

Economic efficiency of sanitation interventions in Southeast Asia

Guy Hutton, U-Primo Rodriguez, Asep Winara, Nguyen Viet Anh, Kov Phyrum, Liang Chuan, Isabel Blackett and Almud Weitz

ABSTRACT

Economic evidence on sanitation supports decisions on resource allocation and selection of efficient and affordable sanitation interventions. This study presents the economic efficiency (costs versus benefits) of sanitation interventions to better manage human excreta, from 47 field sites, covering six countries of Southeast Asia (Cambodia, China, Indonesia, Lao PDR, the Philippines and Vietnam). Costs were estimated in each location, while benefits (improved health, avoided water pollution, reduced sanitation access time, resource recovery) were estimated using evidence from published studies and field sites. The economic return per currency unit invested, known as the benefit-cost ratio (BCR), and the cost per disability-adjusted life-year (DALY) averted were estimated. Across 25 rural field sites, pit latrines had a BCR of at least 5 in all countries, except Cambodia where the BCR was 2. In 22 urban field sites, septic tanks with wastewater management had a BCR of at least 2. Costs per DALY averted were found to be 'cost-effective' for most sanitation interventions in all countries. Economic performance declined significantly when considering non-use of facilities by households or unused infrastructural capacity. However, the economic net returns were positive under all pessimistic scenarios examined in one-way sensitivity analysis. This study demonstrates that sanitation is a highly profitable social and economic investment in six Asian countries.

Key words | Asia, benefit-cost ratio, capital cost, economic return, recurrent cost, sanitation

Additional geographic key words | Cambodia, China, East Asia, Indonesia, Lao PDR, Philippines, Southeast Asia, Vietnam

Guy Hutton (corresponding author)
Water and Sanitation Program,
World Bank, 55 Lodi Estate, New Delhi, 110003,
India
E-mail: ghutton@worldbank.org

Kov Phyrum
Water and Sanitation Program,
World Bank, 113 Norodom Blvd,
Phnom Penh, Cambodia

Isabel Blackett
Water and Sanitation Program,
World Bank, Indonesia Stock Exchange Building,
Tower 1, 9th Floor. Jl. Jenderal Sudirman Kav 52-53,
Jakarta 12190, Indonesia

Almud Weitz
Water and Sanitation Program,
World Bank Group Singapore Office, 10 Marina
Boulevard, Marina Bay Financial Center,
Tower 2, #34-02 Singapore 018983

U-Primo Rodriguez
Economics Department,
University of the Philippines,
Guerrero corner Osmeña Sts. Diliman,
Quezon City, 1101, Philippines

Asep Winara
Mitra Lingkungan Duta Consult (MLD),
Ventura Building, 4th floor, Suite 405, Jl. R.A.
Kartini No. 26, Cilandak, Jakarta 12430,
Indonesia

Nguyen Viet Anh
Institute of Environmental Science and Engineering
(IESE), Hanoi University of Civil Engineering,
55 Giai phong Road, Hai Ba Trung District, Hanoi,
Vietnam

Liang Chuan
Yunnan Academy of Social Sciences (YASS),
577 Huan Cheng Xi Lu, Kunming City, Yunnan
Province, 650034 China

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ABBREVIATIONS

BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CEA	Cost-Effectiveness Analysis
CLTS	Community-Led Total Sanitation
CSR	Corporate Social Responsibility
ESI	Economics of Sanitation Initiative (of WSP)
GDP	Gross Domestic Product
HCA	Human Capital Approach
IRR	Internal Rate of Return
JMP	Joint Monitoring Programme for Water Supply and Sanitation
MDG	Millennium Development Goal
UDDT	Urine-diverting dehydration toilet
UN	United Nations
UNICEF	United Nations Children's Fund
US\$	United States Dollar
VSL	Value-of-a-statistical life
WHO	World Health Organization
WSP	Water and Sanitation Program

BACKGROUND

Good sanitation is a basic human need. At home as well as at the workplace, school or a public place, people appreciate and value a clean, safe, private and convenient place to urinate and defecate. The importance of good sanitation was recognized in the Millennium Development Goals (MDG), where target 7C is to 'halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation'. In 2010, the human right to safe drinking-water and sanitation was adopted by the United Nations General Assembly, which recognizes that sanitation is essential for the full enjoyment of life and of all human rights (United Nations 2010).

As well as being important in its own right, good sanitation contributes importantly to achieving other MDG targets such as child mortality reduction, school enrolment, improved nutrition, gender equality, clean drinking water, environmental sustainability and quality of life of slum dwellers.

However, despite its central place in human development, sanitation continues to lose ground to other development targets when it comes to priority setting by governments, households, the private sector and donors. For example, from a global review with a cross-section of 13 countries reporting data, government expenditure on drinking-water and sanitation comprised a median of 0.7% of Gross Domestic Product (GDP), compared with 2.3% for health and 5.5% for education (World Health Organization 2012). Aid commitments for water and sanitation were at 4.7% (US\$ 7.8 billion) (billion =10⁹) of the total reported development aid in 2010, at around the same cost as the stated administrative costs of donors. However, these aid flows do not target well the lowest income countries, nor the low cost sanitation solutions that reach the poorest and most vulnerable groups (World Health Organization 2012).

The reasons for low prioritization of water and sanitation are many. Sanitation remains a largely taboo subject in most cultures; it is not an attractive subject for media or politicians to promote as a worthy cause; and policy makers are unmotivated or remain ignorant of evidence of the health and economic benefits of sanitation.

One source of valuable advocacy material is evidence of the economic impacts of the lack of good sanitation. Economic evidence has been put to good effect in other sectors to raise awareness of low priority issues. One example is the WHO Commission on Macroeconomics and Health which in 2001 published a report that drew the link between the high rate of avoidable diseases and lack of economic growth in low income countries (Sachs 2001). Hence, in 2007 the World Bank Water and Sanitation Program initiated a series of studies that estimated the economic and social impacts of unimproved sanitation on the populations and economies of five countries in Southeast Asia (Hutton *et al.* 2008, 2009). The studies showed that the economic impacts of poor sanitation for the year 2006 were US\$ 23 per capita, or equivalent to 2% of annual GDP across the five countries (1.3% in Vietnam, 1.5% in the Philippines, 2.3% in Indonesia, 5.6% in Lao PDR and 7.2% in Cambodia). These results have helped galvanize action in and beyond these countries.

Economic impact figures highlight a problem society has. However, the estimates do not support policy makers in making rational decisions on *how* to act. Cost-benefit

analysis (CBA) is a well-known technique for assessing the comparative performance of different intervention options (Drummond *et al.* 2005), thus supporting the selection of socially efficient sanitation policies, programs and technologies. CBA specifically provides efficiency metrics such as the benefit-cost ratio (BCR) and the internal rate of return (IRR) which help identify which interventions generate greater economic return (Curry & Weiss 1993). Previous global studies have provided an indication that 'improved' sanitation delivers high economic returns, in the most recent study at US\$ 5.5 per US\$ invested (Hutton 2012). However, improved country studies are needed to provide greater granularity on which sanitation interventions are more efficient, and in which sub-national contexts.

CBA requires all major costs and benefits to be converted into monetary units, which often presents methodological challenges. To avoid converting benefits into monetary units, cost-effectiveness analysis (CEA) enables comparison of physical units of benefits with intervention costs to inform where the greatest marginal gain per unit of expenditure is. Ministries of Health compare the cost per health unit obtained from sanitation interventions, while Ministries responsible for environmental or water protection compare the cost per pollution reduction unit from sanitation interventions. Less common in CBA or CEA is the assessment of social impacts. To date, economic efficiency studies have not measured aspects of sanitation such as dignity, comfort, prestige, security, gender equality, household cleanliness, and aesthetics of the community environment (Van Minh & Nguyen-Viet 2011).

METHODS

The purpose of this study is to generate improved economic information to help sanitation decision makers incorporate efficiency criteria into their selection of sanitation technologies. On the cost side, decision makers need to understand more about the size of costs (e.g. investment, operation, maintenance) and when they occur, in order to make the appropriate investment decision that increases intervention effectiveness and sustainability. On the benefit side, the monetary as well as non-monetary impacts need to be better understood to select interventions that provide better value-

for-money. In this study, the following technical efficiency measures were calculated: BCR, cost per health impact averted, net present value, IRR and payback period (Sugden & Williams 1978; Hanley & Spash 1993; Hutton *et al.* 2007). The first two of these are presented in this paper; full results are available from the Water and Sanitation Program. The study aim was therefore to evaluate the technical efficiency of different sanitation intervention options, as delivered in real field settings, and make recommendations for which interventions should be considered in planning exercises to maximize the returns on the allocation of a specific budget ('allocative' efficiency).

Alternative scientific designs for determination of causality were compared. While more robust study designs – such as randomized controlled trials – are preferred from the scientific perspective, however, the study budget, timeline and inherent difficulties in conducting trials in sanitation did not allow for such studies to be conducted. Instead, evidence of the health impact of improved sanitation was extracted from meta-analysis studies. Field surveys were implemented in 47 field sites across the six countries (25 rural and 22 urban) to provide key contextual evidence to feed into the economic model. These surveys included a household questionnaire applied in 8,470 households (roughly 180 per field site, based on a minimum sample of 30 per type of household sanitation); focus group discussions; a physical location survey; health facility survey; market survey for local prices; and a review of implementing agency and government reports.

The economic model captures and compares all the costs and benefits, using best available sources for each model variable. The model was run for 20 years, with costs and benefits after the initial year being discounted at a rate of 8% per year, reflecting the typical discount rate applied in public sector projects in these countries. The present value of the discounted costs and benefits were compared to estimate the technical efficiency measures. Primary data from surveys in each field setting were used where possible, and these were supplemented with other selected data from national surveys or international sources. The economic model enabled comparison of outcomes of households both with and without improved sanitation, and comparing different technologies on the sanitation ladder. These include shared sanitation (share with neighbors,

public toilet), private dry sanitation (dry pit latrine, urine-diverting dehydration toilet (UDDT)), and private wet sanitation (wet pit latrine, biogas digester, septic tank and sewerage – with and without wastewater management). The options evaluated varied between field sites.

Capital, operational and maintenance cost information was collected from households, private sector providers and government or donor projects, and triangulated to estimate the full costs of on-site and off-site sanitation (where relevant). For the cost-benefit comparisons, costs were converted to annual equivalent values based on the expected lifespan of each sanitation technology. The year of cost data was 2008.

Benefits estimated in the field sites include improved health, reduced water pollution and hence improved access to clean drinking-water sources, reduced sanitation access time, and resource reuse (value of fertilizer and biogas produced, in the Philippines, Vietnam and Yunnan Province only). Diseases considered in this study include all types of diarrheal disease, helminths, hepatitis A and E, malnutrition and diseases related to malnutrition (malaria, acute lower respiratory infection and measles). Disease rates and mortality were collected from Demographic and Health Surveys and the World Health Organization (World Health Organization 2009), adjusted to each field site based on socio-economic characteristics of the sampled populations. As not all fecal-oral diseases have a pathway from human excreta, 88% (attribution rate) of diarrheal diseases were assumed to be due to poor management of human excreta (Prüss *et al.* 2002).

For CBA, three health-related economic costs were included: health care costs, health-related productivity costs, and premature mortality costs. For fecal-oral disease, the relative risk reduction of 36% for improved sanitation was based on the latest published meta-analysis (Waddington *et al.* 2009). For improved on-site sanitation with fecal sludge management, a reduction in fecal-oral disease of 56% was used as an average of two previous studies (Moraes *et al.* 2003; Barreto *et al.* 2010). Health care savings were calculated by applying the relative risk reduction to the average disease cost per household (based on treatment-seeking rates for different health care providers, hospital admission and unit costs of health care). Gains in health-related productivity were estimated by applying the relative health risk reduction to the disease rates, the average time taken off productive

activities due to illness, and the opportunity cost of time. The latter was approximated by using 30% of the average income for adults and 15% of the average income for children (Hutton *et al.* 2007). For children under 5, the time of the child carer was applied at 15% of average income. Welfare gains due to averted premature death were valued by applying the relative health risk reduction to the risk of death per age group from fecal-oral disease, and multiplying by the estimated value of life using the human capital approach (HCA). The HCA approximates economic losses by estimating the future discounted income stream from a productive person who dies prematurely. The HCA provides a lower bound estimate compared to other techniques such as the value-of-statistical-life, and hence gives a conservative estimate of the benefits.

The benefits of avoided water pollution from poor sanitation focused on water use for domestic purposes, in particular drinking water. When the financial means and products are available, communities and individual households often take mitigative measures to avoid consuming water drawn from polluted sources. This study modeled the potential economic gains from improving sanitation on two sets of common mitigation measures – switching water source and conducting household water treatment. The costs of these practices were compared with the costs under a situation of minimal pollution levels, and a partial cost attributed to the contribution of poor sanitation to overall water resources pollution. Water quality measurement studies were conducted to enable detailed analysis of the likely impacts of improved sanitation on local water quality.

Access time savings due to poor sanitation were estimated based on practices of those with no household facility, including distance to sites of defecation. These were extracted from the household surveys and assessed separately for men and women, and for children, due to their different practices. The value of time saved was estimated based on the same opportunity cost of time as the health-related time savings (see above).

Resource reuse was practiced in 13 out of 47 field sites: UDDT in the Philippines, and both UDDT and biogas in Vietnam and Yunnan province, China. In these sites, the value of excreta reuse was measured based on the uses to which the products were put. More commonly, the household used the product, in which case the value of saved

expenditure on fertilizer or energy was estimated. When the product was sold, the selling price (and revenue) was obtained from the household or the market place. In the case of biogas digesters, additional excreta volume was commonly sourced freely from livestock belonging to the household.

Sensitivity analysis was conducted to assess the robustness of results under different input values of key variables. Two representative sites and technologies from Indonesia (Malang urban site, community sewerage system; and Lamongan rural site, private wet pit latrines) were selected to illustrate the impact on the BCR of the alternative input values of each of the following seven selected parameters: discount rate; different number of members per household; disease morbidity risk; mortality risk; value of time; the value of averting a premature death using the value-of-statistical-life method, adjusting a value of US\$ 2 million from developed countries by the difference in GDP per capita; and the length of life span of the hardware.

Intangible benefits of sanitation such as comfort, privacy, convenience, safety, social status, prestige and environmental aesthetics are major factors in personal and community welfare, and are thus important determinants of sanitation choices. Due to the private and subjective nature of intangible benefits, reliable information is difficult

to elicit from individuals. Furthermore, perceptions and preferences vary considerably from one individual and social group to another. Therefore, intangible benefits were not converted to monetary values. Instead, the understanding of sanitation, sanitation preferences and the sanitation decision-making process were elicited from household interviews. A total of 115 focus group discussions were conducted across the six countries.

For CEA, three indicators of disease burden were evaluated: numbers of cases (incidence or prevalence), deaths, and disability-adjusted life-years (DALYs). DALYs are reported in this paper, calculated using standard methods by combining morbidity components (disease rate, disability weight and illness duration) with mortality components (mortality rate and life expectancy). Standard weights and disease durations are sourced from the Global Burden of Disease study (Murray et al. 2001), and average healthy life expectancy is based on values for each country (Fox-Rushby & Hanson 2009; World Health Organization 2001).

RESULTS

Figure 1 shows the BCRs for rural areas. The most basic sanitation type, the pit latrine, had returns of at least five

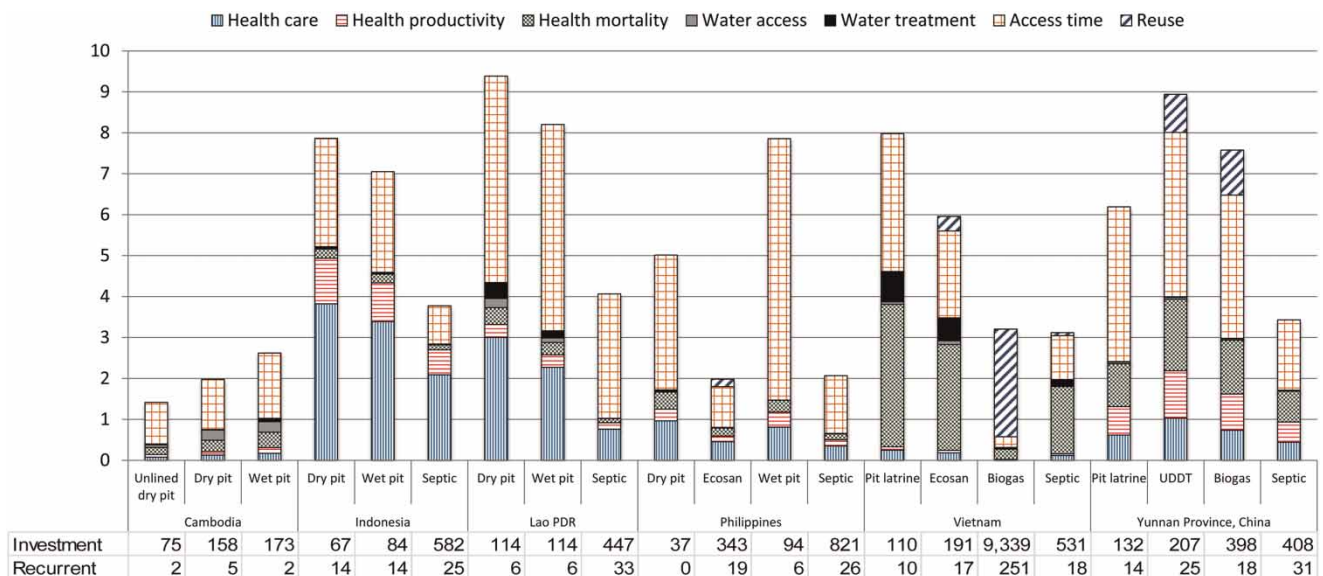


Figure 1 | Benefit-cost ratios of sanitation interventions in rural areas, and up-front investment and annual recurrent costs per household (US Dollars, 2008). Note: in Vietnam, 'pit latrine' includes both dry and wet pits.

times its costs in all but one country, Cambodia. Across both wet and dry pit latrines, the returns were highest in Lao PDR at over eight times. The returns were two or more times in Cambodia for both dry and wet pit latrines. The average returns are lower in Cambodia partly due to the fact that costs in Cambodia were at least as high as other countries, while the value of the benefits was diminished by the lower average incomes in Cambodia. A second finding is that dry pit latrines do not consistently have a higher return, despite having a lower investment cost in all countries. In the Philippines and Cambodia, dry pit latrines have lower returns than wet pit latrines, while the reverse is true in Indonesia and Lao PDR. This finding was observed for the Philippines and Cambodia largely due to the fact that the expected life of a dry pit latrine was less than half that of a wet pit latrine.

Returns for private toilets with septic tanks are significantly lower compared to pit latrines. In only two countries do the economic returns reach four times (Vietnam and Lao PDR), while the returns are two times in the Philippines. However, the economic returns are net positive for all technologies and all countries (i.e. the BCR remains above one).

Reuse options have economic returns of at least two times, ranging from 2 in the Philippines to 9 in Yunnan for the UDDT option. Some variation was found between

reuse options and pit latrines in each country. In Yunnan, the UDDT had higher returns than a pit latrine. This was accomplished through a large-scale government program that made the unit cost of UDDT facilities similar to ordinary pit latrines. In the Philippines, the UDDT had significantly lower returns than a pit latrine, due to the high unit costs of delivering UDDTs to populations (both higher hardware and software costs). In Vietnam, the UDDT had a marginally lower return than a pit latrine, due to the higher unit cost and limited economic value of compost. For the biogas digesters, the large on-farm systems surveyed in Vietnam had high positive economic returns, largely accounted for by the resource reuse value. In Yunnan, the high return on biogas of at least seven times was accounted for largely by the health and time savings rather than the recovered gas. In Yunnan, the value of compost or biogas alone was enough to cover the cost of the improved sanitation intervention.

Figure 2 shows the BCRs of different technologies found in urban areas. In some urban settings, where density is low and properties have sufficient plot size for constructing additional buildings, pit latrines remain a feasible, affordable and efficient sanitation option. While wet pit latrines in urban areas had a poorer economic performance compared to rural areas in most countries, they were the most efficient option in urban areas with economic returns ranging from 3 times in

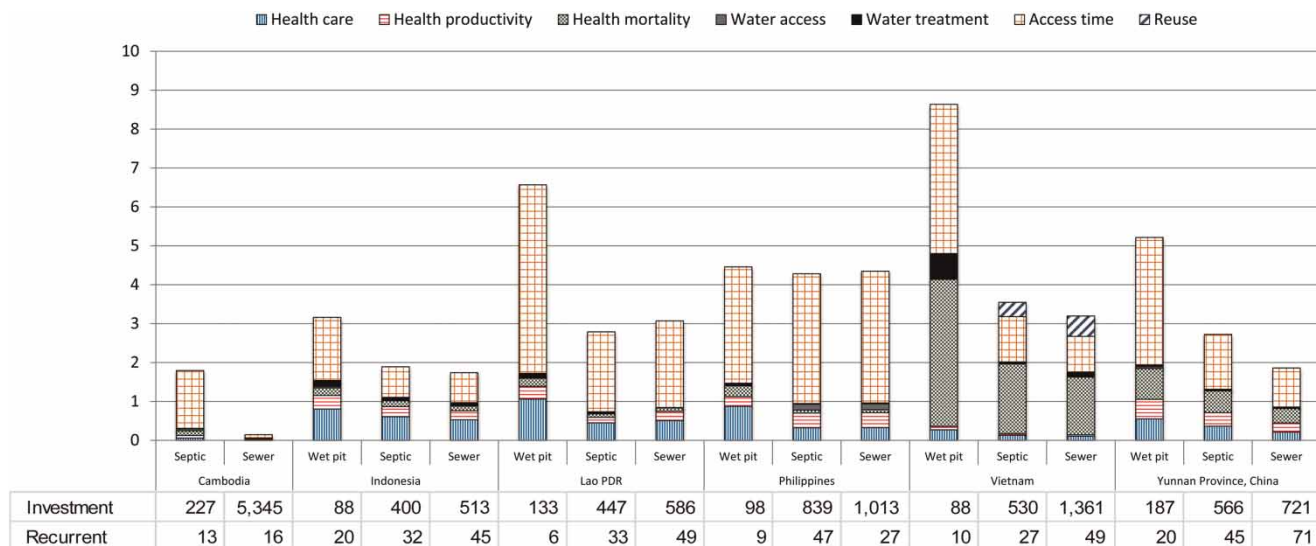


Figure 2 | Benefit-cost ratios of sanitation interventions in urban areas, and up-front investment and annual recurrent costs per household (US Dollars, 2008).

Indonesia to 8.5 times in Vietnam. This favorable result needs to be balanced with the health risk of using pit latrines in densely populated areas, especially the risk due to groundwater pollution. The higher cost option of septic tanks (with wastewater management) was also economically viable in all countries, with economic returns of around two or more per unit spending. However, there are significant variations between countries, with returns from under two times in Cambodia and Indonesia, around three times in Yunnan and Vietnam, to at least four times in the Philippines. The omission of the monetized environmental benefits of sludge wastewater management also leads to lower BCRs for these options than would otherwise be the case.

The highest annualized cost option – sewerage with wastewater treatment – had slightly lower economic returns than septic tanks in most countries. In Cambodia, the sewerage and treatment system performed poorly with an economic return of 0.14 times. This is the case because the urban site is a relatively small town with connections planned for only 3,300 households, with a high land purchase cost and costly infrastructure (wastewater treatment plant and new sewerage system), made more costly by hilly terrain. In most sites assessed, wastewater treatment plants release the treated wastewater to the environment. In Vietnam, on the other hand, wastewater is reused after treatment in some cities and hence makes an important contribution to the overall economic returns.

In all countries and for most sanitation technologies, health benefits and time savings accounted for the majority of the overall benefits. Significant variation was found across countries in the specific contributors to benefits. This was due to the different levels of impact and the different relative values of those impacts. For example, health care savings make up a significant share of overall benefits in Lao PDR and Indonesia, while mortality reductions are more important in Vietnam. The value of time saving makes up at least 50% of the overall benefit in four out of six countries. Reduced costs due to less polluted water sources are an insignificant benefit in all countries, except Vietnam where these accounted for close to 10% of benefits. However, it is worth noting the full benefits from improved water quality and avoided cost of pollution downstream was not considered for assessed urban sites in this study.

The results presented above show the ideal performance of the sanitation technologies, where all households who obtain a sanitation facility would use it appropriately over the full life of the hardware. However, this was not always the case, either due to non-compliance of the household in using the facility consistently or due to the non-function of the hardware itself. The household survey obtained information on general usage of the facility by all household members; and the survey of the projects found out the extent to which infrastructure, such as sewerage and wastewater treatment plant capacity, was underutilized. Decline in performance from ideal to actual was significant for technologies in all countries. For rural areas, most technologies experienced a decline in performance of between 10 and 30%. In urban areas, the decline in performance was on average higher than in rural areas, with the BCRs for most technologies reducing by between 20 and 40%. The highest decline was observed in Cambodia (urban site), because at the time of the study, only 20% of the targeted households were connected to the sewerage system.

The sensitivity of these baseline results was assessed by examining the impact of changing key assumptions and input values on the BCRs of one urban site (Malang) and one rural site (Lamongan) in Indonesia. The results are shown in [Table 1](#). While the economic returns did diminish, they remained net positive under all scenarios. In Malang urban site, economic returns were most sensitive to the value of time, number of household members, and discount rate. For Lamongan rural site, where the baseline economic returns were higher at 6.1, the economic returns did not dip below 2.2 times in any of the scenarios explored. The economic returns for Lamongan increased to above 10 when morbidity rates were double the baseline values and when a high value of time was used. A key variable for both sites is the number of household members – when there were three adults but no children in the household, the BCR reduced significantly.

The cost per DALY averted differs significantly between countries and between technologies. According to the World Health Organization, a health-improving intervention with a cost per DALY of less than the GDP per capita reflects a *very cost-effective* use of funds for health interventions, and a cost per DALY of between one and three times the GDP per capita reflects a *cost-effective* use

Table 1 | Results of one-way sensitivity analysis – benefit-cost ratios

Parameter	Range (high and low values)	Malang (urban)		Lamongan (rural)	
		Ideal ^e	Actual ^f	Ideal ^e	Actual ^f
Baseline BCR		2.3	1.9	6.1	5.1
Discount rate (baseline 8%)	0%	5.3	4.4	9.0	7.5
	12%	2.0	1.6	5.8	4.8
	20%	1.6	1.3	5.5	4.5
Morbidity rate (all diseases)	Half baseline value	1.8	1.5	3.9	3.3
	Double baseline value	3.4	2.8	10.6	8.7
Mortality rate (all diseases)	Half baseline value	2.2	1.8	6.0	5.0
	Double baseline value	2.5	2.0	6.3	5.2
Value of life ^a	Use of VSL	2.8	2.3	7.0	5.8
Value of time ^b	Low assumption	1.4	1.1	4.6	3.8
	High assumption	5.5	4.6	12.0	10.1
Household members ^c	3 adults only	1.3	1.1	2.7	2.2
	3 adults and 4 children	3.2	2.7	11.3	9.3
Life span of hardware ^d	Low assumption	1.6	1.3	4.9	4.0
	High assumption	2.8	2.3	7.2	6.0

^aValue-of-statistical life (VSL) is US\$ 50,818 (transfer of VSL of US\$ 2 million from developed countries based on GDP per capita differential), while using the human capital approach the value of premature death for adults is US\$ 14,367.

^bIn baseline, value of time 30% and 15% of GDP per capita, for adults and children respectively. Low value is 15% and 0%, respectively. High value is 100% and 50%, respectively.

^cBaseline is 1.8 children and 3.2 adults in Malang; 1.6 children and 3.4 adults in Lamongan.

^dCommunal sewerage life span assumptions: 20 years in the baseline, 10 years for low scenario and 30 years for high scenario. Wet pit latrine life span assumptions: 5 years in the baseline, 3 years for low scenario and 8 years for high scenario.

^eThe 'ideal' scenario reflects a situation where all households who obtain a sanitation facility use it appropriately over the full life of the hardware.

^fThe 'actual' scenario reflects the situation where households who obtain a sanitation facility do not use it due to disrepair or not changing habit, or in the case of infrastructure, such as sewerage and wastewater treatment plant, the capacity of the facility is underutilized.

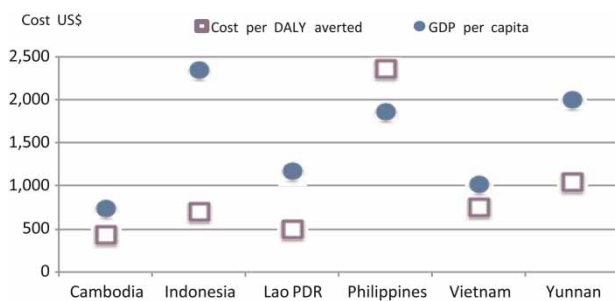


Figure 3 | Cost per DALY averted for wet pit latrines in rural areas, compared with the GDP per capita (all prices are for 2008 except Lao PDR 2010 prices).

of funds for health interventions (Sachs 2001; World Health Organization 2011). Figure 3 illustrates the case of wet pit latrines in rural areas. In Cambodia and Lao PDR, a DALY can be averted for less than US\$ 500, which reflects a very cost-effective health intervention. In Indonesia and Yunnan, the cost per DALY averted for both pit latrines

and septic tanks was also lower than the GDP per capita, as was the case for pit latrines in Vietnam. Septic tanks in Lao PDR and Philippines had a cost per DALY averted greater than three times the GDP per country. Hence the health arguments alone cannot justify these latter interventions, based on the international thresholds defined above.

In urban areas, the cost per DALY averted was significantly higher than in rural areas, due to the higher cost of the sanitation interventions and also the lower potential for health benefits compared to rural areas. Using the same thresholds defined above, pit latrines reflect a cost-effective intervention in urban areas of all countries, except Vietnam where they were very cost-effective. Septic tanks reflect a cost-effective intervention in Yunnan, Indonesia and Cambodia, and were very cost-effective in Vietnam. Sewerage was a cost-effective intervention only in Indonesia and Vietnam.

Table 2 | Factors explaining sanitation coverage and lack of coverage

Country	Why those with toilets have them	Why those without toilets do not have them
Cambodia	<ol style="list-style-type: none"> 1. Saves time and is convenient 2. Safe from danger (women) 3. Improved health 4. Does not smell and spoil environment 	<ol style="list-style-type: none"> 1. High cost of latrine 2. Not used to using latrine 3. No space for building latrine 4. (Unimproved) latrine has bad smell
Indonesia	<ol style="list-style-type: none"> 1. Source of pride (men) 2. Safe to go any time (women) 3. Offers privacy (women) 4. No need to worry about children (women) 5. No need to queue for public toilets or get up early 6. Clean and comfortable, no flies 	<ol style="list-style-type: none"> 1. High cost of latrine 2. No space in or near house 3. Never been offered latrine 4. Not thought about it
Lao PDR	<ol style="list-style-type: none"> 1. Provided support by project 2. Clean, no smell 3. Convenient 4. Easy to install and use 	<ol style="list-style-type: none"> 1. High cost of latrine 2. Never offered a toilet 3. Not enough water for pit
Philippines	<ol style="list-style-type: none"> 1. Could not tolerate smell 2. Toilet was donated, came with house or respondent grew up with toilets 3. Embarrassment being seen 4. Pollution 5. Health problems 	<ol style="list-style-type: none"> 1. High cost of latrine 2. Lack of space or do not own land 3. Never been offered toilet 4. Toilet ruined by flood
Vietnam	<ol style="list-style-type: none"> 1. Saves time and is convenient 2. Cleanliness 3. Comfort 4. Safe, especially at night (women) 5. Everyone now has a toilet, and saw the benefit of neighbors' toilets 6. Gives greater independence 7. Shy to practice open defecation 8. Visitors can be offered the toilet 	<ol style="list-style-type: none"> 1. High cost of latrine 2. Never been offered toilet 3. Lack of space in or near house 4. Not enough water for flushing 5. Habit not to have toilet, and do not care about toilet 6. Have use of someone else's toilet
Yunnan	<ol style="list-style-type: none"> 1. Privacy, not being disturbed 2. Convenient (especially during rainy periods) and proximity 3. Clean, sanitary 4. Comfortable 5. Water and environmental protection 6. Safety, avoid snakes and pests 7. Civilized 8. Use of toilet room for shower 	<ol style="list-style-type: none"> 1. No space 2. High cost of latrine 3. Never considered having a latrine 4. Limited by location and city planning 5. Toilet has not been provided 6. Have public toilet to use 7. Do not own property 8. Toilet not considered necessary

The intangible aspects of sanitation – decisions around sanitation choices and the act of toilet going – were assessed with respect to two key questions covered in the focus group discussions. First, why should a household own a toilet or latrine? Specifically, what do respondents appreciate about having an improved toilet facility at their home?

Second, why have those households without sanitation not yet made the decision to invest in their own toilet facility? Specifically, what factors or constraints prevent a household from getting a toilet, whether of a financial or cultural nature? Table 2 presents the top ranked factors for households with and without sanitation, in order of

importance. Gender differences in sanitation preferences are also indicated.

Many of the same reasons why households have toilets recur across the countries, but often in a different order of importance. Time saving and convenience were ranked among the top responses in four countries, but as a lower-ranked response in Indonesia, and in the Philippines it was not ranked. Convenience also includes not having to get up early, not having to leave children unattended, and not having to leave the household plot in the rain. The safety aspect is considered important in five countries, especially for women and at night-time. Linked to this is the privacy aspect (including shyness and embarrassment), ranked as a key consideration to have a toilet in four of the six countries. Health, hygiene, and sanitary conditions were mentioned directly, or more indirectly (e.g. reduces number of flies), in all six countries. The aesthetic aspects were also mentioned (pollution, no smell, environmental protection) in most countries. Having a toilet also gives some households a sense of pride, including being able to offer visitors a place to use the toilet.

The most commonly cited reason why households did not have a toilet was the high cost of a latrine. This finding is confirmed by the relatively high cost of even pit latrines as a proportion of the local wages. For example, the full investment costs of an improved dry pit latrine, as a proportion of the average GDP per capita (which is a lower limit on the average wage in a country) was 21% in Cambodia, 4% in Indonesia, 2% in Lao PDR and in the Philippines, 11% in Vietnam and 7% in China. These percentages approximate the proportion of a household's income that would need to be spent on a dry pit latrine, if that household earned the same income as the GDP per capita. These percentages are in fact a lower limit for the lowest income groups, which are most likely to have a total household (cash) income below the GDP per capita, especially in rural areas. On the other hand, these costs reflect the full investment costs and not what households themselves spent on the options. Subsidies in some sites did reduce the cost to the household. In some settings, especially communities implementing community-led total sanitation (CLTS) in Cambodia and Indonesia, a considerable cost was non-financial in nature (e.g. own labor input) which makes a latrine more affordable.

Examining the non-financial barriers to owning a toilet, the lack of land for building a pit latrine or lack space in dwelling for a toilet room were cited as important reasons, especially in urban areas. Other context-specific constraints include lack of water for flushing, and the risk of flooding due to low-lying land. For families renting their dwelling, it was stated that there was little incentive to invest in a toilet in a dwelling owned by someone else. Some respondents did not feel the need to have their own toilet as they use someone else's facility or they use a public facility. Other cited reasons include lack of interest in having a toilet ('never thought about it'), the fact that they are not habituated with latrines, or they do not want to use a latrine because they are content with their traditional practice. Some respondents had had a bad experience with smelly latrines. The 'recipient' mentality is echoed in all countries – many respondents stated that they do not have a toilet because they have never been offered one.

Further building on the reasons to invest in an improved toilet facility, information gathered from the household survey interviews indicates that a significant proportion of households felt in danger while going to the toilet in the open (at least 24%) or have worried about the safety of their children (at least 31%). It is clear that the majority of households are concerned about the dangers of open defecation. A smaller proportion of respondents had heard about animal attacks while practicing open defecation (at least 13%).

DISCUSSION

The key finding from this study covering six countries in Southeast and East Asia is that sanitation is a highly profitable social investment. The significant amount of evidence collected indicates that sanitation spending brings high rates of economic return when selected benefits are converted to monetary values. In five out of six countries, BCRs were at least 5 in rural areas and at least 3 in urban areas. The lower average ratios in urban areas is largely due to higher unit costs of sanitation interventions, but also slightly lower absolute health gains due to lower starting disease or mortality rates. Inclusion and valuation of

sanitation benefits was conservative throughout the analysis, while other benefits were omitted altogether from the BCRs, in particular the social and broader environmental impacts such as those on water resources. Hence, BCRs presented reflect the lower bound of likely economic returns.

There are two main implications of the research that decision makers need to consider. The first implication relates to the financing of sanitation, while the second relates to the loss in efficiency experienced when taking into account observed sanitation utilization rates.

It becomes apparent from sectoral analyses that current spending on sanitation is insufficient to provide universal coverage in the medium-term, for example the next 5 years. Therefore, further funds need to be allocated to sanitation. Funds from governments, donors and households can be sourced either by giving sanitation greater priority over other programs – hence increasing overall efficiency of spending – or funds can be raised by taking loans to pay for sanitation investments. A further source of funds is from private stakeholders (either financiers or providers) who need to recognize that sanitation offers significant – but as yet largely unexploited – business opportunities.

In order to attract more resources to sanitation, financiers need to be confident that the funds will be put to good use. Hence, a first step is to draw up sanitation plans, detailing the costs of achieving sanitation scale-up and the expected realistic financing sources. Decisions about how to invest in sanitation need to be made based on evidence of the comparative returns on different options, such as those presented here. A dialogue needs to be started with a range of financiers including non-traditional financiers of sanitation programs, such as ministries of tourism and agriculture, private sector investment funds and corporate social responsibility (CSR) programs of the private sector.

The example of Indonesia shows that important advocacy can be provided by local government leaders, such as regents and mayors. An alliance of districts and cities has been formed which includes sanitation as one of their development mainstreams. Since 2010, the Central Government has been implementing the ‘Acceleration of Residential Sanitation Development Program’ (Program Percepatan Pembangunan Sanitasi Permukiman, known as the PPSP). The program provides technical assistance to local governments to prepare

their medium-term sanitation development strategic planning, which serves as a precondition for funding from the central government and sanitation donors.

The second key implication of the study is that the results of economic analysis should be considered when designing and implementing sanitation policies and programs. Higher efficiency was observed in larger households, especially those with more children – thus making these households a priority for public programs. On the other hand, a decline in efficiency was observed in all project sites due to either non-adoption by the household of the technology on offer, or else a gradual decline in performance over time due to disrepair or unsustainable behavior. While these observations do not come as a surprise, the scale of the impact on efficiency is sufficient for policy makers to take note.

Low initial uptake has several interlinked causes. First and foremost, the unaffordability of the offered sanitation options is a key reason why households decide to remain without improved sanitation. In the urban site of Cambodia, households chose not to pay the connection fee to the sewerage because there was no legal obligation and they did not see the benefit to themselves of doing so. This led to very low capacity utilization of the sewerage network and the wastewater treatment plant, hence increasing the cost per household served to five times what it would have been if operating at its design capacity. Households may not adopt sanitation because they are not sufficiently aware of the negative impacts of poor sanitation, or there is insufficient social mobilization for them to change their behavior.

A decline in efficiency over time was observed, which was found to be caused by households not sustaining improved behaviors either because of force of habit and lack of conviction, or because the technology itself had stopped functioning. In Cambodia, the CLTS approach had a high initial uptake with most households building their own latrines, but it was not sustained over time because the pit latrines collapsed or they quickly became too filthy and unhygienic to use. In Indonesia and Lao PDR, some population groups did not sustain behavior change for long because they were content with the traditional practice of open defecation. Furthermore, in rural areas, people who work in the fields are unlikely to travel back to their home to access their sanitation facility.

In some sites, lack of consultation and supply of inappropriate technologies was responsible for non-sustained use of sanitation systems. For example, in the Philippines, 7% of households in one site (Bayawan) with a sewerage system answered that they have insufficient household water supply for flushing their toilet; and over 50% of households in the same site said that they were not offered any other sanitation options. Across all sites in the Philippines, 20% of households answered that they experience regular pit flooding, hence making it unusable for certain periods of the year. For these reasons, many unimproved sanitation practices were found to exist, even in sites with sanitation projects. In particular, a high proportion of households saw children regularly defecating in the open, thus exposing a public perception that children do not need to conform to the sanitation behavior of adults. Also, urination in open areas and public spaces was still particularly prevalent for men, in both rural and urban areas.

RECOMMENDATIONS

Five recommendations are proposed based on the findings of this multi-country study on the health and economic returns of improved sanitation. First, sanitation should be promoted as a central development priority. The evidence generated in this study demonstrates the importance of improved sanitation for a number of development outcomes and provides arguments to be made in a variety of forms and to a variety of audiences. While the responsibility for sanitation policies and programs may fall on one or two government ministries, improving sanitation is in the interest of all. Line ministries or government departments that need to buy into sanitation, in particular, are those responsible for education (both schools and higher education establishments), health, workplaces, water resources management and regulation, municipal services, rural development and tourism.

Second, evidence-based decision-making should be promoted, specifically drawing on economic analyses as well as other key decision factors (such as budget or resources available, health impacts and cost recovery options). Until now, very few previous decisions on sanitation spending in the six countries have been made based on an explicit comparison of the costs and benefits of the alternative technology options.

Decisions are largely cost-based – i.e. what can be afforded with a budget. However, this study has clearly demonstrated that there is significant economic value – and to a lesser extent, financial value – in delivering improved sanitation services and that efficiency varies considerably between the options. Alternative means of recovering sanitation costs need to be explored to make the delivery of these demanded services a practical reality. To make this happen, decision makers need to be better versed in economic and financial analysis, the evidence needs to be made more available, and decision makers across different departments or jurisdictions should work together to solve common problems.

Third, financial innovations are needed to promote a sustainable market-based supply of sanitation services, including mechanisms to reach the most needy. The study identified that the upfront costs of sanitation hardware constitute an important share of the annual income of the unserved population, who tend to be in the lower income groups. Hence, few households are able to pay upfront the full cost of a facility. On the other hand, households are usually able and willing to make smaller but more regular payments. These households will be successfully reached with an appropriate combination of smart subsidies, loans and lower cost sanitation options. The CLTS movement largely relies on the third of these, while other demand-led approaches also include a subsidy element to encourage households to invest themselves. However, micro-finance and bank or government loans for sanitation are still not common.

Fourth, to capture the full benefits of sanitation programs, further attention is needed to improve program design and implementation. This study showed that there is a significant drop in efficiency and benefits actually received by households and the communities, because the wrong technology is chosen, solutions are delivered inappropriately and individual and community practices are not sustained. Hence, sanitation programs need to be more people-centered: in other words, they need to be demand driven and involve everyone, not just traditional social structures. Public decision makers and private suppliers should make available different sanitation options, so that individuals and communities can weigh up the costs and benefits themselves, and they can be supported in this decision making process.

Fifth, the evidence base needs to be built to support evidence-based decision-making. 'Evidence' needs to be understood in its broadest form; it includes not only focused research but also improved (and where possible, standardized) monitoring and evaluation of sanitation programs and routine information systems. Where funds are available, impact evaluations of projects or programs are highly valuable for understanding the actual impact and determinants of impact, in real-life conditions – and are hence key for identifying factors of success and reasons for failure or sub-optimal performance. Further economic research is needed on the value of time, the value of life, business opportunities (e.g. value-chain assessments, willingness to pay surveys), and the welfare value of hard-to-monetize impacts.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

GH designed the study, recruited the country teams, guided the country studies, compiled and analyzed the data, and drafted and finalized the manuscript. PR, KP, ASW, VAN, and LC lead their respective country teams, fine-tuned the study design, implemented and guided the research, and drafted the country reports. IB and ALW guided the study, recruited the study team and provided overall management. All authors read and approved the final manuscript.

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DISCLAIMER

The findings, interpretations, and conclusions expressed herein are entirely those of the authors and should not be attributed to the organizations they represent.

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