sustainable sanitation alliance

SuSanA factsheet

Financial and economic analysis

April 2012

1 Summary

This factsheet introduces financial and economic costs and benefits in relation to sanitation systems. It provides an overview of analytical approaches for comparing sanitation interventions using financial and economic analyses and illustrates these using results from various studies. The target group of this factsheet includes sanitation practitioners, researchers, policy makers and their advisers. The main focus is to provide a basis for informed choice based on financial decisions concerning the scaling up of sanitation services.

Financial and economic analyses are a crucial part of feasibility studies assessing the benefits of improved sanitation and thus feed into policy decisions, sanitation programming and project design. The data generated by financial and economic analyses have major implications for the programming and design of sanitation projects, and are therefore crucial for the planning and delivery of affordable and sustainable sanitation services.

In order to assess the relative sustainability of sanitation options, a range if comparative studies need to be conducted to show the real costs and benefits of moving from unimproved to improved and more sustainable sanitation options.

A comparison of costs and benefits of different sanitation options using economic and financial analyses provides a justification for investments in sanitation in the first instance and enables decision makers to allocate limited resources more efficiently. Financial analyses only measure the costs and benefits that have direct and measurable financial implications, whereas economic analyses include all broader costs and benefits, including those that do not have financial implications. For instance the costs for premature mortality are economic rather than financial.

Capital expenditure (CAPEX), operational expenditure (OPEX) and capital maintenance expenditure (CapManEx) are the key parameters for both the financial and economic assessment of sanitation options. Important tools for financial and economic analysis include the cost-effectiveness ratio, Benefit-Cost Ratio (BCR), Net Present Value (NPV), or Internal Rate of Return (IRR). Key indicators for setting tariff structures and the assurance of affordability include: i) Full cost of sanitation per capita as a percentage of per capita GDP, ii) Cost of access to sanitation as a percentage of household income, iii) Annual cost of sanitation as a percentage of household income, iv) Long run marginal cost and cost of sanitation services as a percentage of water tariffs. Economic analysis can also be used to assess the cost benefit of investments in sanitation in relation to other types of development interventions.

2 Background

Financial investment costs are often stated as one of the major barriers to increasing sanitation coverage – next to the lack of political will. Therefore, it is important to know what cash sum is affordable for the beneficiaries (households, communities, schools) and which share has to be financed either by the government, through grants (subsidies), loans from banks, or in-kind contributions (Mehta, 2005).

Although improvements in sanitation are known to result in large economic benefit for society as a whole, the priorities of those who are responsible for investment, whether at the household, municipal or national government level, tend to set investment priorities differently, based on financial constraints and self-interest.

Figure 1: Excavations for a biogas digester in Livingstone, Zambia at a project of the Devolution Trust Fund (DTF) (source: P. Feiereisen, 2011)

Financial and economic analyses are key policy tools, which provide practical guidance on sanitation options, and can be used alongside other decision making frameworks such as multi-criteria analyses. These analyses enable assessment of intervention efficiency for different sanitation options and assist decision makers in maximising the return on limited financial resources available to sanitation programmes. Outputs of economic analysis can show the overall costs and benefits of improved sanitation compared to no or unimproved sanitation.

Financial and economic evaluation seek to provide further insight into the relative cost efficiency of different options –

not just one or two standard options, but the locally adapted range of feasible options – as a basis for an informed choice. The inclusion of all feasible options is of key importance to the process of informing decision makers and planners of the potential range of sanitation options in a single context.

Hence, financial and economic analyses need to provide the decision maker with specific information that helps to judge the real costs and sustainability of different technologies. This means not just knowing the purchase price or capital costs but also operation and maintenance (O&M) costs, and the associated additional (direct or indirect) benefits to the user such as health, comfort and protection of the local environment.

An assessment of the benefits of improved sanitation may be applied to the following activities:

a) Policy decisions

Results from an economic analysis can play an important role in influencing political decisions about the need to invest in improving sanitation (cost benefit analysis). Analyses of economic benefits can support sanitation advocacy efforts, with the aim of increasing political support and potentially household and community knowledge, leading to greater prioritisation of sanitation and hygiene.

Figure 2: Uschi Eid (UNSAGB) giving a speech on the importance of sanitation in the plenary session of the Second Africa Water Week in South Africa (source: A. Panesar, 2009).

b) Sanitation programming

Economic analysis may also be required to justify the rationale for a project or programme in the first instance. On the basis that there is economic justification, financial analysis is used to compare long term costs of different alternative solutions (cost effectiveness) taking into account capital investment (CAPEX), operational and maintenance expenditures (OPEX) and capital maintenance expenditures (CapManEx).

c) Project design

Sound financial analysis is fundamental for good project design. To be able to appropriately cost a project within a given budget, engineers need to base estimates on accurate unit costs and have a clear understanding of the uncertainties surrounding data sets.

Clearly, financial and economic evidence has value for a range of target groups – groups that have different roles and levels of influence in decisions on choice of sanitation technology or programme implementation:

- *For those controlling budgets* for allocation to sanitation programmes the primary concern is for overall programme efficiency; including household, community and external benefits of improved sanitation. Also important to policy makers are the overall financing needs for different programme components and the different sources from which to finance these programmes.
- *For implementing agencies* concern will be not only the overall gains, but also the equitable distribution of the programme gains, and targeting of subsidies to poor and vulnerable groups.
- *For the ultimate beneficiaries* – the households – the interest will be on private benefits and the investment and running costs that must be covered by the household.

3 Financial analysis: elements and indicators

Financial analysis focuses on expenditures and revenue streams and considers subsets of data that are identifiable as financial transactions. Financial assessment of sanitation options considers capital expenditure (CAPEX), operational expenditure (OPEX) and capital maintenance expenditure (CapManEx).

To ensure sustainability, investors of sanitation systems such as utilities or local authorities need to consider the recurring costs for the operation and maintenance to ensure sustainability and not only the initial investment costs. In addition, there is a need to take into consideration service charges and other sources of revenue such as from the sale of by-products (e.g. treated wastewater for irrigation, compost or digested sludge, or electricity derived from biogas).The capital cost of different sanitation options is a very important variable for the decision whether to invest or not, and for the choice of technology. Households, in particular poor ones, are highly sensitive to price in their purchase decisions, especially for sanitation which is not usually a priority item.

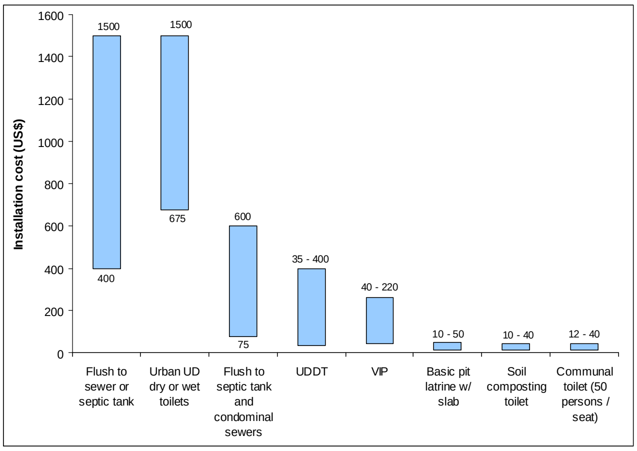

Figure 3: Example capital cost range for different sanitation options, per unit (source: Rosemarin et al., 2005). Note that most of these options do not cover the whole sanitation chain.

As shown in Figure 3, capital costs vary between different sanitation options, the project scale and even within one technology type **CAPEX** includes both hardware for household and shared toilet facilities as well as costs for waste collection, transport and treatment facilities. CAPEX also includes labour and management overheads for planning, construction and works supervision.

OPEX costs are those that are required to sustain the operation and maintenance of a system or facility. These include day to day costs such as labour, fuel, cleaning materials, and costs for repairs OPEX costs include for example pit or vault emptying, a fee for the treatment costs of faecal sludge and for software components.

Software components targeting community acceptance and behaviour change are essential for the uptake, compliance and long-term sustainability of all sanitation systems. Therefore, costs for sanitation promotion and advocacy are important costs that also need to be included in the analysis. Costs of "software" include sanitation promotion and demand creation (e.g. social marketing), awareness and educational campaigns to promote improved hygiene and system use, and capacity development of stakeholders (such as training of artisans, operators and sanitation suppliers). These costs should be planned and fully budgeted for implementation of programmes on a larger scale; these costs should also be considered in the project design and in the OPEX.

CapManEx[1] are costs that cover all expenditures to reduce the chances of asset failure and ensure the same level of service delivery as existed after construction. This includes the renewing, replacement, rehabilitation or refurbishing of broken system such as replacement of pumps.

The decision about which data to include in the financial analysis depends upon the boundary for the analysis which will be determined by the purpose of the analysis and the target group (see above). The most important boundary is between the private and public domains, which defines the costs and benefits to be allocated to the household and those to be allocated to the project respectively. The project expenses include costs that are not incurred by households directly but are incurred by agencies or institutions responsible for promoting and implementing sanitation projects and programmes.

Given the range of sanitation stakeholders, there may exist different interpretations of the word "cost" and the forms of cost presentation. Households are naturally interested in the costs of a single sanitation option as it relates to their particular household, including only the components they actually have to pay for. Therefore, a disaggregation of household and third party costs is useful to be able to account for these different perspectives:

- *Households* - at the time of investment (e.g. connection fee, toilet investment) and during operation (e.g. wastewater levy, cost of sludge removal); and
- *Third parties* - in the form of investment subsidies or recurrent subsidies sourced from donor funds, state budget or cross subsidies such as from water tariffs.

From a household perspective, the main consideration is the expenditure related to sanitation facilities. Household expenditures or costs may be subsidised with external financing in order to reduce the cost to the household. These subsidies are included as part of the total financial analysis, and are expressed as a project cost.

Figure 4: Hygiene promotion activities for Filipino children during Global Handwashing Day in 2008 (source: R. Gensch, 2008).

Financial costs to households can be reduced by encouraging in-kind contributions from household members, and hence not only increasing participation (which is likely to increase the use of and make it easier for the household to maintain and repair their sanitation facility) but also reducing the requirement for cash funds. Households, especially in rural areas, have access to materials such as sand, stone, wood or plant materials for latrine construction. Experience has shown that people are willing to contribute their time and effort as a substitute to local workmen who must be paid in cash[2]. Also, for toilets with reuse options, or simple pit emptying, there will be costs for the work involved, transportation and storage, whether covered through cash payments or in-kind contributions.

It is important to note that increasing the level of investment does not necessarily lead to increased level of service. The service delivery approach tries to shift the focus from the service delivery of physical hardware to the service itself and to differentiate between the different types of service. The IRC WASHCost project assumes that a cost-benefit decision can only be made relating to the level of service delivery (Moriarty et al. 2010).

The following indicators are relatively simple and can provide decision makers with information to support decisions about tariffs and affordability:

i) Full cost of sanitation per capita as a percentage of per capita GDP (gross domestic product): To allow for a

[1] See: IRC Briefing Note 1b: www.washcost.info/page/866. Further information on life-cycle cost approach on IRC WASHCost working papers: www.washcost.info/page/1293

[2] See for example SuSanA case study on UDDTS in rural Kenya: www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=129

comparison between different projects or different options within one region.

ii) *Cost of access to or annual cost of sanitation as a percentage of household income:* If households are expected to make a significant up-front contribution without access to a credit mechanism, this single payment might constitute a serious barrier. This can be expressed as per capita access cost as a percentage of the per capita household income. However, average data such as household income should be treated with caution due the large income differences between poor and rich households.

iii) *Long run marginal costs (LRMC):* The cost for one additional unit with the best resource allocation. It is calculated in relation to per capita and year to compare different regions with different household income.

iv) *Cost of sanitation services as a percentage of water tariffs:* decision makers often *prefer the cost of sanitation* related to water sales. This allows correlating full costs to current sanitation tariffs.

Table 1 shows some examples for these cost indicators and illustrates considerable differences in the share of operation and maintenance costs as part of total costs, ranging from 0% in an Indian example of pour flush latrines to 42% in the case of a biological treatment plant in Turkey. Table 1 also shows total costs of sanitation options as a percentage of gross domestic product (GDP) per capita, and household costs as percent of income for some examples. However, the comparability of these examples is quite low as some options include wastewater conveyance and treatment while others do not.

Table 1: Total costs, average household costs and operation and maintenance (O&M) cost as a percentage of total costs, and software as a percentage of investment expenditure for some sanitation examples worldwide – just to give a rough indication of a possible cost analysis and ranges of figures.

Location and type of sanitation	Inhabitants served	Total LRMC[a] as % of GDP[b]	Annual costs of sanitation as % of household income	O&M[c] as % of full cost	Software cost as % of total investment	Source
Kuje, Nigeria Combined sewage and offline treatment	582 (rural)	1.14%	1.82%	N/A	N/A	Illesanmi (2006)
Berlin, Germany Conventional gravity based systems, wastewater treatment plant	4,891 (peri-urban)	0.86%	0.84%	15%	N/A	Oldenburg (2007)
Conventional gravity based systems, one stream, sequencing batch reactor (SBR)	4,891 (peri-urban)	0.64%	0.63%	10%		
Urine separation/storage, brownwater vacuum system and biogas reactor, greywater treatment SBR	4,891 (peri-urban)	0.69%	0.68%	5%	N/A	
Rajasthan, India Pour-flush and bathroom, on-site (mostly deep soak pit); no pit emptying included	1,050,000 (rural)	0.5%	N/A	(no cash)	11%	KfW (2008a)
Bahia, Brazil Mixed systems (ponds, anaerobic Imhoff tanks and gravel sand filters)	34,000 (rural)	0.6%	0.1 – 0.2%	27%	21%	KfW (2008b)
Haikou, China Centralised system, reuse of energy and nutrients (parts of the sewer already existed)	850,000 (urban)	0.7%	0.4%	31%	2.4%	KfW (2008c)
Fethiye, Turkey Mechanical-biological treatment, nutrient removal, disinfection	65,000 (urban + tourists)	0.7%	N/A	42%	5%	KfW (2008d)

[a] LRMC: Long run marginal costs; [b] GDP: Gross domestic product; [c] O&M: operation & maintenance

4 Economic analysis: elements and indicators

Economic analysis includes the financial costing as the core of the analysis and additionally takes a broader perspective, encompassing social and environmental costs and benefits that can be ascribed with a monetary value. Therefore input data will include not only the financial cash flows but also in-kind or external costs and benefits.

Economic benefits include those related to:

- Health benefits such as avoided deaths and avoided morbidity;
- Economies of time saved seeking sanitation facilities or waiting to use these facilities as well as fewer sick days which results in greater productivity
- Environmental benefits such as reduced water pollution
- Reuse of human excreta - fertiliser, biogas etc.
- Wider benefits for the economy related to increased attractiveness for tourism and the business community.

There are also other benefits such as perceived improvement of living quality through attainment of privacy, dignity, convenience and status, however these are difficult to quantify in economic terms.

Thus, economic analysis includes all costs and benefits of households – including the monetary value of in-kind contributions of materials and labour. The most common approach for "shadow price" valuation of own labour is the price of local non-qualified labour. Economic analysis also reflects the full opportunity cost of resources employed. This refers to the economic opportunity lost from using cash, in-kind labour and materials in sanitation that could be employed for another productive use.

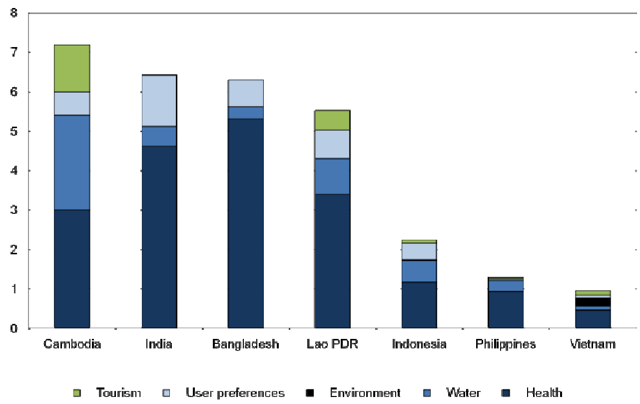

Figure 5: Economic losses resulting from poor sanitation and hygiene in seven countries of Southeast Asia, as a percentage of annual GDP (source: WSP, see Footnote 3).

Where reliable data are available, these economic benefits can be quantified and converted to monetary units to be included in full economic evaluation. A study conducted by WSP in South East Asia in 2007 found that poor sanitation and hygiene led to annual economic losses in the order of 1% (Philippines, Vietnam), 2.3% (Indonesia), 5.5% (Lao PDR) and as high as 7% (Cambodia) of GDP (Hutton et al., 2008).

A recent study by WSP found that eighteen African countries lose around USD 5.5 billion every year due to poor sanitation, with annual economic losses between 1% and 2.5% of GDP[3].

5 Economic benefits of resource-orientated sanitation

Different types of sanitation provide different levels of economic benefit in terms of mitigation of pollution impacts and environmental protection. Further financial or economic gains can be achieved with resource-oriented sanitation systems: reuse of treated wastewater, human excreta fertiliser and biogas. Human excreta (also in the form of sludge from central treatment plants) can be used as fertiliser and soil conditioner after composting. A detailed analysis of three ecological sanitation (ecosan) projects has been carried out by Schuen et al. (2008).

By reusing excreta, households can generate monetary benefits and increased crop production can have a positive impact on them financially. Evidently, poorer households seek to gain more in proportion to their household income (Schuen et al. 2008). The use of human excreta as fertiliser is especially relevant in land-locked countries where the cost of imported fertiliser is significantly higher. Given the increasing scarcity (and price) of phosphorus, the monetary reuse value of human excreta also increases (Gensch et al., 2012).

The value of excreta products which are produced and used on the person's own property can be estimated by comparing the value of the included nutrients at the shadow prices for synthetic fertiliser including transport costs minus the value of the additional personal labour required. If the nutrients are transferred to somebody else's farm, the effective payment (price) of the transaction can be included in the financial analysis.

In addition, biogas generation in sludge digesters of larger wastewater treatment plants and household or community biogas digesters produce biogas as well as fertiliser. A household biogas digester mainly relies on organic waste from animals, because human excreta can cover only 15-30% of a household's energy need for cooking (depending on climate and cooking habits). Similar to nutrient reuse, biogas for cooking can be valued at market prices of firewood or other locally used fuels for cooking. If faeces are converted to compost, the local price of compost can be used for economic estimates.

Other economic gains or cost savings which can be calculated:

- *Water savings* can be valued at the cost of provision of additional drinking water.
- *Treated wastewater or greywater* may be reused for irrigation or aquifer recharge. The market price for irrigation water from other sources can be used to value the benefit of reusing treated wastewater. The calculation

[3] See WSP Africa: Economics of Sanitation Initiative (2012) for more information: www.wsp.org/wsp/content/africa-economic-impacts-sanitation

would include the effective payment (market price) for water minus cost of transfer[4].

- *Households* who reuse their waste do not need to pay for pit emptying services or build a new pit when the old one is full.

Many of the argued (or predicted) benefits of reuse oriented sanitation are heavily related to context-specific programme conditions. For instance, the extent of the benefit will be closely related to the degree of community acceptance of excreta reuse, hygiene behaviour change and other factors that determine successful adoption of technologies.

Figure 6: A stove in a school kitchen running on biogas produced from human excreta in Rilima, Rwanda (source: P. Feiereisen, 2011). More photos on this school: www.flickr.com/photos/gtzecosan/sets/72157627230220319/with/6008002835/.

6 Tools for financial and economic analysis

Whole life-cycle analysis involves a long term perspective which takes into account all costs incurred and benefits received over the total duration of the planned project (including operation as well as construction), which is known as the planning horizon. Depending on the type of asset, the quality of construction and the chosen planning horizon, the design life for individual components of the sanitation system may be greater than or smaller than the planning horizon.

A concept similar to the accounting term of asset "depreciation" encourages long-term thinking and investment in technologies that are financially sustainable. For a comparison beyond specific requirements of programme implementers or national governments, some basic tools and ratios are helpful for comparing sanitation interventions with respect to monetary as well as non-monetary outcomes, and from several perspectives.

Costs can be annualised to aid judgments about affordability. Costs expressed in local currency and in real prices of the base year of the study (i.e. without inflation) are most appropriate for financial analyses where the results are to be used to support national or sub-national level decision-making. The discount rate used should reflect the opportunity costs of capital in a given national economy. If there is no accepted national discount rate, economists frequently use a discount rate of 5%.

While providing the results of financial and economic analyses to potential users, measures such as the cost-effectiveness ratio, Benefit-Cost Ratio (BCR), Net Present Value (NPV), or Internal Rate of Return (IRR) can be utilised. In each case, the tools are essentially the same for financial and economic analyses; but the input data will of course vary. Only larger programmes will justify research and full cost-benefit analysis. In these cases, the *ratio of total benefits divided by total costs* or the *internal rate of return* can provide additional information for policies and decisions.

a) Cost-effectiveness ratio

The cost-effectiveness ratio is a more specific tool that compares costs with a single outcome of sanitation improvement, expressed in physical (non-monetary) units such as inhabitants better served, health gain or reduction in pollution. It is generally used in public sector planning.

b) Benefit-Cost Ratio (BCR)

The benefit-cost ratio (BCR) is calculated by dividing the discounted benefits by the discounted costs of the sanitation intervention.[5] This indicator can be used to compare different sanitation improvement options and to compare a sanitation option with 'doing-nothing'. Two types of studies reporting BCRs can be distinguished: (i) those reporting the costs and benefits generally associated with improved sanitation on a regional or national level ('macro' studies); and (ii) those comparing the costs and benefits of alternative sanitation options in a single context on the household level('micro' studies).

c) Net Present Value (NPV)

Long-term outcomes of sanitation interventions can be measured either in monetary terms in cost-benefit analysis (CBA) or cost-effectiveness analysis (CEA). This is used to assess financial costs over a period of time and is particularly relevant where sanitation projects achieve similar or identical outcomes. The narrower CEA can be used if valuation of benefits is difficult; while CBA is a broader method that combines multiple impacts of improved sanitation in a single framework expressed in monetary units.

For both CEA and CBA, the NPV is a common parameter for comparing sanitation technologies, which can be expressed in financial and economic terms. The calculation of these two values is similar, but the input data and costing factors are different in each case.

The combined investment and recurrent costs are expressed as a NPV over the useful lifetime of major investment components, and can be subtracted from the NPV of

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[4] Until now the cost saving that can be achieved with treated wastewater is still however close to zero in most countries, but the concept might have importance in the future.

[5] The discount is the difference between the present amount and the amount in the future. The discount rate is usually given at 5% per year.

financial benefits to estimate the financial net present value (FNPV). The economic analysis of selected factors (e.g. reuse of nutrients and energy) can use the long run household costs and benefits per person served per year, as a percentage of local or regional per capita household income to calculate the costs and benefits as a percentage of household income.

d) Internal Rate of Return

The ratio of the financial benefits to the costs is termed the financial internal rate of return (FIRR). This measure takes into account investment and recurrent costs and provides a measure of the annual equivalent return on investment in percentage terms, taking into account monetary cash-flows over the life span of the investment. It allows comparison between the efficiency of the intervention with other potential uses of funds.

Economic internal rates of return (EIRR) tend to be significantly higher than financial ones because it also includes non-monetary costs and benefits (health, environmental and reuse benefits of sustainable sanitation options) over the lifetime of the sanitation improvement. For example, a study of three African countries on integrated household biogas and sanitation showed a financial IRR of around 10% compared to an economic IRR of over 70% (Renwick et al., 2007).

7 Limitations of these analyses

Economic analysis requires the valuation of economic costs and benefits and is limited to the availability of reliable data. The large diversity of measures and settings make it hard to compare the results from studies in different locations. There is therefore a need for greater awareness of the analytical methods and indicators by researchers and practitioners and the application of standardised methodologies for data collection and analysis.

Many projects promoting excreta reuse as fertiliser or soil conditioner and biogas production involve use of the products by the same households or the institutions, such as a school or a prison, which has produced the excreta in the first place. But so far, little data exists to suggest the actual financial or economic value of these products. In the absence of in-depth research, a careful use of shadow prices is most appropriate to reflect the upper limit of economic value (i.e. equivalent fertiliser).

Available estimates of economic benefit of excreta reuse in the literature are challenging as they are largely based on hypothetical returns using expected excreta production, quality and prevailing market prices, as opposed to actual household economic impacts (Rockström et al., 2005; Oldenburg, 2007; Renwick et al., 2007). Established markets for trade in human excreta are not yet documented, and it is not clear whether the same nutrient or fuel volume/weight would receive the same prices as, say, synthetic fertiliser, conventionally produced compost or liquefied petroleum gas (LPG).
To date, although some data exists, there is still relatively limited published cost and economic evidence relating to different sanitation options, and all available evidence has not been systematically estimated and compiled[6]. Quantifying sanitation impacts and converting to monetary values to give accurate estimates of economic impact or benefit is a challenging task for various reasons:

- Firstly, improved sanitation is one of many ongoing development 'interventions' that affect socio-economic outcomes, such as health, education, agriculture and private sector development initiatives. Hence, robustly designed studies are needed which conduct data analyses adequately, accounting for a range of confounding variables.
- Secondly, the step of monetisation adds a further layer of uncertainty on the already uncertain physical/natural measurements of sanitation benefits. Prices can be highly variable, or markets may be imperfect thus distorting prices from the market equilibrium price level (which is the standard measure of welfare impact in economics).
- Additionally, prices may not exist at all, such as for some benefits of sanitation (e.g. comfort value, increased security for women or social impacts of improved sanitation) and thus need to be ascertained through proxy pricing or contingent valuation techniques. Hence, the analyst must compare the methods available, justify selection of a single method; and conduct sensitivity analysis to assess how uncertainty in price assumptions affects the overall benefit estimation.

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[6] See Hutton et al. (2008) for more details.

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