Annex A

Evaluating the benefits: methodological issues

This Annex sets out in more detail methodologies that are commonly used to evaluate the types of benefits generated by investments in water and sanitation services. It examines how benefits can be defined and how each main category of benefits can be measured, with respect to health, environmental, economic and intangible benefits.

A.1. Defining and valuing benefits

Benefits can be defined in a number of ways. In cost-benefit analysis terms, benefits can be defined as net improvements from a given intervention (including a given investment) or as an "avoided cost" irrespective of whether the intervention has taken place or not. For example, a recent OECD report estimated the "costs of inaction" for selected environmental policy challenges (see OECD, 2008). In this report, inaction was defined as the hypothetical scenario that "no new policies would be taken beyond those which currently exist".

Benefits may include direct and indirect effects. For example, the direct effects from investing in water would include the health impact from improved quality whereas the indirect effect would include the impacts on improved productivity, school attendance or reduction in fertility rates (resulting from a drop in child mortality).

A critical issue is to define a common unit in which to express the benefits. The unit in which benefits are expressed would usually depend on the type of benefits: for example, DALYs are used for expressing health impacts, whereas % GDP may be used to assess economic impacts. To be able to compare and aggregate different types of benefits, it is necessary to express benefits in a single monetary unit in order to be able to compare different types of benefits. Doing so requires attributing monetary values to benefits that may be difficult to quantify: for example, whereas DALYs can be "translated" into monetary benefits by attributing a value to human life, this raises a number of methodological issues such as how to value the life of an under-5 as opposed to

that of an adult. This is particularly important for WSS given that those most affected by inadequate water and sanitation are children under 5 years old.

Using benefit values: the limits of benefit transfer. Transferring benefit values across countries is a difficult and potentially misguiding exercise, particularly if such values are transferred between developing countries and developed countries. This is important to bear in mind, given that transferring benefit values is often used, somewhat abusively, to cut the costs of measuring benefits. Some more reflections on the use of benefit transfers are given in Box A.1.

Box A.1. **Benefit transfer: limitations and opportunities**

Applying economic values measured on one site to another site for a similar good can be a useful tool, especially when the alternative consists of having no value estimates at all, given that collecting primary data is a costly and time-consuming exercise. However, several risks and uncertainties are linked to using benefit values across sites, which is referred to as "benefit transfer". Several issues need to be considered, including converting values from one currency to another or accounting for income differences from one country to the other. Given the need to make assumptions, benefit transfers inevitably increase subjectivity and uncertainty compared to the original study. It has to be decided on an individual basis whether this is acceptable and whether the transferred values are still informative.

Given the potentially essential role of benefit values in the environmental decision-making process, it is surprising that no generally accepted practical transfer protocols exist to guide analysts. However, well accepted recommendations can be found. They include amongst others:

- Accuracy and quality of the original study have to be carefully examined;
- The study site and the newly considered site must be similar in terms of population characteristics; otherwise, implications of the differences on the WTP values have to be considered;
- Changes with respect to the good in question should be similar on both sites;
- The use of meta-analysis (combining the results of several similar studies) or the adaptation of a benefit function to the new situation should be preferred over applying single values directly.
- All judgements and assumptions made when transferring benefits and their potential impact on the final estimates must be made clear.

In general, the greater the similarities between the two sites, the smaller the risk of error is likely to be. Finding study sites similar and close to the site under review should therefore be a priority.

Sources: EPA 2000b; OECD 2006b; Ready and Navrud, 2006.

The magnitude of benefits is directly influenced by the level of economic development. For example, investing in wastewater treatment activities would have higher benefits (in monetary terms) in southern Spain, for example, where revenues from tourism are very dependent on the quality of bathing waters than in some remote area in developing countries. This can partly be corrected in two ways: first, by using locally-relevant values (such as the value of a statistical life, based on domestic income values) and by evaluating the benefits against the local GDP.

Evaluating benefits: marginal benefits and location-specific factors. Benefit values are very difficult to measure in absolute terms: instead, one has to focus on the marginal benefits of an additional action, depending on what has happened previously. For example, investments driven by the European Nitrate Directive resulted in a substantial reduction in nitrate levels in the 1990s. As a result, any additional reduction has a much higher marginal cost than what has happened previously. With respect to the impact of providing access to water and sanitation on diarrheal diseases, the actual benefits are highly dependent on the prevalence of such diseases in the area under concern prior to the intervention.

A.2. Measuring health benefits

Health benefits can materialise at different steps of the value chain, from providing access to water and sanitation services or from investing in wastewater treatment so as to improve the overall environment (such as bathing water quality for example).[1]

Common ways of measuring health benefits include:

Measuring the direct health care costs: this evaluation can be based on the actual medical costs or, if those are either unavailable or too difficult to collect, on the number of hospital days or the costs of medicine that result from water-related illnesses. These are likely to be under-estimates as they would only include the direct costs associated with a particular episode of illness (as opposed to the long term impacts, such as on child malnutrition for example). However, this methodology can be well-suited to specific outbreaks, such as resulting from a sewer outflow or the contamination of drinking water.

Impact on productivity: this can be estimated through the impact of sickness on overall labour productivity (through estimating the number of days of work lost to sickness affecting the individual or a close relative), reduced labour productivity, reduced school attendance, etc. Time away from work or home activities due to sickness can be valued through an estimation of the

opportunity cost of time, based on alternative measures (such as the average compensation of employees, the minimum wage or the average wage).

Impact on mortality: inadequate water and sanitation can result in loss of life, in which case the value of such life lost needs to be measured. Such value would vary depending on level of development and age of individuals. Alternative methods to estimate the value of statistical life (VSL) include the human capital approach. A common method estimates the VSL based on the future discounted economic output of the individual lost following death. This method has been criticised as it only values life based on the productive capacity of an individual. It is also not particularly suited to estimating the value of life for children under 5, since they have not yet reached a productive age. Alternative methods include hedonic pricing (based on the observation of labour markets and measurement of the premium that individuals ask for to take comparatively riskier jobs) and contingent valuations (based on the stated preferences from individuals exposed to risk).

Box A.2. **Measuring Disability Adjusted Life Years (DALYs) and the Burden of Disease**

The World Health Organisation (WHO) defines **Disability Adjusted Life Years (DALYs)** as the sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability. It extends the concept of potential years of life lost due to premature death to include equivalent years of "healthy" life lost by virtue of being in states of poor health or disability. As a result, mortality and morbidity are combined into a single, common metric: one DALY is equal to one year of healthy life lost. This unit is becoming increasingly common in the field of public health and health impact assessment and is also being used in measuring the impact of measures such as water, sanitation and hygiene. The sum of these DALYs across a given population is referred to as "**the burden of disease**". This can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability.

In 1996, WHO published the first "Global Burden of Disease" report, using data from 1990 (and hence referred to as GBD 1990). This report was the first consistent and comparative description of the burden of diseases and injuries and the risk factors that cause them, in order to inform health decision-making and planning processes. That study quantified the health effects of more than 100 diseases and injuries for eight regions of the world in 1990, using DALYs as a common metric. This study was subsequently updated, and incorporated analysis of the mortality and burden of disease attributable to 26 global risk factors, one of which being water, sanitation and hygiene. The next update of the study, the GBD 2005 study, is due to be published in late 2010. This revised study will also assess trends in the Global Burden of Disease from 1990 to 2005.

Source: the Global Burden of Disease project. *www.who.int/healthinfo/global_burden_disease/about/en/index.html*.

Methods that use wage data in order to derive the value of life (or death avoided) are highly sensitive to differences in wage levels across countries. Whereas the value of life in less developed countries can be as low as USD 4 500 (as per the estimates shown in Table 2.3. in the main text), estimates in developed countries are higher by several orders of magnitude. For example, the US EPA typically a VSL estimate of more than USD 6 million, which takes into account estimates from dozens of published VSL studies using hedonic wages and contingent valuation studies (EPA, 2000b).

Impact on morbidity: short of causing death, poor water and sanitation can cause repeated illness. To measure the combined negative impact on morbidity and mortality from a broad range of health interventions, the World Health Organisation has defined DALYs (Disability Adjusted Life Years) as a single indicator of health conditions. In cases where benefits are not monetised, a common practice is to compare the cost-effectiveness of alternative interventions in terms of DALYs averted (see Box A.2. and Box 5.3).

A.3. Estimating environmental benefits

Assigning values to the environment. In order to describe the different types of values linked to the environment, ecosystem goods and services are often classified according to how they are used. The different categories are frequently differentiated into (Pagiola *et al.* 2004, see also OECD 2000):

- **Direct use values**: This type of value refers to ecosystem goods and services that are used directly, either by *consumptive uses* (*e.g.* extraction of timber for construction, food, medicinal plants) or by *non-consumptive use*. The latter includes for example nature related tourism, education or scientific research. Mainly people visiting or living in the ecosystem itself are benefiting from direct use values.
- **Indirect use values**: Benefits from indirect use refer to ecosystem services that occur outside the ecosystem itself and which support economic activities or human welfare. This includes the water filtration function of wetlands, water retention or carbon sequestration.
- **Option values**: This kind of value is based on the option to use the ecosystem goods and services in the future, either by oneself (*option value*) or by others/heirs (*bequest value*) .[2]
- **Non-use values**: This category refers to the enjoyment people may feel by knowing that a resource exists even if they never expect to use that resource directly themselves. This value is often also known as *existence value*.

Some economists define furthermore an intrinsic value, which "reflects the belief that all living organisms are valuable regardless of the monetary value placed on them by society" (NOAA, web).

Valuation methods. The valuation of environmental assets involves placing monetary values on ecosystem related goods and services as well as on changes in environmental quality which results from human activities. Contrary to other goods and services, environmental ones are less often subject to market transactions. Their value is therefore not revealed by market prices and needs different valuation approaches (OECD 2000). The valuation of environmental goods and services is largely based on the assumption that individuals are willing to pay for keeping or augmenting environmental benefits. Determining the willingness-to-pay (WTP) is hence one important instrument to attach values to the environment.

Different valuation methods exist, but only the most relevant ones for the values given in this report are presented below:

The Contingent Valuation Method (CVM): The CVM is one approach to value non-market environmental goods, including for example option and existence values. They attempt to measure the WTP for environmental improvements by directly questioning a representative sample of individuals (OECD 2000). The CVM survey includes a questionnaire presenting a scenario or hypothetical market which describes an improvement or a decline in environmental quality. The interviewed persons are then asked to estimate their willingness to pay (*e.g.* through higher utility charges) for the improved environmental good or service. Based on the individual responses, the mean and median willingness-to-pay for an environmental improvement are estimated as an indication of its value. However, CVM studies may be subject to certain biases, *e.g.* the respondent's belief that his answers may be used to affect government policy, leading him to intentionally understate or overstate his willingness to pay to achieve the desired policy result. To minimise bias, analysts must be very careful when designing surveys and conducting interviews (NOAA, web).

Choice experiments: Unlike CVM studies, choice experiments confront respondents with a set of alternatives relative to environmental policy options. Using this method, preferences for various components or attributes can be examined at a more detailed level. This provides the analyst with a more complete understanding of individual preferences. Whereas CVM lead to a single value for a change in environmental quality, choice experiments provide independent values for the individual attributes of an environmental change (NOAA, web).

Travel cost method (TCM): This method can be applied to the valuation of recreational benefits of a specific site. It relies on deriving a demand curve from data on actual monetary and time costs of travel to the destination of

recreation, collected through surveys (Pagiola, 2007). These expenditures are considered as an indicator of the willingness-to-pay for accessing the recreational services provided by the site (NOAA, web). This method has limits, for example when trips include several destinations (Pagiola, 2007). Furthermore, the TCM cannot be used to measure non-use values (NOAA, web).

Hedonic pricing: The quality of the water environment (driven partly by the quality of water and sanitation services) would typically affect the value of land or housing stock situated next to the water bodies. Examination of land market values can reveal the value attached to cleaning up water pollution.

A.4. Accounting for economic benefits

Economic benefits can be measured via the impact of water and sanitation on economic activities, such as power production, fishing, aquaculture or tourism. These benefits can be estimated based on the lost economic outputs linked to the impact of poor quality water and sanitation. Economic benefits may also materialise in the form of time gained from not having to collect water or seek a secluded spot to defecate: such time would need to be valued based on the opportunity cost of the individuals concerned.

When measuring economic benefits, it is crucial to avoid double-counting. For example, if health benefits are estimated by looking at increase in productivity (*i.e.* reduction in number of sick days), this should not be counted as a separate economic benefit. Similarly, if environmental benefits are measured based on the impact on fish population and fish production, this cannot be included as a separate benefit. However, there are likely to be some overall economic benefits (such as on tourism or agriculture) which have not been adequately captured through the other types of benefits.

Indirect economic benefits may be significant but cannot always be accounted for. For example, if there is an increase in school attendance as a result of building toilets in school, this could later results in higher incomes for the girls who attended school. Although the impact may be significant, it may be difficult to quantify as it only materialises over time.

A.5. Including other benefits

Other benefits may be more difficult to quantify and value, such as the non-health impacts from water and sanitation services, including the impact on dignity, amenity value, etc. Methodologies exist to value those types of benefits, especially based on contingent valuations but they have not been applied on a consistent basis to estimate the benefits of water and sanitation investments.

Notes

1. This section borrows heavily from Hutton *et. al*. (2008).

2. Some analysts also add a quasi-option value, *i.e*. the value of avoiding irreversible decisions until new information reveals whether certain ecosystem services have values we are not currently aware of (Arrow and Fisher 1974, in: Pagiola *et al*., 2004).