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Social cost–benefit analysis – principles

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The economic assessment of drinking-water interventions – especially small-scale interventions – is challenging because of the complexity of the information needed to assess all direct and indirect outcomes. Meeting these challenges requires the following steps to be taken:

- *Combine information on physical and socioeconomic systems*. Economic assessment of water and sanitation interventions is expected to cover changes in the physical environment (such as water contamination and environmental pollution) and changes in livelihoods. A systematic framework is needed to keep the analysis manageable.
- *Model causality and linking concepts and variables.* Both physical and human processes are complex in themselves, and even more complex in

combination. Economic assessment also bears responsibility for attributing causality, from the planned activities of a development agency to the impact on human and environmental well-being.

- *Identify observable and measurable indicators*. Logical frameworks have been invaluable for economic assessments in making sure that stakeholders agree on observable indicators (Akroyd, 1999).
- *Cope with data gaps and inaccuracy*. Identifying observable indicators does not guarantee they can be measured accurately. In addition, there may be gaps because baseline data may never have been collected and there may be ethical or political reasons for not identifying or observing control groups. Economic assessment frameworks need to provide explicit room for incorporating such concerns.
- *Weight indicators to form composite indices*. Evaluative comparisons also frequently require aggregating indicators into a single number index. This requires weighting of indicators, de facto a form of relative valuing or pricing.
- *Incorporate time to achieve sustainability goals and uncertainty about achieving the goals*. Sustainability is a keyword in wider development thinking as well as in economic assessment. Sustainability involves explicit consideration of long-term processes. Economic assessments clearly cannot be delayed indefinitely to assess impact and sustainability. Hence, assessment frameworks need to be able to incorporate long-term processes and the associated inevitable uncertainty.

The argument here is that an up-to-date social cost–benefit analysis can help meet all these challenges in appraising and evaluating drinking-water interventions.

SOCIAL COST-BENEFIT ANALYSIS – BACKGROUND

The technique of social cost–benefit analysis was originally developed in the 1960s in response to continuing demands on the State to build basic infrastructure. The technique was prompted by growing confidence in a mixed economy with associated widespread market prices, innovations in electronic data processing capacity, and shortage of investable savings and international purchasing power. In the late 1960s, Little & Mirrlees and UNIDO developed social cost–benefit analysis techniques that gave answers to a number of technical questions in pricing costs and benefits (Little & Mirrlees, 1974 – originally published in 1968). This gave economists the apparent power to make a comparative appraisal of any developmental activities against an international standard in terms of their net benefits to the global human condition. This framework included:

- chains linking any developmental activities to final outcomes;
- a numeraire (a common measure of value, e.g. South African rand at 2008 purchasing power), to give an international standard for comparison;
- relative valuation of activities in terms of socially appropriate shadow prices;
- valuation of time through discounting.

An appraisal or evaluation decision then could be made by ranking activities using net present values or benefit/cost ratios or internal rates of return. The framework also gave systematic insights into choice of techniques and the assignment of distributional weights (Mosley, 2001).

The basic social cost–benefit analysis model builds on standard commercial, financial cost–benefit analysis. Financial cost–benefit analysis is what a commercial enterprise would use to appraise or evaluate an investment activity. The model for financial cost–benefit analysis assumes that the enterprise accepts market prices (including interest on borrowing), pays the taxes it cannot avoid (or evade) and welcomes any subsidies. The model also assumes that if the enterprise can displace or externalize costs onto other economic agents (producers, consumers, government, neighbours, the human species), it will. The end result is simply financial profitability for the enterprise as a single institution. Neoclassical economists would claim that this is necessary and sufficient for appraising activities, and that free markets will deliver the best of all possible economic worlds as part of a wider neoliberal developmental agenda (Lipton, 1987).

But social cost–benefit analysis claims the right for an analyst to modify the prices used in the commercial accounts (Al-Tony & Lashine, 2000). This modification is claimed to be valid if and when competitive market forces are not operating as assumed by neoclassical economics or the distribution of wealth is not considered to be just. Criteria to evaluate markets using structure, conducts and performance analysis are presented in Box 11.1.

Social cost–benefit analysis claims to capture market "failures" such as:

- *Absent markets*. Many environmental goods do not have markets. They may be treated as common or pooled property, to which people have access through rights, or which people simply appropriate as they wish. Where assets are being depleted, such as non-recharging fossil water

Box 11.1 Evaluating markets using structure, conduct and performance analysis

What is a perfectly competitive market?

A perfectly competitive market needs:

- a well-specified good or service;
- independent demanders of the good or service, with well-defined tastes;
- independent suppliers of the good or service, with a well-defined technology;
- an institutional framework in which demanders and suppliers meet as well-informed equals to engage in voluntary contracts.

A perfectly competitive market theoretically results in:

- an equilibrium price;
- stability;
- efficiency;
- equity.

A system of perfectly competitive markets theoretically results in:

- general equilibrium and, perhaps, security;
- Pareto superiority and, perhaps, harmony.

supplies or water sources depleted at a faster rate than they can re-charge in drinking-water systems, then social cost–benefit analysis can give a price to that resource by valuing this non-sustainability in terms of future costs of supplying an alternative supply.

- *Externalities.* People's lives may be affected by activities in ways that do not enter into any commercial accounts. People may experience monetary or non-monetary costs and benefits as a result of such activities – air and water pollution are obvious examples.
- *Public goods.* An activity may allow people to get benefits without paying for them individually or preventing others from consuming (e.g. information on a poster at a communal tap giving health information on cleaning containers). People can "free-ride" once the poster is up, because the supplier cannot be sure how much benefit anyone is receiving individually.
- *Imperfect competition.* An imperfect market will allow some economic agents to use power to become price setters in their own interest. Monopoly producers can set prices above the social optimum, while

monopsonistic purchasers[1] can set prices below the social optimum. Control of a spring was used as an early example in economics of the effect of monopoly on pricing.

- *Civil society institutional conventions*. Social conventions may not permit the full operation of market forces. The buying and selling of some goods and services will not be allowed. For other goods and services, prices may only operate within a socially restricted range – common property or pooled rights over forest or water usually have such characteristics.
- *Government regulatory and fiscal actions*. Governments intervene to affect many markets through regulations, taxes and subsidies at regional, national and international levels. Varying taxes and subsidies on agricultural products has implications for imputed values of sanitation and water.

In social cost–benefit analysis, all these forms of market failure could justify modifying observed prices to so-called "shadow prices". A shadow price may be higher or lower than observed prices depending on the specific nature of the market failure. Social cost–benefit analysis involves establishing the value of an activity from the public perspective; at its most ambitious this is a global perspective.

Social cost–benefit analysis always involves judgements on accuracy of data, and the interpretation of data as shadow prices has to take into account the risks and uncertainty surrounding the future. Therefore, sensitivity tests are always needed. The need for sensitivity tests somewhat undermines the claim that social cost–benefit analysis ranks developmental activities on purely technical criteria. But social cost–benefit analysis (through sensitivity testing) does allow healthy deliberation over variables that may crucially influence project performance. The need for sensitivity tests was seen as a weakness in the 1970s and contributed to social cost–benefit analysis being perceived as "smuggling" political judgements into technical assessments. This explicit concern with data inaccuracy and conceptual interpretation is now seen as strength rather than a weakness.

Much of the original work on social cost–benefit analysis focused on government interventions affecting markets through regulations, taxes and subsidies at regional, national and international levels. But economic strategy over the past 30 years across the globe has substantially reduced governmental interventions, removed regulations and reduced variations in taxation and subsidy rates. Generally, confidence in open market forces was high among leading development funders (external support agencies) in the 1980s and the

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1 A monopsonist has market power, because he or she can affect the market price of the purchased good by varying the quantity bought.

influence of social cost–benefit analysis on resource allocation declined. From the early 1980s, neoclassical economics was predominant, claiming that market forces would work directly and indirectly to prevent economic and environmental crises. In the shorter term, markets would ration non-renewable and difficult to renew resources by price rises. In the longer term, profits-induced technological change would prevent environmental melt-down. But such reasoning did not engage with the realities of non-substitutability and irreversibility in many physical environmental processes.

Today, social cost–benefit analysis is being increasingly used as a technique for including environmental factors in projects (Pearce, 1993; Vanclay & Bronstein, 1995; Quah & Tan, 1999; Wattage et al., 2000; Crookes & de Wit, 2002). Most funding agencies wish to incorporate environmental concerns in sanitation and water conservation projects alongside socioeconomic factors. Social cost–benefit analysis can help achieve this aim.

Where a project is causing negative environmental effects, then there are techniques for making explicit calculations of the social costs of the damage:

- If the damage is reversible, then costs for reinstating the natural environment of the project to the pre-project condition should be included in the social cost–benefit analysis, even if this reinstatement is unlikely to occur.
- If the project generates waste or involves resettlement, then costs for the environmentally responsible (including responsibility for health) disposal of that waste or resettlement should be included in the social cost–benefit analysis.
- If the damage to landscape quality is irreversible, then costs of a compensating environmental improvement, not necessarily in the project area, should be included in the social cost–benefit analysis.

The precautionary principle states that if a project has great environmental uncertainties, then, given the complexity of eco-systems, the project should be postponed and only implemented if and when we possess sufficient knowledge of the eco-system to act with reasonable certainty that the environmental risk is acceptable. The precautionary principle is very risk averse, being concerned that unforeseen spread effects may cause disastrous damage. Recognizing that eco-systems are complex, the precautionary principle states that, if the environmental uncertainties are great, then a project should be postponed. As a corollary to the precautionary principle, a project can go ahead if and only if we possess sufficient knowledge of the eco-system to be reasonably certain that the project will not create unacceptable environmental damage. Social cost–benefit analysts may be in the front line of identifying the need to exercise the precautionary principle, because they must identify risks and uncertainties as part of the social cost–benefit analysis procedure.

High discount rates tend to work against environmental responsibility. For example, reinstatement costs at the end of a 20-year project discounted at 12% are worth only a tenth of what they would have been at the start of the project. A 40-year project reduces their value to a hundredth. But social cost–benefit analysts have a responsibility to build environmental costs into assessments, even if these costs may never be paid – the social cost–benefit analyst's task is to assess the full social benefits and costs of an activity, not to compromise with de facto implementation.

In the mid-1970s, many social cost–benefit analysts thought they could introduce distributional concerns into social cost–benefit analysis by identifying the costs and benefits associated with particular social groups and allocating them different weights. The weights were always a matter of judgement – and in that sense political. This was seen as a weakness at that time, and contributed to the side-lining of social cost–benefit analysis.

In the 1990s, governments were making political statements about the importance of reducing poverty and promoting gender equality. A social cost–benefit analysis could support this strategy by applying weights to costs and benefits accruing to women and people judged to be in poverty. It is now much more acceptable not to have technical closure in project decision-making, but rather to present decision-makers with a range of choices, including differing distributional weightings for groups of people with differing socioeconomic characteristics.

Conditions for a perfectly competitive market

Social cost–benefit analysis seeks in principle to value all goods and services as if they were traded in perfectly competitive markets – such market prices are seen as reflecting social valuations. A perfectly competitive market in economics is not directly observable. An important criterion for a perfectly competitive market is that interaction between demand and supply determines the price, not any specific producer or consumer. In other words, in a perfectly competitive market, everyone is a price-taker rather than a price-maker.

Putting monetized values on changes induced by an intervention requires judgements and some knowledge of economic analysis (beyond conventional financial accounting). The analysis involves estimating what markets would do if they were operating freely and universally in conditions approaching perfect competition, in other words if goods and services were being bought and sold until the point where price equates supply and demand, with no market imperfections.

The following conditions are likely to improve the competitiveness of a market:

- active information flows with widespread access;
- low costs of entry into and exit out of a market;
- flexible technology, in terms of variable scales of production, to produce goods and services of comparable quality.

But, in practice, it is difficult to determine how competitive a market is simply by observing the market. Some indication can, however, be gained by asking the following questions relating to the structure, conduct and performance of the market.

Structure

- How many suppliers and demanders are in the market?
- Is an effective framework for legal redress in place?
- Are there barriers to information flows in the institutional framework?

Conduct

- Do transactions occur frequently?
- Are contracts transparent and fair to supplier and consumer?
- Do suppliers and demanders frequently enter into and exit from the market?

Performance

- Is the spatial pattern of prices closely related to transport costs? For example, does the price in area A equal the price in area B plus the transport cost from B to A?
- Do prices move in an economically rational fashion? For example, are prices in step with seasonality in production?
- Are price fluctuations swiftly damped after an external shock?
- Are there signs of large, permanent profits in the system, in terms of growing economic inequality?

If all these questions can be answered positively then the market approaches perfect competition – if not then the analyst needs to reflect on the effects of the negative answer on the observed price. The more nearly the market reflects perfect competitiveness in terms of structure, conduct and performance, the more confidence we can have in the current market price as an indicator of the social worth of a good or service.

Social cost–benefit analysis also requires reflection on causalities to remove double counting. For example, an improved kitchen-garden produces food of greater value (whether the food is consumed by the household or sold), and the value of the kitchen-garden land increases (whether or not the household has any intention of ever selling the land). But changes in both measures of monetary value are caused by the same gain in social value – one directly as an income flow, the other indirectly as a wealth gain. They cannot both go into the social cost–benefit analysis, but which one is used is a matter of empirical convenience, not analytical rigour.

Social cost–benefit assessments of monetized values can also include explicit judgments about distributional social justice. Combinations of judgements on incomplete or imperfect markets, causalities and social justice give rise to so-called shadow prices, monetized values over which the analyst has made choices. These choices should, of course, be stated explicitly in the documentation that accompanies the social cost–benefit analysis.

All the values of the variables can be represented in annualized time profiles moving through a matrix, as shown in Table 11.1.

Table 11.1 Indicative matrix for an intervention showing differing patterns of movements of variables across time

Variable	Year 0	Year 1	Intervening years	Year X (end of intervention)
Variable A value	High	Zero	Periodic maintenance for optimum performance	Estimated value of restoring environment to pre-intervention state
Variable B value	Zero	Positive	Constant	Discounted values beyond year X
Variable C value	Zero	Low	Steadily rising and then falling	Zero

Note: Year 0 is start year of intervention; year X is when the intervention is considered not worth continuing for technological or cost reasons (although some variables may continue to have positive values after year X, for example incomes of people whose lives were saved by the intervention).

The social cost–benefit analysis matrix may well look decades into the future and thus involve considerable risk and uncertainty. The effects of this can be incorporated in the matrix by varying the time profiles of key variables to create sensitivity tests.

WILLINGNESS TO PAY

Given all the complexities in using social cost–benefit analysis, plus the risk that expert judgments are being smuggled in disguised as technical truths and not being subjected to sensitivity tests, it is not surprising that so many evaluators of interventions have emphasised willingness to pay as a valuation technique (Piper & Martin, 1999; Ranasinghe, Bee-Hua & Barathithasan, 1999; Vaughan et al., 2000).

Willingness to pay as a criterion avoids all the complications of listing and valuing by simply asking end-users how much they would be willing to pay for an intervention. This assumes that, as rational people, end-users will factor in all the changes they expect, remove all double-counting, and put values on the net changes, to arrive at a single aggregate monetary value. This then is the maximum price the end-users would be willing to pay for their share of benefits from the intervention.

But can such complete information and benign decision-making be assumed? Will a head of household think disinterestedly about the welfare of all household members, and will neighbours recognize their shared interest in a healthier environment (externalities)? Also, the question needs to have been asked in a way that prevents a free-rider undervaluing (if there is a prospect of really paying) or overvaluing (if paying is unlikely and there is a prospect of not receiving the service) the intervention.

In addition, in social justice terms, how can hypothetical willingness to pay be divorced from de facto ability to pay or lack of effective demand? For example, poorer people may express a lower willingness to pay than richer people, not because they value the intervention less, but because they have a different scale of financial valuation. Also, people may associate the question with possible prices that they will have to pay in the future, and hence they would have a material interest in understating the value of the service. The assumptions surrounding willingness to pay as an estimate of monetary value are as demanding as those required for a full social cost–benefit analysis. The empirical concept of willingness to pay may look simpler, but asking the question – 'What would you be willing to pay for improved access to safer drinking-water?' – in a naive fashion makes interpretation of the answer very difficult.

THE SPECIFICS OF SOCIAL COST-BENEFIT ANALYSIS FOR DRINKING-WATER INTERVENTIONS

There is a wide range of variables that may be relevant to a full social cost–benefit analysis of water and sanitation interventions. Each of these variables may merit its own row in the social cost–benefit analysis matrix. For our purposes here, the data requirements are initially presented as empirical questions.

Although the variables are expressed as means, counts and proportions in the questions below, it is important to remember that, in practice, the most accurate way to estimate these aggregate measures is to ask households about their most recent experiences and then aggregate those experiences. That is, do not ask a household: What is the average annual number of "x" episodes? But instead ask a number of households: When did you last experience "x"? The population mean can then be estimated by taking the average lapse in time since the last episode and converting this into an annual rate.

Also worth noting in terms of data collection, is that many of these variables can be estimated using focus group techniques rather than extensive questionnaire surveys.

With both these practical considerations in mind, we can now identify a list of questions that a social cost–benefit analysis may need to see answered:

- What is the mean annual total cash expenditure, if any, of the household on gaining access to drinking-water and sanitation services before and after the intervention? Payments for public or private sources of water will need to be distinguished, because payments for public sources may well have an element of subsidy that will need to be added to give a shadow price reflecting the full social cost. Imperfections in the private sector market, such as elements of monopoly power, may also be identified as price distorting factors.
- What is the cyclical and seasonal pattern of drinking-water access and use? For instance, how many days a year do households use untreated surface water for drinking? What are the health implications of the intervention in changing this pattern of access and use, in terms of DALYs?
- What is the proportion of diarrhoea episodes prevented per year by the intervention (for example, having groundwater available at neighbourhood taps rather than only untreated surface water)? What is the mean incapacitating length of a diarrhoea episode?
- What is the mean time needed for caring, per diarrhoea episode, including accompanying the ill member of the household to seek treatment?
- What is the proportion of people with diarrhoea who seek curative care? What is the mean financial equivalent cost to the household of consultation and treatment for one diarrhoea episode? In answering these two questions, it may be important to distinguish between different socio-economic groups.

- What is the mean or marginal net cost (after deducting any household user payments to the government health service) of treating a diarrhoea episode?
- What is the mean time saved per household per day in collecting water as a result of the intervention (including travel and waiting time for tap water)? Whose time is being saved (by sex and age)?
- What was the mean annual expenditure of the household on water containers and wheelbarrows for transporting water? Is this likely to change as a result of the intervention?
- What proportion of women in the household suffer from permanent back pain or a prolapsed womb that might be attributed to long-term lifting and carrying heavy water containers? What is the gain in DALYs from the improvement in women's health as a result of the intervention?
- What was the mean household expenditure on soap and detergents in the year prior to the intervention? Is this likely to change as a result of the intervention?
- What was the proportion of households undertaking measures to protect drinking-water quality at the point of use? What is the cost of these measures in terms of equipment, consumables and time, including fuel for boiling water, chlorine and other chemicals for water protection, and water filters?
- What was the mean household time spent in activities to protect household hygiene, including cleaning the kitchen, washing containers, and laundering clothes and bed linen? Is this likely to change as a result of the intervention?
- What proportion of children aged 6 to 14 years have improved school attendance as a result of improved water supply?
- What proportion of households has water meters? What is the unit cost of receiving water through the meter?

In addition, in many schemes, benefits may accrue to non-household users or users outside the immediate catchment area of the intervention. In such circumstances, the following questions are relevant to the social cost–benefit analysis.

- What is the proportion of total water demand from the scheme attributable to commercial users? What is the unit cost that commercial users are paying for this water?
- What is the proportion of total water taken by water distributors transporting water to areas outside the scheme? What is the unit cost that water distributors are paying for this water?

Much of the literature on monitoring and evaluating water and sanitation interventions understandably has focused on physiological health improvements brought about by reduced exposure to pathogens. But these are only one aspect of the potential gains from such interventions. Social cost–benefit analysis aims at building a comprehensive list of all the livelihood effects on all the people affected by the interventions over the whole lifetime of the intervention. For instance, if the intervention has a positive impact on productivity in kitchen gardens, perhaps by providing "grey" water irrigation and good quality compost, then this should be included as a benefit. There may be increased food availability for household consumption or sale. Plus, the food may be nutritionally superior and reinforce the direct health gains from the intervention itself.

As we have seen in Chapter 10, in order to assess the impact of the intervention on human well-being, health improvements can be converted into gains in time (measured, for example, as DALYs) available for pursuing valued activities. Some non-health benefits can also be seen as time gains, such as a reduction in the time required to collect water. All such time gains can be given a value in terms of the most valuable livelihood use of the time released (the opportunity cost), even if that time use is not itself monetized. By making comparisons with broadly equivalent monetized activity, a value can be found. For example, more time spent in cultivation for household consumption may be valued at the local agricultural wage rate for paid labour.

Some benefits may not be reducible to more time available, such as the improvement of a kitchen garden. Thus, time saving is not a universal standard of value (or numeraire). By assigning monetized values to changes induced by an intervention, it is possible not only to include all the changes but also to differentiate between different uses of saved time, reflecting their differing worth to society as a whole, for example time used in socializing in a bar compared with time hoeing a kitchen garden. Such differentiation allows social cost–benefit analysis to provide a more subtle understanding of relative gains from different interventions, compared to valuing only time gains. Table 11.2 indicates the range of possible benefits, linked to potential indicators, that might result from a drinking-water intervention.

In terms of framing the social cost–benefit analysis, the target population will need to be segregated by age and sex. Information on population movements, permanent, cyclical and seasonal, may well be relevant. Given the long time horizon for many water and sanitation interventions, it may be worth investing time and resources in developing a full demographic model showing population change. This model can be brought into interaction with changing exposure rates induced by the water or sanitation intervention. The most dramatic effect

Table 11.2 Forms of possible livelihood benefits resulting from a drinking-water intervention

Benefit variables	**Indicators (pre- and post-intervention mean values)**
Sickness time saved (economically active adults)	Number of annual ill-health episodes and mean length of episode
Sickness time saved (economically inactive adults)	Number of annual ill-health episodes and mean length of episode
Sickness time saved (children)	Number of annual ill-health episodes and mean length of episode
Benefits from mortalities postponed per household	Mean net income earned per person over additional years
Caring time saved (economically active adults)	Mean length of caring time per ill-health episode
Caring time saved (economically inactive adults)	Mean length of caring time per per ill–health episode
Caring time saved (children)	Mean length of caring time per ill–health episode
Household health-care costs saved	Mean household health-care cost per ill-health episode (including transport)
Government health-care costs saved	Mean cost to government of providing the health care per ill-health episode
Water collection time saved per household	
• economically active adults	Mean hours per day (including waiting time)
• economically inactive adults	Mean hours per day (including waiting time)
• children	Mean hours per day (including waiting time)
Disabilty damage prevented in water collection per household	Mean health-care costs plus loss of income earning capacity
Gains from improved educational performance	Percentage of children improving school attendance, by age
Value added gains from additional irrigated crops	Mean increased value of crops cultivated less all input costs
Environmental gains (What proportion of households considers that the changes in the water and sanitation system have changed the physical environment of the village? What proportion thinks the changes have been for the better? What proportion thinks that the changes have been for the worse?)	Total increased amenity value of land in area

(*Continued*)

Table 11.2 *Continued*

Benefit variables	Indicators (pre- and post-intervention mean values)
Social capital benefits (What proportion of households considers that the changes in the water and sanitation system have changed the social atmosphere in the village? What proportion thinks that the changes have been for the better? What proportion thinks that the changes have been for the worse?)	Percentage people stating increased confidence and trust in planning and implementing developmental activities
Proportion of financial benefits devoted to productive investment in equipment or tools	Proportion of additional income from health and non-health benefits invested to increase future income

of interventions on demographic variables is reduction in infant and child mortality, but accurate data on changes are very difficult to collect for relatively small affected populations. Therefore larger scale population data sets enabling comparison of relatively well-provided and less well-provided groups of people, may be needed to get a reliable parameter on mortality rates for the affected population.

Estimating lifetime earnings for those lives saved will require judgments to be made on long-term economic change and will be sensitive to the discounting rate over time, given that much of this gain will be far in the future. Considerations of social justice may be significant here in terms of the value of a human life being seen only as the discounted value of future earnings. Also, the impact of greater child survival on future fertility choices may be a significant externality that needs to be incorporated into the demographic model.

REVIEW OF THE COMPLETE PROCESS FOR SOCIAL COST–BENEFIT ANALYSIS

The process of social cost–benefit analysis can begin by using a modified logical framework to identify the numerous linkages between activities and final impacts, using a brainstorming approach with people who have had direct experience of similar activities in the locations where the development agency is operating. The brainstorming also can use a stakeholder model to identify groups of people likely to be affected, both positively and negatively, by the activities. Risk analysis can be used to identify variables that would be relevant to sensitivity tests.

With the results of these brainstorming activities to hand, a list of all physical inputs, outputs and effects giving rise to costs and benefits can be made in a single column on an Excel spreadsheet. A timescale in terms of years is then put on to the columns of the spreadsheet, starting from the year of construction. Social cost–benefit analysis also requires the choice of a final year.

The final year will be: either when flows of costs and benefits have steadied and discounting reduces present values to insignificant levels, or when a scheme is believed to require such heavy capital expenditure that a substantial new investment activity would be needed beyond normal operation and maintenance activities.

For that final year, decisions have to be made, preferably at the appraisal stage (or, if not, in the impact evaluation), about the socially acceptable environmental status it should obtain (or should have obtained) at the end of project. There may need to be a complete reinstatement of the pre-intervention conditions, or an environmentally compensating activity elsewhere.

Estimates of physical quantities of inputs and outputs are then made and fed into the timescale in the years they affect. Market prices for unit quantities of all inputs and outputs are identified wherever possible from primary and secondary sources. Each of these market prices is scrutinized and discussed to decide whether it should be modified to a socially more appropriate shadow price. The scrutiny focuses on institutional factors that are affecting the observed prices and then modifies these observed prices, in the direction of removing the institutional effects to reveal a shadow price. In some cases, such as taxes and subsidies, the effects can be relatively easily quantified. In others, such as foreign exchange rates, standard formulae often exist at national level. Where there are believed to be private monopolies controlling peak-season transactions, the effects can be quantified by finding low-season transactions outside the monopoly relationship and assessing where a market clearing price might lie, taking the scale of activity into account.

In some cases, missing prices for some inputs and outputs can be derived from related inputs and outputs that have observable prices. Land is an example, even though not readily bought and sold in many rural societies. Changes in land use can be given an imputed price by observing changes in net value of the produce from the land.

The challenges are greater where the physical changes induced by the activities of the development agency have no observable prices, or the linkages are very indirect. Best estimates of values for such changes can be made using secondary material where available or allocating a notional value added. Such estimates would be prime candidates for sensitivity tests.

Once a complete set of shadow prices representing social values and real scarcities has been established, then these are applied to the quantities of inputs and outputs, and a spreadsheet expressed solely in shadow price values is produced. Where particular costs and benefits are seen as accruing heavily to vulnerable or other target groups, weightings could be applied to reflect distributional concerns. All assumptions about the time pattern of physical activities, pricing of resource use and physical effects, and distributional weightings should be fully documented.

The spreadsheet is then expanded by three rows to calculate total costs and total benefits, and net costs/benefits in each year. A standard discounting formula is applied to net costs/benefits in each year to take account of the effects of time. Either net present values can be calculated for a target discount rate, or an internal rate of return (reducing the sum of discounted net costs and benefits to zero) can be calculated as a first complete scenario.

This scenario presents the most likely estimate. It can then be adjusted to best case and worst case scenarios by reviewing the risk analysis and the assumptions made. All risks and assumptions that tended to increase benefits and decrease costs are quantified and used for a best case scenario. To construct a worst case scenario, all risks and assumptions that would increase costs and decrease benefits are quantified.

All three scenarios, with their associated documentation, can then be offered to decision-makers for consideration in the final assessment process. Presenting at least three scenarios is a clear signal to the decision-makers that the social cost–benefit analysis is not merely a technical calculation, but an indicative exercise in which judgement must be exercised by decision-makers.

Social cost–benefit analysis is not presented here as a panacea for appraising or evaluating water interventions. Social cost–benefit analysis can help in making an assessment but cannot determine a decision on the results. The practice of social cost–benefit analysis has matured since the 1970s. In its best practice, social cost–benefit analysis today is explicit and transparent about assumptions and judgements involved. Social cost–benefit analysis presents decision-makers with choices they can make with good deliberative reason, and does not seek technical closure (Morimoto & Hope, 2004).

In this chapter we have attempted to describe social cost–benefit analysis at its most technically ambitious, in terms of a wide-ranging livelihoods framework. We have found no studies of water interventions that meet the high demands of both rigorous principles and empirical range. We hope that this book will encourage more ambitious efforts to apply social cost–benefit analysis to more local drinking-water interventions in the future. Chapter 12 outlines the best examples currently available of using social cost–benefit analysis to assess water interventions at a highly aggregated level.

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