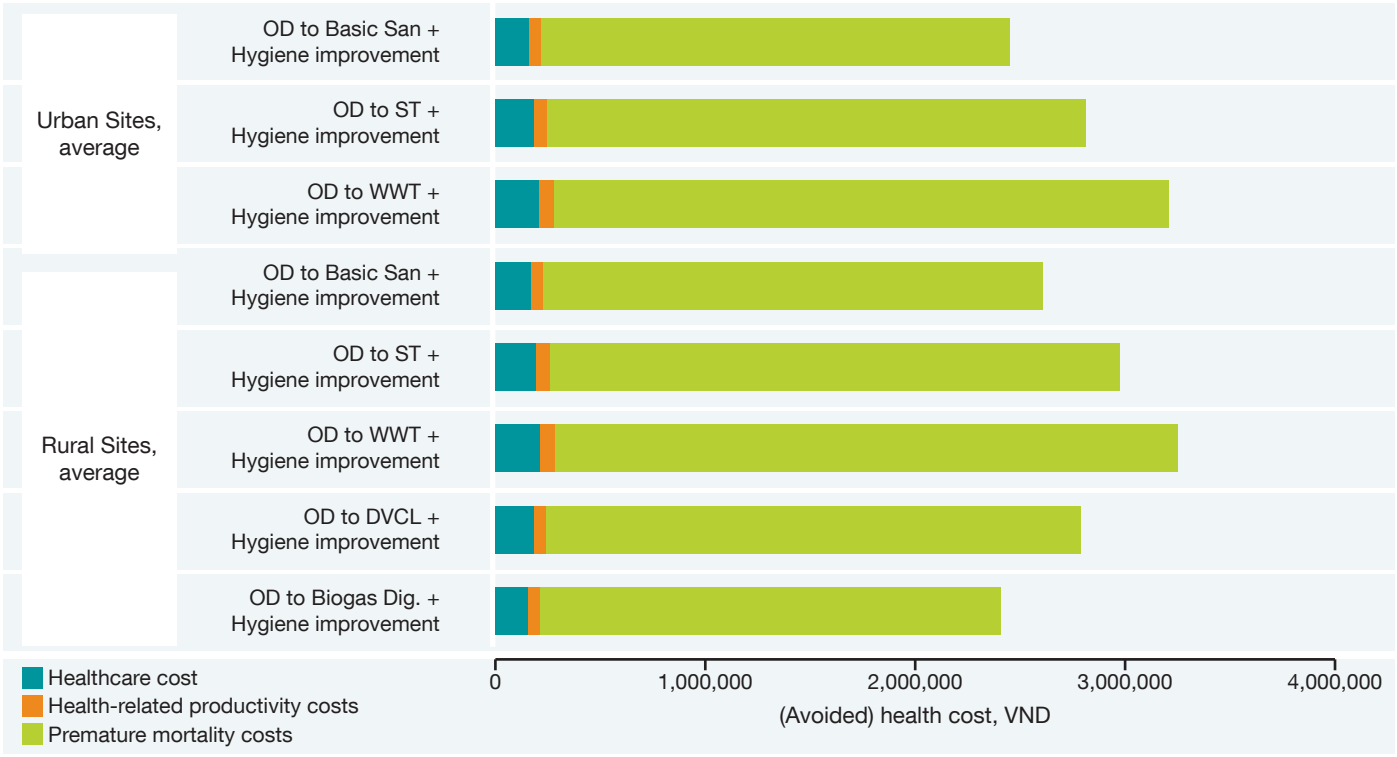
The highest annual recurrent costs are required for urban wastewater management systems (VND1,174,000 or US$67 per household, including program costs). Annual operation and maintenance costs for all on-site sanitation systems in urban and rural areas, except pit latrines, were of a similar value (VND324,000, or US$18 per household). Simple low-cost pit latrines involve fewer annual operation and maintenance costs (VND163,000, or US$9.3). Major recurrent costs for on-site sanitation systems were for flushing water, toilet cleaning and sludge handling.

The choice of sanitation option by households, and the price paid, is expected to vary by wealth quintile. The richest households prefer septic tanks. No household from the richest quintile practised OD. All sanitation types were found in the middle and lower income households. There are big differences among rich and poor households in the percentages of income paid for the same type of sanitation. It takes 1.5 years for the economic benefit value to exceed the septic tank construction costs, and households spend around 17% of their income (or income from 9 working weeks) on recurrent costs each year. The richest households have to pay only 5% of their income (an average of 2.5 working weeks' income) to pay for the construction of a septic tank, and spend 2% of their income (1 working week's income) on recurrent costs.

In urban sites, the total contribution from the government and donors for centralized wastewater management projects was much higher than the contribution from households (77% versus 23%). In wastewater treatment projects in Vietnam, besides household contributions, the major funding still comes from overseas development assistance (grants or loans) compared to local and central government contributions (56% versus 21%). In sites where sanitation improvement was made only at household scale, contributions from the households ranged from 59% to 98%.

In rural sites, household contribution to sanitation costs in all surveyed sites ranged from 50% (cluster wastewater management) to 90% (biogas digester). Contributions from the government and other donors were less significant at less than 30%, except at one rural site (R7) where cluster wastewater management was implemented with a contribution of 50%. In the latter case, the external contributions financing soft interventions (awareness raising, management and technical support) were crucial to the project's success.

FIGURE C: HEALTH COST SAVINGS FROM IMPROVED SANITATION OPTIONS (VND, 2009)



E2. HEALTH BENEFITS

Figure C shows the annual health cost savings from sanitation and hygiene improvement in urban and rural areas as calculated average values per household from all surveyed sites. In urban areas, the highest health risk reduction is found when households move from OD to basic sanitation and hygiene improvement. In rural areas, double-vault composting urine-diverting toilets (DVCL) and pit latrines incorporated with hygiene education, can bring significant reductions in health risk. However, those options have some limitations such as a lack of gray water treatment and the potential risk of incomplete compost product reuse. Using a biogas digester, combined with hygiene education helps to avoid most health-related costs in rural households.

E3. WATER BENEFITS

Table D presents annual average water costs per household, including water source access, and water treatment, and averted costs per household in the case of improved sanitation. The averted costs for water access in urban areas are low compared to those in rural areas, where people may see significant benefits from on-site water source improvement. The larger saving comes from averting the costs of water treatment, which may be reduced by 13% under a successful sanitation program. Some other factors are also to be considered such as available water source quality and quantity at the site, the quality of water supply service utility, and sources of pollution other than poor household sanitation such as solid waste and farming practices.

TABLE D: WATER ACCESS AND HOUSEHOLD TREATMENT COSTS INCURRED AND AVERTED (VND '000, 2008)

Variable	Annual average costs per household		Annual average costs saved per household following 100% sanitation coverage	
	Urban	Rural	Urban	Rural
Water source access	476	413	4	26
Water treatment	2,658	2,973	337	318
Total	3,134	3,386	341	343

E4. ACCESS TIME SAVING

Families without a toilet have to use one of the following options for defecation: (a) the backyard or a bush in their own plot; (b) public land, a river, lake or pond; (c) a neighbor's toilet; or (d) a community (shared) latrine.

Table E presents the average time saved per household from all surveyed sites realized by using improved sanitation and the percentage of annual household income it represents in both urban and rural sites.

TABLE E: AVERAGE ANNUAL ACCESS TIME SAVINGS PER HOUSEHOLD

Location	Average annual savings per household (VND '000, 2009)	% of household income
Urban	2,487	6.6%
Rural	1,686	4.3%

E5. INTANGIBLE BENEFITS OF SANITATION OPTIONS

Table F shows the reuse value per household in one rural site (R4: Dan Phuong commune, Hoai Duc district, Hanoi city), where a composting and biogas project was implemented.

TABLE F. VALUE ASSOCIATED WITH REUSE PER HOUSEHOLD IN TAN LAP SITE, HANOI (R4)

Variable	% households		Average value (VND '000, 2009)	
	Own use	Selling	Own use	Selling
Composting (fertilizer)	77	23	1,320	540
Biogas generation (with animal excreta)	100	0	960	0

E6. EXTERNAL ENVIRONMENT

The study analyzed the following:

- The communities' understanding of what 'sanitation' is
- Why households use their current sanitation option
- Householders' satisfaction with their current sanitation option, and for those without toilet
- Their reasons for getting a toilet, toilet preferences, and willingness to pay for a toilet.

Respondents' understanding of sanitation was taken primarily from focus group discussions and the household questionnaire.

The respondents have a comprehensive knowledge of sanitation. However, their answers also reflect the fact that in Vietnam, people tend to think of sanitation as public sanitation rather than personal hygiene such as hand washing and stopping OD. The surveys found that OD does exist, despite the high rates of households with their own or shared toilets, especially in the Northern and Urban Central sites.

All people consider "no garbage" as a key element of good sanitation. But the availability and type of solid waste management (SWM), as well as attitudes to solid waste, varied across surveyed sites. More than 90% of households in all regions consider that the government should make SWM "somewhat of a priority" or a "high priority". The household survey showed that there is poor management of animal excreta in both urban and rural areas. Almost all interviewees, especially in the North, stated that animal excreta is to be found around their homes.

The main reasons that households have toilets are for cleanliness, comfort and freedom, as well as being the societal norm, especially in urban areas. Households without toilets gave lower scores than households with toilets on key aspects of sanitation. The reasons for not having a toilet included a lack of money, not caring much about sanitation, and the availability of a neighbor's or relative's toilet nearby.

In most urban and rural areas, wastewater from septic tank toilets goes directly into an open drainage system, spoiling the environment with its bad odor. Some people interviewed do acknowledge the benefit of the wastewater treatment. However, households living close to a treatment station suffer from bad odors, and the area still becomes polluted by overflow of wastewater from the station.

E7. TOURISM BENEFITS

In the ESI survey of 300 tourist and business visitors to Vietnam, 58% of respondents give a low score of 1 or 2 (out of 5) for public toilets and 40% of respondents give a low score of 1 or 2 to toilets at bus stations. Seventy percent of tourist respondents were concerned that sanitation conditions, tap water and food may cause diarrhea. Some 33% and 69% of the causes of diarrhea are perceived to be related to water and food, respectively.

Among the 18% of tourists replying "maybe" or "hesitancy" in respect to returning to Vietnam, 13% gave poor sanitation as a major or contributory reason. While poor sanitation is a general issue that needs to be tackled to make a tourist's stay in Vietnam more enjoyable, it is neither a defining issue for tourists in terms of enjoyment of their stay, nor a reason to stop the majority from coming back. In a different survey of 8,300 tourists conducted in 2005, 74% of respondents considered Vietnam's environment to be clean and beautiful but only 66% of respondents said that they were satisfied with the sanitation facilities in their accommodation.

E8. BUSINESS BENEFITS

Surveyed businesses assigned different levels of importance to environmental sanitation. The hotel business considered environmental sanitation as the most important of all criteria. Beverage production and consumer goods firms consider the quality of water sources as the most important aspect of environmental quality. Consulting firms prefer to select locations that provide their staff a pleasant environment, which should increase competitiveness. Sanitation improvement means more business opportunities for almost all firms.

E9. PROGRAM PERFORMANCE

A program approach analysis (PAA) was conducted for 14 selected programs to show the levels and determinants of performance of sanitation programs/projects.

Urban sanitation: In most urban sanitation projects, the challenges faced are technological option selection, quality of design and construction, linked to consultant competency, administrative appraisal procedures, low rates of household connection, financial sustainability, local capacity for operations and maintenance (O&M), and monitoring, evaluation and control in the implementation stages.

A range of different sanitation technologies must be considered during project development. Local aspects to be considered include low incomes, and topographical and other

natural socio-economic conditions. An explicit assessment of the options should be made, for example: a combined sewerage and drainage versus a separate system; centralized versus decentralized sanitation schemes; conventional versus high-tech or low-cost technological options; or a combination of these.

Neglecting a tertiary sewerage and drainage network is a common issue in urban sanitation projects. A combined sewerage and drainage network is common in urban areas of Vietnam, often leading to system overloads and/or water source pollution. As well as examining financial sustainability, lessons from the technical operations of new urban sanitation systems should be studied. The sanitation options analyzed in this study are: separate small-bore sewerage; decentralized or centralized low-cost wastewater treatment options in baffled septic tank with anaerobic filter (BASTAF); constructed wetland and waste stabilization ponds in Buon Ma Thuot city (Dak Lak province), Cho Moi and Cho Ra towns (Bac Kan province) and Bai Chay tourist area (Quang Ninh province); and wastewater reuse in Buon Ma Thuot city (Dak Lak province).

Rural sanitation: In the coming years, targets for rural sanitation should be more precisely specified in terms of the quantity and quality of sanitary structures. Greater investment is needed with an emphasis on sanitary planning and selection of technologies. Even though a major share of the investment in sanitation is coming from households, incentives for household investment into sanitary latrines, solid waste management and improved drainage are still limited. Marketing activities and the promotion of sanitation in association with the application of preferential financial mechanisms are crucial, such as appropriate credit models, and more efficient sanitation and hygiene awareness rising programs.

Until now, there have been extremely limited applications of effective solutions for liquid and solid waste management in rural areas, particularly in handicraft villages. Some successful models have been observed using decentralized anaerobic (biogas) digesters in pig farms. Besides household toilet improvement, a pilot effort such as the Lai Xa project demonstrates the promising option of investing in decentralized wastewater management. A decentralized low-cost sanitation approach with appropriate technical options and management schemes, together with information, education and communication (IEC) and behavior change activities, should be promoted in future projects. A solid waste component should be integrated into the project vision.

Biogas projects: Considerable success has also been achieved from individual biogas plant construction and electricity generation for livestock breeding farms. Economic and environmental sanitation benefits have been observed and confirmed by the farmers. Key points for achieving success in the biogas program were: a clear vision and the support of provincial and district authorities; appropriate selection of biogas technology; adequate technical training provided to set up a team of qualified and motivated local technicians; and a quality control system to help establish the trust of the livestock community in the biogas facility. Besides the common practice of slurry utilization, the adequate post-treatment of biogas products (both liquid and solid phase) needs further consideration. More efforts should be made by central and local governments to disseminate cleaner production methods, resource recovery and other green farming technologies and equipment to farmers. Technical guidance and oriented marketing activities should be set up with the involvement of different players.

Solid waste management: The main current method of solid waste disposal is landfill. However, more sustainable waste treatment and disposal methods should be further considered. The 3R project shows a very promising concept, but it requires a number of developments to be realized on the ground. There are different models of cooperatives, private enterprises, and "equitized" enterprises providing solid waste collection, transportation, treatment and disposal in urban, rural and industrial areas. Waste service companies need more support to improve their performance.

F. CONCLUSIONS AND RECOMMENDATIONS

The economic performance of sanitation and hygiene projects is favorable throughout the country. Hygiene improvement activities and sanitation improvement efforts realize the highest BCR values. The actual performance of sanitation programs is often lower than ideal performance, as indicated by the non-use of toilets and the continued pollution of the environment, indicating that attention needs to be paid to the determinants of non-performance.

The study findings emphasize the importance of selecting the right sanitation option when moving up the sanitation ladder to upgrade to a system that is financially sustainable. It also indicates the need to consider other, non-quantified benefits that are not included in the benefit-cost ratios. The study recommendations are:

Recommendation 1: Intensify efforts to increase access to basic improved sanitation in rural areas and improved wastewater management in urban areas. Despite the progress of the country in meeting the MDG target for sanitation, there remains a sizeable number of rural people still using unimproved sanitation facilities; furthermore, only a small proportion of urban wastewater is treated adequately. As a result, the estimated economic burden of poor sanitation in the country remains high. This suggests the need for more investment in improved sanitation and waste management facilities. Such investments are essential to reducing the costs that poor sanitation imposes on health, water for drinking and other uses, tourism, business operations, and the overall quality of life. This investment may also stimulate economic activity in markets that provide inputs to the sanitation sector, as well as those that utilize human excreta or solid waste for productive activities. The benefit of each US$ invested in sanitation and hygiene improvement ranges from US$1.4 to US$9.4 in urban areas, and from US$2.7 to US$11.7 in rural areas. Sources of investment funds to the sanitation and hygiene sector should be strengthened and diversified, while interventions by the public sector and development banks should be targeted to maximize their developmental benefits, aiming especially to increase access and uptake among poor and vulnerable households.

Recommendation 2: Sanitation planning should carefully consider the performance of alternative technology options and delivery approaches to maximize program efficiency. Proper planning processes would avoid inefficient investment in sanitation systems that are not financially sustainable or are inadequate for the population's needs and require later upgrading. The broader economic costs and benefits, as well as direct financial requirements and impacts, should be considered as part of technology and program delivery selection. Technology selection and project design should take into account life-cycle costs, the future construction price increases, the specific conditions of target sites and the opportunities and limitations related to sanitation programs. Decision makers at all levels should be encouraged to select those technologies and designs that not only successfully capture the financial and economic benefits of sanitation, but also at an affordable cost in each specific context. The reuse of treated wastewater and sludge in agriculture would bring significant benefits to the integrated sanitation system. Safe and efficient resource recovery should be targeted in sanitation projects, especially in areas where funds are most limited.

Based on the results of this and other studies, guidelines should be drawn up for technology options and program delivery approaches for different geographical, demographic and socio-economic settings in Vietnam. To enable improved planning at decentralized level, capacities and skills in planning, design and contracting by local authorities should be built and mobilized. To increase program efficiency, lower-cost and standard designs that incorporate improved environmental features should be made available to design teams. Vietnamese environmental standards need to be better developed to enable the planning of sustainable sanitation options.

Recommendation 3: A manageable monitoring and evaluation (M&E) framework should be designed for sanitation programs – a framework that defines how to measure the relevant impacts of sanitation options comprehensively. Sanitation program managers and implementers and government staff need to better understand the efficiency of sanitation programs. This will enable them to fine-tune ongoing programs under implementation, and to conduct ex-post evaluation for better design and implementation of future sanitation programs. Outcome-oriented M&E is a relatively new concept in Vietnam and it needs to be introduced in a way that matches national systems and processes. It is necessary to develop an adequate information mechanism and database, as well as M&E and a reporting system for the water and sanitation sector. Furthermore, users need to be sensitized and trained appropriately in the proposed M&E systems.

Recommendation 4: Stimulate and allow the private sector to be part of the solution. There are significant opportunities for sanitation markets in Vietnam, in which the private sector is well placed to play a major role. Besides

providing economic benefits in terms of reduced environmental pollution, improved public health and resource recovery, sanitation market activities also create jobs, develop and expand enterprises, and contribute to poverty alleviation, industrialization and modernization. Demonstration projects on critical issues such as cost and resource recovery are needed. Since resource recovery covers different stakeholders, inter-sectoral cooperation is needed. Government capital subsidy to households creates favorable conditions for implementation, but to ensure the financial sustainability of the sanitation system, the "polluter pays" principle should be applied. The fact that not all economic benefits lead to immediate cash gain will require the adoption of special financial instruments to fill the financial gap. The two models with the greatest potential for Vietnam are Revolving Funds, mainly in urban areas, and Micro-Finance, which is widely applicable. However, poorer households should receive loans with more favorable interests rate and payback conditions to increase uptake and reduce inequity.

Recommendation 5. Recognize community acceptance and participation as crucial to the sustainability of sanitation programs. A comprehensive behavior change strategy that includes community/beneficiary participation should be implemented, covering all phases of project development: from preparation to post-construction. Approaches should be based on consultation and participation and the key stakeholders (customers, service providers and scheme owners) should not only be at the receiving end of information, but also be actively involved in decision-making, promotion and the improvement of services. The participation of women in particular is crucial to the success of sanitation projects. This strategy and plan will need to be accompanied by proper selection and capacity building of the (local) facilitators of the behavior change strategy. Moreover, the project or program should provide support to local organizations so that after it is phased out, local stakeholders will follow up.

Foreword

Target 10 of the Millennium Development Goals recognizes access to safe sanitation as a key aspect of human development: "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, in the workplace and at school, people appreciate and value a clean, safe, private and convenient place in which to urinate and defecate. Good sanitation also contributes importantly to achieving other development goals related to child mortality reduction, school enrolment, nutritional status, gender equality, clean drinking water, environmental sustainability and the quality of life of slum dwellers.

Despite recognition of its importance, sanitation continues to lose ground to other development targets in terms of 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 the media or politicians to promote as a worthy cause. Furthermore, limited data exist on its 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 allocations.

Phase 1 of ESI in 2007-8 conducted and published a 'sanitation impact' study, which estimated the economic and social impacts of unimproved sanitation on the populations and economies of Vietnam and other countries of Southeast Asia. This study showed that the economic impacts of poor sanitation are US$780 million per year for Vietnam, or US$9.8 per capita. This is equivalent to 1.3% of annual GDP in 2005 prices. These and other results were disseminated widely to national policy makers, sector partners, and decentralized levels of Vietnam.

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 Vietnam. Its 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 Vietnam. On the cost side, decision makers and stakeholders need to understand more about the timing and size of costs of sanitation interventions (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, both financial and socio-economic impacts need to be more fully understood when advocating for improved sanitation and when making the optimal sanitation choice. For cost-benefit estimations, a sample of sites representing the different contexts of Vietnam was selected to assess the efficiency of sanitation interventions, and thus illustrate the range and sizes of sanitation costs and benefits.

The research under this regional program is being conducted not only in Vietnam, but also in Cambodia, China (Yunnan Province), Indonesia, Lao PDR and the Philippines. Similar studies are also ongoing in selected South Asian and African countries. While WSP has supported the development of this study, it is an 'initiative' in the broadest sense, which includes the active contribution of many people and institutions (see Acknowledgments).

Abbreviations and Acronyms

ADB	Asian Development Bank
ALRI	Acute lower respiratory infection
AusAID	Australian Agency for International Development
BASTAF	Baffled septic tank with anaerobic filter
BCR	Benefit-cost ratio
BOD	Biochemical oxygen demand
CBA	Cost-benefit analysis
CDM	Clean Development Mechanism
CEFACOM	Research Centre for Family Health and Community Development
CER	Cost-Effectiveness Ratio
CLTS	Community-Led Total Sanitation
COD	Chemical oxygen demand
CSO	Combined Sewer Overflow
DALY	Disability-Adjusted Life-Year
DANIDA	Danish International Development Assistance
DHS	Demographic and Health Survey
DO	Dissolved oxygen
DVCL	Double-vault composting latrine
Ecosan	Ecological sanitation
ESI	Economics of Sanitation Initiative
FDI	Foreign direct investment

FGD	Focus group discussion
GDP	Gross domestic product
GoV	Government of Vietnam
GSO	General Statistics Office
GTZ	German Technical Cooperation (newly reformed as GIZ)
HCA	Human capital approach
HCMC	Ho Chi Minh City
HH	Household
IE	Income elasticity
IDE	International Development Enterprises
IEC	Information, education and communication
IESE	Institute of Environmental Science and Engineering
IRR	Internal rate of return
ITI	International Trachoma Initiative
JMP	Joint Monitoring Programme (WHO, UNICEF)
Kg	Kilograms
lpcd	Litres per capita per day
M&E	Monitoring and evaluation
MARD	Ministry of Agriculture and Rural Development
MDG	Millennium Development Goal
Mg/l	Milligrams per liter
Mio	Million
MONRE	Ministry of Natural Resources and Environment

MOC	Ministry of Construction
MOF	Ministry of Finance
MOH	Ministry of Health
MOST	Ministry of Science and Technology
MPI	Ministry of Planning and Investment
MSW	Municipal Solid Waste
NCERWASS	National Center for Rural Water Supply and Environmental Sanitation
NGO	Non-governmental organization
NPV	Net present value
NTP	National Target Programme
OD	Open defecation
ODA	Official development assistance
OECD	Organization of Economic Cooperation and Development
OER	Official Exchange Rate
O&M	Operation and maintenance
PAA	Program approach analysis
PCERWASS	Provincial Centre for Rural Water Supply and Sanitation
PBP	Payback period
PMU	Project Management Unit
PPP	Public/private partnership
RWSS	Rural Water Supply and Sanitation
SHWIP	Sanitation, Hygiene and Water Improvement Project
SNV	SNV Netherlands Development Organization

SWM	Solid waste management
TA	Technical assistance
TOR	Terms of Reference
UDDT	Urine Diverting Dehydration Toilet
UNICEF	United Nations Children's Fund
URENCO	Urban Environmental Company
US$	United States Dollars
VND	Vietnamese Dong
VIP	Ventilated improved pit
VOSL	Value of a statistical life
VWU	Vietnam Women's Union
WB	World Bank
WHO	World Health Organization
WSPST	Water and Sanitation Programme for Small Towns in Vietnam
WS&S	Water Supply and Sanitation
WSH	Water, sanitation and hygiene
WSP	Water and Sanitation Program (World Bank)
WTP	Willingness to pay
WWM	Wastewater management
WWTP	Wastewater treatment plant

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. The higher the BCR, the more economically efficient the intervention.

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

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

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

Cost-effectiveness ratio (CER): the ratio of the present value of the future costs 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).

Ecological sanitation (Ecosan): a new paradigm in sanitation that recognizes human excreta and water from households not as waste but as resources that can be recovered, treated where necessary and safely used again. It is based on the systematic implementation of reuse and recycling of nutrients and water as a hygienically safe, closed-loop and holistic alternative to conventional sanitation solutions (GTZ, 2009).

Improved sanitation: the use of the following facilities at home: 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).

Intangible benefits: the 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, among others.

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 for which the BCR equals unit (1).

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

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

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

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

Unimproved sanitation: the use of 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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The Economics of Sanitation Initiative was conducted in Cambodia, China (Yunnan Province), Indonesia, Lao PDR, the Philippines and Vietnam. The study was led by the World Bank's Water and Sanitation Program (WSP), with the contribution of WSP teams and consultants in each of the participating countries. The study took three years to complete, and has undergone several major peer review processes.

Regionally, Guy Hutton (WSP Senior Water and Sanitation Economist and Task Team Leader) led the development of the concept and methodology for the ESI, the management and coordination of the country teams, provision of regional tools and templates, and report writing. Björn Larsen contributed to the development of generic data collection tools and the health methodology. The study benefited from the continuous support of other WSP staff–Nguyen Diem Hang (Country Coordinator, Vietnam), Almud Weitz (Senior Regional Team Leader for the East Asia and Pacific region), Isabel Blackett (Senior Sanitation Specialist), Eddy Perez (Senior Sanitation Specialist), Yosa Yuliarsa (Regional Communications Specialist), Irvan Tjondronegoro (Resource Management Officer), Nguyen Thanh Vinh (former Vietnam Team Leader), Hoang Anh Nga (Team Assistant) and WSP support staff.

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Full research reports as well as summary reports are available for each country, in both English and in local languages. All country reports are accessible from http://www.wsp.org.

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Selected Development Indicators for Vietnam

Variables	Value
Population	
Total population (2009)[1]	85,790,000
Rural population (%)	70.4
Urban population (%)	29.6
Annual population growth (%) (2009)	1.2
Under 5 population (% of total) (2009)	7.8
Under 5 mortality rate (deaths per 1,000) (2007)[2]	19
Female population (% of total) (2007)	50.6
Population below poverty line (%) (2007)	15.5
Economic	
Currency name	Vietnamese Dong (VND)
Year of cost data presented	2008
Currency exchange with US$ (31 Dec. 2008)[3]	17,400
GDP per capita[1] (US$)	
2008	US$1,024
2010	US$1,200
GDP per capita in International $, adjusted for purchasing power[2]	I$ 3,300
Sanitation	
Improved total (%) (2009)[1]	54
Improved rural (%) (2009)[1]	39
Improved urban (%) (2009)[1]	88
Sewerage connection (Hanoi, 2008) (%)[1]	70

[1] General Statistics Office (GSO), 2010
[2] ESI study, phase 1
[3] Vietcombank, 2009

I. Introduction

1.1 THE STATE OF SANITATION COVERAGE IN VIETNAM

Economic growth in Vietnam remains impressive. In less than a decade, Vietnam has lifted around 20 million people out of poverty. However, Vietnam is still in the bottom half of countries in terms of GDP per capita. The productivity and well being of its population remain well below their potential.

The Government of Vietnam is making considerable efforts to improve the country's infrastructure, which provides the foundation for adequate living conditions and for socio-economic development. However, the water supply and sanitation sector in Vietnam still faces a number of challenges, which can only be overcome through enhanced effort. While considerable investment has been made in the water and sanitation sector, the country is still far from meeting its targets. For example, the National Rural Water Supply and Sanitation Strategy (NRWSS) set a target that 100% of the rural population should have access to adequate sanitation by the year 2020. Currently, about 40% of the population has access to clean water meeting domestic water supply quality[1] and 55% has access to basic improved sanitation according to national standards (NCERWASS, 2010). On the other hand, the WHO/UNICEF Joint Monitoring Programme shows higher rates of basic sanitation access at 76% in the latest 2012 report, reflecting 2010 estimates (Joint Monitoring Programme, 2012). The differences between national and JMP numbers are due to differences in sanitation access definitions and different years of estimates.

In Vietnam, distribution of coverage is not equal; it varies between region and income groups. According to JMP, open defecation stands at under 0.5% in urban areas but at 6% in rural areas. In some rural areas, and particularly in ethnic minority communities, adequate latrine coverage rates are under 5%. In urban areas, most of the population has access to sanitation facilities such as septic tanks, double vaults, 'sulabh' or pit latrines, and between 30% and 70% of towns and cities are served by a sewerage and drainage network. Huge disparities exist between different urban centers. Only 10% of urban domestic wastewater is treated, while the government orientation for urban and industrial sewerage and drainage has set a target to treat 60% of domestic wastewater for the urban areas of 3rd category and above.

Table 1 and Figure 1 show the variation between different surveys over time, by region. The coverage levels clearly depend on the definition of 'sanitation', whether measuring physical infrastructure or an actual improved service. Annex Table A2 shows coverage by ethnicity and socio-economic grouping. The lowest values of sanitation coverage in rural areas in Vietnam were found in the Ministry of Health (MOH)–UNICEF joint survey of 2006, whereby only 18% of surveyed latrines were considered hygienic latrines meeting MOH standards of construction and maintenance (see Figure 2). It is worth noting that the MOH standard provides only quantitative criteria for hygienic latrine evaluation.

A lack of access to basic sanitation and drinking water facilities and poor hygiene behaviors have a series of negative effects on the population. Firstly, these are critical risk factors associated with water-related diseases, especially acute diarrhea. Global statistics show that accesses to basic sanitation and drinking water services and improving hygiene have the potential to prevent at least 9.1% of the disease burden, or 6.3% of all deaths (WHO, 2009). Children in developing countries suffer a disproportionate share of this burden; the

[1] According to standard QCVN 02:2009/BYT

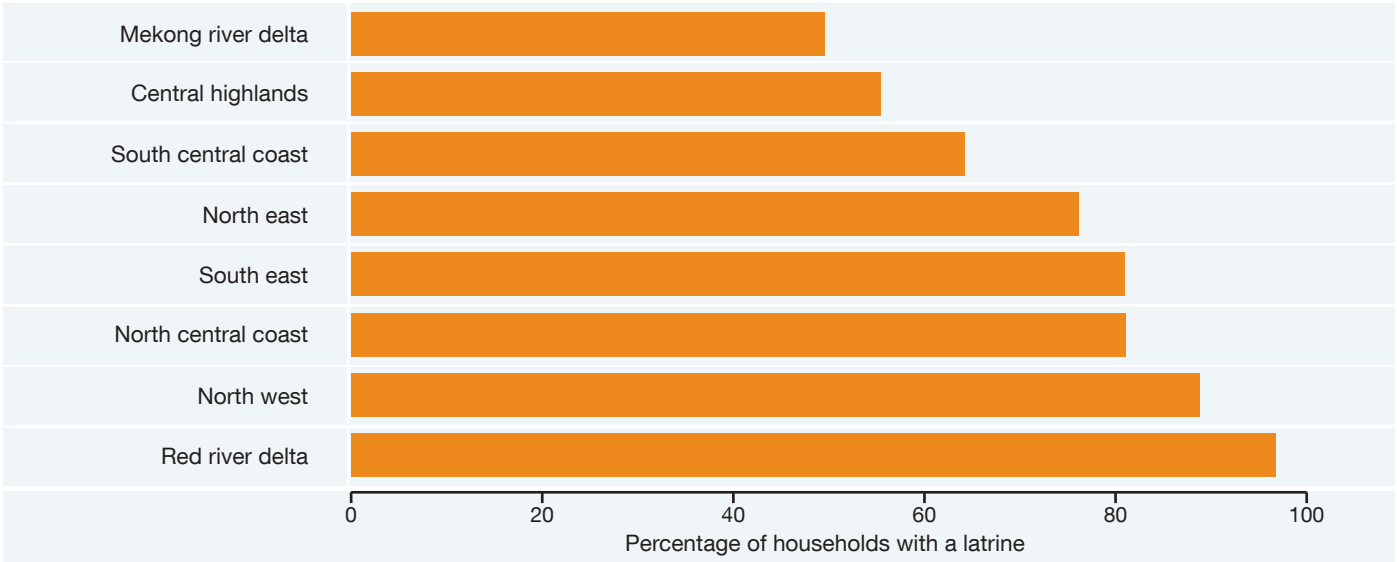
proportion of total deaths or disability-adjusted life-years (DALYs) attributable to unsafe drinking-water, inadequate sanitation and insufficient hygiene is more than 20% in children aged below 15 years. Phase 1 of the Economics of Sanitation Initiative (ESI) showed that water-related diseases were responsible for 34% of the US$780 million annual impact of poor sanitation in Vietnam (Thang et al, 2007). The remaining 66% was contributed by impact on water sources (US$287 million), land use (US$118 million), access time (US$41.6 million) and tourism (US$69 million).

TABLE 1: SANITATION COVERAGE (%) (HYGIENIC LATRINES ONLY) IN VIETNAM FROM 1998 TO 2007 REPORTED IN DIFFERENT DATA SOURCES

Ecological region	National survey on environmental hygiene, MOH 1998[1]	National Health Survey, MOH 2002[2]	Survey on living standards of HHs (GSO) 2004[3]	National Target Programme - 2004[4]	Survey on environmental sanitation in rural Vietnam MOH 2007[5]		
					% HHs having sanitary latrines	% latrines attaining standard on construction	% latrines attaining standard on construction and maintenance
Red River Delta	3.5	32	69.2	65	37.9	30	22.9
North East	2.4	27	52.5	38	10.2	3.9	2.9
North West		4	18.6		6.2	4.5	3.3
North Central Coast	6.5	33	57	56	43.8	24.3	14.1
South Central Coast	11.4	21	52.2	50	49.6	20	16.1
Central Highlands	1.3	12	35.3	39	13.3	10.2	7.0
South East	7.2	37	71.4	62	53.8	43.3	39.1
South West	4.3	12	23.9	35	26.1	21.2	19.3
Vietnam[6]	**4.8**	**21.0**	**50.8**	**50**	**33.0**	**22.5**	**18.0**

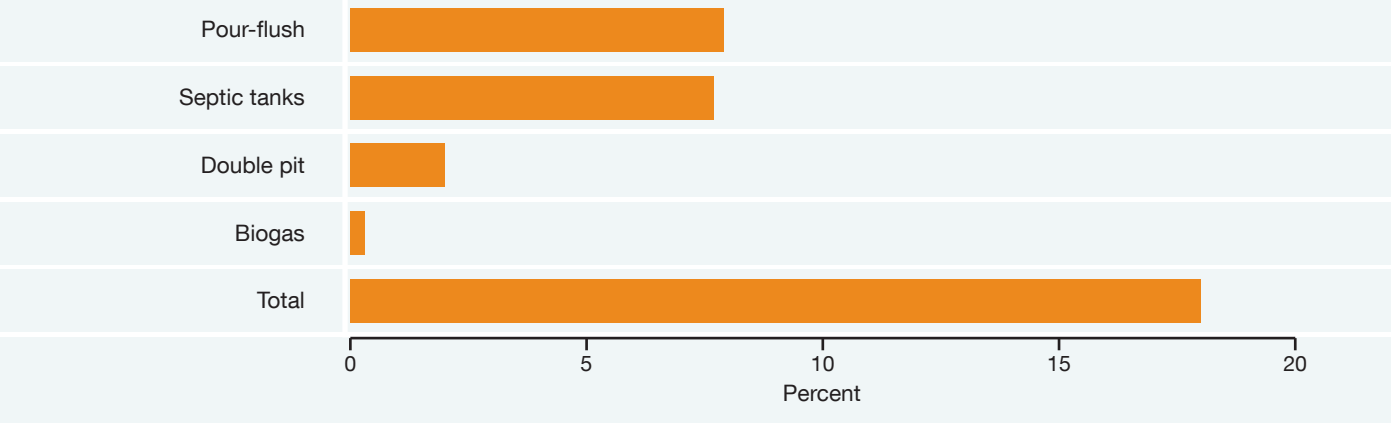
HH – household
[1] MOH-UNICEF (1998), Survey on latrines at households in rural Vietnam
[2] MOH (2002), National Health Survey
[3] GSO (2004). Survey on living standards of households
[4] Ministry of Agriculture and Rural Development (2004), Report of the 5-year implementation of the NTP
[5] Survey on environmental sanitation in rural Vietnam, MOH – UNICEF, 2007
[6] Reflects national average (weighted average of regions according to population size)

FIGURE 1: PERCENTAGE OF HOUSEHOLDS WITH A LATRINE, BY ECOLOGICAL REGION



Source: MOH – UNICEF (2007). Report on Water Supply and Environmental Sanitation Status in Rural Areas of Vietnam.

FIGURE 2: TYPES OF TOILET IN HOUSEHOLDS WHERE CONSTRUCTION, OPERATION AND MAINTENANCE STANDARDS ARE MET



1.2 SANITATION SECTOR ISSUES

This section introduces efforts by the Vietnamese Government to improve sanitation, and the remaining challenges. The water and sanitation sector in Vietnam lacks mechanisms for regular sector assessment that addresses critical issues such as the different institutional, managerial and operational aspects of the sector and its links to health, wellbeing and economic development. The institutions responsible for urban and rural water supply and sanitation do not exchange information effectively, which prevents synergy, information exchange and good coordination. There is no national institution mandated with the important role of coordination and cooperation for the whole drinking water and sanitation sector.

Along with the rise in government funding for the construction and rehabilitation of sewerage and drainage systems and capacity building for companies overseeing the operation and maintenance (O&M) of the systems, there has been a significant increase in number of urban sewerage and drainage projects funded by preferential loans from agencies. In urban areas, there have been more than 10 sewerage and drainage projects with a total budget of over US$2 billion (excluding user contributions). Over 80% of budget for these projects is in the form of official development assistance (ODA) contributions from international financial institutions like World Bank and the Asian Development Bank, or from the governments of countries including Japan, France, Denmark, Belgium and Switzerland. In rural areas, an average of between US$100 million and US$170 million is being invested annually for water and sanitation.

Combined sewerage and drainage systems with overflow chambers (CSOs) are the most common wastewater collection systems in urban Vietnam. These entail a lot of operation and maintenance and involve the risk of environmental pollution. It is very expensive to upgrade existing CSO systems to separate sewers and drains. Separate systems must be designed and built for new urban development areas. The most challenging context for urban drainage is found in the flat delta areas. Large diameter and deep laying sewers require significant investment to cover high construction and O&M costs. The coastal urban areas such as Hai Phong, Da Nang, Nha Trang and Quy Nhon are also facing such difficulties as uneven terrain, soil composition consisting mostly of sand and sandy loam, and fluctuating tidal levels.

Lessons should be learned from successful sanitation projects that have significantly improved urban environmental sanitation in Hanoi, Hai Phong, Buon Me Thuot, Quang Ninh and many other cities.

1.3 BROADER SANITATION ASPECTS

Sanitation covers more than providing latrines and sewage treatment. According to Vietnam's Unified Sanitation Sector Strategy and Action Plan (U3SAP), sanitation includes solid waste management, sludge management, and improved sanitary practices in trade villages and in agriculture, among others. According to the Ministry of Construction (MOC), the total amount of solid waste (urban and rural) is estimated at 12.8 million tons per year, of which urban areas (category 4 and above) produce 7.2 million per year (54%). This amount is forecast to reach 22 million tons in 2020 (MoC website, October 2008). Some 82% of the

current solid waste is collected and of that amount approximately 10% is recycled and 12% is treated (MOC, January, 2009).

Although small amounts of organic solid waste are separated and composted, most urban solid waste in Vietnam is disposed of in landfills. Only 15% of the landfills are considered sanitary, while the remaining 85% are unsanitary, open dumping sites. The lack of proper treatment of waste results in leakage from dump sites, creating serious pollution problems for the surrounding land and ground water.

Private sector involvement in Vietnam seems more successful in solid waste management than in wastewater management. Decree 78 of 2007 regulates the modalities for private sector involvement. Different models of cooperatives, private enterprises, and "equitized" enterprises provide solid waste collection, transportation, treatment and disposal of solid waste in urban, rural and industrial areas. Some private enterprises conduct collection, delivery and treatment of solid waste from industries, including hazardous waste. Besides solid waste fees, the enterprises can gain additional income from the recovery of valuable materials such as plastic, paper and metal and from recycled products such as compost fertilizers and plastic goods.

Fecal sludge from septic tanks and night soil from twin-pit toilets and bucket latrines are emptied by the Cities' Urban Environmental Companies (URENCOs). In many places, night soil is still being collected illegally by farmers from villages for aquaculture feeding or agricultural fertilizer. Private enterprises providing cleaning services are also important players in urban and peri-urban septage collection. As an effluent from poorly managed septic tanks, a portion of septage is also discharged directly into urban drainage channels and water bodies.

Methods of fecal sludge disposal include dumping in city landfills, which is the most common option, aquaculture feeding, discharging into drainage channels, and fertilizer processing at composting plants (in some cities). The latter option is considered one of the most promising, although there are a number of questions to be addressed such as the best way of achieving at-source separation of waste, optimal disposal techniques, hygiene concerns and the marketability of the organic fertilizer products.

In Vietnam there are nearly 2,800 trade villages contributing important products for the market and providing an income for rural populations. Wastewater management in handicraft villages is a major current concern. A large amount of waste is generated from the intensive but low-tech production of goods in these villages, which is seriously polluting the environment. Some successful models of sanitation management have been implemented, most notably using decentralized anaerobic (biogas) digesters.

The application of raw wastewater, including industrial effluent, domestic sewage and human excreta in agriculture is widespread, especially in northern Vietnam. Besides the undeniable benefits and efficiency that the reuse of untreated wastewater has brought to agricultural and aqua-cultural production, the negative impacts on human health of the use of untreated wastewater in irrigation are of great concern to public health. At present, little has been done in Vietnam to enforce the existing laws and guidelines regarding the reuse of wastewater in agriculture and aquaculture. In particular, there is a lack of regulation addressing the health impacts of reuse of wastewater on the users. Furthermore, there is a lack of awareness in the community of the health impacts of wastewater reuse, and the importance of improved hygiene behavior. Hence, all these aspects need urgent attention.

1.4 REPORT OUTLINE

The current report consists of 9 further chapters. Chapter 2 describes the study aims and research questions and Chapter 3 details the study methodology. Chapter 4 describes the study results relating to the benefits of improved sanitation and hygiene at local level. Chapter 5 presents selected benefits of improved sanitation at national level. Chapter 6 presents the results of the cost assessment of sanitation improvement from each field-level case study. Analysis of the performance of selected sanitation programs is provided in Chapter 7. Chapter 8 presents the efficiency of sanitation and hygiene improvement at local and national levels, including that of selected solid waste management projects. Chapter 9 discusses the results and finding implications, and Chapter 10 provides recommendations.

II. Study Aims

2.1 OVERALL PURPOSE

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

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

2.2 STUDY AIMS

The aim of this study is to generate robust evidence on the costs and benefits of sanitation improvements in different programmatic and geographic contexts in Vietnam, leading to selection of the most efficient and sustainable sanitation interventions and programs. Basic hygiene aspects are also included, insofar as they affect health outcomes. Selected aspects of sanitation are assessed in this study. It is expected that it will lead to further economic studies on other aspects of sanitation.

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, households and the private sector.

Standard outputs of cost-benefit analysis include benefit-cost ratios, internal rate of return, payback period, and net benefits (see Glossary). Cost-effectiveness measures relevant to health impacts will provide information on the cost 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.

This study also contributes to the debate on approaches to sanitation financing and ways of scaling up sanitation improvements to meet national targets.

2.3 SPECIFIC STUDY USES

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

- Provide **advocacy material** for increased spending on sanitation, and to prompt greater attention from sector stakeholders to 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.
- Intensify 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 target), and contribute to national strategic plans for meeting and surpassing the MDG targets.
- Contribute to the design of **feasible financing options** through identification of the beneficiaries as well as the cost incidence of sanitation programs.
- **Maximize the benefits** of sanitation programs by providing an understanding of the determinants of sanitation program efficiency.

2.4 RESEARCH QUESTIONS

In order to fulfill the overall purpose of the study, research questions were defined that had a direct bearing on sanitation policies and decisions, and that were distinguished be-

tween overall efficiency questions (i.e. cost versus benefit), cost questions and benefits questions[2].

The major concern in economic evaluation is to understand economic and/or financial efficiency – in terms of return on investment and recurrent expenditure. Hence the focus of economic evaluation is on what it costs to deliver an intervention and what the returns are. Different efficiency measures allow the examination of this question from different angles, such as the amount by which benefits exceed costs, annual equivalent returns, and the time taken to repay costs and start generating net benefits (see Box 1). Moreover, as sanitation and hygiene improvement also fall within the health domain, economic arguments can be made for investment to be made in sanitation and hygiene interventions from the health budget (if the health return per unit cost invested is competitive compared with other uses of the same health funds).

As well as overall efficiency questions, it is useful from decision-making, planning and advocacy perspectives to better understand the nature and timing of costs and benefits, and how non-economic factors affect the implementation of sanitation interventions and affect their eventual efficiency (see Boxes 2 and 3 below). Furthermore, this study attempts to give greater emphasis to the impacts of improved sanitation that cannot easily be quantified in monetary terms in the overall cost-benefit assessment.

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 annual internal rate of return (IRR) of sanitation spending? How does the IRR compare to national or international standards for investments of public and private funds? How does the IRR compare to other non-sanitation development interventions?
iii. How long does it take for a household to recover its initial investment costs, at different levels of cost sharing (payback period – 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?

BOX 2. RESEARCH QUESTIONS ON SANITATION COSTS

i. What is the range of costs for each technology option in different field settings? What factors determine cost levels (e.g. quality, duration of hardware and software services)?
ii. What proportion of costs are capital, program and recurrent costs, for different interventions? What are necessary maintenance and repair interventions, and costs, to extend the life of hardware and increase sustainability?
iii. What proportion of total (economic) cost is financial in nature? How are financial and economic costs financed in each field location?
iv. How do costs of each sanitation option vary by wealth quintile? What is the average cost per sanitation option as a percentage of annual household cash income, by income quintile?
v. What are the incremental costs of moving from one sanitation improvement to another–i.e. up the sanitation ladder – for specified populations to meet sanitation targets?

[2] 'Costs' and 'benefits' refer simultaneously to financial and economic costs, unless otherwise specified.

BOX 3. RESEARCH QUESTIONS ON SANITATION BENEFITS

i. What local evidence exists for the links between sanitation and the following impacts: health impact, water quality, time use, welfare, tourism, and the business environment (including Foreign Direct Investment)?

ii. What are the size of financial and economic benefits related to health expenditure, health-related productivity and premature mortality; household water uses; time savings; property value; and other welfare impacts?

iii. What proportion of the benefits are pecuniary benefits (financial gains) and what proportion are non-pecuniary benefits?

iv. What proportion of each benefit accrues to households who invest in sanitation and what proportion is external to the investor?

v. What is the actual or likely willingness to pay of households and other agencies for improved sanitation? What is up-front versus annual recurrent willingness to pay?

vi. How do benefits accrue or vary over time?

vii. How is improved sanitation – and the related costs and benefits – tangibly linked with poverty reduction? What is the potential impact on national income and economic growth?

viii. What is the overall household and community demand (expressed and latent demand) for improved sanitation?

BOX 4. OTHER RESEARCH QUESTIONS

i. How do program design and program implementation affect costs and benefits? In practice, (how) can sanitation programs be delivered more efficiently – i.e. reducing costs without reducing benefits?

ii. How to leverage grants to incentivize investments in sanitation?

iii. What factors determine program performance? What are the key factors of success and constraint, covering contextual, institutional, financial, social and technical aspects?

iv. Which program approaches are best suited to which technical options?

v. What is the cultural acceptability of different sanitation options and program approaches?

vi. What other issues determine intervention choice and program design in relation to local constraints: energy use, water use, polluting substance discharge, and option robustness/durability/maintenance requirements?

vii. Based on research findings, what other key issues enter into sanitation option decisions?

In addition, other research questions are crucial to the appropriate interpretation and use of information on sanitation costs and benefits. Most importantly, the full benefits of a sanitation intervention may not be received due to factors in the field that affect uptake of and compliance with the intervention. These factors need to be better understood to advise future program design. Moreover, the ESI study touches on many financing issues, related to who is paying for the interventions and who is benefiting from them (and who, therefore, may be willing to pay). Given that scale-up cannot be achieved with full subsidization of sanitation interventions by government or other sector partners, it will be vital to better understand how public money and subsidies can be used to leverage further investment from the private sector and from households themselves (See Box 4).

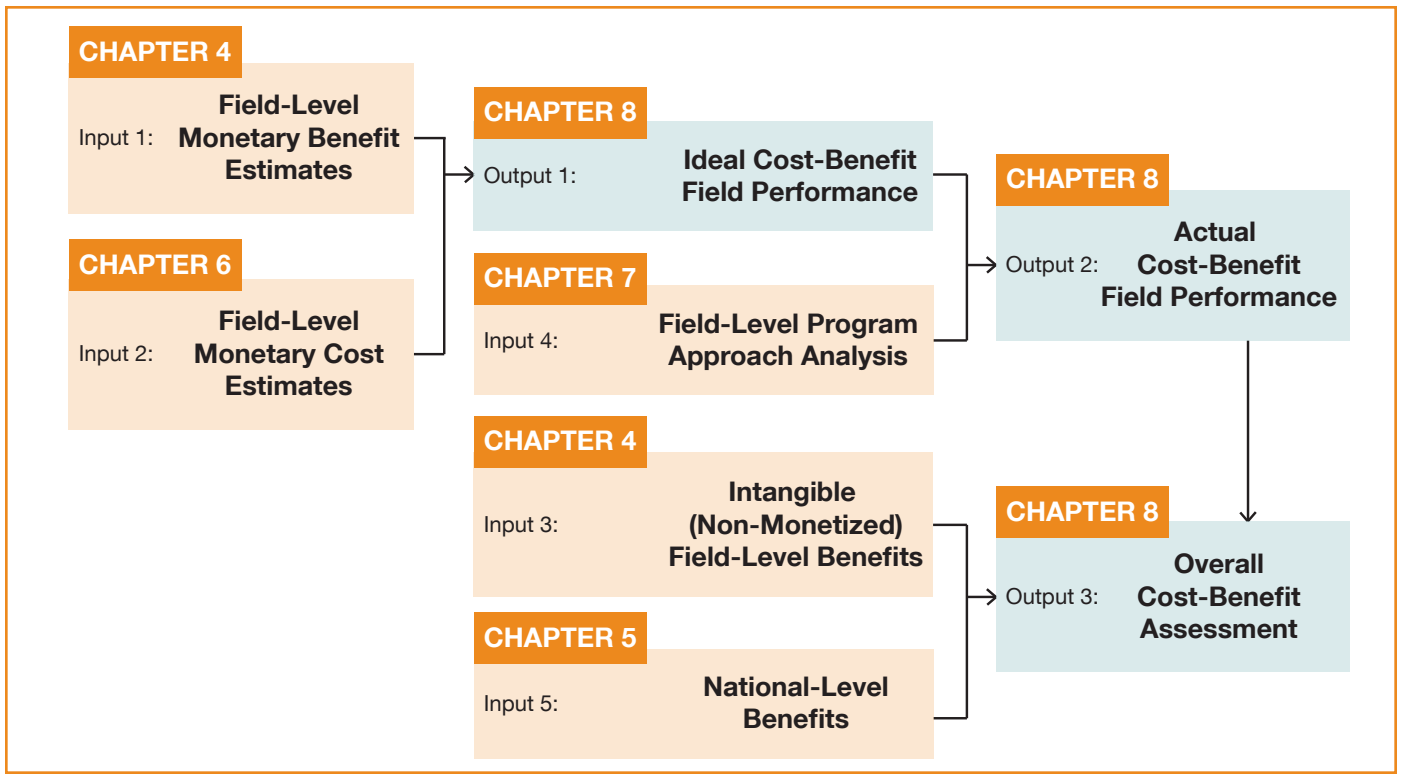
III. Study Methods

The study methodology in Vietnam follows a standard methodology developed at regional level reflecting established cost-benefit techniques (Hutton et al, 2012), which have been adapted to sanitation interventions and the Vietnam field study based on specific research needs and opportunities. As shown in Figure 3, the study consists of a field component that leads to quantitative cost-benefit estimates and in-depth study of qualitative aspects of sanitation. Two types of field-level cost-benefit performance are presented: Output 1 reflects **ideal performance** assuming the intervention is delivered, maintained and used appropriately, and Output 2 reflects **actual performance** based on observed levels of intervention effectiveness in the field sites. However, both these analyses are partial, given that intangible benefits of sanitation improvements and other benefits that may accrue outside the sanitation improvement site are excluded. Hence Output 3, **overall cost-benefit assessment**, takes these into account.

3.1 TECHNICAL SANITATION INTERVENTIONS EVALUATED

The sanitation component to be emphasized in the regional component of the study is human excreta. Interventions to improve human excreta management will focus on both on-site and off-site sanitation options; indeed one of the key aims of this study is to compare the relative efficiency of these from the perspective of different indicators. Hygiene-related practices are also included. In Vietnam, according to the TOR of the study, the scope of sanitation is broader than in other countries where ESI was conducted (see Table 2), and includes:

FIGURE 3: FLOW OF DATA COLLECTED (INPUTS) AND EVENTUAL COST-BENEFIT ASSESSMENTS (OUTPUTS)



- Human excreta not only from households, but also from schools, clinics, hospitals and other public places.
- Gray water, sullage and storm water from households and from residential areas.
- Domestic solid waste from urban and rural areas.
- Agricultural waste in rural and peri-urban areas, focusing on animal excreta.
- The area of social and cultural environment, where the cost and benefit of hygiene and responsibility-related behavior and interventions are considered, such as hand washing with soap, toilet cleanliness, immediate household environment (rubbish, drainage, mosquito and fly breeding), community area cleanliness, use of untreated feces as fertilizer and waste reduction.

As well as human excreta management, interventions that jointly address human waste with domestic wastewater management (especially in urban areas) and with animal waste management (in the case of biogas generation) are considered. The study includes modeling of the costs and benefits of other sanitation improvements, covering solid waste management, agricultural waste management (biogas digesters for pig farms) and trade village waste management.

To qualify as an economic evaluation study, cost-benefit analysis 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: ideally the analysis should compare all affordable, technically feasible, and culturally acceptable sanitation options for each setting, 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 4 presents a generalized sanitation ladder. The upward slope of the ladder reflects the assumption of greater benefits as it is climbed, but (generally) with higher costs. The progression shown in Figure 4 is not necessarily true in all settings and hence needs to be altered based on setting-specific features (e.g. rural or urban, different physical/climatic environments such as soil type or water scarcity).

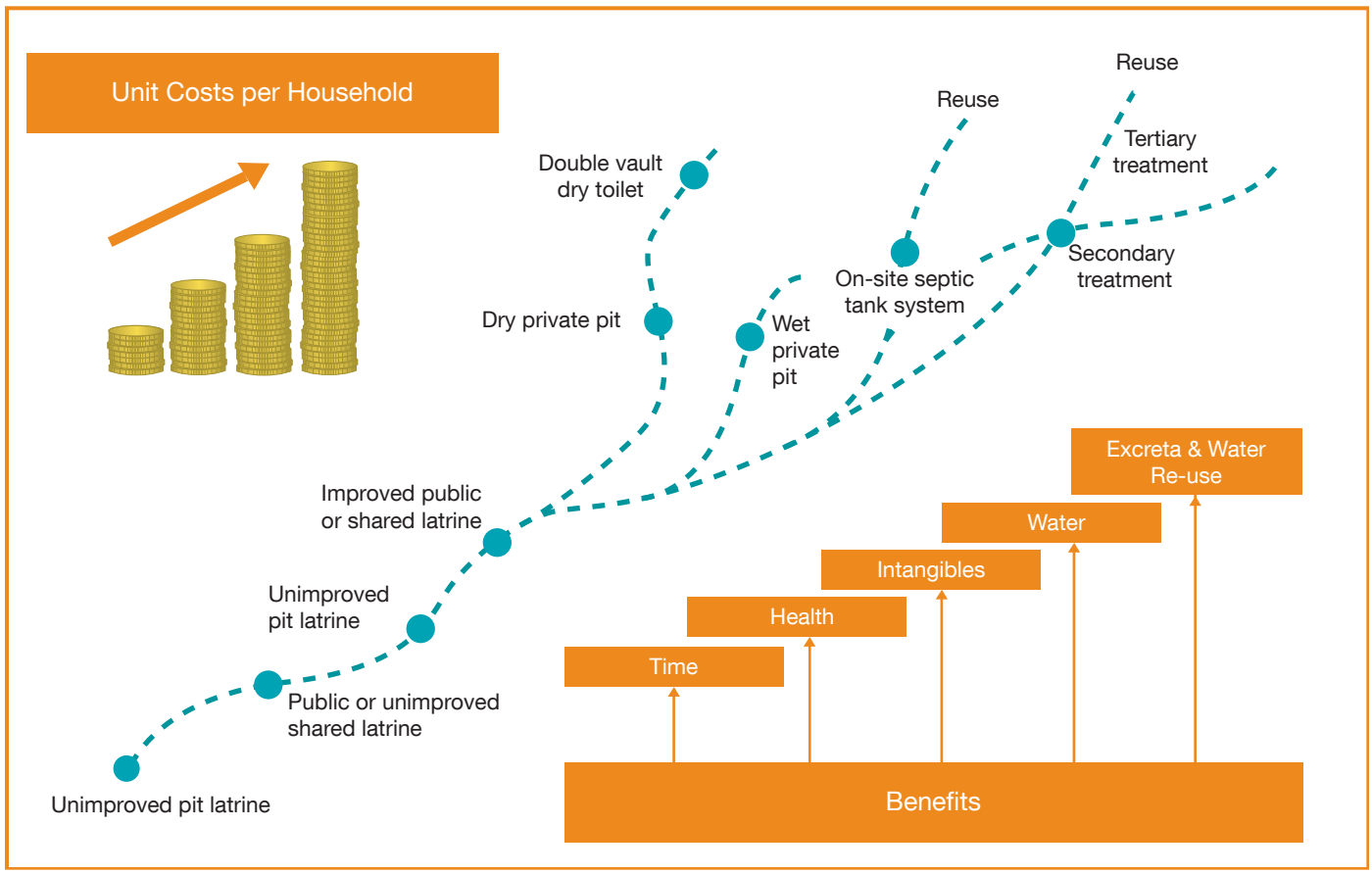
While the study conducts analyses of the costs and benefits of achieving the MDG targets and beyond, sanitation options should not be restricted by 'unimproved' and 'improved' sanitation as defined by the WHO/UNICEF Joint Monitoring Programme (JMP). For example, some households will be interested in upgrading from one type of improved sanitation to another, such as from ventilated improved pit latrine (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. And under some program approaches (e.g. Community-Led Total Sanitation [CLTS]), households are encouraged to move up the ladder, even if it does not imply a full move to JMP-defined 'improved' sanitation, such as the use of shared or unimproved private latrines.

TABLE 2: SCOPE OF SANITATION INTERVENTIONS COVERED BY THE ESI STUDY

Location	Type of waste treated	Scope of targeted interventions
Urban	Household sanitation (human excreta) + Urban wastewater	- Household toilet - Sewerage and drainage system - Personal hygiene
	Urban solid waste[1]	- Solid waste management for households and community
Rural	Household sanitation (human excreta) + Trade village wastewater	- Household toilet - Excreta, wastewater and floodwater management - Personal hygiene
	Solid waste[1]	- Solid waste management in rural community
	Animal waste	- Animal waste management for farms

[1] Excluding hazardous medical waste, pesticides, herbicides, etc

FIGURE 4: REPRESENTATION OF THE SANITATION "LADDER"



The ladder in Figure 4 as a starting point shows different types of intervention (sub-category) within the more broadly defined sanitation options. This classification provides an overview to allow a framework for interpretation of the specific options evaluated in the field settings (shown in section 3.3), given that option sub-categories may have different associated costs and benefits.

The sanitation ladder concept is potentially useful to policy making, given the meaning embedded in it and its simple presentation format. It is expected that by using robust data on the costs and benefits of different sanitation options, this study will further the understanding of the concept of the sanitation ladder. While taking care not to over-simplify the concept, it is expected that integration of economic thinking in the sanitation ladder will assist program managers, communities and households to think through the range of costs and benefits in moving from one point in the ladder to another. It is recognized that the sanitation ladder options are distinguished for different contexts in which sanitation services are provided, such as rural areas, urban areas and challenging environments.

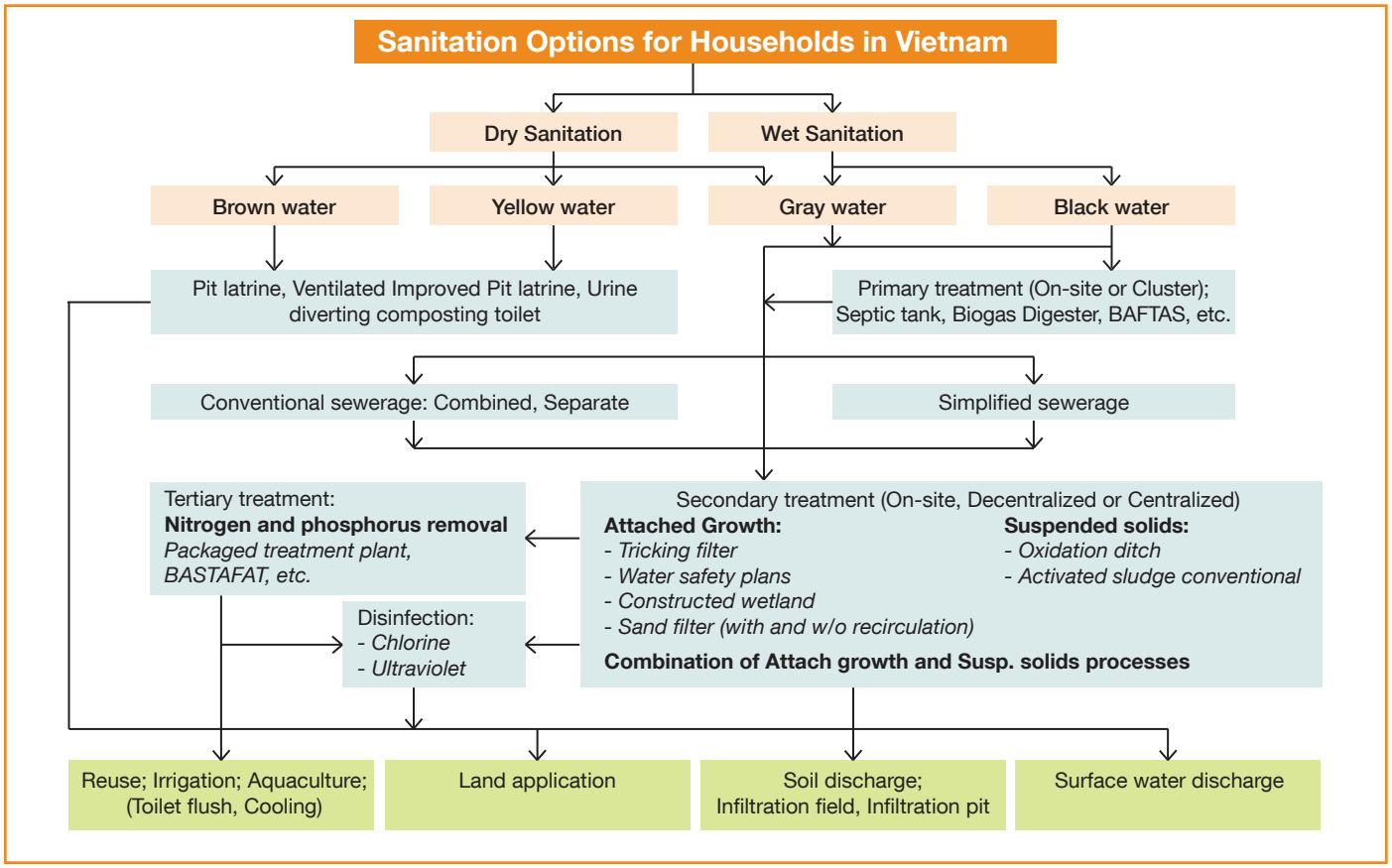
An overall perspective of alternative sanitation options for household wastewater and solid waste management is illustrated in Figure 5 and Figure 6, respectively.

In general, technological sanitation options applied to different areas and target groups in Vietnam are classified by this study into four types:

- On-site dry sanitation options.
- On-site wet sanitation options.
- Off-site (centralized or decentralized sanitation options).
- Solid waste management.

Details of the sanitation types are described in Table 3.

FIGURE 5: OPTIONS FOR HOUSEHOLD WASTEWATER MANAGEMENT



[1] 'Dry sanitation' means the type of sanitation not using water for toilet flushing.
[2] 'Wet sanitation' means using water for toilet flushing.
[3] In the case of dry sanitation brown water means feces that is separated from urine.
[4] In the case of dry sanitation yellow water means urine that is separated from feces.
[5] 'Gray water' means wastewater flow apart from toilet flushing, such as wastewater from washing sinks, shower, kitchen, laundry and floor cleaning.
[6] 'Black water' means the flushing toilet wastewater.

FIGURE 6: OPTIONS FOR IMPROVED SOLID WASTE MANAGEMENT

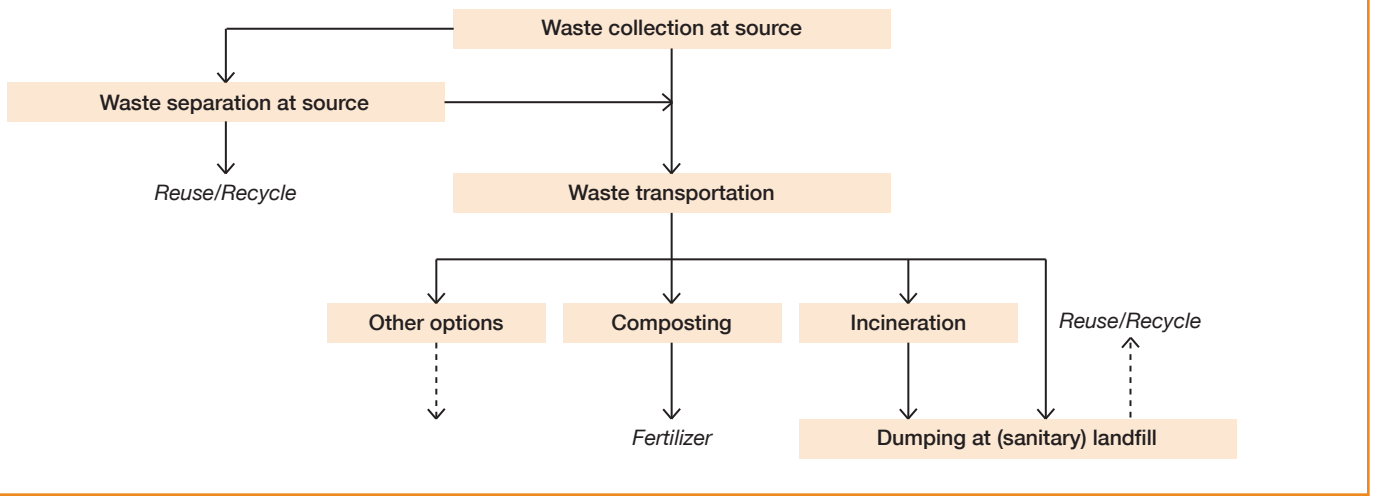


TABLE 3: SANITATION, WASTEWATER AND SOLID WASTE MANAGEMENT OPTIONS IN VIETNAM

No	Sanitation Options
A	ON-SITE DRY SANITATION OPTIONS
0	Open defecation
1	Dry pit latrine
2	Ventilated improved pit latrine (VIP)
3	Hanging latrine + composting pit in flood areas (VIPF)
4	Single vault composting toilet
5	Double vault composting toilet
5	Three vault toilet (co-composting of feces with organic waste)
6	Others
B	ON-SITE WET SANITATION OPTIONS
0	Open defecation
1	Wet pit latrine
2	Pour-flush toilet + infiltration pit
3	Septic tank + infiltration pit
4	Biogas digester
5	Others
C	OFF-SITE SANITATION OPTIONS
0	Open defecation
1	Public toilet + sanitation facilities such as B1, B2, B3, B4, C2
2	On-site wet sanitation facilities (mostly septic tanks) + combined/separate sewerage + cluster/decentralized wastewater treatment system at community scale
3	Separate sewerage + wastewater treatment system
4	Others
D	SOLID WASTE MANAGEMENT
0	No solid waste management at all
1	Collection and dumping in unsanitary landfill
2	Collection and dumping in sanitary landfill
3	Collection, recycling, composting of organics, dumping of remains in sanitary landfill
4	The same as D3, plus waste separation (at source)
5	The same as D3, plus incineration for energy recovery
6	Others

The solid waste management projects have been studied with the goal of finding evidence of the qualitative and quantitative benefits of each. Among the main challenges to developing cost and benefit calculations for the different improvement scenarios was the limited information on the relationship between solid waste management improvement and health indicators.

The following scenarios for the solid waste improvement projects have been considered in the study, based on the categories shown in Table 3:

1) No solid waste management at the household scale at all. Solid waste is discharged and dumped anywhere. From time to time, the local authority sends trucks to take the dumped solid waste away. However, these actions do not reflect systematic or sufficient attempts to manage solid waste.
2) Solid waste is collected regularly by the local cooperative or community, or the local authority, transported and dumped in **unsanitary** landfills nearby.
3) Solid waste is collected regularly by the local cooperative or community, or the local authority, trans-

ported and dumped in **sanitary** landfills in the area.

4) Solid waste is collected and separated at source or at the treatment plant. Part of the organic waste is composted for fertilizer production. The inorganic fraction of the waste in dumped in sanitary landfills. Combustible materials can be incinerated for energy recovery. Hazardous waste is collected separately, transported and treated.

The current study conducted surveys at four sites with solid waste management projects. The scenario evaluated for each site is shown in Table 4.

TABLE 4: SCENARIO FOR SOLID WASTE MANAGEMENT PROJECTS IN THE SURVEYED SITES

Site (identifier)	Scenarios
Bac Giang (U6)	1 → 2
Hanoi (U7)	2 → 4
Nghe An (U8)	1 → 3
Bac Giang (R6)	1 → 2

For scenario definitions, refer to Table 3, label D

3.2 COSTS AND BENEFITS EVALUATED

Sanitation costs serve as the denominator in the calculations to estimate the cost-benefit and cost-effectiveness ratios. 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, program and recurrent costs; by financial and economic costs[3]; by financier; and by wealth quintile. The incremental costs of moving up the sanitation ladder are assessed.

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

1. **Household direct benefits**: are incurred by households making the sanitation improvement. These actual or perceived benefits will drive the decision by the household to invest in sanitation, and guide choice of sanitation improvement. These benefits may include: health impacts related to household sanitation and hygiene; local water resource impacts; access time; intangible impacts; house prices; and the value of human excreta reuse.
2. **Local level external benefits**: are potentially incurred by all households living in the environment where households improve their sanitation. However, some of these 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 on land); the aesthetics of environmental quality[4]; and usability of local water sources for productive activities. Given the challenges in designing studies to distinguish household from local external benefits, the quantitative benefit-cost analysis groups these benefits together. Tentative conclusions are made, based on available literature, and on the likely relative proportions of private and external benefits.
3. **Wider scale external benefits**: result from improved sanitation at the macro-level. They may include improvements in: 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 areas or industrial zones), or to the country in general (e.g. the investment climate). As well as improved management of human excreta, other contributors to environmental improvement such as solid waste management and wastewater treatment are considered.

Therefore, this study distinguishes the economic analysis results between local community impacts where the sanitation and hygiene improvements take place, and national level impacts. Table 5 shows the monetary and non-monetary impacts included in the current study.

While this study focuses on household sanitation, the importance of **institutional sanitation** also needs to be highlighted. For example, improved school sanitation affects decisions about children (especially girls) starting or staying in school to the end of secondary level, and workplace sanitation affects decisions by the workforce (especially women) to take or continue work with a particular employer. These impacts are incremental over and above the first three outlined above. However, these impacts are outside the scope of this present study.

[3] In essence, financial costs are cash outlays, while economic costs include other inputs such as household labor.
[4] Aesthetic impacts of a degraded environment include unpleasant sights, smells and atmosphere.

TABLE 5: 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	- Healthcare costs - Health-related productivity - Premature death	- Disease and mortality rates - Quality of life impacts - Gender impacts
	Domestic water	- Water sourcing - Household treatment	- Link poor sanitation, water quality & practices - Use for income generating activities
	Other welfare	- Time use	- Convenience, comfort, privacy, status, security, gender
	Environmental quality		- Land use changes - Aesthetics of household and community environment
	Output reuse	- Fertilizer or biogas generated	- Preferences for handling human excreta
National benefits	Tourism		- Sanitation-tourism link: potential impact of poor sanitation on tourist numbers
	Business		- Sanitation- business link: potential impact of poor sanitation on local business and FDI
	Sanitation markets	- Potential national value of sanitation services - Potential national value of reuse of human excreta	

The next sections describe the study methods for the three major study components: the field level cost-benefit assessment (3.3), the assessment of program effectiveness (3.4) and national level impacts (3.5). Section 3.6 summarizes the main cost-benefit presentations and section 3.7 describes process aspects of the research such as study steering and collaboration.

3.3 FIELD STUDIES

3.3.1 FIELD SITE SELECTION

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

The principal criterion for site selection applied in this study is that there has been a sanitation project or program implemented in the past five years, and at a scale that allows minimum sample sizes of 30 households to be collected per sanitation option per site.

A number of sites have to be identified for inclusion in the study. The principal aim was that ESI should evaluate a range of sanitation options in different 'typical' contexts, so that all the feasible sanitation options and principal setting types are reflected. The team has conducted evaluation of context-specific costs and benefits of a range of sanitation options addressing the targeted issues, which not only include technical options, but also management/institutional/partnership options and financial options in investment and O&M. The selected sites should reflect the major categories of uncovered or inadequately covered populations, as well as the socio-economic activities targeted in this study.

The research team first listed all the potential sanitation programs for inclusion, and from this complete list developed a long list by applying a set of initial criteria to exclude those projects that are not amenable or relevant for evaluation in the program approach analysis (PAA). The programs were assessed according to three initial criteria:

- Project/program completion.
- Sufficiency of information.
- Relevance of program or technology.

Based on the long list, the characteristics of the sanitation programs were described in more detail to further assess their relevance and representational value for the study, leading to selection of the short-listed field survey sites:

FIGURE 7: LOCATIONS OF THE VIETNAM STUDY SURVEYED SITES

- Location: 17 locations (eight urban and nine rural) were selected for the field surveys to represent sanitation improvement case studies throughout the country. Field sites from most of the seven ecological zones in Vietnam – distinguished by geophysical, climatic, demographic and socio-economic characteristics – were included in the short list.
- Type of waste treated: the types of sanitation assessed in the Vietnam study included on-site and off-site management of human excreta, urban and rural wastewater management, solid waste management and animal waste from the farms. Therefore, field survey locations covered all types of sanitation and sanitation improvement options in both rural and urban settings.
- Sanitation options applied: Selection of short-listed sites was also based on different technical options applied at different scales. The scale of sanitation interventions considered in the selection of sites included:
  - Household level, distinguishing by income groups (e.g. poor versus non-poor).
  - Community level (village, farm).
  - Whole area level (city, town).

The short list of locations to be included in the field survey was selected based on the above criteria. Brief information about selected survey sites is given in Table 6.

TABLE 6: SHORTLISTED STUDY SITES

Project Name and Label (U – urban site: R – rural site)	Household toilet	Community sewerage and drainage	Solid waste management	Animal waste
U1. Environmental Sanitation project in Sa Dec town, Dong Thap province.	✓	✓	✓	
U2. Expanding Benefits for the Poor through Urban Environmental Improvements in Tam Ky, Quang Nam	✓	✓	✓	
U3. Sanitation project in Hai Phong	✓	✓	✓	
U4. Sanitation project in Ha Long city: Bai Chay area		✓	✓	
U5. Environmental Sanitation project for Buon Ma Thuot city	✓	✓		
U6. Private water supply and solid waste management model in Hiep Hoa district, Bac Giang province			✓	
U7. 3R project in Hanoi city (reduce, reuse, recycle)			✓	
U8. Solid waste management improvement project for Cua Lo town, Nghe An province			✓	
R1. Biogas program for animal husbandry in Binh Tan village, Xuan Phu commune, Xuan Loc district, Dong Nai province	✓			✓
R2. Rural WSS improvement in Binh Thanh and Binh Hoa Bac communes, Vinh Long province - Cuu Long delta Rural WSS Project	✓			
R3. Hygiene and Sanitation Improvement in Tinh Dong commune, Son Tinh district, Quang Ngai province	✓			
R4. Installation of household biogas digesters in 16 communes, Tan Lap, Dan Phuong, Ha Tay (Hanoi)	✓			✓
R5. Sanitation Marketing project in Tam Dan commune, Tam Ky district, Quang Nam province	✓			
R6. Private solid waste management model in Hong Giang commune, Luc Ngan, Bac Giang province			✓	
R7. Waste management project in Lai Xa, Hanoi (formerly Ha Tay)	✓	✓	✓	
R8. Biogas for electricity generation: Livestock breeding farm in Thieu Duong, Thieu Hoa district, Thanh Hoa province				✓
R9. Expanded environmental sanitation project in Phu Loc district, Thua Thien – Hue province	✓			

3.3.2 FIELD SITE DESCRIPTION

Table 7 and Table 8 provide details of the urban and rural sites, respectively. Further details are given in Annex Table A12. The sites have been selected to represent the ecological regions of Vietnam. Sanitation projects have mostly been completed at the sites. Some of sites have received combined water, sanitation and hygiene projects. Other field sites have focused on the sanitation components of solid waste collection (Bac Giang province and Cua Lo town), solid waste separation at source (Hanoi city), and biogas digester for pig farm waste treatment and resource recovery (biogas project in pig farm in Thanh Hoa province).

TABLE 7: BACKGROUND INFORMATION ON SELECTED URBAN FIELD SITES

Variable	U1	U2	U3	U4	U5	U6	U7	U8
Name	Sa Dec town	Tam Ky city	Hai Phong city	Bai Chay town	BMT city	Thang Town	Hanoi city	Cua Lo town
Rural/urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban
Households	2,170[1]	4,169	175,000	80,000	17,000	2,500	18,200	11,600
Population	9,327	17,511	0.7 mio.	330,000	65,000	10,750	72,820	48,730
Av. household size	4.3	4.2	4.0	4.1	4.9	4.3	4.0	4.3
Av. Children <14	22.9%[2]	24.2%	21.4%	24.2%	33.7%	29.4%	21.4%	26.5%
Area surveyed	5 clusters in 1 ward	2 wards	1 ward from 4 districts	1 of 7 project wards	5 wards	5 wards	4 wards	5 wards + 2 communes
Sanitation coverage (%)	ST increased from 56 to 90%[3]	10.8% toilets added	42.9% (300,000 HHs)	60%	67.7% (32.4% connected, 80% SW collected)	> 90%	87%	SW collection increased from 70% to 100%
Project period	10/2001 – 10/2008	5/2005 – 5/2008	2001 – 2007	2001 - 2007	2001 – 2007	1998 – now	12/2006 – now	4/2004 – 7/2007
Project budget	AusAID: A$49.98 mio. for 3 provinces GoV: A$28.34 mio.	JFPR: $1 mio. GoV: $140,000 Community: $60,000	Finnish Gov. $7.26 mio, WB loan $25.5 mio., GoV $11.9 mio.	Grant: $10.86 mio, Loan: $20.28 mio., GoV: $5.59 mio.	Grant; DKK121.2 mio; GoV: DKK25.0 mio.		Japan: JPY435.5 mio; GoV: VND1,429 mio.	Grant: DKK1.6 mio.
Interventions	Integrated, community based: water supply systems, HH water tank, ST (7,500 HHs), IEC, SWM, Institutional support, IEC	Infrastructure improvement (drainage, road), water supply for 200 HHs, HH toilets for 300 HHs, SWM, IEC	Infrastructure improvement (drainage, pumping station, ponds & lakes), ST connection improvement, ST emptying, septage treatment, revolving fund, IEC, management capacity	Infrastructure improvement (pumping station, WWTP), septic tank and connection improvement, septage treatment, SWM with landfills, revolving fund, IEC, management capacity	Infrastructure improvement (drainage, low-cost sewerage, pumping station, WWTP), HH connection, SWM, school toilets, IEC, management capacity	Establishment of Environ. Sani. Cooperative, solid waste collection and disposal, IEC	URENCO capacity building, IEC, source separation, composting or organic waste	URENCO capacity building, IEC, job creation for 120 poor, SW collection and disposal
Target households	6 wards, including poor	6 wards, including poor	300,000 HHs benefited; 7,227 HHs involved in revolving fund program per 2 mio. per HH	WW treatment: 193,000 persons; SWM: 330,000 persons; revolving fund program: 11,504 HHs	5,500 HHs benefited (21,000 persons) from total 17,000 HHs	Whole area in the town	All HHs in 4 pilot wards	7 wards and communes
Interviewed in ESI survey	80	89	102	100	109	100	100	100

[1]Source: Current ESI survey; [2]Source: GSO, 2006; [3]Source: Project document

TABLE 8: BACKGROUND INFORMATION ON SELECTED RURAL FIELD SITES

Variable	R1	R2	R3	R4	R5	R6	R7	R8	R9
Name	Xuan Phu, Xuan Loc, Dong Nai	Huu Thanh, Tra On, Vinh Long	Tinh Dong, Son Tinh, Quang Ngai	Tan Lap, Dan Phuong, Hanoi	Binh Trieu, Thang Binh, Q.Nam	Hiep Hoa, Bac Giang	Lai Xa, Kim Chung, Hoai Duc, HN	Thieu Duong, Thanh Hoa	Loc Dien & Vinh My, Phu Loc, TT - Hue
Rural/urban	Rural	Rural	Rural	Rural	Rural	Rural	Rural	Rural	Rural
Households	5 HHs and farms	2,240	1,528	2,800	2,310	2,150	900	1 farm	4,362
Population	38 persons from total 25,000	9,630	6,970	13,000	9,701	9,460	4,000	11 persons	22,690
Av. household size	4.3	4.3	4.6	4.6	4.2	4.4	4.4		5.2
Av. Children <14	23.1%	22.9%	26.5%	21.4%	24.4%	29.4%	21.4%		26.5%
Area	3 communes	1 from 9 benefited communes	8 villages from 1 commune	4 villages	5 villages from 1 commune	1 commune	1 village	1 farm	9 villages from 2 communes
Sanitation % improved	NA	97% schools	WS&S: 70%; Water only: 85%	NA	Hygienic toilets increased from 16 to 35%	> 80%	+ 40%		+ 40.5 and 42.8%
Project period	2003 – 2009	2001 – 2008	2006 - 2009	2000 - 2004	2003 - 2004	1998 – now	2002 – 2008	2004 – 2008	2001 – 2005
Project budget	Support VND1 mio. per HH. 10 – 20 mio. per biogas system by HH	Vinh Long province: AusAID: A$6.7 mio.; GoV: VND30.2 billion	Plan: $1.17 mio, GoV: $100,000, HHs: $126,000	Support VND0.55 mio. per HH. 10 – 20 mio. per biogas system by HH	IDE (marketing sanitation): $150,000; HHs: $397,400[1]		YWAM: VND0.8 billion GoV: 0.33 billion, local contrib. VND0.85 billion[2]	VND405 mio. for biogas system and elect. generator	Support 0.55 mio. per HH toilet
Interventions	IEC, Technical & financial support for biogas construction	IEC, community participation, School sanitation, HH WSS, central WS systems, capacity building	HH toilets, water supply, IEC, capacity building for service providers	IEC, Technical & financial support for biogas construction	Demand creation through IEC and capacity building for providers	Establishment of Envi. Sani. Coop., solid waste collection and disposal, IEC	Improved drainage, demon. HH toilets, cluster WWTP, SWM, IEC	Construction of biogas system for pig farm, electricity generation	Support for HH toilet, IEC, school toilets, demon. toilet, etc.
Target households	354 biogas constructed	5 prov./ 45 comm./ 390,000 persons. 232 wells, 116 school toilets, 150 HH toilets, 21,000 HH water tanks, 51 central WS systems	10,000 HH toilets, 2,000 HH WS facilities over 16 communes in 3 districts. In Tinh Dong: 745 from 1,528 HHs (50%)	700 HHs from 2,800 HHs over 4 villages	54,000 HHs from 30 communes in 6 districts of 2 provinces (H&QN). Toilets increased from 8,637 to 9,361	Whole area in the ward	Whole area in the village, including poor		3 communes Whole program (2001 – 2005): 20 provinces, budget VND400 – 600 mio. per year
Interviewed	5	107	155	101	159	200	196	1	147

[1]Source: Project report
[2]Source: Current ESI field survey

TABLE 9: SANITATION AND HYGIENE INTERVENTIONS EVALUATED IN URBAN SITES

Urban sites	U1	U2	U3	U4	U5	U6	U7	U8
SANITATION								
1. Open Defecation	✓	✓	✓	✓	✓	✓	✓	✓
2. Community shared toilet						✓		✓
3. Wet pit latrine	✓	✓	✓		✓	✓	✓	✓
4. Septic tank + soak away	✓	✓	✓	✓	✓	✓	✓	✓
5. Septic tank + sewer	✓	✓	✓	✓	✓	✓	✓	✓
6. Septic tank + sewer + WWTP			✓	✓	✓			
HYGIENE								
IEC campaigns	✓	✓	✓		✓		✓	✓
Hand washing with soap	✓	✓	✓		✓			

TABLE 10: SANITATION AND HYGIENE INTERVENTIONS EVALUATED IN RURAL SITES

Rural sites	R1	R2	R3	R4	R5	R6	R7	R8	R9
SANITATION									
1. Open Defecation	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Community shared toilet						✓			
3. Wet pit latrine	✓	✓	✓	✓	✓	✓	✓		✓
4. Septic tank + soak away		✓	✓	✓	✓	✓	✓		✓
5. Septic tank + sewer		✓	✓	✓	✓	✓	✓		✓
6. Septic tank + sewer + WWTP							✓		
7. Double vault composting toilet			✓						✓
8. Biogas digester	✓			✓				✓	
HYGIENE									
IEC campaigns	✓	✓	✓		✓		✓		✓
Hand washing with soap		✓	✓		✓		✓		✓

The interventions included in economic evaluation are shown in Table 9 and Table 10 for urban and rural sites, respectively. Note that the costs and benefits for all sub-types of intervention are different.

3.3.3 COST ESTIMATION METHODOLOGY

This study estimates the comprehensive costs of different sanitation options, including program management costs as well as on-site and off-site costs. Cost estimation was based on information from three data sources (sanitation program or project documents, the provider or supplier of sanitation services, and the ESI household questionnaire, described in section 3.3.5. Data from these three sources were compiled, compared, and adjusted, and finally 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 and software components) and adding annual maintenance and operational costs. For data analysis and interpretation, financial costs were distinguished from non-financial costs, and costs were disaggregated by financier. Information from the documents of sanitation projects and providers as well as market prices was supplemented with interviews with key resource people to ensure correctness of interpretation, and to enable adjustment where necessary.

For solid waste management, capital costs included construction, equipment and project management costs, while operation and maintenance costs included labor, rent of facility and warehouse, amortization, electricity, chemicals, repair, replacement, waste transportation and others.

3.3.4 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, requiring a robust study design. Annex Table A4 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 both 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, time use), as well as understanding attitudes towards poor and improved sanitation, and the factors driving decisions. 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 (e.g. behavior and risk factors for health assessment). Figure 8 shows an overview of the methods for estimating the benefits of moving up the sanitation ladder. The actual size of the benefit depends on the specific sub-type of sanitation intervention implemented.

The specific methods for evaluating sanitation benefits are described below. For a mathematical representation of the methodology, refer to the aggregating equations in Annex A6.

Health: For the purposes of cost-benefit and cost-effectiveness analysis, three types of disease burden were evaluated: the number of cases (incidence or prevalence); the numbers of deaths; and disability-adjusted life-years (DALYs). The

FIGURE 8: OVERVIEW OF METHODS FOR ESTIMATING FIELD-LEVEL BENEFITS OF IMPROVED SANITATION

BENEFIT CATEGORY	POPULATION WITH UNIMPROVED SANITATION	POPULATION WITH IMPROVED SANITATION	BENEFIT ESTIMATED
HEALTH	Data on health risk per person, by age category & socioeconomic status	Generic risk reduction, using international literature	Averted health care costs, reduced productivity loss, reduced deaths
WATER	Data on water source and treatment practices	Observed changes in practices in populations with improved sanitation	Reduced water sourcing and water treatment costs
ACCESS TIME	Data on time to access toilet per person per day	Observed reductions in time to access toilet	Opportunity cost of time applied to time gains
INTANGIBLES	Attitudes and preferences of householders to sanitation	Benefits cited of improved sanitation	Strength of preferences for different sanitation aspects and willingness to pay
REUSE		Practices related to excreta reuse	Value gained, based on sales or own use

diseases included were all types of diarrheal disease, helminths, hepatitis A and E, trachoma, scabies, malnutrition and diseases related to malnutrition (malaria, acute lower respiratory infection, measles) (see Annex Table A7). Health costs averted through improved sanitation were calculated by multiplying overall health costs per household by the relative health risk reduction resulting from the improved sanitation and/or hygiene measures. Health costs were made up of disease treatment costs, productivity losses and losses through premature mortality. For cost-effectiveness analysis, DALYs were 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 were sourced from the Global Burden of Disease study, and an average life expectancy for Vietnam of 72 years was used (Vietnam GSO, 2008).

- Rates of morbidity and mortality were 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 (WHO, 2000). National disease and mortality rates were adjusted to rates used for the field sites based on socio-economic characteristics of sampled populations. As not all fecal-oral diseases have a pathway from human excreta, an attribution fraction of 0.88 was applied for these diseases. Skin diseases are attributed 0.80 due to poor hygiene. Methods for the estimation disease and mortality rates from indirect diseases via malnutrition are provided in the ESI Impact study report (WSP, 2009).
- Health care costs were calculated by applying treatment-seeking rates for different healthcare providers to the disease rates, per population age group. The calculations also took into account hospital admission rates for severe cases. Unit costs of services and patient travel and sundry costs were applied based on treatment-seeking.
- Health-related productivity costs were 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 were based on the average income rates per location. For adults a rate of 30% of average income was applied, reflecting a conservative estimate of the value of time lost. For children aged 5-14 years, sick time reflects lost school time, which has an opportunity cost, valued at 15% of average income. For children under 5, the time of the child carer was applied at 15% of average income. Values are provided in Table 11.
- Premature death costs were 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 lack of studies (e.g. value-of-a-statistical-life[10]). Values are provided in Table 11, including VOSL adjusted to Vietnam from developed country studies.
- Risk reductions of illness and death associated with improved sanitation and hygiene interventions were assessed from the international literature, and were applied and adjusted to reflect risk reduction in local settings based on baseline health risks and interventions applied. Risk reductions depended on whether the intervention provided a safe place to defecate without full isolation or treatment (basic sanitation), or whether a high degree of isolation and/or treatment was achieved (basic sanitation + wastewater management). The reductions in diarrheal disease, other fecal-oral disease and diseases related to resulting malnutrition were applied as follows: basic sani-

[5] 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 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. No VOSL studies have been conducted in Vietnam.

tation alone (36%[6]); basic sanitation with hygiene (50%[7]); basic sanitation + wastewater management (56%[8]); and basic sanitation + wastewater management with hygiene (65%[9]). For soil-transmitted helminths, fewer primary studies were available to estimate risk reduction; the following was assumed: basic sanitation alone (50%), basic sanitation with hygiene (70%), basic sanitation + wastewater management (80%), and basic sanitation + wastewater management with hygiene (100%).

Water: While water has many uses at community level and in larger-scale productive purposes (e.g. industry), 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 or treated piped water supply. In some communities it may involve putting an end to the use of water from shallow dug wells, due to the risk of contamination from pit latrines and septic tanks. Therefore, water quality measurement was conducted as part of this study in representative field sites, to enable detailed analysis of the impacts of improved sanitation on local water quality (see Annex C). This study measures the actual or potential economic impact of improving sanitation on two sets of mitigation measures:

- Accessing water from the source. Because households pay more or walk further to access water from cleaner sources such as drilled wells, or they pay more for piped water, it would in theory reduce these costs if sanitation were improved. For example, traditionally people prefer the taste of water from shallow wells to deeper wells, and hence would likely return to using shallow wells if they could guarantee cleaner, safer water. Moreover, providers of piped water have to treat water less if it is less contaminated, thus saving costs. Hence, expected percentage cost reductions are applied to the current cost of clean water access to estimate the cost savings from improved sanitation.
- Household treatment of water. Traditionally, many households treat their water due to concerns about 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 providing potable water. However, boiling water can require considerable cash outlay and collecting fuel consumes time. Furthermore, boiling water for drinking purposes is more costly to the environment due to the use of wood, charcoal or electricity, and results in correspondingly higher CO2 emissions than those produced by other treatment methods. If sanitation is improved and the pathogens in the environment reduced to low levels, households would feel more ready to use a simple and less costly household treatment method such as filtration or chlorination. Hence, the cost savings associated with alternative water treatment practices are calculated based on observation and expected future treatment practices in households using improved sanitation.

TABLE 11: UNIT VALUES FOR ECONOMIC COST OF TIME PER DAY AND OF LOSS OF LIFE (VND, 2009)

Technique	Daily value of time			Value of life		
	0-4 years	5-14 years	15+ years	0-4 years	5-14 years	15+ years
Human capital approach[1]	5,742	5,742	11,310	561,811,200	668,455,800	344,015,400
VOSL[2]				708,493,200	708,493,200	708,493,200

[1] 2% real GDP per capita or wage growth per year, discount rate = 8%
[2] 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

[6] 36% reflects the average of Waddington 2009, Fewtrell 2005, Esrey 1991 and Esrey 1996.
[7] 50% reflects the sanitation interventions alone of 36% plus 14% add-on for hygiene.
[8] 56% reflects the average for the two Brazilian studies which found 43% and 69% risk reduction for high risk populations, and is also close to the 57% that is the half way risk reduction from scenario IV (or Vb) to scenario II (Prüss, 2002)
[9] 65% reflects 56% reduction from sanitation plus hygiene add-on, which brings 9% marginal impact.

Access time: Households with their own private latrine save time every day that would otherwise have been spent going to the bush or using shared a 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. Therefore, this study calculates the time saved by different population groups using improving sanitation, based on observations of households both with and without improved sanitation. The value of time is based on the health-related time savings discussed above.

Excreta reuse: Human excreta, if handled properly, can be a safe source of fertilizer, wastewater for irrigation or aquaculture, or biogas. However, improved human excreta reuse is not commonly practiced in Vietnam. Five sites are included in this analysis (R1, R4, R8 [biogas], R3 and R9 [UDDT or DVCL]). In these sites, different sanitation options are practiced. The value of excreta reuse is measured through assessment of both the non-market value (when used by the household, which either saves costs or generates additional benefit) and the market value (when sold at a price). This enables calculation of an average value per household practicing human excreta reuse. In the case of combined human and animal excreta reuse (as in the case of biogas), both the full cost and the full benefit of the biogas digester are included.

Intangibles: Intangibles are major determinants of personal and community welfare such as comfort, privacy, convenience, safety, status and prestige. Due to their often very private nature, it is difficult to elicit reliable responses from individuals about intangibles, and they may vary considerably from one individual and social group to another. Intangibles are therefore difficult to quantify and summarize from a population perspective, and are even more difficult to value in monetary terms for cost-benefit analysis. 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 preferences that have been valued elsewhere (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: Likewise, 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. Given human-related sanitation is only one of several factors of 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.

The benefits of improved solid waste management are presented in Table 12.

3.3.5 DATA SOURCES

Because of the range of costs and benefits estimated in this study, a range of data sources was defined, including both up-to-date evidence from the field sites and evidence from other databases and studies. Given the limitations of the field study, data related to some benefits needed to be gathered from other more reliable sources. Routine 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, or not conducted in the ESI field locations.

The data collection in field sites involved several different tools, including household surveys, focus group discussion (FGD), market surveys, water quality surveys, and information collection from available reports. The survey team for each field site often contained two experts, including a sociology expert as team leader, and an environmental expert, dealing with physical-market surveys and sanitation option description. Twelve collaborators from the local Women's Union and local People's Committee were selected to conduct the survey after two days of training. Using local officers and Women's Union representatives has many advantages, including a strong relationship with local people, and experience working in social affairs, water and sanitation.

TABLE 12: ASSESSMENT METHODS FOR THE BENEFITS OF SOLID WASTE MANAGEMENT PROJECTS

No	Aspect	Description	Qualitative benefit	Basics for quantitative benefit calculation
1	Health	Less insects, reduced health problems for waste collectors, recycling material pickers, neighborhoods	- Reduced disease and mortality rates[1] - Quality of life impacts - Gender impacts	Not assessed
2	Water environment	Reduced treatment costs for landfill leachate		- 0.3 m^3 of leachate from 1 ton of dumped solid waste (during whole landfill life)[2]; - Investment: VND30 mio. per m^3/day capacity[3]; - O&M: VND100,000 per m^3 of leachate[4];
		Reduced water treatment costs for the residential area surrounding landfill	- Link poor sanitation, water quality & practices - Use for income generating activities	- Water sourcing - Household treatment - Investment costs VND10,000,000/m^3 capacity[5]; - O&M costs VND4,000/m^3 [6]
		Reduced expenses for sewer and canal dredging from uncollected garbage	- Quality of life impacts	- Uncollected garbage is discharged to the sewer and canal. Cost of dredging and transportation to the dumping site: VND60,000 /m^3
3	Access time	Reduced time for garbage disposal	- Convenience, comfort, privacy, status, security, gender	- Time per day x value of time
		Reduced transportation of solid waste to the landfill sites	- Reduced traffic loadings	- VND1,000 per ton per kilometer
4	Land	Reduced land for dumping site[7]	- Land use changes - Aesthetics of household and community environment	- Reduced area x land price - Reduced 1 ton of treated organic waste leads to reduced 0.239 m^3 of landfill
5	Reuse	Benefit from recycle materials	- Use for income generating activities	- Market value
		Benefit from compost	- Use for income generating activities	- 5 ton MSW = 1 ton compost; - Market cost (VND600 – 1,000/kg)
		Benefit from biogas to energy	- Use for income generating activities	- 1 ton MSW: 60% organics - 1 ton organic MSW = 300 KWh generated - Market cost
		Reduced greenhouse gas emission		- 1 ton MSW treated = 1.785 ton CO_2 reduced - US$10 - 20/ton carbon emissions (CDM)
		Reduced impacts from chemical fertilizers	- Quality of water, soil and other environment parameters	- Market cost

[1] No published evidence has been found on the reduced disease burden or mortality rates from improved solid waste management.
[2] Adapted from: Landfill leachate: Growing Concerns to Aquatic Environment. Tonni Kurniawan. 2010. IWA.
[3, 4] Summarized and analyzed from available information on leachate treatment in Hanoi and Ho Chi Minh cities.
[5, 6] Summarized and analyzed from available information on water projects in Vietnam.
[7] According to the Vietnamese construction code, minimum distance from landfill to other constructions is 1,000 metres.

The total number of staff involved in the 17 field surveys as roughly 200. The survey team consisted of a local coordinator, one or two assistants and between eight and ten interviewers. The interviewers were selected based on their age (less than 45 years old), education (high school as the lowest), and health (good health). The total number of days spent conducting field surveys was 85.

A preliminary visit was made to most field sites, in order to develop detailed programs and schedules for the survey, which were discussed and agreed by the local authorities. A survey of physical environment was also often conducted during the preliminary surveys at the sites. Sampling sites for the water quality survey were also prepared during the preliminary trips.

The field tools applied are introduced briefly below (the tools applied in Vietnam are available from WSP).

Field tool 1: Household questionnaire. Household questionnaires consisted of two main parts: the first was addressed to household representatives (the senior male and/or female household member available at the time of the interview); and the second was a shorter observational component mainly covering the physical water, sanitation and hygiene features of the household. The interview consisted of sections on:

- 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 health treatment seeking.
- Hygiene practices.
- Household solid waste practices.

The household questionnaire was applied to a total of 2,400 households over the 17 sites. Approximately 200 households were interviewed at each rural site, and approximately 100 households were interviewed at each urban site. In most cases, control sites were established for comparison with intervention sites. Annex Tables A9 and A10 present the sample sizes per sanitation option and per field site. Each interview required between 2 and 3 hours. The use of local officers and Women's Union staff helped the collection of positive responses from most households during interview and other survey activities.

Field tool 2: Focus group discussion. The purpose of the focus group discussion (FGD) was to elicit information on behavior and preferences relating to water, sanitation and hygiene from different population groups, with main distinctions made according to sanitation coverage (with versus without) and gender. 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. FGDs were lead by a social expert from the study team and notes taken by the other assistants. Each FGD took an average 3.5 hours.

Field tool 3: Physical location survey. A survey of the physical environment was conducted in all field locations. The main purpose was to identify important variables in relation to water, sanitation and hygiene in the general environment, covering land use, water sources, and environmental quality. This information was triangulated with the household surveys and FGDs and with the water quality measurement survey, to enable appropriate conclusions to be made about the extent of poor sanitation and links to other impact variables. This survey was conducted by water and sanitation experts from the study team.

Field tool 4: Water quality measurement. Because one of the major detrimental impacts of poor sanitation is its impact on surface and ground water quality, special attention was paid in this study to identifying 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 present 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 three laboratories (the Laboratory of NCERWASS for the northern provinces; the laboratory of Hue National University for the central provinces; and the Laboratory of the National University in Ho Chi Minh City for the southern provinces) and carried out between September 2009 and January 2010. The study enabled an assessment of the impact of specific local sanitation features on water quality. It also enabled a broader comparison of water quality between study sites with different sanitation coverage levels. Water sources tested at each site included ground water (dug shallow wells, deeper drilled wells), standing water (ponds, lakes, canals), and flowing water (river, wastewater channels). Annex A8 shows the type of test and location per parameter, and the number and type of water sources tested. Parameters measured var-

ied per water source, but generally included turbidity, dissolved oxygen, biological oxygen demand (BOD), chemical oxygen demand (COD), E-coli and total coli-form.

Field tool 5: Market survey. Local prices are required to enable an economic valuation of the impacts of improved sanitation and hygiene. Selected resource prices, and in some cases resource quantities, were recorded from the most appropriate local source: labor prices (average wage, minimum wage) and employment rate; water prices by different source; water treatment filters; fuel prices; sanitation improvement costs; soap costs; fertilizer costs (when excreta is used for fertilizer); and pharmacy drug costs. Seventeen market surveys were carried out – one at each field site.

Field tool 6: Health facility survey. Because of the importance of health impacts, a separate survey was conducted in two or three health facilities serving each field site. Variables collected included the number of patients with different types of WSH-related disease, and the types and cost of treatment provided by the facility. Data were supplemented by data collected or compiled at higher (commune, district or provincial) levels of the health system.

Other data sources: data were collected not only from field sites, but also from other sources to support the field-level cost-benefit study, such as national reports, interviews, and data sets. These included:

- DHS: data compiled from latest survey (2002).
- WHO – UNICEF JMP data, 2008 (WHO).
- The Report on Water Supply and Environmental Sanitation Status in Rural Areas of Vietnam. MOH – UNICEF (2007).
- International health literature: rates of disease from burden of environmental risk factors in 2008 and review of effectiveness of WSH interventions to avert disease (Fewtrell et al 2005, Waddington et al 2009).

3.3.6 DATA ANALYSIS

The types of costs and benefits included in the study are listed in section 3.2. Annex Table A5 provides an overview of the variables for calculation, the algorithms, and the main data sources/inputs for the equations. This section describes how costs, benefits and other relevant data are analyzed to arrive at overall estimates of cost-benefit.

The field-level cost-benefit analysis generates a set of efficiency measures from site-specific field studies, focusing on actual implemented sanitation improvements, including household and community costs and benefits (see Table 5). 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 year 1) are discounted to present value using a discount rate of 8% (sensitivity analysis: low 3%, high 10%).
2. The cost-effectiveness ratio (CER) is the present value of the future health benefits in non-monetary units (cases, deaths, disability-adjusted life-years) divided by the present value of the future costs, for the 20-year period. Future costs and health benefits (i.e. beyond year 1) 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.
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 point that is break even.
5. The net present value (NPV) is the net discounted benefits minus the net discounted costs.

Results are presented by field site and for each sanitation improvement option compared with no sanitation option (i.e. open defecation). Selected steps up the sanitation ladder are also presented, such as from shared latrine to private latrine, from dry pit latrine to wet pit latrine, or from wet pit latrine to sewerage. The efficiency ratios are presented both for well-delivered sanitation programs that lead to well-functioning sustainable sanitation systems, and for sanitation systems and practices under actual conditions, observed from the program approach analysis (see section 3.4). 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.

Gender issues will be particularly important in the presentation of intangible benefits.

The results described above reflect data on the input variables of the 'average' population. Therefore, to assess whether intervention efficiency is higher or lower for different income categories and socio-demographic groups, input values for poor and vulnerable groups without sanitation are entered into the economic model, and compared with the average and with high-income groups. The main variables are household size, value of time, disease and mortality rates, water supply and treatment practices, and the investment (cost) most likely to be made in the sanitation option.

Further assessments are conducted to enable national interpretation of efficiency results. This involves entering input values in the economic model corresponding to national averages for rural and urban areas, which is likely to give different results from the specific field sites.

3.4 PROGRAM APPROACH ANALYSIS

The aim of the program approach analysis (PAA) is to show the levels and determinants of sanitation program performance. It evaluates the link between different program approaches and the eventual efficiency and impact of the sanitation options. The PAA also shows current practices of sanitation program evaluation, and provides recommendations for improved monitoring and evaluation of sanitation programs.

The PAA is essentially a desk study, assessing sanitation program documents, with additional information gained through interviews with sanitation program managers and implementers. More in-depth studies and data were possible using the field sites for the cost-benefit analysis (see section 3.3). The PAA focused on the following:

1. Listing in-country sanitation programs and their characteristics, followed by a selection of sanitation programs to include in the PAA. Chapter 7.2 shows the selected programs and their main characteristics.
2. Assessment of specific types of program 'approach' to be compared. Sanitation projects were first classified by the implemented location (urban/rural, representing ecological zone), type of waste treated, target groups and sanitation option applied. Then the actual program or delivery approach was assessed, as follows:
   - Implementing and financing agents, such as:
     - Direct government, donor or NGO implementation using own funds.
     - Contracted firm or NGO with government or donor funds.
     - Private sector (including small and medium enterprises).
   - Implementation approaches, such as:
     - Community Led Total Sanitation.
     - Sanitation Marketing, with Informed Choice.
     - Supply-driven approaches.
   - Financing approaches or mechanisms, such as:
     - Subsidy: full subsidy, hardware subsidy, software subsidy, targeted or smart subsidy, no subsidy.
     - Alternative funding: micro-finance/loan, revolving fund.
   - Partnerships, such as:
     - Implementation partnership.
     - Financing partnership.
     - Private sector partnership.
     - Public sector partnership (e.g. between more than one government agency).
3. Evaluation of selected sanitation programs in terms of their programming or delivery approach and measures of output and success (e.g. unit costs, coverage, and uptake). For the assessment of actual efficiency, key indicators of program effectiveness were selected.
4. Analysis of factors determining program performance, focusing on economic variables.

3.5 NATIONAL STUDIES

National-level studies served two main purposes: (a) to assess impacts of improved sanitation outside field sites to enable more comprehensive cost-benefit analysis (tourism, business and sanitation markets); and (b) to complement or supplement data collected at field level to enable better assessment of local-level impacts (health and water sources).

3.5.1 TOURIST AND VISITOR SURVEY

There is an arguable link between sanitation and tourism, but to-date very little hard evidence has been gathered to

demonstrate it. Poor sanitation and hygiene may affect tourists in two ways:

1. **Short-term welfare loss and expenses.** Tourists get ailments such as diarrhea, intestinal worms and hepatitis, which entail direct healthcare costs, and when tourists are exposed to environments with poor sanitation their enjoyment is affected.
2. **Reduced tourist numbers.** In the longer term, tourists stay away from tourist locations that are deemed to be unsafe (from a health perspective) or unpleasant, such as those with unclean water, a smelly environment or no proper toilets. Tourists may stay away from Vietnam, either because they have already had an unpleasant experience and have chosen not to come back, or because they have been advised to avoid a location due, among other things, to poor sanitation.

The present study attempts to explore these two impacts via a survey of non-resident foreign visitors. As well as holiday tourists, business visitors were also included to enable an important link to be made with the business survey (see section 3.5.2). A total of 300 tourists and business visitors were interviewed across the country. It was planned that the survey would be conducted at international airports as the visitors were leaving Vietnam. However, due to strict airport control during avian influenza and other disease outbreaks, this was not possible. Instead, the team, with the agreement of WSP, interviewed tourists during their tours in Vietnam. The study was supported by number of tour agencies.

Table 13 shows the sample size by type of visitor, major categories of nationality, and whether they were return visitors or not. Among the 300 respondents, more than 60% were from Australia/New Zealand, North America and Europe, less than 30% were from Asia, and only 10% were from South America. Although Asian tourists account for the largest proportion of overall tourists to Vietnam, it was much easier for the survey to approach Western tourists because they could speak English and were more familiar with questionnaire surveys. An approximately equal number of men and women answered the questionnaire. The average number of previous trips made by respondents was 1.5, indicating previous experience of Vietnam and suggesting that the answers given were reliable.

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 during the holiday stay in Vietnam.
- Intention to return to Vietnam, recommendation to friends, and reasons.

TABLE 13: BASIC INFORMATION ABOUT THE TOURISTS SURVEYED

Variable		Asia	Australia/New Zealand	North America and Europe	South America	Total
No. of tourists interviewed		76	45	146	33	300
Gender (%)	Male	53%	42%	61%	39%	54%
	Female	47%	58%	39%	61%	46%
Average no. of previous trips to country (time)		2.4	0.8	1.6	0.2	1.5
Average length of stay for this trip (day)		129.6	20.2	40.3	-	58.6
Purpose of visit (%)	Tourism	49%	78%	78%	100%	73%
	Business	51%	22%	22%	0%	27%

3.5.2 BUSINESS SURVEY

Poor sanitation has the potential to affect not only tourism, but also businesses. Two types of impact were assessed; the local-level 'micro' impact, and the higher-level 'macro' impact:

1. 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, however, that the customer losses assessed here are not necessarily absolute losses to the country, as customers may have the choice to go elsewhere – i.e. to other locations in Vietnam.
2. Foreign businesses that decide not to locate in Vietnam. Sanitation may be among the many reasons for deciding whether to locate a business in Vietnam. This decision may include: (a) the health of the workforce, due to actual statistics or a business leader's perception of the poor health of a nation's workers; (b) poor (perceived) quality of water available to the business, and the related costs; (c) a generally poor environment (solid waste, unsightliness), which affects the ability to do business; and (d) the undesirability of locating foreign staff in Vietnam due to the poor sanitary conditions.

In order to assess both of these hypothesized effects, 21 business firms were surveyed using the questionnaires. Table 14 lists the type of firms surveyed and identifies their ownership (local or foreign). These firms were selected because of the link between sanitation and their business, and the importance of the sector and specific firm to the economy of Vietnam. Since the survey included only those foreign firms that had already located in Vietnam, a key category – firms that had decided against locating in Vietnam – were omitted from the sample. However, foreign firms were asked about the factors affecting their decision to locate in Vietnam, 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 14: NUMBER OF BUSINESSES APPROACHED FOR SURVEY, BY MAIN SECTORS OF LOCAL AND FOREIGN FIRMS

Main business or sector of firm	Local business	Foreign firm	Total
Hotel	1	1	**2**
Aviation		2	**2**
Real estate		1	**1**
Food and drink producer		7	**7**
Pharmacy		2	**2**
Tourism	2		**2**
Soap and domestic goods		1	**1**
Green civil engineering and architecture	1		**1**
Development and cooperation consultancy		2	**2**
Life, health and other insurances		1	**1**
Pump and wastewater equipment		1	**1**
Total	**4**	**18**	**22**

3.5.3 NATIONAL SANITATION MARKETS

Sanitation markets include both input markets (the market value of expenditure to improve sanitation) and output markets (reuse of human excreta; animal excreta is also included as biogas option – biogas rarely involves human excreta alone).

The assessment of sanitation input markets has three main aims:

1. To contribute to the estimation of intervention costs, for inclusion in the cost-benefit analysis and cost-effectiveness analysis.
2. To examine how much interventions cost at field, project and national level, and the main contributors to cost, in order to assess in detail how to finance these costs.
3. To explore what the beneficial economic impacts might be on the local and national economy, based on the estimated size of the sanitation inputs market.

Details of sanitation inputs and costs are sourced principally from the field studies (household questionnaire, local market survey) where the specific toilet types and related input needs and costs have been assessed. Project and program costs were also collected from the PAA (see section 3.4). To estimate the overall potential market size of increasing sanitation coverage at national level, generic unit costs per sanitation option were applied to the likely options demanded by the population. Two scenarios were included: the market size of reaching the MDG target by 2015, and the market size of achieving and maintaining 100% coverage.

While the reuse of sanitation 'outputs' (such as fertilizer, soil conditioner, biogas) is currently limited in Vietnam, it is useful to estimate their potential economic benefits. This analysis will help support policy makers and the private sector in assessing whether reuse options could be financially viable and stimulate investment. Hence this study calculates potential economic value based on assumptions of different adoption levels and output values, ranging from realistic to higher (potential) adoption and price levels.

3.5.4 NATIONAL HEALTH STATISTICS

The ESI field surveys provide data from the sampled households and health facilities on the incidence of selected diseases related to poor sanitation. For some sites, other studies conducted in the same locality provided alternative sources of disease incidence data. However, constraints in data robustness at field level means that these data should be supplemented with estimates on disease incidence and mortality rates from other sources, and adjusted to the health conditions of the specific field sites. Data were therefore sourced from national surveys (e.g. Demographic and Health Survey) and research studies as well as internationally compiled statistics for Vietnam and the Southeast Asia region (World Health Organization; Disease Control Priorities Project 2). The data from these sources were compared in terms of their quality and applicability to the field sites, so that the most appropriate values could be selected for use in the cost-benefit analysis and the national health overview. The results are presented in section 4.1.

3.5.5 NATIONAL WATER STATISTICS

National water quality data were collected and presented in the sanitation 'impact' study, covering mainly the surface water of major lakes and rivers. The present study updates these data to provide a national level picture of the quality of water sources (including ground water quality). Most of the data used in the report came from the National Environmental Monitoring Database under the Vietnam Environment Administration (VEA).

The economic impacts of polluted water sources depend on three main factors: the extent of water sources in the country; the release of polluting substances into these water resources; and the actual or potential uses of the water. While water is recognized to have many economic and non-economic uses, three selected uses were evaluated in the first ESI study on sanitation impacts: water for drinking; water for other household non-commercial uses; and water for freshwater fish production. The statistics provided in the ESI impact study report showed that, despite the abundance of water sources in Vietnam, most suffer from pollution due to human activity. The water bodies near cities or densely populated areas are usually more polluted than remote water bodies due to the excessive discharge of pollutants generated by human settlements and industrial activities.

Poor or non-existent drainage systems in urban areas have received a high public profile due to regular flooding. Poor sanitation, such as insufficient drainage or unimproved sol-

id waste disposal (which blocks drains) can lead to avoidable flooding in the rainy season. Moreover, inappropriate sanitation options in seasonally flooded rural areas can lead to avoidable surface water pollution and health hazards. Therefore, this study gathered secondary evidence from government and donor assessments, university research, and media reports of flooding incidents, focusing on Hanoi and Ho Chi Minh cities. Information has also been gathered from the Hanoi Sewerage and Drainage Company, the Ho Chi Minh City flood center, and other sources.

The links between poor sanitation, water quality and inland fish production were assessed in the ESI sanitation 'impact' study. Where sewage is a significant contributor to degraded water sources – affecting biological oxygen demand and toxicity (e.g. bacteria, parasites) – it was concluded, based on limited scientific evidence, that fish reproduction, fish growth and fish survival is most likely affected by poor sanitation. However, given the limited evidence available from Vietnam, these conclusions were largely inferred from studies made in developed countries. In the present study, the phase 1 assessment was revisited based on new data, and supplemented by interviews with government and research staff and representatives of fisheries who have real experience of the links between water quality and the health of fish.

3.6 STEERING AND COLLABORATION

The study team consisted of a group of 20 people from different governmental and private organizations. Given the ambitious goal of ESI to provide economic evidence to decision makers, it was very important to involve different stakeholders from an early stage in evaluating alternative policy options. Therefore, the study team created a National Advisory Group (NAG) to help guide the formulation and implementation of the study. Government organizations at different levels and representatives from different stakeholders such as academic bodies, professional associations, unions, donors, the private sector and local communities were also involved in study activities, such as participation in project workshops and field surveys, and providing interviews. The NAG and other stakeholders assisted WSP and the research team at different stages: ensuring the proper orientation of study activities; providing adequate information; evaluating study results; and planning the integration of the findings into their decision making process in an efficient way.

IV. Local Benefits of Improved Sanitation and Hygiene

This chapter discusses the following local impacts of improved sanitation and hygiene:

- Health (section 4.1)
- Water (section 4.2)
- Access time (section 4.3)
- Intangibles (section 4.4)
- External environment (section 4.5)
- Reuse (section 4.6)
- Summary of local benefits (section 4.7)

4.1 HEALTH

One of the major arguments commonly used in favor of improving sanitation is a reduction in disease incidence, and the various associated health-related benefits. There are many diseases associated with poor sanitation and hygiene practices, including diarrhea, dysentery, cholera, salmonellosis, shigellosis, typhoid fever, hepatitis A, trachoma, and some parasitic diseases (ascariasis, trichuriasis, hookworm, schistosomiasis) (see Annex Table A6). Disease and poverty are linked in a vicious circle, and hence disease reduction can lift populations out of poverty, or prevent them from falling into poverty. Less disease means less treatment seeking costs and a gain in healthy time, leading to more time for productive or leisure activities, which have a direct welfare impact. When productive time gained leads to a net increase in economic activity, it can contribute to economic growth and poverty reduction. Disease reduction also leads to savings for society, such as health care and other state benefits for chronic sufferers.

ESI study, phase 1 (WSP, 2009) reported the estimated cases and deaths per year from selected diseases attributed to poor sanitation in Vietnam. It showed that, of the disease attributed to poor sanitation, diarrhea has the highest number of cases at 7.05 million per year. Diarrhea is also the main cause of death from poor sanitation and hygiene, accounting for around 4,600 deaths per year in Vietnam. Malnutrition-related diseases, in particular acute lower respiratory infection (ALRI), account for an estimated 1,500 deaths per year attributed to poor sanitation, followed by malaria with 600 deaths per year. In 2004, the World Health Organization estimated that diarrheal disease accounted for 12% of overall deaths of 0-14 year olds in Vietnam, and 50% of infectious and parasitic diseases. The number of deaths from diarrhea exceeded the number of deaths from intentional and unintentional injuries, including road traffic accidents.

Diseases such as scabies, helminths and hepatitis A appear to account for only a small proportion of the total disease burden. There are no reported cases in official statistics of mortality from these diseases. Collectively, they account for only about 5.4% of the number of cases. However, their collective influence on the quality of life cannot be ignored. The prevalence of trachoma is still high as it is endemic in Vietnam. Treatment is sought for only a small fraction of cases, so healthcare costs would be much higher if all sufferers sought formal health care for every incidence of disease.

4.1.1 DISEASE BURDEN OF POOR SANITATION AND HYGIENE

Table 15 presents the data available from the national health information system in Vietnam on the number of cases and deaths resulting from key sanitation and hygiene-related diseases. Although these data are not representative of the total disease burden at national level due to underreporting, they do provide an indication of which diseases are of most significance nationally, and aid the selection of diseases to include in this present study.

Table 15 shows that there were 964,420 cases of diarrheal diseases in 2005. The actual number of cases is expected to be many times higher, as concluded in the ESI phase 1 study (WSP, 2009). Diarrhea is also reported as the major direct cause of death due to poor sanitation and hygiene,

although indirect diseases through malnutrition, especially ALRI, take a heavy toll. Malnutrition is considered as an important disease related to sanitation and hygiene since there are nearly 1.8 million children under-five years suffering from malnutrition. Although the prevalence of helminths and scabies are not high compared to diarrhea and malnutrition, these diseases are included because of their obvious links to poor sanitation and hygiene.

TABLE 15: REPORTED SANITATION AND HYGIENE-RELATED ILLNESS CASES AND DEATHS (2005)

Disease		Annual morbidity		Annual reported deaths[4]
		Total cases	Cases per person	
Diarrheal diseases		964,420	0.0116028	42
	Urban	260,116		
	Rural	704,304		
Helminths (worms)[1]		24,545	0.0002953	-
	Urban	6,620		
	Rural	17,925		
Trachoma[2]		982,667	0.0118223	-
	Urban	192,780		
	Rural	789,887		
Scabies[3]		206,137	0.0024800	-
	Urban	55,598		
	Rural	150,540		
Hepatitis A		7,834	0.0000942	-
	Urban	2,113		
	Rural	5,721		
Malnutrition (under fives)		1,818,939	0.0218833	-
	Urban	463,742		
	Rural	1,355,197		
Diseases associated with malnutrition (under fives)		596,046	0.0071709	2,494
ALRI (Pneumonia)		488,610	0.0058784	2,476
	Urban	163,201		
	Rural	325,410		
Measles		8,160	0.0000982	-
	Urban	2,201		
	Rural	5,959		
Malaria		99,276	0.0011944	18
	Urban	24,240		
	Rural	75,036		

[1] Prevalence of helminths is sourced from the survey on soil-transmitted nematodes by the Institute of Malaria, Parasitology and Entomology/MOH, 2006-2007.
[2] Prevalence of trachoma is sourced from the survey on trachoma by the Department of Preventive Medicine/MOH, 2007.
[3] Incidence of scabies is assumed to be 20% of reported skin disease as there is no specific information on scabies.
Source: MOH (2007).
[4] Note that these statistics from the national information system underestimate the number of deaths due to these causes.

Trachoma is endemic in Vietnam. For decades, trachoma control has been an important part of Vietnam's health agenda. Globally, it is estimated that there are 3.8 million cases of blindness and 5.3 million cases of low vision in countries known or suspected to have trachoma, resulting in $2.9 billion in lost productivity. In Vietnam, through trichiasis surgery, antibiotic treatment and health and hygiene education, the national prevalence of active disease decreased considerably from 17.5% in 1975 to 7% in 1999. A 2006 – 2007 study by the International Trachoma Institute (ITI) and its main partners the MOH and the Institute for Ophthalmology, estimated a trachoma prevalence of 1.76% in 2006. This study indicates that there are still districts where trachoma remains a public health problem. In the Central and Northern areas, trachoma prevalence is still high, especially in children.

Disease rates and premature mortality were sourced from available surveys in the field sites, which indicate total disease burden, and not just reported disease burden, which severely underreports cases and deaths. Many sick people prefer not to seek medical care at their inadequate local clinic, and go instead to district, provincial, or even central hospitals in large cities. Therefore data were collected not only from local medical centers but also from the centers of preventive medicine at provincial level.

Table 16 presents the disease burden attributable to poor sanitation and hygiene. In rural sites annually, it is estimated there are 2.64 cases of disease per person, 0.074 DALYs, and an annual risk of death of 2.12 per 1,000 people due to poor sanitation and hygiene (see Annex B). In urban areas the rates are lower, at 0.96 cases of disease per person, 0.03 DALYs, and an annual risk of death of 1.02 per 1,000 people. Site-specific rates used are tabulated in Annex B.

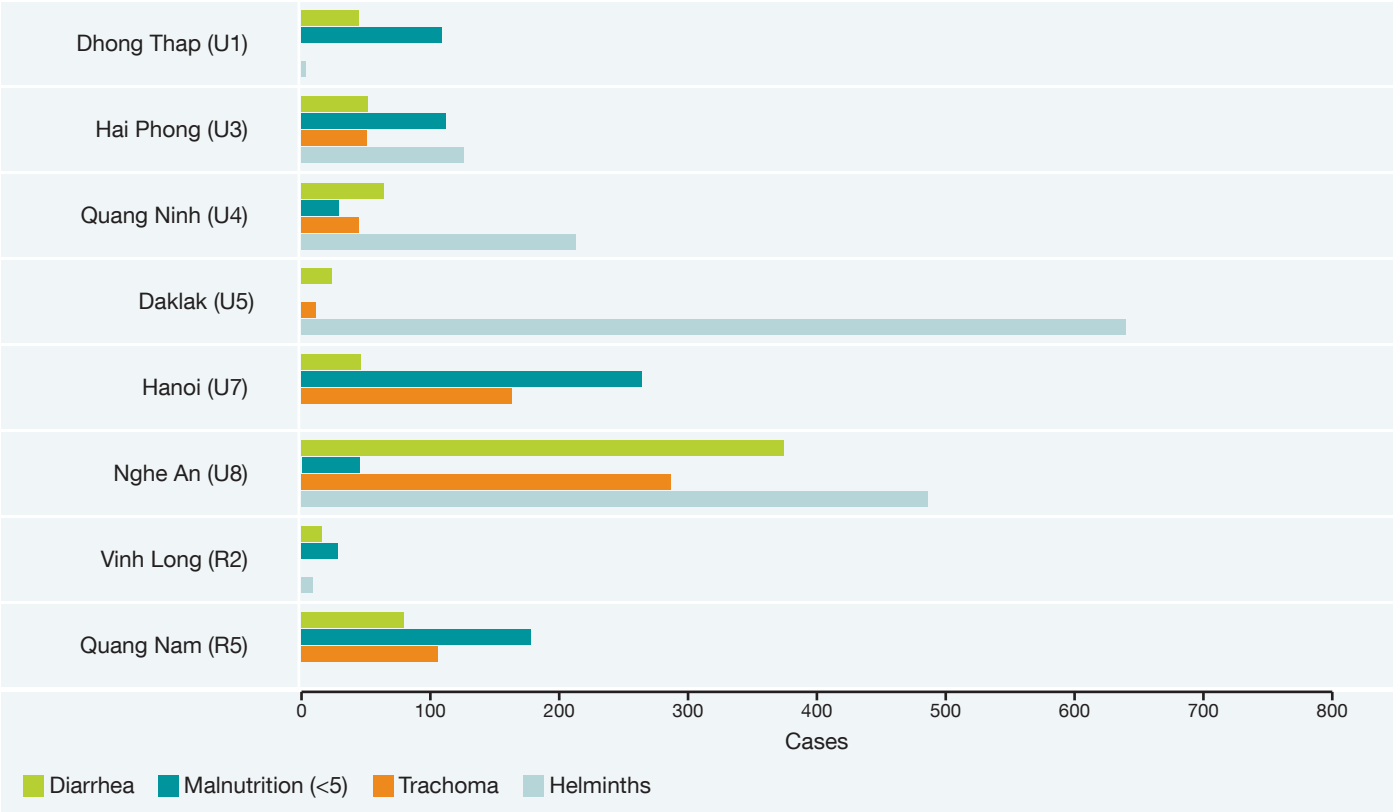
Quality of life impacts associated with morbidity are, to some extent, reflected in the DALY calculations above, and in the estimates of health care and productivity costs (see later sections). There is no significant difference in recorded cases between urban and rural areas. Although living standards in urban households seem higher, the population is often exposed to numerous health threats including open sewers and canals, and where there is high population density and crowding infectious diseases spread easily. Moreover, large hospitals in the regional centers like Nghe An, Hanoi and Quang Nam receive a number of visitors from surrounding provinces, which makes the record of disease cases in those provinces higher. To know the precise origin of patients in urban centers would require separate research studies, and hence the current report uses unadjusted statistics available from government sources. An artificially high helminth egg contamination figure for Quang Nam (about 31% of the commune population) is given in Annex Table B.

Exposure to household solid waste, agricultural and industrial waste can also lead to disease and premature death,

TABLE 16: DISEASE RATES ATTRIBUTABLE TO POOR SANITATION AND HYGIENE, 2006

Disease	Rural Sites			Urban Sites		
	Cases/ person/year	Deaths/ 1000 people/year	DALYs/ person/year	Cases/ person/year	Deaths/ 1000 people/year	DALYs/ person/year
DIRECT DISEASES	2.4859	0.2569	0.0515	0.9120	0.0951	0.0191
Diarrheal disease	1.6733	0.2569	0.0128	0.6191	0.0951	0.0047
Helminths	0.7402	0	0.0044	0.2739	0	0.0016
Scabies	0.0117	0	0.0000	0.0043	0	0.000003
Trachoma	0.0603	0	0.0342	0.0145	0	0.0127
Hepatitis A,E	0.0004	0	0.0000009	0.0002	0	0.0000003
INDIRECT DISEASES	0.1533	1.8645	0.0222	0.0503	0.9253	0.0082
Malnutrition	0.1339	0	0.0001	0.0455	0	0.00005
Malaria	0.0010	0.0267	0.0003	0.0003	0.0085	0.0001
ALRI	0.0179	1.8212	0.0215	0.0043	0.9106	0.0080
Measles	0.0005	0.0167	0.0002	0.0002	0.0062	0.0001
Total	**2.6392**	**2.1214**	**0.0737**	**0.9623**	**1.0203**	**0.0273**

FIGURE 9: COMPARISON OF HEALTH STATUS BETWEEN SELECTED STUDY SITES (CASES)



from contact with toxic materials or otherwise dangerous substances. With respect to solid waste, health impact on population in the vicinity of dumps and landfills is very high. They are exposed to high levels of dust, germs, noxious substances, rodents and insect bites, which can result in diseases like flu, dysentery, fever, tuberculosis, diarrhea, rash and scabies, asthma, pneumonia, bronchitis, parasites, articulation disorders and eye infections. The risk is even higher for waste pickers working in dump sites. Waste pickers are also exposed to bruises, factures, injuries and death. These diseases and occupational health problems are not considered in the present study due to time constraints and lack of routinely available data sources.

4.1.2 HEALTHCARE COSTS

Healthcare costs are estimated based on disease cases, the proportion of illnesses treated by each provider (see Annex B), and the unit costs associated with each provider. Table 17 shows a summary of treatment-seeking rates from different data sources. The evidence suggests that the majority of the population seeks care from self-treatment. Diarrhea disease data show that more patients from rural areas are seeking treatment from public and private clinics than urban ones (15% versus 7%). Both prefer self-treatment as a major treatment seeking behavior for diarrhea, while the urban population has higher rates of self-treatment (70%) compared with the rural population (50%). The proportion of the population not seeking treatment from any type of medicine is still high in Vietnam, at 23% and 35% urban and rural areas, respectively.

Data on treatment seeking behavior for 10 sanitation- and hygiene-related diseases collected from field surveys at local and provincial medical centers are shown in Annex Tables B3 and B4. As in the data from the ESI-1 study, self-treatment of diarrhea was a major choice in the surveyed sites (67%).

Self-treatment is also a major choice for diseases including helminths, scabies, hepatitis, malnutrition, and even acute diseases such as ALRI, measles and malaria. Trachoma is the only disease that is treated by public medical service providers.

TABLE 17: TREATMENT-SEEKING BEHAVIOR FOR SANITATION- AND HYGIENE-RELATED DISEASES (ALL AGES)

Disease	% seeking treatment from:		Self-treatment	No treatment	Total
	Public provider	Private clinic			
Diarrheal diseases	964,420	1,370,737	5,219,670	360,960	7,915,788
Nationwide	3.0%	8.0%	66.0%	23.0%	100.0%
Urban	2.0%	5.0%	70.0%	23.0%	100.0%
Rural	5.0%	10.0%	50.0%	35.0%	100.0%
Helminths	24,545	34,886	132,845	9,187	201,464
Nationwide	2.0%	8.0%	70.0%	20.0%	100.0%
Urban	1.0%	4.0%	80.0%	15.0%	100.0%
Rural	5.0%	10.0%	60.0%	25.0%	100.0%
Trachoma	982,667	-	-	-	982,667
Nationwide	100.0%	0.0%	0.0%	0.0%	100.0%
Urban	10.0%	0.0%	0.0%	0.0%	10.0%
Rural	90.0%	0.0%	0.0%	0.0%	90.0%
Scabies	206,137	292,985	1,115,665	77,152	1,691,939
Nationwide	1.0%	4.0%	85.0%	10.0%	100.0%
Urban	0.0%	2.0%	90.0%	8.0%	100.0%
Rural	2.0%	5.0%	80.0%	13.0%	100.0%
Hepatitis A	7,834	11,135	42,399	2,932	64,300
Nationwide	10.0%	18.0%	55.0%	17.0%	100.0%
Urban	20.0%	20.0%	55.0%	5.0%	100.0%
Rural	10.0%	15.0%	50.0%	25.0%	100.0%
Malnutrition	1,818,939	-	-	-	1,818,939
Nationwide	10.0%	18.0%	55.0%	17.0%	100.0%
Urban	20.0%	20.0%	55.0%	5.0%	100.0%
Rural	10.0%	15.0%	50.0%	25.0%	100.0%
ALRI (Pneumonia)	488,610	694,466	2,644,476	182,875	4,010,427
Measles	8,160	11,598	44,164	3,054	66,976
Malaria	99,276	141,102	537,305	37,157	814,840

Source: ESI Phase 1 study, 2009; MOH, 2006.

The estimated numbers of people of all ages in both urban and rural areas seeking care from different providers for diseases attributed to poor sanitation and hygiene are presented in Table 18, Table 19 and Table 20.

The unit costs for treatment of diarrheal disease are provided in Table 21, and broken down by healthcare provider. As indicated in Table 21, treatment costs include: (1) Direct healthcare expenses such as diagnostics and medical treatment costs; (2) Incidental expenses, i.e. non-health patient costs, including transport, food, etc. For inpatient treatment, healthcare expenses also include inpatient stay.

There are significant differences in the cost of diarrhea treatment between health providers and self-treatment, and between outpatient and inpatient care. The highest treatment costs associated with diarrhea are from inpatients at public health providers in rural areas (US$19.9 per person

TABLE 18: ESTIMATED NUMBERS OF CASES (ATTRIBUTED TO POOR SANITATION AND HYGIENE) SEEKING CARE FROM DIFFERENT PROVIDERS (ALL AGES)

Disease	Attribution to Sanitation	Public sector			Private clinic	Self-treatment	No treatment
		Reported cases	% under-reported	Estimated actual cases			
Diarrheal diseases	88%	964,420	10%	1,060,862	1,206,249	4,593,310	317,645
Helminths	100%	24,545	10%	27,000	34,886	132,845	9,187
Trachoma	80%	982,667	10%	1,080,934	-	-	-
Scabies	80%	206,137	10%	226,751	234,388	892,532	61,722
Hepatitis A	60%	7,834	10%	8,617	6,681	25,440	1,759
Malnutrition:	48%	1,818,939	10%	2,000,833	-	-	-
ALRI	5%	784,792	10%	863,271	55,682	212,034	14,663
Malaria	2%	110,032	10%	121,035	3,078	11,720	810

Source: ESI Phase 1 study, 2009; MOH, 2006.

TABLE 19: ESTIMATED NUMBERS OF CASES (ATTRIBUTED TO POOR SANITATION AND HYGIENE) PER PERSON PER YEAR (ALL AGES)

Disease	0-4 Years	5-14 Years	15+ Years
Diarrheal disease	4.2	0.5	0.3
Helminths	0.7	0.8	0.7
Hepatitis A, E	0.001	0.0001	0.00002
Scabies	0.03	0.003	0.001
Trachoma	0.2	0.01	0.001
Malnutrition	0.4	0.04	0.00
Indirect: malaria	0.0003	0.002	0.0004
Indirect: ALRI	0.04	0.01	0.001
Total	5.5	1.4	1.0

Source: ESI Phase 1 study, 2009; MOH, 2006.

TABLE 20: ESTIMATED NUMBERS OF CASES (ATTRIBUTED TO POOR SANITATION AND HYGIENE) SEEKING CARE FROM DIFFERENT PROVIDERS

Region	Percentage of population receiving medical examination and treatment over 12 months	Inpatient treatment	Outpatient treatment	Self-treatment or no treatment
Urban	37.2%	7.4%	34.2%	58.4%
Rural	33.4%	7.0%	29.9%	63.1%
Total	**34.3%**	**7.1%**	**30.9%**	**62.0%**

Source: VHLSS, 2004.

per case). Self-treatment of patients at home in urban areas involves the lowest cost (US$3.3 per person per case). This is a main reason why the majority of patients select self-treatment when they think the disease is not serious (see Table 18). A long queue of patients seeking diagnosis and treatment under the health assurance system is often a major barrier to low-income patients and their relatives seeking treatment, while wealthier patients often prefer to shift to a more expensive, but more flexible 'demand-driven' treatment option.

TABLE 21: UNIT COSTS ASSOCIATED WITH TREATMENT OF DIARRHEA (US$, 2008)

Health provider	Outpatient cost (US$)		Inpatient cost (US$)		
	Healthcare	Incidentals[1]	ALOS[2]	Healthcare[3]	Incidentals[1]
Public					
Urban	3.76	0.83	4.55	8.80	4.74
Rural	3.98	1.48	4.55	10.99	4.37
Private					
Urban	3.05	1.13	4.55	5.02	1.00
Rural	3.49	1.66	4.55	5.16	1.10
Self-treatment					
Urban	2.68	0.6	-	-	-
Rural	3.00	1.09	-	-	-

Source: ESI-1 study
[1] Incidentals: non-healthcare patient costs such as transport, food, and incidental expenses, per outpatient visit and per inpatient stay.
[2] ALOS: average length of stay.
[3] Inpatient healthcare costs are presented per stay.

TABLE 22: AVERAGE HEALTHCARE COST PER PERSON PER YEAR AT FIELD SITES, BY DISEASE AND AGE CATEGORY (US$, 2008)

Disease	0-4 Years	5-14 Years	15+ Years
Diarrheal disease	17.95	2.18	1.09
Helminths	0.69	0.81	0.69
Hepatitis A, E	0.03	0.00	0.00
Scabies	0.09	0.01	0.00
Trachoma	6.05	0.33	0.04
Malnutrition	0.25	0.03	0.00
Indirect: malaria	0.01	0.06	0.01
Indirect: ALRI	0.50	0.11	0.01
Total	25.56	3.53	1.84

Source: ESI-1 study.

Table 22 shows the annual cost per person (by age group) attributed to poor sanitation and hygiene in Vietnam, by disease. Diarrheal disease contributes the largest proportion of healthcare costs per person per year for all ages, but it is most significant among children aged 0 to 4 years old. Healthcare expenses are reduced as patients move up from the first to the second and the third age groups. After trachoma, the treatment of helminths involves the highest treatment costs compared to other diseases. Children aged from 5 to 14 years incur the most expense for the treatment of helminths compared to other age groups. Malnutrition costs are incurred mostly by children aged 0 to 4 years, while those above 15 years old incur no costs.

4.1.3 PRODUCTIVITY COSTS

Table 23 presents the estimated time lost to disease. Cases of each disease are divided into severe, and non-severe. As severe cases require more time to treat, more productive time is lost. Severe Hepatitis A leads to a largest number of days lost (30) compared to no days lost when people are seeking treatment of non-severe helminths, scabies and trachoma. Amount of time lost serves a basis for calculating of productivity costs of diseases. GDP per capita was used as the basis of time value, at US$0.12 per hour.

As would be expected, the productivity costs of treating diarrhea are the highest (Table 24). The productivity cost

TABLE 23: VARIABLES FOR ESTIMATING AMOUNT OF TIME LOST TO DISEASE (2008)

Disease	% cases		Days off daily activities			
	Severe[1]	Non-severe[2]	Treated		Not treated	
			Severe	Non-severe	Severe	Non-severe
Diarrhea	29.5%	70.5%	5.0	2.0	2.0	1.0
Helminths	29.5%	70.5%	2.0	-	1.0	-
Trachoma	29.5%	70.5%	3.0	-	1.0	-
Scabies	29.5%	70.5%	1.0	-	1.0	-
Hepatitis A	29.5%	70.5%	30.0	5.0	30.0	5.0
Malnutrition	29.5%	70.5%	7.0	5.0	7.0	5.0
ALRI	29.5%	70.5%	7.0	1.0	10.0	1.0
Malaria	29.5%	70.5%	10.0	5.0	5.0	3.0

Source: ESI-1 study.
[1] 'Severe' cases involve treatment at a public or private hospital
[2] 'Non-severe' cases which can be self-treated

TABLE 24: AVERAGE HEALTH-RELATED PRODUCTIVITY COST PER PERSON PER YEAR IN FIELD SITES, BY DISEASE, AGE (US$, 2008)

Disease	0-4 Years	5-14 Years	15+ Years
Diarrheal disease	4.15	0.51	0.51
Helminths	0.23	0.27	0.45
Hepatitis A, E	0.004	0.0006	0.0002
Scabies	-	-	-
Trachoma	0.06	0.003	0.001
Malnutrition	0.71	0.08	-
Indirect: malaria	0.001	0.005	0.001
Indirect: ALRI	0.04	0.01	0.002
Total	5.19	0.87	0.97

Source: ESI-1, 2009.

associated with diseases such as hepatitis, trachoma and malaria are smaller, since the number of cases of these diseases are comparatively infrequent.

4.1.4 MORTALITY COSTS

Table 25 presents estimated number of annual deaths associated with poor sanitation and hygiene for Vietnam. Table 26 provides the unit values for the cost of a premature death using two calculation approaches: willingness to pay, using benefit transfer; and a human capital approach.

Table 27 presents estimated premature mortality cost per person per year due to diseases associated with poor sanitation and hygiene: diarrhea, malaria and ALRI for those aged 0 to 4 years old. Calculations have been made using methodology presented in the ESI-1 study (WSP, 2009).

4.1.5 AVOIDED HEALTH COSTS

Central to the arguments for improving sanitation and hygiene is its affect on health. Limited evidence exists for the actual impact of sanitation or hygiene programs on health outcomes in Vietnam and this study draws on international evidence. Figure 10 shows the relative risk reduction of fecal-oral and helminth-related disease following different sanitation improvement scenarios.

TABLE 25: ESTIMATED NUMBER OF ANNUAL DEATHS FROM POOR SANITATION AND HYGIENE, VIETNAM

Disease	Age grouping		Total
	Under 5	Over 5	
Diarrheal diseases	4,136	440	4,576
ALRI	1,475	-	1,475
Measles	335	-	335
Malaria	631	-	631

Source: Environmental Health and Child Survival. World Bank, 2007.

TABLE 26: UNIT VALUES FOR THE COST OF A PREMATURE DEATH, VIETNAM

Disease	Values (VND, 2009)		
	Low	Mid (base case)	High
Willingness to pay using benefit transfer			
VSL Income elasticity 1.0 at OER, transferring value of US$2 million from OECD countries	VND287,604,600	VND575,226,600	VND1,150,453,200
Human capital approach			
0-4 years	VND311,233,800	VND443,073,600	VND944,698,200
5-14 years	VND383,670,000	VND522,974,400	VND1,041,703,200
15+ years	VND246,175,200	VND277,721,400	VND357,465,600

Source: ESI-1, 2009.

TABLE 27: AVERAGE PREMATURE MORTALITY COST PER PERSON PER YEAR, BY DISEASE AND AGE (VND, 2009)

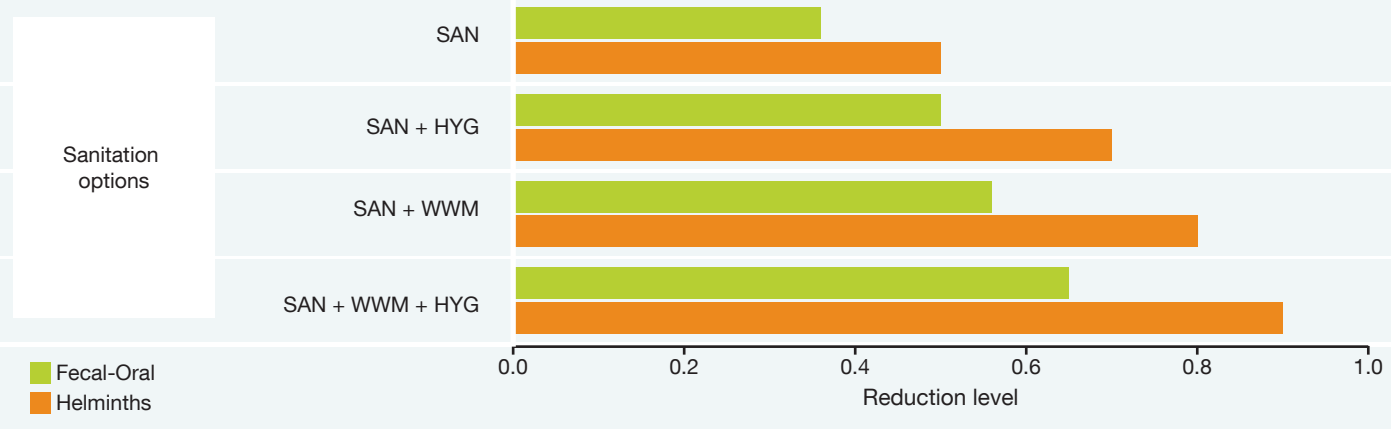
Disease	0-4 Years	5-14 Years	15+ Years
Diarrheal disease	415,512	10,266	5,220
Indirect: malaria	44,892	-	-
Indirect: ALRI	112,230		
Total	**572,634**	**10,266**	**5,220**

Source: ESI-1, 2009.

Figure 11 shows the costs averted due to sanitation and hygiene improvement in urban and rural areas as calculated average values from all surveyed sites. The highest reduction in risk results from moving from unimproved sanitation (OD) to wastewater treatment and hygiene improvement. Similar results have been found in both rural and urban areas. Double-vault composting, urine diverting toilets (DVCL) and biogas digesters can reduce health risk significantly, but the value of averted costs is less. Those options are associated with some limitations such as a lack of gray water treatment and the potential risks of incomplete compost product reuse (from DVCL), and incomplete treatment of effluent from biogas digesters.

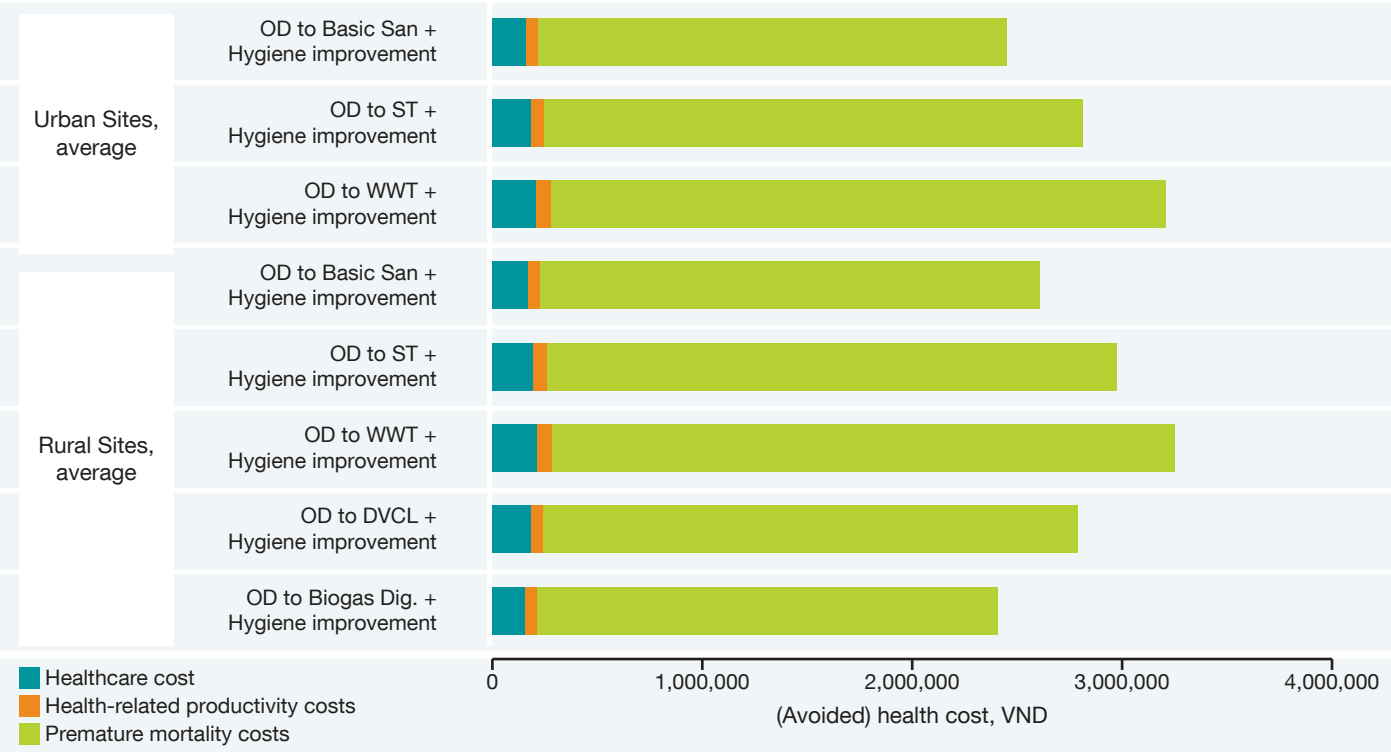
Annex Table B7 summarizes the total costs of poor sanitation and hygiene in Vietnam, per household for the selected urban field sites, and the costs averted. The results from the rural field sites are presented in Annex Table B8. Health costs associated with unimproved sanitation have a higher value in rural areas (VND4,862,000 or US$278.0 versus VND3,977,000 or US$227.4 in urban areas). In urban areas, the highest average costs are averted by moving from unimproved sanitation to centralized wastewater management, combined with hygiene improvement interventions (VND3,206,000, or US$183.3). In rural areas, the highest average costs are averted by moving from unimproved sanitation to cluster wastewater management, combined with hygiene improvement interventions (VND3,251,000 or US$185.9).

FIGURE 10: THE RELATIVE RISK REDUCTION ASSOCIATED WITH FECAL–ORAL AND HELMINTH-RELATED DISEASES FROM DIFFERENT SANITATION IMPROVEMENT SCENARIOS



SAN – basic on-site sanitation; WWM – wastewater management; HYG – basic hygiene interventions

FIGURE 11: HEALTH COSTS AVERTED BY IMPROVED SANITATION OPTIONS



4.2 WATER

Internal freshwater sources per capita in Vietnam amount to 3,840 m^3 per year (MONRE, 2010), which classifies Vietnam as a country with potential water scarcity. In terms of major water resources, there are nine major river basins. Biochemical oxygen demand (BOD) (from agriculture, industry and domestic sources) on many of these inland water sources is high. The ESI Phase 1 study estimated that, in 2005, domestic sources contributed 357,500 tons of BOD to inland water sources, from an estimated 2.275 million tons of feces, 22.754 million m^3 of urine, and at least 609.8 million m^3 of gray water (mainly from urban populations).

With small populations and abundant water sources, pollutants would be diluted naturally. However, given the high density of population in many parts of Vietnam – especially in the Red River and Mekong River deltas – sufficient dilution is not guaranteed, and the water quality indicators presented below suggest that significant pollution is taking place. Furthermore, over-extraction of some rivers and water sources for irrigation purposes leads to greater pollution of the water sources. Indeed, there is increasing evidence of pollution in surface, ground and coastal waters.

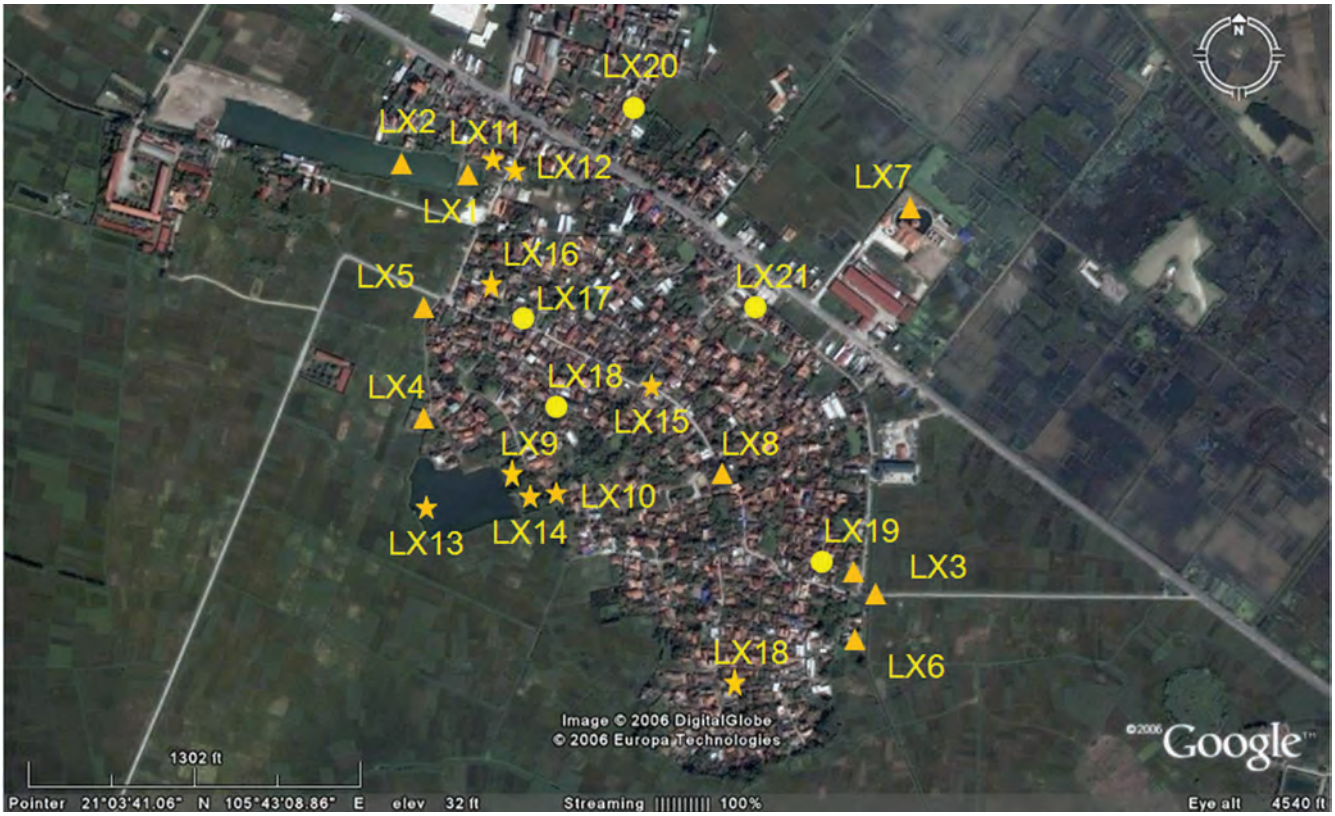
4.2.1 WATER SOURCES

Table 28 presents a summary of the water sources in the eight urban and nine rural field sites.

TABLE 28: WATER SOURCES IN FIELD SITES

Field site	Location	Water sources				
		Lake	Pond	River	Canal	Others
Urban 1	Sa Dec town, Dong Thap province			2 rivers	2 canals	Central tap water system
Urban 2	Tam Ky town, Quang Nam	2 lagoons		1 river	5 canals	Tap water, lots of individual wells
Urban 3	Trang Cat, Hai An, Hai Phong city	2 lagoons (Cat Bi, Phuong Luu)	-	1 river (Cua Cam)	4 canals (An Kim Hai, Tay Nam, Dong Bac, Le Hong Phong)	Central tap water, central sewerage network
Urban 4	Bai Chay, Ha Long, Quang Ninh		3 lagoons	-	-	Tap water, wastewater treatment plant
Urban 5	Buon Ma Thuot city, Dac Lak	2	5	6 streams	-	Central tap water, w/w treatment plant
Urban 6	Thang town, Hiep Hoa, Bac Giang		1 lagoon	2 streams	2 canal	Dug wells
Urban 7	Phan Chu Trinh, Hoan Kiem, Hanoi		4 lagoons	1 stream	2 canals	Central drainage, tap water
Urban 8	Cua Lo, Nghe An		1 lagoon			
Rural 1	Xuan Phu, Xuan Loc, Dong Nai	4 lagoons	1 small	1 river	2 streams	8 wells
Rural 2	Huu Thanh, Tra On, Vinh Long		3 small	2 rivers (Tra On river, Tra Ngoa river)	5 small streams	3 wells, 1 tap water system
Rural 3	Tinh Dong, Son Tinh, Quang Ngai		2 lagoons	4 streams	2 canals	6 wells
Rural 4	Tan Lap, Dan Phuong, Hanoi	1 lake	6 small ponds		2 canals	10 wells
Rural 5	Thang Binh, Quang Nam		1 lagoon	-	1 canal	8 tube wells with pumps
Rural 6	Duc Thang, Hiep Hoa, Bac Giang		3 lagoons	3 streams	1 canal	1 tube well, 6 dug wells
Rural 7	Lai Xa, Kim Chung, Hoai Duc, Hanoi	2 lakes	4 small ponds	-	2 canals	6 tube wells, 7 main sewage drains (4 km), 2 cluster wastewater treatment plants
Rural 8	Thieu Duong, Thieu Hoa, Thanh Hoa	1 lagoon	1 small pond	1 stream	6 canals	2 drains, 2 tube wells, 3 dug wells
Rural 9	Phu Loc, TT - Hue	1 lagoon	-	3 rivers	-	7 tube wells with pump, 1 public well

FIGURE 12: MAP OF TYPICAL RURAL AREA (R7, LAI XA VILLAGE, HANOI SUB-URBAN) WITH SAMPLING POINTS FOR WATER QUALITY ANALYSIS



Note:
- LX1 … LX8: surface water sources;
- LX9 … LX16: sewers and drains;
- LX17 … LX21: groundwater sources.

4.2.2 WATER QUALITY AND ITS DETERMINANTS

E-Coli contamination was found in almost all surface water samples at every site. This finding was expected, since there are few inhabited places in Vietnam where waste is isolated and fully treated.

In most samples taken from surface water (rivers, canals, lakes and ponds), water quality indicators exceed allowable values according to class A1, Vietnamese surface water quality standard QCVN 08:2008/BTNMT, which is applicable to drinking water supply sources. This means people using these surface water sources for their water supply may risk chemical and biological contamination. The surface water quality at sites very much depends on the sanitation status of the community. Non-isolated sanitation facilities are serious water contaminating sources. As shown in Figure 13, BOD and COD in samples at sites R4 and R8 are higher than those allowable according to Class A1, QCVN 08:2008. This is because of incomplete collection and treatment of wastewater in the surveyed sites. After black water from toilets and pig farms is treated in the biogas digesters that have been built in a large number of high-density communities, the resultant gray water and biogas digester effluent (and waste from other sanitation facilities) are discharged directly into the environment.

Analysis of groundwater quality parameters conducted in rural areas also shows that most surveyed sites have been contaminated with pathogen indicators such as E-Coli. The highest contamination has been found in urban area U1 in Sa Dec town, Dong Thap province. Other sites showed similar contamination by microbial pathogenic parameters. Since there is no rural site with fully isolated toilet facilities, there is clear evidence that contamination of groundwater – including that used for drinking and cooking – is due to poor sanitation. Full details of water quality in rural and urban sites are given in Annex Table C.

In Figure 13 below, we can see correlation between a number of non-isolated sanitation facilities and the pathogenic contamination in surface water samples. At site U1 and site R2 at Huu Thanh, Vinh Long province, where non-isolated sanitation facilities make up a high percentage of the total, a higher number of pathogens are found in the surface water samples. Similar results were also found in groundwater at site U1.

FIGURE 13: PATHOGENIC PARAMETERS OF SURFACE WATER QUALITY, RURAL SITES (R1 TO R9)

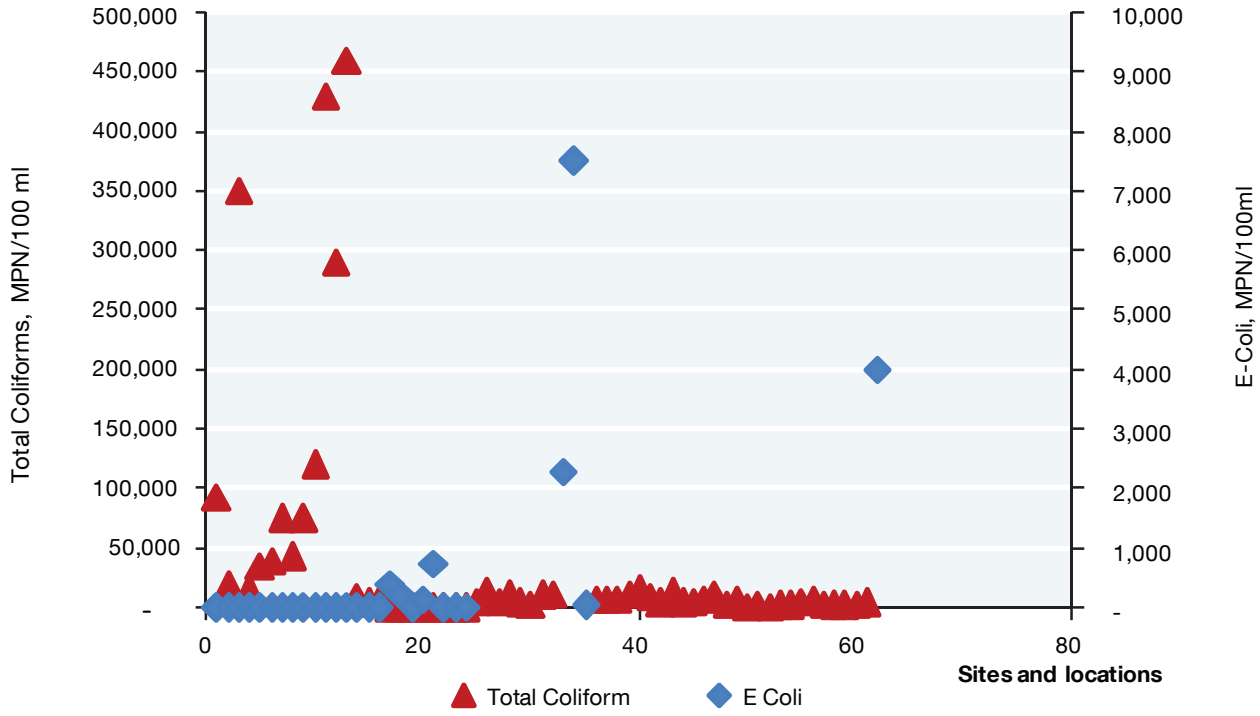
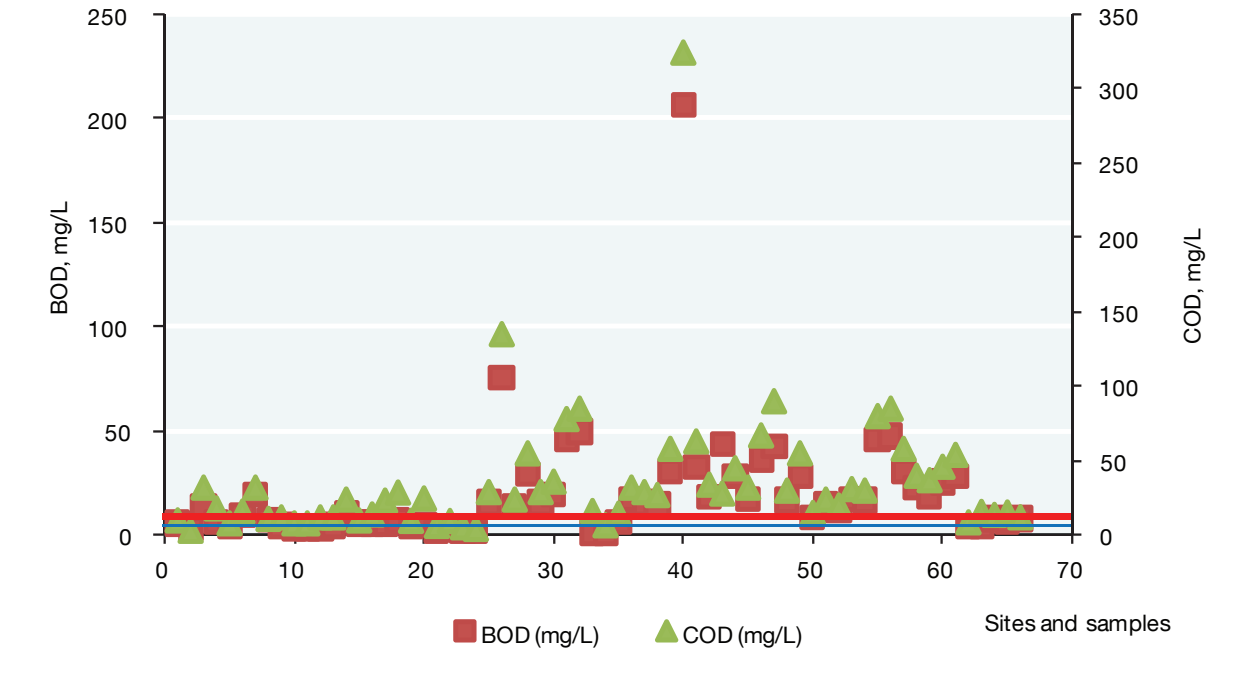


FIGURE 14: BIOLOGICAL OXYGEN DEMAND (BOD) AND CHEMICAL OXYGEN DEMAND (COD) PARAMETERS OF SURFACE WATER QUALITY, RURAL SITES (R1 TO R9)



A similar picture has been found for other parameters analyzed (see Figure 14). Surface water samples at sites R6 and R7 were polluted with organic matter, and the BOD and COD values significantly exceeded the QCVN 08 standard (see horizontal red line in Figure 14). High pollution is found in standing waters such as ponds and reservoirs, and in small flow canals, where the dilution coefficient and self-purification capacity of the water bodies are limited. More pollution is also found in places with high population density, such as sites R4, R6 and R7.

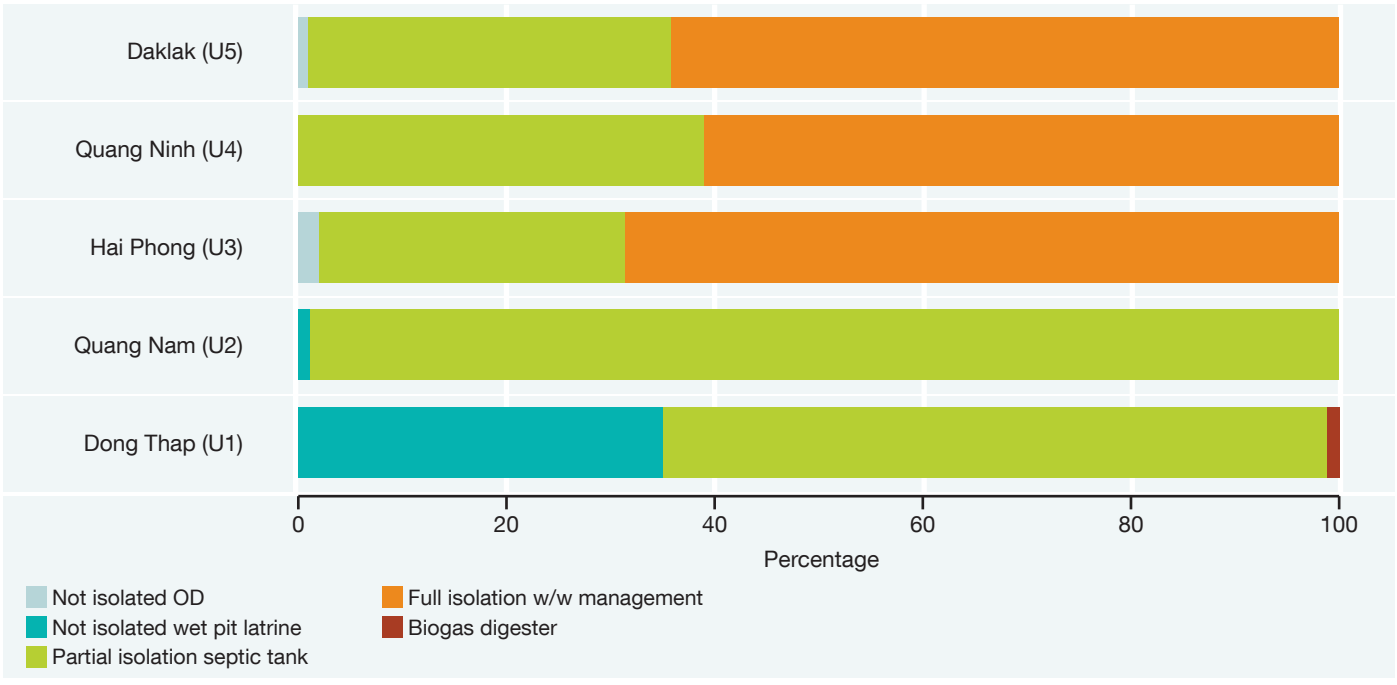
BOD and COD values at R2 and R3 are much lower, even though sanitation facilities at these sites are also non-isolated, and pollution risks for children are still high. Reasons for the better water quality at R2 and R3 include better permeability of the soil (at R3), low-population density (at R2), and less overflow of untreated wastewater.

Figure 15 and Figure 16 below show the extent of isolation of human excreta at urban and rural field sites. Households are classified 'partially isolated' or 'fully isolated', according to the type of sanitation systems applied.

In urban areas, a 'partially isolated' septic tank system is the most common application (as at rural sites, if effluent from septic tanks and gray water are not treated further, the system is considered 'partially isolated'). Only Hai Phong (U3), Quang Ninh (U4) and Dak Lak (U5) are 'fully isolated' sites, where wastewater treatment is applied in part of the city. Lower values for pathogens and organic matter (BOD, COD) in surface water at U3, U4, and in groundwater at U3, U4 and U5 surveys confirm the role of improved sanitation. A highly dense population served by an old combined sewerage system in which most wastewater is still untreated is among the reasons for low surface water quality at Hai Phong (U3), the second largest city in Northern Vietnam.

In rural areas, OD and wet pit latrines are considered 'not isolated'. These types of toilet are also considered 'unhygienic' according to Vietnam MOH classification (Decision 08/QD-BYT-2005). No single type of sanitation system in the surveys has been found to be 'fully isolated' because of incomplete collection and treatment of wastewater flows. The septic tank receives black water from the toilet; the septic tank effluent is then mixed with untreated gray water (from the kitchen, shower, etc) and discharged directly into the soil or into a combined sewer. A similar picture is found with biogas digesters. Only one site (R7, Lai Xa village) had cluster wastewater treatment. However, the system was built for only a part of the village, and the combined sew-

FIGURE 15: EXTENT OF ISOLATION OF HUMAN EXCRETA AT URBAN FIELD SITES (%)



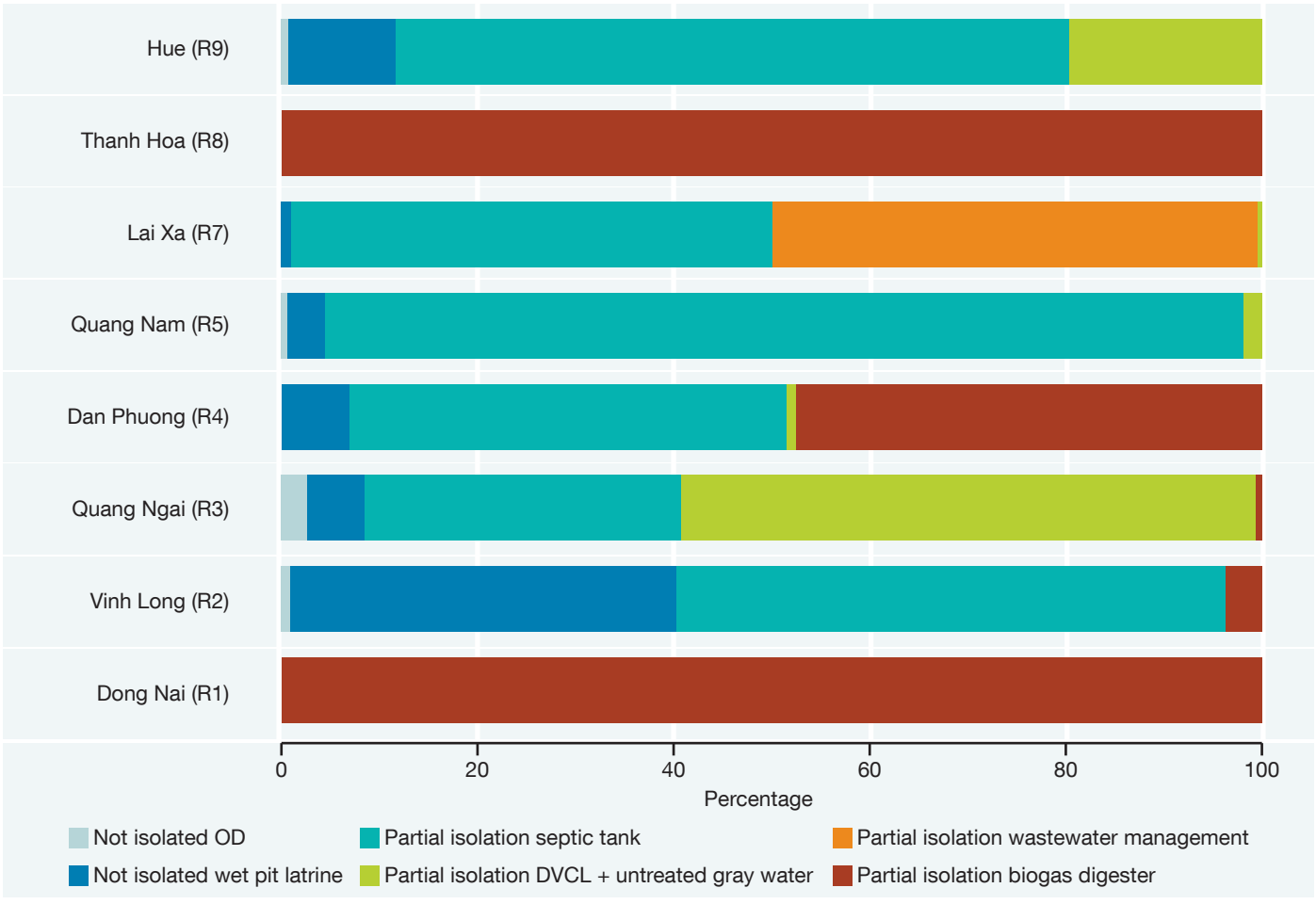
erage and drainage network has number of disadvantages such as serious leaking, frequent clogging due to uncollected sludge and solid waste, overflow at times of heavy rainfall and illegal connections. The system that is closest to 'fully isolated' is the application of double-vault composting and urine diverting toilets. An addition of gray water treatment would make this system 'fully isolated'. The application of a large number of this type of sanitation system (R3 and R9) is associated with evidence of better water quality (lower BOD, COD, total coli-forms and E-Coli in both surface and groundwater samples) in the surveyed areas.

The conclusion is that a degree of isolation and treatment of waste by a sanitation system that fully isolates or treats sludge/wastewater correlates with an improvement in local ground and surface water quality. A household toilet alone is not enough to ensure the adequate isolation of pollutants and pathogens. An appropriate sanitation system providing reliable collection and treatment as close to the generation source as possible for all waste flows is crucial for the achievement of improved local water quality.

4.2.3 HOUSEHOLD WATER ACCESS AND TREATMENT COSTS

One of the major impacts of polluted water in wells, springs, rivers and lakes is that populations and water supply agencies will have to treat water, or treat water more intensively, for safe human use. Alternatively, populations and water supply agencies can access cleaner water from different and more distant sources, thus increasing access costs. Those who do not take precautionary measures are exposed to higher risk of infectious disease, or poisoning due to chemical content. Table 29 shows the average monthly cost of water treatment for different water sources in urban and rural areas. The costs vary between dry and rainy seasons. Data from each site are given in Annex C.

FIGURE 16: EXTENT OF ISOLATION OF HUMAN EXCRETA AT RURAL FIELD SITES (%)



Access to piped water is still very low in the surveyed rural areas, at less than 20% of households. In urban areas, piped water is the main household water source for around 75% of households. Where there is no piped water, people try to use protected water sources. Some 8% to 14% of the rural population and 6% to 7% of the urban population still use unprotected water sources in the surveyed areas. These values do not change over the seasons, since few people have alternative water sources.

TABLE 29: WATER ACCESS, TREATMENT PRACTICES, AND RELATED COSTS (VND '000, 2009)

Rural/Urban	Season and water source	Piped water (treated)		Non-piped protected source (including untreated piped)		Non-piped unprotected source	
		% access	Average monthly cost	% access	Average monthly cost	% access	Average monthly cost
Urban	Dry season						
	Major source	78.3	22	14.5	18	7.2	11
	Minor source	35.6	27	58	18	6.4	10
	Rainy season						
	Major source	75.4	20	18	26	6.6	12
	Minor source	31.7	20	62.3	22	6	11
Rural	Dry season						
	Major source	17.3	31	68.5	20	14.2	20
	Minor source	5.8	18	85.4	22	8.8	10
	Rainy season						
	Major source	14.9	27	71.8	21	13.3	21
	Minor source	4.8	18	87	22	8.2	59

FIGURE 17: AVERAGE WATER ACCESS (%) IN ALL SURVEYED SITES

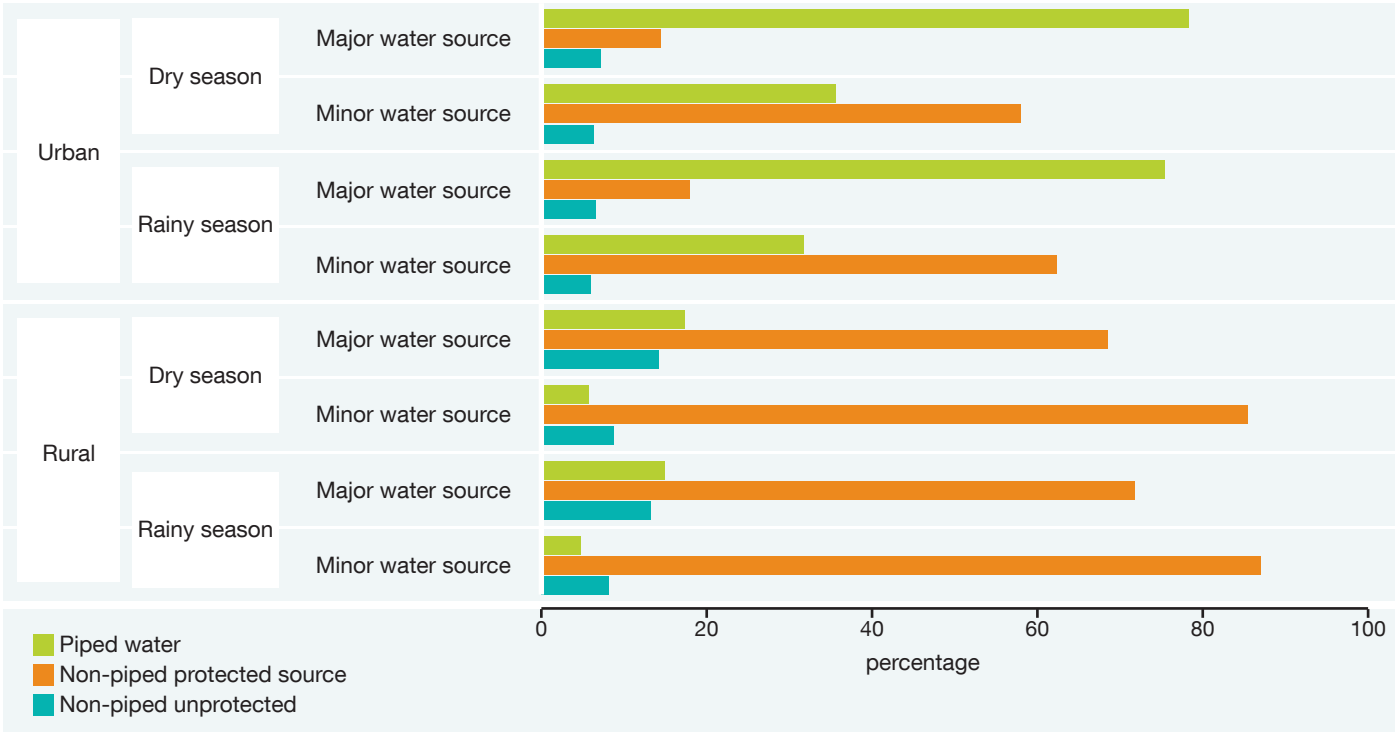
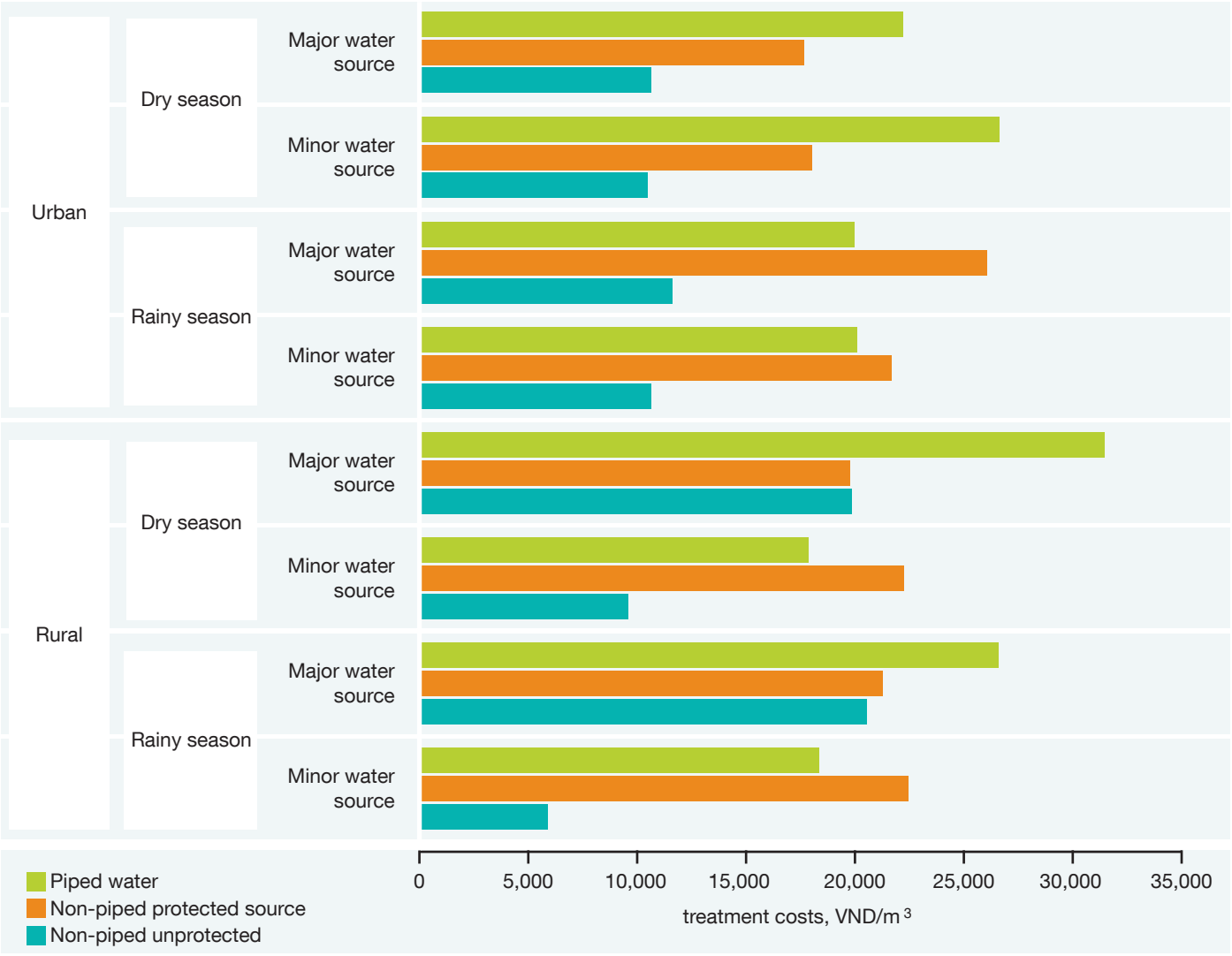


FIGURE 18: AVERAGE MONTHLY WATER TREATMENT COST (VND) IN ALL SURVEYED SITES



'Major' and 'Minor' refer to whether the listed water sources provide the major or a minor contribution to domestic water supply needs.

As shown in Figure 17, people use different water sources for different uses, due to variations in its availability, quality and cost. Households are sensitive to price, and average monthly treatment costs are provided in Figure 18. For example, piped water – which is relatively more expensive than other water sources – is used more in the dry than in the rainy season, as alternative, cheaper protected water sources are more available in the rainy season in both rural and urban areas. However, piped water is generally the safest water source in terms of avoiding waterborne diseases. The monthly cost of household treatment of unprotected water sources varies between 48% and 77% of the costs of accessing piped water; hence it is cheaper to treat collected water than to pay for piped water.

4.2.4 HOUSEHOLD RESPONSE TO CONTAMINATED WATER AND RELATED COSTS

Households may respond to traditional water sources they know to be polluted in several ways: changing source of purchased water; walking further to haul free but cleaner water; or treating water at home. In addition, those who are able to may choose to connect to a piped water source (if available and affordable), or they may harvest rainwater. When cheaper water sources are not available or trusted, and/or when households are relatively well off, they may purchase bottled water or bring in a tanker (more in urban areas). Figure 19 presents average values of responses from surveyed households on the reasons for using water sources at all rural and urban sites. There is no significant differ-

ence between rural and urban values where people consider water quality as the most important reason for selecting a piped-water source (92% versus 95%). Having sufficient quantity was the reason 42% of urban population chose a piped water source, while in rural sites it was 17%. These findings mean that water access cost was not a main reason for selecting the main household source, since piped water usually requires higher household expenditure. In areas where piped water is not available, water quality was the main reason for selecting a particular water source (85% versus 86% among non-piped protected sources, and 69% versus 76% among unprotected sources). Households using unprotected water sources were more likely to cite cost as a factor in their choice of water source.

FIGURE 19: REASONS CITED FOR USING WATER SOURCES – RURAL VERSUS URBAN (%)

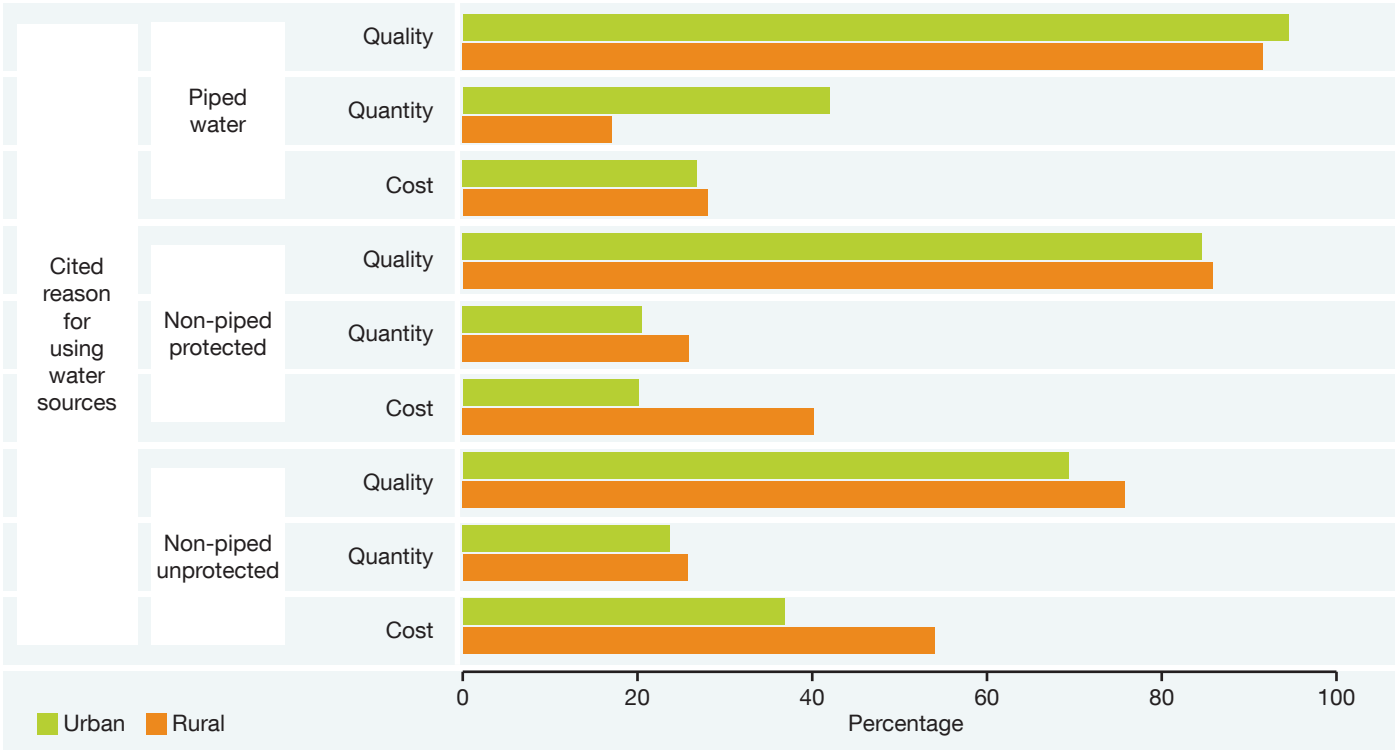
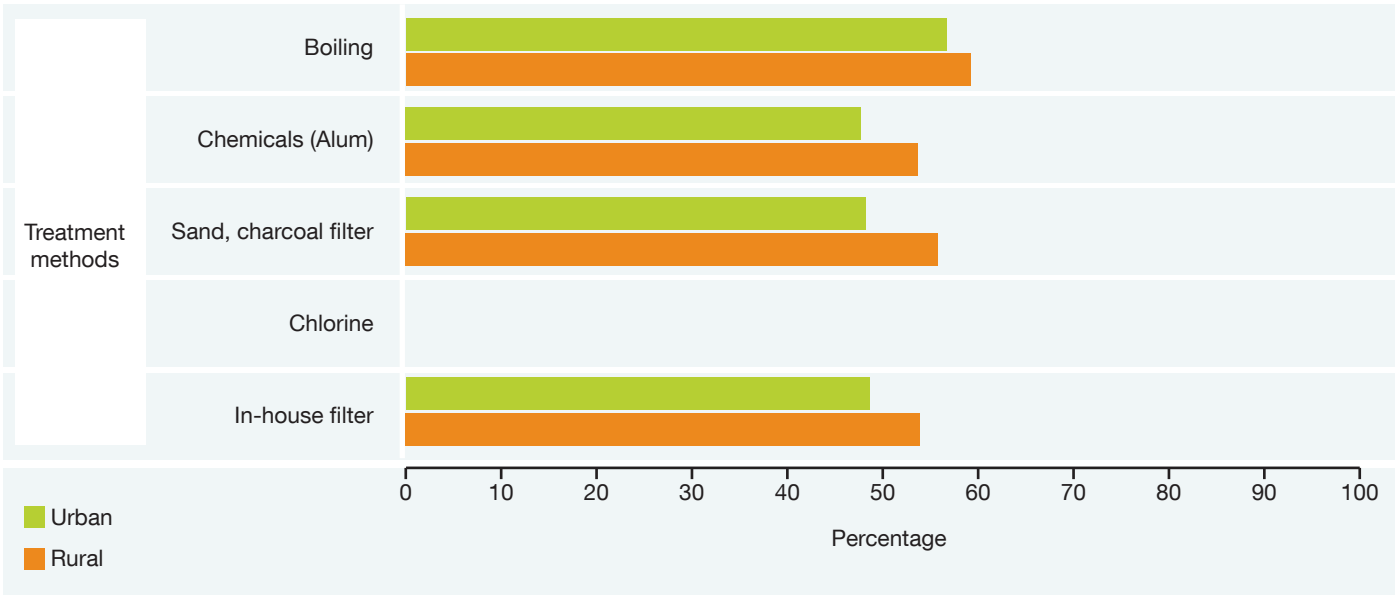


FIGURE 20: HOUSEHOLD WATER TREATMENT PRACTICES (%)



As well as the above options, or in isolation, households may treat water at home by different methods. Figure 20 shows household water treatment practices at all sites. All households use at least one method of household water treatment. Boiling is the prevailing choice of both rural and urban households when treating their water before drinking. Other treatment options are also popular and there is no significant difference between them at the surveyed sites. Information, materials and equipment available from the market enable households to select treatment alternatives to boiling. Details of treatment practice at surveyed sites are given in Annex C.

Figure 21 shows average household water treatment costs by method and by urban/rural location. The high investment cost associated with in-house filtration, which may serve only to produce water for drinking and cooking purposes makes this the most expensive treatment method. Chlorine is not used in any urban and rural areas as a household water treatment method except in the case of emergency treatment during and after flooding. Different types of chlorination products with different prices are available. For all methods, the unit cost per cubic meter of water treated is higher in urban than that in rural areas.

4.2.5 HOUSEHOLD WATER COSTS AVERTED FROM IMPROVED SANITATION

Table 30 presents annual average water access and treatment costs per household, and averted costs per household in cases of improved sanitation. The averted costs of water access in urban areas are low compared with those in rural areas, where people may get significant benefit from on-site water sources if a sanitation system is implemented. The average cost of water source access is much less than the cost of water treatment. The latter may be reduced by 10% to 13% in the case of improved sanitation, amounting to over VND300,000 per household per year. Other factors for consideration include available water source quality and quantity, the quality of water supply service utility, and sources of pollution apart from poor sanitation such as solid waste and farming practices.

FIGURE 21: AVERAGE HOUSEHOLD WATER TREATMENT COSTS, BY METHOD AND URBAN/RURAL LOCATION (VND/M^3, 2008)

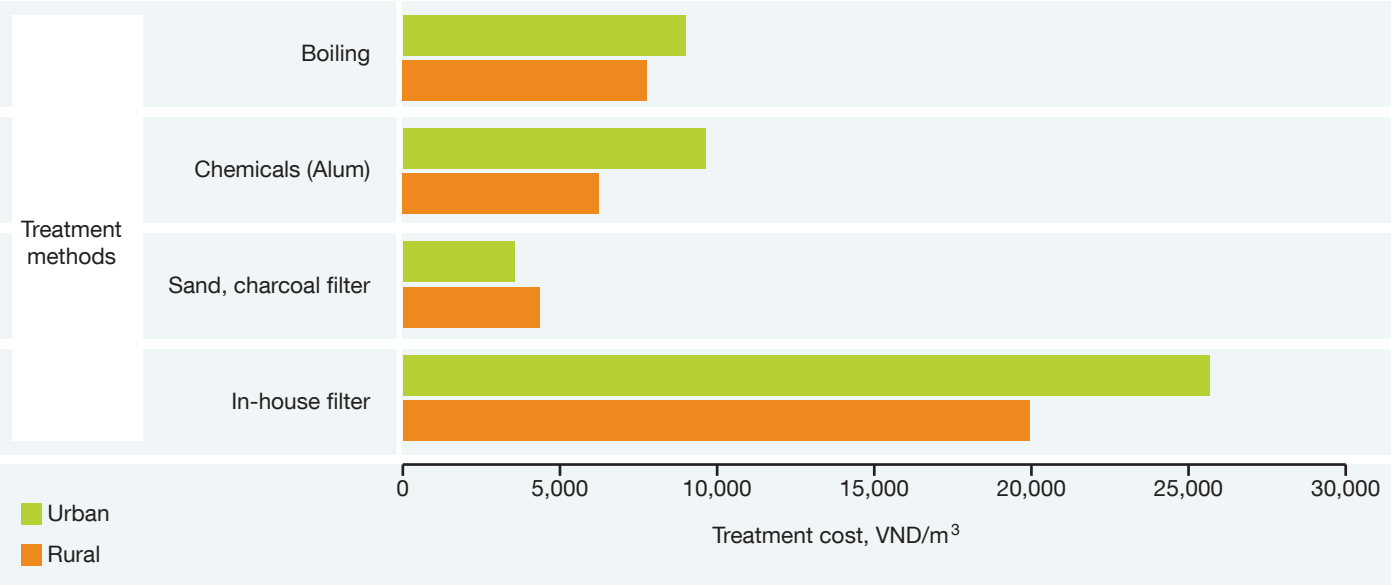


TABLE 30: HOUSEHOLD WATER ACCESS AND TREATMENT COSTS INCURRED AND AVERTED (VND '000, 2008)

Variable	Annual average costs per household		Annual average costs saved per household following 100% sanitation coverage	
	Urban	Rural	Urban	Rural
Water source access	476	413	4	26
Water treatment	2,658	2,973	337	318
Total	3,134	3,386	341	343

4.2.6 WATER USE COSTS IN NON-DOMESTIC ACTIVITIES

In addition to its household uses (drinking, cleaning, bathing and cooking), water is crucial to other activities in the urban/village environment. In urban areas, this includes its use in offices, shops and factories. In rural areas, this includes irrigation for agriculture, livestock farming, fish production and production in cottage industries.

4.3 ACCESS TIME

Families without a toilet have to use one of the following options for excretion:

(a) using the backyard or a bush in their own plot;
(b) using public land, rivers, lakes, and ponds;
(c) using a neighbor's toilet; and
(d) using a community (shared) latrine.

The average access times (including travel and queueing time) for each of these options, gathered from the household survey, are:

- Round trip to use the bush or backyard: 5 min.
- Round trip to use public land: 7 min.
- Round trip to use a shared latrine (including waiting time): 10 min.
- Round trip to use a community latrine: 15 min.

Some gender differences were found in the use of places most commonly accessed by those without household toilet. Women more often went to places with more privacy for options (b) and (c) while men often use option (a) for urination, and options (b) and (c) for defecation. The average time of young children with accompanying parent accessing off-plot sanitation was 40% of the adult values, as not all toilet visits required an accompanying parent. Adults use these locations on average 4.1 times per person per day in urban areas, and 3.1 times per day in rural areas. While these data were gathered from relevant questions in the ESI household survey, it was not always easy to get direct and true answers on these personal and sensitive issues. The survey team combined results from household surveys, field observations and expert opinion in order to tabulate this information. Table 31 presents average savings per household from all surveyed sites who gain access to an on-plot toilet facility.

TABLE 31: AVERAGE ANNUAL ACCESS TIME SAVINGS PER HOUSEHOLD (VND, 2008)

Location	Average value of annual savings
Urban	2,487,000
Rural	1,686,000

4.4 REUSE OF HUMAN EXCRETA

Table 32 shows the sanitation options used at representative site R4 (Dan Phuong commune), detailing the number and percentage of households using composting, urine diverting toilets (45 households, or 1.5%), toilets and pig pens with a biogas digester (825 households, or 27%). The table shows that of those with composting toilets and biogas digesters, 100% reuse the excreta. Some 5.6% of households reuse the sludge from their septic tanks. Most sludge from the biogas digesters and composting toilets is reused as fertilizer.

TABLE 32: SANITATION COVERAGE, AND % REUSE OF EXCRETA IN SITE R4 (DAN PHUONG COMMUNE)

Field site	Number of households	%	Of which reuse
UNIMPROVED			
OD	0	0	0
Private pit	95	3.1	21
Shared	0	0	0
IMPROVED			
Simple pit	185	6.1	49
UDDT	45	1.5	44
Biogas	825	27.0	825
Septic tank	1,900	62.3	107

There is limited awareness of safe reuse. Most double-vault composting toilets are emptied after a storage time of less than 6 months, according to the need for fertilizer and seasonal cropping factors. Therefore, it is necessary to improve the safety of the composting process through behavior change campaigns and other activities. Sludge collected from a biogas digester is also considered a good fertilizer, which is used to grow tropical fruit and vegetables. Some households practice co-composting of septic tank sludge or biogas digester sludge with organic waste from the garden, after which it is applied to the crops. This method of sludge handling significantly enhances reuse safety.

TABLE 33: VALUE ASSOCIATED WITH REUSE PER HOUSEHOLD IN R4

Variable	% households		Average value (VND '000, 2009)	
	Own use	Selling	Own use	Selling
Composting (fertilizer)	77	23	1,320	540
Biogas generation (with animal excreta)	100	0	960	0

Table 33 shows the value of reuse per household at site R4. Most households with a composting toilet reuse the compost product for fertilizer. Composting toilets are found in a small number of non-farming households, which represent only 1% of the total population. These households give or sell their composting fertilizer to other households. Since it is not easy to sell biogas, households and farms with biogas digesters can only use it in their own plot. At site R4, about 5% of biogas digesters have problems of leaking and improper operation, leading to insufficient gas generation. The reason for these problems is the poor construction and installation quality of the first series of digesters, which were installed by inexperienced workers. Other reasons were an unstable number of pigs kept at the household, and improper operation and maintenance.

A very similar picture is found at other rural places where sludge, excreta and biogas are utilized. Calculations of the benefit of reusing resources from sanitation interventions compared to costs at other surveyed sites are described in Chapter 6 and Chapter 8.

4.5 INTANGIBLE SANITATION PREFERENCES

Due to a lack of other studies examining the intangible aspects of sanitation, the data presented here come entirely from ESI fieldwork. The data come from two main sources: a close-ended household questionnaire that was applied to the most senior available household member; and focus group discussions (FGD), which were held with both men and women of different ages. These two surveys collected perceptions, opinions and preferences from a representative section of the communities (see section 2.3 for methods and sampling approach). The results presented here describe: (a) the communities' understanding of what 'sanitation' is; (b) why households have a particular sanitation option; (c) the degree of satisfaction with current sanitation options; and for those without a toilet (d) the reasons to get one, the characteristics they look for in a toilet, and the willingness to pay for one. These data were collected from 11 sites with improved toilet and human excreta management (excluding case studies at two sites – Thanh Hoa and Dong Nai – and SWM at four sites – Nghe An, Hanoi, Bac Giang U and R) in rural and urban areas in Northern, Central and Southern Vietnam (see Table 34).

TABLE 34: GEOGRAPHICAL LOCATION OF SURVEYED SITES

Region	Urban sites	Rural sites
North	Hai Phong (U3); Quang Ninh (U4)	Dan Phuong (R4); Lai Xa (R7)
Central	Quang Nam (U2)	Quang Nam (R5); Hue (R7); Quang Ngai (R3)
South	Dong Thap (U1); Dak Lak (U7)	Vinh Long (R2)

Respondents' understanding of sanitation is taken primarily from FGD and the household questionnaire. These showed that respondents have a comprehensive knowledge about sanitation. However, their answers also reflect the fact that in Vietnam, people tend to think of sanitation as public sanitation rather than personal hygiene (such as hand washing and stopping OD). One reason could be because OD is no longer common at some study sites, and most households have access to tap water, which is considered clean and good for hand washing, even without soap. Another reason is that there are several campaigns related to the "green environment" and "village cleaning events" held at provincial, district and village levels through the year. All respondents referred "no garbage" as a key element of sanitation.

At the Northern Vietnam field sites, men and women with a toilet rank "freedom" and "cleanliness" as the most important reasons they have one. Those without toilets refer to "lack of money" as the main reason. At Lai Xa (R7) there are only a few households without toilets, and most live next to their brothers and sisters' houses, which do have toilets. Therefore, going to the toilet can sometimes be inconvenient but is rarely a big issue. Despite the fact that Dan Phuong (R4), Hai Phong (U3) and Quang Ninh (U4) are in the North, these sites are quite economically developed, and all selected households have toilets. As shown in Table 36, they refer to the "tendency of society" as the reason for having a toilet not only for the house, but also on each floor within the house.

TABLE 35: RESPONDENTS' UNDERSTANDING OF SANITATION, IN RANKED ORDER OF IMPORTANCE (1 = MOST IMPORTANT)

Region	Focus Group Discussions	
	With toilet	Without toilet
Rural North	1. Clean environment 2. No garbage 3. No bad smell 4. Sewerage and drainage 5. No flies or rats	1. No garbage 2. No bad smell from drainage system 3. Septic tank toilet 4. Tap water 5. No pollution
Urban North	1. High coverage of trees 2. Dispose of garbage in the right places 3. No bad smell 4. Safe food 5. Waste water doesn't run directly into the sea	(no households without toilet)
Rural Central	1. Clean environment 2. No garbage 3. No flies 4. No human or animal excreta	1. No garbage 2. Water sources protection 3. No flies
Urban Central	1. Clean environment 2. Sewerage system, especially after the rain 3. No garbage 4. Waste water does not exist in the streets	(no households without toilet)
Rural South	1. Clean environment 2. No flies 3. No garbage 4. No pollution	1. No garbage 2. Green environment 3. Low density of people
Urban South	1. No animal waste 2. Treated waste water 3. Clean environment 4. Garbage collection service	1. Clean environment 2. Pour flush toilet 3. No flies

At the Central Vietnam field sites, women with toilets consider "comfort" and "cleanliness" as the most important factor, while men simply think of a toilet as a must for urban households. The situation in the South is quite similar to that in the North and Central regions. Safety was emphasized by women as a reason to own a toilet, especially for easy and safe access at night.

In terms of the level of satisfaction with current toilet option, the analysis compares the satisfaction between those with improved toilets and those with unimproved toilets (Figure 22). The result is that in the Rural North there is very little difference between the satisfaction of households with improved and unimproved toilets. The data are based on a small sample size (only in Lai Xa [R7] there were households with unimproved toilets). Second, respondents had some difficulty in scoring differently multiple criteria, all of which they considered important; hence, the score for all criteria is at least 4.

In the Urban North, 100% of selected households have improved toilets, which makes comparison with the Rural North not possible. While most criteria are given scores of over 4, the criterion related to their pride in front of visitors gets the lowest score, because respondents consider a toilet a must in the household and "there are many other things we are proud of rather than toilets." In addition, many households with improved toilets want to improve their toilets with more facilities, add toilets for each floor, or combine toilets and bathrooms in one block. This indicates that they are demanding "comfort and privacy" for each member of the family rather than for the family as a whole.

Figure 22 shows that rural households with and without improved toilets in Central Vietnam gave the highest scores to the criteria "privacy", "pollution", "cleanliness" and "freedom". This shows that even people without improved sanitation understand the problem.

TABLE 36: REASON FOR CURRENT SANITATION COVERAGE – TOP RANKED RESPONSES

Region	Household interview	Focus Group Discussions			
	Why families do not have a toilet	Why families have a toilet		Why families do not have a toilet	
		Men	Women	Men	Women
Rural North	1. Cost is too high 2. Never been offered toilet facilities 3. No space in or near house 4. Not enough water for flushing	1. Freedom, use the toilet any time if needed 2. Sensitive activity 3. There exists no-one without toilets now 4. Cleanliness 5. Comfort	1. Cleanliness 2. Comfort 3. Independence 4. Visitors have toilet to use 5. Children will not be shy when going to the toilet	1. Lack of money 2. Can share toilet with brothers and sisters 3. Do not care much	1. Lack of money 2. Old lady, no need to build new latrine 3. Use toilet of family's member living next door
Urban North	(no households without toilet)	1. Tendency of society now to have toilets 2. Comfort			
Rural Central	1. Cost is too high 2. Not enough water for flushing	1. Freedom 2. Comfort 3. Higher living standard	1. Cleanliness 2. Comfort 3. Independence 4. Shy of practicing OD or using another family's toilet	1. Lack of money 2. Do not care much	1. Lack of money 2. Have never had a toilet 3. Use toilet of another family
Urban Central	(no households without toilet)	1. Everybody has a toilet now 2. Comfort 3. No place for OD	1. Cleanliness 2. Comfort 3. Everyone has toilets	(no households without toilet)	(no households without toilet)
Rural South	1. Cost is too high 2. Never been offered toilet facilities	1. Comfort 2. Better life 3. Public toilets are often not protected by people	1. Comfort 2. Cleanliness 3. See the benefits of neighbors' toilets 4. Safe, especially at night	1. Lack of money 2. A habit	1. Lack of money 2. Never been offered a toilet
Urban South	1. Cost is too high 2. Never been offered toilet facilities	1. Nobody around without toilets 2. Cleanliness 3. Comfort	1. Cleanliness 2. Everybody has a toilet now	1. Use shared toilet with parents	1. Lack of money 2. Nobody in the family cares about toilet

The responses from Tam Ky, Quang Nam (U2) are analyzed because it is the only urban site at which 100% of households with toilets have improved toilets. The order of criteria getting the highest scores is a little different compared with the rural sites.

In the South of Vietnam, there is a big difference in satisfaction between households with improved and unimproved toilets. While households with improved toilets in both rural and urban areas give a score of a least 4 for 15 of the 16 criteria, households with unimproved toilets give a maximum score of 3 for up to half of the criteria, and especially low scores for "privacy", "proximity", "status", and "visitors".

Figure 23 shows the reasons for getting a toilet with corresponding scores for different characteristics of toilets. In rural areas, "cleanliness and freedom" score highest, and other criteria score highly at 4 or over. It can be concluded that rural households have quite similar reasons for getting a toilet. They may not know the exact benefits of having a toilet because they have never had one, so the scores they give could be seen as their expectation of the potential benefits.

FIGURE 22: LEVEL OF SATISFACTION OF HOUSEHOLDS WITH IMPROVED AND UNIMPROVED TOILETS (1 = NOT SATISFIED; 5 = VERY SATISFIED)

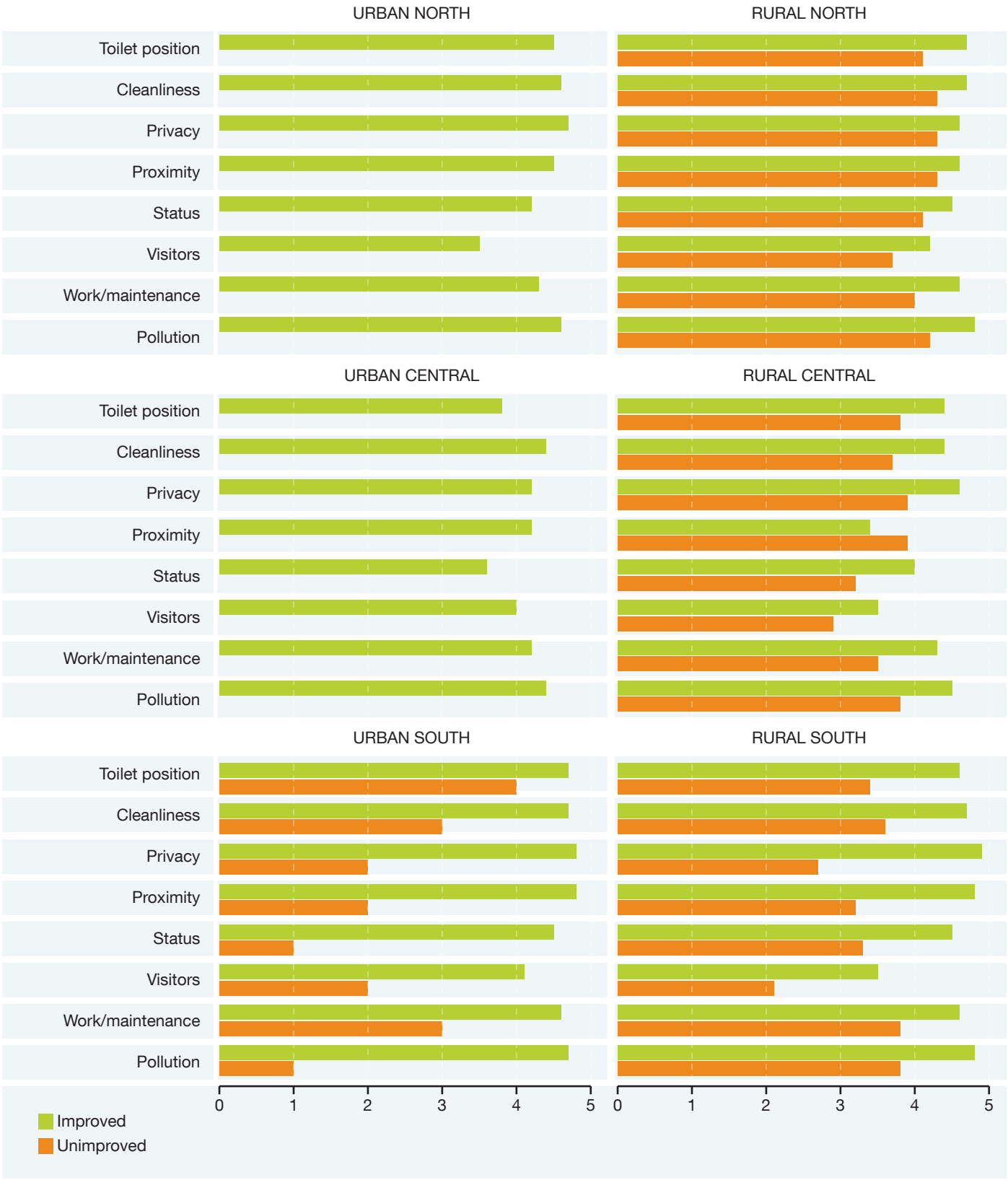
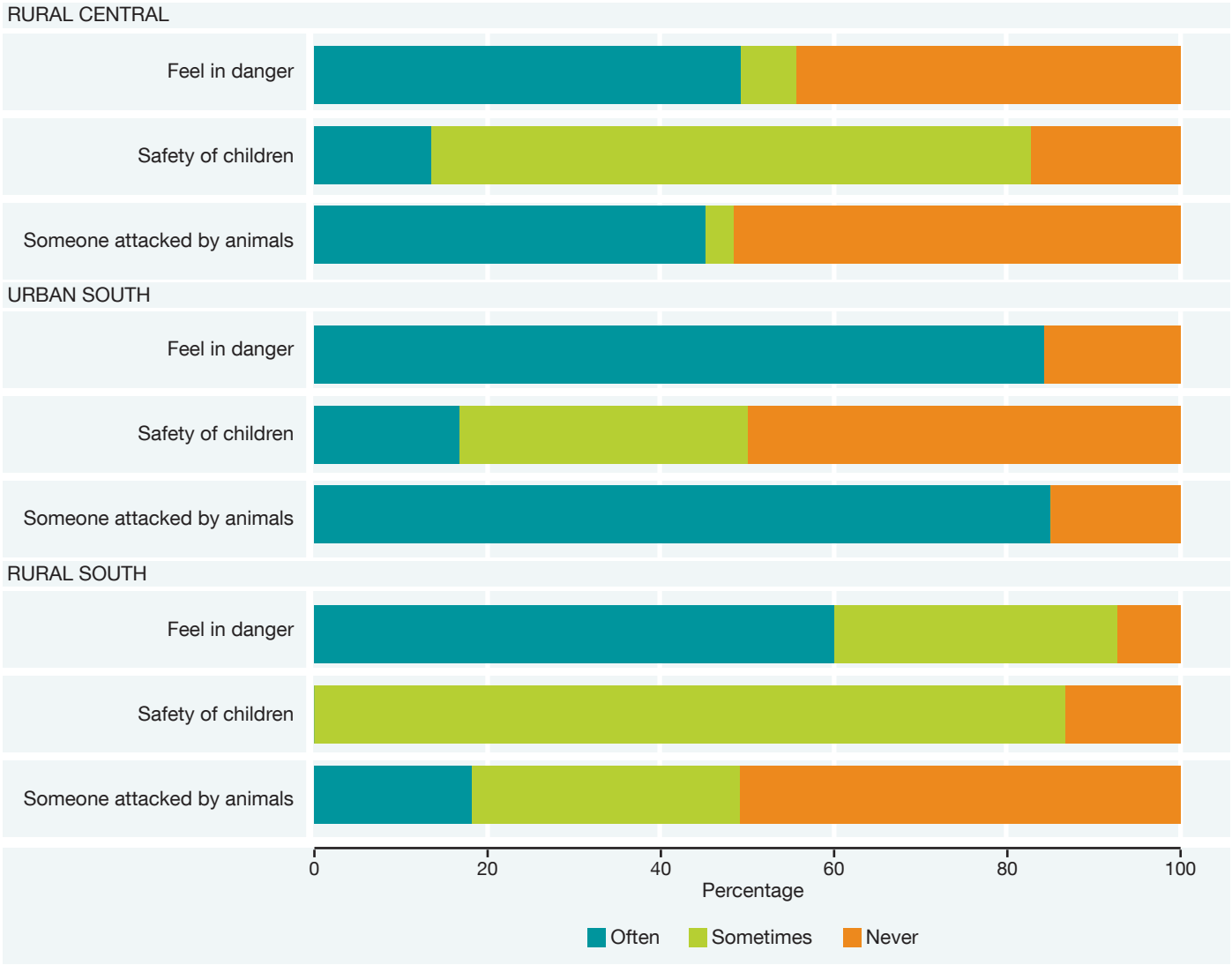


FIGURE 23: REASONS TO GET A TOILET FOR THOSE CURRENTLY WITHOUT ONE (1 = NOT IMPORTANT; 5 = VERY IMPORTANT)

There is almost no difference between the responses given by rural and urban in Southern Vietnam, except for the criterion "visitors", which people in urban areas scored lower than people in rural areas. The FGD showed that urban households see toilets as a 'must' rather than a source of pride. Another notable point at all sites is that people are aware of decreasing the impact of pollution on the surrounding area and neighbors.

The concerns of those practicing open defecation in rural areas of Central Vietnam are quite diverse. Many respondents in urban areas indicated being concerned with being attacked (and/or bothered) by animals during open defecation, and worried especially for the safety of their children. They already know of people being attacked by animals (see Figure 24).

FIGURE 24: CONCERNS OF THOSE PRACTICING OPEN DEFECATION (% OF RESPONDENTS)



4.6 EXTERNAL ENVIRONMENT

The 'External' environment refers to the area outside the toilet itself and is not related to the use of toilets by respondents. It can include living areas, public areas and private land, which can all be affected by open defecation practices and unimproved toilets. The consequences of water pollution have already been covered in section 4.2. The sources of data are mainly the ESI surveys: the physical location survey, household interviews, and FGD. These data sources have been assessed comprehensively to understand the contribution of each poor sanitation practice to the pollution of the external environment, and preferences regarding their improvement.

The solid waste management practices reflected in the household survey have been investigated to assess the different ways people treat organic waste. Figure 25 shows the main disposal practices for organic waste among populations in different field locations. People in the Rural North often give organic waste to the animals they raise, while most people in the Urban North give it away, which reflects the income generating activities in each area (people in the Rural North sites practice husbandry, while people in the Urban North sites earn their living through business and monthly salaries).

However, other urban areas apart from those in the Urban North also give organic waste to animals. The explanation for this is that Dong Thap (U1) and Tam Ky (U2) are cities in Urban Central and Southern areas, containing many households making an income from husbandry.

FIGURE 25: HOW PEOPLE DISPOSE OF ORGANIC WASTE (% OF RESPONDENTS)

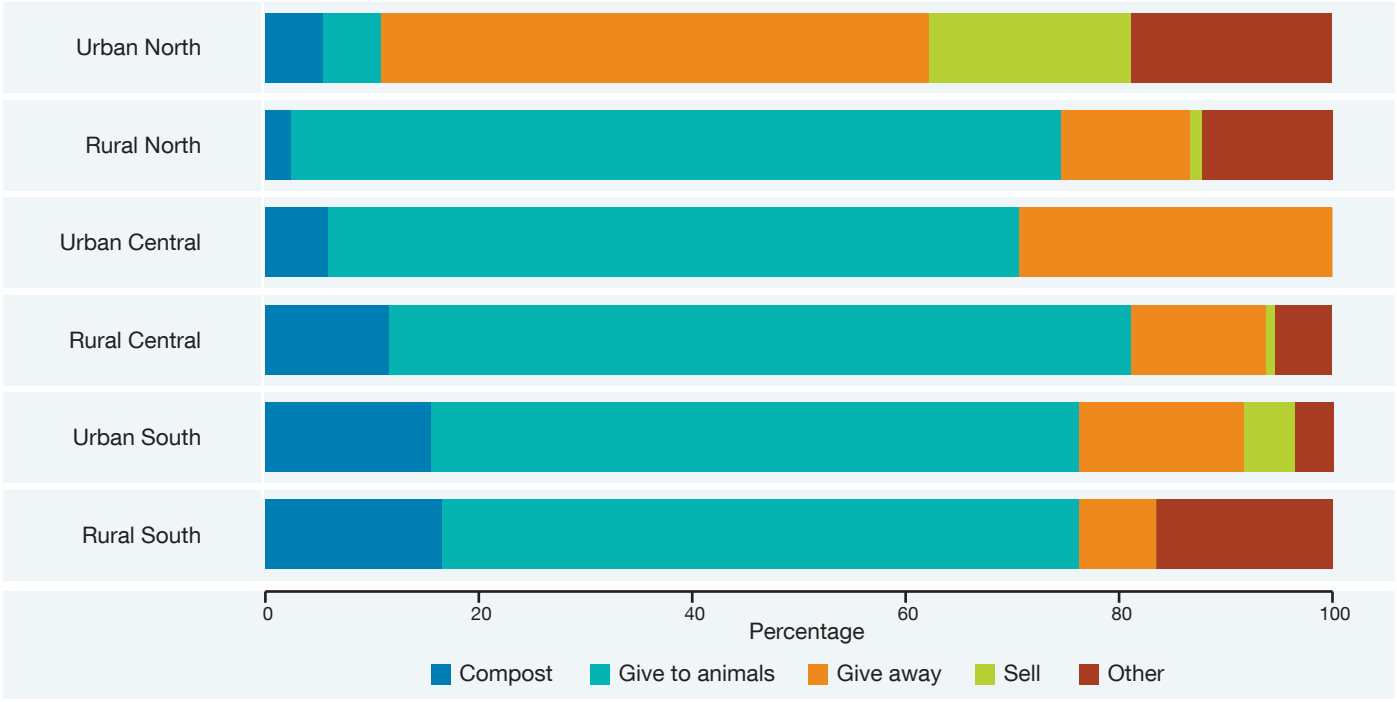
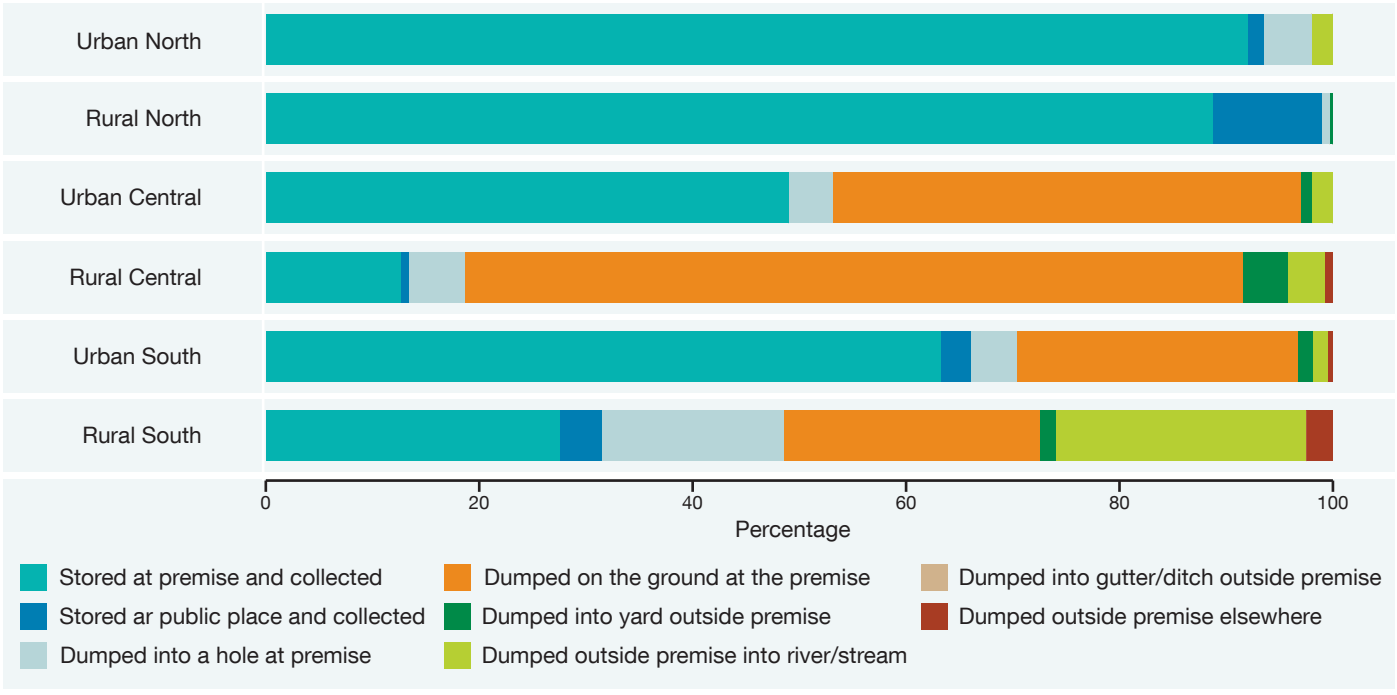


FIGURE 26: HOW PEOPLE DISPOSE OF SOLID (INORGANIC) WASTE (% OF RESPONDENTS)



Garbage collection has been in operation in northern survey sites for many years, with some 90% of households receiving this public service in both urban and rural sites (see Figure 26). There was general acknowledgement in FGDs of the positive impacts of garbage collection. However, there remain some difficulties in the Rural North sites, which have old and inadequate facilities, and in the Urban North sites, where there are problems with bad odors from overloaded garbage containers.

In the Central and Southern regions, the situation is different as solid waste is commonly dumped. This means that

there may be areas with or without a garbage collection service, or that people are not willing to use the service. For example, the FGDs showed that there is no garbage collection system in Hue (R9). Almost all households throw garbage into their gardens, then burn or bury it when the gardens are full. Solid waste in public areas is collected only on holidays, then burned or buried. In the case of Quang Nam (R5), although garbage collection exists, it is conducted only once per week, so garbage is kept inside houses or piled in the market area, polluting the environment. Some other kinds of refuse such as dead animals and plastic bags are thrown into village lakes. In the case of Dong Thap (U1), a garbage collection service exists, but only households living in the main streets use it.

The household survey found that the problem of animal excreta is still relevant in both urban and rural areas. Almost every interviewee acknowledged its presence around their homes. The problem seems to be more evident in both the Urban and Rural North sites (Figure 27).

FIGURE 27: ANIMAL EXCRETA AROUND THE LIVING AREA (% OF RESPONDENTS)

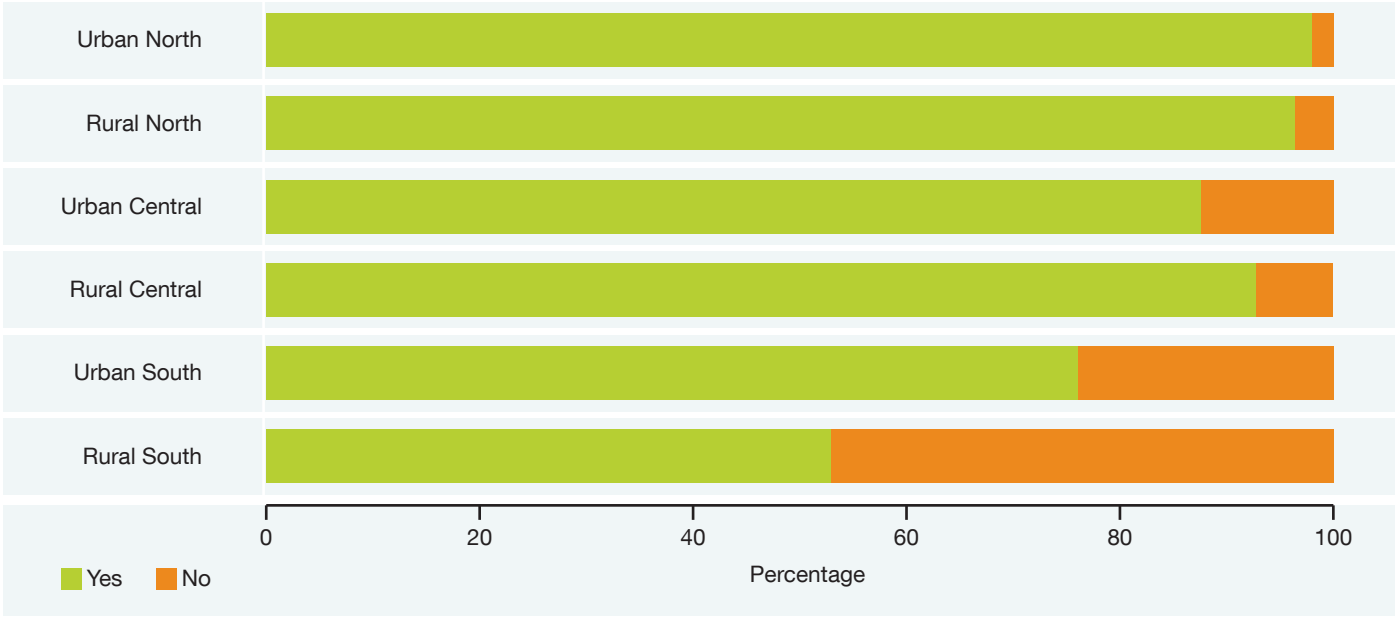


FIGURE 28: PROPORTION OF HOUSEHOLDS WITH IMPROVED TOILET BUT UNIMPROVED SANITATION PRACTICES (%)

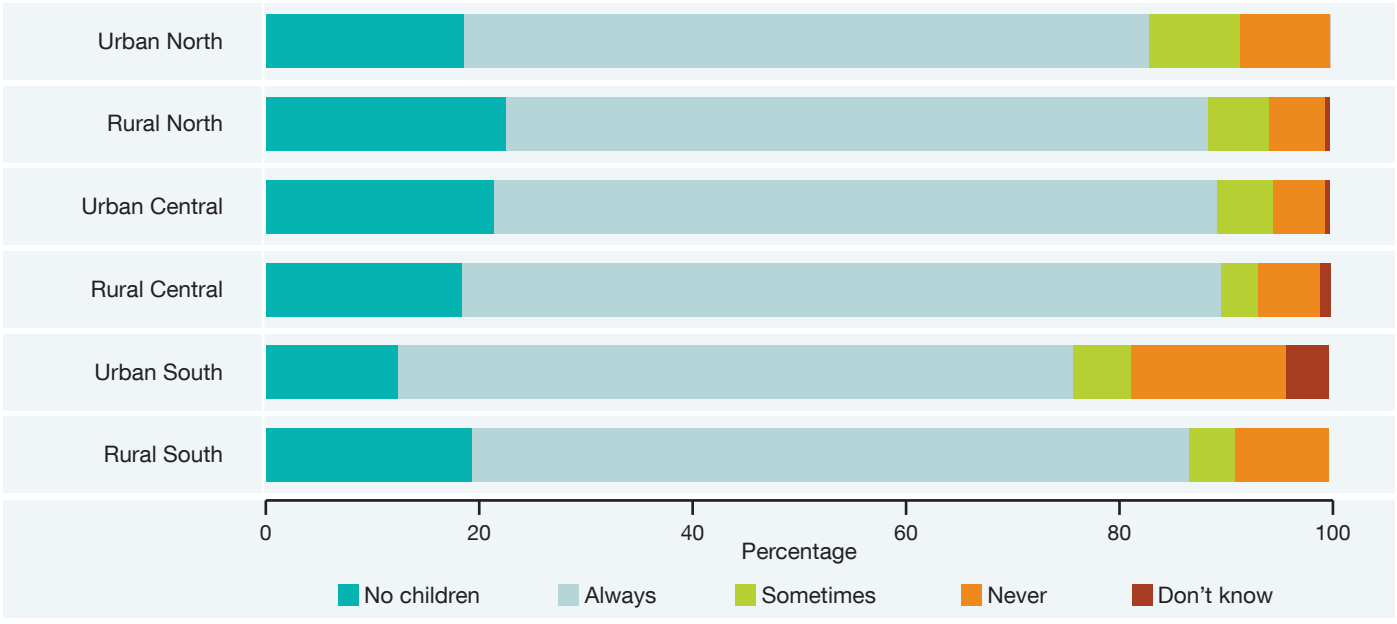


Figure 28 shows the percentage of families with a toilet but who still practice OD and open urination, and who dispose of young children's excreta into the environment (put in a drain/ditch, thrown in the garbage, buried or left in the open). More than 10% of households with children "sometimes" or "never" use their toilets. As shown in the household survey, that number includes the children who may practice OD and open urination at school, and boys who may practice open urination elsewhere.

In the Northern sites, and in urban sites of the Central region, open defecation exists despite the high rate of 100% households using toilets (including private and shared toilets), shown in Figure 29. This can be explained by the negative attitude and behavior shown by people toward keeping common places clean. The data show that open defecation is more popular in the Urban North than the Rural North. However, when challenging people in the Urban North and South about this result, they laugh and explain "human excreta is easier to be seen in streets than in bushes and rivers" (FGD).

The study examined the frequency with which septic tanks and pit latrines are emptied. About 90% of septic tank toilets in the survey were older than 2 years. However, only 4.4% had been emptied once, and 0.55% had been emptied twice. Among the households emptying toilets, 21% used the service designated "tanker truck to unknown location", 5.3% emptied their toilets in a river, stream, pond, canal or other water body, and the rest did not know exactly where their toilets were emptied (the case in Lai Xa – R7).

FGDs show that in most urban and rural areas, black wastewater from septic tanks, together with untreated gray wastewater, goes directly into the combined drainage, spoiling the environment with a bad odor. The situation is the same both for households benefiting and households not benefiting from a community wastewater treatment station. People do acknowledge the benefit of a station that accumulates and treats village wastewater in one place. However, households living close to a station have to suffer from bad odors, and villages are still polluted by overflow wastewater from the station. At sites with centralized treatment systems, such as Hai Phong (U3), Quang Ninh (U4) and Dak Lak (U7), people complain about the bad smell coming from the stations. They do not know for certain, but still accuse the stations as the cause of environmental pollution to both the water and air.

Regarding the state of environmental sanitation, people throughout the sites give relatively high and analogous scores to all criteria (see Figure 30). Of the six regions areas, the Rural North, Urban Central and Urban South give a lower score, equivalent to 3.2-3.5, while the others give scores of about 4.2-4.5.

FIGURE 29: OPEN DEFECATION PRACTICE BY LOCATION OF FIELD SITE (% OF RESPONDENTS)

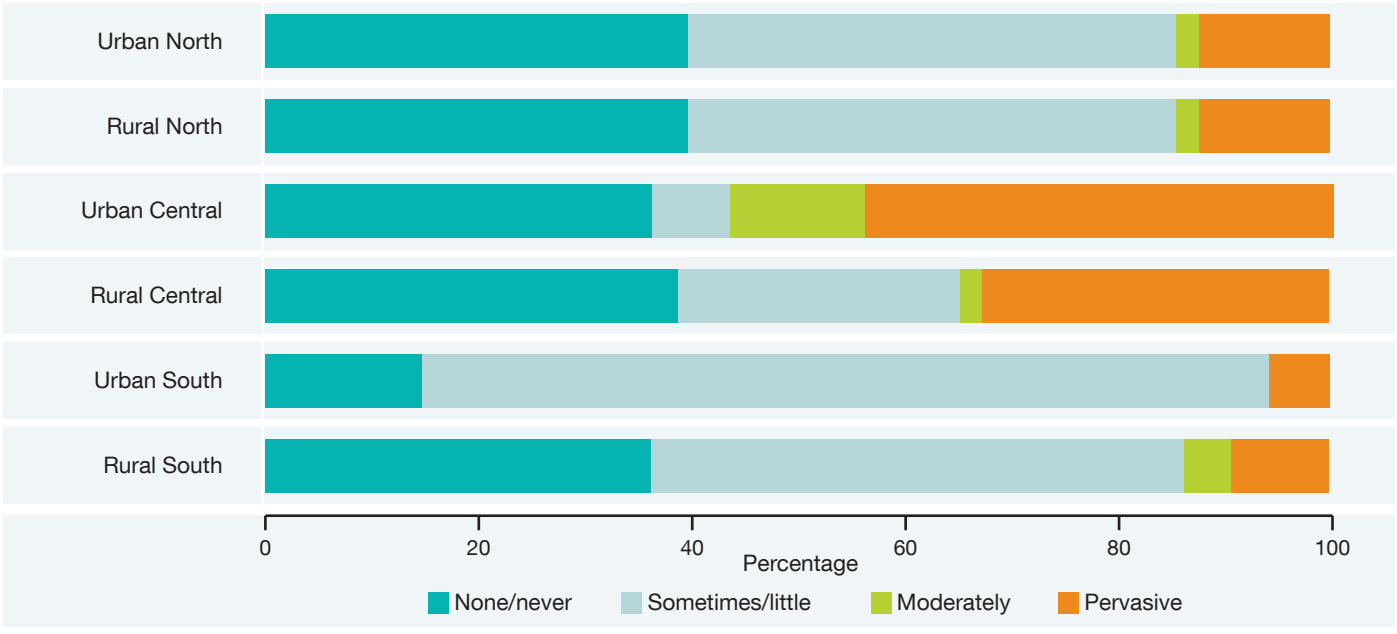
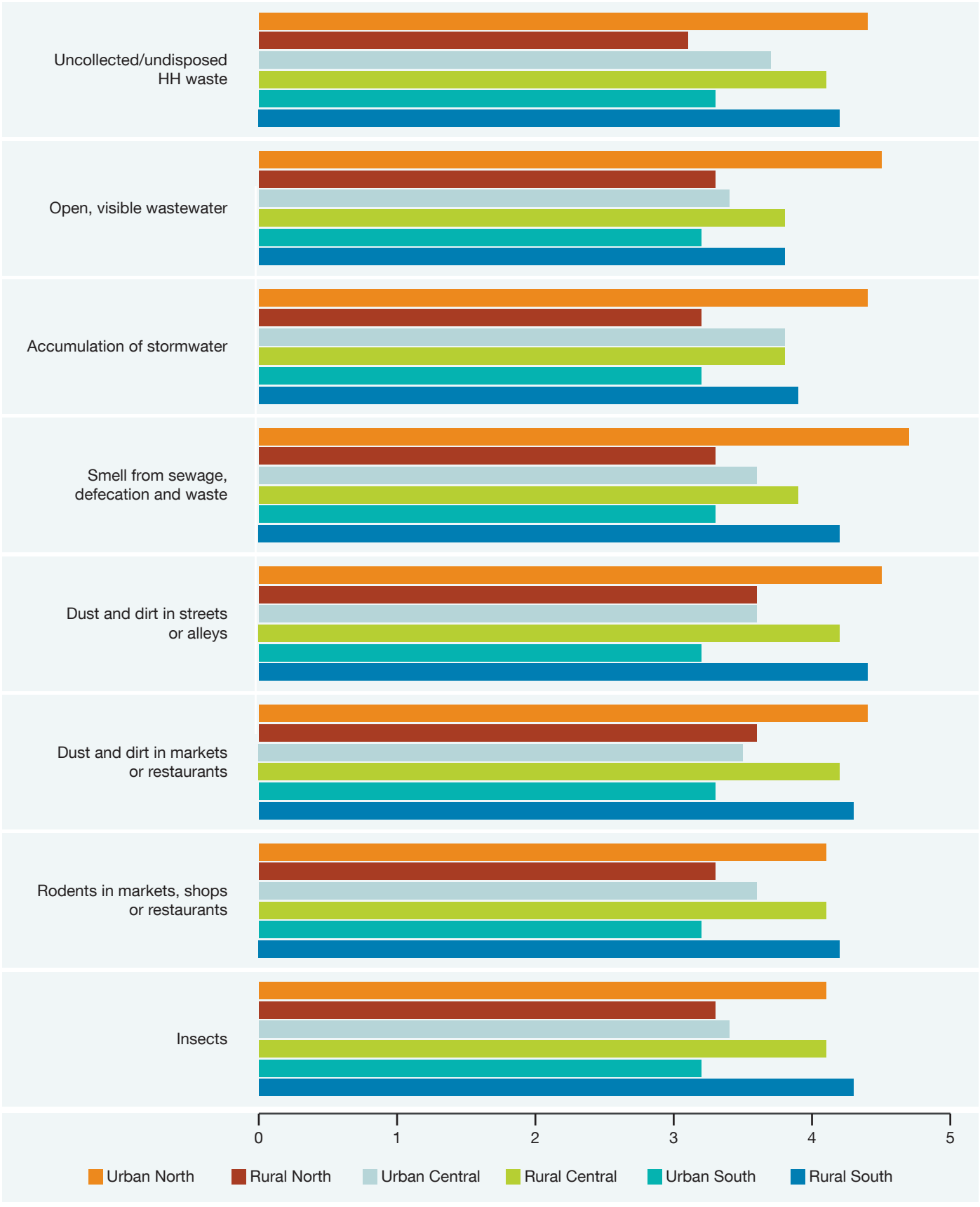


FIGURE 30: PERCEPTIONS OF THE STATE OF ENVIRONMENTAL SANITATION, BY OPTION TYPE (1 = VERY BAD; 5 = VERY GOOD)



There is almost no difference between the regions when it comes to opinions on the importance of environmental sanitation (see Figure 31). This could be explained in several ways: respondents honestly assess these criteria highly and equally; respondents are uncritical when providing their scores; or interviewers have not clearly explained the meaning of each criterion. From the FGDs, it is obvious that people see the importance of all these criteria, but that they are not sure about the different weighting they should place on each.

FIGURE 31: IMPORTANCE OF ENVIRONMENTAL SANITATION STATE, BY OPTION TYPE (1 = VERY BAD, 5 = VERY GOOD)

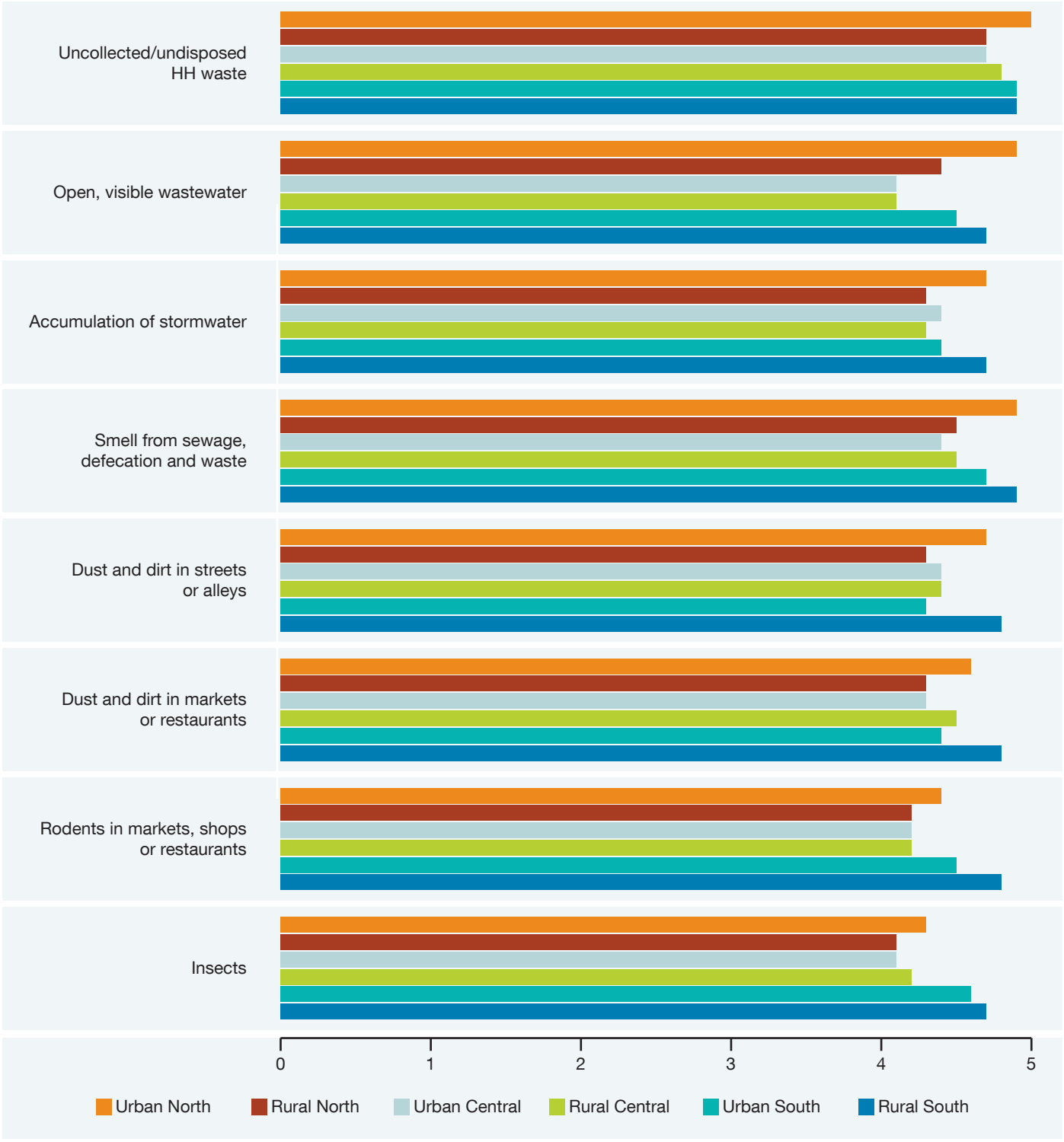
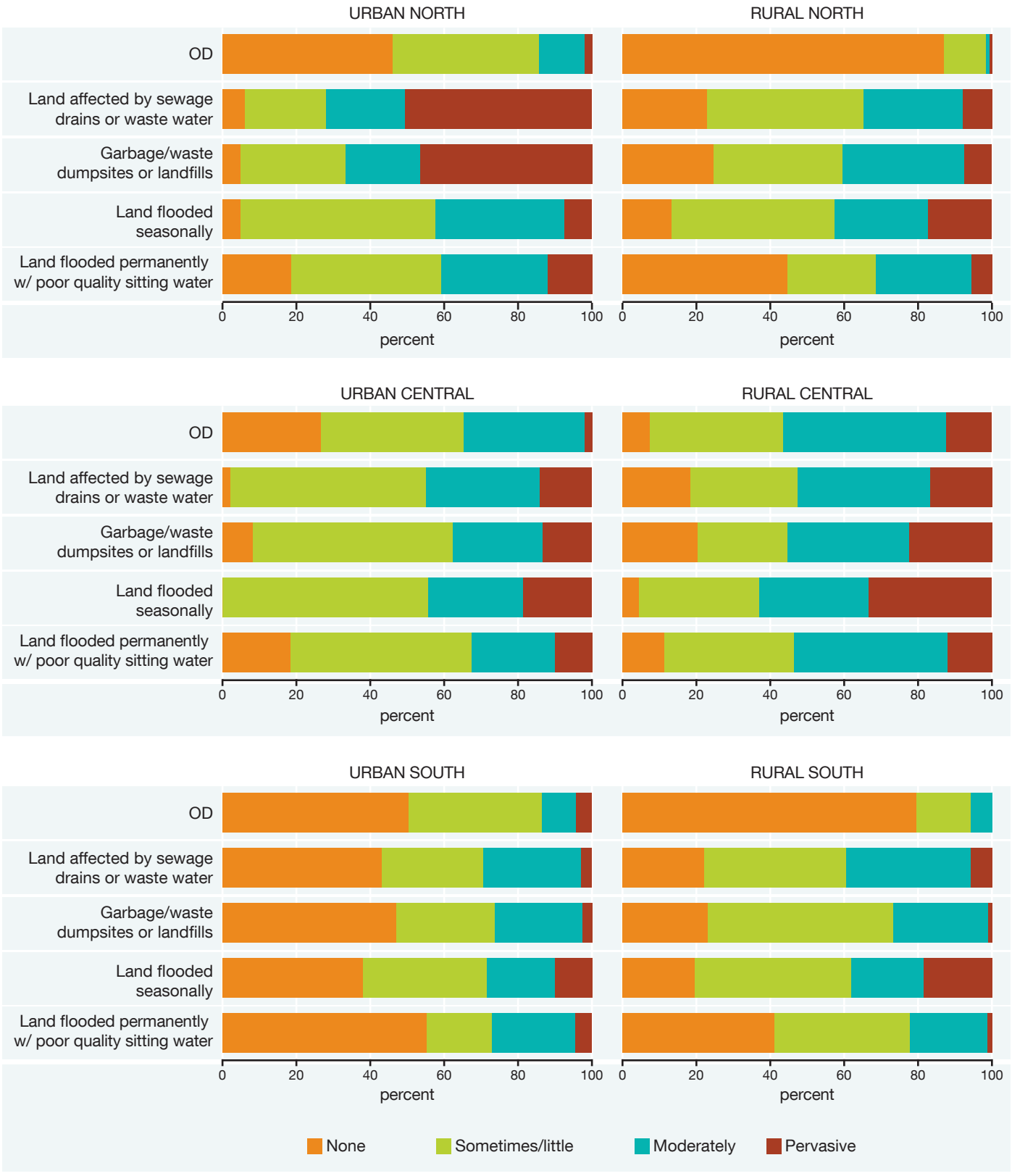


FIGURE 32: DEFECATION AND SOLID WASTE MANAGEMENT PRACTICES AND PERCEPTIONS (FROM HOUSEHOLD INTERVIEWS)



Flooded land, garbage dumpsites and land affected by wastewater are all issues that are relevant to both the Rural and Urban Northern field sites (see Figure 32). Open defecation and garbage dumpsites, and especially flooded land, are common – even pervasive – in the Central Vietnamese field sites. In the South, it seems that these issues do exist, but they are not as urgent as in the Central and the North. However, seasonally flooded land needs to be taken into account.

More than 90% of households think that the government should make solid waste management "somewhat of a priority" or a "high priority" throughout the regions (see Figure 33).

4.7 SUMMARY OF LOCAL BENEFITS

Table 37 presents a summary of poor sanitation and improved sanitation impacts, by benefit.

FIGURE 33: HOUSEHOLDER VIEWS ON WHETHER GOVERNMENT SHOULD MAKE SWM A PRIORITY (%)

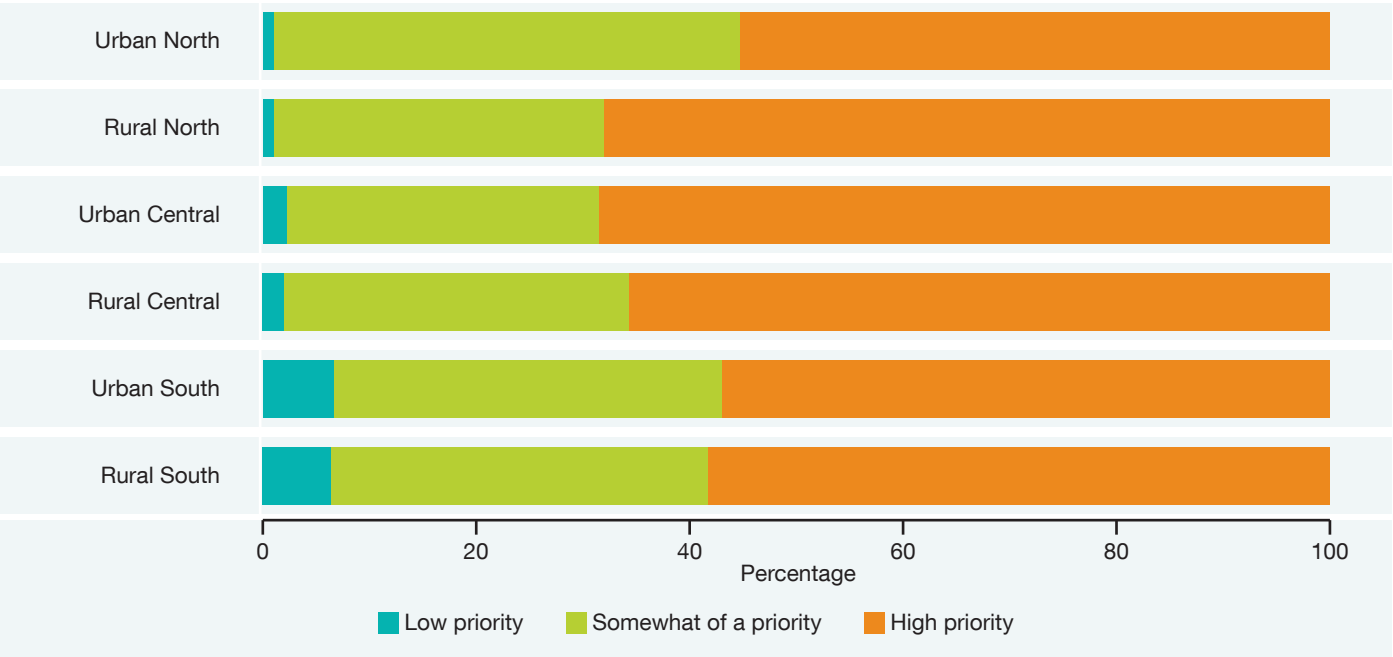


TABLE 37: SUMMARY OF LOCAL IMPACTS OF SANITATION IMPROVEMENT

Benefit	Value of improved sanitation and hygiene		
	Monetized benefit (VND '000 per household per year)		Qualitative Benefit
	Urban	Rural	
Health			• Avoided pain and discomfort because of illness • Avoided lost productivity from a worker who reports for work despite illness • Avoided costs from other diseases associated with poor sanitation
Health burden/quality of life	n.c	n.c	
Health care			
OD to Basic	159	169	
OD to Sewerage	208	212	
Productivity			
OD to Basic	54	58	
OD to Sewerage	70	72	
Mortality			
OD to Basic	2,235	2,379	
OD to Sewerage	2,928	2,968	
Water			• Improved water quality (smell, appearance, lower contaminants, etc.) for drinking, domestic purposes, recreation and other purposes
Overall quality	n.c	n.c	
Savings from access costs	476	413	
Savings from treatment costs	2,658	2,973	
Access time	2,487	1,686	• Avoided discomfort from having to wait in a queue • Time loss associated with urination
Intangibles	n.c	n.c	• Comfort associated with the use of clean toilets • Pride in having a toilet or an expensive and fancy toilet • Privacy • Safety of women and children • Confidence associated with inviting guests to the house • Not being seen going to the toilet
External environment	n.c	n.c	• Cleaner surrounding areas • Less exposure to insects and rodents
Reuse	n.c	980	• Biogas, slurry and other uses of human excreta and urine

Note: n.c. = not calculated.

V. National Benefits of Improved Sanitation and Hygiene

This chapter presents the potential impacts of improved sanitation on:

- Tourism (section 5.1)
- Businesses and foreign investment (section 5.2)
- Sanitation markets (section 5.3)
- National water resources (section 5.5)

5.1 TOURISM

According to Vietnam Tourism statistics, tourism in Vietnam has seen a remarkable growth in the past decade. From 1998 to 2008, tourist arrivals increased by 286%. In 2008, tourism contributed US$3 billion in revenue to the economy of Vietnam, which is equivalent to 4.2% of the country's GDP (using the market exchange rate).

Table 38 compares tourism numbers in 2008 and 2009, which shows an 11% decline due to the global economic downturn and the H1N1 virus in April 2009 (Vietnam National Administration of Tourism). Asian tourists account for more than 65% of the total number visiting Vietnam, with tourists from China, South Korea, Taiwan and Japan making up the top four arrivals from Asian countries. In 2008, Europe and North America accounted for 15% and 13% of tourist arrivals, respectively (General Statistics Office).

TABLE 38: OVERVIEW OF VISITORS TO VIETNAM IN 2009 AND 2008

Variable	2009	2009 compared to 2008 (%)
Total tourists	**3,772,359**	**89.1%**
TRANSPORTATION MEANS		
Air	3,025,625	92.2%
Sea	65,934	43.5%
Road	680,800	85.0%
ACCORDING TO PURPOSE		
Tourist	2,226,440	85.2%
Business	783,139	99.8%
Visiting friends	517,703	101.4%
Others	245,077	91.4%
ACCORDING TO NATIONALITY		
China	527,610	82.0%
U.S.A	403,930	97.4%
South Korea	362,115	80.6%
Japan	359,231	91.4%
Taiwan (China)	271,643	89.6%
Australia	218,461	93.1%
France	174,525	95.9%
Malaysia	166,284	95.3%
Thailand	152,633	83.7%
Others	1,135,927	90.3%

Source: General Statistics Office, 2009

While this chapter reports the results from a survey conducted under ESI, another similar survey conducted in 2005 is noted briefly. As part of a survey of 8,300 tourists on their perceptions of environment, sanitation and health, it was found that 74% considered Vietnam's environment to be clean and beautiful and 66% of respondents said that they were satisfied with the sanitation facility in their accommodation (Source: GSO, 2006).

Table 39 presents the background characteristics of tourist respondents from the ESI survey. Among 300 tourists interviewed, the highest percentage was visitors from North America and Europe (49%), Australia and New Zealand (15%). However, Asian tourists are coming back to the country more often (making 2.4 previous trips), and staying for longer periods (130 days). This is because Vietnam receives more businessmen and workers from Asian countries who may combine their business trip with tourism activities, while a greater proportion of visitors from other regions come to Vietnam purely as tourists. Tourists prefer to visit more than two places (62% – 71% among tourists from Asia, Australia and New Zealand, North America).

Table 40 describes tourists' assessment of tourist locations. General scores of 3 to 5 reflect a positive attitude toward Vietnam. The highest scores are for historical/temple sites (4.0) and natural/forest sites (4.1). Most scores are similar among tourists across different hotel cost brackets, traveling within Vietnam attracted high scores (4.0 and 4.1) from tourists staying at hotels in the US$1-29 and US$150+ cost brackets. A possible reason for this is that tourists living in $1-29 hotels are mostly backpackers who do not consider comfort the most important factor of a good trip, while tourists living in $150+ hotels are provided with luxury services and may not face many instances of poor sanitation and hygiene when traveling in Vietnam. For those few tourists who gave a low score of 1 or 2, the main reasons included traffic jams, no fixed price for foreigners, garbage everywhere, irresponsible public security (police), dangerous road crossings and air pollution.

TABLE 39: BACKGROUND CHARACTERISTICS OF RESPONDENTS

Variable		Asia	Australia/NZ	North America and Europe	South America	Total
No. of tourists interviewed		76	45	146	33	300
Average no. of previous trips to country (times)		2.4	0.8	1.6	0.2	1.5
Average length of stay of this trip (days)		129.6	20.2	40.3	0.6	58.6
All figures in Percentage (%)						
Gender (%)	Male	52.6	42.2	61.0	39.4	53.7
	Female	47.4	57.8	39.0	60.6	46.3
Purpose of visit (%)	Tourist	48.7	77.8	78.1	100.0	73.0
	Business	51.3	22.2	21.9	0	27.0
Hotel bracket (%) (nightly tariff in US$)	Free					
	1-29	34.2	46.7	45.9	3.0	38.3
	30-59	19.7	35.6	32.2	3.0	26.3
	60-89	18.4	0	8.2	0	8.7
	90-119	21.1	11.1	8.2	0	11.0
	120-149	5.3	2.2	3.4	3.0	3.7
	150 +	1.3	4.4	2.0	90.9	12.0
	Total	100	100	100	100	100
Places visited	North	32.9	15.6	18.5	0	19.7
	Central	0	0	2.7	0	1.3
	South	5.3	13.3	11.0	63.6	15.7
	> 1 place	61.8	71.1	67.8	36.4	63.3
	Total	100	100	100	100	100

Table 41 shows that the highest proportion of tourists give a score of 3 ("average") followed by 2 ("poor") to sanitation in Vietnam. The exceptions are Australians and New Zealanders, for whom the second rank is 4 ("good") and South Americans for whom the first rank is 2 ("poor"). All tourists living in hotel bracket $150+ gave scores of 1 or 2 ("very good" and "good"). This result first seems to be positive, but it is not very useful, since this category of tourists receive a high standard of service at their hotels and restaurants, and do not experience bus station or public toilets.

TABLE 40: SCORES PER TOURIST LOCATION ACCORDING TO HOTEL COST LEVELS AND PURPOSE OF VISIT (SCORE: 5 = VERY HIGH; 1 = VERY LOW)

Nightly hotel cost (bracket)	Average score						
	Hanoi	Historical/ temple sites	Beaches	Natural or forest sites	Traveling within Vietnam	Other 1 (traffic in cities)	Other 2 (city life)
Difference according to hotel cost bracket (US$)							
1-29	3.9	3.8	3.7	4.1	4.0	3.8	3.0
30-59	3.8	4.1	3.7	4.2	3.6	2.7	4.2
60-89	3.8	3.7	3.7	3.9	3.6	4	4
90-119	4.0	4.1	3.7	4.3	3.1	1.8	2.5
120-149	3.7	4.1	4.2	3.8	3.3	2.8	3
150 +	4	4.3	3	4.2	4.1	4.8	4
Average (all)	**3.9**	**4.0**	**3.7**	**4.1**	**3.7**	**3.5**	**3.5**
Difference according to purpose of visit							
Tourist	4.0	4.0	3.8	4.2	3.8	3.8	3.8
Business	3.6	4	3.6	3.9	3.4	2.7	3.0

TABLE 41: GENERAL SANITARY EXPERIENCE (SCORE: 5 = VERY GOOD; 1 = VERY POOR)

General sanitary experience (%)	Asia	Australia/NZ	North America & Europe	South America	Total
1	5.3	2.2	5.5	15.1	6.0
2	25.0	17.8	30.8	69.7	31.7
3	51.3	40.0	37.0	9.1	38.0
4	13.2	31.1	19.9	3.0	18.0
5	5.3	8.9	6.8	3.0	6.3
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

TABLE 42: SANITARY EXPERIENCE OF TOILETS AND HAND WASHING (SCORE: 5 = VERY GOOD; 1 = VERY POOR)

Sanitation and toilet	Score (% respondents)					
	1	2	3	4	5	No answer
In hotel	0.7	1.7	16.3	40.7	37.7	3.0
In restaurant	1.3	10.7	37.0	32.3	12.3	6.3
At airport	1.3	10.0	28.3	29.3	19.7	11.3
At bus stations	15.3	25.0	14.7	6.0	1.0	38.0
Public toilets	30.0	27.7	12.3	4.7	1.0	24.3

FIGURE 34: WHAT FACTORS WERE OF MOST CONCERN? (THREE RESPONSES PER RESPONDENT)

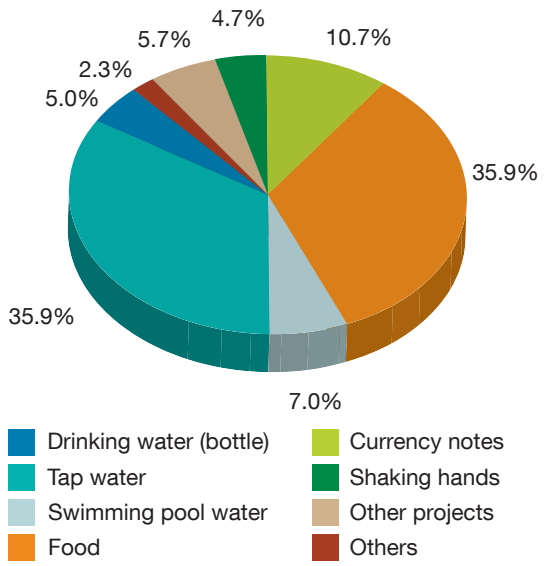


Table 42 reports tourists' sanitary experience of sanitation in relation to public places. Almost 58% of respondents gave a low score of 1 or 2 to public toilets and 40% gave a low score of 1 or 2 to toilets at bus stations. The number of respondents giving no answer is also high, probably because they did not use toilets in these locations. Toilets at airports and restaurants received around 10% of low scores 1 and 2. Tourists complained most about a lack of toilet paper and soap.

Most (70%) tourists are most concerned about catching a diarrheal illness from tap water and food (see Figure 34). This is reflected in their perceptions of what has caused them to have diarrhea, with 33% and 69% citing water and food, respectively (see Figure 35).

Despite the sometimes poor sanitary conditions, and the threat of diarrhea, Figure 36 shows that tourists are willing to return to Vietnam with a majority 74% responding "yes". Among those tourists' who state 'may be' or who are 'hesitant' to return (18%), 13% state poor sanitation as a major or contributory reason (see Figure 37). In general, tourists find it difficult to think of a reason for not coming back to Vietnam. This shows that while poor sanitation is a general issue that needs to be tackled to make tourists' stays more enjoyable, it is not a defining issue for tourists in terms of enjoyment of their stay or a reason to stop the majority from returning.

FIGURE 35: CAUSES OF TOURISTS' CATCHING DIARRHEA, PERCEIVED BY RESPONDENT

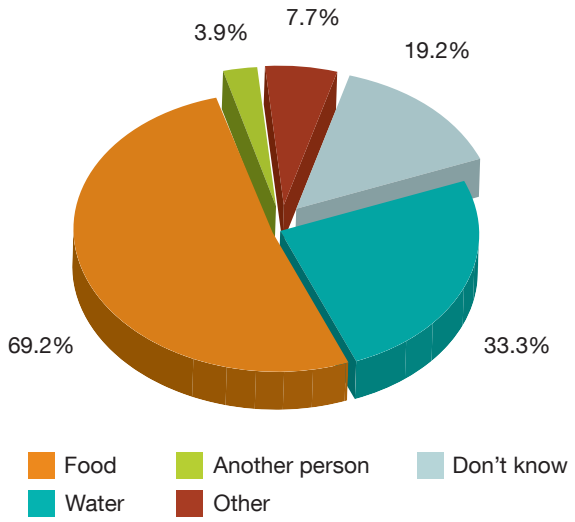


FIGURE 36: TOURISTS' INTENTION TO RETURN TO VIETNAM

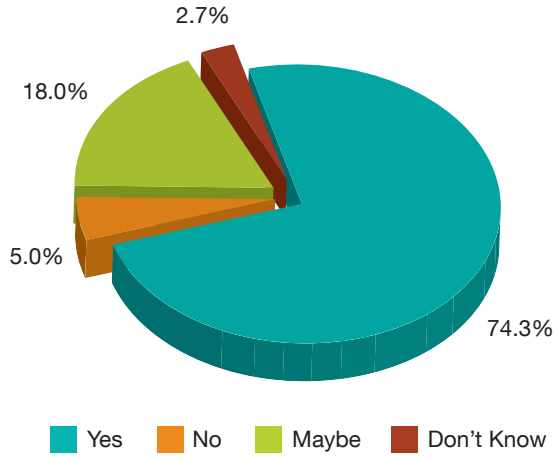
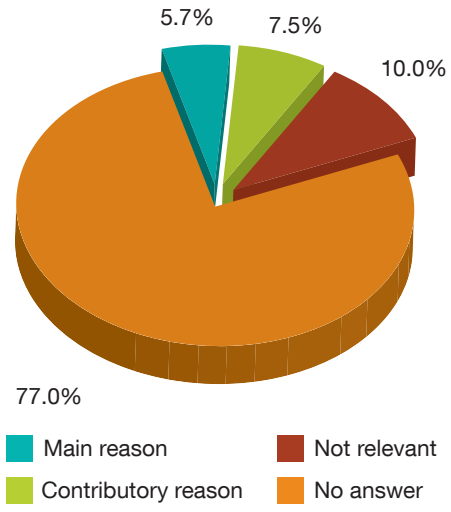


FIGURE 37: REASONS FOR TOURISTS' HESITANCY TO RETURN TO VIETNAM



5.2 BUSINESS AND FOREIGN DIRECT INVESTMENT

The business surveys were conducted by sending survey questionnaires to 22 companies working in different fields including: hotel, food, brewery and drinks, green building consultancy, civil engineering consultancy, pharmacy, aviation, real estates and insurance. The questionnaires were prepared in both Vietnamese and English and sent out by both regular post and email to senior contact points in the firms, and later followed up by telephone. However, the response to the survey forms was very limited (7 from 22) (see Table 43). Possible reasons for such a low response include: (1) no direct relevance of a water and sanitation issue to their business; (2) not enough time for the firms to work on the forms; (3) limited responsibility and understanding of the firm leaders/staff regarding the issues; (4) complexity of the survey form.

Figure 38 indicates very different responses in terms of evaluating the importance of environmental sanitation in selecting a location for the firm, **depending on their type of business**. The hotel business placed most importance on environmental sanitation conditions, giving the highest ranking scored for all criteria.

Firms working in other fields such as brewing consider the quality of water resources as the most important criteria for selecting a location, since the quality of beverage products very much depend on water sources. Polluted sources would increase treatment expenses significantly, affect production technology, and reduce customer loyalty, thus reducing market competitiveness.

Firms working in the consumer goods business have selected Vietnam for doing business because of the population size, the current and potential size of market for their products, and the GDP growth. An important factor for companies to select the specific location of their business is reliability of water source. Besides, some other firms refer to other criteria such as local population density and access to main roads and ports.

Consulting firms prefer to select a location where their staff can experience a pleasant environment, which should increase competitiveness. This may explain why the environment scores highest with these firms, above water quality and health.

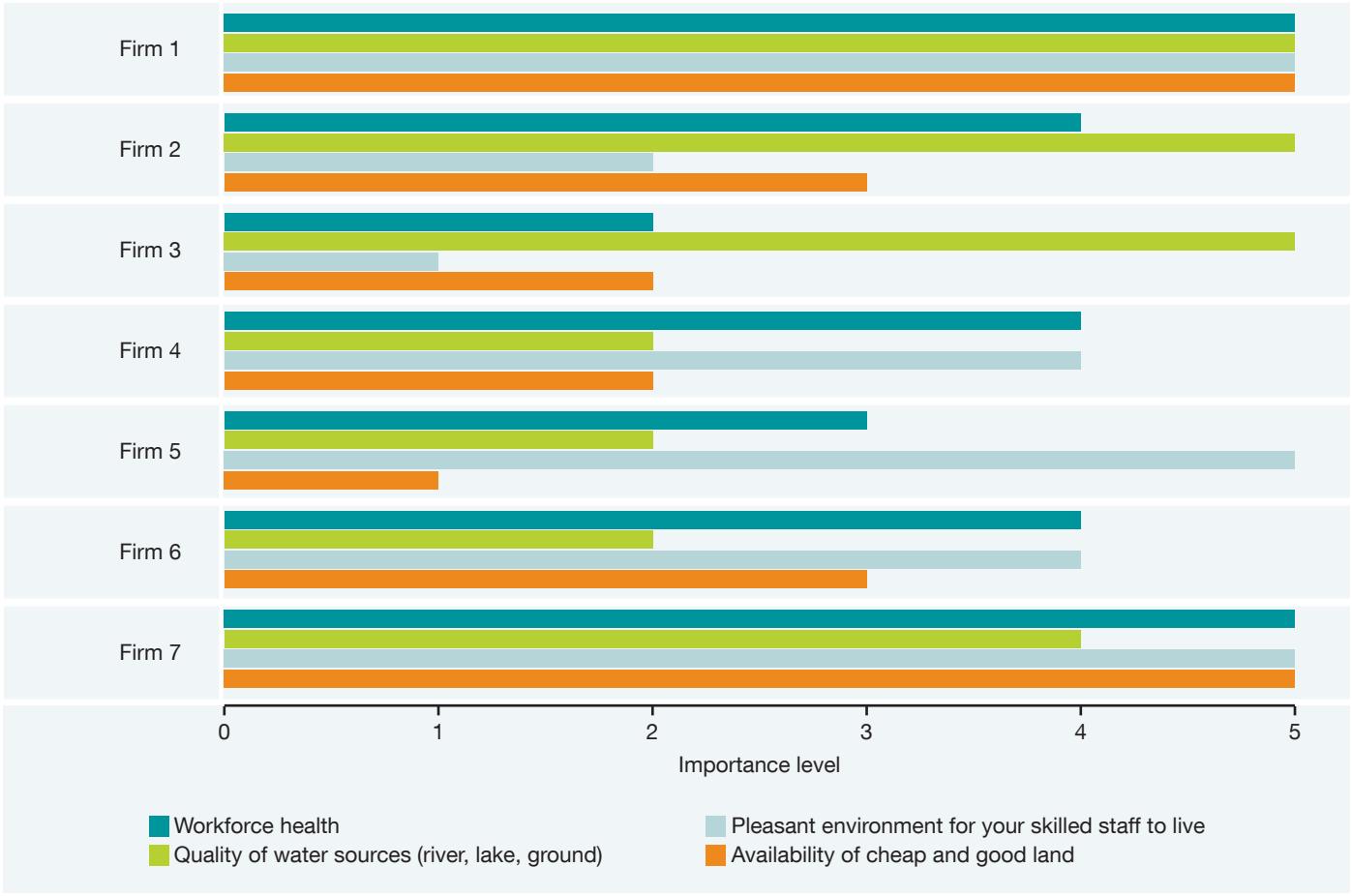
These firms base their location decision on market opportunity.

As with beverage firms, the firm manufacturing pumps and wastewater equipment in workshops gave higher scores for 'workforce health', 'water quality', and 'land quality'.

TABLE 43: SAMPLE SIZE OF BUSINESS SURVEY, BY MAIN SECTORS OF LOCAL AND FOREIGN FIRMS

Main business of firm	Local business	Foreign firm	Number sent	Number replied	Identifier
Hotel	1	1	2	1	Firm 1
Aviation		2	2	0	-
Real estate		1	1	0	-
Food and drink producer		7	7	2	Firm 2, 3
Pharmacy		2	2	0	-
Tourism	2		2	0	-
Soap and domestic goods		1	1	0	-
Green civil engineering and architecture	1		1	1	Firm 4
Development and cooperation consultancy		2	2	2	Firm 5, 6
Life, health and other insurance		1	1	0	-
Pump and wastewater equipment		1	1	1	Firm 7
Total			**22**	**7**	**-**

FIGURE 38: IMPORTANCE OF ENVIRONMENTAL SANITATION CONDITIONS FOR LOCATING THE COMPANY (1 = UNIMPORTANT; 5 = IMPORTANT)



Firms chose sites in Southern Vietnam because they considered them as having a large potential market, and because this region seems more market oriented than others in Vietnam.

Table 44 presents feedback from firms responding about the costs of doing business in Vietnam. All firms gave the impact of workforce health on business a score of 3, apart from hotel businesses, which gave a score of 5. As they have direct contact with customers, hotel staff have to be healthy. Hotels also treat their own water before it is supplied to the hotel rooms. The other firms considered workforce health and local environment as of medium importance for doing business (production). Beverage companies said that the existence of poor quality water sources in other areas is even better for their business. For example, a surveyed purified water producer would sell more bottled water to residential areas where the population could not use tap water or water from the poor water source for the domestic purposes.

In its responses, the hotel firm said it would expand their business in Vietnam thanks to improved sanitation. This is highly relevant to the findings of the tourism survey, which showed sanitation improvement would positively affect the number of tourists to come to and to return to the country, which would certainly improve hotel business. However, the hotel expressed concern that environmental regulations and standards would become stricter. With a fixed building structure, they would have some difficulties in building and operating a wastewater treatment plant to achieve higher environmental effluent standards. Therefore, cooperation among local authorities and firms should be considered for better environmental management and pollution control.

TABLE 44: COSTS OF DOING BUSINESS: PRODUCTION

Variable: Firms saying that…	No. with response	Sectors			
		Hotel	Beverage	Civil engineering	Consultancy
Health					
Poor workforce health affects their business (average score) (1 = unimportant; 5 = important)	6	5	3	3	3
Water					
Poor water quality affects their business (1 = unimportant; 5 = important)	6	5	5	2	2
They treat their own water	6	5	Yes	No	No
Poor local environment (1 = unimportant; 5 = important)	6	5	3	3	2
Affects customers	6	5	3	3	2
Affects current workers	6	5	3	3	2
Affects staff recruitment	6	5	3	3	2
Other aspects					
Considered moving production facilities to industrial parks	6	Not relevant	No	No	No

TABLE 45: COSTS OF DOING BUSINESS: SALES

Variable: Firms who say that…	No. with response	Sectors				
		Hotel	Beverage	Civil engineering	Consultancy	Pump and equipment
The location of sales office affects business (1 = unimportant; 5 = important)	7	5	2	3	3	3
Main measures taken to deal with poor environment	7	Internal measures	Internal measures	N/A	N/A	N/A
Considered moving sales outlets to other parts of town	7	No	No	No	No	No
If no, why not	7	Fixed building	N/A	N/A	N/A	N/A

N/A – not available (no responses)

Sanitation improvement means more business opportunities for firms in Vietnam dealing in pumping and water, wastewater equipment, and water and sanitation consultancy.

Consultancy firms did not cite a link between improved sanitation and expanding their business, since their activities are limited by the size of the market. However, respondents stated that if the environmental sanitation status were improved, they could expand their activities to include other products not directly related to their current core business. Sanitation improvement would lead to more business opportunities for firms in Vietnam. The firms surveyed stated that they would be happy to pay more for better environmental sanitation.

The responses of beverage companies on location focused on market factors, such as GDP growth and other market potential. Although these firms confirmed the importance of having clean water supply for beer and other drink production, they said they would expand their business in Vietnam anyway. They also said improved sanitation standards and regulations would not adversely affect their business in the country.

The following general conclusions can be made from the business survey. First, firms assigned different levels of importance to the environmental sanitation situation. The hotel business considered environmental sanitation conditions to be most important for all criteria: workforce health, water quality from sources, pleasant environment for the staff to live, and availability of cheap and good land. The quality of water sources is considered the most important criterion for firms working in beverage production and consumer goods. Consulting firms prefer to select a location where their staff can experience a pleasant environment, which should increase competitiveness. Sanitation improvement means more business opportunities for almost all of the firms.

5.3 SANITATION MARKET

Wherever it is used as fertilizer, the availability of nutrients from human excreta can lead to the replacement of chemical fertilizer, which saves costs (Werner C. et al, 2003). Furthermore, where fertilizer was not previously being used optimally, the nutritional content and economic value of crops may increase. Moreover, there are long-term benefits to reducing the use of chemical and mineral fertilizers, especially taking into account the fact that some fossil resources are in increasingly short supply (e.g. phosphorous - see Box 6). Alternatively, families with livestock may invest in a biogas digester, which provides bio-fuel for cooking, space heating and lighting.

The reuse of human waste for fertilizer or biogas production cannot be assumed to be population-wide, given cultural attitudes towards the handling and reuse of human waste, and low practical feasibility in many locations. Success often depends on local perceptions of the expected returns on re-use of human waste, whether for biogas or fertilizer. The number of households reusing human and animal feces for biogas and fertilizer purposes were determined from the location surveys and FGDs. The study estimated weight of fecal matter and volume of gas produced, and the economic value of these products using local market prices.

Biogas could also bring other benefits to the country. The reduction in greenhouse gas emissions from biogas activities qualifies for 'carbon credits' under the Clean Development Mechanism (CDM) of the United Nations Framework Convention on Climate Change. These credits can be sold on the international market, resulting in revenue for the country. Each biogas tank is equivalent to 2 credits that can be sold at 6 Euro each. According to the biogas project (MARD and SNV), biogas can bring about 1.8 million Euro per year from 150,000 biogas tanks. Table 46 presents a rough estimate of potential reuse values of waste from the whole country as calculated from the ESI-1 study.

TABLE 46: INPUT VALUES FOR ESTIMATION OF RETURNS TO REUSE OF HUMAN (AND ANIMAL) WASTE

Items	Unit	Urban	Rural	Total
Total households (HH)	HHs	5.4 million	13.9 million	19.4 million
% HHs applying Ecosan	%	0.1%	1%	0.75%
Number of HHs applying Ecosan	HHs	5,400	139,200	144,660
Human waste per year	Kg/year	2.2 million	58.3 million	60.5 million
Animal waste per year	Kg/year	0	8.7 billion	8.7 billion
Total waste to be used for biogas	Kg/year	2.2 million	8.8 billion	11.0 billion
% to be used as fertilizer	%	60%	60%	60%
Amount of fertilizer	Kg	1.3 million	5.3 billion	6.6 billion
Volume of gas	Liters	650,000	2,600 million	3,225 million

Source: ESI-1 study (WSP, 2009).

The market for recyclables (the outputs from solid waste) has a large potential for expansion. Some 32% (or 2.1 million tons per year) of municipal waste is currently placed in disposal sites in urban areas in Vietnam. This consists of commercially recyclable materials such as paper, plastic, metal and glass. This additional recycling could result in a substantial reduction in disposal costs and allow the sector to earn considerable additional revenue.

Composting also has high potential in Vietnam, as there is a high proportion of organic matter in municipal wastes. Composting can result in a reduction in disposal costs and the production of a marketable soil conditioner for use in agriculture and home gardening. With the development of a strong market for composting fertilizer and successful source separation, the effectiveness of centralized composting facilities could increase considerably. Composting can also reduce landfill gas emission, which can result in revenue for the country from selling carbon credits under the Clean Development Mechanism (see above).

Another aspect of the sanitation market is that activities in the sanitation sector could create jobs, develop business and contribute a significant input to the government's plans for industrialization and economic modernization. According to the author's estimation, Vietnam will need to invest between US$4 and US16 billion in the sanitation sector to achieve 100% sanitation coverage in all urban and rural areas (Viet-Anh Nguyen, 2007). Such a wide range of required capital shows a difference between the sanitation options applied. The environmental industry in Vietnam is still at an immature stage of development. More than 90% of equipment for water and wastewater engineering systems is still imported. There are numerous opportunities for local enterprises to find a position in this potential market, including in the manufacture of pumps, pipelines, other equipment for water and wastewater systems, pre-fabricated water and wastewater treatment packages, automatization and control systems and devices, and in supporting the operation and maintenance of engineering equipment, spare parts and other products.

There is also a great potential sanitation market for small local enterprises in low-income areas. From 2003 to 2006, a rural pilot project was conducted in Vietnam with technical support from the non-governmental organization (NGO) International Development Enterprises (IDE) and funding from Danish International Development Assistance (DANIDA). The project tested whether a sanitation marketing approach could improve rural access to sanitary toilets in 30 communes in six districts of the coastal central provinces of Thanh Hoa and Quang Nam. The project trained promotion teams consisting of local health workers, VWU leaders and village heads, as well as small providers (shopkeepers, producers and masons). These teams, in turn, promoted sanitary toilets and helped households to build the type of toilets they wanted and could afford. After 3.5 years, over 15,000 households in the pilot area had gained access to a sanitary toilet out of 32,000 households targeted. This number was 2.5 times the increase achieved under a conventional sanitation program conducted in the three preceding years. Average access grew from 16% to 46%.

Three years after the end of the pilot sanitation marketing program, WSP contracted a team to carry out a case study to investigate the sustainability of the rural sanitation marketing approach. The findings have shown that sanitation efforts were continuing in the community, and sanitation marketing has enabled men who worked part-time in sanitation to move out of the agriculture and fishery sectors and obtain better jobs with more career prospects in small-scale enterprises. Thus, rural sanitation marketing has contributed to Vietnam's policy and strategy for rural poverty reduction, albeit without a specific strategy for gender equity in the capacity development of the providers. However, in the long term, the approach used in the pilot study may not be sustained and expanded without further advocacy for a supportive political and administrative environment, institutionalized capacity building for promoters and providers, more regular consumer studies, further development of promotional materials and communication channels, and the design and testing of a specific strategy enabling the poor to install unsubsidized sanitary toilets (Sijbesma C. et al, 2010). These findings serve as important recommendations for future efforts in the sector.

Box 5 presents a new integrated waste management and resource recovery concept in urban areas proposed by a Joint Vietnam/Germany Research Project: Semi-centralized

waste management for Vietnamese cities – a Hanoi case study (Semi-san project, IESE – TUD). It shows that one of the most sustainable models for urban waste management and resource recovery is to apply an integrated waste management concept including centralized or semi-centralized waste collection and treatment systems. The integrated system may include at-source separation of waste, co-treatment of sludge, organic waste and sewage treatment plant sludge for resource recovery through biogas generation, wastewater reclamation, and digested sludge utilization. Utilization of the same urban engineering infrastructure such as wastewater treatment plants helps to reduce investment and operation costs significantly where resource recovery brings more benefits. Furthermore, a public/private partnership (PPP) model is a potential option for overcoming big investment capital challenges.

BOX 5. INTEGRATED WASTE MANAGEMENT AND RESOURCE RECOVERY IN URBAN AREAS – PROPOSAL BY A SEMI-SAN PROJECT (IESE – TUD)

To combat the increasing problem of waste, environmental pollution and public health, new solutions are needed. This project by the Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering, Vietnam and Technical University of Darmstadt (TUD), Germany (2008 – 2010) is proposing a new waste management model in order to enable resource recovery at scale. The main idea is integrated treatment of the different waste fractions: septic tank sludge, sludge from future wastewater treatment plants, and organic waste. The anaerobic digestions system can accept amounts of organic solids and human waste from the cities. Mesophylic digestion by anaerobic microorganisms (at 35 – 37°C) and thermophilic digestion (at 55°C) can be applied. The produced biogas caters for an energy self-sufficient operation of the plants. The digested sludge (residue) is further treated and utilized for hygienically safe fertilizer to improve soil quality, because it contains rich nutrients and organic fibers ideal for plants. Once a sewage network is established in the area, the operation scheme of the anaerobic digestion system is changed to accept sludge produced from the wastewater treatment plants. Thus the existing infrastructure can be continuously used without major additional modification, which saves significant expenditure by the municipality.

Taking into account the limited space in urban districts, the locations for integrated waste management stations are proposed at the locations planned for construction of the wastewater treatment plants. The advantages of this solution are:

- Economical use of land, engineering system and manpower thanks to a combination of treatment of different waste flows at the same stations.
- Minimization of transportation of sludge generated in future from the wastewater treatment plant to the waste treatment and resource recovery systems. The latest designs can be now constructed at the site of the wastewater treatment plant.
- Co-treatment of the organic fraction of waste and sludge collected from septic tanks and wastewater treatment plants will enhance the biogas generation from the anaerobic digesters from which more biogas would be collected for electricity production. Biogas generated will exceed the electricity need for self-supply of the station, which can be sold to the city's energy supply system.
- Sludge from anaerobic digesters will be further dewatered and composted for safe fertilizer, or dried before it will be used for burning to produce energy. The co-treatment will minimize transportation and other treatment expenses. In case of thermophilic digestion of the fractions (at 55°C) and drying, the digested sludge can be directly used as hygienically safe fertilizer.
- Treatment wastewater will be sent back for use by the city, including in the irrigation of green spaces and recharging to the groundwater. Close recycling of wastewater would reduce significantly the construction and O&M costs of the sewerage network.

(Source: Semi-San project, 2010)

BOX 6. OPTIMIZING WATER AND PHOSPHORUS MANAGEMENT IN THE URBAN ENVIRONMENTAL SANITATION SYSTEM OF HANOI, VIETNAM

A probabilistic model, simulating the impact of measures on groundwater abstraction and nutrient recovery, was used to determine the impact of policy changes in Hanoi. The model was used to analyze the impact of changes in the environmental sanitation and agricultural system on phosphorus recovery. Extreme scenarios were selected to clearly reveal the impact of policy changes. The results obtained reveal that harmonizing environmental sanitation and agricultural systems with one another will considerably increase nutrient recovery for food production, lower expenditure for artificial fertilizers and reduce the nutrient load into the environment.

Scenario 1 describes the situation for the year 2015 assuming unchanged current trends: persistent high population growth, continued shift from latrines to flush toilets with septic tanks, decrease in paddy fields and increase in fish pond and vegetable area as well as in the number of pigs. A persistent slight increase in mineral fertilizer application rate and in industrial production was also assumed.

Scenario 2 describes the situation for the year 2015 assuming that Hanoi's septic tanks are replaced by urine diversion latrines. Furthermore, an increase in organic fertilizer application rate and a decrease in commercial fertilizer use are also presupposed.

Scenario 3 describes the situation for the year 2015 assuming that Hanoi's population eliminates meat from its diet. Protein intake is compensated by a higher consumption of fish, vegetables, beans, soybean, and nuts. Organic fertilizer application rate is also higher than in the status quo, and only drainage water is used for irrigation. As in Scenario 2, septic tanks are assumed to be replaced by urine diversion latrines.

Groundwater abstraction could be reduced by a third, if the water distribution system is improved, gray water is reused for toilet flushing and if water efficiency of industrial processes is enhanced. Despite these measures, the groundwater withdrawal rate still exceeds the aquifer recharge rate. Therefore, other strategies are necessary, in particular, protection of surface water to facilitate its treatment for domestic use.

By replacing septic tanks with urine diversion latrines, the percentage of phosphorus in waste products recovered for food production could be increased from 18% to 45%. Furthermore, replacing livestock production by a higher production of fish, vegetables, beans, soybean, and nuts could further increase recovery of phosphorus from 45% to 82%.

(Source: Agnès Montangero et al, 2007)

Box 6 presents results from a study comparing different scenarios relating to water and phosphorus as resources in the urban environmental sanitation system of Hanoi city. In Scenario 3 ('ideal'), groundwater abstraction could be reduced by a third, if the water distribution system is improved, gray water is reused for toilet flushing and if the water efficiency of industrial processes is enhanced. Despite these measures, the groundwater withdrawal rate still exceeds the aquifer recharge rate. Therefore, other strategies are necessary, in particular the protection of surface water to facilitate its treatment for domestic use. By replacing septic tanks with urine diversion latrines, the percentage of phosphorus in waste products recovered for food production could be increased from 18% to 45%. Furthermore, replacing livestock production with a higher production of fish, vegetables, beans, soybeans and nuts could further increase the recovery of phosphorus from 45% to 82%.

5.4 NATIONAL WATER RESOURCES

Water resources in Vietnam are in danger from increasing scarcity as well as pollution, thus adversely impacting upon the population and economy in a variety of ways. The Asian Development Bank recently published the results of the Water Sector Review Project 2008 (ADB TA 4903-VIE). Information extracted from the project is described in this section.

The Vietnam National Resources Water Strategy (2006) highlights the issue of pending water scarcity in Vietnam. Taking population growth into consideration, by 2025 the average per capita surface water availability will be 2,830 m^3 (rivers in Vietnam) and 7,660 m^3 (including inflows) per year. According to the standards of the International Water Resources Association (IWRA), nations with average per capita water availability of less than 4,000 m^3 per year

are considered nations with inadequate water supply. Furthermore, water resources are not evenly distributed over different regions. About 60% of river water is concentrated in the Cuu Long river delta (Mekong River). The remaining 40% is spread over nearly 80% of the nation's population and over 90% of production, trade and other service activities. Moreover, seasonal variation is considerable: the average volume of water in the three to five months of the wet reason makes up 75% to 85% of the total volume (National Resources Water Strategy, 2006).

Pollutants affecting water-related economic activity include microorganisms, organics, chemicals, solids, gases and heat. Pollution originates from a variety of sources, including those evaluated in the ESI study: households; small industries; leachate from landfill; manufacturing industry; chemical fertilizers; pesticides; treatment of acid-sulfate soils; animal waste; silt release following build-up behind dams; and salinity intrusion from coastal areas. Water in upstream areas is generally still 'clean', while in downstream areas quality has worsened due to the impact of different socio-economic activities, particularly from industry and urban development.

At many river segments and river sub-basins, water pollution has become severe. For example, in the Nhue-Day river sub-basin, the annual average biochemical oxygen demand (BOD) level is about two times the TCVN level B standard, and 12 times the level A standard. BOD in water at some river segments flowing through urban areas in the Dong Nai river basin reaches a similar level as at the Nhue-Day sub-basin. Water quality in the dry season is much worse due to the reduction of water flow. In the Cau river sub-basin, BOD level in many places exceeds the TCVN standard, level B.

Organic substances and suspended solids are the major pollutants in most of the rivers in Vietnam. However in term of pollution effect, some chemicals and heavy metals originating from industrial and mining activities are a big concern as they could pose a high risk to human and ecosystems. Fertilizers and pesticides originating in agricultural activity are also toxic substances. According to the Report on Environmental Status of Vietnam in 2006, the provinces and cities with high water pollution are ranged in the following order: Ho Chi Minh City; Ha Noi; Binh Duong; Hai Phong; and Dong Nai. Four of the 10 provinces with high water pollution levels belong to Dong Nai river basin.

The three basins with the highest water pollution are the Cau, Nhue-Day and Dong Nai (which are sub-basins of the Red river basin). Special concern is given to management of the basins by both the national and provincial governmentsnts. Pollution levels of rivers in the lower reaches of the Dong Nai river basin are the highest in the country. The Thi Vai River is the most polluted basin with a "dead" section of more than 10 km. The river section from the confluence of the Ca stream and Thi Vai River to the My Xuan industrial zone – about 2 km – is severely polluted. Only some kinds of plankton can survive in this water environment. Some algae species, preferring an environment with high BOD, can grow in this area, but there is a high risk that they could make the environment toxic. There are also many other pollution "hot spots" in Dong Nai river basin.

The Nhue-Day river sub-basin is also severely polluted in places. The Nhue River is the worst and is seriously polluted in its upper reaches. Even in the flood season, BOD5, DO, NH4+, and coliform all fail to meet TCVN (standard B). Within Hanoi, surface water in rivers, lakes and drains is also seriously polluted. Levels of DO are low; COD, BOD and coliform far exceed the TCVN standard. As in the Dong Nai river basin, there are still many other pollution "hot spots" in the sub-basin. The Cau river section flowing through Thai Nguyen is highly polluted. Suspended solids, BOD and COD exceed TCVN (standard A) by many times, and the waters contain oil residue. There are other badly polluted areas in the sub-basin, mostly from organic pollution. Although some waste water sources have been reduced, particularly in Thai Nguyen, the water quality has not improved much.

It is necessary to note that the use of chemicals and toxic matter in mining and mineral processing lead to water pollution in many rivers. Moreover, reservoirs and dams for hydropower generation are structures that can strongly affect the water quality of rivers. Although there are not enough data for assessing this effect separately, the change in flow regime under the influence of these structures affect indirectly the water quality of rivers, especially in the dry season. The major reasons for this are associated with the construction of the structures without appropriate plan-

ning, a lack of environmental impact analysis, and the general low level of awareness among the population.

The rate of water-related diseases is high where polluted water runs through areas with high population density. Toxic substances such as oil, heavy metals and chemicals in the water have serious effects on the ecology of the river system, killing fish and destroying the natural food chain. Thus, water pollution has the potential to cause diseases as people ingest food containing those contaminants (vegetables, fish), which over a long period accumulate in the body. The presence of organic substances and toxic chemicals in the water of many rivers makes it no longer usable for domestic supply purposes, and in some water bodies even aquatic organisms cannot survive. Wastewater with high levels of organic substances exceeding the allowable limits can decrease the oxygen in water, causing eutrophication and killing aquatic creatures. The decrease of water quality also affects aquaculture production yields significantly, particularly cage aquaculture.

VI. Costs of Improved Sanitation and Hygiene

This chapter discusses aggregated and disaggregated costs from different perspectives: investment versus recurrent; hardware versus software; economic versus financial; different agencies incurring the costs; and by income quintile. Chapter 6.5 shows the marginal costs of moving up the sanitation ladder.

6.1. SANITATION OPTIONS PER ESI FIELD SITE

Figure 39 and Figure 40 show the variation in sanitation options selected in surveyed households in urban and rural field sites, respectively.

Among surveyed urban areas, most open defecation (OD) was found in Sa Dec town, Dong Thap province (U1). Septic tank, or septic tank with wastewater management is a major sanitation type in all urban areas. At Ban Me Thuot, there is a project to establish a separate sanitation system whereby households connect their sanitation systems to community sewers without using septic tanks.

Between two and five sanitation options are applied at rural sites. Apart from at Dong Nai (R1) and Thanh Hoa (R8), where only farms and households with biogas digesters were surveyed, there are only a few households in rural project sites without a toilet. The septic tank is a major sanitation type selected. Only Lai Xa (R7) has rural cluster wastewater management. Double-vault composting toilets are quite popular in Quang Ngai (R3) and Hue (R9) where sanitation projects have been carried out with well organized behavior change activities associated with informed household choice, even though the cost of this kind of sanitation is comparatively high.

FIGURE 39: PROPORTION OF URBAN HOUSEHOLDS SELECTING DIFFERENT SANITATION OPTIONS (%)

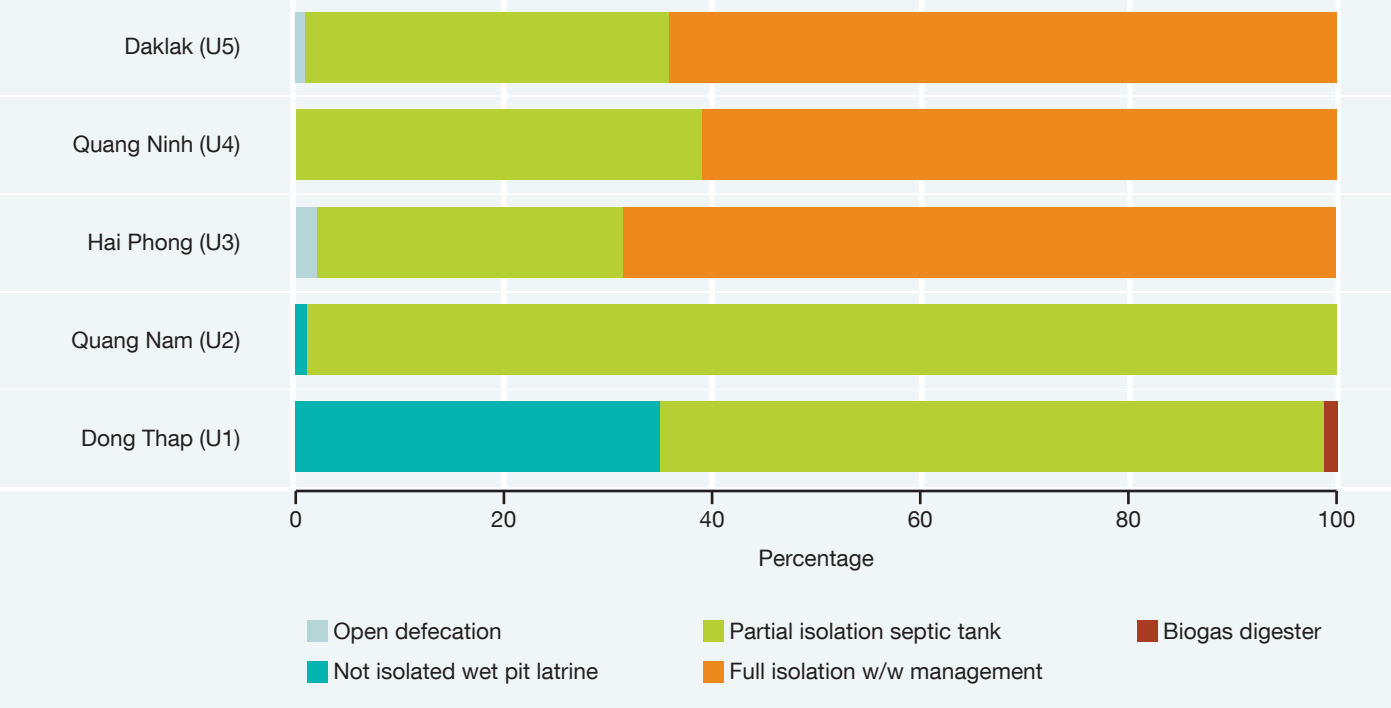
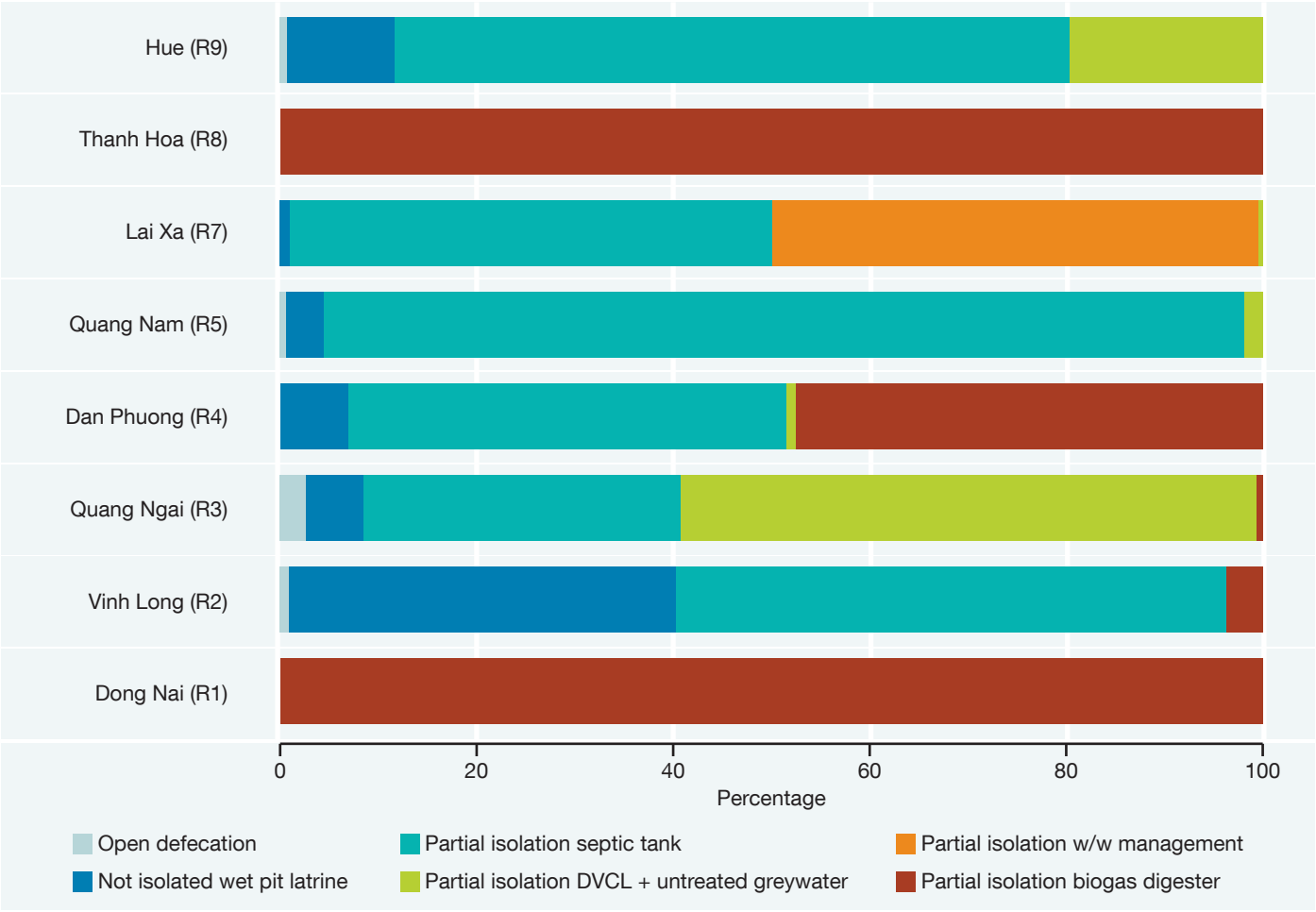


FIGURE 40: PROPORTION OF OF RURAL HOUSEHOLDS SELECTING DIFFERENT SANITATION OPTIONS (%)



6.2 COST SUMMARIES

Table 47 presents the costs of all sanitation options considered at the surveyed sites – urban and rural. It shows the average cost of all 12 sites, where the sanitation improvement interventions were: household toilet improvement; sewerage and drainage improvement; community centralized wastewater treatment; and hygiene activities. The costs of the biogas project at a big pig farm in Thanh Hoa were not included. Solid waste improvement projects are described separately in Chapter 8.4.

In rural areas, the highest investment costs are associated with biogas digester construction, and with community wastewater collection and treatment systems. In urban areas, the costs for centralized wastewater treatment systems were highest. The values of one-off spending urban centralized wastewater systems were VND14,924,000 per household. In rural areas, these values were VND10,836,000 per household for biogas digester construction and VND8,972,000 per household for cluster wastewater management. Average investment costs for a septic tank were VND4,985,000 and VND5,037,000 per household in urban and rural areas, respectively. The investment cost of septic tanks often includes expenses for sanitary ware and superstructure upgrading. The investment cost of rural composting double-vault toilets was VND3,053,000 per household, including superstructure, which is often made from local materials. The lowest investment costs were associated with pit latrines. The average urban pit latrine investment cost per household was VND1,613,000. The value of a rural pit latrine was VND1,746,000 per household.

Urban wastewater management systems (VND1,174,000 per household) incur the highest annual recurrent costs, including program costs. In all cases, the cost of program

activities for on-site sanitation systems was zero. Operation and maintenance costs for all on-site sanitation systems, except pit latrines, in urban and rural areas were similar, ranging from VND258,000 to VND398,000 per household. Pit latrines require less annual operation and maintenance costs (VND182,000 in urban areas, VND144,000 in rural areas). Sludge handling accounted for the major recurrent cost of on-site sanitation systems.

TABLE 47: SUMMARY OF AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND '000, 2009)

Sanitation options	Urban wet pit latrine[1]	Urban septic tank[1]	Urban centralized WWT[1]	Rural wet pit latrine[1]	Rural septic tank[1]	Rural cluster w/w treatment[1]	Rural double-vault Composting[1]	Rural biogas digester[1]
INVESTMENT COSTS: INITIAL ONE-OFF SPENDING								
1. Capital	1,584	4,920	11,970	1,706	4,872	8,567	2,914	10,416
2. Program	29	65	2,954	40	165	406	139	420
SUB-TOTAL	1,613	4,985	14,924	1,746	5,037	8,972	3,053	10,836
RECURRENT COSTS: AVERAGE ANNUAL SPENDING								
1. Operation	98	198	703	69	148	52	120	202
2. Maintenance	84	200	403	61	93	232	150	196
3. Program	0	0	69	14	17	0	50	0
SUB-TOTAL	182	398	1,174	144	258	284	320	398
AVERAGE ANNUAL COST CALCULATIONS								
Duration[2]	7	10	20	7	10	10	10	15
Cost/household	366	766	1,323	357	677	1,088	520	950
Cost/capita	96	202	349	94	179	287	137	251
BREAKDOWN (%)								
% capital	62	64	45	68	72	79	56	73
% program	1	1	11	2	2	4	3	3
% recurrent	37	35	44	30	26	18	41	24
Observations[3]	**29**	**246**	**201**	**82**	**501**	**97**	**125**	**59**

[1] See Annex Tables A10 and A11 for sites contributing sanitation and hygiene option data.
[2] Refers to length of life of hardware before full replacement.
[3] Number of households surveyed.

FIGURE 41: TOTAL COST PER URBAN HOUSEHOLD FOR MAJOR ITEMS (VND)

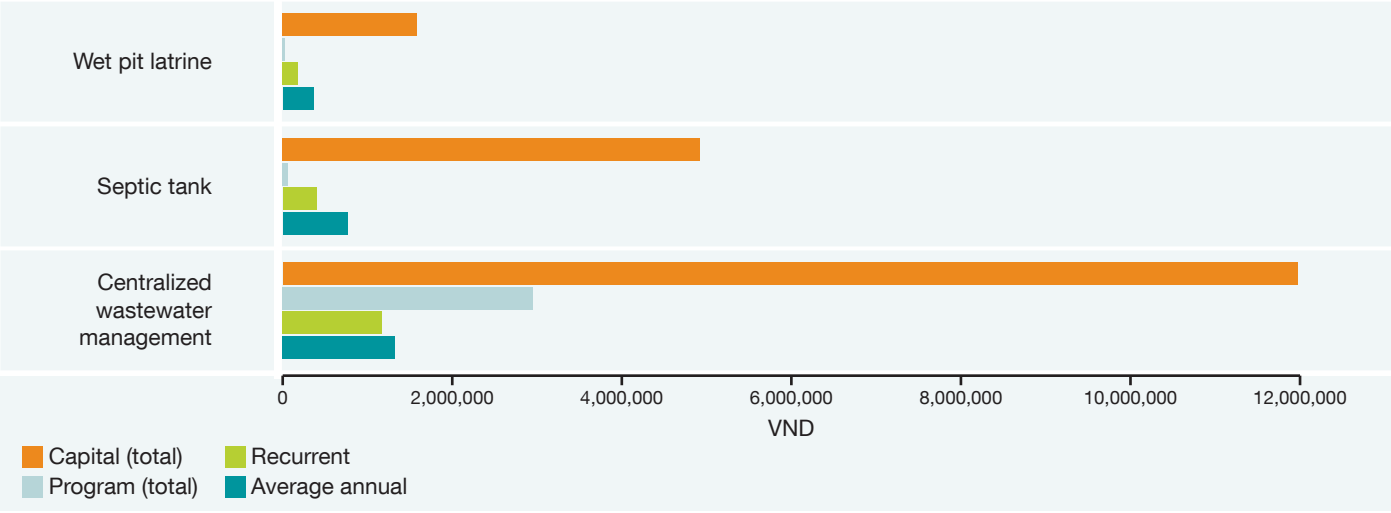


FIGURE 42: TOTAL COST PER RURAL HOUSEHOLD FOR MAJOR ITEMS (VND)

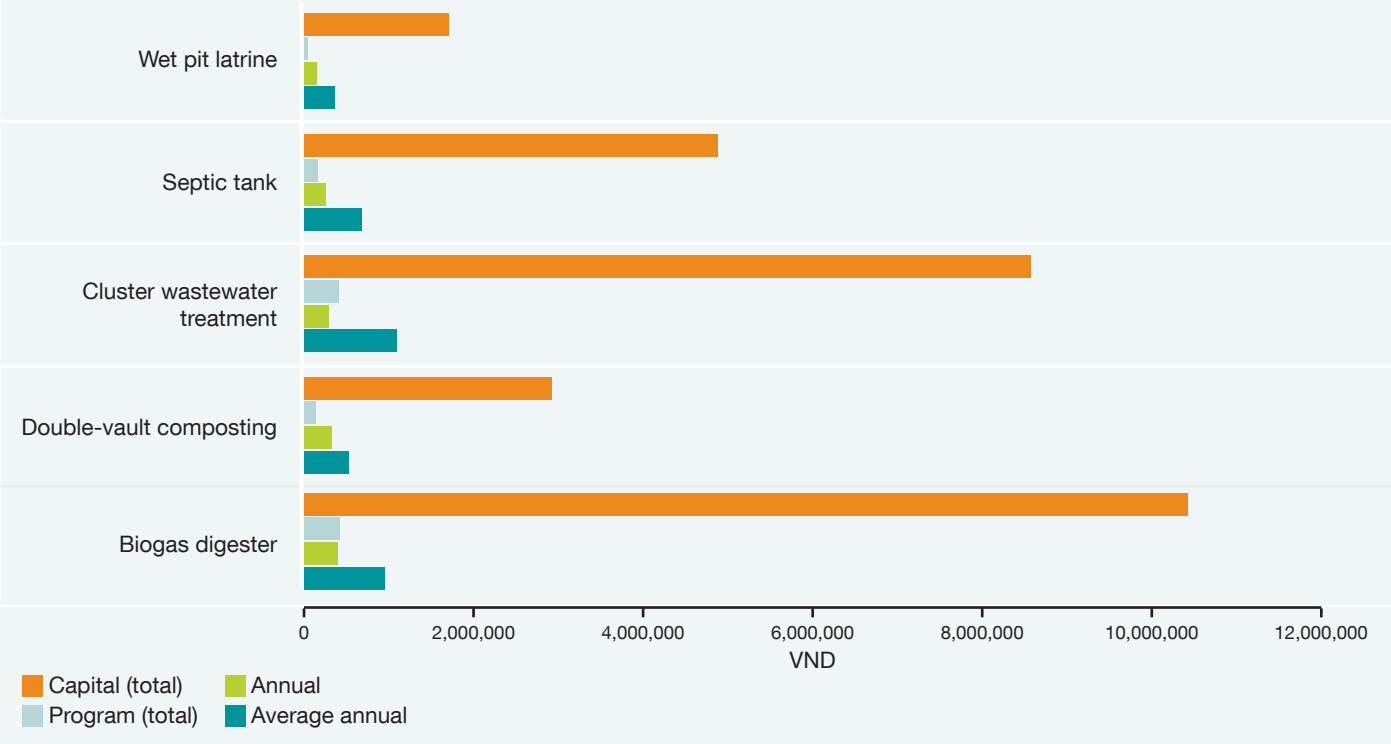


Figure 41 illustrates the main contributors to economic cost in urban areas, showing clear increases in both capital and recurrent costs as the 'sanitation ladder' is climbed. The centralized wastewater treatment option in urban areas involves the highest cost compared to other on-site sanitation options, with large investment required for collection sewers and drains, and wastewater and sludge treatment facilities. Program costs vary from project to project (1.3% to 19.8% of total investment costs), whereas the highest ratio of program costs is incurred by centralized wastewater management projects.

Figure 42 illustrates the main contributors to economic cost in rural areas. It shows that, while there is no significant difference in average recurrent costs for all sanitation options, capital costs do vary. At the household level, a wet pit latrine requires less investment, and cluster wastewater treatment involves the highest investment cost. The latest treatment option also requires the highest annual cost. Septic tanks, double-vault composting toilets, and biogas digesters entail the same range of average annual costs per household. Program costs varied from project to project (2.3% to 4.6% of total investment costs).

Figure 43 and Figure 44 present the proportions of financial costs in terms of total economic cost, across all urban and rural sites, respectively. The proportions of financial cost are high, ranging from 99.4% to 99.5% of total costs in urban areas, and 99.3% to 99.9% in rural areas. Details of financial and economic costs are given in Annex I. Non-financial costs from programmed sanitation improvement projects in the current survey made up a very low proportion of economic costs, and included unpaid volunteer time and contributions of unused construction materials by households. At national level, there are still number of activities where that proportion could be much higher, for example, volunteer activities by youth.

FIGURE 43: PROPORTION OF TOTAL (ECONOMIC) COSTS THAT ARE FINANCIAL, ACROSS ALL URBAN FIELD SITES (%)

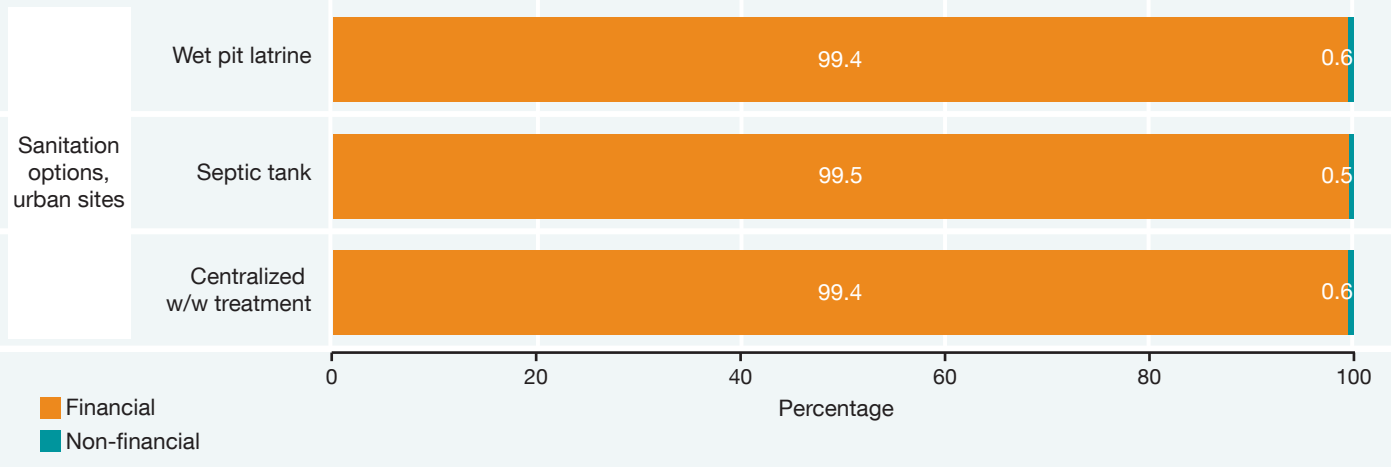
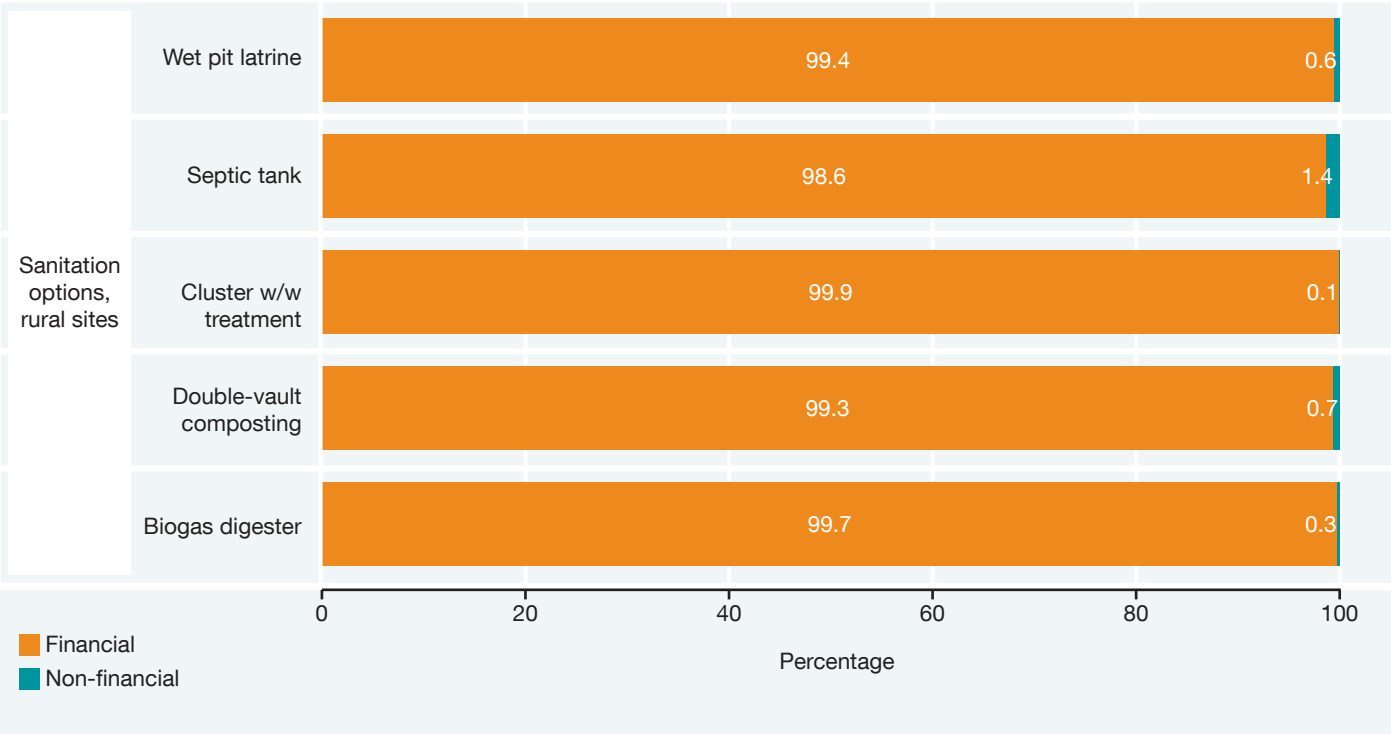


FIGURE 44: PROPORTION OF TOTAL (ECONOMIC) COSTS THAT ARE FINANCIAL, ACROSS ALL RURAL FIELD SITES (%)



6.3 FINANCING SANITATION AND HYGIENE

The percentage contributions of different financiers to overall costs are summarized in Figure 45, for urban areas, and Figure 46, for rural areas. In urban areas, the total contribution of the government and donors for centralized wastewater management projects was much higher than contributions from households (76.8% versus 23.2%). In wastewater treatment projects in Vietnam, besides household contributions, the major funding still comes from official development assistance (ODA) sources (grants or loans) in comparison with the local and central government contributions (56% versus 20.8%). At sites where the only sanitation improvement was household sanitation and drainage (but not yet centralized sewerage and drainage), significant contributions came from households (59.4% to 98%).

FIGURE 45: PROPORTION OF URBAN SANITATION COSTS FINANCED FROM DIFFERENT SOURCES (%)

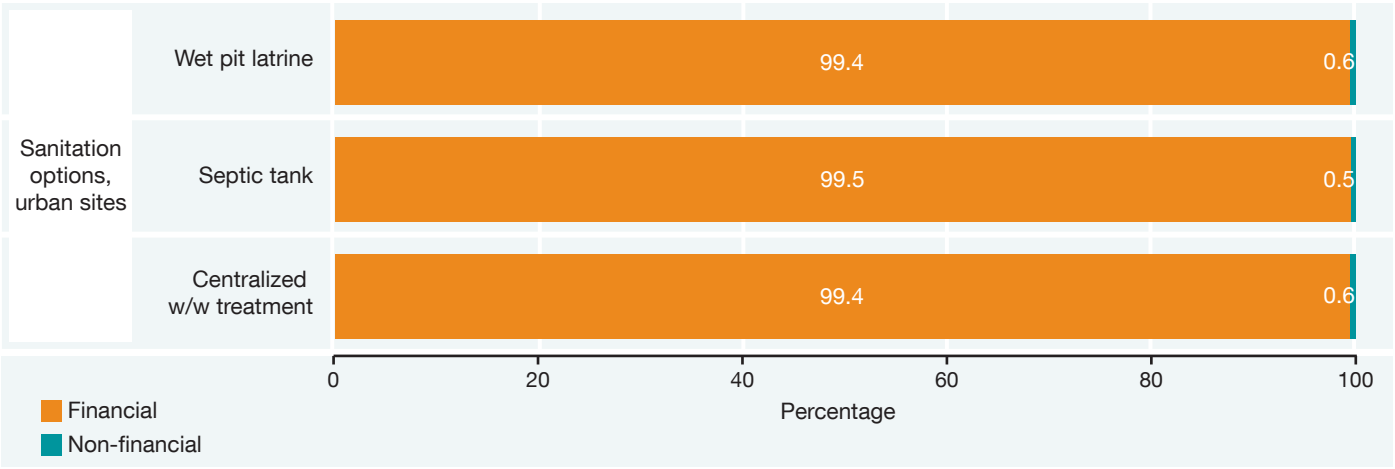
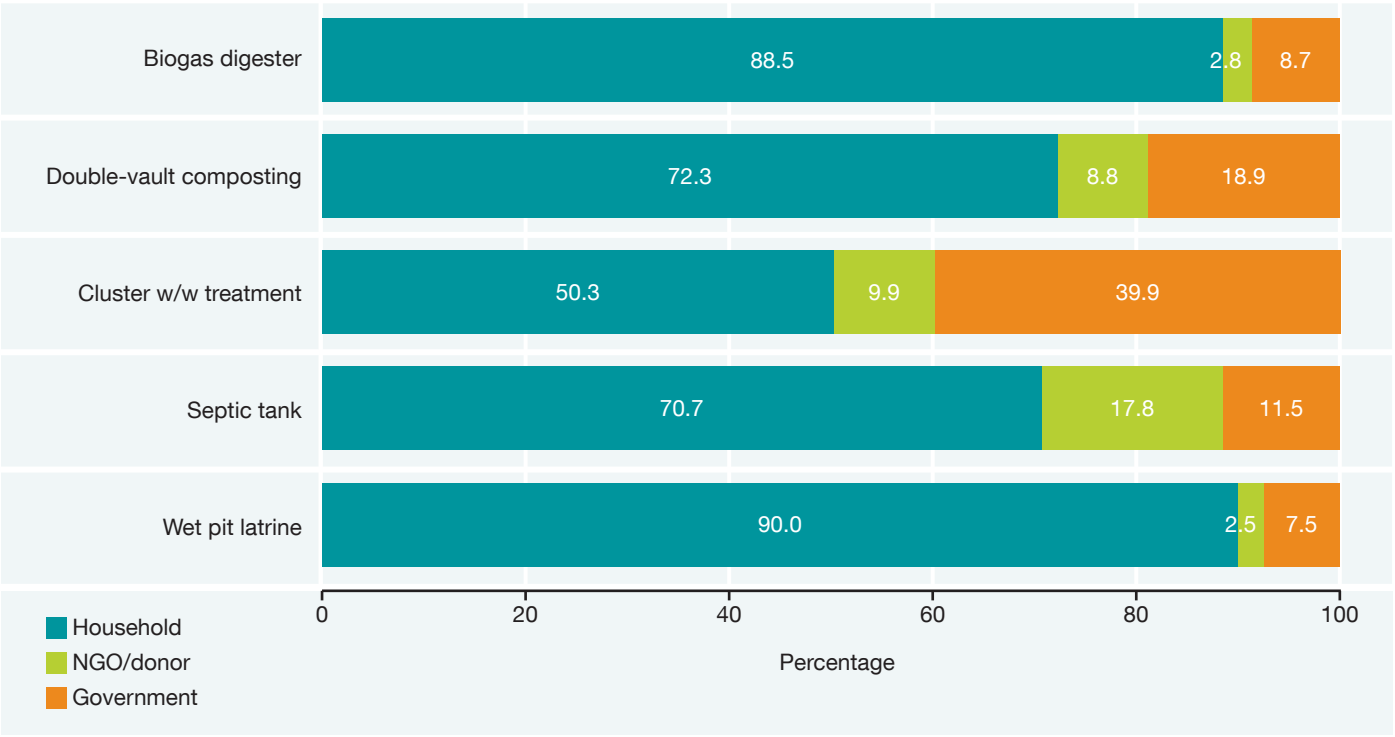


FIGURE 46: PROPORTION OF RURAL SANITATION COSTS FINANCED FROM DIFFERENT SOURCES (%)



In rural areas, household contributions for sanitation at all surveyed sites amounted to between 50.3% (cluster wastewater management) and 90% (biogas digester) of the overall economic cost for the sanitation improvement. Contributions from the government, NGO and other donors were not as significant in terms of overall value in most cases except for cluster wastewater management (10-29.3% versus 49.7%), but these contributions financed the soft interventions that are crucial to the project's success, such as awareness raising, management structure improvement and technical support provision.

Analysis shows that, at the household level, household owners are expected to contribute substantially to the cost of sanitation improvement. The strategy to encourage household owners to invest their resources in sanitation is enacted through soft interventions, such as behavior change activities, external support and technical guidance, regulation enforcement, and micro-financing tools. Beyond this level, sanitation projects cannot expect large financial contributions from households, although communities play a crucial role in the connection and payment of wastewater and environmental sanitation fees for the system recurrent

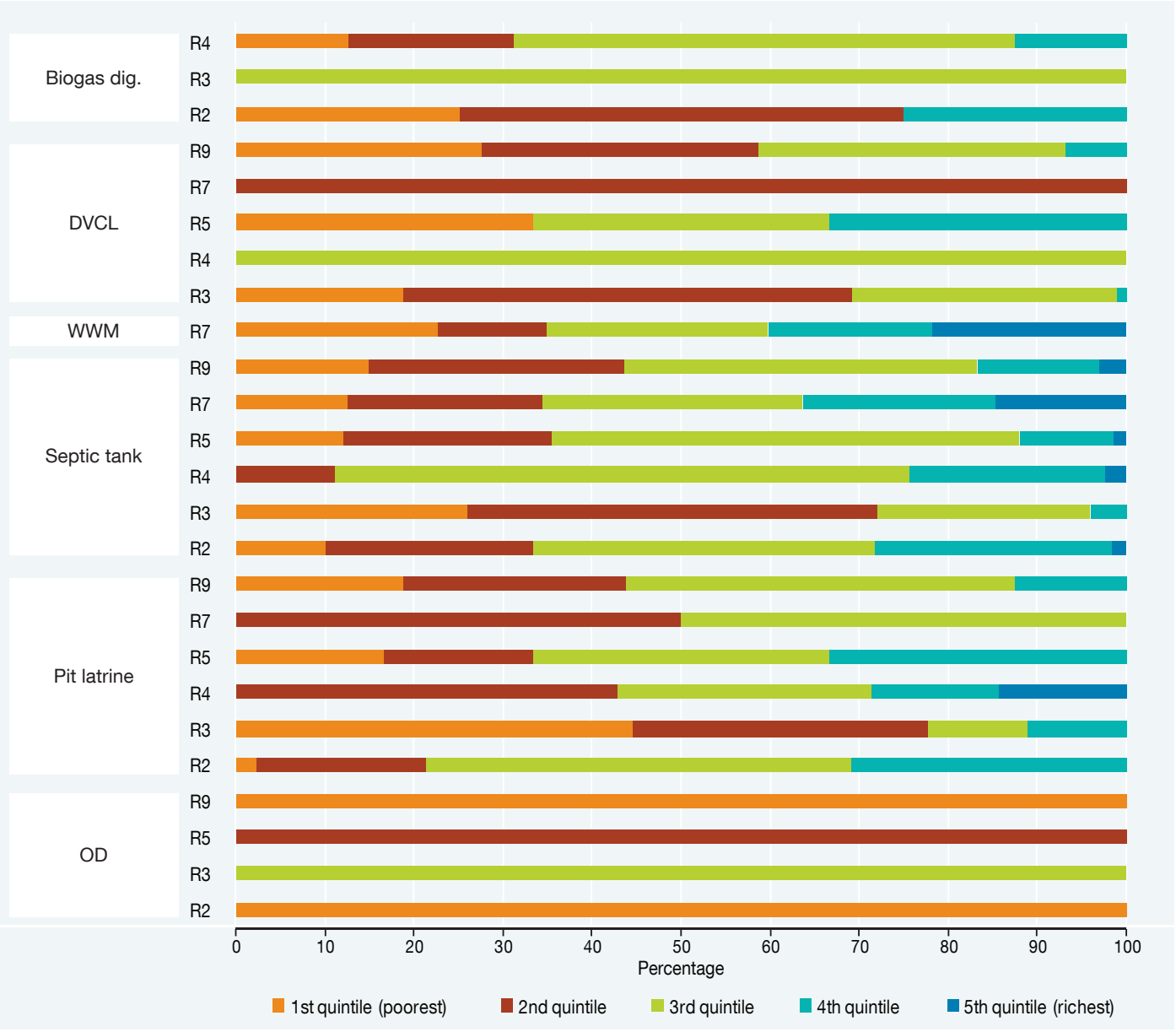
costs recovery. The strategy to mobilize resources in this case is enacted through foreign loans, grants, and other financial initiatives to attract private sector participation.

6.4 SANITATION OPTIONS BY ASSET QUINTILE

The choice of sanitation option by households, and the price paid, is expected to vary by wealth quintile. The decision to improve sanitation is influenced partly by the initial investment cost, and also the recurrent costs. Households with lower cash income will be more sensitive to hygiene and sanitation costs.

According to the Prime Minister's decision No. 170/2005/QD-TTg dated 8th July 2005, for the period 2006 – 2010 urban households with an average monthly income of below VND260,000 per person are classified as 'poor', and below VND200,000 per person for rural households. Many experts claim these figures do not reflect the real poverty situation. The current poverty standard (for the period of 2011 – 2015) is below VND450,000 per person per month in urban areas, and below VND350,000 per person per month in rural areas. Households in Ho Chi Minh City with an average income of VND12,000,000 per person per year are considered 'poor' during the period 2009 to 2015.

FIGURE 47: PROPORTION OF RURAL HOUSEHOLDS SELECTING DIFFERENT SANITATION OPTIONS, BY ASSET QUINTILE



In this study, information about average household incomes has been gathered from all urban and rural field sites. However, it was difficult to obtain adequate information about income from most urban households. Therefore, the proportion of households selecting different sanitation options by asset quintile was determined only for the rural areas (see Figure 47).

The income of surveyed rural households (in million VND-per year) are divided into five quintiles: the poorest (with annual incomes of less than VND10 million; from 10 to 20 million; from 20 to 50 million; from 50 to 100 million; and the richest, earning above 100 million).

The richest households prefer septic tanks. No households among the richest quintile practiced OD. Households in the fourth quintile households have all types of sanitation, but do not practice OD. All sanitation types were found in middle- and lower-income households.

The average cost per sanitation option is presented as a percentage of household annual cash income, by quintile. Therefore, this analysis focuses on the financial cost to households of each option, irrespective of whether the household paid the upfront costs of the facility.

Table 48 presents the average costs of two main sanitation options; wet pit latrines and septic tanks, in percentages of annual rural household income, by quintile. There are big differences between rich and poor households in terms of the percentage of income paid for the same type of sanitation. The poorest households have to pay more than 1.5 years for a septic tank, and spend around 17% of their income (or the average income earned in nine working weeks) for recurrent costs per year. The richest households have to pay only 5% of their income (or the average income earned over 2.5 working weeks) for a septic tank, and spend 2% of their income (or the average income earned in one working week) on recurrent costs. Adequate financing models are needed to enable low-income households to pay for suitable sanitation, if the purpose is to increase sanitation coverage for the entire population. Successful applications of financing models have been demonstrated, such as micro-finance or revolving funds operated through local authorities or local women's union (see Chapter 7.2 for more details). Since most investment during the project period comes from households (see Chapter 6.2), software activities should focus on enhancing household willingness-to-pay.

6.5 COSTS OF MOVING UP THE SANITATION LADDER

To move up the sanitation ladder and get a better sanitation system, further investment and recurrent costs must be met. In some cases, the operation and maintenance costs associated with moving to a more advanced sanitation system are not necessarily higher than the existing system. Investment costs associated with moving up the ladder are presented in Figure 48 for urban areas, and Figure 49 for rural areas. The highest investment costs are encountered when moving up to centralized wastewater treatment plants in urban areas, and, in rural areas, when adopting biogas digesters. Similar results were found at all surveyed sites.

TABLE 48: PERCENTAGE OF RURAL HOUSEHOLD ANNUAL INCOME SPENT ON SANITATION, BY QUINTILE

Options	1st quintile (poorest)	2nd quintile	3rd quintile	4th quintile	5th quintile (richest)
	< VND10 mio.	10 – 20 mio.	20 – 50 mio.	50 – 100 mio.	>100 mio.
Wet pit latrine					
Capital (investment)	45.8%	15.3%	6.5%	3.1%	1.5%
Recurrent (annual)	8.6%	2.9%	1.2%	0.6%	0.3%
Average annual	18.2%	6.1%	2.6%	1.2%	0.6%
Septic tank					
Capital (investment)	158.9%	53.0%	22.7%	10.6%	5.3%
Recurrent (annual)	17.3%	5.8%	2.5%	1.2%	0.6%
Average annual	59.3%	19.8%	8.5%	4.0%	2.0%

Mio = Million

FIGURE 48: INCREMENTAL COSTS OF MOVING UP THE SANITATION LADDER, AT URBAN SITES (PER HOUSEHOLD, VND, 2009)

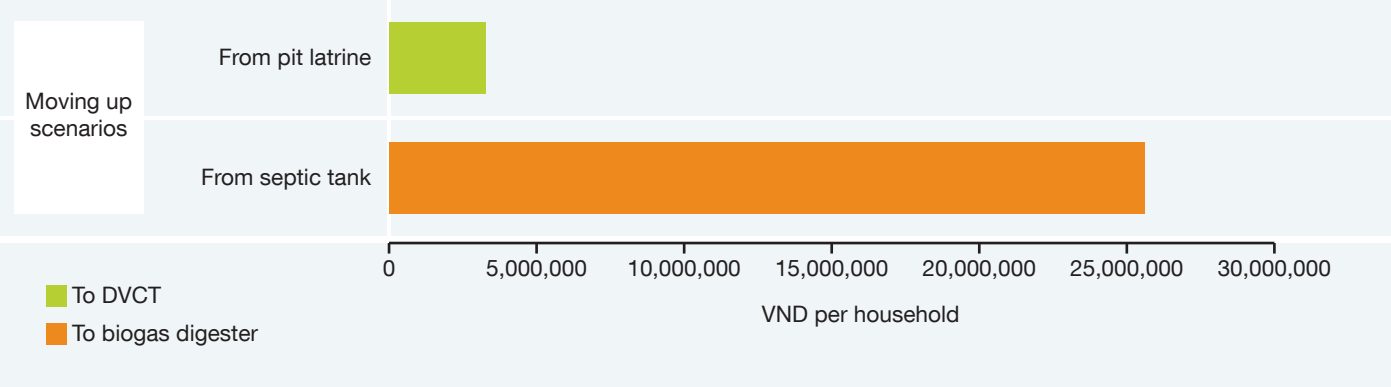
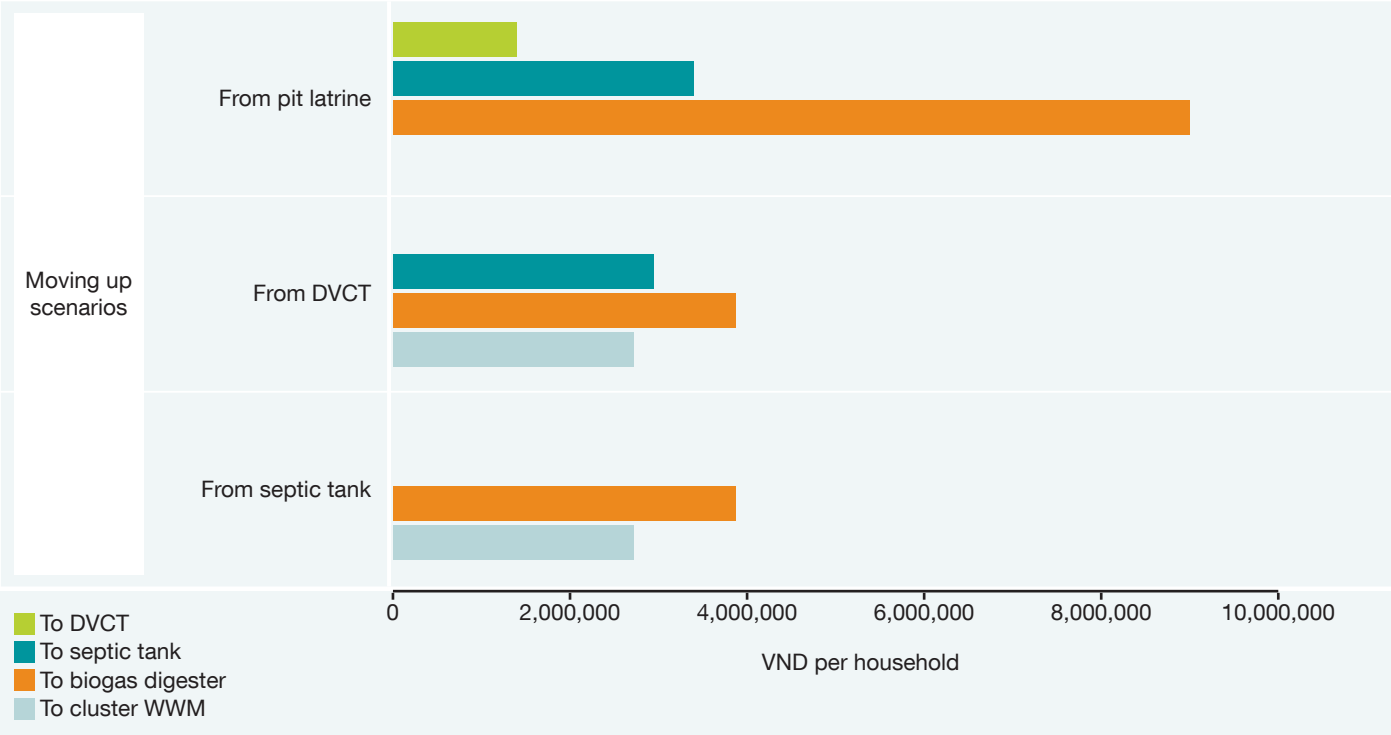


FIGURE 49: INCREMENTAL COSTS OF MOVING UP THE SANITATION LADDER, AT RURAL SITES (VND, 2009)



VII. Sanitation Program Design and Scaling Up

7.1 OVERVIEW OF PROGRAMS AT FIELD SITES

This chapter considers projects more widely, beyond the single sites of the ESI field work. Table 49 lists the projects and programs analyzed, and their approaches and activities. Five urban sanitation projects are analyzed that represent three different regions: the northern region (Three Cities project, WSPST); the central region (Tam Ky project, Buon Ma Thuot project); and the southern region (Three Delta Towns project). The cities affected by the projects belong to different urban categories, from the 1st category (Hai Phong, Da Nang) to the 4th and 5th category (Small Towns program). The projects also target different beneficiaries including: the urban poor (Tam Ky); communities in mountainous areas (Small Towns program); tourism areas (Bai Chay, Ha Long city). The Three Delta Town project provided an integrated program of support for the improvement of water supply, drainage and household toilets, as well as capacity building for local water supply and sanitation service providers. The Tam Key project included similar infrastructure improvement. The Bai Chay, Ha Long and Buon Ma Thuot projects aimed to improve sewerage and drainage systems with centralized wastewater collection and treatment. Bai Chay focused on the primary and secondary sewerage and drainage network, and end-of-pipe wastewater treatment plant. Buon Ma Thuot was a pilot project implementing small-bore sewerage and without-septic-tank household connection followed by low-cost wastewater treatment in ponds and reuse. A solid waste management component was included only in the Three Cities project. Support for some projects came from loans from international financiers (World Bank, ADB). Others were provided with grants or loans from foreign countries (Australia, Finland, and Denmark).

Rural sanitation projects were implemented in the Northern Peri-urban (Lai Xa, Hanoi), Rural Central (Quang Nam, Quang Ngai) and Rural Southern regions (Vinh Long, Cuu Long delta). These projects were supported by bilateral agencies (Australia), and international NGOs (Plan International, YWAM, and IDE). The integration of soft interventions and household toilet improvement support was a common approach of the projects analyzed, except the project of IDE in Quang Nam, where a soft sanitation marketing intervention was adopted. The only cluster wastewater management was applied in a community-based sanitation project in Lai Xa.

This chapter also analyzes a biogas program, which is being implemented throughout most provinces in Vietnam by SNV and the Vietnamese Government. The program provides technical input and seed financial support at the household scale, and also includes a biogas project implemented by a pig farm owner's initiative.

Three different solid waste management projects are analyzed. One is the 3R initiative in some pilot wards in Hanoi city, funded by the Japanese Government. The other is a solid waste management project for the small tourism town of Cua Lo, Nghe An province, funded by the Danish Government, where the management model of a Joint Stock Company for solid waste service has been supported. The last project is an initiative by a local cooperative trying to build its capacity for a solid waste collection and disposal service for the rural community in a mountainous area of Northern Vietnam.

The conduct of a robust program approach analysis (PAA) was severely constrained by a lack of available input data from the programs evaluated, which limited the number of programs that could be included in the study. The results of the analysis are interpreted taking into account setting-specific conditions that are partially responsible for the performance results; hence findings are not definitive, but instead illustrative and instructive.

TABLE 49: LIST OF PROGRAMS AND PROJECTS ANALYZED

1		**Urban sanitation projects**
	a	Three Delta Towns Water Supply and Sanitation Project
	b	Expanding benefits for the poor through urban environmental improvements in Tam Ky city
	c	Three Cities sanitation project (Hai Phong, Da Nang, Ha Long)
	d	Environmental sanitation project for Buon Ma Thuot city
	e	Water supply and sanitation for a small towns program (WSPST)
2		**Rural sanitation projects**
	a	Cuu Long Delta RWS Project
	b	Sanitation, Hygiene and Water Improvement Project (SHWIP) in Quang Ngai province
	c	Sanitation marketing project in Binh Trieu commune, Thang Binh district, Quang Nam province
	d	Community-based sanitation in Lai Xa village, Kim Chung commune, Hoai Duc district, Hanoi
3		**Biogas digester promotion projects**
	a	The Vietnam Biogas Programme
	b	Biogas for a pig farm in Thieu Duong commune, Thieu Hoa district, Thanh Hoa province
4		**Solid waste management improvement projects**
	a	Implementation support for 3R Initiative in pilot wards of Hanoi city
	b	Solid waste management improvement project in Cua Lo town, Nghe An province
	c	Solid waste management improvement in a Duc Thang commune, Hiep Hoa district, Bac Giang province

7.2 KEY FINDINGS OF THE PROGRAM APPROACH ANALYSIS

A detailed assessment of each project is provided in Annex 1. This section provides a summary of lessons learned.

7.2.1 URBAN SANITATION PROJECTS

In most projects, the challenges faced relate to: technological option selection; the quality of design and construction; consultant competency; administrative appraisal procedures; low rates of household connection; financial sustainability; and local capacity for operation and maintenance (O&M), monitoring, evaluation and control in the project definition stages.

Most urban sanitation projects are associated with external support. Over 80% of urban sanitation funding comes from official development assistance (ODA) contributions (World Bank, 2006).

A systematic and comprehensive approach for project formulation, management, implementation and evaluation is necessary to ensure the project success and sustainability, where the following elements are crucial: (a) during investment studies–socio-economic survey, and studies on willingness to pay and commitment to connect to sewerage; (b) activities accompanying infrastructure development-capacity building, human resource development strategy, management model and financial structure, awareness-raising programs, evaluation of different technological options; and (c) project monitoring and evaluation.

A range of sanitation approaches and technologies must be considered while a project is under development. Local aspects to be considered include low-incomes, topographical and other natural features, and other socio-economical conditions. Some initial options to be considered are: combined sewerage and drainage versus a separate system; centralized versus decentralized sanitation schemes; conventional versus high-tech or low-cost technological options; or a combination of these. The proper collection, treatment and disposal of sludge from septic tanks needs special attention in Vietnam. Also, urban environmental sanitation projects commonly do not include tertiary treatment of sewage and providing a drainage network for stormwater. An appropriate technical solution for a combined sewerage and drainage network should be developed in order to avoid untreated wastewater from sewers. Lessons from the first implemented systems should be studied

for the later stages and for the other projects. The separate small-bore sewerage, decentralized or centralized low-cost wastewater treatment options in baffled septic tank with anaerobic filter (BASTAF), constructed wetland and waste stabilization ponds in Buon Ma Thuot city, Cho Moi and Cho Ra towns, Bai Chay tourist area, and wastewater reuse Buon Ma Thuot city should provide valuable insights for future similar projects in Vietnam.

The Sanitation Revolving Fund (micro-credit scheme) contribution for poor households and households close to poverty criteria should be enough to cover investment costs for sanitation construction. The poor should be able to cope with other financial factors including interest rates and payback period.

Delays in project implementation should be foreseen. Slow disbursement of donor funds leads to project delays. Project design should take into account future price increases for construction.

In urban sanitation projects, the main challenges related to O&M are: low connection ratios; the consequences of poor construction work; low wastewater and solid waste management tariffs; wastewater treatment plant operation below design capacity; and low O&M budgets allocated by local authorities.

7.2.2 RURAL SANITATION PROJECTS

In the coming years, the targets for rural sanitation should be more specific in relation to the quantity and quality of sanitary structures. Larger investment is needed with an emphasis on sanitary planning and technological selection in rural areas.

Incentives for family investment in sanitation structures, especially sanitary latrines, solid waste and drainage, are still limited, even though households cover a major part of investment in sanitation. Marketing activities and the promotion of sanitation in association with the application of preferential mechanisms on finance (such as appropriate credit models and more efficient sanitation and hygiene behavior change programs) are crucial. Meanwhile, challenges include ensuring a clear definition of the institutional aspects of behavior change activities in order to encourage rural people to become aware of the close relationship between water supply, sanitation and health, and to encourage people to invest in sanitary infrastructure. A reliance on external support, without which private operators would not be able to develop a marketing campaign, is crucial. Sanitation promotion has been shown to be efficient in generating local investment and demand. The examples reviewed were found to generate more than twice the investment than projects that provide full subsidy for capital cost, due to tapping household resources. Financing capacity building and human resource training is also necessary and will be profitable in terms of the improved sustainability of sanitation investment. For a project to be accepted by the community, it must ensure that the households affected – including poor households – are given an informed choice ad that they actually participate.

To date, there have been no effective solutions for liquid and solid waste management in rural areas, particularly in handicraft villages. It is estimated that over the past 10 years, the number of handicraft villages in rural Vietnam has increased by about 8% per year (to approximately 2,450 handicraft villages). Pollution reduction is now considered an urgent issue. So far, only a few successful sanitation models have been recorded with decentralized anaerobic (biogas) digesters at pig farms. As well as improving household toilets, a pilot effort like the Lai Xa project demonstrates the promising option of investing in decentralized wastewater management. A decentralized low-cost sanitation approach with appropriate technical options and management schemes, and increased investment in behavior change communications should be promoted in future projects. A solid waste component should be integrated in to the project vision.

The development of a local implementation model of Rural Water Supply and Sanitation (RWSS) facility ownership, piped scheme management and a demand-responsive approach (which incorporates community participation and health/hygiene promotion at each phase of the project cycle) is crucial, especially when the guidance from the National Strategy for Rural Water Supply and Sanitation is too general for all regions. More efforts to set up continuous community participation and health promotion programs within and beyond the project framework should be funded

by the central and local Vietnamese authorities.

Better coordination and integration between project activities and activities under central and local government programs is necessary to improve resource mobilization, efficiency and sustainability. A population's interest in maintaining cleanliness and wastewater reuse are key factors in promoting participation demand and willingness-to-pay for wastewater treatment. The analysis also shows that the hamlet and commune administration could play an effective coordinating role in the project when management capacities are reinforced. A clear mandate and operational mechanism for financing, implementation, and monitoring and evaluation of these activities at the provincial level should be set up. Better coordinated interaction between the local authorities would expand the service to a greater number of households within and beyond the project cycle. Co-financing by different local authorities provides opportunity for a more efficient and sustainable infrastructure service. More focus should be paid to capacity building for the local project implementers, monitoring and evaluation, and follow-up activities. RWSS projects in Vietnam should focus on identifying implementation and funding structures that promise more sustainable integration of community consultation, health promotion, and infrastructure. Requiring a significant financial contribution from households limits the impact of improved sanitation on the poor.

7.2.3 BIOGAS PROJECTS

Key points for achieving success with a biogas program are: a clear vision and support on the part of provincial and district authorities; selection of the correct biogas technology to be introduced; adequate technical training to be provided to set up a team of qualified and enthusiastic local technicians; a quality control system should be established that helps the livestock community to place or regain their trust in the sanitation option. Clear monitoring and evaluation of indicators, and a mechanism to monitor the activities of district technicians should be developed.

Great success has also been achieved from individual biogas construction and electricity generation for livestock breeding farms. Economic and environmental sanitation benefits have been observed and confirmed by the farmers.

Limitations to be overcome include: more investment should be made on demonstration models and capacity building; projects should try to increase bottom-up planning and to simplify the administrative system, and link with other biogas-related projects and programs. Besides the common practice of slurry utilization, adequate post-treatment of biogas products (liquid and solid phase) should be considered.

More efforts should be made by the central and local government to disseminate available cleaner production, resource recovery and other green farming technologies and equipment to farmers. Technical guidance and marketing activities should be set up, with the involvement of different players.

7.2.4 SOLID WASTE MANAGEMENT PROJECTS

The current method of waste disposal in most of places is land filling. More sustainable waste treatment and disposal methods should be further considered. The 3R project demonstrates a very promising concept, but it requires a great deal of efforts to be made on the ground.

There are different models of cooperatives, private enterprises, and "equitized" enterprises providing solid waste collection, transportation, treatment and disposal in urban, rural and industrial areas. Besides solid waste fees, enterprises can get additional income from the recovery of valuable materials such as plastic, paper, and metal, and from recycled products such as compost fertilizers and plastic goods. Solid waste management by a local cooperative such as Hiep Hoa in the small towns and peri-urban communities is a good model, which has been confirmed and promoted by the provincial and central government. Appropriate incentives and supporting measures should be developed in order to enable local cooperatives to improve their capacity and the sustainability of solid waste management services.

More efforts should be made by city governments to provide a more conducive legal framework support and coordination among relevant stakeholders, such as local authorities, the urban environment company (URENCO), households, mass organizations and the media. Waste collection companies need increased budget and debt financing services to increase their coverage and performance. IEC activities also

play an important role during the project period, and must be continued.

7.2.5 CONCLUSIONS

Planning: Early planning of house connection activities is essential. For example, the house connection administrative unit must take an active role in promotion to end users. A regulatory framework should decree mandatory connection of households.

In selecting sanitation options and technologies, the project owner should consider all life cycle costs. Project design should take into account future price increases for construction.

Increasing the volume of water supplied to urban communities will exacerbate existing drainage problems. Therefore, water supply projects should always be considered in combination with environmental sanitation. Furthermore, a solid waste management component considered in combination with drainage and sewerage activities reduces negative impacts. The absence of a solid waste component is one concern relating to program sustainability.

Outcome oriented monitoring and evaluation is a new concept for Vietnamese counterparts. Process and outcome monitoring systems for community development activities need to be set up early in a project.

Vietnamese environmental standards are still not fully developed. There are still big gaps and contradictions in effluent standards, water resource classification and values for parameters. This complexity leads to inefficient expenditure and inequity in relation to different methods of wastewater discharge. The reuse of wastewater and excreta in agricultural production is very popular in Vietnam. However, sanitary standards and guiding solutions that consider local factors are needed in planning, management and technical option selection, as well as monitoring and control.

Software: Institutional strengthening and community development must be regarded as key components of water and sanitation projects. In order to be most effective, the resources devoted to institutional strengthening and community development should be adequate, and also related in terms of budget, duration and timing to the resources devoted to engineering infrastructure works. Due to weak organizational capacity, capacity building of local resources plays an important role in effectiveness. There is a vital need for the promotion and development of strong links and good coordination between water supply and sanitation companies and community organizations at all stages of project planning and implementation.

Community participation, especially by women, is crucial to project success. IEC promotion will stimulate positive community response. Project information should be provided in a carefully organized way. The participation of consumers, with special attention to the poor and women, should be highlighted.

Implementation: The local planning, design and contracting capacities of local authorities should be built and mobilized. Crucial in this are the ownership, selection of sanitation service management model and organization, as well as capacity building for the local service providers.

Financial sustainability: Making links between water companies and the community is essential for the establishment of effective, realistic tariffs and connection fees. Only in this way can subsidies be reduced and companies provided with greater financial autonomy, thereby enabling them to further improve the services they provide. "Willingness to pay" data must be carefully collected and used with caution. Government capital subsidies to households creates favorable conditions for implementation, but to ensure financial sustainability of the sanitation system, the "polluter pays" principle should be applied.

VIII. Efficiency of Improved Sanitation and Hygiene

This chapter synthesizes the information presented in Chapters 4 to 7 in order to discuss present sanitation option efficiency under both ideal and actual program conditions. Non-quantified impacts are presented alongside the quantitative cost-benefit and cost-effectiveness ratios. The chapter consists of three sections:

- Efficiency of sanitation and hygiene interventions compared with adopting no option (section 8.1).
- Efficiency of alternative ways to move up the sanitation and hygiene ladder (section 8.2).
- Scaling up results for national policy making (section 8.3).

8.1 EFFICIENCY OF SANITATION AND HYGIENE IMPROVEMENTS COMPARED WITH ADOPTING NO OPTION

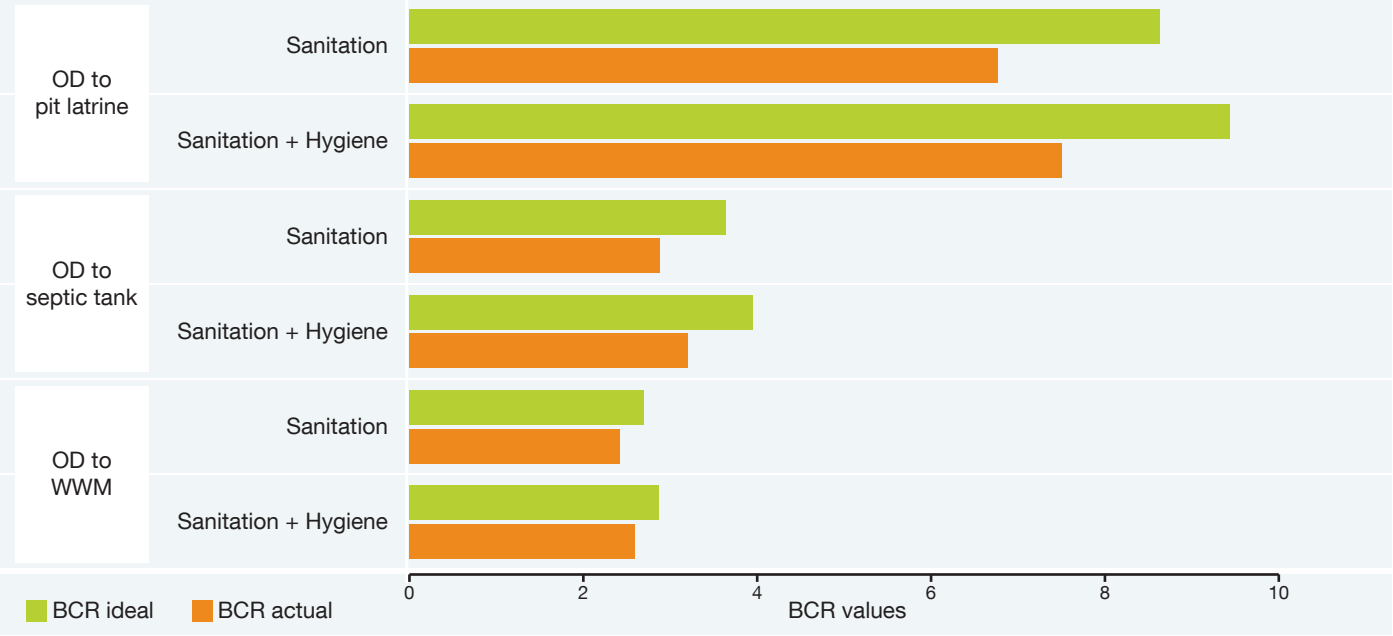
8.1.1 URBAN SITES

The economic analysis summarized in this chapter combines evidence of the cost and benefits of sanitation improvements already presented in earlier chapters, resulting in a number of alternative measurements of efficiency. Efficiency measures are presented in Table 50 and Figure 50 for urban interventions.

TABLE 50: AVERAGE URBAN AREA EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARED TO "NO TOILET" (OPEN DEFECATION - OD)

Efficiency measure	Scenario	OD to pit latrine	OD to Septic tank	OD to WWM
Field sites included		U1, U2	U1, U2, U3, U4, U5	U3, U4, U5
No. households surveyed		52	223	201
Option sub-types included		Shared toilet	Septic tank + soak away, ST + sewers w/o WWT	ST + separate or combined sewers + WWTPs
COST-BENEFIT MEASURES				
Benefits per VND input	Ideal	8.6	3.6	2.7
	Actual	6.8	2.9	2.4
Internal rate of return (%)	Ideal	>100%	>100%	57.0%
	Actual	>100%	>100%	49.6%
Pay-back period (years)	Ideal	<1	1.7	4.9
	Actual	<1	2.0	5.1
Net present value (VND '000)	Ideal	33,655	35,212	29,568
	Actual	24,925	24,617	24,356
COST-EFFECTIVENESS MEASURES				
Cost per DALY averted (VND '000)	Ideal	5,789	38,105	20,271
	Actual	7,099	41,335	20,726
Cost per case averted (VND '000)	Ideal	125	531	1,229
	Actual	154	576	1,256
Cost per death averted (VND '000)	Ideal	108,961	280,452	383,340
	Actual	133,608	304,237	391,909

FIGURE 50: SUMMARY OF AVERAGE BENEFIT-COST RATIOS IN URBAN SITES, SANITATION VERSUS SANITATION WITH HYGIENE



Key: WWM - wastewater management

Table 50 shows that actual benefits per US$1 input from all sanitation options amounted to more than US$1, with a benefit-cost ratio (BCR) ranging from 2.4 to 6.8. Under the ideal scenario, higher BCR values ranging from 2.7 to 8.6 were found. The highest BCR was found when moving up to on-site pit latrine (ideal 8.6, actual 6.8). Actual benefits as a proportion of ideal benefits ranged from 78.3% to 90.5%. The most closely matching values between ideal and actual were found with centralized wastewater management systems (2.4 and 2.7), showing a high rate of capacity utilization. The highest actual and ideal benefits came from moving from open defecation (OD) to pit latrine. The reasons for the differences between ideal and actual benefits of sanitation interventions are incomplete treatment levels and under capacity service of facilities, associated with planning, design and construction, and management activities. Hygiene interventions added to health benefits at low cost, and BCRs were higher for sanitation plus hygiene than for sanitation alone (see Figure 50).

Different internal rates of return (IRR) have been found. From a starting point of open defecation, the highest IRR was found from the adoption of an on-site pit latrine (more than 100%). IRR values were much higher than bank interest rates and those from government bonds, showing the possibility of mobilizing different financial resources to invest in sanitation systems, based on social returns.

The actual payback period ranged from less than 1 year (moving from OD to a pit latrine) to 5 years (moving from OD to a centralized wastewater treatment system). This short payback period is a key finding of this study, making sanitation a very attractive investment for government and social investors.

The actual net present value of the sanitation options compared to 'no toilet' ranged from VND24,356,000 (US$1,625) for centralized wastewater management to VND24,925,000 (US$1,750) for a pit latrine.

In terms of cost-effectiveness, with respect to health outcomes:

- Actual cost per disability-adjusted life year (DALY) averted ranged between VND7,099,000 (US$406) for a wet pit latrine and VND20,726,000 (US$1,185) for centralized wastewater management.
- Actual cost per case averted ranged from VND154,000 (US$8.8) for a wet pit latrine to VND1,256,000 (US$71.8) for centralized wastewater management.
- Actual cost per death averted ranged from VND133,608,000 (US$7,640) for a wet pit latrine to VND391,909,000 (US$22,410) for centralized wastewater management.

TABLE 51: AVERAGE RURAL AREA EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARED TO "NO TOILET" (OPEN DEFECATION - OD)

Efficiency measure	Scenario	OD to private wet pit (3)	OD to septic tank (4, 5)	OD to cluster w/w treatment (6)	OD to double-vault composting (7)	OD to biogas digester (8)
Field sites included		R2, R3, R4, R6, R7	R2, R3, R4, R5, R7	R7	R3, R4, R5, R7	R1, R2, R4
No. households surveyed		66	400	97	96	59
COST-BENEFIT MEASURES						
Benefits per VND input	Ideal	8.0	4.2	4.1	6.0	4.5
	Actual	6.4	3.4	3.6	4.5	4.0
Internal rate of return (%)	Ideal	>100	>100%	>100%	>100%	>100%
	Actual	>100	>100%	>100%	>100%	>100%
Pay-back period (years)	Ideal	<1	1.3	1.6	<1	1.8
	Actual	<1	1.6	1.8	<1	2.2
Net present value (VND '000)	Ideal	35,725	37,573	34,993	37,255	65,620
	Actual	26,560	25,973	27,324	26,147	53,468
COST-EFFECTIVENESS MEASURES						
Cost per DALY averted (VND '000)	Ideal	29,337	30,659	27,840	8,980	26,183
	Actual	31,429	34,766	27,299	10,714	28,013
Cost per case averted (VND '000)	Ideal	140	413	387	186	535
	Actual	156	462	379	223	571
Cost per death averted (VND '000)	Ideal	121,820	219,148	205,625	161,516	465,243
	Actual	135,283	245,059	201,629	193,415	496,020

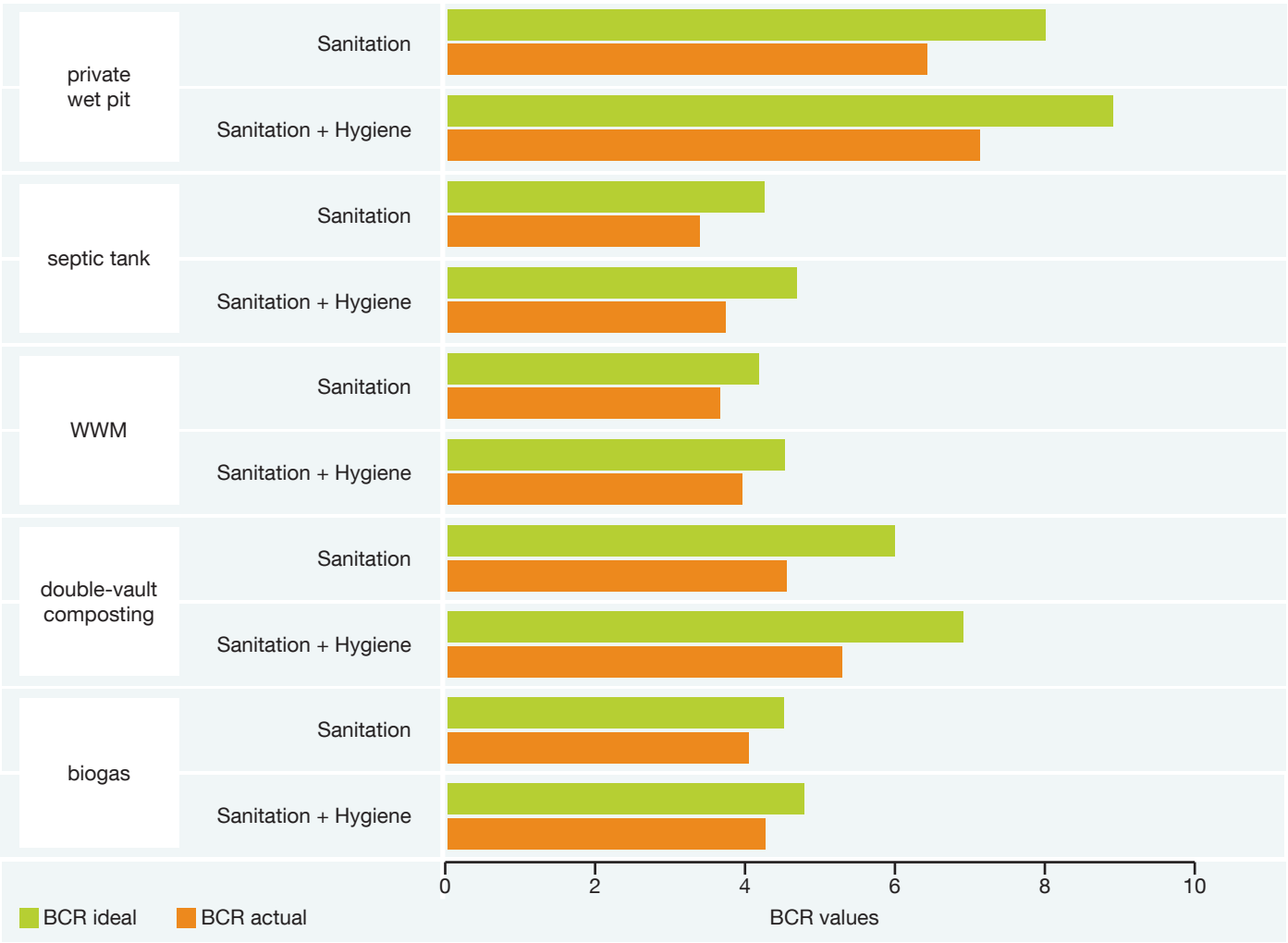
8.1.2 RURAL SITES

Table 51 and Figure 51 show that at rural sites, the ideal benefits per 1 US$ input from all sanitation options amounted to more than 1 US$, whereas the actual BCR ranged from 3.4 to 6.4. The highest actual BCR was found from adopting an on-site pit latrine (ideal 8.0, actual 6.4). Actual BCRs ranged from 75.9% to 87.7%. The lowest actual and ideal benefits were realized by projects using double-vault composting toilets. Although these toilets would significantly solve pollution issues (because they are a waterless sanitation option and add value through safe excreta and urine reuse), it is difficult to achieve a high coverage ratio of this kind of toilet. The highest performing actual ratio compared to the ideal scenario was found in community wastewater management projects, because of the high participation of households in project activities.

Different IRRs have been found. The highest IRR was found in on-site pit latrine and double-vault composting toilets (more than 100%), thanks to the low cost of moving up from OD to rural sanitation options. The IRR values were much higher than bank interest rates and those from government bonds, showing the possibility of mobilizing different financial sources to invest in sanitation systems. However, low rates of return have been found for other sanitation options such as septic tanks, cluster wastewater collection and treatment, and double-vault composting toilets. This shows that in order to stimulate the participation of potential funders in investment for sanitation improvement, special financial policies should be applied. The private sector may not be interested in investing in rural sanitation if it does not see sufficient benefits from this kind of business. Sanitation sector practices have shown the success of different financial resource models, such as mobilizing a revolving fund in cities and towns, and micro-finance in rural areas, where households could receive loans with a favorable interest rate and payback conditions.

The actual payback period ranged from less than 1 year (moving from OD to a pit latrine) to 2.2 years (moving from OD to a biogas digester). The highest payback period was for a biogas digester, due to its complexity and high construction cost. The ideal payback period is only 1.8 years.

FIGURE 51: SUMMARY OF AVERAGE COST-BENEFIT RATIOS AT RURAL SITES, SANITATION VERSUS SANITATION WITH HYGIENE



Key: WWM - wastewater management

The actual net present value of these sanitation options, compared to 'no toilet' ranged from VND25,973,000 (US$1,485) for a septic tank to VND53,468,000 (US$3,060) for a biogas digester.

In terms of cost-effectiveness, with respect to health outcomes:

- Actual cost per DALY averted ranged from VND10,714,000 (US$613) for a double vault composting toilet to VND34,766,000 (US$1,979) for a septic tank.
- Actual cost per case averted ranged from VND156,000 (US$8.9) for a wet pit latrine to VND571,000 (US$32.6) for a biogas digester.
- Actual cost per death averted ranged from VND135,283,000 (US$7,735) for a wet pit latrine to VND496,020,000 (US$28,360) for a biogas digester.

8.2 EFFICIENCY OF ALTERNATIVE WAYS TO MOVE UP THE SANITATION AND HYGIENE LADDER

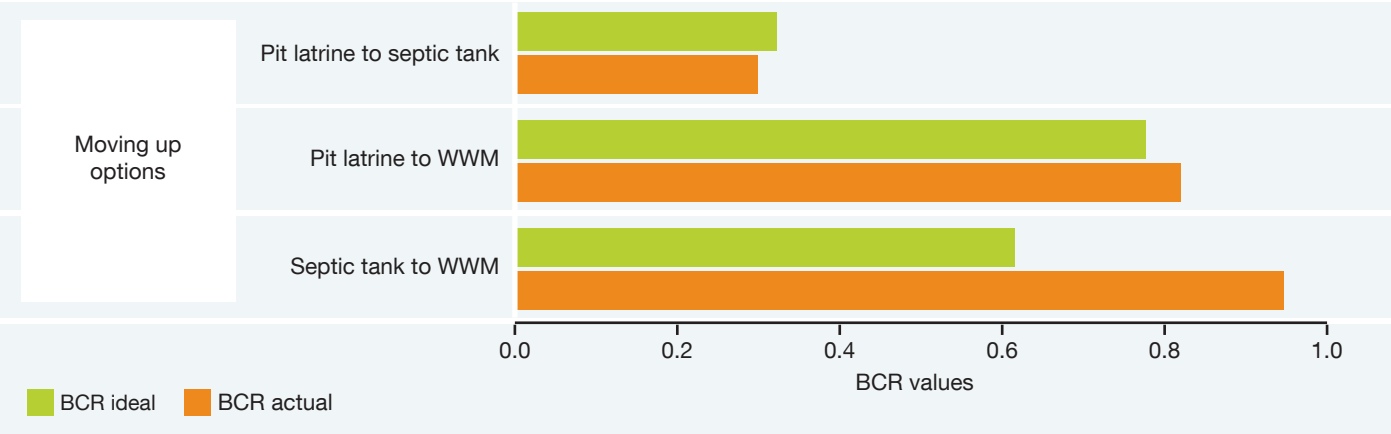
8.2.1 URBAN SITES

The analysis of moving up the sanitation ladder in urban areas has yielded interesting results (see Table 52 and Figure 52). When moving up from pit latrine to septic tank, or to a centralized wastewater treatment system, the BCR was less than 1. This finding indicates clearly that sanitation planning is crucial to the maximization of the benefits of a sanitation project. Well-considered decision-making at the early stages of the project cycle will reduce the cost of system upgrading.

TABLE 52: AVERAGE URBAN AREA EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Wet pit latrine to septic tank	Wet pit latrine to WWT	Septic tank to WWT
Field sites included		U1	U3, U5	U3, U4, U5
COST-BENEFIT MEASURES				
Benefits per VND input	Ideal	0.3	0.8	0.6
	Actual	0.3	0.8	0.9
Internal rate of return (%)	Ideal	-	-	-
	Actual	-	-	-
Pay-back period (years)	Ideal	>20	>20	>20
	Actual	>20	>20	>20
Net present value (VND '000)	Ideal	(10,906)	(24,642)	(17,807)
	Actual	(10,642)	(23,027)	(14,254)
COST-EFFECTIVENESS MEASURES				
Cost per DALY averted (VND '000)	Ideal	(41,272)	88,718	122,484
	Actual	(44,670)	89,430	105,870
Cost per case averted (VND '000)	Ideal	(2,022)	(2,568)	(3,545)
	Actual	(2,188)	(2,526)	(3,022)
Cost per death averted (VND '000)	Ideal	1,400,455	1,639,888	1,908,607
	Actual	1,515,737	1,611,744	1,626,000

FIGURE 52: ECONOMIC PERFORMANCE MOVING UP THE SANITATION LADDER (URBAN)



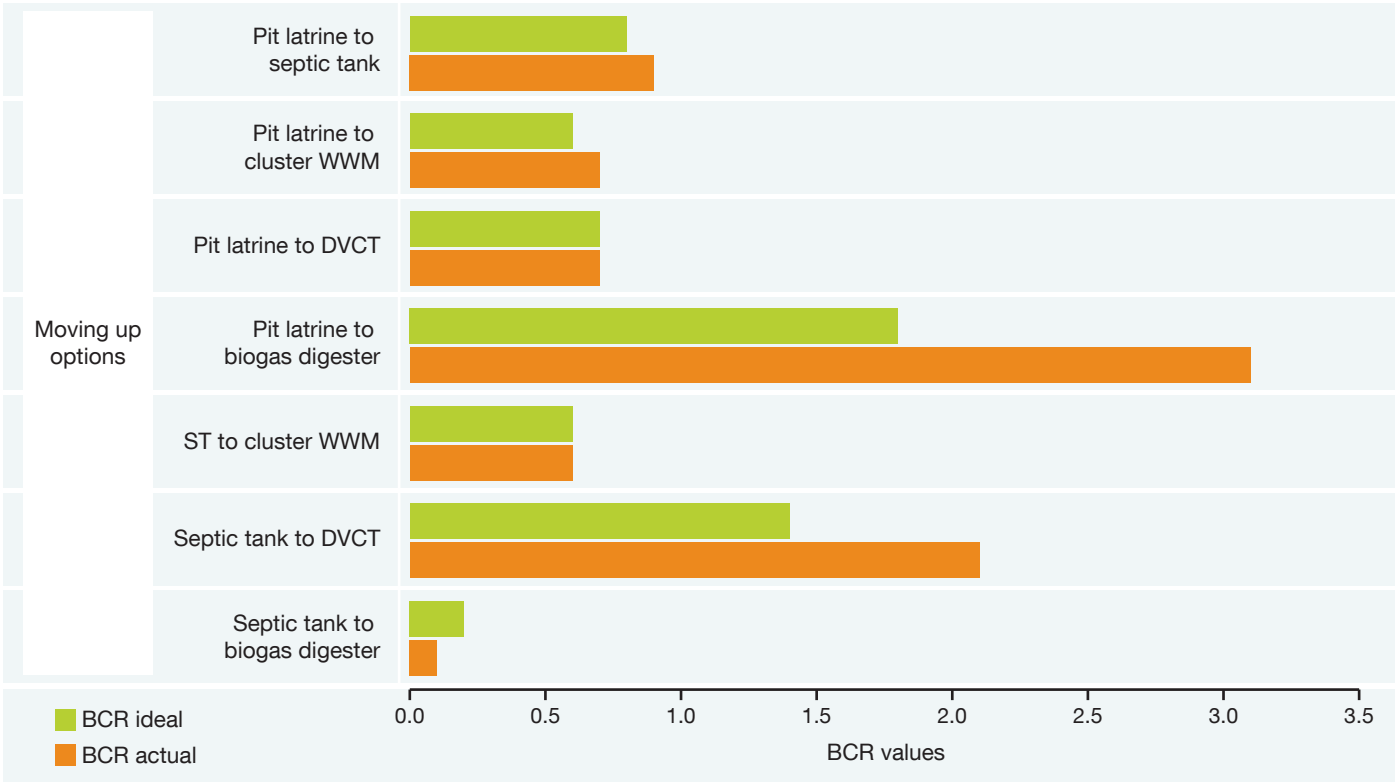
8.2.2 RURAL SITES

Moving up the sanitation and hygiene ladder is a common practice in rural areas, especially when a household is able to upgrade its house and other infrastructure components. The upgrade may be the result of a decision by the household, or be the result of awareness-raising activities in the community or other external information sources. As shown in Table 53 and Figure 53, most upgrading options involve higher costs than corresponding benefits. The exceptions to this include moving from pit latrine to biogas digester, and moving from septic tank to double-vault composting toilet. Significant improvements in health status, the environment and other aspects can be realized when moving up from OD to a pit latrine, but apart from the aesthetic and convenience factors, it is difficult to find quantitative evidence of improvement when moving up to a new sanitation type, especially when they are all considered to be hygienic. The BCR value (which is more than 1) realized when moving

TABLE 53: AVERAGE RURAL AREA EFFICIENCY MEASURES FOR MAIN GROUPINGS OF SANITATION INTERVENTIONS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Wet pit latrine to septic tank	Wet pit latrine to cluster WWT	Wet pit latrine to double-vault composting	Wet pit latrine to biogas digester	Septic tank to cluster WWT	Septic tank to double-vault composting	Septic tank to biogas digester
Field sites included		R2, R3, R4, R7, R9	R7	R3, R9	R1, R4	R7	R3, R9	R4
COST-BENEFIT MEASURES								
Benefits per VND input	Ideal	0.3	0.8	0.6	0.3	0.8	0.6	0.3
	Actual	0.3	0.8	0.9	0.3	0.8	0.9	0.3
Internal rate of return (%)	Ideal	-	-	-	-	-	-	-
	Actual	-	-	-	-	-	-	-
Pay-back period (years)	Ideal	>20	>20	>20	>20	>20	>20	>20
	Actual	>20	>20	>20	>20	>20	>20	>20
Net present value (VND '000)	Ideal	(10,906)	(24,642)	(17,807)	(10,906)	(24,642)	(17,807)	(10,906)
	Actual	(10,642)	(23,027)	(14,254)	(10,642)	(23,027)	(14,254)	(10,642)
COST-EFFECTIVENESS MEASURES								
Cost per DALY averted (VND '000)	Ideal	(41,272)	88,718	122,484	(41,272)	88,718	122,484	(41,272)
	Actual	(44,670)	89,430	105,870	(44,670)	89,430	105,870	(44,670)
Cost per case averted (VND '000)	Ideal	(2,022)	(2,568)	(3,546)	(2,022)	(2,568)	(3,546)	(2,022)
	Actual	(2,188)	(2,526)	(3,022)	(2,188)	(2,526)	(3,022)	(2,188)
Cost per death averted (VND '000)	Ideal	1,400,455	1,639,888	1,908,607	1,400,455	1,639,888	1,908,607	1,400,455
	Actual	1,515,737	1,611,744	1,626,000	1,515,737	1,611,744	1,626,000	1,515,737

FIGURE 53: ECONOMIC PERFORMANCE MOVING UP THE SANITATION LADDER (RURAL)



up from a pit latrine to biogas is due to the added benefits of biogas and slurry utilization. The BCR of over 1 realized when moving up from a septic tank to a double-vault composting latrine (DVCL) was due to the reduced operating costs of DVCL, and the added value of compost and urine. BCR values of less than 1 when moving up the ladder show the importance of sanitation planning and careful choice during project implementation. This is because changing sanitation options during the existing option's service lifespan is not economically beneficial.

8.3 SCALING UP RESULTS FOR NATIONAL POLICY MAKING

The ultimate purpose of this study is not only the improvement of sanitation decisions at the surveyed field sites, but an assessment of national policies in the light of the field level results. Therefore, the applicability of the study results to the national level depends on the extent to which they represent the rest of the country, and the level of agreement between field sites with different characteristics.

Figure 54 shows a summary of the results per field site and per option, and the average BCR per technology. All sanitation interventions at all sites have brought positive results. All BCR values are more than 1. At urban sites they range from 1.4 to 7.5 (actual values) and 1.4 to 9.4 (ideal values). At rural sites, actual BCR values range from 2.0 to 9.7, and the ideal values range between from 2.7 and 11.7. In both urban and rural areas, on-site pit latrines realize the highest benefit values, thanks to the low costs involved. In comparison with on-site sanitation facilities, centralized wastewater treatment plants require higher investment and operation and maintenance costs.

An individual BCR calculation was conducted for medium- and large-scale biogas digester projects, based on the case of Thanh Hoa. A significant difference has been found between two calculation approaches. The BCR value was less than 1 when benefits were calculated from the sanitation component only. Investment costs required for a large-scale biogas digester system are higher than the value of reuse benefits. Actual and ideal BCR values are close, ranging from 0.6 to 0.7 for 'sanitation only' and for 'sanitation + hygiene', respectively. However, for a farm incorporating biogas into its entire business, the actual and ideal BCR values are 2.0 and 2.1, respectively. A biogas digester can help a farm deal with its waste problem, because there are net benefits of electricity generation from biogas and the crops grown with the aid of bio-slurry utilization.

The field results lead to the following conclusions:

- The benefits of sanitation and hygiene improvement do not vary significantly between different locations within the country.
- Hygiene improvement activities, along with sanitation improvement efforts, bring the highest BCR values. Due to economies of scope (reducing the marginal cost of adding a service), an integrated approach to the implementation of water supply, sanitation and hygiene components is likely to produce more sustainable results and more benefits.
- The reuse of treated wastewater and sludge in agriculture would bring significant benefits to integrated sanitation systems. Safe and efficient resource recovery should be targeted in sanitation improvement projects, especially in areas where resources are lacking.
- Different BCR values are found with different sanitation options. Early sanitation planning would avoid inefficient investment in sanitation systems that would later require upgrading.

8.4 EFFICIENCY OF SOLID WASTE MANAGEMENT

Figure 55 presents the BCR of solid waste management improvement projects. The actual BCR values range from 0.9 to 2.5, while the ideal values range from 1.4 to 4.5. Ideal values are 49% to 61% less than actual values, when there is increased coverage of solid waste management service and hence higher household participation. Sanitary landfill increases the BCR value due to both reduced water treatment costs and increased land values. The BCR is high in areas where the cost of land is high. Improved solid waste management practices also increase other non-quantified aesthetic values.

When moving up from conventional solid waste collection and sanitary land filling to source separation and composting of the organic fraction of solid waste, the BCR value can be less than 1 (the actual value of BCR of the Hanoi 3R pilot project is 0.9), or more than 1 (the ideal BCR value is

1.4). The higher BCR value could be achieved when service coverage and community participation are assured. This information is crucial for solid waste management planning in both urban and rural areas, where big investment and recurrent costs may constitute a barrier for decision makers. The benefits of compost products, reduced transportation and landfill land, and an improved environment around landfill sites are major benefits associated with sustainable approaches to solid waste management. Further benefits may be also gained if more resources are recovered by the anaerobic digestion of organic waste, capturing biogas from landfill under the Clean Development Mechanism.

FIGURE 54: BENEFIT-COST RATIOS FOR ALL SURVEY SITES IN URBAN AND RURAL AREAS

FIGURE 55: BENEFIT-COST RATIOS FOR SOLID WASTE MANAGEMENT IMPROVEMENT PROJECTS

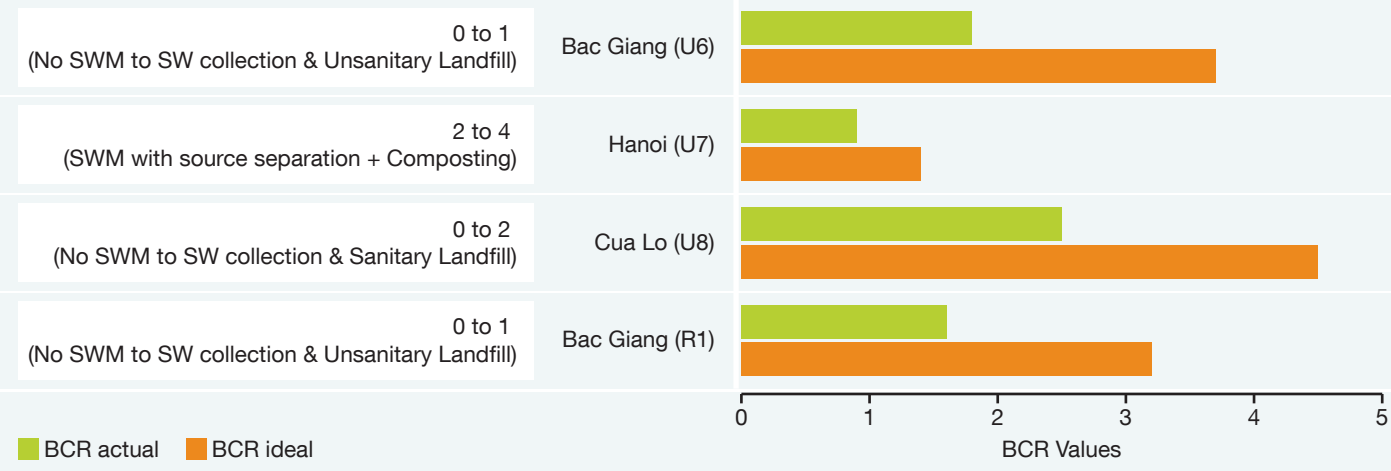


Figure key: SWM - solid waste management; SW - solid waste

IX. Discussion

9.1 STUDY MESSAGES AND INTERPRETATION

9.1.1 MAIN MESSAGES

Costs: In urban areas, there is a clear increase in costs associated with moving up the sanitation ladder. Centralized wastewater treatment in urban areas is more expensive than options that involve only on-site sanitation improvement in household. This is because it involves a big investment in collection sewers and drains, and wastewater and sludge treatment facilities. The value of one-off spending urban centralized wastewater systems were VND14,924,000 (US$853) per household.

In rural areas, the highest investment costs are associated with biogas digester construction (VND10,836,000 (US$620) per household), and for community wastewater collection and treatment systems (VND8,972,000 (US$513) per household for cluster wastewater management). Investment costs for a septic tank in urban and rural areas varied from VND3,323,000 (US$190) to VND6,000,000 (US$343) per household. The investment cost for composting double-vault toilets in rural areas was VND3,053,000 (US$175) per household, including superstructure, which is often made from the local materials. The lowest investment costs were associated with pit latrines, which cost an average of VND1,700,000 (US$97).

Program costs varied from project to project (19.8% of total investment costs in urban projects, and 4.6% in rural projects), while the highest ratio of program costs was seen in urban centralized wastewater management projects.

Non-financial costs of programmed sanitation improvement projects in the current survey, which included unpaid volunteer time and contributions of unused construction materials by households, were very low.

The highest annual recurrent costs were associated with urban wastewater management systems (VND1,174,000 or US$67 per household, including program costs). Annual operation and maintenance costs for all on-site sanitation systems in urban and rural areas, except pit latrines, were of a similar value (VND324,000 or US$18 per household). Low-cost, simple pit latrines involve fewer annual operation and maintenance costs (VND163,000 or US$9.3). The major recurrent costs for on-site sanitation systems were for washing water, toilet cleaning and sludge handling.

Sources of funding: The major funding in urban areas still comes from the official development assistance grants or loans (56%), while local and central government contributions account for 20.8%. Total contributions for centralized wastewater management from the government and donors were much higher than contributions from households (76.8% versus 23.2%). At sites where the only sanitation improvement was household sanitation and drainage (not including centralized sewerage and drainage), households made the most contribution (59.4% to 98%).

In rural areas, household contributions as part of the overall economic cost of sanitation improvement at all surveyed sites ranged from 50.3% (cluster wastewater management) to 90% (biogas digester). Contributions from the government, NGOs and other donors accounted for not only financing, but also crucial soft interventions, such as awareness raising, management structure improvement and technical support provision.

Sanitation options: Septic tanks, or septic tanks with wastewater management are major sanitation types in all urban areas, except for Buon Ma Thuot (U5) where a centralized separate wastewater collection and treatment system was applied. Septic tanks are also a major sanitation type in

rural survey sites. Only at Lai Xa (R7) was a different (rural cluster wastewater management) system applied. Double-vault composting toilets are quite popular in Quang Ngai (R3) and Hue (R9) where sanitation projects have been carried out with well-organized IEC activities associated with informed choice for households.

Household sanitation options, and prices paid, are expected to vary by wealth quintile. The richest households prefer septic tanks, and none of the richest quintile households practiced OD. All types of sanitation were found in middle- and lower-income households.

There are big differences between rich and poor households in terms of the percentage of income paid for the same sanitation type. The poorest households take more than 1.5 years to pay for septic tank construction, and spend around 17% of their income on recurrent costs each year. The richest households have to spend only 5% of their annual income for the construction of a septic tank, and spend 0.6% of their income annually on recurrent costs.

Effectiveness of sanitation interventions: Actual benefits per US$1 spent on all urban sanitation options amounted to more than US$1, while the average BCR ranged from 2.4 to 6.8. In the ideal scenario, average BCR values ranged from 2.7 to 8.6. The highest BCR was found in moving up from OD to an on-site pit latrine (ideal 8.6, actual 6.8). Hygiene interventions added to health benefits at low cost, and ratios were higher for sanitation plus hygiene than for sanitation alone.

The possibility of reusing treated wastewater and sludge adds value to the benefits of improved sanitation. In practice, it takes time to establish a complete wastewater management system in any area. The actual value of moving up from a septic tank or another on-site treatment facility to a centralized wastewater treatment system realizes a BCR of below 0.5, because high investment and running costs are involved, while incomplete wastewater collection and treatment reduces public health and environmental benefits.

At rural sites, the ideal benefits per US$1 input from all sanitation options were more than US$1, while the average actual BCR ranged from 3.4 to 6.4. The highest actual BCR was associated with on-site pit latrines (ideal 8.0, actual 6.4).

The actual payback period at urban sites ranged from less than 1 year (moving from OD to a pit latrine) to 4.9 (ideal) and 5.1 (actual) years (moving to a centralized wastewater treatment system). The actual payback period in rural areas ranged from less than 1 year (moving from OD to a pit latrine) to 2.2 years (moving to a biogas digester). The payback period associated with a biogas digester is mostly accounted for by the complexity and high construction cost involved in its construction. The payback period of a biogas digester under the ideal scenario is only 1.8 years. Such a short payback period should make decision makers and investors as well as public service utilities very interested in investing in sanitation.

Different internal rates of return (IRR) have been found. Thanks to the comparatively low cost of moving up from the OD, the highest IRRs were associated with on-site pit latrines and double-vault composting toilets (more than 100%). IRR values were much higher than bank interest rates and returns from government bonds, showing the possibility of mobilizing different financial resources to invest in sanitation systems. However, very low rates of return are associated with other sanitation options, such as septic tanks, cluster wastewater collection and treatment double-vault composting toilets. This shows that special financial policies should be applied in order to increase interest in investment for sanitation improvement, and to enhance participation. The private sector may not be interested in investing in rural sanitation if it does not see sufficient benefits from doing so. Sanitation sector practices have shown the success of different models of financial resource mobilization, such as revolving funds in cities and towns, and micro-finance in rural areas, where households can get loans with favorable interest and payback conditions.

In relation to solid waste management projects, while moving up from conventional solid waste collection and sanitary land filling to source separation and composting of organic fraction of solid waste, the BCR value varies from less marginally less than 1, to 2.5 (actual scenario) and as high as 4.5 under ideal scenario. The major benefits of sustainable solid waste management include compost products, re-

duced transportation and landfill land and improved environment around landfill sites. Further benefits may be also gained if resources are increasingly recovered by anaerobic digestion of organic waste, and gathering biogas from landfill under the Clean Development Mechanism (CDM).

Efficiency of moving up the sanitation ladder: The BCR associated with moving from pit latrine to septic tank, or to a centralized wastewater treatment system was less than 1 in urban areas. In rural areas, moving up the sanitation and hygiene ladder is a common practice, especially when household are able to upgrade their houses and other infrastructure components. All upgrades have a higher cost than benefit, except for moving from a pit latrine to a biogas digester, or from a septic tank to double-vault composting toilet. BCR values of less than 1 associated with moving up the ladder show the importance of sanitation planning and choosing carefully during project implementation, since switching to a new sanitation option during the service lifespan of another is not economically beneficial (according to the assumptions of the cost-benefit analysis).

Sanitation and tourism: In a previous survey of 8,300 tourists conducted in 2005, 74% of respondents considered Vietnam's environment to be clean and beautiful and 66% said that they were satisfied with the sanitation facility in their accommodation. The tourist survey conducted in the ESI study found that 58% of respondents gave a low score of 1 or 2 (out of 5) for public toilets and 40% of respondents give a low score 1 or 2 (out of 5) for toilets at bus stations. Some 70% of tourists asked about their concerns regarding sanitation cited tap water (33%) and food (69%) as potential causes of diarrhea. Of the 18% of tourists saying that they 'may' or are 'hesitant' to return to Vietnam, 13% cited poor sanitation as a major or contributory reason. While poor sanitation is a general issue that needs to be tackled to make a visit to Vietnam more enjoyable, it is not a defining issue for tourists in terms of the enjoyment of their stay or a reason to stop the majority from coming back.

Sanitation and business: The ESI survey found different levels of importance of environmental sanitation different types of business. The hotel business considered environmental sanitation conditions to be the most important of all criteria, as it affects its workforce health, water quality, a pleasant environment for its staff, and the availability of cheap and good land. The quality of water sources is considered the most important criteria for firms working in beverage production, and consumer goods. Consulting firms prefer to select locations where their staff can experience a pleasant environment, which should increase competitiveness. Sanitation improvement means more business opportunities for almost all of the firms surveyed.

9.1.2 ROBUSTNESS OF RESULTS

Health data: Health data collection was a big challenge. Health record-keeping is not performed well at the lower levels of administrations and clinics in Vietnam. Many patients prefer not to get treatment at local clinics, and instead visit central hospitals that are much better equipped. This phenomenon makes estimation of area-specific reporting rates difficult for some urban sites.

Selection of sampling points for the water quality survey: The water quality survey was made only one time at each site, hence limiting the ability to attribute findings to the type of sanitation facilities serving each field site.

Project documents of completed projects: Some data inputs for the cost-benefit analysis model had to be calculated based on data from other sources than field surveys. Since some of the selected projects had been completed, it was difficult to obtain the additional data.

Value of time: Access time was estimated based on the household survey, focus group discussion and expert opinion. The time value of 30% of the average hourly income was assumed with reference to previous peer-reviewed economic studies, and was applied in the same way to all urban and rural sites.

Health and solid waste management: No relationship could be established between solid waste improvements and the health status of the community and landfill workers, due to lack of underlying data. Therefore, the health benefits of solid waste management improvement were not included in the BCR for solid waste management projects.

9.2 UTILIZATION OF RESULTS IN DECISION MAKING

9.2.1 POTENTIAL USES OF RESULTS

This study aims not only to improve the sanitation decisions made at field sites, but also to assess national policies in the light of the field level results. Governments need to decide what resources to allocate to sanitation and which sanitation services to promote. This study provides information that has never previously been available in Vietnam. Data on costs, efficiency and program performance could be used as a critical driver to support new and fine-tune existing sanitation programs and policies. Importantly, the results from different socio-economic settings and from different parts of the country all show similar conclusions in relation to the general efficiency of sanitation options. Therefore, policy makers can be confident that the results can be generally applied to the rest of the country.

Comparative performance of promising new interventions: New technology options such as small-bore sewerage, low-cost wastewater treatment in ponds or constructed wetland, and improved septic tanks have been well accepted. There was also a case where a combination of low-cost and high-tech technologies was applied. The decentralized wastewater management scheme in rural and peri-urban areas seem a very promising approach, including cluster wastewater treatment stations that apply low-cost treatment technologies, and combined wastewater collection networks with overflow chambers.

Costs of moving 'up the ladder': Costs increase when moving up the ladder, with the higher options involving higher capital and recurrent costs. The centralized wastewater treatment option in urban areas is the costliest in comparison with those at other sites (that involve only on-site sanitation improvement in the households), because it involves substantial investment in collection sewers and drains, and wastewater and sludge treatment facilities.

Public good arguments: Analyzing cost contribution for the sanitation projects, one finding is that the household itself mainly pays for on-site sanitation options. The appropriate strategy to encourage household owners to invest in sanitation is through soft interventions, such as information, education and communication (IEC) activities, externally supported technical guidance, regulation enforcement, and micro-financing tools. Beyond the household level, sanitation projects cannot expect a significant contribution from households, though community mobilization plays a crucial role in increasing connection rates. The appropriate strategy in this case is to utilize foreign loans, grants and other financial initiatives to attract private sector participation.

Financial mechanisms are needed to enable low-income households to pay for sanitation, in order to achieve universal coverage and capture the full community-wide benefits of improved sanitation. Good lessons are provided by such models as micro financing or revolving funds operated through local authorities or local women's unions. Since most investment comes from households during the project period, willingness-to-pay should be improved by interventions besides hardware activities.

A higher BCR value for solid waste management projects could be achieved when service coverage and community participation are assured. This is crucial for solid waste management planning in both urban and rural areas, where big investment and recurrent costs may be barriers for decision makers.

9.2.2 UP-SCALING SUCCESSFUL CASE STUDIES

The experiences gained during the Three Delta Towns water supply and sanitation (WS&S) Project in including institutional development and community development, capacity building and implementation activities are highly applicable. There is a vital need for the promotion and development of strong links and good coordination between water supply and sanitation companies and community organizations at all stages of project planning and implementation. Similar lessons have been learnt through efforts to deliver infrastructure services to the urban poor in the project 'Expanding benefits for the poor through urban environmental improvements in Tam Ky city'.

The Three Cities sanitation project demonstrated a number of useful technical experiences for dissemination. The project has shown a good combination of a high-tech and

low-cost wastewater treatment options (maturation pond), which allow an environmental-friendly pathogen removal and polishing/maturation treatment step, before treated wastewater is discharged into Ha Long Bay. Besides, with wastewater treatment plants and capacity building component for the Urban Environmental Companies, septic tank sludge management has been improved. Furthermore, adding a solid waste management component to drainage and sewerage activities reduces negative impacts further.

The environmental sanitation project for Buon Ma Thuot City has shown that separate, small-bore sewerage systems without a septic tank can work in urban areas of Vietnam. The experience gained through the connection of households to a separate sewerage system in Buon Ma Thuot City should provide valuable insights for future similar projects in Vietnam. The use of waste stabilization ponds in series and water reclamation in Buon Ma Thuot also provides a good demonstration of successful low-cost sanitation.

The Water Supply and Sanitation for Small Towns in Vietnam Program (WSPST) provides good examples of scaling up. The project shows the importance of studies and training to support implementation, including: a socio-economic survey; and studies into willingness to pay and commitment to connect, capacity building, a human resource development strategy, awareness-raising programs, evaluation of different technological options, and project monitoring and evaluation. Currently the project is conducting its second phase, in which lessons learned are being utilized in water supply and sanitation in another four provinces in the northern mountains.

The Cuu Long Delta Rural Water Supply Project has also demonstrated key findings for dissemination. The Vietnamese central and local authorities should make more effort to set up continuous community participation and health promotion programs within and beyond the project framework. A clear mandate and operational mechanism for financing, implementing, and monitoring and evaluating these activities at the provincial level should be set up. Co-financing among relevant local authorities increases the efficiency and sustainability of services.

Models of Sanitation, Hygiene and Water Improvement Project (SHWIP) supported by international NGOs, such as Plan in Quang Ngai, YWAM in Lai Xa, Hanoi, International Development Enterprises (IDE) in Quang Nam, and SNV biogas program with the Ministry of Agriculture and Rural Development, are very good demonstration cases. The Quang Ngai project shows that better coordination and integration between project and government activities is necessary for better resource mobilization, efficiency and sustainability.

An important finding in the project supported by IDE was that the increase in demand was achieved without using capital cost subsidies. This was accomplished by using locally available market innovations that suited local lifestyles, and most importantly, through effective communication. Now that the project has been completed, private sector providers can continue to serve rural communities. It has been shown that masons can now supply spare parts and provide post-sale services to existing customers, cater to the demands of new customers, and even expand their customer base and business through innovative local promotional strategies.

At Lai Xa, the population's interest in maintaining cleanliness and wastewater reuse were key factors in promoting participation demand and willingness-to-pay for wastewater treatment. Analysis also shows that hamlet and commune administrations can play an effective coordinating role in the project when management capacities are reinforced. As Vietnam aims to improve sanitation coverage in the coming years, a pilot effort like the Lai Xa project demonstrates the promising option of investing in decentralized wastewater management. A decentralized low-cost sanitation approach that involves appropriate technical options and management schemes, and increased investment in IEC and behavior change activities should be strongly promoted in future projects.

As seen in Lai Xa, some level of decentralized sanitation responsibility could effectively improve sanitation coverage in Vietnam if management and technical capacities are reinforced at lower institutional level. This supporting task could be undertaken by the government water and sanitation agencies, or by urban water and sanitation companies.

The great success achieved in biogas construction and electricity generation for livestock-breeding farms is attracting the interest of farmers. Appropriate technical guidance, pollution control by local environmental management authorities, and favorable money lending policies are necessary elements of this intervention.

All solid waste management projects considered in the current study provide good lessons for dissemination. As in other water and sanitation projects, the success of a solid waste management project very much depends on household participation. Financial and associated technical support for local environmental sanitation service providers are needed, while IEC and behavior change activities are necessary for raising awareness and keeping the community involved.

X. Recommendations

The economic performance of sanitation and hygiene projects is favorable throughout the country. The actual performance of sanitation programs is often lower than ideal performance, as indicated by the non-use of toilets and continued pollution of the environment. This indicates that attention must be given to the determinants of non-performance.

The study findings emphasize the importance of choosing the right sanitation option in terms financial sustainability, when moving up the sanitation ladder and upgrading existing systems. They also indicate the need to consider other, non-quantified benefits not included in the benefit-cost ratios. Recommendations from the study are:

Recommendation 1: Intensify efforts to increase access to basic improved sanitation in rural areas and improved wastewater management in urban areas

Despite the progress of the country in meeting the MDG targets for sanitation, a sizeable number of rural people still use unimproved sanitation facilities, and only a small proportion of urban wastewater is treated adequately. As a result, the estimated economic burden of poor sanitation in the country remains high. This suggests a need for more investment in improved sanitation facilities. This investment is essential to reducing the costs that poor sanitation imposes on health, water for drinking and other uses, tourism, business operations, and the overall quality of life. This may also stimulate economic activity in markets that provide inputs to and outputs from (reuse) the sanitation sector. The sources of investment funds for the sanitation and hygiene sector should be strengthened and diversified, while interventions by the public sector and development banks should be targeted to maximize developmental benefits, especially aiming to increase access and uptake among poor and vulnerable households.

Recommendation 2: Sanitation planning should carefully consider the performance of alternative technology options and delivery approaches to maximize program efficiency

Early sanitation planning would avoid inefficient investment in sanitation systems that are not financially sustainable or that are inadequate for a population's needs and later require upgrading. Broader economic costs and benefits and direct financial requirements and impacts should both be considered as part of technology and program delivery selection. Technology selection and project design should take into account life-cycle costs, future increases in the price of construction, the specific conditions of target sites and the related opportunities and limitations of sanitation programs. Decision makers at all levels should be encouraged to select those technologies and designs that not only successfully capture the financial and economic benefits of sanitation, but also at an affordable cost that is appropriate to the specific context.

Based on the results of this and other studies, guidelines should be drawn up for technology options and program delivery approaches for different geographical, demographic and socio-economic settings in Vietnam. Local authority capacity and skill in planning, design and contracting should be built and mobilized to enable improved planning at decentralized level. To increase program efficiency, lower-cost and standard designs that incorporate improved environmental features should be made available to project design teams.

Furthermore, Vietnamese environmental standards are still not fully developed to enable the planning of sustainable sanitation options. There are still large gaps and contradictions among effluent standards and water resource classification. This complexity leads to the selection of inefficient technol-

ogy and inequity in relation to different wastewater discharges. Therefore, continued attention is required in these areas.

Safer reuse of treated wastewater and sludge in agriculture would bring significant positive benefits in Vietnam. Safe and efficient resource recovery systems should be applied more widely, especially in areas (e.g. farming communities) that have a high capacity to benefit from these systems.

Recommendation 3: A manageable monitoring and evaluation (M&E) framework should be designed for sanitation programs – a framework that defines how to measure relevant impacts of sanitation options comprehensively

Sanitation program managers and implementers, and government staff, need to better understand the efficiency of sanitation programs, so that they can fine-tune ongoing programs for implementation, and practice ex-post evaluation for better design and implementation of future sanitation programs. Outcome-oriented M&E is a relatively new concept in Vietnam and hence needs to be introduced in a way that fits in with national systems and processes. It is necessary to develop an adequate information mechanism, database, and M&E and reporting systems in the water and sanitation sector. Furthermore, users need to be sensitized and trained appropriately in the M&E system.

Recommendation 4: Encourage the private sector to be part of the solution

There are significant opportunities for sanitation markets in Vietnam, in which the private sector is well placed to play a major role. Besides the benefits of reduced environmental pollution and improved public health, the benefits associated with resource recovery and sanitation market activities are potentially major, including job creation and poverty alleviation. Integrated waste management also brings a number of social and economic benefits. Adequate policies and mechanisms and sufficient supporting tools are needed to encourage public and private sector participation. Demonstration projects are needed that relate to critical issues such as cost reduction and resource recovery. Since resource recovery covers different stakeholders, inter-sectoral cooperation is needed.

'Willingness to pay' data must be carefully collected and used with caution. Government capital subsidies to households create favorable conditions for implementation, but the 'polluter pays' principle should be applied to ensure financial sustainability of the sanitation system. Regulatory frameworks are also needed to strengthen pollution control capacity at different levels of management.

The differences between the economic and social benefits to society versus the financial benefits to sanitation businesses (based on the willingness of consumers to pay) mean that special financial instruments should be applied. The two models with greatest potential in Vietnam are Revolving Funds, mainly in the urban areas, and Micro-Finance, which is widely applicable. However, poorer households should receive loans with more favorable interest rates and payback conditions to increase uptake and reduce inequity.

Recommendation 5: Mobilize community participation as it is crucial to the sustainability of sanitation programs

Appropriate sensitization and involvement of both customers and service providers/scheme owners is crucial to the sustainability of sanitation program investment and service flows. It is therefore recommended that a comprehensive behavior change strategy that includes community/beneficiary participation be implemented, covering all phases of project development, from preparation to post-construction. Approaches should be based on consultation and participation, and the key stakeholders (customers, service providers and scheme owners) should not only be at the receiving end of information, but also actively involved in decisions, and the promotion and improvement of services. The participation of women in particular is crucial to the success of a project. Strategies and plans must be accompanied by proper selection and capacity building of local behavior change strategy facilitators. Moreover, the projects should provide support to local organizations so that after it is phased out, behavior change and IEC follow-up will be performed by local stakeholders.

Recommendation 6: Further operational research is needed to inform decision makers on benefits not covered adequately in this study, and impacts and determinants of success that are highly context-specific

Following the limitations cited in Chapter 9, there is clearly a greater need for more research in the sanitation sector. This includes:

- Generating reliable site-specific and age group-specific incidence and mortality rates for sanitation-related diseases such as diarrhea and helminths.
- Establishing rigorous and site-specific quantitative links between sanitation improvement and: disease incidence (attribution factors); tourism; water use and access; water quality; business activity.
- Generating more reliable estimates of the potential benefits of the reuse of human waste as fertilizer and biogas. This includes on-site solutions such as double- or triple-pits and biogas digesters, and off-site options such as wastewater treatment and reuse, and sludge use from septage treatment facilities.
- Establishing stronger evidence of the efficiency and success of projects based on actual performance, and ways of improving performance.
- Attempts to better quantify the intangible benefits of sanitation (such as comfort, prestige and privacy), which are strong drivers of 'willingness to pay'.

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ANNEX 1: PROGRAM APPROACH ANALYSIS

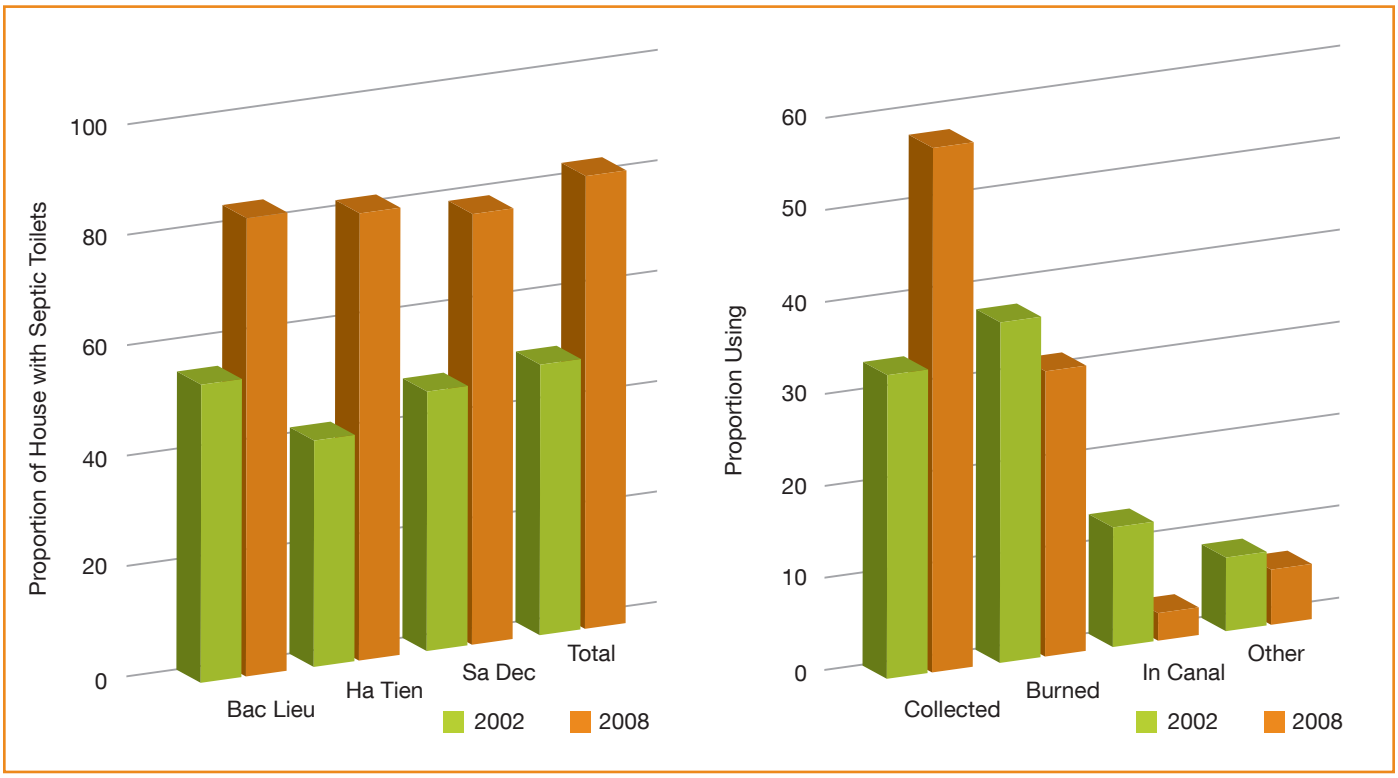
The methodology of the Program Approach Analysis (PAA) has been described in the Chapter 3.4, and key findings were presented in Chapter 7.

1. PROGRAM APPROACH ANALYSIS FOR URBAN SANITATION PROJECTS

Project	Three Delta Towns Water Supply and Sanitation Project
Rational	Integrated water supply and sanitation improvement for the 3rd category towns in the Mekong delta with financial and technical support from the Australian Government (2001 – 2008). Site U1 is in the current study.
Implementer	The project is being implemented through the provincial Water Supply, Sanitation and Environment Co. Ltd. Of Bac Lieu, Dong Thap and Kien Giang provinces, under the management of the provincial people's committees.
Program approach and activities	Each participating town of Bac Lieu, Ha Tien and Sa Dec (three provincial towns in the Mekong Delta of Vietnam) was a component with an integrated program of objectives and activities contributing to integrated infrastructure improvements in the water supply, drainage, wastewater and solid waste management sectors with capacity building of relevant provincial institutions and community development. Urban planning and infrastructure coordination was included, together with management of resettlement and compensation for households affected by construction. The final component was overall project management.
Impacts	Communication activities helped people become aware of how to keep their families and public areas clean, and of the benefits of clean water usage and water protection. While people used to leave garbage in ditches or public areas, they have got into the habit of gathering garbage in the right places and at the right time. See Figure 56 for a comparison of sanitation coverage before and after the project.

Lessons	The Project strategy, which included much larger technical assistance inputs for design and construction supervision than those provided in the ODA loan-funded water supply and sanitation projects, was correct. Although it is difficult to quantify the benefits of these higher levels of engineering technical assistance, they were undoubtedly effective and highly beneficial. The inclusion of the institutional development and community development, capacity building and implementation activities was highly appropriate and provided technical assistance in areas that are under-funded in governmental and other ODA loan-supported water sector activities . There is a vital need for the promotion and development of strong links and good coordination between water supply and sanitation companies and community organizations at all stages of project planning and implementation. Institutional strengthening and community development must be regarded as key components of water and sanitation projects. In order to be most effective, the resources devoted to institutional strengthening and community development should be adequate, and also related in terms of budget, duration and timing to the resources devoted to the engineering infrastructure works. Links between water companies and the community are essential for the establishment of effective, realistic tariffs and connection fees. Only in this way can subsidies be reduced and companies provided with greater financial autonomy, thereby enabling them to further improve the services they provide. Increasing the volume of water supplied to urban communities will exacerbate existing drainage problems. Therefore, water supply projects should always be considered in combination with environmental sanitation. 'Willingness to pay' data must be carefully collected and used with caution. Communities with low levels of knowledge and awareness of the value of clean water supplies and environmental hygiene and health cannot be expected to understand the value of services they know nothing about, nor can they be expected to have any expectations of such services, until their awareness is raised. Outcome-oriented monitoring and evaluation is a new concept for Vietnamese counterparts. Process and outcome monitoring systems for community development activities need to be set up early in the project.

FIGURE 56: CHANGE IN SANITATION PRACTICES IN PROJECT BENEFICIARY TOWNS



Source: Three Delta Towns WS&S Project Viet Nam Project report. June 2008

Project	Expanding benefits for the poor through urban environmental improvements in Tam Ky City
Rational	Provision of better access to water supply, sanitation and other urban infrastructure conditions for the poor in a central region, low-income urban area by financial and technical support from Asian Development Bank (ADB) (2005 – 2008). Site U2 is in the current study.
Implementer	Tam Ky People's Committee, Quang Nam province
Program approach and activities	(a) Improve community infrastructure to mitigate flooding, environmental hazards and health-related diseases. (b) Skills training on environmental sanitation, simple construction methods using appropriate technology, production/assembly of construction materials, and community organizing. (c) Community participation in solid waste management. (d) Project coordination.
Impacts	The project has significantly improved infrastructure status for the poor families in the six project wards, where small infrastructure facilities have been provided such as household water taps, local access roads, household toilets, multi-purpose community buildings and community-based solid waste management. All households in the six wards have received and are now utilizing the project infrastructure facilities. Besides increasing the number of households with an improved clean water supply, improved sanitation and drainage, better rubbish collection services and cleaner neighborhoods, the management and coordination role of the local authorities has been also enhanced, and, community participation in urban management activities has been positively changed. Significant in-kind contributions by the community have been mobilized in the project activities and follow-up activities. Currently, all in the An Xuan ward are participating in solid waste management activities.
Lessons	Community participation, especially of women, was crucial to the project's success. Project information should be provided in a carefully organized way. Due to weak organizational capacity, capacity building for local resource plays an important role in project effectiveness. Project designs should take into account future price increases for construction. Slow disbursement of donor funds leads to project delays. Poor communication between project stakeholders can lead to poor outcomes.

(Source: Implementation Completion Memorandum (ICM), JFPR 9058 – VIE project, MOC, 2009)

Project	Three Cities Sanitation Project
Rational	Improvement of environmental sanitation conditions for the three 2nd category cities located in the core socio-economic development regions, with technical and financial support from donors through the World Bank (2000 – 2009). Site U4 is in the current study.
Implementer	Quang Ninh People's Committee, through Ha Long and Cam Pha Urban Environment Companies (URENCOs)
Program approach and activities	Construction of sewerage, drainage system; revolving fund for toilet improvement via local Women's Union; solid waste management, with sanitary landfill; capacity building for urban public services; and organization of communication awareness participatory programs in environmental issues. Applied sanitation options at the site: combined sewerage and drainage system (primary and secondary sewers, overflow chambers and elevation pumping stations, centralized wastewater treatment plant with activated sludge process – SBR followed by 3-step maturation ponds for disinfection before discharge into the sea).
Impacts	435,000 people living in the catchment area have benefitted from reduced flooding. Some 45,000 people in the Bai Chay area and 100,000 people in the Hon Gai area have benefited from wastewater collection and treatment systems. Solid waste from approximately 80,000 households (330,000 people) collected and safely disposed in sanitary landfill. The investments in solid waste management have also triggered many changes. With the initial project investment, URENCOs have made great progress in operational capability and financial management, although the budget was not balanced as originally planned. Ha Long City has changed and become more attractive to domestic and foreign visitors and external investors.
Lessons	The project demonstrates well the combination of high-tech and low-cost wastewater treatment options (maturation pond), which allow an environmentally friendly pathogenic removal and polishing / maturation treatment step, since treated wastewater is discharged into Ha Long Bay. The septic tank sludge management issue seems to have been solved by the URENCOs inclusion of wastewater treatment plants and a capacity building component. A solid waste management component, in combination with drainage and sewerage activities reduces negative impacts and provides more benefits to the whole system. Other components of infrastructure improvements are also being implemented in Ha Long. Neglecting tertiary sewerage and drainage network is a common approach in urban environmental sanitation projects. However, this leads to a big gap of the urban sewerage and drainage system, whereby many households, hotels and restaurants remain unconnected to the drainage system, and a major protion of wastewater runs directly into the sea (Ha Long Bay). An appropriate technical solution for a combined sewerage and drainage network should be developed in order to avoid untreated wastewater from sewers. Many parts of the drain are broken because of trucks passing by, and the drain is not dredged frequently, so wastewater becomes stuck. According to informants, fishermen do not go fishing within a radius of 1 kilometer because of sea pollution. Wastewater has overflowed into some people's houses due to a design fault – the drainage system is higher than their floors. Residents complain of a smell coming from the drainage and sewerage system due to covers not being airtight. People are willing to pay a monthly garbage collection fee at a rate of VND15,000/normal household (equivalent to US$0.8). However, some problems remain. For example, agreement has not been reached between the market management board and the urban environment company. Consequently, garbage collection has not been conducted properly, polluting the surrounding environment. Wastewater leaking from garbage trolleys has created a bad smell in the streets. Trolley gathering areas are close to inhabited places, impacting upon the environment and people's health. A low connection ratio, low wastewater and solid waste management fees are again the main challenges to project efficiency and sustainability. The wastewater treatment plant is operating at below the capacity for which it was designed. Tariffs have not yet covered the operational costs of the Bai Chay wastewater treatment plant, and leachate treatment station of landfills.

Project	Environmental sanitation project for Buon Ma Thuot City
Rational	Improvement of the environmental sanitation situation in this 3rd category town in the central highlands, characterized by low-incomes, and including ethnic minorities, from technical and financial support from a bilaterial grant by Danida. Future expansion is expected under the loan conditions (2001 – 2009). Site U5 is for the current study, 2001 – 2009.
Implementer	Urban Management and Environmental Sanitation Company of Buon Ma Thuot city
Program approach and activities	Construction of a separate sewerage and drainage system, household connection, treatment of wastewater, and reuse of treated wastewater for coffee irrigation. Communication activities.
Impacts	While Tan Tien used to be the city's 'trash bag', the environment has now been improved and the streets are clean. All residents are willing to cooperate with the urban environment company in trash collection, and to pay a fee. Diseases related to a polluted environment and solid waste (for example, diarrhea and sore eyes) have decreased. People's knowledge has been improved: people better understand the dangers and negative impacts of a polluted environment on health, and at the same time, people gather garbage at the right place, and agree voluntarily to connect to the drainage system. The quality of treated wastewater is compatible with coffee tree irrigation. Residual wastewater nutrients have reduced the need for supplemental fertilizer. Calculations show the cost of supplying reclaimed wastewater was equal to or less than alternative supply costs. Reclamation of wastewater also provides a reliable, sustainable water supply to help reduce poverty among subsistence farmers, including those from ethnic minorities.
Lessons	The Buon Ma Thuot City separate sewerage system is the first of its kind in Vietnam. The connection of households to a separate sewer system has never before been attempted in Vietnam. Thus, the experience gained through this project should provide valuable insight for similar future projects. The selected sewerage option was a low-cost, small-bore sewerage scheme, based on plastics and pipelines. The combination of waste stabilization ponds and water reclamation presents a good example of a successful low-cost sanitation option. Early planning of house connection activities is essential. For example, the house connection administrative unit must take an active role in promotion to end-users. The institutional framework must decree mandatory connection. IEC promotion will stimulate positive community response. Government capital subsidy to households creates favorable conditions for implementation, but to ensure the financial sustainability of the sanitation system, the "polluter pays" principle should be applied.

Project	Water supply and sanitation for small towns program (WSPST)
Rational	Improvement of water supply and sanitation situation in the 4th and 5th category towns in the northern delta and mountainous areas, with technical and financial support (grant and loan) from the Finish Government (2002 – 2011).
Implementer	Department of Construction in four provinces: Hai Phong, Hung Yen, Thai Binh and Bac Kan.
Program approach and activities	Provision of centralized water supply systems under the loan agreement provided that the capital and operation and management (O&M) costs of the system will be fully recovered. Construction of drainage and sewerage systems in the central parts of the towns using low-cost technologies; involvement of a broad group of stakeholders in the different steps of the approach; broad capacity development program of good quality, especially for water and sanitation sector stakeholders; revolving fund and micro-finance for toilet facility improvement through local Women's Union. Communication activities.

Impacts	The WSPST program contributes to the sustainability of water and sanitation services for the small towns covered. This is the first time in Vietnam an official development assistance (ODA) project has supported 4th and 5th category towns in water supply and sanitation. The emerging model is in line with the overall decentralization and privatization processes and provides an important opportunity for the different stakeholders to define their new roles and responsibilities and to develop their capacity accordingly. Support takes the shape of day-to-day guidance in the preparation and implementation of the investment projects according to the policies and capacity development of the different stakeholders. Important policies for the water and sanitation sector were developed during Phase I of the program, notably Decree 117 for the provision of clean water and Decree 88 for sewerage and drainage management in urban areas. The WSPST program has been instrumental in developing Decree 117 and continues to be instrumental in working out the practical modalities for its implementation. The program is also at the forefront of the implementation of Decree 88 in small towns. An important factor is that under Decree 117 the connection fee has been abolished and these costs are incorporated in the service fee. This has strongly enabled the ability of poorer households to get connected. The WSPST program is making important contributions to the development of a sustainable financial water and sanitation services model for small towns in Vietnam. Consumers are consulted and made aware of the tariffs and the benefits for their health. The feasibility of the investments is assessed and first results related to collection rates are very satisfactory (almost 100%). The steps made by the program in making the paradigm shift from a subsidy/budget model to a public business model are promising and laudable. WSPST is considered to have encouraged an important evolution in development of the water sector in the provinces involved, whereby the provincial water enterprises can expand their service area and build their capacity beyond the provincial towns.
Lessons	The systematic and comprehensive approach of the project formulation, management, implementation and evaluation of the WSPST provides good lessons and serves as an example for other projects, and for the preparation of appropriate legislative documentation for the urban water supply and sanitation sector of Vietnam. This includes the following components: a socio-economic survey; 'willingness to pay' and 'commitment to connect' studies and activities that accompany infrastructure development (capacity building, human resource development strategy, management model and financial structure, awareness raising programs, evaluation of different technological options, and project monitoring and evaluation). These kinds of component are often neglected in national budget programs and WSPST is showing the benefits of these components and the way to bring them into the project cycle. WSPST is an excellent testing field for new approaches and technologies in sanitation involved, especially for low-income areas with differing topographical and other natural, socio-economical conditions. Separate sewerage and wastewater treatment (off-site) technologies are uncommon in Vietnam. The decentralized sanitation scheme, which uses low-cost technology options such as small bore sewerage, baffled septic tanks with anaerobic filters and constructed wetlands, and waste stabilization ponds seems to have been accepted in the project towns. The applicability of technology alternatives has been tested under the program and lessons from the first implemented systems will be taken into account at later stages, and in other projects. The costs of a centralized water supply can be fully recovered even in low-income communities. The key is adequate quality from the service supplier, and appropriate awareness-raising to ensure willingness-to-pay on the demand side. In terms of water supply technology options, centralized system are often the only ones considered. However, decentralized options should also be considered, especially for more remote and/or poor inhabitants. Technologies include rain water harvesting (on roofs), household-level treatment, and shared water supply connections. Solid waste management should be included in the program, at least in the IEC activities. The program approach is especially strong in increasing the participation of consumers, with special attention paid to the poor and women. The application of a Service Based Approach instead of a System or Project Approach could strengthen poverty reduction even more. The new administrative and financial tools and mechanisms further develop implementation capacities. The Sanitation Revolving Fund (micro-credit scheme) contribution for poor households and households close to meeting the poverty criteria should cover the investment cost of sanitation construction. Interest rate and payback period conditions should be within the reach of the poor. Delays in project implementation should be foreseen.

2. PROGRAM APPROACH ANALYSIS FOR RURAL SANITATION PROJECTS

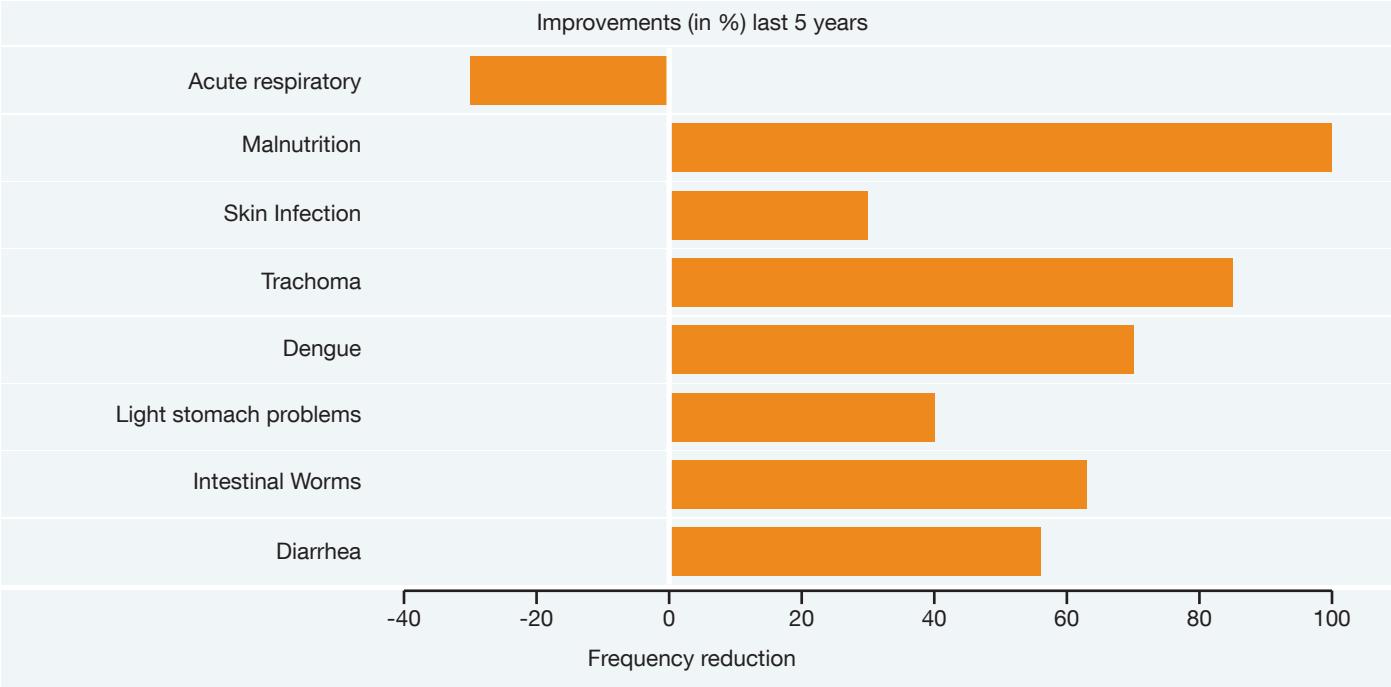
Project	Cuu Long Delta RWS Project
Rational	Improvement of rural water supply and sanitation situation for rural communities in the Cuu Long (Mekong) delta with technical and financial support from the Australian Government (2001 – 2008). Site R2 of the current study.
Implementer	Provincial Centres for Rural Water Supply and Sanitation (PCERWASS) in Bac Lieu, Ben Tre, Kien Giang, Long An and Vinh Long. The National Centre for Rural Water Supply and Sanitation (NCERWASS) was responsible for state management of the Project.
Program approach and activities	The four main components of the project were: water supply and sanitation promotion; institutional capacity building; a district town water and sanitation services investment program; and a rural water and sanitation services investment program.
Impacts	Approximately 390,000 people in 45 communes across five provinces have directly benefited from sustained access to improved water supply and sanitation services. The Community Participation Approach ensured communication channels between community and institutional stakeholders were established and effective throughout the project implementation cycle. IEC campaigns targeting infrastructure beneficiaries have focused on improved health and hygiene practices with respect to water supply and sanitation. The rate of water and sanitation-related diseases has decreased thanks to improved infrastructure. Improved access to safe water by the poor and others who handle water appropriately will benefit their health in the long term and in many cases will reduce the incidence of poverty as a result of reduced water- and excreta-related illness. Households living close to the main road are willing to pay a monthly fee for garbage collection. Households living far from the main road put garbage into holes or burn it in their gardens. Many people are aware of the danger of using plastic bags.
Lessons	The development of a local implementation model for rural water supply and sanitation facility ownership, piped scheme management and a demand-responsive approach (which incorporates community participation and health/hygiene promotion in each phase of the project cycle) was crucial, especially when the guidance from the National Strategy for Rural Water Supply and Sanitation was too general for all regions. The project also documented a capacity-building framework for managers of rural piped schemes and developed a pricing model for calculating water tariffs. Although the project had a strong impact on the poorer sections of its recipients, it has not yet reached the general population in the project provinces. Better-coordinated interaction between the local authorities would expand the service to a greater number of households within and beyond the project cycle. More effort to set up continuous community participation and health promotion programs within and beyond the project framework should be made by the central and local authorities. A clear mandate and operational mechanism for the financing, implementation and monitoring and evaluation of these activities at the provincial level should be set up. Share funding for a more efficient and sustainable infrastructure service among relevant local authorities is necessary. The project completion report stated that future RWSS projects in Vietnam should focus on identifying implementation and funding structures that promise more sustainable integration of community consultation, health promotion and infrastructure.

Project	Sanitation, Hygiene and Water Improvement Project (SHWIP) in Quang Ngai Province
Rational	Improvement of the sanitation, hygiene and water situation for the rural poor in the central area, with technical and financial support from an international NGO, Plan International, (2006 - 2010). The project is implemented in 16 communes in Tu Nghia, Nghia Hanh and Son Tinh districts, Quang Ngai Province. Son Tinh commune is Site R3 in the current study.
Implementer	Plan Australia and Plan Vietnam, local authorities, Women's Union of Quang Ngai.
Program approach and activities	The SHWIP Project proposed to bring about change in five key areas: improvement of sanitation and hygiene practice among school children; enhancement of women's participation; behavior change in household water and sanitation investment; institutional involvement of the local authorities and technical agencies responsible for hygienic sanitation and safe drinking water; and access to water and sanitation through the introduction of improved latrines and water supply. The main components of the project are: capacity for the stakeholders involved; introduction of informed choice water and sanitation facilities; provision of water supply for water-scare sites; and project management, monitoring and evaluation.
Impacts	The project has been running for three years, and has provided improvement and new construction of 9,100 facilities, including 8,000 toilets, and 1,300 water supply facilities. There are 8,100 beneficiary households. At Tinh Dong commune (the survey site of the current study), 745 households have been supported. The water and sanitation facilities constructed include: 201 septic tanks; 185 double-vault composting toilets; 203 bathrooms; 13 water filters; 169 household dug wells; and 10 community wells. Coverage of households with access to an adequate water supply has risen from 40% (2006) to 70% (September 2009). Hygienic latrine coverage has risen from 30% (2006) to 72% (2009). Local capacity has been significantly improved and awareness of hygiene and health has been increased. Sanitation facilities and improved communication and public participation have contributed greatly to the socio-economic development of the community.
Lessons	Informed choice of poor household should be supported. Key project activities, which are highly valued by the community include project area mapping, and ensuring actual participation, communication, clarity and equity. Large household contributions to cover the full cost of the sanitation facility (besides set financial support from the donors and local government) would limit the participation of the poor. Actual inflation and local prices are to be considered. The solid waste component should be integrated. More focus should be placed on capacity building for local project implementers, monitoring and evaluation, and follow-up activities. Better coordination and integration between project activities and activities under central and local government programs is necessary for better resource mobilization, efficiency and sustainability.

Project	Sanitation marketing project in Binh Trieu commune, Thang Binh district, Quang Nam Province
Rational	Enhancing environmental sanitation awareness and demand responsiveness, as well as capacity building for the sanitation service provider, through sanitation marketing activities in low-income rural communities in the central region, with technical and financial support from an International NGO, IDE (2003-2004). Site R5 of the current study.
Implementer	IDE Quang Nam
Program approach and activities	IEC activities and training
Impacts	Waste water mostly runs onto gardens and becomes absorbed into the soil. Although garbage collection exists, it is conducted once per week. Therefore garbage is kept inside houses or piled in market areas, polluting the environment. Only 200 of 600 households in the project area have access to clean water. In addition, a sand plant located close to the residential area has negative impacts on underground water, decreasing the water reserve for agriculture. Some 30% of households in the selected area do not have latrines, so open defecation takes place in the forest or on sand banks. The remaining 70% of households have pit latrines or one-vault latrines. The decrease in the prevalence of diarrhea among children aged under 16 in both the experiment and control groups was significant, and appears to be the result of two factors: the substantial increase in household access to hygienic latrines; and the significant improvement of key hygiene practices within the experiment core target groups. Cluster key indicators for hygiene practices were: consistent use of sanitation facilities; improved rates of hand washing with soap; and safe excreta disposal. The core target groups were defined as the primary child caregivers and children under 16 years old.
Lessons	A reliance on external support (IDE) was crucial, as this was central to the development by private operators of a marketing campaign that involved significant research, the use of communication professionals, and the employment of different media strategies. Perhaps the most important finding was that the increase in demand among the experiment group was achieved without the use of capital cost subsidies. This was accomplished through the use of locally available market innovations that suited local lifestyles, and most importantly, through effective communication. During project implementation, rural households made more than 10,000 investments in improved latrines from local, small-scale service providers at full market cost. The use of external subsidies for business development and promotion is often more sustainable than subsidizing sanitation hardware, because once demand is stimulated and the market is established, suppliers take over promotion even if external funds are withdrawn. This also means that the consumer does not have to experience a sudden price shock from unsubsidized hardware, which has led to the collapse of many past sanitation programs. Prior to the project, IDE had encountered this and other negative consequences of subsidizing sanitation hardware in Vietnam. Private sector providers can now continue to serve rural communities well beyond the duration period of the project. It has been shown that masons can supply spare parts and provide post-sale services to existing customers, cater to the demands of new customers, and even expand their customer base and businesses through innovative local promotional strategies. Full cost recovery also offers better hope for the sustainability of sanitation investment. When households consciously choose to purchase a facility representing more than 10% of their annual budget, the likelihood that they will properly use and maintain the facility is high. It is not surprising that post-sale services have now emerged in the local sanitation market in the project areas. Consumers making such an important investment tend to demand increased accountability from service providers.

Project	Community based sanitation in Lai Xa village, Kim Chung commune, Hoai Duc district, Hanoi
Rational	Community-based environmental sanitation for a peri-urban community with technical and financial support from an international NGO and a local institution, 2002 – 2008. Site R7 of the current study.
Implementer	NGO Youth with a Mission (YWAM), Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering.
Program approach and activities	Technical options applied in Lai Xa include: solid waste management with at-source separation and composting of organic waste; upgrading of drainage network and household wastewater systems, decentralized low-cost wastewater treatment in community anaerobic reactors followed, for some clusters, by constructed wetlands and reuse of treated wastewater for fish farming.
Impacts	The village has changed its physical and social environment significantly through solid waste management, sanitation and hygiene improvement efforts (See Figure 57). It is estimated that about 90% of wastewater in Lai Xa is now collected by the improved, combined sewerage and drainage lines, while 25% is treated at the two low-cost treatment stations.
Lessons	Promotion has shown to be efficient in generating local investment and demand. The examples reviewed lead to generation of more than twice the investment funds than a top-down subsidy approach. Financing capacity building and human resource training is also necessary and will be profitable in terms of improved sustainability of sanitation investment. The population's interest in maintaining cleanliness and wastewater reuse were key factors in promoting participation demand and willingness-to-pay for wastewater treatment. Analysis also shows that the hamlet and commune administrations can play an effective project-coordinating role when management capacities are reinforced. As Vietnam aims to increase improvement of sanitation coverage over the coming years, a pilot effort like the Lai Xa project demonstrates the promising option of investing in decentralized wastewater management. A decentralized low-cost sanitation approach with appropriate technical options and management schemes, and increased IEC investment should be promoted in future projects. Many infrastructure projects in Vietnam involve low efficiency and a limited IEC component. In the context of Vietnam targeting improved sanitation with limited financial resources, the results demonstrate the efficiency of including a strong IEC component (which is often limited to high-tech centralized infrastructure supply) in sanitation programming.

FIGURE 57: REDUCTION OF WATERBORNE DISEASE FREQUENCY IN LAI XA BETWEEN 2001 AND 2006



Source: J. Beauséjour and A. V. Nguyen, 2007

3. PROGRAM APPROACH ANALYSIS FOR BIOGAS DIGESTER PROMOTION PROJECTS IN RURAL AREAS

Project	The Vietnam Biogas Programme
Rational	Promotion of biogas digesters for households across rural and peri-urban areas in Vietnam. Phase 1: 2003 – 2006; phase 2: 2007 – 2011.
Implementer	Livestock Development Department of the Ministry of Agriculture and Rural Development (MARD), through its Biogas Project Division (BPD), with technical assistance from SNV (Netherlands).
Program approach and activities	Set up a decentralized program management structure that is able to facilitate the construction and quality control of biogas plants in Vietnam; mobilize and professionalize different actors in the biogas sector, including construction companies, provincial technicians, research institutes, schools and trainers, banks and companies, who together are able to guarantee the quality and sustainability of biogas plants constructed under the program; and maintain the pro-poor dimension of the biogas program.
Impacts	Some 27,000 biogas plants have been constructed over phase 1 (only 10,000 were planned), and 140,000 more biogas plants are planned in phase 2. A flat-rate subsidy of VND1 million to households that have a biogas plant constructed was provided from the program, covering 25% to 30% of the investment (6 m3 to 8 m3 digester volume). About 60% of the farmers took the opportunity to modernize or improve their stables, kitchen and latrine at the same time, increasing total investment costs to VND6 to 10 million. Economic and environmental sanitation benefits have been confirmed by the users and local residents. Biogas is treated with gas filtration (using an adsorption column) to eliminate hydrogen sulfide gas, and is collected for water heating and cooking. Some 40% of the plants have a toilet attached. About 55% of the farmers use bio-slurry for agriculture. On average, 1 to 1.5 hours of work load per household per day are saved, and about 1,190 kg of firewood, 172 kg of agricultural waste and 34 kg of charcoal, 47 kg of coal, 6.3 kg of LPG and 30 kWh electricity are saved per household per year. In addition, between 81,000 and 135,000 tones of greenhouse gas CO2 equivalent have been reduced per year. The program has created job opportunities in rural areas, with at least 270,000 man days of input. Trained biogas masons can develop their own businesses (adapted from program reports). In addition, partly thanks to biogas activity, the number of flies has decreased, leading to a decrease in diarrhea. The number of unhygienic latrines and the practice of open defecation have decreased significantly.
Lessons	**Key points for achieving success were:** Clear orientation, guidance and budget provided in organizing local promotion activities; clear vision and support of provincial and district authorities; appropriate selection of biogas technology to be introduced; adequate technical training to be provided to set up a team of qualified and enthusiastic local technicians; quality control system should be established that helps livestock community to place/regain its trust in the sanitation option. In relation to monitoring and evaluation activity: clear indicators for monitoring and evaluation and a mechanism to monitor the activities of district technicians should be developed. **Limitations to be overcome:** Previous defective biogas technologies hindering marketing efforts at the start of the program; not including local authorities and civil societies, from which resources and opportunities for biogas promotion could be mobilized; insufficient budget allocated to activities, especially media programs; more investment needed on demonstration models; more attention should be given to monitoring the use of biogas plants. The project should try to increase bottom-up planning, simplify the administrative system and link with other biogas-related projects and programs. In addition to the common practice of slurry utilization, adequate post-treatment of biogas products (liquid and solid phase) should be considered. High concentrations of nitrogen ammonia, remaining organic matter and pathogens often create water pollution, unsafe cropping, eutrophication and oxygen depletion, which reduces fish productivity. Lessons from previous small biogas projects could be also useful. For example, many households with biogas models have not used them for energy purposes, because: electricity has recently come to the area, which is reasonably priced and does not smell bad; animal husbandry has become less popular in the commune; many biogas constructions are unusable due to technical issues; and some households rebuild their houses and biogas constructions are destroyed.

Project	Biogas for pig farms in Thieu Duong commune, Thieu Hoa district, Thanh Hoa Province
Rational	Application of biogas digester and electricity generation for the private medium- and large-scale pig farms in rural areas. Site R8 of the current study.
Implementer	Mr. Le Nguyen Long, the farm owner.
Program approach and activities	The project is at a livestock breeding farm with 700 pigs. Seven biogas digesters have been constructed using the farm's money, including a bank loan. Total volume is 500 m^3. VND350 million has been invested.
Impacts	Biogas is collected for cooking and other purposes. Mr. Long has invested in a biogas-based electricity generator with a capacity 12 KVA, for lighting, cooking, pumping, etc. Eight workers have been recruited. Sludge from digesters is utilized for composting. The farm has developed cultivation based on the biogas digester, adding a stable additional income to that from pig breeding.
Lessons	The project has been highly successful in terms of electricity generation. Economic and environmental sanitation benefits have been observed and confirmed by the farmers. However, the biogas digester cannot fully treat the waste from the farm. Further treatment steps are required in order to achieve adequate treatment levels of wastewater and solid waste for discharge, disposal or utilization. So far there has been no optimum solution for these follow-up steps. Strict environmental regulations should be applied to awareness-raising and technical support efforts. More effort should be made by central and local government to disseminate available cleaner production, resource recovery and other green farming technologies and equipment to the farmers. Technical guidance and oriented marketing activities should be set up with the involvement of relevant players.

4. PROGRAM APPROACH ANALYSIS FOR THE SOLID WASTE MANAGEMENT IMPROVEMENT PROJECTS

Project	Implementation support for 3R Initiative in pilot wards of Hanoi City
Rational	The first systematic 3R project piloted in four wards of Hanoi City, with technical and financial support from the Japanese Government, from 2007 to the present. Site U7 of the current study.
Implementer	Hanoi Urban Environment Company (URENCO), 3R project office.
Program approach and activities	At-source separation of waste, solid waste composting, communication campaigns, capacity building for the local urban environmental sanitation service provider and other stakeholders.
Impacts	The activities of 3R provide promising solutions to the solid waste problem in Hanoi, enabling the reduction of waste volume, and leading to economic benefits from waste reuse. The percentage of people living in the inner core, urban fringe, suburban and rural districts get waste collection service reach 98%, 96%, and 41.5%. However, the poor are largely unserved by collection services; some of the wards far from the main road in poor sub-rural districts do not receive a solid waste collection service, and depend on commune waste teams and on-site waste treatment. The regulation on waste management practices is not enforced properly by residents, community leaders and district leaders.
Lessons	While people understand that the organic waste is recycled into fertilizer, it takes a long time to change their habits because the process is not directly beneficial to them. Mobilization of financial resources for capital investment and operation and maintenance for URENCO in solid waste management is increasing but has not kept pace with urban growth and industrialization, and the resulting increases in demand for solid waste collection systems. Waste collection companies need better budget and debt services to increase their performance. More efforts should be made by the city government to provide better legal framework support and coordination among the stakeholders involved, including local authorities, URENCO, households, mass organizations and the media.

Project	Solid waste management improvement project in Cua Lo town, Nghe An Province
Rational	Solid waste management improvement in a small tourist (beach) town in a central region through capacity building for a local Urban Environment Joint Stock Company (JSC) and IEC. Site U8 of the current study.
Implementer	Cua Lo URENCO JSC, Nghe An Province.
Program approach and activities	Solid waste management, capacity building for URENCO staff and communication activities.
Impacts	Only a few households are still burning trash and throwing it into the sea, making the sea cleaner. The rate of access to toilets has increased dramatically since the town was established, so the beach is rarely used for open defecation as it was 10 years ago. The main street lies by the beach and is the centre of tourism, hence, waste collection is better conducted. The sea is clean, and attracts a large number of tourists every year. In recent years, infectious diseases such as diarrhea and eye soreness have not appeared as epidemic diseases, mainly because most people have standard toilets, and use tap water for drinking, eating, washing and toilet flushing.
Lessons	It was correct to establish a URENCO JSC and to provide it with financial and technical support. This model of an urban public service company should provide better service quality, whereby company staff are more interested in long-term investment and make more effort. Villagers were threatened with fines if they left garbage in the wrong place, so that they gradually got used to this new habit. Communication activities have played an important role during the project period, and are to be continued. The waste collection system is not sufficient. Almost all households are willing to pay VND2,000 per person per month, which is low, but inadequate considering the workload of the service provider. The current method of disposing of the waste collected is land filling. More sustainable waste treatment and disposal methods should be further considered.

Project	Solid waste management improvement in a Duc Thang commune, Hiep Hoa district, Bac Giang Province
Rational	Solid waste management improvement initiative in a rural area by a local cooperative. Site R6 of the current study.
Implementer	The Cooperative of Clean Water and Environmental Sanitation of the Hiep Hoa district, established in 1998.
Program approach and activities	Cooperative activities cover water supply, solid waste management, green areas (parks, trees) and recreational places in the small town. Activities include: waste collection; waste treatment (for volume reduction and odor control); biogas digester construction for clients; and waste fee collection.
Impacts	The solid waste situation has significantly improved since the cooperative operation and upgrading. In addition, a number of jobs in the town have been created.
Lessons	Solid waste management in small towns and peri-urban communities by a local cooperative like Hiep Hoa is a good model, which has been confirmed and promoted by the provincial and central governments. However, solid waste management has so far only been conducted through improved collection, and not through hygienic and safe treatment options. Dumping sites are still considered unsanitary landfill. Appropriate incentives and supporting measures should be developed to enable the local cooperative to improve its capacity and sustainable solid waste management.

ANNEX TABLES

ANNEX A. STUDY METHODS

TABLE A1. SUB-NATIONAL SANITATION COVERAGE RATES IN VIETNAM FROM 1998 TO THE PRESENT REPORTED FROM DIFFERENT DATA SOURCES

Ecological regions	National survey on environ-mental hygiene, MOH (1998)[1]	Survey on household living standards (GSO) (2004)[2]	National targeted program on clean water and environmental hygiene 2004[1,3]	National Health Survey, MOH 2002[1,4]	Survey on environmental sanitation in rural Vietnam 2006 (MOH)		
					% HHs with sanitary latrines	% latrines attaining construction standards	% latrines attaining construction and maintenance standards
Red river delta	3.5	69.2	65	32	37.9	30	22.9
North east	2.4	52.5	38	27	10.2	3.9	2.9
North west		18.6		4	6.2	4.5	3.3
N. central coast	6.5	57	56	33	43.8	24.3	14.1
S. central coast	11.4	52.2	50	21	49.6	20	16.1
Central highlands	1.3	35.3	39	12	13.3	10.2	7.0
South East	7.2	71.4	62	37	53.8	43.3	39.1
Mekong river delta	4.3	23.9	35	12	26.1	21.2	19.3
Vietnam	4.8	50.8	50	21.0	33.0	22.5	18.0

[1] MOH-UNICEF (1998), Survey on latrines at households in rural Vietnam.
[2] GSO (2004), Survey on living standards of households.
[3] Ministry of Agriculture and Rural Development (2004), Report of a 5-years implementation of the National Targeted Programme on clean water and environmental sanitation in rural Vietnam.
[4] MOH (2002), National Health Survey.

TABLE A2. PERCENTAGE OF HOUSEHOLDS WITH LATRINES IN SURVEYED RURAL VIETNAM (%)

Characteristics	With latrine	Hygienic latrine	Attaining construction standards	Attaining operation and maintenance standards	Attaining construction, operation and maintenance standards	Number of households in sample
EDUCATION						
Illiterate	34.8	7.1	4.6	3.6	2.5	2,295
Literate	51.2	12.7	8.4	7.7	5.4	1,517
Primary school	65.5	19.7	12.7	13.3	10.2	10,770
Secondary school	81.7	32.6	20.9	21.3	16.2	16,497
High school	87.9	50.7	33.9	36.1	28.3	5,000
College, university	92.7	65.5	45.0	54.1	40.2	1,227
ETHNICITY						
Kinh	77.7	38.5	25.4	27.0	20.6	27,246
Tay	80.5	10.3	2.7	2.6	1.9	2,173
Nung	74.5	7.7	2.3	1.6	1.6	427
Mong	24.1	0.0	0.0	0.0	0.0	108
Thai	78.5	3.7	2.1	1.2	1.0	1,961
Dao	50.4	5.8	1.0	0.2	0.2	585
Muong	93.2	4.6	3.3	2.6	2.2	1,750
E De	32.6	4.8	3.7	3.7	3.0	438
Ba Na	17.4	13.4	13.4	0.0	0.0	580
Gia Rai	16.9	0.0	0.0	0.0	0.0	806
Van Kieu	31.6	6.0	2.5	1.9	1.4	364
Mnong	41.1	9.3	3.9	3.9	3.9	129
Ra Glai	23.7	2.9	1.1	1.1	1.1	279
Others	66.3	26.1	21.5	21.7	19.3	460
INCOME/MONTH						
≤ 200,000	68.2	18.1	10.9	9.6	7.5	15,878
> 200,000	78.5	38.8	25.9	28.4	21.7	21,428
ECOLOGICAL REGIONS						
North east	76.1	10.1	3.8	3.6	2.9	4,624
North west	88.8	6.2	4.5	3.9	3.4	4,655
Red river delta	96.7	37.8	29.6	25.8	22.9	4,690
N. central coast	81.0	43.8	24.2	18.3	14.1	4,655
S. central coast	64.2	48.8	19.6	37.1	16.0	4,660
Central highlands	55.4	13.2	10.1	8.5	7.0	4,661
South East	80.9	53.6	43.2	44.8	39.2	4,658
Mekong river delta	49.6	26.1	21.1	21.1	19.3	4,703
Total	**74.1**	**30.0**	**19.5**	**20.4**	**15.6**	**37,306**
Total adjusted	**75.0**	**33.0**	**22.5**	**22.2**	**18.0**	**14,097,606**

[1] MOH – UNICEF (2007). The Report on Water Supply and Environmental Sanitation Status in Rural Areas of Vietnam

TABLE A3. SELECTION OF FIELD SITES FOR ECONOMIC STUDY

Project Name	Household toilet	Community sewerage and drainage, WWTP	Solid waste management	Animal waste
U1. Environmental Sanitation project in Sa Dec town, Dong Thap prov.	✓	✓	✓	
U2. Expanding Benefits for the Poor through Urban Environmental Improvements in Tam Ky, Quang Nam	✓	✓	✓	
U3. Sanitation project in Hai Phong	✓	✓	✓	
U4. Sanitation project in Ha Long city: Bai Chay area		✓	✓	
U5. Environmental Sanitation project for Buon ma Thuot city	✓	✓		
U6. Private water supply and solid waste management model in Hiep Hoa district, Bac Giang prov.			✓	
U7. 3R project in Hanoi city			✓	
U8. Solid waste management improvement project for Cua Lo town, Nghe An prov.			✓	
R1. SNV Biogas program for animal husbandry in Binh Tan village, Xuan Phu commune, Xuan Loc district, Dong Nai prov.	✓			✓
R2. Rural WSS improvement in Binh Thanh and Binh Hoa Bac Communes, Vinh Long province (Cuu Long delta Rural WSS Project, by Ausaid)	✓			
R3. Hygiene and Sanitation Improvement in Tinh Dong commune, Son Tinh district, Quang Ngai province (by Plan International)	✓			
R4. Installation of household biogas digesters in 16 communes, Tan Lap, Dan Phuong, Ha Tay (Hanoi)	✓			✓
R5. Sanitation Marketing project in Tam Dan commune, Tam Ky district, Quang Nam province (by IDE)	✓			
R6. Private solid waste management model in Hong Giang commune, Luc Ngan, Bac Giang				✓
R7. Waste management project in Lai Xa, Hanoi (formerly Ha Tay)	✓	✓	✓	
R8. Biogas and use for electricity generation: Live-stock breeding farm in Thieu Duong, Thieu Hoa dict., Thanh Hoa				✓
R9. Expanded environmental sanitation project in Phu Loc dictrict, Thua Thien – Hue prov.	✓		✓	✓

TABLE A4. 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 long time period • May not capture health impact • Limited generalisability
2	Economic research attached to other research studies (e.g. randomized clinical trial)	• 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 long time period • Few ongoing clinical 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 A5. METHODOLOGY FOR BENEFIT ESTIMATION (CALCULATIONS, DATA SOURCES, EXPLANATIONS)

Impacts included	Variable	Data sources	Specific value/comment
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)	DHS	
	Diarrheal disease incidence (over 5 years)	WHO stats	
	Helminthes prevalence	Global review	
	Hepatitis A and E incidence	National health statistics	
	Indirect diseases incidence (malaria, ALRI)	WHO statistics	
	Malnutrition prevalence	UNICEF/WHO statistics	
	Scabies and trachoma Incidence	National health statistics	
	Attribution of fecal-oral diseases to poor sanitation	WHO (Prüss et al. 2002)	Value = 88%
	Attribution of helminthes to poor sanitation	Global review	Value = 100%
	% disease cases seeking health care	DHS, ESI household survey, health statistics	
	Outpatient visits per patient	Health facility statistics, ESI household survey	
	Inpatient admission rate		
	Inpatient days per admission		
	Health service unit costs		
	Other patient costs (transport, food)	ESI household survey	
	% disease cases averted	International literature review	See Annex B for 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	(cross-checked with local stats)
	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 productive life
	Discount rate for future earnings	National governments	Cost of capital estimate (8%)
	Long-term economic growth	Assumption	
	Value-of-statistical-life	Developed country studies	Adjusted to local purchasing power by multiplying by GDP per capita differential

TABLE A5. METHODOLOGY FOR BENEFIT ESTIMATION (CALCULATIONS, DATA SOURCES, EXPLANATIONS) (CONTINUED)

Impacts included	Variable	Data sources	Specific value/comment
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	based on average length of each disease
	Disability weighting	WHO burden of disease project	
	Healthy life expectancy	WHO statistics	
	Discount rate for future disease burdens	National governments	Cost of capital estimate (8%)
	Morbidity and mortality rates	Various: see 1.1 and 1.3 (above)	
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	ESI household survey; ESI market survey	
	Annual non-financial cost per household, per water source	ESI household survey	
	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	Validated by other national statistics (DHS, SES)
	Full annual cost per water treatment method	ESI household survey; ESI market survey	
	Proportion of households currently treating who stop treating under scenario of 100% improved sanitation	ESI household survey; assumption	As well as stopping to treat, 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	ESI household survey	
	Average round trip time to access site of open defecation	ESI household survey	For households moving from shared to private toilet, access time to shared toilets is used instead of OD
	Average number of round trips to defecation site per day	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

TABLE A5. METHODOLOGY FOR BENEFIT ESTIMATION (CALCULATIONS, DATA SOURCES, EXPLANATIONS) (CONTINUED)

Impacts included	Variable	Data sources	Specific value/comment
4. EXCRETA REUSE GAINS *(reuse of excreta as fertilizer from either UDDT or double-vault pit latrine; and reuse of energy value from biogas digester)*			
Calculation: (% households using product themselves X value in own use) + (% households selling product X selling price)	% households using reuse methods	ESI household survey	
	% households using product themselves	ESI household survey	
	% households selling product to others	ESI household survey	
	Selling price	ESI household & market survey	
	Value in own use	ESI market survey; assumption	

TABLE A6. 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)
- Intestinal Capillariasis (raw freshwater fish in Philippines)

TABLE A7. WATER QUALITY MEASUREMENT PARAMETERS TESTED PER LOCATION, AND TEST METHOD

Parameter	Test	Location	Test conducted for		
			Surface water	Well water	Piped tap water
E-coli (cfu/100 ml)	Coliscan	Laboratory	Yes	Yes	
Biological Oxygen Demand (BOD_5) (mg/L)	5 day incubation	Laboratory	Yes		
Chemical Oxygen Demand (COD) (mg/L)	5 day incubation	Laboratory	Yes	Yes	
Dissolved Oxygen (DO) (mg/L)	Hach DO Probe	Field	Yes		
Nitrate (NO^{3-}) (mg/L)	Hach Photometer	Laboratory	Yes	Yes	
Ammonia (NH^4)	Hach Photometer	Laboratory	Yes	Yes	
Conductivity (µS/cm)	YSI Conductivity Meter	Field	Yes	Yes	
Turbidity (NTU)	TurbidiMeter	Field	Yes	Yes	
pH	pH Probe	Field	Yes	Yes	
Water temperature (°C)	Hach ThermoProbe	Field	Yes	Yes	
Residual chlorine (Cl) (in places provided with centralized chlorinated water supply) (mg/L)	Field Kit	Field			Yes

TABLE A8. HOUSEHOLDS SAMPLED VERSUS TOTAL HOUSEHOLDS PER URBAN COMMUNITY

R/U	Sites	OD (1)	Wet pit latrine (3)	Septic tank (4/5)	WWM (6)	Double-vault composting (7)	Biogas (8)	Total
U1	Dong Thap	-	51	28	-	-	1	80
U2	Quang Nam	-	1	88	-	-	-	89
U3	Hai Phong	2	-	30	70	-	-	102
U4	Quang Ninh	-	-	39	61	-	-	100
U5	Daklak	1	-	38	70	-	-	109
	Total	**3**	**52**	**223**	**201**	**0**	**1**	**480**

TABLE A9. HOUSEHOLDS SAMPLED VERSUS TOTAL HOUSEHOLDS PER RURAL COMMUNITY

R/U	Sites	OD (1)[1]	Wet pit latrine (3)	Septic tank (4/5)	Cluster WWT (6)	Double-vault composting (7)	Biogas Digester (8)	Total
R1	Dong Nai	-		-	-	-	5	5
R2	Vinh Long	1	42	60	-	-	4	107
R3	Quang Ngai	4	9	50	-	91	1	155
R4	Dan Phuong	-	7	45	-	1	48	101
R5	Quang Nam	1	6	149	-	3	-	159
R7	Lai Xa	-	2	96	97	1	-	196
R8	Thanh Hoa	-	-	-	-	-	1	1
R9	Hue	1	16	101	-	29	-	147
	Total	**7**	**82**	**501**	**97**	**125**	**59**	**871**

[1] Number (1, 3, 4/5, 6, 7, 8) indicates respective sanitation option. (see Table 3 in Methods section)

TABLE A10. SANITATION OPTIONS USED BY HOUSEHOLDS PER FIELD SITE

Urban/Rural	Sites	OD	Wet pit latrine	Septic tank	Wastewater treatment	Double-vault composting	Biogas Digester
U1	Dong Thap	-	35.0%	63.8%	-	-	1.3%
U2	Quang Nam	-	1.1%	98.9%	-	-	-
U3	Hai Phong	2.0%	-	29.4%	68.6%	-	-
U4	Quang Ninh	-	-	39.0%	61.0%	-	-
U5	Daklak	0.9%	-	34.9%	64.2%	-	-
R1	Dong Nai	-	-	-	-	-	100.0%
R2	Vinh Long	0.9%	39.3%	56.1%	-	-	3.7%
R3	Quang Ngai	2.6%	5.8%	32.3%	-	58.7%	0.6%
R4	Dan Phuong	-	6.9%	44.6%	-	1.0%	47.5%
R5	Quang Nam	0.6%	3.8%	93.7%	-	1.9%	-
R7	Lai Xa	-	1.0%	49.0%	49.5%	0.5%	-
R8	Thanh Hoa	-	-	-	-	-	100.0%
R9	Hue	0.7%	10.9%	68.7%	-	19.7%	-

TABLE A11. BACKGROUND INFORMATION ON SELECTED URBAN FIELD SITES

Variable	U1	U2	U3	U4	U5	U6	U7	U8
Name	Sa dec town	Tam Ky city	Hai Phong city	Bai Chay town	BMT city	Thang town	Hanoi city	Cua Lo town
Rural/urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Urban
Households	2,170	4,169	175,000	80,000	17,000	2,500	18,200	11,600
Population	9,327	17,511	0.7 mio.	330,000	65,000	10,750	72,820	48,730
Av. household size	4.3	4.2	4.0	4.1	4.9	4.3	4.0	4.3
Av. Children <14	22.9	24.2	21.4	24.2	33.7	29.4	21.4	26.5
Area surveyed	5 clusters in 1 ward	2 wards	1 ward from 4 districts	1 ward from 7 project wards	5 wards	5 wards	4 wards	5 wards + 2 communes
Sanitation % improved	ST increased from 56 to 90%	10.8% toilets added	42.9% (300,000 HHs)	60%	67.7% (32.4% connected, 80% SW collected)	> 90%	87%	SW collection increased from 70% to 100%
Hygiene % hand washing	18%	NA	NA	NA	NA	NA	NA	NA
PROJECT INFORMATION								
Start date	10/2001 – 10/2008	5/2005 – 5/2008	2001 – 2007	2001 - 2007	2001 – 2007	1998 – now	12/2006 – now	4/2004 – 7/2007
Project budget	Ausaid: A$49.98 mio. for 3 provinces GoV: A$28.34 mio.	JFPR: $1 mio. GoV: $140,000 Community: $60,000	Finnish Gov. $7.26 mio, WB loan $25.5 mio., GoV $11.9 mio.	Grant: $10.86 mio, Loan: $20.28 mio., GoV: $5.59 mio.	Grant; DKK121.2 mio; GoV: DKK25.0 mio.		Japan: JPY 435.5 mio; GoV: VND1,429 mio.	Grant: DKK1.6 mio.
Interventions	Integrated, community based: water supply systems, HH water tank, ST, IEC, SWM, Institutional support, IEC	Infrastructure improvement (drainage, road), water supply for 200 HHs, HH toilets for 300 HHs, SWM, IEC	Infrastructure improvement (drainage, pumping station, ponds & lakes), septic tank and connection improvement, ST emptying, septage treatment, revolving fund, IEC, management capacity	Infrastructure improvement (pumping station, WWTP), septic tank and connection improvement, septage treatment, SWM with landfills, revolving fund, IEC, management capacity	Infrastructure improvement (drainage, low-cost sewerage, pumping station, WWTP), HH connection, SWM, school toilets, IEC, management capacity	Establishment of Environ. Sani. Cooperative, solid waste collection and disposal, IEC	URENCO capacity building, IEC, source separation, composting or organic waste	URENCO capacity building, IEC, job creation for 120 poor, SW collection and disposal
Target households	6 wards, including poor	6 wards, including poor	300,000 HHs benefited; 7,227 HHs involved in revolving fund program per 2 mio. per HH	WW treatment for 1 ward in BC (93,000 persons) + 6 wards in HG (100,000 persons). SWM improvement for 330,000 persons. 11,504 HHs involved in revolving fund program	5,500 HHs benefited (21,000 persons) from total 17,000 HHs	Whole area in the town	All HHs in 4 pilot wards	7 wards and communes

TABLE A12. BACKGROUND INFORMATION ON SELECTED RURAL FIELD SITES

Variable	R1	R2	R3	R4	R5	R6	R7	R8	R9
Name	Xuan Phu, Xuan Loc, Dong Nai	Huu Thanh, Tra On, Vinh Long	Tinh Dong, Son Tinh, Quang Ngai	Tan Lap, Dan Phu-ong, Hanoi	Binh Trieu, Thang Binh, Q.Nam	Hiep Hoa, Bac Giang	Lai Xa, Kim Chung, Hoai Duc, HN	Thiu Duong, Thanh Hoa	Loc Dien & Vinh My, Phu Loc, TT - Hue
Rural/ urban	Rural	Rural	Rural	Rural	Rural	Rural	Rural	Rural	Rural
House-holds	5 HHs and farms	2,240	1,528	2,800	2,310	2,150	900	1 farm	4,362
Popula-tion	38 persons from total 25,000	9,630	6,970	13,000	9,701	9,460	4,000	11 persons	22,690
Av. house-hold size	4.3	4.3	4.6	4.6	4.2	4.4	4.4		5.2
Av. Children <14	23.1	22.9	26.5	21.4	24.4	29.4	21.4		26.5
Area	3 com-munes	1 com-mune from 9 benefited communes	8 villages from 1 com-mune	4 villages	5 villages from 1 com-mune	1 commune	1 village	1 farm	9 villages from 2 communes
Sanita-tion % improved	NA	97% schools	WS&S: 70%; WS: 85%	NA	Hygienic toilets in-creased from 16 to 35%	> 80%	+ 40%		+ 40.5 and 42.8%
Hygiene % hand washing	NA	96% schools, 59%HHs	NA	NA	NA	NA	+ 40%		NA
PROJECT INFORMATION									
Start date	2003 – 2009	2001 – 2008	2006 - 2009	2000 - 2004	2003 - 2004	1998 – now	2002 – 2008	2004 – 2008	2001 – 2005
Project budget	Support VND1 mio. per HH, HH invested VND10 – 20 mio. per biogas system	Vinh Long province: AusAid: A$6.7 mio.; GoV: VND30.2 bio.	Plan: $1.17 mio, GoV: $100,000, HHs: $126,000	Support VND0.55 mio. per HH, HH invested VND10 – 20 mio. per biogas system	IDE (marketing sanitation): $150,000; HHs: $397,400		YWAM: VND0.8 bio. GoV: 0.33 bio., local contrib.VND0.85 bio.	VND405 mio. for bio-gas system and elect. generator	Support 0.55 mio. per HH toilet
Interven-tions	IEC, Technical & financial support for biogas construc-tion	IEC, com-munity participa-tion, School sanitation, HH WSS, central WS systems, capacity building	HH toilets, water sup-ply, IEC, capacity building for service providers	IEC, Technical & financial support for biogas construc-tion	Demand creation through IEC and capacity building for providers	Establish-ment of En-viron. Sani. Coopera-tive, solid waste col-lection and disposal, IEC	Improvement of drainage, construction of demonstra-tion HH toilets, construction of cluster WWTP, SW separation, collection and composting, IEC	Construc-tion of biogas and pond system for pig manure treatment, electricity generation	Support for HH toilet improve-ment, IEC, school toilets, con-struction of demonstra-tion toilet, etc.
Target house-holds	354 biogas construct-ed	5 prov./ 45 comm./ 390,000 persons. 232 wells, 116 school toilets, 150 HH toilets, 21,000 HH water tanks, 51 central WS systems	10,000 HH toilets, 2,000 HH water sup-ply facilities over 16 communes in 3 districts. In Tinh Dong: 745 from 1,528 HHs (50%)	700 HHs from 2,800 HHs over 4 villages	54,000 HHs from 30 com-munes in 6 districts of 2 provinces (Thanh Hoa and Quang Nam). Toilets increased from 8,637 to 9,361	Whole area in the ward	Whole area in the village, including poor		3 com-munes. Whole pro-gram (2001 – 2005): 20 provinces, budget VND400 – 600 mio. per year

ANNEX B. HEALTH IMPACT

TABLE B1. DISEASE INCIDENCE PER POPULATION

Cases per disease	Dong Thap (U1)	Hai Phong (U3)	Quang Ninh (U4)	Daklak (U5)	Hanoi (U7)	Nghe An (U8)	Vinh Long (R2)	Quang Nam (R5)
Diarrhea	44	51	64	24	46	375	16	80
Malnutrition (<5)	109	112	29		264	45	28	178
Trachoma		51	44	11	163	287		106
Helminthes	3	126	213	640		487	9	3,071
TOTAL POPULATION								
2005	7,857	8,494	10,653	14,693	13,324	45,097	11,541	9,693
2006	7,929	8,686	11,072	15,324	13,572	45,489	11,702	9,812
2007	8,055	8,714	11,324	15,335	13,806	46,578	11,870	9,930
Average	**7,947**	**8,631**	**11,016**	**15,117**	**13,567**	**45,721**	**11,704**	**9,812**

TABLE B2. DIARRHEAL INCIDENCE IN THE PAST YEAR AT ALL FIELD SITES, BY SANITATION OPTION

Sanitation coverage	Households in sample	Age group			Total
		<5	5 - 14	15+	
Open defecation (OD)	243	12	10	126	148
Shared/public	1	1	0	3	4
Unimproved pit	132	7	4	31	42
Dry pit	435	12	24	110	146
Wet pit	245	0	7	38	45
Septic tank	262	9	9	78	96
Sewerage	124	1	6	39	46
Biogas digester	54	0	6	23	29

TABLE B3. EVIDENCE ON TREATMENT-SEEKING BEHAVIOR FOR OTHER DISEASES (NUMBER OF CASES)

Data source by disease, rural/ urban and year	Observations	% seeking treatment from					No treatment
		Public provider	Private formal clinic	Private informal care	Pharmacy	Self-treatment	
Cough	49	18	2	0	8	17	4
High temperature	60	9	5	0	15	29	2
Having breathing difficulties	8	3	0	0	2	1	2
Colic	11	7	0	0	0	4	0
Diarrhea	15	3	1	0	1	10	0
Sore eyes	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Skin infection	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scabies (diagnosed by the health workers)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Worm infection	3	1	2	0	0	0	0
Gynecological disease	4	2	0	0	1	0	1

TABLE B4. EVIDENCE ON TREATMENT-SEEKING BEHAVIOR FOR OTHER DISEASES (IN %)

Data source by disease, rural/urban and year	Observations	% seeking treatment from					No treatment	Total (%)
		Public provider	Private formal clinic	Private informal care	Pharmacy	Self-treatment		
Cough	49	36.7	4.1	0.0	16.3	34.7	8.2	100.0
High temperature	60	15.0	8.3	0.0	25.0	48.3	3.3	100.0
Having breathing difficulties	8	37.5	0.0	0.0	25.0	12.5	25.0	100.0
Colic	11	63.6	0.0	0.0	0.0	36.4	0.0	100.0
Diarrhea	15	20.0	6.7	0.0	6.7	66.7	0.0	100.0
Sore eyes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Skin infection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scabies (diagnosed by the health workers)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Worm infection	3	33.3	66.7	0.0	0.0	0.0	0.0	100.0
Gynecological disease	4	50.0	0.0	0.0	25.0	0.0	25.0	100.0

TABLE B5. HEALTH SERVICE USE AND UNIT COSTS ASSOCIATED WITH OUTPATIENT CARE (US$)

Provider and disease	Financial Cost		Economic Cost	
	Urban	Rural	Urban	Rural
PUBLIC PROVIDER				
Diarrheal diseases	4.34	5.33	4.59	5.46
Helminths	1.08	1.90	1.33	2.03
Trachoma	17.58	20.05	17.83	20.18
Scabies	2.58	3.55	2.83	3.68
Hepatitis A	10.58	12.35	10.83	12.48
Malnutrition	-	-	-	-
ALRI	8.58	10.15	8.83	10.28
Malaria	10.58	12.35	10.83	12.48
PRIVATE PROVIDER				
Diarrheal diseases	3.52	4.62	4.18	5.15
Helminths	0.97	1.68	1.63	2.21
Trachoma	17.47	19.83	18.13	20.36
Scabies	2.47	3.33	3.13	3.86
Hepatitis A	10.47	12.13	11.13	12.66
Malnutrition	-	-	-	-
ALRI	8.47	9.93	9.13	10.46
Malaria	10.47	12.13	11.13	12.66
SELF-TREATMENT				
Diarrheal diseases	3.08	3.92	3.28	4.09
Helminthes	0.90	1.47	1.10	1.64
Trachoma	17.40	19.62	17.60	19.79
Scabies	2.40	3.12	2.60	3.29
Hepatitis A	10.40	11.92	10.60	12.09
Malnutrition	-	-	-	-
ALRI	8.40	9.72	8.60	9.89
Malaria	15.40	17.42	15.60	17.59

(1) All cost figures reflect the cost per outpatient consultation
(2) Rural cost is estimated 10% higher than urban cost

TABLE B6. HEALTH SERVICE USE AND UNIT COSTS ASSOCIATED WITH INPATIENT CARE (US$)

Provider and disease	Days admission per patient	Financial Cost		Economic Cost	
		Urban	Rural	Urban	Rural
PUBLIC PROVIDER					
Diarrheal diseases	4.55	7.99	13.62	13.54	15.36
Hepatitis A	5.00	12.47	13.72	16.12	17.37
ALRI	7.00	10.47	11.52	14.12	15.17
Malaria	2.00	12.47	13.72	16.12	17.37
PRIVATE PROVIDER					
Diarrheal diseases	4.55	2.38	2.61	6.03	6.26
Hepatitis A	5.00	12.47	13.72	16.12	17.37
ALRI	7.00	10.47	11.52	14.12	15.17
Malaria	2.00	12.47	13.72	16.12	17.37

Note: (1) Rural cost is estimated 10% higher than urban cost

TABLE B7. ANNUAL COSTS PER URBAN HOUSEHOLD OF POOR SANITATION AND HYGIENE, AND ANNUAL COSTS AVERTED THROUGH IMPROVED SANITATION (VND '000, 2008)

Costs, urban sites	Costs (baseline risk of unimproved sanitation OD)	Average costs averted		
		OD to Basic Sanitation+Hygiene	OD to Septic tank+Hygiene	OD to w/w management+Hygiene
Healthcare costs	243	159	183	208
Health-related productivity costs	78	54	62	70
Premature mortality costs	3,656	2,235	2,570	2,928
Total	**3,977**	**2,448**	**2,815**	**3,206**

TABLE B8. ANNUAL COSTS PER RURAL HOUSEHOLD OF POOR SANITATION AND HYGIENE, AND ANNUAL COSTS AVERTED THROUGH IMPROVED SANITATION (VND '000, 2008)

Costs, rural sites	Costs (baseline risk of unimproved sanitation OD)	Average costs averted				
		OD to Basic Sanitation+ Hygiene	OD to ST+ Hygiene	OD to w/w management +Hygiene	OD to DVCL+ Hygiene	OD to Biogas Digester+ Hygiene
Health care costs	298	169	193	212	181	156
Health-related productivity costs	96	58	66	72	62	53
Premature mortality costs	4,469	2,379	2,717	2,968	2,544	2,198
Total	**4,863**	**2,606**	**2,976**	**3,251**	**2,787**	**2,407**

ANNEX C. WATER QUALITY IMPACT

TABLE C1. WATER QUALITY MEASUREMENT RESULTS IN XUAN PHU COMMUNE, XUAN LOC DISTRICT, DONG NAI PROVINCE (R1)

Location and Code	Water source	Total Coliform (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
N0909781	River	93,000	5	10	4.5	27	ITO	
N0909782	River	21,000	2	3	4.8	11	ITO	Improved
N0909783	River	350,000	13	32	2.2	32	ITO	
N0909784	River	15,000	6	18	6	34	ITO	Improved
N0909791	Well	24,000	10			2	CBD	
N0909792	Well	460,000				1	CBD	Improved
N0909793	Well	2,300				3	CBD	Improved
N0909801	River	35,000	4	8	3.8		ITO	
N0909802	River	39,000	9	16	4.7		ITO	
N0909803	River	75,000	19	32	1.8		ITO	
N0909804	River	43,000	7	11	3.8		ITO	Improved
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		3	-	-	-	-		
QCVN 14: 2008/ BTNMT[d]		3,000	30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

(a) QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

(b) QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

(c) QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

(d) QCVN 14:2008/BTNMT: Vietnamese national technical regulation on domestic wastewater – Column A (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C2. WATER QUALITY MEASUREMENT RESULTS IN HUU THANH COMMUNE, TRA ON DISTRICT, VINH LONG PROVINCE (R2)

Location and Code	Water source	Total Coliform (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
N090961	River	75,000	4	12	2.7	119	ITO	
N090962	River	120,000	2	8	2.8	112	ITO	
N090963	River	430,000	3	8	2.7	110	ITO	
N090964	River	290,000	3	12	2.4	98	ITO	
N0909651	River	460,000	4	12	2.7	117	ITO	
N0909652	River	9,300	10	24	1.8	229	ITO	Improved
N0909653	River	4,300	5	10	2.7	107	ITO	Improved
N0909654	River	7,500	5	14	2.3	100	ITO	Improved
N090964	Well	28,000				10	CBD	Improved
N090964	Well	23				2	CBD	
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		3	-	-	-	-		
QCVN 14: 2008/ BTNMT[d]		3,000	30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

(a) QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

(b) QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

(c) QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

(d) QCVN 14:2008/BTNMT: Vietnamese national technical regulation on domestic wastewater – Column A (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C3. WATER QUALITY MEASUREMENT RESULTS IN TINH DONG COMMUNE, TINH SON DISTRICT, QUANG NGOAI PROVINCE (R3)

Location and Code	Water source	E Coli (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
RW31	Dug well	0	-	-	-	0	CBD	
RW32	Dug well	0	-	-	-	0	CBD	Improved
RWC32	Dug well	0	-	-	-	0	CBD	
RR31	Irrigation	400	5.2	23.3	7.6	13	IT	Improved
RRC31	Canal	240	6.3	28.7	7.3	12	IO	
RR32	Stream	0	3.4	9.7	7.1	16	CBD	Improved
RRC32	Stream	150	4.6	24.7	6.8	27	CBD	
RR33	Stream	750	1.5	6.3	6.2	12	CBD	
RRC33	Stream	0	2.1	9.6	7.4	25	CBD	Improved
RR34	Bong Lake	0	1.1	5.4	6.8	15	IT	
RRC34	Lake	9	1	4.3	6.7	19	IT	Improved
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		Not detected	-	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

(a) QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

(b) QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

(c) QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C4. WATER QUALITY MEASUREMENT RESULTS IN TAN LAP COMMUNE, DAN PHUONG DISTRICT, HANOI (R4)

Location and Code	Water source	Total Coliform (MPN/100ml)	BOD	COD	DO	Turbidity	Uses	Sanitation related remarks
CANAL, DRAIN, RIVER, POND								
Village temple pond from 11th zone - Tan Lap commune- Dan Phuong district	pond	5,000	15	29	6.9	15	I	
Outlet drain from Cau Xay to canal	drain	13,000	75	135	0.25	85	IW	
Water lake - People's committee of Tan Lap Commune	lake	6,000	13	24	7.82	20	I	
T-Juntion lake	lake	11,000	29	55	1.14	90	IW	
Village temple pond (near the field)	pond	4,000	15	29	6.76	13	I	
Bac Ho's Fish pond	lake	3,000	19	36	5.53	12	IW	
Dispensary pond	pond	11,000	45	78	1.89	45	I	
Cau Xay canal	canal	12,000	49	85	1.08	65	IO	
SEWAGE DRAIN, OUTFLOW WTP								
Mr. Tran Quang Thai- Ha Hoi - Tan Lap - Biogas digester outlet	sewage drain	20,000	1,000	2,100	0.06		W	
Mr. Nguyen Van Thanh - Ha Hoi - Tan Lap - Biogas digester outlet	sewage drain	25,000	1,200	2,300	0.02		W	
WELL								
Ms. Tham - 12th group, Tan Lap - Dan Phuong - Filterable tubewell	tubewell	26			3.9	1	CBD	
Ms. Tham - 12th group, an Lap - Dan Phuong - Raw water of tubewell	tubewell	42			1.19	4	CBD	
Mr. Nhan, 2nd group, Tan Lap - Raw water of tubewell	tubewell	190			1.63	3	CBD	
Mr. Tran Quang Thai	tubewell	36			2.14	1	CBD	
Raw water of tubewell	tubewell	100			1.26	4	CBD	
Filterable tubewell	tubewell	85			1.03	1	CBD	
Ms. Phan Thi Phuong - Dan Hoi (Raw water of tubewell)	tubewell	40			0.06	2	CBD	
Mr. Nguyen Kim Le - Dan Hoi (Raw water of tubewell)	tubewell	120			0.34	6	CBD	
Ms. Phan Thi Phuong - Dan Hoi (Filterable tubewell by RO)	tubewell	23			5.25	1	CBD	
Mr. Nguyen Kim Le - Dan Hoi (Filterable tubewell)	tubewell	100			3.66	3	CBD	
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		3	-	-	-	-		
QCVN 14: 2008/BTNMT[d]		3,000	30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

(a) QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

(b) QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

(c) QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

(d) QCVN 14:2008/BTNMT: Vietnamese national technical regulation on domestic wastewater – Column A (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C5. WATER QUALITY MEASUREMENT RESULTS IN BINH TRIEU COMMUNE, THANG BINH DISTRICT, QUANG NAM PROVINCE (R5)

Location and Code	Water source	E Coli (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
RW510	Deep well	0	-	-	-	1	CBD	Improved
RW511	Deep well	0	-	-	-	1	CBD	Improved
RR51 (Drain)	Drain	2,300	0.8	16.3	7.2	-	BD	Improved
RR52	Irrigation canal	7,500	0.3	6.7	6.6	6	IT	Improved
RR53	River	40	6	14.5	10.6	11	ITO	
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		Not detected	-	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

[a] QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

[b] QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

[c] QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C6. WATER QUALITY MEASUREMENT RESULTS IN DUC THANG COMMUNE, HIEP HOA DISTRICT, BAC GIANG PROVINCE (R6)

Location and Code	Water source	Total Coliform (MPN/100ml)	BOD	COD	DO	Turbidity	Uses	Sanitation related remarks
Cau Dong Ngoai river site	river	8,000	32	17	5.6	8	IT	
Hiep Hoa's Clean water project outlet	river	7,500	29	15	5.9	1	CBTI	
Hiep Hoa's Clean water project inlet	river	8,200	27	14	6.3	3	BDIO	
Dinh Huong, Duc Thang lake	lake	12,000	58	30	1.8	10	BDIO	
Dinh Huong canal	canal	15,000	324	206	1.6	80	BDIO	
Thong Nhat lake from the Thang town	lake	9,000	63	32	1.7	100	BDIO	
4th zone's pond from the Thang town	pond	4,000	34	18	5.8	85	W	
Thong Nhat lake (near populated areas)	lake	13,000	43	28	5.5	75	WI	
Mr.Chau - Dinh Huong village, Duc Thang commune	dug well	35				1	CBD	
Mr.Ngo Duc Ho - Duc Thang commune	dug well	21				1	CBD	
Mr.Dang Ba Tu - Dinh Huong village, Duc Thang commune	dug well	200				2	CBD	
Mr. Ngo Xuan Nguyen Dinh Huong village, Duc Thang commune	dug well	150				3	CBD	
Mr. Ngo Xuan Nguyen Dinh Huong village, Duc Thang commune	tube well	15				1	CBD	
Mr. Khuong Viet Ho	dug well	45				1	CBD	
Mr.Dung - 5th zone- Thang town	dug well	37				1	CBD	
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		3	-	-	-	-		
QCVN 14: 2008/BTNMT[d]		3,000	30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

[a] QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

[b] QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

[c] QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

[d] QCVN 14:2008/BTNMT: Vietnamese national technical regulation on domestic wastewater – Column A (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C7. WATER QUALITY MEASUREMENT RESULTS IN LAI XA VILLAGE, KIM CHUNG COMMUNE, HOAI DUC DISTRICT, HANOI CITY (R7)

Location and Code	Water source	Total Coliform (MPN/100ml)	BOD	COD	DO	Turbidity	Uses	Sanitation related remarks
CANAL, DRAIN, RIVER, POND								
Pond in group I (LX-1)	pond	4,500	28	45	3.5	30	IT	
Lake in group I (LX-2)	lake	4,800	17	32	2.8	25	IT	
Canal in N11 near Dong gate (LX-3)	canal	8,000	36	67	1.8	95	IO	
Canal behind Mr Giang's pond (LX-4)	canal	12,000	42	90	1.3	100	IO	
Pond near Tay Gate (LX-5)	pond	3,000	16	30	5.5	16	IO	
Pond near Dong Gate (LX-6)	pond	7,000	28	55	2.4	40	IO	
Lake in 75 Company (LX-7)	lake	1,000	8	15	5	15	IO	
Pond near Lai Temple (LX-8)	pond	3,000	14	24	4.2	45	IO	
SEWAGE DRAIN, OUTFLOW WTP								
Sewage drain to Mr Giang's pond (LX-9)	Sewage drain	18,000	415	800	0.5		IO	
Sewage drain No. 2 (LX-10)	Sewage drain	25,000	426	850	0.1		IO	
Sewage drain before wastewater treatment station 1 (LX-11)	Sewage drain	24,000	524	1,000	0.1		IO	
Outlet from No.1 waste treatment station (LX-12)	Sewage drain	16,000	321	700	0.3		IO	
Mr Giang 's pond (LX-13)	Sewage drain	14,000	124	215	0.8		IO	
Outlet from No. 2 wastewater treatment station (LX-14)	Sewage drain	13,000	86	154	1.3		IO	
Sewage drain from center of the village (LX-15)	Sewage drain	11,000	134	236	1.1		IO	
WELL								
Dinh Van Thinh - group 1 (LX-16)	tube well	200				3	CBD	
Pham Thi Nga - group 1 (LX-17)	tube well	180				5	CBD	
Dinh Van Quang - group 3 (LX-18)	tube well	200				4	CBD	
Mr Xuan - group 3 (LX-19)	tube well	160				2	CBD	
Luong Ngoc Lu - group 4 (LX-20)	tube well	170				3	CBD	
Luong Thi Truc - group 5 (LX-21)	tube well	240				3	CBD	
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		3	-	-	-	-		
QCVN 14: 2008/BTNMT[d]		3,000	30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

[a] QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

[b] QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

[c] QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

[d] QCVN 14:2008/BTNMT: Vietnamese national technical regulation on domestic wastewater – Column A (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C8. WATER QUALITY MEASUREMENT RESULTS IN PIG FARM, THIEU DUONG COMMUNE, THIEU HOA DISTRICT, THANH HOA PROVINCE

Location and Code	Water source	Total Coliform (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
CANAL, DRAIN, RIVER, POND								
Thieu Duong commune pond	pond	1,000	11	20	5.4	12	I	
12th canal	canal	2,000	17	31	3.6	10	I	
Ma river from 7th village	river	2,000	16	30	4.2	14	ITO	
Con Song drain	drain	6,000	45	80	4.7	50	BD	
Ong Ve canal from 7th village	canal	7,000	47	85	5.3	60	I	
Near Dong canal	canal	3,000	30	58	4.2	35	IT	
2nd village cannal	canal	2,400	22	40	4.3	35	IT	
Canal	canal	2,200	18	37	4.2	42	IT	
2nd village lake	lake	3,000	25	46	3.8	30	IT	
1st village cannal	canal	4,000	28	54	3.7	29	ITO	
SEWAGE DRAIN, OUTFLOW WTP								
Biogas digester outlet	sewage drain	18,000	200	325	0.5	100		
Outlet drain from 2nd village	sewage drain	13,000	125	265	1.2	55		
WELL								
Mr. Le Nguyen Long	tubewell	52				2	CBD	
Mr. Duong Dinh Dung - 7th village	tubewell	43				2	CBD	
Mr. Duong Khac An	Dug well	35				3	CBD	
Mr. Duong Binh Minh	tubewell	30				2	CBD	
Ms. Doan Thi Cuc - 3rd village	Dug well	40				4	CBD	
Mr. Le Van Bay - 3rd village, Thieu Duong commune	Dug well	65				12	CBD	
Mr. Duong Van Dong	tubewell						CBD	
Mr. Le Ngoc Sam - 3rd village	Dug well	32				4	CBD	
Mr. Le Van Bay - 3rd village	tubewell	25				5	CBD	
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		3	-	-	-	-		
QCVN 14: 2008/BTNMT[d]		3,000	30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

TABLE C9. WATER QUALITY MEASUREMENT RESULTS IN LOC DIEN COMMUNE, PHU LOC DISTRICT, THUA THIEN – HUE PROVINCE (R9)

Location and Code	Water source	E-Coli (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
RW91	Deep well	0			-	2	CBD	Improved
RWC91	Deep well	7,000			-	1	CBD	Improved
RW92	Dug well with bucket	0	-	-	-	25	CBD	
RWC92	Deep well	0			-	0	CBD	Improved
RWC93	Deep well	0			-	3	CBD	
RWC94	Deep well	0			-	0	CBD	Improved
RC90	Tap water	9	2.1	5.7	5.8	0	CBD	
RR91	River	4,000	3.3	8.7	7.7	2	ITW	Improved
RRC91	River	0	3.8	15.7	7.8	2	IT	Improved
RR92	Drain	0	7.2	13.7	7.2	31	CBD	
RRC92	Lake	0	5.9	15.3	4.2	28	IT	
RR93	River	0	7.2	12.1	7.9	6	IT	
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		Not detected	-	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

[a] QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

[b] QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

[c] QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C10. WATER QUALITY MEASUREMENT RESULTS IN SA DEC TOWN, DONG THAP PROVINCE (U1)

Location and Code	Water source	Total Coliform (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
N0909591	Wastewater	750,000	8	15	2.3		IOW	
N0909592	Wastewater	750,000	8	15	2.3		IOW	Improved
N0909593	Wastewater	210,000	5	9	4.4		IOW	Improved
N0909581	River	43,000	2	3	3.8	100	ITO	
N0909582	River	28,000	2	3	3.3	90	ITO	
N0909583	River	750,000	3	5	2.4	78	ITO	
N0909601	Canal	9,300	2	4	2.8	54	CBD	
N0909602	Canal	15,000	2	4	3	46	CBD	
N0909603	Canal	75,000	2	5	3	49	CBD	
N0909621	River	93,000	2	4	2.6	70	ITO	
N0909622	River	21,000	2	4	3.9	115	ITO	Improved
N0909623	River	150,000	3	5	3.4	157	ITO	Improved
N0909624	River	110,000	1	6	3.1	29	ITO	Improved
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		3	-	-	-	-		
QCVN 14: 2008/BTNMT[d]		3,000	30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

[a] QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

[b] QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

[c] QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

[d] QCVN 14:2008/BTNMT: Vietnamese national technical regulation on domestic wastewater – Column A (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C11. WATER QUALITY MEASUREMENT RESULTS IN TAM KY CITY, QUANG NAM PROVINCE (U2)

Location and Code	Water source	E Coli (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
UW21	Dug well	0	-	-	-	0	CBD	Improved
UW22	Deep well	0	-	-	-	1	CBD	
UW23	Deep well	0	-	-	-	1	CBD	
UWC23	Deep well	0	-	-	-	0	CBD	Improved
UR21	Canal	900	5.9	12.5	6.9	7	ITO	
UR22	Canal	75	2.5	26.7	5.6	5	ITO	
UR23	Canal	110	5.1	10.3	7.2	45	ITO	
URC21	River	3,000	0.9	8.7	6.2	10	ITO	
URC22	Canal	700	0.2	4.5	6.9	8	ITO	
URC23	Canal	240	1.3	6.1	6.9	8	ITO	
US21	Wastewater	0	37.2	82.5	3.3	3	W	Improved
US22	Lake	0	12.8	68.7	11.5	176	IT	
US23	Lake	4,600	8	25.1	5.9	345	IO	
USC21	Domestic wastewater	110,000	21.1	76.8	2.7	14	WI	
USC22	Domestic wastewater	150,000	11.4	58.4	3.5	132	IW	
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		Not detected	-	-	-	-		
QCVN 14: 2008/BTNMT[d]		3,000	30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

[a] QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

[b] QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

[c] QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

[d] QCVN 14:2008/BTNMT: Vietnamese national technical regulation on domestic wastewater – Column A (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C12. WATER QUALITY MEASUREMENT RESULTS IN TRANG CAT WARD, HAI AN DISTRICT, HAI PHONG CITY

Location and Code	Water source	Total Coliform (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
CANAL, DRAIN, RIVER POND								
Cat Bi lakenlet	lake	11,000	189	277		18	IT	
Outlet from Lamp company, Le Chan Dist.	canal	15,000	305	452		270	IT	
Cat Bi Lake, Cat Bi commune, Hai An dist., outlet	lake	10,000	57	98		12	IT	
Tay Nam canal	canal	14,000	124	216		50	IT	
An Kim Hai canal, Trang Cat, Hai An district	canal	5,000	78	146		55	IT	
Dong Bac canal	canal	6,000	87	152		20	IT	
SEWAGE DRAIN, OUTFLOW WWTP								
Cong den Canal- An Kim Hai commune - Trang Cat - Quan Hai An	Sewage drain	16,000	103	187		14	IW	
Phuong Luu lake- Phuong Luu commune	lake	17,000	165	287		21	IWO	
Canal crossing Le Hong Phong st., Ngo Quyen dist.	Sewage drain	13,000	124	216		31	WO	
Cam river, May Chai commune, Ngo Quyen district	river	12,000	97	165		125	WO	
Canal crossing Le Van Linh	Sewage drain	18,000	72	120		22	IO	
Vinh Niem canal, Hai An district	Sewage drain	11000	85	147		25	WO	
QCVN 01:2009/ BYT[a]			-	-	-	2		
QCVN 08:2008/ BTNMT[b]			4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		3	-	-	-	-		
QCVN 14: 2008/BTNMT[d]			30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

TABLE C13. WATER QUALITY MEASUREMENT RESULTS IN BAI CHAY WARD, HA LONG CITY, QUANG NINH PROVINCE (U4)

Location and Code	Water source	Total Coliform (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
CANAL, DRAIN, RIVER POND								
Cau Tau- Hoang Gia - Bai Chay (QN-1)	Sewage drain	2,000	85	148	2.47	24	ITO	
Thanh Nien beach- far from 100m- Bai Chay	Sewage drain	1,500	72	134	2.87	20	ITO	
Canal from Cai Ram - Hung Thang Lake	Sewage drain	3,000	154	284	0.9	65	IWO	Not polluted
Cai Ram lake	lake	3,500	132	224	2.7	50	IWO	
Hung Thang lake (opposite highway)	lake	1,500	54	100	2.3	28	IWO	Improved
Hung Thang lake (near highway)	lake	3,200	134	240	1.5	42	IWO	
SEWAGE DRAIN, OUTFLOW WWTP								
Inlet from Bai Chay treatment	Sewage drain	25,000	286	526	0.5	120	W	
Sewage drain from group II	Sewage drain	16,000	129	227	0.64	100	W	
Outlet from treatment Cai Ram, Bai Chay commune	Sewage drain	3,000	23	45	1.28	18	W	
Hung Thang lake (inlet)	Sewage drain	8,000	45	88	1.26	56	IW	
Sewage drain from Vron Đao (Buu Dien)	Sewage drain	20,000	273	495	1.44	110	W	
Sewage drain 50 metres from Vuon Dao	Sewage drain	10,000	65	137	1.65	23	W	
QCVN 01:2009/ BYT[a]			-	-	-	2		
QCVN 08:2008/ BTNMT[b]			4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		3	-	-	-	-		
QCVN 14: 2008/BTNMT[d]			30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

[a] QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

[b] QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

[c] QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

[d] QCVN 14:2008/BTNMT: Vietnamese national technical regulation on domestic wastewater – Column A (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C14. WATER QUALITY MEASUREMENT RESULTS IN BUON MA THUOT CITY, DAK LAK PROVINCE (U5)

Location and Code	Water source	E Coli (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
RW51	Dug well	0	-	-	-	1	CBD	
RW52	Dug well	0	-	-	-	0	CBD	
RW53	Deep well	0	-	-	-	0	CBD	Improved
RWC51	Dug well	0	-	-	-	1	CBD	Improved
RWC52	Deep well	240	-	-	-	2	CBD	
RWC53	Dug well	0	-	-	-	1	CBD	Improved
UT51	Tap water	-	-	-	-	-	CBD	
UR51 ()	Stream	4,600	67	154	5.7	45	IW	
UR52	Stream	110	12	36	6.8	85	IT	Improved
UR53	Stream	240	21	52	7.1	52	CBD	
UR54	Stream	2,300	52	149	6.7	14	CBD	
UR55	Stream	7,500	51	147	7.5	52	CBD	
UR56	Stream	11,000	96	175	4.6	75	ITO	
US51	Domestic WW	180,000	190	752	2.3	-	IW	
US52	Domestic WW	4,100	35	140	5.1	-	IW	
US53	Domestic WW	150,000	180	387	4.7	-	IW	
USC51	Domestic WW	430,000	210	450	2.1	-	IW	
	Domestic WW	240,000	190	343	1.7	-	IWO	
QCVN 01:2009/ BYT[a]		0	-	-	-	2		
QCVN 08:2008/ BTNMT[b]		20	4	10	≥ 6	-		
QCVN 09:2008/ BTNMT[c]		Not detected	-	-	-	-		
QCVN 14: 2008/BTNMT[d]		3,000	30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

[a] QCVN 01:2009/BYT: Vietnamese national technical regulation on drinking water quality (Ministry of Health - MOH, 2009);

[b] QCVN 08:2008/BTNMT: Vietnamese national technical regulation on surface water quality – column A1: using for domestic water supply and other purposes (Ministry of Natural Resources and Environment - MONRE, 2008);

[c] QCVN 09:2008/BTNMT: Vietnamese national technical regulation on underground water quality (Ministry of Natural Resources and Environment - MONRE, 2008).

[d] QCVN 14:2008/BTNMT: Vietnamese national technical regulation on domestic wastewater – Column A (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C15. WATER QUALITY MEASUREMENT RESULTS IN HANOI CITY (U7)

Location and Code	Water source	Total Coliform (MPN/100ml)	BOD (mg/L)	COD (mg/L)	DO (mg/L)	Turbidity (NTU)	Uses	Sanitation related remarks
LAKES AND RIVERS								
Thien Quang lake- near Thanh Nien theatre	river	41,000	20	46.5	3.64	55	IW	
Hoan Kiem lake - near Ba Trieu turning point	river	7,000	17	31	5.6	38	CBI	
Hong river at Liem Mac canal-riverhead	river	2,000	5	16.21	5.05	84	WO	
Hong river at Van Phuc- final point	lake	5,000	5	17.39	4.91	61	BDTO	
Ho Tay lake - near Thanh nien street	canal	13,000	17	41.2	3.76	41	CBI	
Truc Bach lake- near Truc Bach treatment Station	lake	19,000	28	52	4.18	44	IW	
SEWAGE DRAIN, OUTFLOW WWTP								
Dong Tac bridge, waste of Kim Lien sewage works	sewage drain	20,000	236	425	0.1		W	
To Lich river at Cau Moi bridge	WW	140,000	148	281	0.31		W	
To Lich river at Thanh Liet bridge	WW	160,000	106	198.7	0.24		W	
Kim Nguu river at Mai Dong bridge	WW	180,000	201	390	0.37		W	
Kim Nguu river atYen So canal	WW	160,000	89	187	3.64		W	
QCVN 14: 2008/BTNMT[(d)]			30	-	-	-		

Note: C: Cooking; B: Bathing and Laundry; D: Drinking; W: Wastewater; I: Irrigation; T: Transport; O: Other.

[(d)] QCVN 14:2008/BTNMT: Vietnamese national technical regulation on domestic wastewater – Column A (Ministry of Natural Resources and Environment - MONRE, 2008).

TABLE C16. WATER ACCESS AND COSTS (VND, 2009) AT URBAN SITES

Field site	Location	Piped water (treated)		Non-piped protected source (including untreated piped)		Non-piped unprotected source	
		% access	Average monthly cost (VND)	% access	Average monthly cost (VND)	% access	Average monthly cost (VND)
Hai Phong	DRY SEASON						
	Major	99.0	20,958.4	1.0	10,00	0	0
	Minor	100.0	10,000	0	0	0	0
	RAINY SEASON						
	Major	99.0	209,58.4	1.0	10,000	0	0
	Minor	100.0	10,000	0	0	0	0
Tam Ky	DRY SEASON						
	Major	41.8	5,594.9	33.7	7,007.6	24.5	10,375
	Minor	16.3	6,450	63.3	5,679.2	20.4	12,725
	RAINY SEASON						
	Major	41.8	5,594.9	35.7	6,607.1	22.5	11,318.2
	Minor	16.3	6,450	63.3	5,679.2	20.4	12,725
Dong Thap	DRY SEASON						
	Major	73.0	23,904.8	6.0	19,166.8	21.0	11,000
	Minor	23.2	63,437.5	63.6	12,300	13.1	7,000
	RAINY SEASON						
	Major	60.0	8,264.2	21.0	65,944.4	19.0	11,947.4
	Minor	8.0	1,875	81.0	24,802.8	11.0	6,909.1
Buon Me Thuat	DRY SEASON						
	Major	77.3	25,398.7	22.7	25,260.9	0	0
	Minor	61.8	24,166.7	38.2	27,307.7	0	0
	RAINY SEASON						
	Major	75.5	25,279.2	24.5	25,640	0	0
	Minor	60.0	22,500	40.0	29,634.2	0	0
Quang Ninh	DRY SEASON						
	Major	100.0	23,986.8	0	0	0	0
	Minor	8.0	65,000	92.0	22,878.4	0	0
	RAINY SEASON						
	Major	99.0	23956.8	1.0	0	0	0
	Minor	7.0	65000	93.0	22,878.4	0	0
Total	DRY SEASON						
	Major	78.3	22,198.5	14.5	17,654.1	7.2	10,666.7
	Minor	35.6	26,624.7	58.0	18,021.1	6.4	10,469.7
	RAINY SEASON						
	Major	75.4	19,977.7	18.0	26,060.1	6.6	11,609.8
	Minor	31.7	20,088	62.3	21,689.0	6.0	10,661.3

TABLE C17. WATER ACCESS AND COSTS (VND, 2009) AT RURAL SITES

Field site	Location	Piped water (treated)		Non-piped protected source (including untreated piped)		Non-piped unprotected source	
		% access	Average monthly cost (VND)	% access	Average monthly cost (VND)	% access	Average monthly cost (VND)
Hoai Duc	DRY SEASON						
	Major	0	0	96.5	23,828.3	3.5	20,000
	Minor	0	0	90.0	25,463.2	10.0	0.3
	RAINY SEASON						
	Major	0	0	99.0	23,950.5	1.0	0
	Minor	0.5	0	88.0	25,202.1	11.5	6,250.3
Dan Phuong	DRY SEASON						
	Major	0	0	100.0	15,706.6	0	0
	Minor	0	0	98.7	17,405.8	1.4	0
	RAINY SEASON						
	Major	0	0	100.0	17,112.7	0	0
	Minor	0	0	98.2	22,310.3	1.8	0
Hue	DRY SEASON						
	Major	10.1	30,000	59.6	0	30.3	33,000
	Minor	22.0	30,000	50.9	0	27.1	25,000
	RAINY SEASON						
	Major	10.1	30,000	59.6	0	30.3	33,000
	Minor	15.5	30,000	58.6	0	25.9	2,500
Vinh Long	DRY SEASON						
	Major	42.3	35,583.5	49.3	13,242.4	8.5	13,470.6
	Minor	17.0	17,782.6	78.5	22,628.3	4.4	10,833.3
	RAINY SEASON						
	Major	27.7	31,810.9	67.8	19,485.1	4.5	13,555.6
	Minor	14.8	18,285.7	84.5	20,683.1	0.7	20,000
Quang Nam	DRY SEASON						
	Major	42.0	2,923.1	36.5	15,555.6	21.5	14,125
	Minor	7.0	0	83.0	13,985.1	10.0	0
	RAINY SEASON						
	Major	42.0	2,923.1	36.5	15,555.6	21.5	14,125
	Minor	5.0	0	85.5	13,779.4	9.5	0
Quang Ngai	DRY SEASON						
	Major	0	0	85.6	24,320	14.4	26,807.7
	Minor	0	0	93.6	25,202.5	6.4	19,750
	RAINY SEASON						
	Major	0	0	85.0	24,543.6	15.0	26,461.5
	Minor	0	0	94.7	25,860.6	5.3	7,800
Average	DRY SEASON						
	Major	17.3	31,455.1	68.5	19,767.6	14.2	19,866.7
	Minor	5.8	17,875	85.4	22,247.3	8.8	9,593.8
	RAINY SEASON						
	Major	14.9	26,582.4	71.8	21,288.9	13.3	20,531.3
	Minor	4.8	18,363.6	87.0	22,440.6	8.2	58,841.7

TABLE C18. HOUSEHOLD RESPONSES TO POLLUTED WATER – REASONS FOR USING WATER SOURCES

Field site	Location	Piped water (treated)			Non-piped protected source (including untreated piped)			Non-piped unprotected source		
		Quality (%)	Quantity (%)	Cost (%)	Quality (%)	Quantity (%)	Cost (%)	Quality (%)	Quantity (%)	Cost (%)
Hoai Duc	DRY SEASON									
	Major	0	0	0	90.2	20.7	46.1	85.7	14.3	42.9
	Minor	0	0	0	92.2	22.9	41.3	70.0	0	85.0
	RAINY SEASON									
	Major	0	0	0	91.3	20.9	45.9	0	0	50.0
	Minor	100.0	0	0	91.5	22.7	42.1	78.3	4.4	78.3
Dan Phuong	DRY SEASON									
	Major	0	0	0	97.0	38.4	58.6	0	0	0
	Minor	0	0	0	94.5	26.0	52.1	100.0	0	0
	RAINY SEASON									
	Major	0	0	0	94.1	27.1	50.6	0	0	0
	Minor	0	0	0	92.7	26.6	47.3	100.0	0	0
Hue	DRY SEASON									
	Major	100.0	40.0	35.0	72.9	43.2	44.9	65.0	45.0	41.7
	Minor	100.0	46.2	23.1	93.3	73.3	83.3	75.0	56.3	93.8
	RAINY SEASON									
	Major	100.0	40.0	35.0	72.9	43.2	44.9	65.0	45.0	41.7
	Minor	100.0	22.2	33.3	94.1	76.5	73.5	73.3	60.0	93.3
Vinh Long	DRY SEASON									
	Major	97.7	2.4	21.2	44.4	1.0	17.2	35.3	5.9	58.8
	Minor	91.3	4.4	13.0	58.5	0	16.0	16.7	0	16.7
	RAINY SEASON									
	Major	100.0	1.8	27.3	54.5	2.2	16.4	33.3	0	77.8
	Minor	100.0	4.8	14.3	56.8	0.9	20.3	100.0	0	0
Quang Nam	DRY SEASON									
	Major	86.9	12.1	42.9	93.2	64.5	68.5	97.7	37.2	41.9
	Minor	71.4	35.7	28.6	92.2	39.1	50.0	100.0	20.0	85.0
	RAINY SEASON									
	Major	86.9	12.1	42.9	93.2	64.4	68.5	97.7	37.2	41.9
	Minor	70.0	50.0	30.0	91.8	38.0	49.1	100.0	21.1	89.5
Quang Ngai	DRY SEASON									
	Major	0	0	0	96.3	21.1	29.8	81.5	7.4	11.1
	Minor	0	0	0	96.6	20.0	28.6	58.3	8.3	8.3
	RAINY SEASON									
	Major	0	0	0	96.2	20.1	29.6	82.1	14.3	14.3
	Minor	0	0	0	96.6	20.3	28.8	50.0	0	0
Rural	DRY SEASON									
	Major	93.1	11.4	32.5	83.6	28.4	42.4	74.7	30.5	38.3
	Minor	87.8	24.5	20.4	88.6	24.9	39.4	73.3	18.7	68.0
	RAINY SEASON									
	Major	93.0	12.6	36.7	83.5	25.7	39.9	75.4	33.1	38.7
	Minor	92.5	20.0	22.5	87.4	24.7	38.9	79.7	20.3	71.0

TABLE C19. HOUSEHOLD RESPONSES TO POLLUTED WATER – REASONS FOR USING WATER SOURCES (CONT.)

Field site	Location	Piped water (treated)			Non-piped protected source (including untreated piped)			Non-piped unprotected source		
		Quality (%)	Quantity (%)	Cost (%)	Quality (%)	Quantity (%)	Cost (%)	Quality (%)	Quantity (%)	Cost (%)
Hai Phong	DRY SEASON	99.0	67.3	55.5	100.0	100.0	0	0	0	0
	Major	100.0	100.0	100.0	0	0	0	0	0	0
	Minor									
	RAINY SEASON	99.0	67.3	55.5	100.0	100.0	0	0	0	0
	Major	100.0	100.0	100.0	0	0	0	0	0	0
	Minor									
Tam Ky	DRY SEASON	87.8	34.2	17.1	87.9	15.2	21.2	83.3	4.2	37.5
	Major	100.0	12.5	6.3	85.5	27.4	27.4	80.0	5.0	25.0
	Minor									
	RAINY SEASON	87.8	34.2	17.1	82.9	14.3	22.9	90.9	4.6	36.4
	Major	100.0	12.5	6.3	85.5	27.4	27.4	80.0	5.0	25.0
	Minor									
Dong Thap	DRY SEASON	91.8	6.9	12.3	33.3	16.7	50.0	61.9	42.9	52.4
	Major	91.3	8.7	13.0	87.3	7.9	25.4	38.5	61.5	30.8
	Minor									
	RAINY SEASON	91.7	6.7	15.0	76.2	19.1	14.3	57.9	36.8	57.9
	Major	100.0	0	0	86.4	9.9	23.5	36.4	63.6	36.4
	Minor									
Buon Me Thuat	DRY SEASON	96.5	47.1	28.2	88.0	20.0	24.0	0	0	0
	Major	97.1	48.5	33.8	90.5	28.6	16.7	0	0	0
	Minor									
	RAINY SEASON	96.4	48.2	27.7	88.9	18.5	25.9	0	0	0
	Major	97.0	50.0	34.9	90.9	27.3	15.9	0	0	0
	Minor									
Quang Ninh	DRY SEASON	78.0	29.0	4.0	0	0	0	0	0	0
	Major	100.0	75.0	0	76.1	25.0	4.4	0	0	0
	Minor									
	RAINY SEASON	77.8	29.3	4.0	100.0	0	0	0	0	0
	Major	100.0	85.7	0	76.3	24.7	4.3	0	0	0
	Minor									
Urban	DRY SEASON	91.8	40.3	25.5	84.4	18.9	24.4	73.3	22.2	44.4
	Major	96.8	41.1	27.0	84.4	22.9	16.9	63.6	27.3	27.3
	Minor									
	RAINY SEASON	91.7	41.7	26.1	84.8	17.9	22.3	75.6	19.5	46.3
	Major	97.6	44.9	28.5	84.6	22.2	16.7	64.5	25.8	29.0
	Minor	0	0	0	96.6	20.3	28.8	50.0	0	0

TABLE C20. TREATMENT PRACTICES, RURAL SITES (%)

Field site	Boiling	Chemicals	Sand filter	Chlorine	In-house filter
Ha Noi	84.0	54.5	61.5	0	56.0
Dan Phuong	93.1	93.1	100.0	0	94.1
Hue	3.5	0.5	0.5	0	0.5
Vinh Long	74.1	74.1	74.1	0	74.1
Quang Nam	50.0	49.0	49.0	0	49.0
Quang Ngai	67.0	70.0	70.5	0	69.0
Average rural	**59.2**	**53.7**	**55.8**	**0**	**53.9**

TABLE C21. TREATMENT PRACTICES, URBAN SITES (%)

Field site	Boiling	Chemicals	Sand filter	Chlorine	In-house filter
Hai Phong	54.9	1.0	2.9	0	5.9
Tam Ky	26.5	27.6	27.6	0	27.6
Dong Thap	89.0	86.0	87.0	0	87.0
Buon Me Thuot	61.8	61.8	61.8	0	61.8
Qung Ninh	45.0	46.0	46.0	0	46.0
Average urban	**56.7**	**47.7**	**48.2**	**0**	**48.6**

TABLE C22. TREATMENT COSTS, RURAL SITES (VND/M^3, 2009)

Field site	Boiling	Chemicals	Sand filter	Chlorine	In-house filter	Nothing
Ha Noi	22,949	4,590	8,106		20,221	14
Dan Phuong	6,884	3,262	3,102		24,500	1
Hue	9,143	15,000	5,000	24,000		88
Vinh Long	2,281	6,950		32,000	12,611	29
Quang Nam	2,577		1,200	18,000	31,847	47
Quang Ngai	2,806	1,400		17,000	10,509	27
Average rural	**7,773**	**6,240**	**4,352**	**22,750**	**19,938**	**34**

TABLE C23. TREATMENT COSTS, URBAN SITES (VND/M^3, 2009)

Field site	Boiling	Chemicals	Sand filter	Chlorine	In-house filter	Nothing
Hai Phong	24,464	19,000		15,000	10,654	12
Tam Ky	10,654		3,700			73
Dong Thap	6,340	264	3,400	29,000	16,132	5
Buon Me Thuot	2,665				73,500	38
Quang Ninh	8,420				2,413	54
Average urban	**8,993**	**9,632**	**3,550**	**22,000**	**25,675**	**36**

TABLE C24. WATER ACCESS AND HOUSEHOLD TREATMENT COSTS, INCURRED AND AVERTED (VND, 2009)

Sites	Annual average costs per household, VND		Annual averted costs per household, VND	
	Water source access	Water treatment	Water access saved	Water treatment saved
RURAL				
R1	58,948	784,718	1,624	30,850
R2	143,771	530,990	1,588	84,990
R3	2,108,960	2,356,063	104,989	704,893
R4	496,014	4,071,372	56,893	610,888
R5	170,001	11,426,570	10,530	729,374
R7	62,441	1,163,327	1,010	266,235
R8	120,760	561,960	3,970	26,531
R9	144,397	2,892,180	25,781	87,493
Average rural	**413,162**	**2,973,398**	**25,798**	**317,657**
URBAN				
U1	542,454	6,169,293	5,294	1,097,310
U2	98,937	524,622	1,992	273,302
U3	430,034	5,369,651	9,578	58,829
U4	1,036,443	340,910	376	202,575
U5	271,648	885,232	628	53,091
Average urban	**475,903**	**2,657,941**	**3,574**	**337,021**

ANNEX D. ACCESS TIME

TABLE D1. PLACE OF DEFECATION FOR HOUSEHOLDS WITHOUT 'OWN' TOILET - URBAN SITES

Site	No.	Place of defecation, %		
	Observations	Neighbor	Own plot	Outside plot
Hai Phong	0	0	0	0
Tam Ky	10	50.0	50.0	0
Dong Thap	18	38.9	55.6	5.5
BMT	0	0	0	0
Quang Ninh	0	0	0	0
Total Urban	**28**	**42.9**	**53.6**	**3.6**

TABLE D2. PLACE OF DEFECATION FOR HOUSEHOLDS WITHOUT 'OWN' TOILET - RURAL SITES

Site	No.	Place of defecation, %		
	Observations	Neighbor	Own plot	Outside plot
Hanoi	4	100.0	0	0
Dan Phuong	0	0	0	0
Hue	39	20.5	59.0	20.5
Vinh Long	55	76.4	23.6	0
Quang Nam	39	5.1	92.3	2.6
Quang Ngai	40	5.0	70.0	25.0
Total rural	**177**	**32.8**	**56.5**	**10.7**

TABLE D3. DAILY TIME SPENT ACCESSING A TOILET FOR THOSE WITH NO TOILET, MINUTES - URBAN SITES

Location	Time per trip and waiting	No. of times per day
Hai Phong	0	1.6
Tam Ky	5.2	1.4
Dong Thap	4.1	4.0
BMT	0	5.5
Quang Ninh	0	6.4
Total Urban	**4.5**	**4.1**

TABLE D4. DAILY TIME SPENT ACCESSING A TOILET FOR THOSE WITH NO TOILET, MINUTES - RURAL SITES

Location	Time per trip and waiting	No. of times per day
Hanoi	1.5	4.3
Dan Phuong	0	1.9
Hue	9.0	2.7
Vinh Long	5.3	3.6
Quang Nam	10.2	3.8
Quang Ngai	14.3	1.6
Total rural	**9.2**	**3.1**

TABLE D5. TOILET PRACTICES RELATED TO YOUNG CHILDREN - URBAN SITES

Location	Parents accompanying young children	Of which:	
		% outside plot	No. of times per day
Hai Phong	0.8	100.0	2.1
Tam Ky	0.5	100.0	1.3
Dong Thap	1.1	100.0	2.8
BMT	1.0	100.0	2.6
Quang Ninh	2.9	100.0	7.3
Average Urban	**1.2**	**100.0**	**2.9**

TABLE D6. TOILET PRACTICES RELATED TO YOUNG CHILDREN - RURAL SITES

Location	Parents accompanying young children (40% of toilet times)	Of which:	
		% outside plot (100%)	No. of times per day
Hanoi	1.3	100.0	3.3
Dan Phuong	0.4	100.0	1.1
Hue	0.7	100.0	1.7
Vinh Long	0.9	100.0	2.2
Quang Nam	0.9	100.0	2.2
Quang Ngai	0.6	100.0	1.5
Total rural	**0.9**	**100.0**	**2.3**

TABLE D7. PREFERENCES RELATED TO TOILET CONVENIENCE, FROM HOUSEHOLD QUESTIONNAIRE - URBAN SITES (MAX = 5; MIN = 0)

Site	Perceived benefits of sanitation (B6.1): proximity cited as satisfied or very satisfied	
	Those with toilet	Those without toilet
HAI PHONG		
Comfortable toilet position	4.1	0
Cleanliness and freedom from unpleasant odors and insects	4.4	0
Privacy when using the toilet	4.4	0
Proximity of toilet to house	4.1	0
A feeling of status from having an attractive toilet facility	3.6	0
Feeling good about your toilet facility when you have friends and other guests at your home	3.0	0
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	3.8	0
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.4	0
SA DEC, DONG THAP		
Comfortable toilet position	3.9	2.8
Cleanliness and freedom from unpleasant odors and insects	4.3	3.8
Privacy when using the toilet	4.2	4
Proximity of toilet to house	4.2	3
A feeling of status from having an attractive toilet facility	3.6	1.8
Feeling good about your toilet facility when you have friends and other guests at your home	4.0	1
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.2	3.8
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.4	4.8
TAM KY		
Comfortable toilet position	4.8	5
Cleanliness and freedom from unpleasant odors and insects	4.9	5
Privacy when using the toilet	4.9	4
Proximity of toilet to house	4.8	4.7
A feeling of status from having an attractive toilet facility	4.7	4.8
Feeling good about your toilet facility when you have friends and other guests at your home	4.6	3.5
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.8	5
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	5.0	5

TABLE D7. PREFERENCES RELATED TO TOILET CONVENIENCE, FROM HOUSEHOLD QUESTIONNAIRE - URBAN SITES (MAX = 5; MIN = 0)(CONT.)

Site	Perceived benefits of sanitation (B6.1): proximity cited as satisfied or very satisfied	
	Those with toilet	Those without toilet
BUON MA THUOT		
Comfortable toilet position	4.7	0
Cleanliness and freedom from unpleasant odors and insects	4.6	0
Privacy when using the toilet	4.7	0
Proximity of toilet to house	4.7	0
A feeling of status from having an attractive toilet facility	4.3	0
Feeling good about your toilet facility when you have friends and other guests at your home	3.8	0
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.4	0
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.5	0
QUANG NINH		
Comfortable toilet position	4.9	0
Cleanliness and freedom from unpleasant odors and insects	4.8	0
Privacy when using the toilet	4.9	0
Proximity of toilet to house	4.8	0
A feeling of status from having an attractive toilet facility	4.8	0
Feeling good about your toilet facility when you have friends and other guests at your home	3.9	0
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.8	0
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.9	0
AVERAGE URBAN		
Comfortable toilet position	4.5	4.2
Cleanliness and freedom from unpleasant odors and insects	4.6	4.5
Privacy when using the toilet	4.7	4
Proximity of toilet to house	4.6	4
A feeling of status from having an attractive toilet facility	4.2	3.6
Feeling good about your toilet facility when you have friends and other guests at your home	3.8	2.5
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.4	4.5
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.6	4.9

TABLE D8. PREFERENCES RELATED TO TOILET CONVENIENCE, FROM HOUSEHOLD QUESTIONNAIRE - RURAL SITES (MAX = 5; MIN = 0)

Site	Perceived benefits of sanitation (B6.1): proximity cited as satisfied or very satisfied	
	Those with toilet	Those without toilet
LAI XA, HANOI		
Comfortable toilet position	4.2	3.7
Cleanliness and freedom from unpleasant odors and insects	4.3	5.0
Privacy when using the toilet	4.3	4.3
Proximity of toilet to house	4.3	4.3
A feeling of status from having an attractive toilet facility	4.1	4.7
Feeling good about your toilet facility when you have friends and other guests at your home	3.7	4.0
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.1	4.3
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.2	4.3
DAN PHUONG, HANOI		
Comfortable toilet position	4.7	0
Cleanliness and freedom from unpleasant odors and insects	4.6	0
Privacy when using the toilet	4.6	0
Proximity of toilet to house	4.6	0
A feeling of status from having an attractive toilet facility	4.4	0
Feeling good about your toilet facility when you have friends and other guests at your home	4.2	0
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.6	0
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.8	0
THUA THIEN - HUE		
Comfortable toilet position	3.5	3.8
Cleanliness and freedom from unpleasant odors and insects	3.5	4.3
Privacy when using the toilet	3.8	3.8
Proximity of toilet to house	3.5	3.8
A feeling of status from having an attractive toilet facility	3.0	3.8
Feeling good about your toilet facility when you have friends and other guests at your home	2.9	2.9
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	3.5	3.8
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	3.6	4.1

TABLE D8. PREFERENCES RELATED TO TOILET CONVENIENCE, FROM HOUSEHOLD QUESTIONNAIRE - RURAL SITES (MAX = 5; MIN = 0)(CONT.)

Site	Perceived benefits of sanitation (B6.1): proximity cited as satisfied or very satisfied	
	Those with toilet	Those without toilet
VINH LONG		
Comfortable toilet position	4.4	4.9
Cleanliness and freedom from unpleasant odors and insects	4.5	4.9
Privacy when using the toilet	4.5	4.8
Proximity of toilet to house	4.5	4.9
A feeling of status from having an attractive toilet facility	4.3	4.9
Feeling good about your toilet facility when you have friends and other guests at your home	3.3	4.8
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.5	4.9
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.6	4.9
QUANG NAM		
Comfortable toilet position	4.6	5
Cleanliness and freedom from unpleasant odors and insects	4.7	5
Privacy when using the toilet	4.8	5
Proximity of toilet to house	4.6	5
A feeling of status from having an attractive toilet facility	4.1	5
Feeling good about your toilet facility when you have friends and other guests at your home	3.3	5
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.4	5
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.8	5
QUANG NGAI		
Comfortable toilet position	4.6	5
Cleanliness and freedom from unpleasant odors and insects	4.5	5
Privacy when using the toilet	4.5	4.5
Proximity of toilet to house	4.6	5
A feeling of status from having an attractive toilet facility	4.1	4
Feeling good about your toilet facility when you have friends and other guests at your home	3.7	3.6
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.4	4.6
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.6	5

TABLE D8. PREFERENCES RELATED TO TOILET CONVENIENCE, FROM HOUSEHOLD QUESTIONNAIRE - RURAL SITES (MAX = 5; MIN = 0)(CONT.)

Site	Perceived benefits of sanitation (B6.1): proximity cited as satisfied or very satisfied	
	Those with toilet	Those without toilet
AVERAGE RURAL		
Comfortable toilet position	4.3	4.7
Cleanliness and freedom from unpleasant odors and insects	4.3	4.8
Privacy when using the toilet	4.4	4.6
Proximity of toilet to house	4.3	4.7
A feeling of status from having an attractive toilet facility	4.0	4.6
Feeling good about your toilet facility when you have friends and other guests at your home	3.5	4.3
Work/maintenance of the toilet disposal system (pit, septic tank, sewer)	4.2	4.7
Pollution of your, your neighbors', or your community's environment from the toilet disposal system (pit, septic tank, sewer)	4.4	4.7

TABLE D9. AVERAGE TIME SAVED PER YEAR, BY URBAN HOUSEHOLD MEMBER (HOURS)

Site	Household	Adult time with young children	Per average household
Hai Phong	219.0	36.5	255.5
Tam Ky	589.7	71.4	661.1
Dong Thap	0.0	0.0	0.0
BMT	0.0	0.0	0.0
Quang Ninh	0.0	0.0	0.0
Average Urban	**1,586.7**	**157.3**	**1,744.0**

TABLE D10. AVERAGE TIME SAVED PER YEAR, BY RURAL HOUSEHOLD MEMBER (HOURS)

Site	Household	Adult time with young children	Per average household
Hanoi	707.4	48.8	756.2
Dan phuong	0.0	0.0	0.0
Hue	1,317.3	76.7	1,394.0
Vinh Long	0.0	0.0	0.0
Quang Nam	1,460.0	85.2	1,545.2
Quang Ngai	640.6	57.2	697.8
Average rural	**1,130.6**	**52.1**	**1,182.7**

TABLE D11. AVERAGE ANNUAL VALUE OF TIME SAVED (VND), URBAN SITES

Site	Household	Adult time with young children	Per average household
Hai Phong	312,252.9	52,042.2	364,295.1
Tam Ky	840,801.6	101,803.0	942,604.6
Dong Thap	-	-	-
BMT	-	-	-
Quang Ninh	-	-	-
Average Urban	**2,262,336.7**	**224,280.3**	**2,486,617.0**

TABLE D12. AVERAGE ANNUAL VALUE OF TIME SAVED (VND), RURAL SITES

Site	Household	Adult time with young children	Per average household
Hanoi	707.4	48.8	756.2
Dan phuong	0.0	0.0	0.0
Hue	1,317.3	76.7	1,394.0
Vinh Long	0.0	0.0	0.0
Quang Nam	1,460.0	85.2	1,545.2
Quang Ngai	640.6	57.2	697.8
Average rural	**1,130.6**	**52.1**	**1,182.7**

ANNEX E. INTANGIBLE USER PREFERENCES

TABLE E1. LEVEL OF SATISFACTION FOR IMPROVED TOILETS VS. UNIMPROVED TOILETS (1 = NOT SATISFIED; 5 = VERY SATISFIED) BY SITE

Sites	Types of toilet	Toilet position	Cleanliness & freedom	Privacy	Proximity	Status	Visitors	Mainte-nance	Pollution
Lai Xa	Improved	4.2	4.3	4.3	4.3	4.1	3.7	4.1	4.2
	Unimproved	3.0	2.0	4.0	4.0	1.0	1.0	2.0	3.0
Dan Phuong	Improved	4.7	4.7	4.6	4.6	4.5	4.2	4.6	4.8
	Unimproved	1.0	1.0	4.0	5.0	1.0	1.0	3.0	2.0
Quang Ninh	Improved	4.9	4.8	4.9	4.8	4.8	3.9	4.8	4.9
	Unimproved	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hai Phong	Improved	4.1	4.4	4.4	4.1	3.6	3.0	3.8	4.4
	Unimproved	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Quang Nam R	Improved	4.7	4.7	4.9	4.7	4.2	3.3	4.5	4.9
	Unimproved	2.3	2.3	3	2.5	2.3	1.5	2.3	2.8
Hue	Improved	3.8	3.8	4.1	3.8	3.4	3.3	3.9	4.0
	Unimproved	2.5	2.6	2.9	2.8	1.9	2.0	2.3	2.6
Quang Ngai	Improved	4.8	4.8	4.7	4.8	4.6	4.2	4.7	4.7
	Unimproved	4.4	4.3	4.4	4.4	3.8	3.4	4.2	4.5
Quang Nam U	Improved	3.8	4.4	4.2	4.2	3.6	4.0	4.2	4.4
	Unimproved	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vinh long	Improved	4.6	4.7	4.9	4.8	4.5	3.5	4.6	4.8
	Unimproved	3.4	3.6	2.7	3.2	3.3	2.1	3.8	3.8
Dong Thap	Improved	4.8	4.9	4.9	4.8	4.7	4.6	4.8	5.0
	Unimproved	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dak Lak	Improved	4.7	4.6	4.7	4.7	4.3	3.8	4.4	4.5
	Unimproved	4.0	3.0	2.0	2.0	1.0	2.0	3.0	1.0

TABLE E2. REASONS TO GET A TOILET FOR THOSE CURRENTLY WITHOUT ONE (1 = NOT IMPORTANT; 5 = VERY IMPORTANT) BY SITE

Sites	Toilet position	Cleanliness & freedom	Privacy	Proximity	Status	Visitors	Mainte-nance	Pollution
Lai Xa	3.7	5.0	4.3	4.3	4.7	4.0	4.3	4.3
Dan Phuong	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Quang Ninh	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hai Phong	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Quang Nam R	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Hue	3.8	4.3	3.8	3.8	3.8	2.9	3.8	4.1
Quang Ngai	5.0	5.0	4.5	5.0	4.0	3.6	4.6	5.0
Quang Nam U	2.8	3.8	4.0	3.0	1.8	1.0	3.8	4.8
Vinh Long	4.9	4.9	4.8	4.9	4.9	4.8	4.9	4.9
Dong Thap	5.0	5.0	4.0	4.7	4.8	3.5	5.0	5.0
Dak Lak	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

TABLE E3. CONCERNS OF THOSE PRACTICING OPEN DEFECATION BY SITE

Sites	Concern	No. responding	Responses		
			Never	Sometimes	Often
Quang Nam R	Feel in danger	39	48.7	2.6	48.7
	Safety of children	28	3.6	78.6	17.9
	Attack by animals	39	10.3	0	89.7
Hue	Feel in danger	44	59.1	9.1	31.8
	Safety of children	11	27.3	63.6	9.1
	Attack by animals	44	79.6	6.8	13.6
Quang Ngai	Feel in danger	43	39.5	7.0	53.5
	Safety of children	13	23.1	53.9	23.1
	Attack by animals	43	41.9	2.3	55.8
Quang Nam U	Feel in danger	10	70.0	0	30.0
	Safety of children	1	0	0	100
	Attack by animals	10	0	0	100
Vinh long	Feel in danger	55	60.0	32.7	7.3
	Safety of children	15	0	86.7	13.3
	Attack by animals	55	18.2	30.9	50.9
Dong Thap	Feel in danger	19	84.2	0	15.8
	Safety of children	6	16.7	33.3	50.0
	Attack by animals	20	85.0	0	15.0

TABLE E4. WHAT DO PEOPLE DO WITH ORGANIC WASTE?

What do you do with organic waste?	Lai Xa	Dan Phuong	Quang Ninh	Hai Phong	Quang Nam R	Hue	Quang Ngai	Quang Nam U	Vinh long	Dong thap	Dak lak
Compost	2.6	2.3	n/a	51.4	0	30.3	6.3	5.9	16.5	14.3	16.3
Give to animals	42.86	97.7	n/a	5.4	87.3	51.3	70.5	64.7	59.8	74.3	51.0
Give away	25.97	0	n/a	5.4	5.6	5.3	22.3	29.4	7.2	11.4	18.4
Sell	2.6	0	n/a	18.9	0	1.3	0.9	0	0	0	8.2
Other	25.97	0	n/a	18.9	7.1	11.8	0	0	16.5	0	6.1
Total (%)	**100**	**100**		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

TABLE E5. WHAT DO PEOPLE DO WITH INORGANIC SOLID WASTE?

What do you do with solid waste?	Lai Xa	Dan Phuong	Quang Ninh	Hai Phong	Quang Nam R	Hue	Quang Ngai	Quang Nam U	Vinh long	Dong thap	Dak Lak
Stored at premises and collected by a garbage collection company, the community or others	84.9	96.0	95.0	89.1	25.5	4.5	7.6	49.0	27.5	32.0	91.7
Stored at public place and collected by a garbage collection company, the community or others	13.6	4.0	1.0	2.0	0.5	1.0	1.0	0	4.0	0	5.5
Dumped at premises into a hole at the premises	1.01	0	4.0	4.9	3.5	4.0	8.1	4.1	17.0	8.0	0.9
Dumped on the ground at the premise	0	0	0	0	61.5	79.4	78.2	43.9	24.0	53.0	1.8
Dumped outside premises into dump yard	0.5	0	0	0	5.0	6.5	1.0	1.0	1.5	3.0	0
Dumped outside premises into river/ stream/canal/pond	0	0	0	4.0	4.0	2.0	4.1	2.0	23.5	3.0	0
Dumped outside premises into gutter/ ditch/along the road	0	0	0	0	0	0	0	0	0	0	0
Dumped outside premises elsewhere	0	0	0	0	0	2.5	0	0	2.5	1.0	0
Burnt at or outside premises	0	0	0	0	0	0	0	0	0	0	0
Buried in or outside yard	0	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0	0
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

TABLE E6. ANIMAL EXCRETA AROUND THE LIVING AREA BY SITE

Are there animal excreta around the village?	Yes	No	Total
Lai Xa	93.65	6.35	100
Dan Phuong	100	0	100
Quang Ninh	100	0	100
Hai Phong	97.3	2.7	100
Quang Nam R	94.5	5.5	100
Hue	84.1	15.9	100
Quang Ngai	98.2	1.8	100
Quang Nam U	87.6	12.4	100
Vinh Long	52.9	47.1	100
Dong thap	68.8	31.2	100
Daclak	82.7	17.3	100

TABLE E7. PROPORTION OF HOUSEHOLDS WITH IMPROVED TOILET THAT PRACTICES UNIMPROVED SANITATION, BY SITE

Site	% of households with children using toilets: children using toilet					
	No children	Always	Sometimes	Never	Don't know	Total
Lai Xa	2.14	65.71	11.43	13.57	7.14	100
Dan Phuong	59.4	29.2	1.0	10.4	0	100
Quang Ninh	75.0	24.0	0	1.0	0	100
Hai Phong	56.0	20.9	11.0	11.0	1.1	100
Quang Nam R	72.9	20.7	3.2	3.2	0	100
Hue	60.7	21.4	5.0	11.4	1.4	100
Quang Ngai	69.8	22.2	6.7	1.3	0	100
Quang Nam U	71.3	18.4	5.8	3.5	1.1	100
Vinh Long	63.4	12.4	14.5	5.5	4.1	100
Dong thap	57.5	24.7	12.3	5.5	0	100
Daclak	74.1	15.7	6.5	3.7	0	100

TABLE E8. OPEN DEFECATION PRACTICES AMONG POPULATION WITH IMPROVED SANITATION

OD	None/never	Sometimes/little	Moderate	Pervasive	Total
Lai Xa	83	15	1.5	0.5	100
Dan Phuong	94.9	4.0	0	1.0	100
Quang Ninh	45.2	43.0	7.5	4.3	100
Hai Phong	46.5	36.6	16.8	0	100
Quang Nam R	2.1	14.0	65.3	18.7	100
Hue	10.6	32.8	43.4	13.1	100
Quang Ngai	9.4	63.9	22.2	4.4	100
Quang Nam U	26.5	38.8	32.7	2.0	100
Vinh Long	79.6	14.7	5.8	0	100
Dong thap	30.6	48.0	12.2	9.2	100
Daclak	67.9	25.7	6.4	0	100

TABLE E9. PERCEPTIONS OF ENVIRONMENTAL SANITATION, BY SITE (1 = VERY BAD; 5 = VERY GOOD)

Perceptions of environmental sanitation state	Lai Xa	Dan Phuong	Quang Ninh	Hai Phong	Quang Nam R	Hue	Quang Ngai	Quang Nam U	Vinh long	Dong thap	Dak-lak
Uncollected/undisposed household waste	3	3.4	4.7	4.1	4.2	3.6	4.5	3.7	4.2	4.3	2.4
Open, visible sewage or wastewater	3.0	3.9	4.7	4.2	4.0	3.3	4.2	3.4	3.8	4.0	2.5
Accumulation of rain and storm water	29	3.7	4.7	4.2	4.0	3.2	4.4	3.8	3.9	3.9	2.6
Smell from sewage, defecation and waste	3.1	3.8	4.6	4.7	4.1	3.4	4.4	3.6	4.2	4.1	2.7
Dust and dirt in streets, or alleys	3.3	4.1	4.7	4.3	4.5	3.6	4.4	3.6	4.4	3.9	2.6
Dust and dirt in markets, or restaurants	3.3	4.1	4.7	4.0	4.5	3.7	4.5	3.5	4.3	3.9	2.8
Rodents markets, shops or restaurants	3.0	4.1	4.7	3.6	4.3	3.6	4.4	3.6	4.2	3.9	2.7
Insects	2.9	4.3	4.7	3.6	4.4	3.7	4.3	3.4	4.3	3.9	2.6

TABLE E10. IMPORTANCE OF ENVIRONMENTAL SANITATION STATE, BY SITE (1 = NOT IMPORTANT; 5 = VERY IMPORTANT)

How important to you and your family is improvement related to the following in your neighborhood?	Lai Xa	Dan Phuong	Quang Ninh	Hai Phong	Quang Nam R	Hue	Quang Ngai	Quang Nam U	Vinh long	Dong thap	Dak-lak
Collection and disposal of household waste	4.7	4.8	5	4.9	4.9	4.5	4.9	4.7	4.9	5.0	4.9
Open, visible sewage or wastewater	4.2	4.7	4.9	4.8	4.4	3.7	4.4	4.1	4.7	4.3	4.7
Accumulation of rain and storm water	4.2	4.7	4.9	4.5	4.6	3.9	4.5	4.4	4.7	4.5	4.4
Smell from sewage, defecation and waste	4.4	4.8	5	4.8	4.8	4.1	4.6	4.4	4.9	4.7	4.6
Dust and dirt in streets, or alleys	4.2	4.6	4.8	4.5	4.8	4.0	4.4	4.4	4.8	4.3	4.3
Dust and dirt in markets, or restaurants	4.2	4.5	4.9	4.3	4.9	4.0	4.5	4.3	4.8	4.4	4.4
Control of rodents	3.9	4.8	4.9	3.9	4.8	3.7	4.2	4.2	4.8	4.6	4.5
Control of insects	3.8	4.5	4.8	3.8	4.9	3.6	4.2	4.1	4.7	4.6	4.5

TABLE E11. SOLID WASTE MANAGEMENT PRACTICES, BY SITE

Sites	Variable	None/never	Sometimes/ little	Moderate	Pervasive	Total
Lai Xa	OD	83	15	1.5	0.5	100
	Land affected by sewage drains or wastewater	19.59	39.69	29.38	11.34	100
	Garbage/waste dumpsites or landfills	22.16	31.96	36.08	9.79	100
	Land flooded seasonally	20.21	38.86	28.5	12.44	100
	Land flooded permanently with poor quality sitting water	45.36	26.8	20.62	7.22	100
Dan Phuong	OD	94.9	4.0	0	1.0	100
	Land affected by sewage drains or wastewater	29.2	47.9	21.9	1.0	100
	Garbage/waste dumpsites or landfills	31.4	42.9	24.3	1.4	100
	Land flooded seasonally	0	54.5	18.8	26.7	100
	Land flooded permanently with poor quality sitting water	43.3	17.8	36.7	2.2	100
Quang Ninh	OD	45.2	43.0	7.5	4.3	100
	Land affected by sewage drains or wastewater	12.8	38.4	32.6	16.3	100
	Garbage/waste dumpsites or landfills	10.8	50.6	38.6	0	100
	Land flooded seasonally	9.5	63.1	21.4	6.0	100
	Land flooded permanently with poor quality sitting water	40.5	34.5	21.4	3.6	100
Hai Phong	OD	46.5	36.6	16.8	0	100
	Land affected by sewage drains or wastewater	0	8.0	12.0	80.0	100
	Garbage/waste dumpsites or landfills	0	10.0	5.0	85.0	100
	Land flooded seasonally	1.0	44.0	46.0	9.0	100
	Land flooded permanently with poor quality sitting water	0	45.5	35.3	19.2	100
Quang Nam R	OD	2.1	14.0	65.3	18.7	100
	Land affected by sewage drains or wastewater	5.7	15.5	46.6	32.1	100
	Garbage/waste dumpsites or landfills	5.6	16.3	36.2	43.9	100
	Land flooded seasonally	1.5	16.9	21.0	60.5	100
	Land flooded permanently with poor quality sitting water	4.1	16.4	60.5	19.0	100
Hue	OD	10.6	32.8	43.4	13.1	100
	Land affected by sewage drains or wastewater	21.6	31.2	35.7	11.6	100
	Garbage/waste dumpsites or landfills	16.2	25.8	45.5	12.6	100
	Land flooded seasonally	7.6	37.9	25.3	29.3	100
	Land flooded permanently with poor quality sitting water	21.9	40.3	25.0	12.8	100

TABLE E11. SOLID WASTE MANAGEMENT PRACTICES, BY SITE (CONT.)

Sites	Variable	None/never	Sometimes/ little	Moderate	Pervasive	Total
Quang Ngai	OD	9.4	63.9	22.2	4.4	100
	Land affected by sewage drains or wastewater	29.3	42.1	23.2	5.5	100
	Garbage/waste dumpsites or landfills	50.8	33.6	10.5	5.2	100
	Land flooded seasonally	4.2	44.3	44.3	7.2	100
	Land flooded permanently with poor quality sitting water	6.3	53.5	38.0	2.1	100
Quang Nam U	OD	26.5	38.8	32.7	2.0	100
	Land affected by sewage drains or wastewater	2.0	53.1	30.6	14.3	100
	Garbage/waste dumpsites or landfills	8.2	54.1	24.5	13.3	100
	Land flooded seasonally	0	55.7	25.8	18.6	100
	Land flooded permanently with poor quality sitting water	18.4	49.0	22.5	10.2	100
Vinh Long	OD	79.6	14.7	5.8	0	100
	Land affected by sewage drains or wastewater	22.1	38.4	33.7	5.8	100
	Garbage/waste dumpsites or landfills	23.0	50.3	25.5	1.2	100
	Land flooded seasonally	19.6	42.4	19.6	18.5	100
	Land flooded permanently with poor quality sitting water	41.0	36.7	21.1	1.2	100
Dong Thap	OD	30.6	48.0	12.2	9.2	100
	Land affected by sewage drains or wastewater	35.9	33.7	30.4	0	100
	Garbage/waste dumpsites or landfills	36.7	34.4	26.7	2.2	100
	Land flooded seasonally	13.7	47.4	23.2	15.8	100
	Land flooded permanently with poor quality sitting water	45.7	19.6	34.8	0	100
Daclak	OD	67.9	25.7	6.4	0	100
	Land affected by sewage drains or wastewater	49.1	22.2	23.2	5.5	100
	Garbage/waste dumpsites or landfills	55.8	20.2	21.1	2.9	100
	Land flooded seasonally	60.0	20.9	14.3	4.8	100
	Land flooded permanently with poor quality sitting water	63.2	16.0	12.3	8.5	100

TABLE E12. IMPORTANCE OF ENVIRONMENTAL SANITATION STATE, BY SITE (%)

Sites	Should it be a priority of local government to improve waste collection and to implement laws to improve the sanitary conditions in your neighborhood (%)			
	Low priority	Somewhat of a priority	High priority	Total
Lai Xa	1.5	40.5	58	100
Dan Phuong	0	50	50	100
Quang Ninh	2.1	34.4	63.5	100
Hai Phong	0	27.7	72.3	100
Quang Nam R	2.1	26.0	71.9	100
Hue	4.6	43.9	51.5	100
Quang Ngai	0	17.1	82.9	100
Quang Nam U	2.0	32.3	65.7	100
Vinh Long	6.6	36.4	57.0	100
Dong thap	10.4	40.6	49.0	100
Dak Lak	2.8	30.6	66.6	100

ANNEX F. TOURISM IMPACT

TABLE F1. BACKGROUND CHARACTERISTICS OF RESPONDENTS

Variable		Asia	Australia/NZ	North America and Europe	South America	Total
No. of tourists interviewed		76	45	146	33	300
Gender (%)	Male	52.6	42.2	61.0	39.4	53.7
	Female	47.4	57.8	39.0	60.6	46.3
Average no. of previous trips to country (time)		2.4	0.8	1.6	0.2	1.5
Average length of stay of this trip (day)		129.6	20.2	40.3	0.6	58.6
Purpose of visit (%)	Tourist	48.7	77.8	78.1	100.0	73.0
	Business	51.3	22.2	21.9	0	27.0
Hotel bracket (%) (nightly tariff in US$)	Free					
	1-29	34.2	46.7	45.9	3.0	38.3
	30-59	19.7	35.6	32.2	3.0	26.3
	60-89	18.4	0	8.2	0	8.7
	90-119	21.1	11.1	8.2	0	11.0
	120-149	5.3	2.2	3.4	3.0	3.7
	150 +	1.3	4.4	2.0	90.9	12.0
	Total	100	100	100	100	100
Place visited (%)	North	32.9	15.6	18.5	0	19.7
	Central	0	0	2.7	0	1.3
	South	5.3	13.3	11.0	63.6	15.7
	More than 2 places	61.8	71.1	67.8	36.4	63.3
	Total	100	100	100	100	100

TABLE F2. SCORES PER TOURIST LOCATION ACCORDING TO HOTEL COST LEVELS AND PURPOSE OF VISIT (SCORE: 5 = VERY MUCH; 1 = NOT AT ALL)

Hotel bracket (US$ per night)	Average score						
	Ha Noi	Historical/ temple sites	Beaches	Natural or forest sites	Traveling within Vietnam	Other 1 (traffic in cities)	Other 2 (city life)
DIFFERENCE ACCORDING TO HOTEL COST BRACKET							
1-29	3.9	3.8	3.7	4.1	4.0	3.8	3.0
30-59	3.8	4.1	3.7	4.2	3.6	2.7	4.2
60-89	3.8	3.7	3.7	3.9	3.6	4	4
90-119	4.0	4.1	3.7	4.3	3.1	1.8	2.5
120-149	3.7	4.1	4.2	3.8	3.3	2.8	3
150 +	4	4.3	3	4.2	4.1	4.8	4
On average	3.9	4.0	3.7	4.1	3.7	3.5	3.5
DIFFERENCE ACCORDING TO PURPOSE OF VISIT							
Tourist	4.0	4.0	3.8	4.2	3.8	3.8	3.8
Business	3.6	4	3.6	3.9	3.4	2.7	3.0

TABLE F3. GENERAL SANITARY EXPERIENCE (SCORE: 5 = VERY GOOD; 1 = VERY POOR)

General sanitary experience (%)	Asia	Australia/NZ	North America & Europe	South America	In general
1	5.3	2.2	5.5	15.1	6.0
2	25.0	17.8	30.8	69.7	31.7
3	51.3	40.0	37.0	9.1	38.0
4	13.2	31.1	19.9	3.0	18.0
5	5.3	8.9	6.8	3.0	6.3
Total	100	100	100	100	100

TABLE F4. SANITARY EXPERIENCE OF TOURISTS FROM SOUTH AMERICA

Sanitation and toilet	South America (%)					
	No answer	1	2	3	4	5
In hotel	0.0	3.0	0.0	0.0	9.2	87.9
In restaurant	6.1	3.0	0.0	15.2	33.3	42.4
At airport	9.1	3.0	0.0	9.1	30.3	48.5
At bus stations	78.8	0.0	3.0	12.1	3.0	3.0
Public toilets	69.7	6.1	0.0	15.2	6.1	3.0

TABLE F5. SANITARY EXPERIENCE IN RELATION TO TOILETS AND HAND WASHING

Sanitation and toilet	Score (%)					
	No answer	1	2	3	4	5
In hotel	3.0	0.7	1.7	16.3	40.7	37.7
In restaurant	6.3	1.3	10.7	37.0	32.3	12.3
At airport	11.3	1.3	10.0	28.3	29.3	19.7
At bus stations	38.0	15.3	25.0	14.7	6.0	1.0
Public toilets	24.3	30.0	27.7	12.3	4.7	1.0

TABLE F6. TOURISTS' INTENTION TO RETURN TO VIETNAM AFTER THE PRESENT TRIP (%)

Variable	Asia	Australia/NZ	North America and Europe	South America	In general
Yes	63.2	73.3	76.7	90.9	74.3
No	5.3	8.9	4.8	0.0	5.0
Maybe	28.9	13.3	15.7	9.1	18.0
Don't know	2.6	4.4	2.7	0.0	2.7
Total	100.0	100.0	100.0	100.0	100.0

TABLE F7. REASON FOR HESITANCY TO RETURN (%)

Reason for hesitancy to return	Main reason	Contributory reason	Not relevant	No answer
Poor sanitation	5.7	7.3	10.0	77.0
Does not offer value-for-money	2.7	2.3	12.0	83.0
Have seen Vietnam	7.3	6.0	11.0	75.7
Do not feel safe	4.0	3.3	12.7	80.0
Other 1 (low-standard public services)	5.3	1.7	1.3	91.7
Other 2 (traffic, tourist scam)	0.7	1.0	1.0	97.3

ANNEX G. BUSINESS IMPACT

TABLE G1. SAMPLE SIZE OF BUSINESS SURVEY, BY MAIN SECTORS OF LOCAL AND FOREIGN FIRMS

Main business or sector of firm	Local business	Foreign firm	Total	Replied to the survey	Name
Hotel	1	1	2	1	Firm 1
Aviation		2	2	0	
Real estate		1	1	0	
Food and drink producer		7	7	2	Firm 2, 3
Pharmacy		2	2	0	
Tourism	2		2	0	
Soap and domestic goods		1	1	0	
Green civil engineering and architecture	1		1	1	Firm 4
Development and cooperation consultancy		2	2	2	Firm 5, 6
Life, health and other insurances		1	1	0	
Pump and wastewater equipment		1	1	1	Firm 7
Total			**22**	**7**	

TABLE G2. COSTS OF DOING BUSINESS: PRODUCTION (IN COLUMNS: MAIN SECTORS REPRESENTED)

Variable: Firms who say that…	No. with response	Sectors				
		Hotel	Bewerage	Civil engineering	Consultancy	Pump and equipment
HEALTH						
Poor workforce health affects their business (average score) (1 = unimportant; 5 = important)	6	5	3	3	3	N/A
WATER						
Poor water quality affects their business (1 = unimportant; 5 = important)	6		5	2	2	N/A
They treat their own water	6		Yes	No	No	N/A
POOR LOCAL ENVIRONMENT (1 = unimportant; 5 = important)	6		3	3	2	N/A
Affects customers	6		3	3	2	N/A
Affects current workers	6		3	3	2	N/A
Affects staff recruitment	6		3	3	2	N/A
OTHER ASPECTS						
Considered moving production facilities to industrial parks	6		No	No	No	N/A

ANNEX H. INTERVENTION COSTS

TABLE H1. SITE U1 (SA DEC TOWN, DONG THAP PROVINCE) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine	Septic tank
Investment costs: Initial one-off spending		
1. Capital	1,500,000	8,857,788
2. Program	-	-
SUB-TOTAL	1,500,000	8,857,788
Recurrent costs: Average annual spending		
3. Operation	36,346	211,883
4. Maintenance	36,346	90,000
5. Program	-	-
SUB-TOTAL	72,692	301,883
Average annual cost calculations		
Duration[1]	7	10
Cost/household	268,352	1,088,345
Cost/capita	70,805	287,162
Of which:		
% capital	79.9%	81.4%
% program	0%	0%
% recurrent	20.1%	18.6%
Observations[2]	28	51

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H2. SITE U2 (TAM KY TOWN, QUANG NAM PROVINCE) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine	Septic tank
Investment costs: Initial one-off spending		
1. Capital	1,220,000	4,062,857
2. Program	143,558	149,854
SUB-TOTAL	1,363,558	4,212,711
Recurrent costs: Average annual spending		
3. Operation	30,650	114,300
4. Maintenance	120,000	200,000
5. Program	-	
SUB-TOTAL	150,650	314,300
Average annual cost calculations		
Duration[1]	7	10
Cost/household	306,843	632,169
Cost/capita	80,961	166,799
Of which:		
% capital	56.8%	64.3%
% program	6.7%	2.4%
% recurrent	36.5%	33.4%
Observations[2]	1	88

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H3. SITE U3 (HAI PHONG CITY) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine	Septic tank	Centralized WWT
Investment costs: Initial one-off spending			
1. Capital	2,400,000	7,450,000	8,118,618
2. Program	-	238,320	684,065
SUB-TOTAL	2,400,000	7,688,320	8,802,683
Recurrent costs: Average annual spending			
3. Operation	153,300	306,600	328,650
4. Maintenance	50,000	133,333	142,783
5. Program			
SUB-TOTAL	203,300	439,933	471,433
Average annual cost calculations			
Duration[1]	7	10	20
Cost/household	494,065	1,064,031	671,564
Cost/capita	130,360	280,747	177,194
Of which:			
% capital	69.4%	70.0%	60.4%
% program	0%	2.2%	5.1%
% recurrent	30.6%	27.7%	34.5%
Observations[2]	2	30	70

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H4. SITE U4 (BAI CHAY WARD, HA LONG CITY, QUANG NINH PROVINCE) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Septic tank	Centralized WWT
Investment costs: Initial one-off spending		
1. Capital	6,710,000	10,403,244
2. Program	-	1,104,976
SUB-TOTAL	6,710,000	11,508,221
Recurrent costs: Average annual spending		
3. Operation	314,265	365,480
4. Maintenance	133,333	158,941
5. Program	-	-
SUB-TOTAL	447,598	524,422
Average annual cost calculations		
Duration[1]	10	20
Cost/household	971,342	832,854
Cost/capita	256,291	219,750
Of which:		
% capital	69.1%	62.5%
% program	0%	6.6%
% recurrent	30.9%	30.9%
Observations[2]	39	61

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H5. SITE U5 (BUON MA THUOT CITY, DAK LAK PROVINCE) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine	Septic tank	Centralized WWT
Investment costs: Initial one-off spending			
1. Capital	1,800,000	5,000,000	24,415,062
2. Program	-	-	9,950,422
SUB-TOTAL	1,800,000	5,000,000	34,365,484
Recurrent costs: Average annual spending			
3. Operation	115,000	250,000	804,638
4. Maintenance	50,000	133,333	303,986
5. Program	-	-	92,440
SUB-TOTAL	165,000	383,333	1,201,063
Average annual cost calculations			
Duration[1]	7	10	20
Cost/household	379,864	757,220	2,307,885
Cost/capita	100,228	199,794	608,941
Of which:			
% capital	67.7%	66.0%	52.9%
% program	0%	0%	21.6%
% recurrent	32.3%	34.0%	25.5%
Observations[2]	-	38	70

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H6. SITE R1 (BIOGAS PROJECT IN BAO XUAN AND BAO HOA COMMUNES, XUAN LOC DISTRICT, DONG NAI PROVINCE) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine[1]	Biogas digester[1]
Investment costs: Initial one-off spending		
1. Capital	1,700,000	12,000,000
2. Program	-	840,000
SUB-TOTAL	1,700,000	12,840,000
Recurrent costs: Average annual spending		
3. Operation	120,000	250,000
4. Maintenance	40,000	120,000
5. Program	-	0
SUB-TOTAL	160,000	370,000
Average annual cost calculations		
Duration[1]	7	15
Cost/household	361,860	1,067,134
Cost/capita	95,478	281,566
Of which:		
% capital	67.1%	75.0%
% program	0.0%	5.2%
% recurrent	32.9%	19.8%
Observations[2]	-	5

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H7. SITE R2 (HUU THANH COMMUNE, TRA ON DISTRICT, VINH LONG PROVINCE) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine[1]	Septic tank[1]
Investment costs: Initial one-off spending		
1. Capital	1,350,000	5,000,000
2. Program	0	-
SUB-TOTAL	1,350,000	5,000,000
Recurrent costs: Average annual spending		
3. Operation	34,125	168,750
4. Maintenance	50,000	70,000
5. Program	-	-
SUB-TOTAL	84,125	238,750
Average annual cost calculations		
Duration[1]	7	10
Cost/household	255,427	660,203
Cost/capita	67,395	174,196
Of which:		
% capital	75.5%	75.7%
% program	0.0%	0.0%
% recurrent	24.5%	24.3%
Observations[2]	42	60

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H8. SITE R3 (TINH DONG COMMUNE, SON TINH DISTRICT, QUANG NGAI PROVINCE) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine	Septic tank	Double-vault Composting
Investment costs: Initial one-off spending			
1. Capital	1,964,000	5,514,700	3,427,440
2. Program	78,500	78,500	78,500
SUB-TOTAL	2,042,500	5,593,200	3,505,940
Recurrent costs: Average annual spending			
3. Operation	65,000	140,677	120,677
4. Maintenance	35,000	80,000	180,000
5. Program	-	-	-
SUB-TOTAL	100,000	220,677	300,677
Average annual cost calculations			
Duration[1]	7	10	10
Cost/household	366,162	707,396	552,351
Cost/capita	96,613	186,648	145,739
Of which:			
% capital	76.6%	78.0%	62.1%
% program	3.1%	1.1%	1.4%
% recurrent	20.3%	20.9%	36.5%
Observations[2]	9	50	91

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H9. SITE R4 (BIOGAS PROJECT IN TAN LAP COMMUNE, DAN PHUONG DISTRICT, HANOI) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine	Septic tank	Biogas digester
Investment costs: Initial one-off spending			
1. Capital	2,830,000	5,400,000	8,832,609
2. Program	-	-	-
SUB-TOTAL	2,830,000	5,400,000	8,832,609
Recurrent costs: Average annual spending			
3. Operation	125,000	285,000	356,000
4. Maintenance	65,000	104,000	468,000
5. Program	-	-	-
SUB-TOTAL	190,000	389,000	824,000
Average annual cost calculations			
Duration[1]	7	10	15
Cost/household	545,601	801,022	1,059,041
Cost/capita	143,958	211,351	279,430
Of which:			
% capital	74.1%	67.4%	55.6%
% program	0.0%	0.0%	0.0%
% recurrent	25.9%	32.6%	44.4%
Observations[2]	7	45	48

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H10. SITE R5 (BINH TRIEU COMMUNE, THANG BINH DISTRICT, QUANG NAM PROVINCE) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine	Septic tank
Investment costs: Initial one-off spending		
1. Capital	900,000	3,315,972
2. Program	-	305,645
SUB-TOTAL	900,000	3,621,617
Recurrent costs: Average annual spending		
3. Operation	68,000	125,000
4. Maintenance	90,000	105,000
5. Program	-	-
SUB-TOTAL	158,000	230,000
Average annual cost calculations		
Duration[1]	7	10
Cost/household	246,087	516,494
Cost/capita	64,931	136,278
Of which:		
% capital	52.2%	64.2%
% program	0.0%	5.9%
% recurrent	47.8%	29.9%
Observations[2]	6	149

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H11. SITE R7 (LAI XA VILLAGE, KIM CHUNG COMMUNE, HOAI DUC DISTRICT, HANOI) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine	Septic tank	Cluster w/w treatment
Investment costs: Initial one-off spending			
1. Capital	1,800,000	6,000,000	8,566,667
2. Program	-	405,556	405,556
SUB-TOTAL	1,800,000	6,405,556	8,972,222
Recurrent costs: Average annual spending			
3. Operation	34,125	36,135	52,135
4. Maintenance	60,000	96,000	232,000
5. Program	-	-	-
SUB-TOTAL	94,125	132,135	284,135
Average annual cost calculations			
Duration[1]	7	10	15
Cost/household	327,150	729,219	760,285
Cost/capita	86,319	192,406	200,603
Of which:			
% capital	78.6%	82.3%	75.1%
% program	0.0%	5.6%	3.6%
% recurrent	21.4%	12.2%	21.3%
Observations[2]	2	96	97

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H12. SITE R8 (BIOGAS PROJECT IN FARM, THIEU DUONG COMMUNE, THIEU HOA DISTRICT, THANH HOA PROVINCE) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Biogas digester
Investment costs: Initial one-off spending	
1. Capital	955,000,000
2. Program	0
SUB-TOTAL	955,000,000
Recurrent costs: Average annual spending	
3. Operation	388,800,000
4. Maintenance	97,200,000
5. Program	0
SUB-TOTAL	486,000,000
Average annual cost calculations	
Duration[1]	15
Cost/household	340,993,776
Cost/capita	N/A
Of which:	
% capital	18.7%
% program	0.0%
% recurrent	81.3%
Observations[2]	1

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H13. SITE R9 (LOC DIEN AND VINH MY COMMUNES, PHU LOC DISTRICT, THUE THIEN - HUE PROVINCE) AVERAGE COST PER HOUSEHOLD FOR DIFFERENT SANITATION AND HYGIENE OPTIONS, USING FULL (ECONOMIC) COST (VND, YEAR 2009)

Cost item	Wet pit latrine	Septic tank	Double-vault composting
Investment costs: Initial one-off spending			
1. Capital	1,400,000	4,000,000	2,400,000
2. Program	200,000	200,000	200,000
SUB-TOTAL	1,600,000	4,200,000	2,600,000
Recurrent costs: Average annual spending			
3. Operation	35,000	135,000	120,000
4. Maintenance	90,000	105,000	120,000
5. Program	100,000	100,000	100,000
SUB-TOTAL	225,000	340,000	340,000
Average annual cost calculations			
Duration[1]	7	10	10
Cost/household	395,919	648,143	488,143
Cost/capita	104,464	171,014	128,798
Of which:			
% capital	50.5%	61.7%	49.2%
% program	7.2%	3.1%	4.1%
% recurrent	42.3%	35.2%	46.7%
Observations[2]	16	101	29

[1] Refers to length of life of hardware before full replacement
[2] Number of households

TABLE H14. PROPORTION OF TOTAL COSTS THAT ARE FINANCIAL, URBAN SITES[1]

Sanitation options	Wet pit latrine	Septick tank	Centralized w/w treatment
ANNUAL EQUIVALENT, VND			
Financial	16,476,748	56,228,640	119,860,412
Non-financial	104,934	256,659	702,912
Total	16,581,681	56,485,299	120,563,325
Percentage, %			
Financial	99.4%	99.5%	99.4%
Non-financial	0.6%	0.5%	0.6%

[1] Costs that are not financial are own labor costs of household or volunteers.

TABLE H15. PROPORTION OF TOTAL COSTS THAT ARE FINANCIAL, RURAL SITES[1] (THANH HOA PROVINCE NOT INCLUDED)

Sanitation options	Wet pit latrine	Septic tank	Cluster w/w management	Double-vault composting	Biogas digester
ANNUAL EQUIVALENT, VND					
Financial	14,030,003	41,314,570	72,009,778	24,573,760	87,484,435
Non-financial	87,798	570,649	85,468	170,339	303,000
Total	14,117,801	41,885,219	72,095,246	24,744,099	87,787,435
Percentage, %					
Financial	99.4%	98.6%	99.9%	99.3%	99.7%
Non-financial	0.6%	1.4%	0.1%	0.7%	0.3%

[1] Costs that are not financial are own labor costs of household or volunteers.

TABLE H16. FINANCIAL CONTRIBUTION FROM HOUSEHOLDS, DONORS AND GOVERNMENT IN URBAN AREAS

Funding sources	Wet pit latrine	Septic tank	Cluster w/w management
Household	98.0%	59.4%	23.2%
NGO/donor	1.8%	23.5%	56.0%
Government	0.3%	17.2%	20.8%

TABLE H17. FINANCIAL CONTRIBUTION FROM HOUSEHOLDS, DONORS AND GOVERNMENT IN RURAL AREAS

Funding sources	Wet pit latrine	Septic tank	Cluster wastewater treatment	Double-vault composting	Biogas digester
Household	90.0%	70.7%	50.3%	72.3%	88.5%
NGO/donor	2.5%	17.8%	9.9%	8.8%	2.8%
Government	7.5%	11.5%	39.9%	18.9%	8.7%

TABLE H18. PROPORTION OF RURAL HOUSEHOLDS SELECTING DIFFERENT SANITATION OPTIONS, BY ASSET QUINTILE

Cost Item	1st quintile (poorest)	2nd quintile	3rd quintile	4th quintile	5th quintile (richest)	Total
Options	< VND10 mio.	10 – 20 mio.	20 – 50 mio.	50 – 100 mio.	>100 mio.	
			OD			
R2	1	0	0	0	0	1
R3	0	0	4	0	0	4
R4	0	0	0	0	0	0
R5	0	1	0	0	0	1
R6	0	0	0	0	0	0
R7	0	0	0	0	0	0
R9	1	0	0	0	0	
			DRY/WET PIT LATRINE			
R2	1	8	20	13	0	42
R3	4	3	1	1	0	9
R4	0	3	2	1	1	7
R5	1	1	2	2	0	6
R6	0	0	0	0	0	0
R7	0	1	1	0	0	2
R9	3	4	7	2	0	16
			SEPTIC TANK			
R2	6	14	23	16	1	60
R3	13	23	12	2	0	50
R4	0	5	29	10	1	45
R5	18	35	78	16	2	149
R6						
R7	12	21	28	21	14	96
R9	15	29	40	14	3	101
			WW MANAGEMENT			
R2	0	0	0	0	0	0
R3	0	0	0	0	0	0
R4	0	0	0	0	0	0
R5	0	0	0	0	0	0
R6	0	0	0	0	0	0
R7	22	12	24	18	21	97
R9	0	0	0	0	0	0
			DVCL			
R2	0	0	0	0	0	0
R3	17	46	27	1	0	91
R4	0	0	1	0	0	1
R5	1	0	1	1	0	3
R6	0	0	0	0	0	0
R7	0	1	-	0	0	1
R9	8	9	10	2	0	29
			BIOGAS DIGESTER			
R2	1	2	0	1	0	4
R3	0	0	1	0	0	1
R4	6	9	27	6	0	48
R5	0	0	0	0	0	0
R6	0	0	0	0	0	0
R7	0	0	0	0	0	0
R9	0	0	0	0	0	0

TABLE H19. INCREMENTAL COSTS OF MOVING UP THE SANITATION LADDER, URBAN SITES (VND, 2009)

Site and baseline sanitation option	Target sanitation option		
	Wet pit latrine	Septic tank	Centralized WWTP
U1: SA DEC, DONG THAP	1,572,692	9,159,671	
Wet pit latrine		7,586,979	
U2: TAM KY, QUANG NAM	1,514,208	4,527,011	
Wet pit latrine		3,012,804	
U3: HAI PHONG	2,603,300	8,128,253	9,274,116
Wet pit latrine		5,524,953	
Septic tank			1,145,863
Centralized WWTP			
U4: BAI CHAY, QUANG NINH	7,157,598	12,032,642	
Septic tank		4,875,044	
U5: BUON ME THUOT, DAK LAK	1,965,000	5,383,333	35,566,548
Wet pit latrine		3,418,333	
Septic tank			30,183,214
AVERAGE, URBAN SITES			
From wet pit latrine to septic tank		3,254,000	
From septic tank to centralized WWTP			26,616,000

TABLE H20. INCREMENTAL COSTS OF MOVING UP THE SANITATION LADDER, RURAL SITES (VND, 2009)

Site and baseline sanitation option	Target sanitation option				
	Wet pit latrine	Septic tank	Cluster WW treatment	Double-vault composting toilet (DVCT)	Biogas digester
R1: DONG NAI	1,860,000				13,210,000
Wet pit latrine					11,350,000
Biogas digester					
R2: VINH LONG	1,434,125	5,238,750			
Wet pit latrine		3,804,625			
Septic tank					
R3: QUANG NGAI	2,142,500	5,813,877		3,806,617	
Wet pit latrine		3,671,377		1,664,117	
Septic tank				-2,007,260	
Double-vault Composting					
R4: DAN PHUONG	3,020,000	5,789,000			9,656,609
Wet pit latrine		2,769,000			6,636,609
Septic tank					3,867,609
Biogas digester					
R5: QUANG NAM	1,058,000	3,851,617			
Wet pit latrine		2,793,617			
Septic tank					
R7: LAI XA	1,894,125	6,537,691	9,256,357		
Wet pit latrine		4,643,566			
Septic tank			2,718,667		
Cluster WW treatment					
R8: THANH HOA					1,441,000,000
Biogas digester					
R9: TT - HUE	1,825,000	4,540,000		2,940,000	
Wet pit latrine		2,715,000		1,115,000	
Septic tank					
Double-vault Composting*		2,940,000			
AVERAGE, RURAL SITES					
From pit latrine to		3,400,000		1,390,000	8,993,000
From DVCT to		2,940,000			
From septic tank			2,719,000		3,868,000

* Cost for Double-vault Composting toilet (DVCT) is cheaper than for septic tank. Economic value of DVCT is higher thanks to reuse values, but users often prefer to move to the septic tank for convenience and due to other reasons.

ANNEX I. PROGRAM APPROACH ANALYSIS

TABLE I1. FINANCING FROM URBAN HOUSEHOLD AND PROJECT SOURCES

Site	Number of households interviewed	Household contribution		Value of household inputs			Project value input
		Yes	No	Cash	Labor	Materials	
Hai Phong	102	61.1	1.1	8,471,186	N/A	N/A	2,908,475
Tam Ky	98	38.6	5.7	735,294	N/A	N/A	3,187,856
Dong Thap	100	12.5	1.3	1,230,000	N/A	N/A	1,122,727
Buon Me Thuot	220	4.6	4.6	780,000	N/A	N/A	1,260,000
Quang Ninh	100	0	0	0	N/A	N/A	
Average Urban		**18.8**	**2.9**	**4,822,124**	**N/A**	**N/A**	**2,674,887**

TABLE I2. FINANCING FROM RURAL HOUSEHOLD AND PROJECT SOURCES

Site	Number of households interviewed	Household contribution		Value of household inputs			Project value input
		Yes	No	Cash	Labor	Materials	
Lai Xa, Hanoi	200	7.2	1.6	941,500	N/A	N/A	2,000,000
Dan Phuong, HN	101	39.4	0	9,118,421	N/A	N/A	912,820.5
Hue	200	66.0	6.0	1,360,917	N/A	N/A	820,535.7
Vinh Long	201	8.1	2.0	2,500,000	N/A	N/A	4,230,769
Quang Nam	200	0	0	0	N/A	N/A	
Quang Ngai	200	67.7	2.0	2,000,092	N/A	N/A	520,990.6
Average rural		**29.8**	**2.0**	**3,150,532**	**N/A**	**N/A**	**943,094.4**

TABLE I3. APPROPRIATE TECHNOLOGY, URBAN SITES

Site	Number of households interviewed	Household contribution		Value of household inputs			Project value input
		Yes	No	Cash	Labor	Materials	
Hai Phong	102	0	100.0	0	0	0	0
Tam Ky	98	1.2	98.8	0	7.1	0	0
Dong Thap	100	1.6	98.4	0	9.1	22.2	0
Buon Me Thuot	220	1.0	99.0	0	11.1	11.1	0
Quang Ninh	100	0	100.0	0	0	0	0
Average Urban		**0.8**	**99.2**	**0**	**5.6**	**5.9**	**0**

TABLE I4. APPROPRIATE TECHNOLOGY, RURAL SITES

Site	Number of households interviewed	Household contribution		Value of household inputs			Project value input
		Yes	No	Cash	Labor	Materials	
Hanoi	200	2.4	97.6	3.7	3.7	3.7	0
Dan Phuong, HN	101	0	100.0	6.3	0	17.7	0
Hue	200	3.3	96.7	31.3	15.7	13.3	13.3
Vinh Long	201	10.3	89.7	61.5	0	15.4	0
Quang Nam	200	0.7	99.3	0	23.8	4.8	14.3
Quang Ngai	200	8.1	91.9	13.0	15.2	15.6	20.0
Average rural		**3.7**	**96.3**	**20.4**	**12.6**	**12.1**	**11.2**

ANNEX J. CBA AND CEA RESULTS

TABLE J1. SITE U1 (DONG THAP, URBAN) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	OD to septic tank	
		Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES			
Benefits per VND input	Ideal	2.6	2.9
	Actual	1.9	2.2
Internal rate of return (%)	Ideal	1.2	1.6
	Actual	0.6	0.9
Pay-back period (years)	Ideal	1.9	1.7
	Actual	2.7	2.2
Net present value (VND)	Ideal	32,386,653	38,187,546
	Actual	18,466,385	23,969,095
COST-EFFECTIVENESS MEASURES			
Cost per DALY averted (VND)	Ideal	52,469,833	16,552,673
	Actual	54,756,153	17,275,121
Cost per case averted (VND)	Ideal	729,411	1,054,611
	Actual	761,195	1,100,639
Cost per death averted (VND)	Ideal	387,103,215	320,684,270
	Actual	403,970,854	334,680,673

TABLE J2. SITE U2 (QUANG NAM, URBAN) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	OD to pit latrine		OD to septic tank	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES					
Benefits per VND input	Ideal	4.3	4.9	2.2	2.5
	Actual	3.2	3.7	1.7	2.0
Internal rate of return (%)	Ideal	>100%	>100%	78.7%	104.3%
	Actual	>100%	>100%	50.1%	67.2%
Pay-back period (years)	Ideal	<1	<1	2.4	2.0
	Actual	<1	<1	3.2	2.6
Net present value (VND)	Ideal	29,146,554	35,870,598	23,824,282	29,269,735
	Actual	20,210,305	25,869,297	14,228,979	18,801,169
COST-EFFECTIVENESS MEASURES					
Cost per DALY averted (VND)	Ideal	11,711,326	8,778,797	50,733,163	16,187,946
	Actual	14,839,598	10,925,943	62,648,032	19,171,243
Cost per case averted (VND)	Ideal	253,875	379,089	706,081	1,032,861
	Actual	321,689	493,432	871,907	1,311,372
Cost per death averted (VND)	Ideal	220,421,019	165,400,695	373,667,957	313,045,891
	Actual	279,298,809	205,864,467	461,425,250	382,396,465

TABLE J3. SITE U3 (HAI PHONG, URBAN) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	OD to septic tank		OD to WWM	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES					
Benefits per VND input	Ideal	1.7	2.0	1.8	2.0
	Actual	1.5	1.7	1.6	1.7
Internal rate of return (%)	Ideal	0.5	0.7	0.4	0.5
	Actual	0.4	0.6	0.4	0.4
Pay-back period (years)	Ideal	3.2	2.6	3.6	3.1
	Actual	3.7	2.9	4.4	3.6
Net present value (VND)	Ideal	16,574,997	21,811,442	19,871,033	23,888,820
	Actual	11,917,596	16,876,601	14,103,408	17,904,688
COST-EFFECTIVENESS MEASURES					
Cost per DALY averted (VND)	Ideal	62,107,830	19,708,898	21,258,035	18,626,139
	Actual	68,998,912	21,090,728	24,233,182	21,067,961
Cost per case averted (VND)	Ideal	866,196	1,260,865	1,293,545	1,886,499
	Actual	962,303	1,435,510	1,474,582	2,203,649
Cost per death averted (VND)	Ideal	456,034,542	379,826,834	400,308,603	349,368,207
	Actual	506,633,175	417,826,622	456,333,391	395,095,073

TABLE J4. SITE U4 (QUANG NINH, URBAN) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	OD to septic tank		OD to septic tank with WWM	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES					
Benefits per VND input	Ideal	1.6	1.8	2.5	2.7
	Actual	1.4	1.5	2.2	2.4
Internal rate of return (%)	Ideal	0.5	0.7	0.5	0.6
	Actual	0.4	0.6	0.5	0.6
Pay-back period (years)	Ideal	3.1	2.5	3.1	2.8
	Actual	3.9	3.0	3.4	3.0
Net present value (VND)	Ideal	15,341,362	20,662,420	27,382,239	31,453,495
	Actual	9,358,827	14,395,350	21,947,289	25,796,500
COST-EFFECTIVENESS MEASURES					
Cost per DALY averted (VND)	Ideal	68,033,647	21,604,906	15,684,438	13,841,812
	Actual	73,209,282	23,241,187	16,298,322	14,387,297
Cost per case averted (VND)	Ideal	947,640	1,379,968	952,831	1,399,090
	Actual	1,019,732	1,484,482	990,124	1,454,226
Cost per death averted (VND)	Ideal	500,457,925	417,200,817	295,890,433	260,103,432
	Actual	538,530,080	448,798,168	307,471,490	270,353,717

TABLE J5. SITE U5 (DAK LAK, URBAN) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	OD to WWM	
		Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES			
Benefits per VND input	Ideal	1.8	1.9
	Actual	1.6	1.7
Internal rate of return (%)	Ideal	1.3	1.9
	Actual	0.9	1.0
Pay-back period (years)	Ideal	1.8	1.6
	Actual	2.2	2.1
Net present value (VND)	Ideal	24,930,956	29,789,822
	Actual	18,747,800	23,341,668
COST-EFFECTIVENESS MEASURES			
Cost per DALY averted (VND)	Ideal	22,667,413	19,879,837
	Actual	25,486,800	22,332,820
Cost per case averted (VND)	Ideal	1,370,972	1,998,293
	Actual	1,541,494	2,244,863
Cost per death averted (VND)	Ideal	429,759,861	375,435,472
	Actual	483,213,664	421,760,654

TABLE J6. SITE R1 (DONG NAI, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	OD to pit latrine		OD to biogas digester	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES					
Benefits per VND input	Ideal	4.1	4.7	2.7	3.1
	Actual	3.6	4.1	2.5	2.8
Internal rate of return (%)	Ideal	>100%	>100%	0.6	0.8
	Actual	>100%	>100%	0.6	0.7
Pay-back period (years)	Ideal	<1	<1	2.9	2.4
	Actual	<1	<1	3.0	2.5
Net present value (VND)	Ideal	26,793,351	33,536,564	26,091,585	32,834,798
	Actual	22,822,491	33,536,564	22,234,195	27,668,197
COST-EFFECTIVENESS MEASURES					
Cost per DALY averted (VND)	Ideal	11,072,425	8,452,358	19,797,979	14,728,179
	Actual	11,730,932	9,309,355	20,186,010	15,633,609
Cost per case averted (VND)	Ideal	239,793	364,547	428,760	635,220
	Actual	254,054	364,515	437,164	612,147
Cost per death averted (VND)	Ideal	208,743,368	159,515,442	373,242,252	277,954,639
	Actual	221,157,894	175,670,115	380,557,623	295,010,542

TABLE J7. SITE R2 (VINH LONG, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	Pit latrine		Septic tank	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES					
Benefits per VND input	Ideal	4.7	5.4	2.7	3.0
	Actual	3.7	4.2	2.1	2.4
Internal rate of return (%)	Ideal	>100%	>100%	>100%	>100%
	Actual	>100%	>100%	77.2%	98.2%
Pay-back period (years)	Ideal	<1	<1	1.9	1.7
	Actual	<1	<1	2.4	2.1
Net present value (VND)	Ideal	29,017,950	36,013,179	29,389,073	35,074,567
	Actual	21,706,788	26,519,999	19,858,628	23,755,025
COST-EFFECTIVENESS MEASURES					
Cost per DALY averted (VND)	Ideal	10,088,140	7,512,183	45,058,264	14,325,521
	Actual	11,791,802	9,285,224	50,976,138	18,724,744
Cost per case averted (VND)	Ideal	218,477	323,997	626,379	912,713
	Actual	255,372	349,011	708,646	952,027
Cost per death averted (VND)	Ideal	190,187,092	141,772,185	332,423,373	277,536,411
	Actual	222,305,465	175,206,253	376,083,284	325,390,446

TABLE J8. SITE R3 (QUANG NGAI, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	Private wet pit		Septic tank		Double-vault composting	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES							
Benefits per VND input	Ideal	3.7	4.3	2.2	2.4	1.6	1.9
	Actual	2.6	3.1	1.6	1.8	1.1	1.3
Internal rate of return (%)	Ideal	>100%	>100%	75.5%	98.8%	40.5%	57.3%
	Actual	>100%	>100%	40.1%	53.7%	14.9%	27.8%
Pay-back period (years)	Ideal	<1	<1	2.5	2.1	3.7	2.9
	Actual	1.3	1.1	3.7	3.0	6.9	4.7
Net present value (VND)	Ideal	32,275,965	39,906,726	27,836,034	34,066,339	17,467,209	25,097,970
	Actual	18,902,938	24,978,281	13,497,527	17,827,763	3,198,970	9,274,313
COST-EFFECTIVENESS MEASURES							
Cost per DALY averted (VND)	Ideal	14,419,436	10,497,350	56,605,455	17,826,373	34,073,121	24,633,170
	Actual	17,860,869	13,004,144	69,990,841	22,043,229	43,770,176	31,639,291
Cost per case averted (VND)	Ideal	312,627	453,387	787,952	1,137,662	739,164	1,063,922
	Actual	387,241	561,657	974,277	1,406,778	949,527	1,366,521
Cost per death averted (VND)	Ideal	271,317,996	197,726,765	416,807,520	344,627,168	641,124,307	463,987,309
	Actual	336,072,455	244,944,427	515,369,218	426,149,252	823,585,364	595,953,722

TABLE J9. SITE R4 (DAN PHUONG, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	Private wet pit		Septic tank		Double-vault composting	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES							
Benefits per VND input	Ideal	5.1	5.9	2.6	2.9	1.9	2.1
	Actual	4.1	4.7	2.1	2.3	1.4	1.7
Internal rate of return (%)	Ideal	>100%	>100%	>100%	>100%	61.6%	86.9%
	Actual	>100%	>100%	90.3%	>100%	37.3%	55.7%
Pay-back period (years)	Ideal	<1	<1	1.8	1.5	2.8	2.3
	Actual	<1	<1	2.2	1.9	3.9	3.0
Net present value (VND)	Ideal	38,311,248	45,942,009	34,020,031	40,250,336	23,080,322	30,711,083
	Actual	27,971,630	34,435,827	22,907,398	28,181,208	11,669,569	18,133,766
COST-EFFECTIVENESS MEASURES							
Cost per DALY averted (VND)	Ideal	210,177,635	9,080,875	57,182,778	18,019,006	35,775,536	25,868,822
	Actual	229,576,404	10,479,062	63,712,486	20,872,900	41,105,465	30,188,511
Cost per case averted (VND)	Ideal	242,178	352,447	715,210	1,005,702	696,931	1,004,021
	Actual	264,530	376,038	717,192	969,998	800,762	1,126,314
Cost per death averted (VND)	Ideal	210,177,635	153,705,705	378,328,931	313,008,147	604,841,497	437,863,686
	Actual	229,576,404	170,590,652	379,377,318	319,566,543	694,952,286	510,955,857

TABLE J10. SITE R5 (QUANG NAM, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	Pit latrine		Septic tank	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES					
Benefits per VND input	Ideal	5.1	5.5	2.2	2.4
	Actual	3.2	3.5	1.5	1.6
Internal rate of return (%)	Ideal	>100%	>100%	82.6%	>100%
	Actual	>100%	>100%	34.6%	43.5%
Pay-back period (years)	Ideal	<1	<1	2.3	2.0
	Actual	<1	<1	4.2	3.5
Net present value (VND)	Ideal	34,758,763	41,229,656	29,749,822	34,942,125
	Actual	18,437,261	22,778,051	11,294,187	14,739,964
COST-EFFECTIVENESS MEASURES					
Cost per DALY averted (VND)	Ideal	11,252,979	9,316,356	64,514,287	20,709,309
	Actual	13,928,249	15,371,421	80,160,588	28,153,432
Cost per case averted (VND)	Ideal	243,939	667,832	897,881	1,321,343
	Actual	301,933	872,047	1,115,639	1,557,394
Cost per death averted (VND)	Ideal	211,794,400	432,596,237	475,170,885	400,480,967
	Actual	262,146,138	574,574,913	590,411,511	509,023,615

TABLE J11. SITE R7 (LAI XA, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	Pit latrine		Septic tank		Septic tank with cluster WWT	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES							
Benefits per VND input	Ideal	4.2	4.7	2.3	2.6	2.1	2.3
	Actual	2.8	3.2	1.7	1.9	1.5	1.6
Internal rate of return (%)	Ideal	>100%	>100%	70.1%	89.0%	59.1%	69.2%
	Actual	>100%	>100%	40.4%	48.7%	34.1%	39.1%
Pay-back period (years)	Ideal	<1	<1	2.6	2.2	2.9	2.6
	Actual	<1	<1	3.7	3.3	4.1	3.8
Net present value (VND)	Ideal	30,120,512	37,071,029	26,851,722	32,463,716	28,019,924	32,293,396
	Actual	17,903,456	21,880,683	13,964,986	17,139,100	13,202,451	15,573,451
COST-EFFECTIVENESS MEASURES							
Cost per DALY averted (VND)	Ideal	11,899,680	8,993,164	50,799,167	16,277,261	19,593,254	17,281,227
	Actual	15,158,555	12,309,684	61,455,419	23,793,644	24,706,484	22,548,881
Cost per case averted (VND)	Ideal	257,556	387,565	705,667	1,036,066	1,186,017	1,738,839
	Actual	328,091	445,169	853,697	1,131,566	1,495,530	1,976,012
Cost per death averted (VND)	Ideal	224,595,240	169,915,223	375,205,497	315,757,220	371,134,464	326,059,423
	Actual	286,103,423	232,529,868	453,913,175	400,091,845	467,989,014	425,821,520

TABLE J12. SITE R8 (THANH HOA, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	Pit latrine	
		Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES			
Benefits per VND input	Ideal	8.0	8.2
	Actual	7.9	8.0
Internal rate of return (%)	Ideal	>100%	>100%
	Actual	>100%	>100%
Pay-back period (years)	Ideal	<1	<1
	Actual	<1	<1
Net present value (VND)	Ideal	122,381,397	128,331,887
	Actual	115,679,536	119,386,820
COST-EFFECTIVENESS MEASURES			
Cost per DALY averted (VND)	Ideal	25,275,992	18,659,449
	Actual	30,363,206	23,685,177
Cost per case averted (VND)	Ideal	547,615	18,659,449
	Actual	657,832	23,685,177
Cost per death averted (VND)	Ideal	476,189,184	351,904,849
	Actual	572,030,195	446,620,091

TABLE J13. SITE U1 (DONG THAP, URBAN) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Wet pit latrine to WWM		Septic tank to WWM	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES					
Benefits per VND input	Ideal	0.3	0.2	0.2	0.2
	Actual	0.3	0.2	0.2	0.2
Internal rate of return (%)	Ideal	-	-	-	-
	Actual	-	-	-	-
Pay-back period (years)	Ideal	>20	>20	>20	>20
	Actual	>20	>20	>20	>20
Net present value (VND)	Ideal	(23,451,893)	(26,985,115)	(19,428,140)	(21,469,829)
	Actual	(24,989,778)	(28,373,846)	(20,787,473)	(22,754,586)
COST-EFFECTIVENESS MEASURES					
Cost per DALY averted (VND)	Ideal	70,607,265	97,049,831	26,818,053	140,246,828
	Actual	76,314,998	104,853,107	29,413,597	153,688,866
Cost per case averted (VND)	Ideal	(1,940,711)	(2,808,521)	(2,787,737)	(4,058,598)
	Actual	(2,097,594)	(3,034,340)	(3,057,544)	(4,447,596)
Cost per death averted (VND)	Ideal	1,347,300,817	1,824,402,624	1,935,332,539	2,186,223,499
	Actual	1,456,213,593	1,971,093,424	2,122,640,684	2,395,763,345

TABLE J14. SITE U2 (QUANG NAM, URBAN) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Pit latrine	
		Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES			
Benefits per VND input	Ideal	7.1	11.4
	Actual	0.6	0.5
Internal rate of return (%)	Ideal	0.4	0.3
	Actual	0.6	0.5
Pay-back period (years)	Ideal	3.3	3.9
	Actual	2.8	3.2
Net present value (VND)	Ideal	5,655,820	4,036,366
	Actual	12,588,462	11,031,498
COST-EFFECTIVENESS MEASURES			
Cost per DALY averted (VND)	Ideal	(880,948)	(2,108,063)
	Actual	(10,519,766)	(51,320,009)
Cost per case averted (VND)	Ideal	91,641	61,071
	Actual	1,094,320	1,486,760
Cost per death averted (VND)	Ideal	(63,258,690)	(32,812,168)
	Actual	(755,398,026)	(798,800,156)

TABLE J15. SITE U3 (HAI PHONG, URBAN) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Wet pit latrine to septic tank		Septic tank to WWM	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES					
Benefits per VND input	Ideal	0.5	0.4	0.8	0.6
	Actual	0.4	0.3	0.7	0.5
Internal rate of return (%)	Ideal	-	-	-	-
	Actual	-	-	-	-
Pay-back period (years)	Ideal	>20	>20	>20	>20
	Actual	>20	>20	>20	>20
Net present value (VND)	Ideal	(10,576,464)	(13,326,141)	(1,145,299)	(2,676,318)
	Actual	(11,670,559)	(14,298,371)	(1,519,498)	(2,989,585)
COST-EFFECTIVENESS MEASURES					
Cost per DALY averted (VND)	Ideal	49,885,661	68,562,617	7,794,079	41,979,033
	Actual	55,774,740	78,184,859	8,501,460	59,430,319
Cost per case averted (VND)	Ideal	(1,372,663)	(1,987,236)	(811,065)	(1,216,731)
	Actual	(1,534,708)	(2,275,441)	(884,676)	(1,360,569)
Cost per death averted (VND)	Ideal	945,483,428	1,280,088,016	558,657,251	652,933,159
	Actual	1,057,099,200	1,458,070,738	609,360,292	717,265,707

TABLE J16. SITE U4 (QUANG NINH, URBAN) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Septic tank to septic tank with WWM	
		Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES			
Benefits per VND input	Ideal	7.1	11.4
	Actual	0.6	0.5
Internal rate of return (%)	Ideal	0.4	0.3
	Actual	0.6	0.5
Pay-back period (years)	Ideal	3.3	3.9
	Actual	2.8	3.2
Net present value (VND)	Ideal	5,655,820	4,036,366
	Actual	12,588,462	11,031,498
COST-EFFECTIVENESS MEASURES			
Cost per DALY averted (VND)	Ideal	(880,948)	(2,108,063)
	Actual	(10,519,766)	(51,320,009)
Cost per case averted (VND)	Ideal	91,641	61,071
	Actual	1,094,320	1,486,760
Cost per death averted (VND)	Ideal	(63,258,690)	(32,812,168)
	Actual	(755,398,026)	(798,800,156)

TABLE J17. SITE U5 (DAK LAK, URBAN) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Wet pit latrine to septic tank		Septic tank to WWM	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES					
Benefits per VND input	Ideal	0.3	0.2	0.2	0.2
	Actual	0.3	0.2	0.2	0.2
Internal rate of return (%)	Ideal	-	-	-	-
	Actual	-	-	-	-
Pay-back period (years)	Ideal	>20	>20	>20	>20
	Actual	>20	>20	>20	>20
Net present value (VND)	Ideal	(23,451,893)	(26,985,115)	(19,428,140)	(21,469,829)
	Actual	(24,989,778)	(28,373,846)	(20,787,473)	(22,754,586)
COST-EFFECTIVENESS MEASURES					
Cost per DALY averted (VND)	Ideal	70,607,265	97,049,831	26,818,053	140,246,828
	Actual	76,314,998	104,853,107	29,413,597	153,688,866
Cost per case averted (VND)	Ideal	(1,940,711)	(2,808,521)	(2,787,737)	(4,058,598)
	Actual	(2,097,594)	(3,034,340)	(3,057,544)	(4,447,596)
Cost per death averted (VND)	Ideal	1,347,300,817	1,824,402,624	1,935,332,539	2,186,223,499
	Actual	1,456,213,593	1,971,093,424	2,122,640,684	2,395,763,345

TABLE J18. SITE R1 (DONG NAI, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Pit latrine to Biogas	
		Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES			
Benefits per VND input	Ideal	0.4	0.4
	Actual	0.9	0.8
Internal rate of return (%)	Ideal	-	-
	Actual	-	-
Pay-back period (years)	Ideal	>20	>20
	Actual	>20	>20
Net present value (VND)	Ideal	(8,223,668.0)	(8,753,847.9)
	Actual	(588,295.4)	(1,118,475.3)
COST-EFFECTIVENESS MEASURES			
Cost per DALY averted (VND)	Ideal		
	Actual		
Cost per case averted (VND)	Ideal		
	Actual		
Cost per death averted (VND)	Ideal		
	Actual		

TABLE J19. SITE R2 (VINH LONG, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Pit latrine to Biogas	
		Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES			
Benefits per VND input	Ideal	0.8	0.7
	Actual	0.8	0.7
Internal rate of return (%)	Ideal	-	-
	Actual	-	-
Pay-back period (years)	Ideal	>20	>20
	Actual	>20	>20
Net present value (VND)	Ideal	(2,833,449)	(4,421,347)
	Actual	(1,848,160)	(3,043,138)
COST-EFFECTIVENESS MEASURES			
Cost per DALY averted (VND)	Ideal	(33,099,196)	81,544,246
	Actual	(27,398,396)	204,149,198
Cost per case averted (VND)	Ideal	(1,621,596)	(2,360,853)
	Actual	(1,342,303)	(1,819,107)
Cost per death averted (VND)	Ideal	1,123,123,202	1,922,215,334
	Actual	929,683,434	1,417,149,195

TABLE J20. SITE R3 (QUANG NGAI, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Wet pit latrine to septic tank		Septic tank to double-vault		Wet pit latrine to double-vault	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES							
Benefits per VND input	Ideal	0.5	0.4	1.0	0.7	0.1	0.1
	Actual	0.5	0.4	0.8	0.6	0.1	0.1
Internal rate of return (%)	Ideal	-	-	-	-	-	-
	Actual	-	-	-	-	-	-
Pay-back period (years)	Ideal	>20	>20	>20	>20	>20	>20
	Actual	>20	>20	>20	>20	>20	>20
Net present value (VND)	Ideal	(8,557,679)	(10,104,465)	(10,984,262)	(9,730,136)	(19,541,942)	(19,688,271)
	Actual	(5,405,411)	(6,672,106)	(10,298,557)	(9,324,522)	(15,703,968)	(15,850,298)
COST-EFFECTIVENESS MEASURES							
Cost per DALY averted (VND)	Ideal	(37,651,636)	91,651,641				
	Actual	(34,276,848)	83,724,278				
Cost per case averted (VND)	Ideal	(1,845,284)	(2,654,801)				
	Actual	(1,679,888)	(2,425,175)				
Cost per death averted (VND)	Ideal	1,275,129,888	(2,654,801)		317,560		1,212,188
	Actual	1,160,837,568	(2,425,175)		427,322		1,241,762

TABLE J21. SITE R4 (DAN PHUONG, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Wet pit latrine to septic tank		Septic tank to Biogas		Wet pit latrine to biogas	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES							
Benefits per VND input	Ideal	0.5	0.4	0.3	0.3	0.1	0.1
	Actual	0.8	0.8	0.3	0.2	0.2	0.2
Internal rate of return (%)	Ideal	-	-	-	-	-	-
	Actual	-	-	-	-	-	-
Pay-back period (years)	Ideal	>20	>20	>20	>20	>20	>20
	Actual	>20	>20	>20	>20	>20	>20
Net present value (VND)	Ideal	(7,570,277)	(9,117,063)	(4,405,891)	(8,220,135)	(19,300,620)	(19,446,950)
	Actual	(2,090,701)	(3,427,419)	(4,369,975)	(7,634,032)	(9,212,037)	(9,358,367)
COST-EFFECTIVENESS MEASURES							
Cost per DALY averted (VND)	Ideal	46,585,737	100,075,087	16,475,960	(40,700,175)	30,585,651	
	Actual	31,457,091	63,977,683	18,345,836	(55,920,320)	18,079,445	329,582,399
Cost per case averted (VND)	Ideal	(1,809,051)	(2,879,375)	725,526	1,171,031		
	Actual	(1,221,564)	(1,895,404)	807,867	1,263,394		
Cost per death averted (VND)	Ideal	1,250,091,771	2,110,532,962	(501,353,984)	(558,253,208)		
	Actual	844,126,406	1,382,175,239	(858,346,109)	(921,297,999)		

TABLE J22. SITE R7 (LAI XA, RURAL) EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Pit latrine to septic tank		Pit latrine to septic tank with WWM		Septic tank to septic tank with WWM	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES							
Benefits per VND input	Ideal	0.5	0.4	0.6	0.5	1.1	0.7
	Actual	0.6	0.5	0.7	0.6	0.8	0.6
Internal rate of return (%)	Ideal	-	-	-	-	-	-
	Actual	-	-	-	-	-	-
Pay-back period (years)	Ideal	>20	>20	>20	>20	>20	>20
	Actual	>20	>20	>20	>20	>20	>20
Net present value (VND)	Ideal	(7,494,401)	(9,315,631)	(7,238,938)	(10,398,691)	255,462	(1,565,768)
	Actual	(3,938,469)	(5,224,291)	(4,701,005)	(6,789,939)	(762,535)	(2,048,356)
COST-EFFECTIVENESS MEASURES							
Cost per death averted (VND)	Ideal		923,936		1,225,452		330,289
	Actual		1,037,148		1,535,226		546,033

TABLE J23. SUMMARY OF ALL URBAN SITES: EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	OD to pit latrine	OD to septic tank	OD to WWT
COST-BENEFIT MEASURES				
Benefits per VND input	Ideal	4.3	2.0	1.9
	Actual	3.2	1.6	1.7
Internal rate of return (%)	Ideal	>100%	75.0%	64.6%
	Actual	>100%	48.1%	50.8%
Pay-back period (years)	Ideal	<1	2.6	3.3
	Actual	<1	3.4	3.9
Net present value (VND)	Ideal	29,146,554	22,031,823	22,685,724
	Actual	20,210,305	13,492,946	16,952,502
COST-EFFECTIVENESS MEASURES				
Cost per DALY averted (VND)	Ideal	11,711,326	58,336,118	21,703,810
	Actual	14,839,598	64,903,095	23,951,051
Cost per case averted (VND)	Ideal	253,875	812,332	1,315,696
	Actual	321,689	903,784	1,451,928
Cost per death averted (VND)	Ideal	220,421,019	429,315,910	410,438,820
	Actual	279,298,809	477,639,840	452,935,123

TABLE J24. SUMMARY OF ALL RURAL SITES: EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARED TO "NO TOILET"

Efficiency measure	Scenario	OD to private wet pit		OD to septic tank		OD to cluster w/w treatment		OD to double-vault composting		OD to biogas digester	
		Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene	Sanitation only	Sanitation and hygiene
COST-BENEFIT MEASURES											
Benefits per VND input	Ideal	4.6	5.3	2.4	2.7	2.3	2.6	2.4	2.8	4.2	4.5
	Actual	3.5	4.0	1.9	2.1	1.7	1.9	1.9	2.2	3.9	4.1
Internal rate of return (%)	Ideal	>100	>100	>100	>100	70.1%	89.0%	83.8%	>100	>100	>100
	Actual	>100	>100	61.5%	80.4%	40.4%	48.7%	55.5%	84.7%	>100	>100
Pay-back period (years)	Ideal	<1	<1	2.2	1.9	2.6	2.2	2.8	2.2	2.2	1.9
	Actual	<1	<1	3.1	2.6	3.7	3.3	4.5	3.3	2.6	2.2
Net present value (VND)	Ideal	32,040,470	39,317,535	29,704,771	35,685,809	26,851,722	32,463,716	23,189,327	31,263,751	57,184,435	63,959,256
	Actual	21,955,277	27,993,407	17,287,187	21,436,325	13,964,986	17,139,100	12,486,069	18,464,776	49,861,100	55,062,928
COST-EFFECTIVENESS MEASURES											
Cost per DALY averted (VND)	Ideal	39,587,819	8,568,615	52,741,244	16,765,094	50,799,167	16,277,261	24,774,073	17,994,958	26,949,836	19,752,150
	Actual	44,209,472	11,031,486	62,262,306	21,844,378	61,455,419	23,793,644	30,289,925	22,369,722	30,551,560	23,169,099
Cost per case averted (VND)	Ideal	239,179	398,188	710,229	1,030,430	705,667	1,036,066	520,260	752,068	557,769	6,766,230
	Actual	282,079	459,843	826,681	1,134,609	853,697	1,131,566	638,437	903,164	631,919	8,474,546
Cost per death averted (VND)	Ideal	207,980,604	194,172,866	376,400,212	314,230,769	375,205,497	315,757,220	451,697,214	328,342,689	484,757,644	355,907,725
	Actual	245,286,139	242,871,144	438,120,101	375,294,051	453,913,175	400,091,845	554,237,535	409,096,497	549,180,035	417,528,830

TABLE J25. URBAN AREA EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Wet pit latrine to septic tank	Wet pit latrine to WWT	Septic tank to WWT
Programs included per option		U1	U3, U5	U3, U4, U5
COST-BENEFIT MEASURES				
Benefits per VND input	Ideal	0.4	0.4	3.1
	Actual	0.4	0.3	0.3
Internal rate of return (%)	Ideal	-	-	-
	Actual	-	-	-
Pay-back period (years)	Ideal	>20	>20	>20
	Actual	>20	>20	>20
Net present value (VND)	Ideal	(8,397,413)	(15,804,208)	(8,086,422)
	Actual	(8,006,436)	(17,142,248)	(7,289,182)
COST-EFFECTIVENESS MEASURES				
Cost per DALY averted (VND)	Ideal	(34,843,479)	70,359,268	67,590,712
	Actual	(34,921,419)	81,817,160	67,029,484
Cost per case averted (VND)	Ideal	(1,707,052)	(2,036,758)	(1,956,464)
	Actual	(1,710,871)	(2,247,943)	(1,849,540)
Cost per death averted (VND)	Ideal	1,182,310,300	1,277,252,084	1,053,280,079
	Actual	1,184,954,950	1,404,735,434	992,892,032

TABLE J26. RURAL AREA EFFICIENCY MEASURES FOR MAIN SANITATION INTERVENTION GROUPINGS, COMPARING DIFFERENT POINTS ON THE SANITATION LADDER

Efficiency measure	Scenario	Wet pit latrine to septic tank	Wet pit latrine to cluster WWT	Wet pit latrine to double-vault composting	Wet pit latrine to biogas digester	Septic tank to cluster WWT	Septic tank to double-vault composting	Septic tank to biogas digester
Programs included per option		R2, R3, R4, R7, R9	R7	R3, R9	R1, R4	R7	R3, R9	R4
COST-BENEFIT MEASURES								
Benefits per VND input	Ideal	0.5	0.5	0.1	0.4	0.7	0.9	0.1
	Actual	0.6	0.6	0.2	0.5	0.6	0.7	0.2
Internal rate of return (%)	Ideal	-	-	-	-	-	-	-
	Actual	-	-	-	-	-	-	-
Pay-back period (years)	Ideal	>20	>20	>20	>20	>20	>20	>20
	Actual	>20	>20	>20	>20	>20	>20	>20
Net present value (VND)	Ideal	(8,142,719)	(10,398,691)	(13,514,962)	(8,486,991)	(1,565,768)	(4,792,667)	(19,446,950)
	Actual	(4,697,028)	(6,789,939)	(10,144,067)	(4,376,254)	(2,048,356)	(4,456,402)	(9,358,367)
COST-EFFECTIVENESS MEASURES								
Cost per DALY averted (VND)	Ideal	-	-	-	-	-	-	-
	Actual	-	-	-	-	-	-	329,582,399
Cost per case averted (VND)	Ideal	(2,008,896)	-	-	-	-	(358,320)	-
	Actual	(1,564,703)	-	(644,995,022)	-	-	(373,923)	-
Cost per death averted (VND)	Ideal	1,156,469,316	1,225,452	-	-	330,289	292,110,810	-
	Actual	821,597,288	1,535,226	-	-	546,033	290,930,845	-

TABLE J27. EFFICIENCY MEASURES FOR SOLID WASTE MANAGEMENT PROJECT IN BAC GIANG PROVINCE (U6)

Efficiency measure	Scenario	Intervention: from 'No solid waste management' to 'Collection and dumping in unsanitary landfill'
COST-BENEFIT MEASURES		
Benefits per VND input	Ideal	3.7
	Actual	1.8
Internal rate of return (%)	Ideal	>100%
	Actual	204%
Pay-back period (years)	Ideal	<1
	Actual	>20
Net present value (VND)	Ideal	6,500,822
	Actual	970,272

TABLE J28. EFFICIENCY MEASURES FOR SOLID WASTE MANAGEMENT PROJECT IN HANOI CITY (U7)

Efficiency measure	Scenario	Intervention: from 'No solid waste management' to 'Collection and dumping in unsanitary landfill'
COST-BENEFIT MEASURES		
Benefits per VND input	Ideal	1.40
	Actual	0.86
Internal rate of return (%)	Ideal	51.93%
	Actual	-
Pay-back period (years)	Ideal	<1
	Actual	>20
Net present value (VND)	Ideal	3,819,545
	Actual	-1,537,173

TABLE J29. EFFICIENCY MEASURES FOR SOLID WASTE MANAGEMENT PROJECT IN CUA LO TOWN, NGHE AN PROVINCE (U8)

Efficiency measure	Scenario	Intervention: from 'Collection and dumping in sanitary landfill' to 'Collection and dumping in unsanitary landfill'
COST-BENEFIT MEASURES		
Benefits per VND input	Ideal	4.53
	Actual	2.52
Internal rate of return (%)	Ideal	>100%
	Actual	>100%
Pay-back period (years)	Ideal	<1
	Actual	<1
Net present value (VND)	Ideal	8,772,681
	Actual	4,396,970

TABLE J30. EFFICIENCY MEASURES FOR SOLID WASTE MANAGEMENT PROJECT IN HIEP HOA DISTRICT, BAC GIANG PROVINCE (R6)

Efficiency measure	Scenario	Intervention: from 'No solid waste management' to 'Collection and dumping in unsanitary landfill'
COST-BENEFIT MEASURES		
Benefits per VND input	Ideal	3.19
	Actual	1.56
Internal rate of return (%)	Ideal	>100%
	Actual	-
Pay-back period (years)	Ideal	<1
	Actual	>20
Net present value (VND)	Ideal	6,221,401
	Actual	1,406,021


wsp
water and
sanitation program