Chapter 5

Economic valuation tools

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Putting a value on the ecosystem services which wetlands provide to human communities can ensure that they are better acknowledged and accounted for in decision-making. This section introduces the basic concepts and thinking behind valuation, and offers guidance in selecting and applying valuation methods.

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Economic valuation tools

This section presents the economic valuation tools. It includes:

- ✔ *An introduction to the ecosystem services approach*
- ✔ *An overview to wetland valuation, and a range of methods through which valuation can be made*
- ✔ *A review of research design techniques and requirements, with practical examples*
- ✔ *Analysis of wetland valuation data*

The subject area is extremely complex and rapidly evolving. In the space available here we can provide only an introduction, and we strongly recommend further reading, which is provided at the end of the section. We also recommend careful selection of a team leader already proficient in these methods.

E1 Why value wetland goods and services?

E1.1 The problem of under-valuation

An inherent tension exists between economic development and wetland conservation, a tension due to divergent economic and social priorities. This in turn relates to making choices about how, where and why to invest, produce, and consume; and balancing the trade-offs that will inevitably arise in the impacts of development activities on conservation goals, and vice versa.

Economic measures and indicators can inform these choices about how to use and allocate funds, resources and land. They can also have a strong influence on how development and conservation trade-offs are conceptualised and decisions are made. Yet the economic calculations that underpin wetland development decisions have conventionally tended to be flawed, and fundamentally incomplete, because they typically omit an important set of costs and benefits — the values associated with ecosystem goods and services.

For the most part, calculations of the returns to different investments or to alternative land and resource uses do not factor in wetland values. Although conventional analysis decrees that the 'best' or most efficient allocation of resources is one that maximizes economic returns, measures of the returns to different land, resource and investment options have for the most part failed to deal adequately with wetland costs and benefits. Most cost-benefit analyses, investment appraisals and other economic calculations are therefore misleading in their conclusions as to the relative costs, benefits and returns to different uses of land, resources and investment funds.

From an economic viewpoint, wetland ecosystems remain some of the world's most under-valued resources. Decision-makers and land-use planners have long perceived there to be little economic benefit to conserving wetlands, and few economic costs attached

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Mat manufacture using wetland resources in Mtanza-Msona to their degradation and loss. In particular, the non-marketed goods and services associated with wetlands (most notably local use of wetland resources, and the ecosystem functions that they yield) are typically excluded from consideration when decisions are made about managing and using land, water, funds and other resources in wetland areas. This does not just underestimate the importance of wetlands as a stock of natural capital and flow of economic services, it also marginalises the (often poor) groups who depend on these values.

As a result, decisions have tended to be made on the basis of only partial information, thereby favouring short-term (and often unsustainable) development imperatives or leading to conservation and development choices that fail to optimise economic benefits. At the worst, in the absence of information about ecosystem values, substantial misallocation of resources has occurred and gone unrecognised (James 1991). As a result, immense economic costs have often been incurred by the coastal populations who depend on ecosystem goods and services.

Given a tendency to under-valuation, the management of wetlands has been biased all over the globe towards modifying, converting, over-exploiting and degrading them, in the interests of other seemingly more 'productive' or 'profitable' land and resource management options. Wetland under-valuation has also been a persistent problem in environmental planning and practice. In all too many cases it has been difficult to justify conservation in development terms, or to make sure that the resulting activities are economically viable, socially equitable, or financially sustainable.

E1.2 Factoring wetland values into decision-making

The problem is not that wetlands have no economic value, but rather that this value is poorly understood, rarely articulated, and as a result is frequently omitted from decision-making. Therefore taking a comprehensive ecosystem service approach would require a very extensive research exercise in order to gain:

- *Biophysical understanding of how and where the ecosystem services are generated*
- *Where and in what terms the benefits are realised*
- *What level of value the services provide*
- *How ecosystems are governed and the opportunities for compensating the providers of public goods*
- *In what ways service flows and values would be likely to change under different management and utilisation scenarios*

(Turner *et al.* 2008)

In this toolkit, we look at how to quantify the economic value of wetland goods and services. Wetland valuation involves determining people's preferences: how much they might be willing to pay for ecosystem goods and services, and how much better or worse off they would consider themselves to be as a result of changes in their supply.

By expressing these preferences, valuation aims to make ecosystem goods and services directly comparable with other sectors of the economy when investments are appraised, activities are planned, policies are formulated, or land and resource use decisions are made. When properly measured, the total economic value of ecosystem functions, services and resources frequently exceeds the economic gains from activities which are based on ecosystem conversion or degradation (Barbier 1994). Although a better understanding of the economic value of ecosystems does not necessarily favour their conservation and sustainable use, it at least permits them to be considered as economically productive systems, alongside other possible uses of land, resources, and funds.

E2 Summary of steps in wetland valuation

This chapter describes the stages in carrying out wetland economic valuation, as part of an integrated economic-biodiversity and livelihood assessment. As illustrated in Figure 24, economic valuation follows a series of iterative steps that complement, and run parallel to, those carried out in biodiversity and livelihood assessment (see Chapters 3 and 4). The rest of this chapter traces through these steps, and describes how to carry out an economic assessment of wetland values.

E3 Stage I: Setting the study scope and parameters

Step 1: Defining the study goal and management focus

However academically interesting it is to know the monetary value of a particular wetland good, service or site, wetland valuation is not an end in itself. It is a means to an end – better and more informed conservation and development decision-making. Economic valuation does not take place in isolation; it is prompted by a particular management or policy issue that needs to be addressed, or a particular decision that needs to be made about the use of funds, land or other resources.

The information that is generated by a valuation study aims to assist in understanding or dealing with this issue, or in making this decision. It is the management or policy issue which determines the scope, objective and parameters of the valuation study – what it will include, what it will exclude, which values will be considered, and to what ends.

The very first step in wetland valuation is therefore to define and understand the management context in which the study is taking place, and the management need and issue it addresses. This in turn determines the questions which have to be answered by the valuation study, and the information it needs to generate.

It is impossible to pre-determine what these questions will be as the specific management issue that is being addressed by the

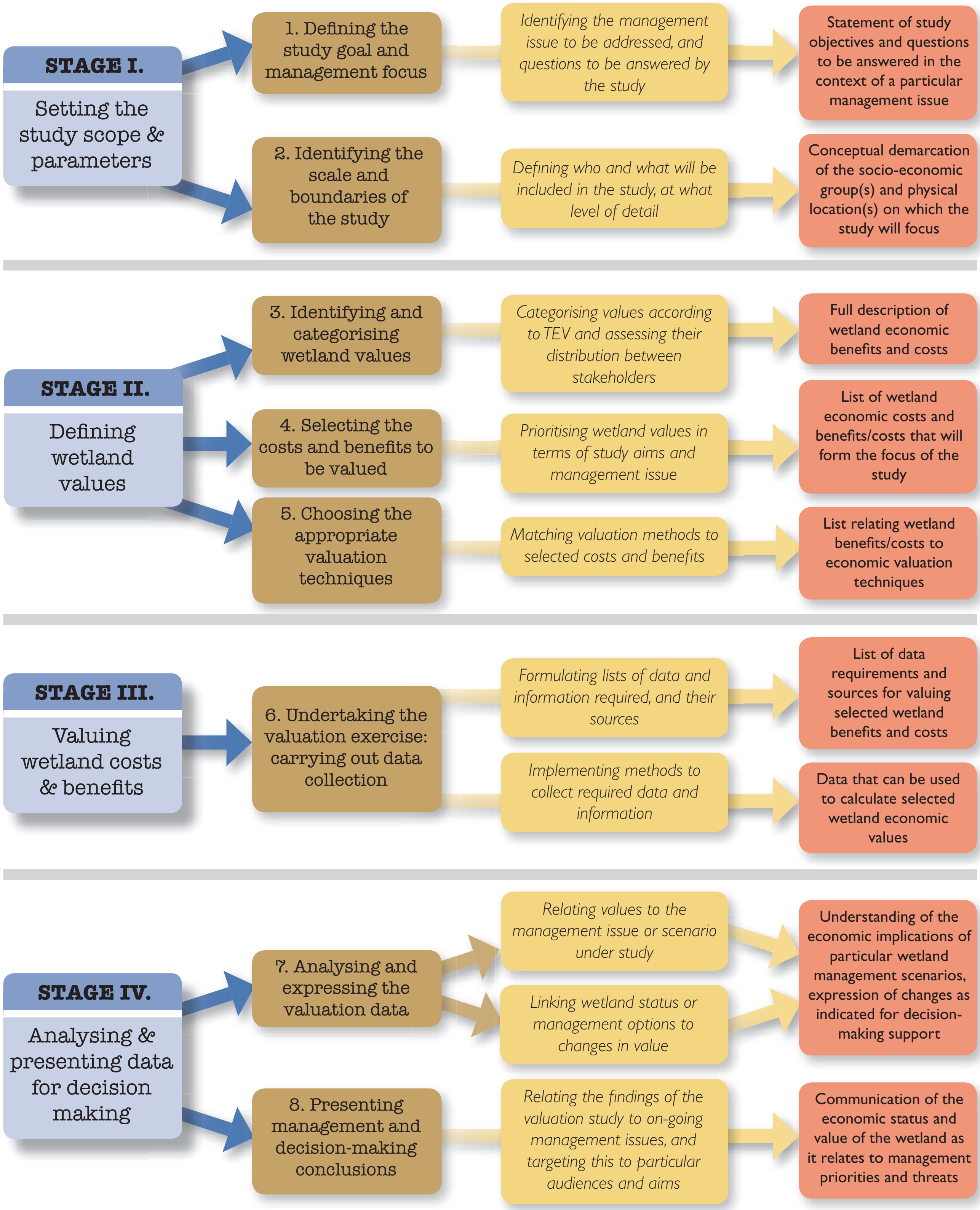
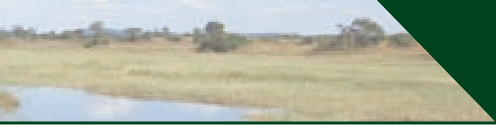


Figure 24: Summary of stages and steps in wetland valuation

valuation study will vary in different cases. There are however certain types of issues and trade-offs which are commonly faced by wetland managers, and for which valuation studies can provide important information to assist in decision-making. For example:

- Justifying or making a case for wetland conservation
- Identifying wetland financing needs and mechanisms
- Assessing the impacts of upstream developments on wetland status
- Choosing between particular wetland management regimes
- Assessing the profitability of different sustainable use options
- Looking at needs and niches for local benefit sharing



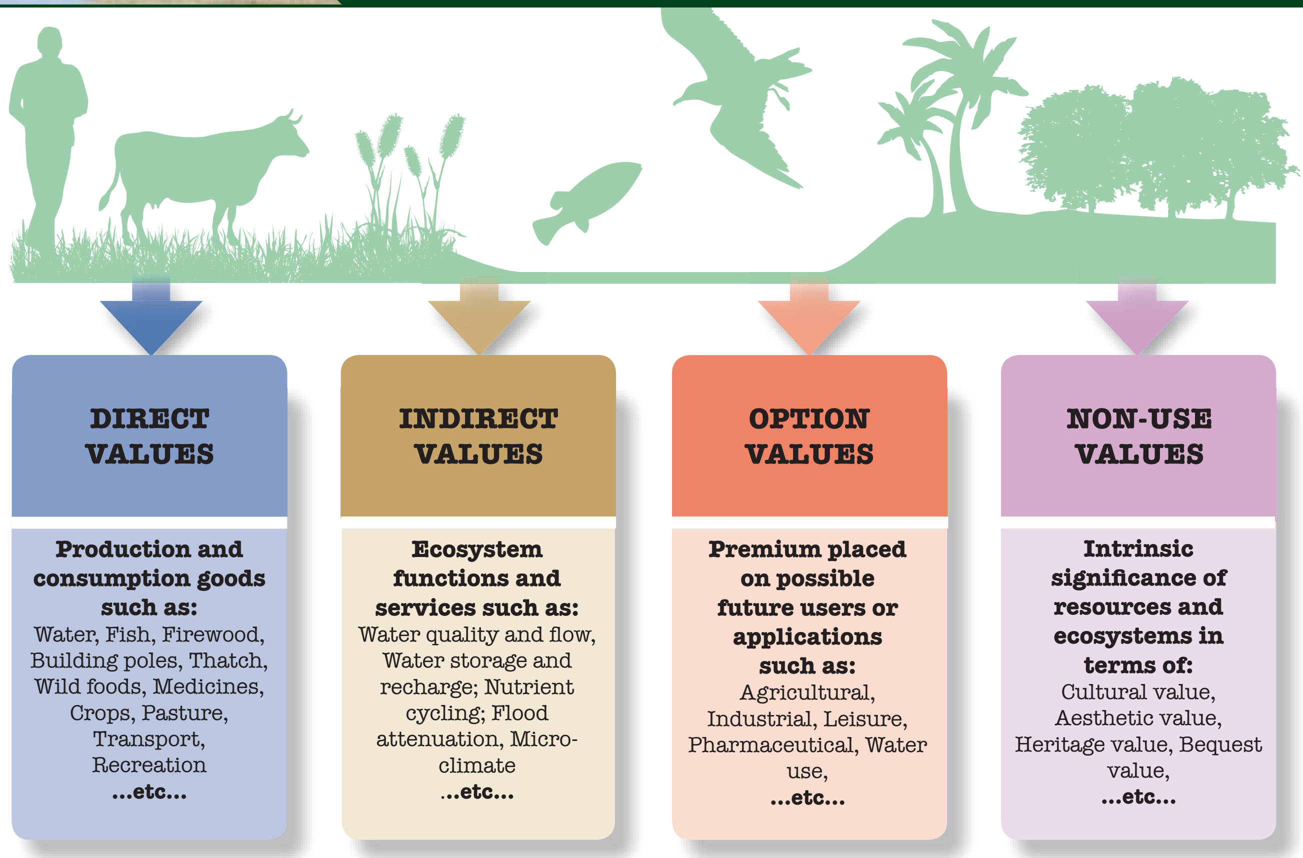


Figure 25: The total economic value of wetlands from Emerton 2005

- Setting fees for wetland use, and penalties or fines for illegal activities
- Estimating the relative profitability, or returns, to different investment, land and resource use options in and around wetlands

Step 2: Identifying the scale and boundaries of the study

In summary, this step involves defining who and what will be included in the study, at what level of detail. It should result in a conceptual demarcation of the socio-economic group(s) and physical location(s) on which the study will focus.

It is rarely necessary, or practical, for a valuation study to consider each and every value, stakeholder or unit of area associated with a given wetland. In line with the overall objective or management/ policy focus, it is necessary to define the boundaries of the valuation study, and to demarcate the area it will actually work in. The second stage of a valuation study is therefore to identify the scale and boundaries within which the study will focus, including the geographic boundary of the site to be studied, its socio-economic boundary or user/beneficiary population, as well as the time period to be incorporated in the study.

E4 Stage II: Defining wetland values

Step 3: Identifying and categorising wetland values

In summary, this step involves prioritizing wetland benefits and selecting those which will be valued in the study. It should result in a list of wetland economic costs and benefits that will form the focus of the study. Field checklists (Figures 52 and 53) for identifying, listing and selecting wetland costs and benefits to be valued are provided in the appendix.

Wetlands yield multiple goods and services, and also incur a range of economic costs. In any valuation study, it is important to define and categorise all the costs and benefits that have relevance to the given wetland under scrutiny, in order to present a broad overview of the economic stocks and flows that are associated with it.

Benefits

One reason for the persistent under-valuation of ecosystems is that, traditionally, concepts of economic value have been based on a very narrow definition of benefits. Economists have seen the value of natural ecosystems only in terms of the raw materials and physical products that they generate for human production and consumption, especially focusing on commercial activities and profits. These direct uses however represent only a small proportion of the total value of ecosystems, which generate economic benefits far in excess of just physical or marketed products. The concept of Total Economic Value (TEV) has now become one of the most widely-used frameworks for identifying and categorising ecosystem benefits (Barbier *et al.* 1997). Instead of focusing only on direct commercial values, it also encompasses the subsistence and non-market values, ecological functions and non-use benefits (Figure 25). As well as presenting a more complete picture of the economic importance of ecosystems, it clearly demonstrates the high and wide-ranging economic costs associated with their degradation, which extends beyond the loss of direct use values.

Looking at the TEV of an ecosystem essentially involves considering its full range of characteristics as an integrated system – its resource stocks or assets, flows of environmental services, and the attributes of the ecosystem as a whole (Barbier 1994). Broadly defined, the TEV of water ecosystems such as wetlands and catchment forests include:

- **Direct values:** raw materials and physical products which are used directly for production, consumption and sale such as those providing energy, shelter, foods, agricultural production, water supply, transport, and recreational facilities
- **Indirect values:** the ecological functions which maintain and protect natural and human systems through services such as maintenance of water quality and flow, flood control and storm protection, nutrient retention and micro-climate stabilisation, and the production and consumption activities they support
- **Option values:** the premium placed on maintaining a pool of species and genetic resources for future possible uses, some of which may not be known now, such as leisure, commercial, industrial, agricultural and pharmaceutical applications, and water-based developments
- **Existence values:** the intrinsic value of ecosystems and their component parts, regardless of their current or future use possibilities, such as cultural, aesthetic, heritage and bequest significance

The TEV of wetlands can also be usefully conceptualised in relation to the schema of ecosystem services provided by the MEA (2005). From an economic perspective, ecosystem services correspond to different elements of TEV, including direct values (provisioning services), indirect values (supporting and regulating services), cultural services (existence values), and their possible uses and applications in the future (option values) – as illustrated in Figure 26.

Costs

There is a tendency, especially in conservation-based assessments, to ignore the fact that wetlands generate a wide variety of costs, which impact on people's livelihoods and economic activities. As in the case for benefits, wetlands costs have tended to be defined narrowly in the past, focusing only on investment and recurrent costs incurred to the institutions

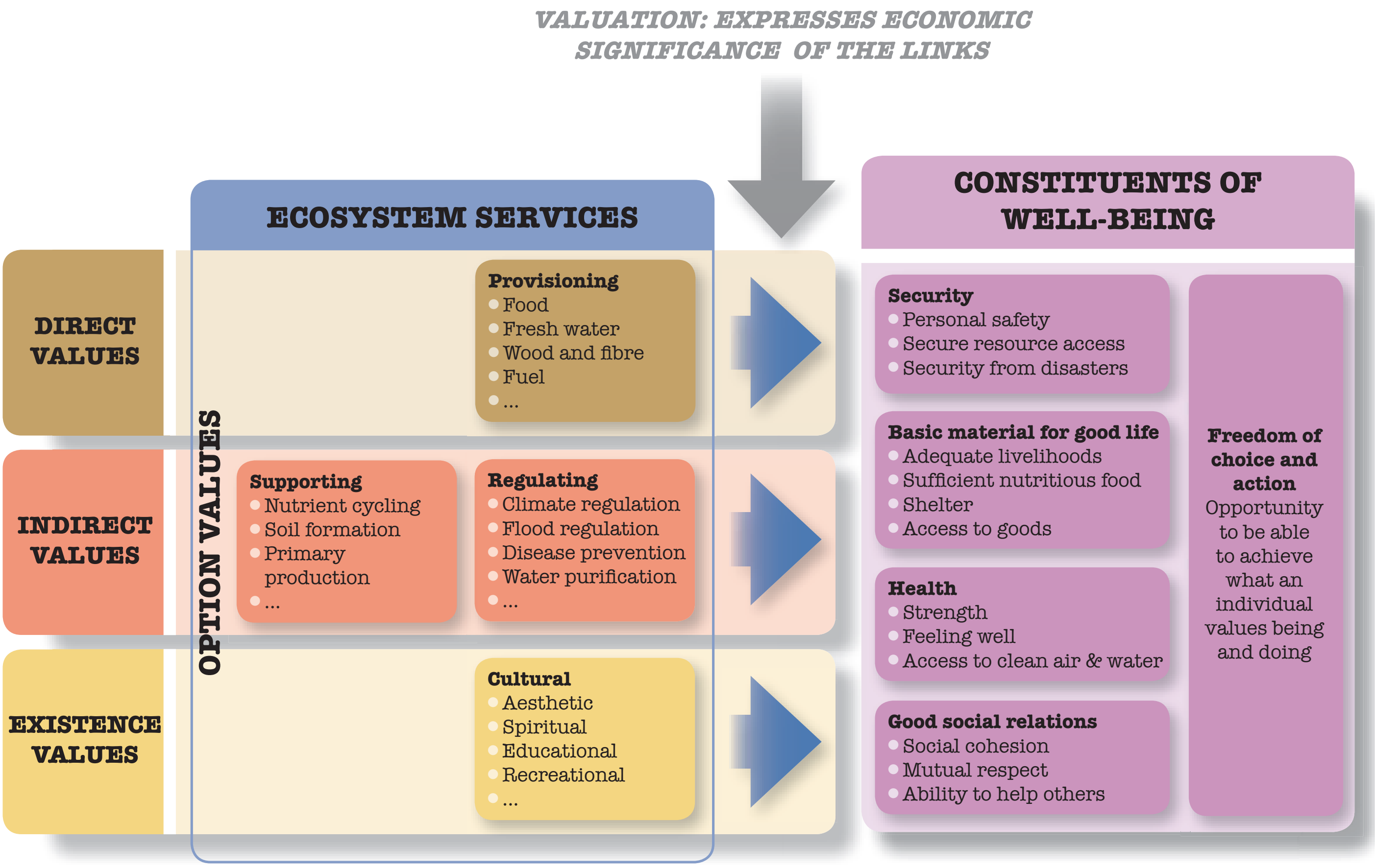


Figure 26: Ecosystem services, human well-being and the total economic value of wetlands. Adapted from MEA (2005)

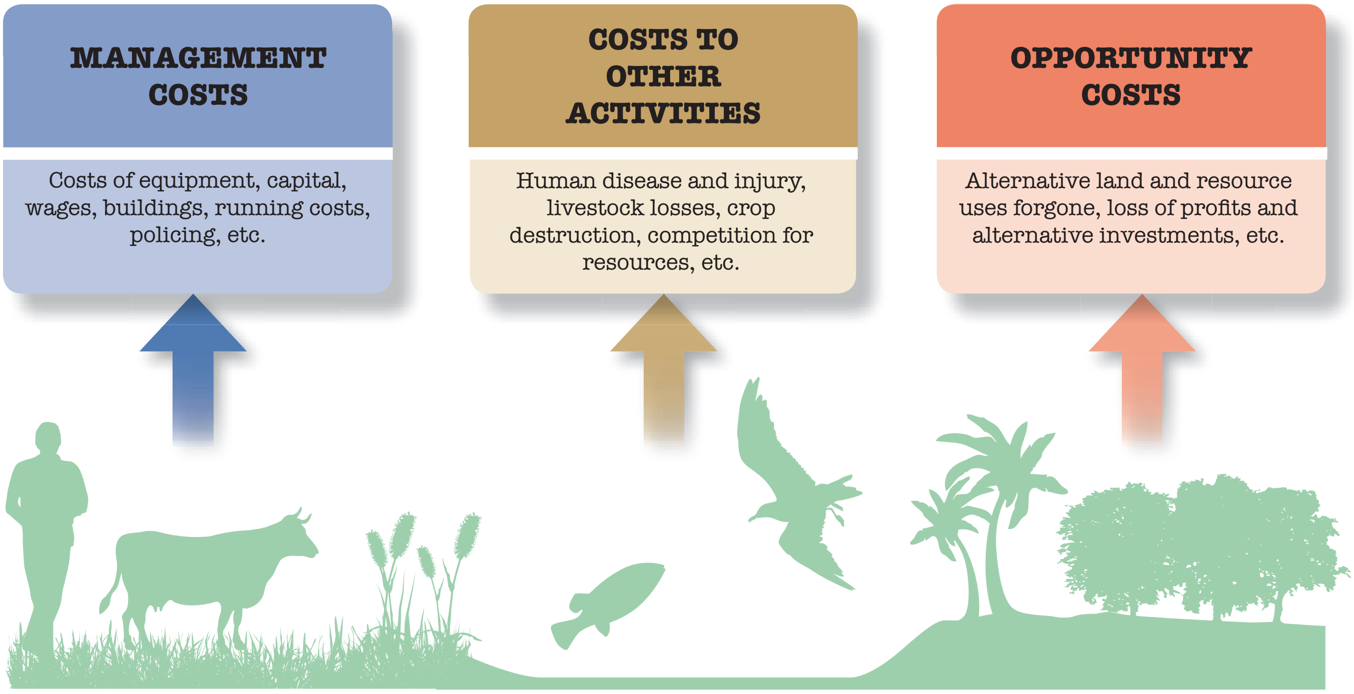


Figure 27: The total economic cost of wetlands (from Emerton 1999)

concerned with wetlands management. Wetlands give rise to costs because they preclude, diminish or interfere with other economic consumption and production activities. Valuation must take account of the full range of economic costs associated with wetlands as illustrated in Figure 27.

- **Management costs:** the direct physical expenditures on the equipment, infrastructure and human resources required to manage wetlands
- **Opportunity costs:** alternative uses of time, land, money or other resources required for wetland conservation which could have generated income and profits had they been used or allocated elsewhere
- **Costs to other activities:** damage and interference to human and economic activities caused by wetlands resources and species, including human and livestock disease and injury, crop pests and sources of competition over resources

All of these costs lead to economic losses because they require cash, necessitate expenditures, decrease income or reduce livelihood options. Valuation, in addition to making a monetary estimate of wetlands benefits, attempts to quantify the total economic costs associated with wetlands.

Step 4: Selecting the costs and benefits to be valued
There are limited data, time and other resources with which to carry out a valuation study. In most cases it is impossible to value each and every economic benefit and cost associated with a particular wetland. For this reason, it is necessary to decide on the coverage of the study – which benefits and costs it will value, and how. Once the major characteristics and values have been identified, they need to be prioritized in terms of their importance to the overall goal and objectives of the study (which, in turn, is determined by its management focus).

Step 5: Choosing the appropriate wetland valuation techniques
In summary, this step involves examining the economic methods and techniques that will be used to value selected wetland benefits/costs. It should result in a list relating wetland benefits/ costs to economic valuation techniques. A field checklist for choosing wetland valuation techniques is provided in the appendix (Figure 54).

A wide variety of methods are now available with which to quantify wetland values. Each method has different data and analytical requirements, is more or less applicable to different types of wetland costs and benefits, and has varying suitability in different contexts and situations. For this reason, having defined and prioritized which costs and benefits the valuation study will focus on, it is necessary to decide which method(s) will be used to determine the value of each.

After identifying the values and the costs and ranking them, they need to be assigned a monetary value. There are a number of techniques that are used to do this, which can be categorized in a number of ways. One way of classifying wetland valuation methods is to distinguish between revealed preference methods (those which rely on observing people's behaviour to ascertain the value of wetland goods and services) and stated preference methods (those which directly ask people the value they place

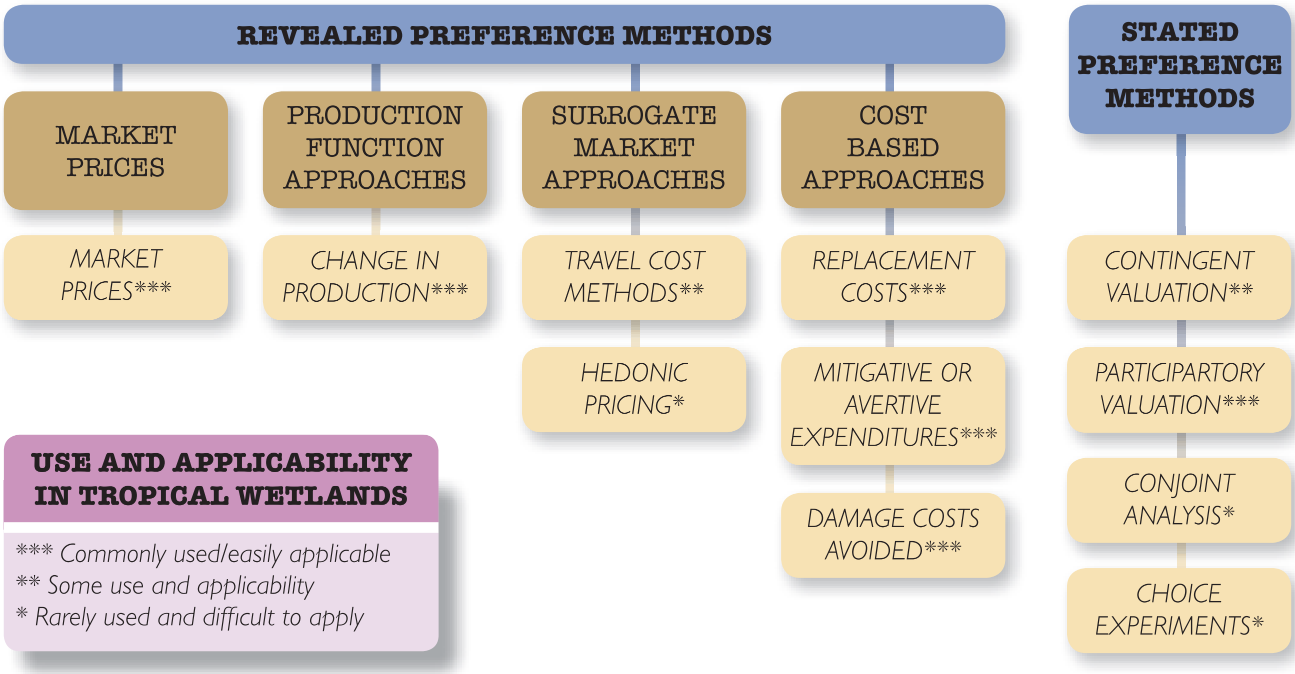


Figure 28: Methods for wetland valuation (from Emerton and Bos 2004)

on wetlands). These are illustrated in Figure 28, and described below.

- **Market prices:** this approach looks at the *market price* of ecosystem goods and services as they are bought or sold in the market

- **Production function approaches:** these approaches, including *effect on production*, attempt to relate changes in the output of a marketed good or service to a measurable change in the quality or quantity of ecosystem goods and services by establishing a biophysical or dose-response relationship between ecosystem quality, the provision of particular services, and related production

- **Surrogate market approaches:** these approaches, including *travel costs* and *hedonic pricing*, look at the ways in which the value of ecosystem goods and services are reflected indirectly in people's expenditures, or in the prices of other market goods and services

- **Cost-based approaches:** these approaches, including *replacement costs, mitigative or avertive expenditures* and *damage costs avoided*, look at the market trade-offs or costs avoided of maintaining ecosystems for their goods and services

- **Stated preference approaches:** rather than looking at the way in which people reveal their preferences for ecosystem goods and services through market production and consumption, these approaches ask consumers to state their preference directly. The most well-known technique is *contingent valuation*. *Participatory valuation* is gaining currency particularly in situations where wetland use is primarily for subsistence purposes, while less commonly-used stated preference valuation methods include *conjoint analysis* and *choice experiments*

All of these methods are elaborated in detail below, in Chapter E6. Different categories of method are more or less suitable for different kinds of wetland costs and benefits. Market price and surrogate market price techniques are most suitable for wetland direct values, while wetland indirect values are commonly measured using cost-based and production function approaches. Stated preference methods are, in principle, applicable to any category of wetland benefit, and provide some of the few available methods which can be used to estimate option and existence values.

E5 Stage III: Valuing wetland costs and benefits

Step 6: Undertaking the valuation exercise: carrying out data collection

In summary, this step involves formulating a list of the data that must be collected to enable the economic valuation of wetland benefits. It should result in a list of data requirements for valuing selected wetland benefits and costs. A field checklist for identifying data needs and sources for the valuation exercise is provided in the appendix (Figure 55).

Having prioritised the wetland costs and benefits to be valued, and selected the most appropriate methods by which to do this, it is necessary to determine what data will be required to apply the chosen valuation methods and to identify how these data will be collected. It should be underlined that before commencing valuation fieldwork, it is important to have thought through what data will be required, and how it will be sourced. Typically, a valuation study will use various data collection techniques and information sources, including both primary and secondary data collection:

- **Literature review:** including a review of similar valuation studies carried out in other areas or countries, as well as of documents and reports that contain information on the wetland under study such as project reports, government statistics and records, scientific articles and publications

- **Expert consultation:** including with technical experts (such as sociologists, hydrologists, biologists and ecologists, and civil engineers) as well as with the various stakeholders who are involved in managing and using the wetland (such as government officials, NGOs, community leaders, local households, and wetland user groups)

- **'Traditional' socio-economic information gathering techniques:** such as questionnaires, interviews and statistical analysis

- **Participatory techniques:** such as focus group interviews, PRA and RRA techniques

Having identified the data sources and collection techniques, the next thing is to actually apply the selected valuation methods. A detailed description of each of the main valuation techniques is given below, which is primarily drawn from IUCN's toolkit for valuing water-based ecosystem services (Emerton and Bos 2004).

E6 Stage III: Applying wetland valuation techniques

E6.1 Market price techniques

E6.1.1 Overview of the method

The simplest, most straightforward and commonly-used method for valuing any good or service is to look at its market price: how much it costs to buy, or what it is worth to sell. In a well-operating and competitive[1] market these prices are determined by the relative demand for and supply of the good or service in question, reflect its true scarcity, and equate to its marginal value[2].

In theory, market price techniques are applicable to any ecosystem good or service that can be freely bought or sold. They are particularly useful for valuing the resources and

Jens Kipping

A channel within the wetlands of the Okavango Delta, Botswana

products that are harvested from water-dependent ecosystems, for example timber, fuel wood, fish, or non-timber forest products. In the example of the Zambezi Basin given in Box 7, the study estimated the value of wetland products including crops, livestock, fish and tourism using market prices.

E6.1.2 Data collection and analysis requirements

There are three main steps involved in collecting and analysing the data required to use market price techniques to value ecosystem goods and services:

1. Find out the quantity of the good used, produced or exchanged
2. Collect data on its market price
3. Multiply price by quantity to determine its value

These data are generally easy to collect and analyse. Market information, including historical trends, can usually be obtained from a wide variety of sources such as government statistics, income and expenditure surveys, or market research studies. In most cases it will be necessary to supplement these secondary sources with original data, for example through performing market checks or conducting some form of socio-economic survey.

When applying this technique it is important to ensure that the data collected covers an adequate period of time and sample of consumers and/or producers. Factors to bear in mind include the possibility that prices, consumption and production may vary between seasons, for different socio-economic groups, at different stages of the marketing or value-added chain, and in different locations.

E6.1.3 Applicability, strengths and weaknesses

The greatest advantage of this technique is that it is relatively easy to use as it relies on observing actual market behaviour. Few assumptions, little detailed modelling, and only simple statistical analysis are required to apply it.

A major disadvantage is the fact that many ecosystem goods and services do not have markets or are subject to markets which are highly distorted or irregular. In such cases, it is inappropriate to use market price techniques:

- **Ecosystem services such as catchment protection or nutrient retention are rarely available for purchase or sale**. Because they have many of the characteristics of public goods[3], it is in fact questionable whether the market can ever accurately allocate or price them
- **Many ecosystem goods and natural products are utilised at the subsistence level**. They are not traded in formal markets, and are consumed only within the household
- **There exist a wide variety of subsidies and market interventions which distort the price of natural products or ecosystem-dependent goods**. Examples include subsidies to water and electricity, centrally-set royalties and fees for products such as timber, and state-controlled prices for basic food and consumer items
- **Because markets for most ecosystem goods and services are not well-developed, they tend not to be competitive, and prices are a poor indicator of true social and economic values**. This may be the case where there is an additional social or environmental premium attached to natural goods and services, where there are only a small number of buyers and sellers, or where there is imperfect market information
- **In many cases, even where an ecosystem good has a market and a price, it is impossible to measure the quantities produced or consumed**. Especially at the subsistence level, natural resource consumption and sale is often highly seasonal or irregular. For example, particular products are only available at particular times of the year, are used under special conditions, or are collected and used on an opportunistic basis. Ecosystem goods are also often collected and consumed as part of a bundle of items or have high levels of substitution[4] or complementarity[5] with other goods. For example, they are used only when other products are unavailable or unaffordable, or they form occasional inputs into the production of other goods
- **Even where an ecosystem good or service has a market, and quantities bought or sold can be measured, prices do not tell us how important this good or service is to society, nor how much some buyers would actually be willing to pay.**

In such cases it is usually necessary to use alternative valuation techniques, such as those described in Box 7.

E6.2 Effect on production techniques

E6.2.1 Overview of the method

Even when ecosystem goods and services do not themselves have a market price, other marketed products often rely on them as basic inputs. For example: downstream hydropower and irrigation depend on upper catchment protection services; fisheries depend on clean water supplies; and many sources of industrial production utilise natural products as raw materials. In these cases it is possible to assess the value of ecosystem goods and services by looking at their contribution to other sources of production, and to assess the effects of a change in the quality or quantity of ecosystem goods and services on

BOX 7: USING MARKET PRICE TECHNIQUES TO VALUE FRESHWATER WETLANDS IN THE ZAMBEZI BASIN, SOUTHERN AFRICA

The Zambezi River runs through Angola, Zambia, Botswana, Namibia, Zimbabwe, Malawi and Mozambique in Southern Africa. It is associated with a large number of wetlands, which yield a wide range of economically valuable goods and services. Wetland-dependent products and services include flood recession agriculture, fish, wildlife, grazing, forest resources, natural products and medicines, and ecotourism.

A study was carried out to estimate the value of the Zambezi's wetland goods using market price techniques. First, an inventory of the products and services was made for each wetland. Market prices were then used to calculate the value derived from each wetland. Crops and livestock were valued at their production value, and fish catches were valued according to their local sale price. Tourism earnings and utilisation charges were used to calculate the value of wildlife, and the market price of wetland products was applied to natural resource use. Donor contributions were assumed to reflect biodiversity conservation values.

Inputs and other production costs were deducted from these figures, so as to yield the marginal value of wetland resources. Total use values were extrapolated through making assumptions about the extent and intensity of wetland land and resource use. This yielded a marginal value of USD145 million a year for the 10 major wetlands in the Zambezi Basin, or an average of USD48 per hectare.

From Seyam *et al*. 2001

these broader outputs and profits.

Effect on production techniques can thus be used to value ecosystem goods and services that clearly form a part of other, marketed, sources of production. For example, watershed protection and water quality services, or natural resources that are used as raw materials. In the example in Box 8, the value of flood attenuation benefits is estimated through its contribution to crop production.

E6.2.2 Data collection and analysis requirements

There are three main steps to collect and analyse the data required for effect on production techniques to value ecosystem goods and services:

1. Determine the contribution of ecosystem goods and services to the related source of production, and specify the relationship between changes in the quality or quantity of a particular ecosystem good or service and output
2. Relate a specified change in the provision of the ecosystem good or service to a physical change in the output or availability of the related product
3. Estimate the market value of the change in production

Effect on production techniques rely on a simple logic, and it is relatively easy to collect and analyse the market information that is required to value changes in production of ecosystem-dependent products (see above, market price techniques).

The most difficult aspect of this method is determining and quantifying the biophysical or dose-response relationship that links changes in the supply or quality of ecosystem goods and services with other sources of production. For example, detailed data are required to relate catchment deforestation to a particular rate of soil erosion, consequent siltation of a hydropower dam and reduced power outputs, or to assess exactly the impacts of the loss of wetland habitat and water purification services on local fisheries production. To be able to specify these kinds of relationships with confidence usually involves wide consultation with other experts, and may require situation-specific laboratory or field research, controlled experiments, detailed modelling and statistical regression.

E6.2.3 Applicability, strengths and weaknesses

Effect on production techniques are commonly used, and have applicability to a wide range of ecosystem goods and services. Their weakness relates to the difficulties that are often involved in collecting sufficient data to be able to accurately predict the biophysical or dose-response relationships upon which the technique is based. Such relationships are often unclear, unproven, or hard to demonstrate in quantified terms. Simplifying assumptions is often required to apply the production function approach.

An additional concern is the large number of possible influences on product markets and prices. Some of these should be excluded when using effect on production techniques. In some cases changes in the provision of an ecosystem good or service may lead not just to a change in related production, but also to a change in the price of its outputs. That product may become scarcer, or more costly to produce. In other cases consumers and producers may switch to other products or technologies in response to ecosystem change or to a scarcity of ecosystem goods and services. Furthermore, general trends and exogenous factors unrelated to ecosystem goods and services may influence the market price of related production and consumption items. They must be isolated and eliminated from analysis.

BOX 8: USING EFFECT ON PRODUCTION TECHNIQUES TO VALUE FOREST FLOOD ATTENUATION BENEFITS IN EASTERN MADAGASCAR

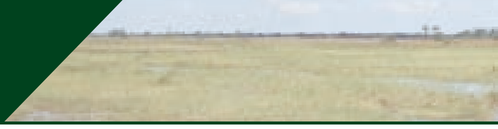
This study looked at the value of Mantadia National Park in conserving the upland forests that form the watershed for the Vohitra River in Eastern Madagascar. It employed effect on production techniques to do so. The productivity analysis measured the forest's watershed benefits in terms of increased economic welfare for farmers. These benefits result from reduced flooding as a consequence of reduced deforestation, which is in turn associated with the establishment of the national park and buffer zone.

The study used a three stage model to examine the relationship between economic value and the biophysical dimensions of the protected area. First, a relationship between land use changes and the extent of downstream flooding was established. Remote sensing was used to construct a deforestation history of the study area, and to ascertain an annual deforestation rate. Records of monthly river discharge were analysed for flood frequency and time trend, and the effects of land conversion on flooding were quantified.

A second stage was to ascertain the impacts of increased flooding on crop production. Flood damage to crops was estimated taking into account a range of parameters such as area of inundation, flood depth, duration, seasonality and frequency. Analysis focused on paddy rice cultivation, a high value and locally important form of agricultural production which is tied closely to flooding.

The final stage in the valuation study was to adopt a productivity analysis approach to evaluate flood damage in terms of lost producer surplus. The economic impact of changes in ecosystem quality was established using the net market value of paddy damaged by flooding. This found that a net present value for forest watershed protection benefits of USD126,700 resulting from the establishment of Mantadia National Park.

From Kramer *et al.* 1997



E6.3 Travel cost techniques

E6.3.1 Overview of the method

Ecosystems often hold a high value as recreational resources or leisure destinations. Even when there is no direct charge made to enjoy these benefits, people still spend time and money to visit ecosystems. These travel costs can be taken as an expression of the recreational value of ecosystems. We can use this technique at the whole ecosystem level, taking into account all of its attributes and components in combination, or for specific goods or services such as rare wildlife, opportunities for extractive utilisation of products such as fishing or resource collection, or for activities such as hiking or boating that are related to its services. In the example given in Box 9, improved freshwater ecosystem quality was estimated through looking at visitor travel costs.

E6.3.2 Data collection and analysis requirements

There are six main steps involved in collecting and analysing the data required to use travel cost techniques to value ecosystem goods and services:

1. Ascertain the total area from which recreational visitors come to visit an ecosystem, and divide this into zones within which travel costs are approximately equal
2. Within each zone, sample visitors to collect information about the costs incurred in visiting the ecosystem, motives for the trip, frequency of visits, site attributes and socio-economic variables (such as the visitor's place of origin, income, age, education and so on)
3. Obtain the visitation rates for each zone, and use this information to estimate the total number of visitor days per head of the local population
4. Estimate travel costs, including both direct expenses (such as fuel and fares, food, equipment, accommodation) and time spent on the trip
5. Carry out a statistical regression to test the relationship between visitation rates and other explanatory factors such as travel cost and socio-economic variables
6. Construct a demand curve relating number of visits to travel cost, model visitation rates at different prices, and calculate visitor consumer surplus[6]

Travel cost techniques depend on a relatively large data set. Quite complex statistical analysis and modelling are required in order to construct visitor demand curves. Basic data are usually collected via visitor interviews and questionnaires, which make special efforts to cover different seasons or times of the year, and to ensure that various types of visitors from different locations are represented.

E6.3.3 Applicability, strengths and weaknesses

The travel cost method is mainly limited to calculating recreational values, although it has in some cases been applied to the consumptive use of ecosystem goods.

Kong Kim Sreng/Darwin Integrated Wetland Assessment project

A lift-net fishery on the Mekong River near Stung Treng

Its main weakness is its dependence on large and detailed data sets, and relatively complex analytical techniques. Travel cost surveys are typically expensive and time-consuming to carry out. An additional source of complication is that several factors make it difficult to isolate the value of a particular ecosystem in relation to travel costs, and these must be taken into account in order to avoid over-estimating ecosystem values. Visitors frequently have several motives or destinations on a single trip, some of which are unrelated to the ecosystem being studied. They also usually enjoy multiple aspects and attributes of a single ecosystem. In some cases travel, not the destination *per se*, may be an end in itself.

BOX 9: USING TRAVEL COST TECHNIQUES TO VALUE THE IMPACTS OF IMPROVED ENVIRONMENTAL QUALITY ON FRESHWATER RECREATION IN THE US

The Conservation Reserve Programme (CRP) in the United States aims to mitigate the environmental effects of agriculture. A study was carried out to see how non-market valuation models could help in targeting conservation programmes such as the CRP. One component of this study focused on the impacts of improved environmental quality on freshwater recreation.

This study was based on data generated by surveys that had been carried out to ascertain the value of water-based recreation, fishing, hunting and wildlife. These surveys sampled 1,500 respondents in four sub-State regions who were asked to recall the number of visits made over the last year to wetlands, lakes and rivers where water was an important reason for their trip. The cost of these trips was imputed using the travel cost method.

The influence of CRP programmes on improved environmental quality and on consumer welfare was then modelled. The study found that the combined benefit of all freshwater-based recreation in the US was worth slightly over USD37 billion a year. The contribution of CRP efforts to environmental quality, as reflected in recreational travel values, was estimated at just over USD35 million, or about USD2.57 per hectare.

From Feather et al. 1999

E6.4 Hedonic pricing techniques

E6.4.1 Overview of the method

Even if they do not have a market price themselves, the presence, absence or quality of ecosystem goods and services influences the price that people pay for, or accept for providing, other goods and services. Hedonic pricing techniques look at the difference in prices that can be ascribed to the existence or level of ecosystem goods and services. Most commonly this method examines differences in property prices and wage rates between two locations, which have different environmental qualities or landscape values. In the example given in Box 10, the value of urban wetlands was estimated through looking at impacts on property prices.

E6.4.2 Data collection and analysis requirements

There are five main steps involved in collecting and analysing the data required to use hedonic pricing techniques to value ecosystem goods and services:

1. Decide on the indicator to be used to measure the quality or quantity of an ecosystem good or service associated with a particular job or property
2. Specify the functional relationship between wages or property prices and all of the relevant attributes that are associated with them, including ecosystem goods and services
3. Collect data on wages or property prices in different situations and areas which have varying quality and quantity of ecosystem goods and services
4. Use multiple regression analysis to obtain a correlation between wages or property prices and the ecosystem good or service
5. Derive a demand curve for the ecosystem good or service

Hedonic pricing techniques require the collection of a large amount of data, which must be subject to detailed and complex analysis. Data are usually gathered through market observation, questionnaires and interviews, which aim to represent a wide variety of situations and time periods.

E6.4.3 Applicability, strengths and weaknesses

Although hedonic pricing techniques can, in theory, be applied to any good or service they are most commonly used within the context of wage and property markets.

In practice, there remain very few examples of the application of hedonic pricing techniques to water-related ecosystem goods and services. One reason for this, and a weakness in this technique, is the very large data sets and detailed information that must be collected, covering all of the principal features affecting prices. It is often difficult to isolate specific ecosystem effects from other determinants of wages and property prices.

BOX 10: USING HEDONIC PRICING TECHNIQUES TO VALUE URBAN WETLANDS IN THE US

This study aimed to value wetland environmental amenities in the Portland, Oregon metropolitan region. It used hedonic pricing techniques to calculate urban residents' willingness to pay to live close to wetlands.

The study used a data set of almost 15,000 observations, with each observation representing a residential home sale. For each sale, information was obtained about the property price and a variety of structural, neighbourhood and environmental characteristics associated with the property, as well as socio-economic characteristics associated with the buyer. Wetlands were classified into four types — open water, emergent vegetation, forested, and scrub-shrub — and their area and distance from the property were recorded.

The first stage analysis used ordinary least squares regression to estimate a hedonic price function relating property sales prices to the structural characteristics of the property, neighbourhood attributes, and amenity value of nearby wetlands and other environmental resources. The second stage analysis consisted of constructing a willingness-to-pay function for the size of the nearest wetland to a residence. Results showed that wetland proximity and size exerted a significant influence on property values, especially for open water and larger wetlands.

From Mahan 1997

Another potential problem arises from the fact that this technique relies on the underlying assumption that wages and property prices are sensitive to the quality and supply of ecosystem goods and services. In many cases markets for property and employment are not perfectly competitive, and ecosystem quality is not a defining characteristic of where people buy property or engage in employment.

E6.5 Replacement cost techniques

E6.5.1 Overview of the method

It is sometimes possible to replace or replicate a particular ecosystem good or service with artificial or man-made products, infrastructure or technologies. For example, constructed reservoirs can replace natural lakes, sewage treatment plants can replace wetland wastewater treatment services, and many natural products have artificial alternatives. The cost of replacing an ecosystem good or service with such an alternative or substitute can be taken as an indicator of its value in terms of expenditures saved. In the example in Box 11, the value of wetland water quality services was estimated through looking at the costs of replacing these services by artificial means.

E6.5.2 Data collection and analysis requirements

There are three main steps involved in collecting and analysing

Sand collection from the Sanaga River in Cameroon for building construction

the data required to use replacement cost techniques to value ecosystem goods and services:

1. Ascertain the benefits that are associated with a given ecosystem good or service, how it is used and by whom, and the magnitude and extent of these benefits
2. Identify the most likely alternative source of product, infrastructure or technology that would provide an equivalent level of benefits to an equivalent population
3. Calculate the costs of introducing and distributing, or installing and running, the replacement to the ecosystem good or service

Data collection is relatively straightforward, and usually relies on secondary information about the benefits associated with a particular ecosystem good or service and alternatives that are available to replace it. In most cases this can be ascertained through expert consultation and professional estimates, supplemented with direct observation.

E6.5.3 Applicability, strengths and weaknesses

Replacement cost techniques are particularly useful for valuing ecosystem services, and have the great advantage that they are simple to apply and analyse. They are particularly useful where only limited time or financial resources are available for a valuation study, or where it is not possible to carry out detailed surveys and fieldwork.

The main weakness of this technique is that it is often difficult to find perfect replacements or substitutes for ecosystem goods and services that would provide an equivalent level of benefits to the same population. In some cases this results in ecosystem under-valuation, as artificial alternatives generate a lower quantity or quality of goods and services. Yet this technique may also lead to the over-valuation of ecosystem benefits, as in some instances the replacement product, infrastructure or technology may be associated with secondary benefits or additional positive impacts. The reality of the replacement cost technique is also sometimes questionable: we may question whether, in the absence of a well-functioning ecosystem, such expenditures would actually be made or considered worthwhile.

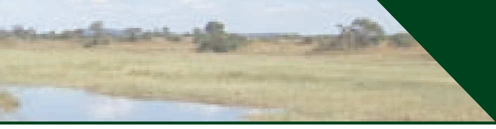
BOX 11: USING REPLACEMENT COST TECHNIQUES TO VALUE WETLAND WATER QUALITY SERVICES IN NAKIVUBO SWAMP, UGANDA

This study used replacement cost techniques to value the wastewater treatment services provided by Nakivubo Swamp, Uganda. Covering an area of some 5.5 km^2 and a catchment of over 40 km^2, the wetland runs from the central industrial district of Kampala, Uganda's capital city, passing through dense residential settlements before entering Lake Victoria at Murchison Bay.

One of the most important values associated with Nakivubo wetland is the role that it plays in assuring urban water quality in Kampala. Both the outflow of the only sewage treatment plant in the city, and — far more importantly, because over 90% of Kampala's population have no access to a piped sewage supply — the main drainage channel for the city, enter the top end of the wetland. Nakivubo functions as a buffer through which most of the city's industrial and urban wastewater passes before entering nearby Lake Victoria, and physically, chemically and biologically removes nutrients and pollution from these wastewaters. These services are important – the purified water flowing out of the wetland enters Lake Victoria only about three kilometres from the intake to Ggaba Water Works, which supplies all of the city's piped water supplies.

The study looked at the cost of replacing wetland wastewater processing services with artificial technologies. Replacement costs included two components: connecting Nakivubo channel to an upgraded sewage treatment plant which could cope with additional wastewater loads, and constructing elevated pit latrines to process sewage from nearby slum settlements. Data were collected from the National Water and Sewerage Corporation, from civil engineering companies, and from a donor-funded water supply and sanitation project that had been operating in a nearby urban wetland area. It also took into account the fact that some level of intervention would be required to manage Nakivubo more efficiently for water treatment, mainly through extending and reticulating the wastewater channels that flow into the swamp. These costs were deducted when wetland benefits were valued. The study found that the infrastructure required to achieve a similar level of wastewater treatment to that provided by the wetland would incur costs of up to USD2 million a year in terms of extending sewerage and treatment facilities.

From Emerton *et al.* 1999



E6.6 Mitigative or avertive expenditure techniques

E6.6.1 Overview of the method

When an economically valuable ecosystem good or service is lost, or there is a decline in its quantity or quality, this almost always has a negative effect. It may become necessary to take steps to mitigate or avert these negative effects so as to avoid economic losses. For example: the loss of upstream catchment protection can make it necessary to desilt reservoirs and dams: the loss of wetland treatment services may require the upgrading of water purification facilities; and the loss of ecosystem flood control may require the construction of flood control barriers. These mitigative or avertive expenditures can be taken as indicators of the value of maintaining ecosystem goods and services in terms of costs avoided. In the example in Box 12, the value of wetland flood attenuation services was estimated through looking at the expenditures that would be required to mitigate or avert the effects of the loss of these services.

E6.6.2 Data collection and analysis requirements

There are four main steps involved in collecting and analysing the data required to use mitigative or avertive expenditure techniques to value ecosystem goods and services:

1. Identify the negative effects or hazards that would arise from the loss of a particular ecosystem good or service
2. Locate the area and population which would be affected by the loss of the ecosystem good and service, and determine a cut-off point beyond which the effect will not be analysed
3. Obtain information on people's responses, and measures taken to mitigate or avert the negative effects of the loss of the ecosystem good or service
4. Cost the mitigative or avertive expenditures

Data collection and analysis is relatively straightforward, and usually relies on a combination of interviews, surveys, direct observation and expert consultation.

E6.6.3 Applicability, strengths and weaknesses

Mitigative or avertive expenditure techniques are particularly useful for valuing ecosystem services. In common with other cost-based valuation methods, a major strength is their ease of implementation and analysis, and their relatively small data requirements.

As is the case with the replacement cost technique, the mitigative or avertive measures that are employed in response to the loss of ecosystem goods and services do not always provide an equivalent level of benefits. In some cases it is also questionable whether in fact such expenditures should be made or can be seen as being worth making. An additional important factor to bear in mind when applying this technique is that people's perceptions of the effects of ecosystem loss, and what would be required to mitigate or avert these effects, may not always match those of 'expert' opinion.

BOX 12: USING MITIGATIVE OR AVERTIVE EXPENDITURE TECHNIQUES TO VALUE WETLAND FLOOD ATTENUATION IN SRI LANKA

This study used avertive expenditure techniques to value the flood attenuation services of Muthurajawela Marsh in Sri Lanka. Muthurajawela is a coastal peat bog which covers an area of some 3,100 hectares, running alongside the Indian Ocean between 10-30 km north of Colombo, Sri Lanka's capital city. One of its most important functions is its role in local flood control.

The study first involved investigating the biophysical characteristics of the marsh, and their relationship to local flooding patterns. Data were obtained from hydrological surveys, which estimated the maximum water storage capacity of the marsh at 11 million cubic metres, with a maximum discharge of 12.5 cubic metres per second and a retention period of more than 10 days. Analysis of historical rainfall and stream flow data found that during the rainy season large volumes of water enter the wetland system, from rainfall, through run-off from surrounding higher grounds and via floodwaters from the Dandugam Oya, Kala Oya and Kelani Ganga Rivers. Muthurajawela buffers these floodwaters and discharges them slowly into the sea.

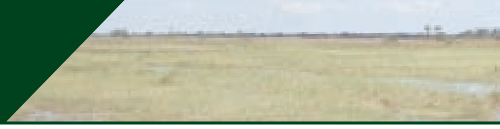
The value of these services was calculated by looking at the flood control measures that would be necessary to mitigate or avert the effects of wetland loss. Consultation with civil engineers showed that this would involve constructing a drainage system and pumping station, deepening and widening the channels of water courses flowing between the marsh area and the sea, installing infrastructure to divert floodwaters into a retention area, and pumping water out to sea. Cost estimates for this type of flood control measure were available for Mudu Ela, a nearby wetland that has recently been converted to a housing scheme. Here infrastructure had been installed to ensure that a total of 443 acres of land remains drained, in order to reclaim an area of 360 acres. Extrapolating the capital and maintenance costs from Mudu Ela to Muthurajawela gave an annual value for flood attenuation of more than USD5 million, or USD1,750 per hectare of wetland area.

From Emerton and Kekulandala 2002

E6.7 Damage cost avoided techniques

E6.7.1 Overview of the method

Ecosystem services frequently protect other economically valuable assets. For example, the loss of catchment protection services may result in increased downstream siltation and flooding, which leads to the destruction of infrastructure, settlements and agriculture. Such damage costs can be taken to represent the economic value of ecosystems in terms of expenditures avoided. In the example in Box 13, the value of



wetland flood attenuation was estimated through looking at costs of damage avoided by conserving ecosystems.

E6.7.2 Data collection and analysis requirements

There are four main steps involved in collecting and analysing the data required to use damage cost avoided techniques to value ecosystem goods and services:

1. Identify the protective services of the ecosystem, in terms of the degree of protection afforded and the on- and off-site damages that would occur as a result of loss of this protection
2. For the specific change in ecosystem service provision that is being considered, locate the infrastructure, output or human population that would be affected by this damage, and determine a cut-off point beyond which effects will not be analysed
3. Obtain information on the likelihood and frequency of damaging events occurring under different scenarios of ecosystem loss, the spread of their impacts and the magnitude of damage caused
4. Cost these damages and ascribe the contribution of the ecosystem service towards minimising or avoiding them

Data collection is for the most part straightforward, usually relying on a combination of analysis of historical records, direct observation, interviews, and professional estimates. Predicting and quantifying the likelihood and impacts of damage events under different ecosystem scenarios is however usually a more complex exercise, and may require detailed data and modelling.

E6.7.3 Strengths and weaknesses of the method

Damage cost avoided techniques are particularly useful for valuing ecosystem services. There is often confusion between the application of damage costs avoided and production function approaches to valuation. Here it is important to underline that whereas this technique deals with damage avoided, such as from pollution and natural hazards (which are typically external effects), change in production techniques usually relates to changes in some input such as water (typically internalised).

A potential weakness is that in most cases estimates of damages remain hypothetical. They are based on predicting what might occur under a situation where ecosystem services decline or are lost. Even when valuation is based on real data from situations where such events and damages have occurred, it is often difficult to relate these damages to changes in ecosystem status, or to be sure that identical impacts would occur if particular ecosystem services declined.

E6.8 Contingent valuation techniques

E6.8.1 Overview of the method

Absence of prices or markets for ecosystem goods and services, of close replacements or substitutes, or of links to other production or consumption processes, does not mean that they have no value to people. Contingent valuation techniques infer the value that people place on ecosystem goods and services by asking them directly what is their willingness to pay (WTP) for them or their willingness to accept compensation (WTA) for their loss, under the hypothetical situation that they could be available for purchase.

Contingent valuation methods might, for example, ask how much people would be willing to see their water bills increase in order

BOX 13: USING DAMAGE COST AVOIDED TECHNIQUES TO VALUE THE ROLE OF FLOOD ATTENUATION IN THE LOWER SHIRE WETLANDS, MALAWI AND MOZAMBIQUE AND BAROTSE FLOODPLAIN, ZAMBIA

The Lower Shire Wetlands in Malawi and Mozambique and the Barotse Floodplain in Zambia cover a combined area of approximately 1.5 million hectares. They generate a number of economically important goods and services, one of which is flood attenuation. The wetlands play an appreciable role in minimising flood peaks and reducing flow velocity, because they store water and even out its release over time. At the onset of the rainy season, or in times of peak river flow, their large surface areas to depth and volume ratios mean that they are able to absorb and spread out water over a large area. The emptying of floodplains may take four times as long as the period between initial and peak season. The Barotse floodplain, for example, is capable of storing over 17.2 X 109 m^3 of water at peak floods, and may delay the downstream flooding peak by some three to five weeks.

The economic value of flood attenuation was assigned by looking at the extent to which the wetlands minimise downstream flooding and thereby reduce damage to infrastructure, land and associated settlement and production opportunities. The valuation study involved assessing the frequency of floods, their severity of impact, and the economic damages they gave rise to. Affected areas were identified by land use and settlement maps which showed where human populations and production activities were concentrated, district-level census and production statistics. Historical records provided estimates of flooding frequency and impacts, and the production and infrastructure damages that had arisen as a result of floods.

Taking account of the costs of temporary relocation of people, replacement of damaged roads and rail infrastructure, loss of farm fields and livestock and settlements destroyed, the study found a flood attenuation value for the two wetlands areas with a present value of over USD3 million.

From Turpie *et al.* 1999

to uphold quality standards, what they would pay as a voluntary fee to manage an upstream catchment in order to maintain water supplies, how much they would contribute to a fund for the conservation of a beautiful landscape or rare species, or the extent to which they would be willing to share in the costs of maintaining important ecosystem water services. In the example given in Box 14, household willingness to pay for conservation was taken as an estimate of the value of coastal wetlands.

E6.8.2 Data collection and analysis requirements

There are five main steps involved in collecting and analysing the data required to use contingent valuation techniques to value ecosystem goods and services:

1. Ask respondents their WTP or WTA for a particular ecosystem good or service
2. Draw up a frequency distribution relating the size of different WTP/WTA statements to the number of people making them
3. Cross-tabulate WTP/WTA responses with respondents' socio-economic characteristics and other relevant factors
4. Use multivariate statistical techniques to correlate responses with respondent's socio-economic attributes
5. Gross up sample results to obtain the value likely to be placed on the ecosystem good or service by the whole population, or the entire group of users

This valuation technique requires complex data collection and sophisticated statistical analysis and modelling, which are described in detail elsewhere (see Carson and Mitchell 1989).

Most contingent valuation studies are conducted via interviews or postal surveys with individuals, but sometimes interviews are conducted with groups. A variety of methods are used in order to elicit people's statement or bids of their WTP/WTA for particular ecosystem goods or services in relation to specified changes in their quantity or quality. The two main variants of contingent valuation are: dichotomous choice surveys, which present an upper and lower estimate between which respondents have to choose; and open-ended surveys, which let respondents determine their own bids. More sophisticated techniques are also sometimes used, such as engaging in trade-off games or using take-it-or-leave it experiments. The Delphi technique uses expert opinion rather than approaching consumers directly.

E6.8.3 Applicability, strengths and weaknesses

A major strength of contingent valuation techniques is that, because they do not rely on actual markets or observed behaviour, they can in theory be applied to any situation, good or service. They remain one of the only methods that can be applied to option and existence values, and are widely used to determine the value of ecosystem services. Contingent valuation techniques are often used in combination with other valuation methods, in order to supplement or cross-check their results.

One of the biggest disadvantages of contingent valuation is the large and costly surveys, complex data sets, and sophisticated analysis techniques that it requires. Another constraint arises from the fact that it relies on a hypothetical scenario which may not reflect reality or be convincing to respondents.

Contingent valuation techniques require people to state their preferences for ecosystem goods and services. They are therefore susceptible to various sources of bias, which may influence their results. The most common forms of bias are strategic, design, instrument, and starting point bias. Strategic bias occurs when respondents believe that they can influence a real course of events by how they answer WTP/WTA questions. Respondents may for instance think that a survey's hypothetical scenario of the imposition of a water charge or ecosystem fee is actually in preparation. Design bias relates to the way in which information is put across in the survey instrument. For example, a survey may provide inadequate information about the hypothetical scenario, or respondents are misled by its description. Instrument bias arises when respondents react strongly against the proposed payment methods. Respondents may for instance resent new taxes or increased bills. Starting point bias occurs when the starting point for eliciting bids skews the possible range of answers, because it is too high, too low, or varies significantly from respondents' WTP/WTA. With careful survey design, most of these sources of bias can however be reduced or eliminated.

BOX 14: USING CONTINGENT VALUATION TECHNIQUES TO VALUE COASTAL WETLANDS IN KOREA

This study used contingent valuation techniques to estimate the non-extractive benefits of conserving coastal wetlands around the Youngsan River in Korea. It focused primarily on the landscape, recreational, amenity and existence values.

The study involved a survey of more than 1,000 local residents. It elicited willingness to pay for a conservation programme designed to maintain coastal wetlands rather than develop them for alternative uses, measured through additional household taxes. Questionnaires ascertained respondents' attitudes and perceptions of coastal wetlands, their willingness to pay a minimum or maximum tax increase, and collected information about socio-economic variables such as age, education, income, marital status and expenditures on recreation.

Correlating these variables with respondent willingness to pay enabled the study to construct a demand curve for coastal wetlands. Overall, respondents stated that they would be willing to pay almost USD40 per household per month to ensure that coastal wetlands were conserved, suggesting an annual aggregate conservation value of more than USD176 million.

From Pyo 2002

E6.9 Participatory valuation techniques

E6.9.1 Overview of the method

It is often difficult to use conventional environmental valuation techniques within largely subsistence-based economies, or to generate realistic estimates of local wetland use. Participatory valuation responds to some of the constraints and problems associated with using conventional valuation techniques, including:

- Many wetland goods have no substitute or market price, or it is unrealistic to use these as a proxy for their value in situations where the majority of the population do not have access to markets or substitutes
- Cash measures and market prices may have little relevance in a subsistence economy where cash is not the main medium of exchange or indicator of local value
- People frequently become suspicious when faced with a scenario where they must state a monetary willingness to pay/ accept compensation for a natural product, if they suspect that they will be actually subjected to some kind of payment, tax or compensation. They will often under-quote the amount of money they would be willing to pay for wetlands goods if they fear that such charges may actually be made in the future, and over-quote the compensation they require if they think there may be a possibility of actually receiving payments
- Wetland resource collection and access are frequently illegal in protected areas. People are reluctant to speak openly about their wetland use activities because they fear arrest. Some activities also have ritual or cultural significance, and knowledge is considered the preserve of specialist groups. Whereas households are reticent in the face of direct questioning, indirect techniques are a good means of stimulating discussion and gathering information

Participatory valuation aims to find a bridge between local economic systems and cash values, and elicit information about wetland use and values at the subsistence, non-market level. It allows people to define wetland values within the context of their own perceptions, needs and priorities rather than according to externally-imposed categories or market prices. It is particularly suitable for valuing occasional, subsistence-based or illegal wetland uses, and for relating wetland values to broader household livelihoods. See Box 15 for an example of participatory wetland resource valuation.

E6.9.2 Data collection and analysis requirements

There are seven main steps to collect and analyse the data required for participatory valuation techniques to value ecosystem goods and services:

1. Establishing the categories of wetland product, and types of activities, that are carried out in a particular locality
2. Defining a numeraire or yardstick for valuation which is not cash. This is usually a commodity or item that forms an important part of the local socio-economy, has wide significance as an item of local value and exchange, and can easily be translated into a cash amount
3. Using picture cards to refer to each wetland product or activity that is used, and to the selected numeraire
4. Performing a ranking exercise on the picture cards, to ascertain the relative importance of different products
5. Establishing values by distributing a set number of counters between different picture cards, including the numeraire
6. Using the number of counters allocated to each card, translating wetland products into numeraire equivalents and converting this to cash amounts based on the price/ market value of the numeraire
7. Discounting the resulting figures to give annual wetland use values

E6.9.3 Applicability, strengths and weaknesses

Participatory valuation techniques have most applicability to subsistence economies, particularly those which are relatively remote and where the majority of the population have a high livelihood dependence on wetland products. They are particularly useful in situations where wetland goods are used for subsistence purposes only, or where wetland use is illegal or for some other reason a sensitive topic.

One factor to bear in mind is that even where markets for wetland products exist, participatory valuation rarely yields the same value estimates as market prices. This is because it is based on local perceptions of value, which may well not coincide with market-driven prices. Different people will value products differently, as values will reflect their relative importance to them in their daily lives, according to their personal preferences and responsibilities. Participatory valuation often yields far higher estimates of wetland value than other methods, because it incorporates a wide range of perceptions of value and is not confined to market prices alone.

Selection of the numeraire must be undertaken carefully, and a single measure used consistently across the community being studied. It is often challenging to identify a measure which has relevance and value for all concerned, and can be accurately reflected via a monetary value. It should be emphasised that the results of participatory valuation *must* be converted to an equivalent annual amount (or whatever time period that wetland values are being calculated for). This depends on the effective lifespan of the numeraire that has been selected.

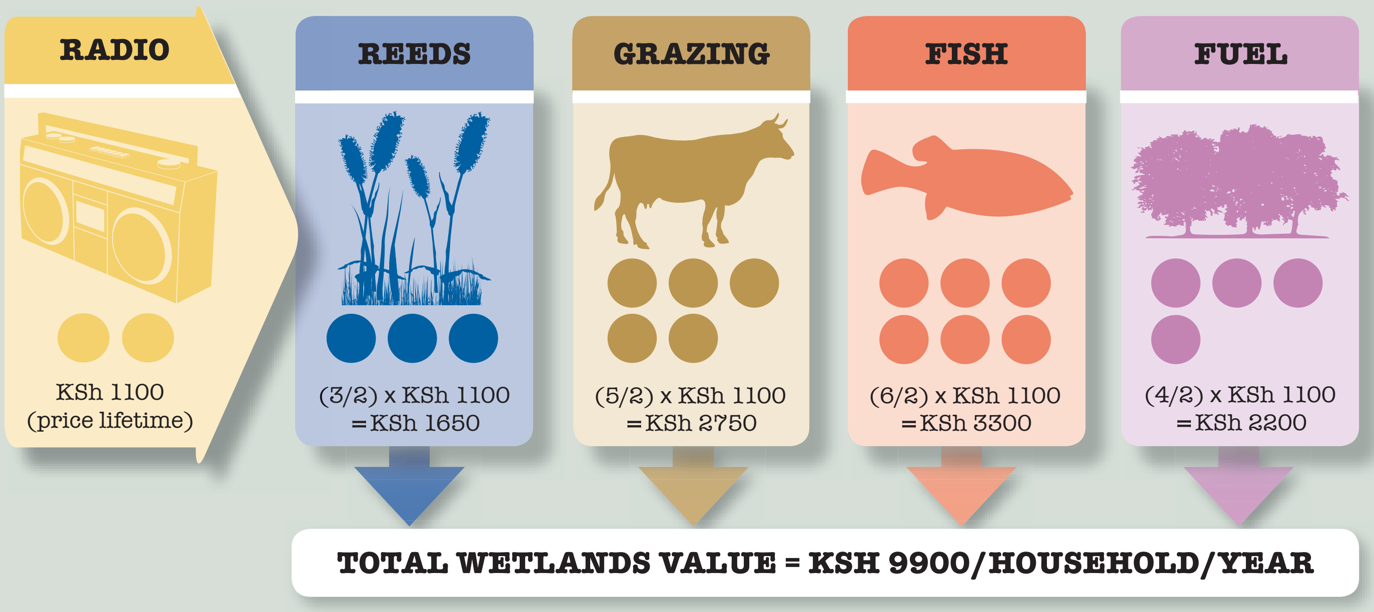
E6.10 Other stated preference techniques: conjoint analysis and choice experiments

Other stated preference valuation methods include conjoint analysis and choice experiments. Due to their complexity in terms of data needs and analysis, and because there exist very few examples of their application to ecosystem water services (see, for

BOX 15: USING PARTICIPATORY VALUATION TO VALUE WETLAND UTILISATION IN SACRED LAKE, KENYA

Wetland resources form an important part of domestic subsistence and local livelihoods around Sacred Lake in Mount Kenya Forest. The bulk of wetland products are used within the household only, and are never bought or sold. Wetland utilisation is also highly variable at different times of the year. Many wetland uses are illegal so people are reluctant to speak openly about their activities because they fear arrest. Some wetland activities also have ritual or cultural significance, and knowledge is considered the preserve of specialist groups.

For all these reasons it was necessary to use an indirect technique for valuation which would allow people to define wetland values within the context of their own perceptions, needs and priorities rather than according to cash amounts. Whereas households proved reticent in the face of direct questioning, drawing and manipulating pictures of different wetland activities was found to be a good means of stimulating discussion. These pictures were used to value wetlands utilisation.



Because cash measures had little relevance in a subsistence economy such as that around Sacred Lake, it was necessary to find a numeraire for valuation which formed part of the local socio-economy, had wide significance as an item of value, and could be translated easily into a monetary amount.

Households chose a radio as the most appropriate measure of local value. Picture cards depicting wetland activities were laid out together with a picture of a radio. Each household then distributed 20 beans as counters between these different activities and the numeraire card. It was thus possible to measure the perceived value of wetland products in terms of radio equivalents, and translate each wetland product into a cash amount based on the market value of a radio, giving a total annual value for wetland utilisation of approximately USD200 per household.

From Emerton 1998

example, DGA and UAC 2000, Griner and Farber 1996, Kuriyama 2002, Morrison *et al.* 1998), these methods are not described in detail here.

Conjoint analysis was originally developed in the fields of marketing and psychology, in order to measure individuals' preferences for different characteristics or attributes of a multi-choice attribute problem. In contrast to contingent valuation, conjoint analysis does not explicitly require individuals to state their willingness to pay for environmental quality. Rather, conjoint asks individuals to consider status quo and alternative states of the world. It describes a specific hypothetical scenario and various environmental goods and services between which they have to make a choice. The method elicits information from the respondent on preferences between various alternatives of environmental goods and services, at different prices or costs to the individual.

Choice experiments techniques present a series of alternative resource or ecosystem use options, each of which are defined by various attributes including price. Choice of the preferred option from each set of options indicates the value placed on ecosystem attributes. As is the case for contingent valuation, data collection and analysis for choice experiments is relatively complex. Usually conducted by means of questionnaires and interviews, choice experiments ask respondents to evaluate a series of 'sets', each containing different bundles of ecosystem goods and services. Usually, each alternative is defined by a number of attributes. For example, for a specific ecosystem this might include attributes such as species mix, ecosystem status, landscape, size of area, and price or cost. These attributes are varied across the different alternatives, and respondents are asked to choose their most preferred alternative. Aggregate choice frequencies are modelled to infer the relative impact of each attribute on choice, and the marginal value of each attribute for a given option is calculated using statistical methods.

E7 Stage IV: Analysing and presenting the data for decision-making

Calculating the economic value of wetlands is not an end in itself. Rather, it is a means of providing information which can be used to make better and more informed choices about how resources are managed, used and allocated. In order for the results of the valuation study to influence real-world policy and practice, it is of critical importance that time and thought is given to analysing the data that has been gathered, and presenting it in a form that captures the attention of decision-makers, and is convincing to them.

Step 7: Analysing and expressing the valuation data
In summary, this step involves relating values to the management issue or scenario under study and expressing changes in wetland status as indicators for decision-making support. It should result in quantified estimates of wetland benefits and costs, understanding of the economic implications of particular wetland management scenarios, and expression of changes in wetland status as indicators for decision-making support.

Decision-makers, whether in conservation or development sectors, are primarily concerned with choosing between different uses of land, funds and other resources, for example: whether to manage a wetland under strict protection or to allow for some form of sustainable use; whether or not to build a dam, irrigation scheme or housing estate; which infrastructure design option to invest in; or whether to zone a wetland for conservation or to convert it to settlement or agriculture (assessing damage to a wetland). To analyse the results of a valuation study thus we need to be able to express ecosystem values as measures that make sense to decision-makers when they weigh up the different funding, land and resource management choices that wetland decisions involve.

Conducting a valuation study provides us with data about the economic value of particular wetland goods and services. However, what is important for decision-making is the ability to understand and express how making choices between alternative uses of land, water, resources or investment funds will influence these values. For example, how much additional flood-related costs would be incurred if a wetland were degraded, and what downstream production losses would arise from additional silt loads? Or, what additional investments in water treatment and purification would be required if a particular wetland were reclaimed? Or, what potential actually exists for raising revenues from urban dwellers to maintain water quality in a particular river or lake?

In order to answer these questions, and to integrate wetlands values into these decision-making processes, it is necessary to be able to analyse data so as to trace the economic implications of changes in the stock of wetland resources, flows of wetland services, or attributes of wetland systems that result from following a particular course of action, and factor them into measures of its economic desirability. In other words, we need to know what the economic impacts of particular decisions will be in terms of wetland costs and benefits.

E7.1 Building up a bio-economic model

Various studies have demonstrated the utility of applying a simple bio-economic model in order to generate information for wetland decision-making (Creemers and van den Bergh 1998, Colavito 2002, Bennett and Whitten 2002). This type of model presents a useful tool for relating wetland values to decision-making, and involves a number of steps which translate baseline data on ecosystem values into information that can be used to assess the economic impacts of decisions on wetlands:

- **Establish ecological and socio-economic background and parameters:** identifying, defining and understanding the status of the wetland and its links to hydrological goods and services, their benefits and beneficiaries, and the way in which various social, institutional and management aspects affect it
- **Calculate baseline economic values from which to measure ecosystem changes:** carrying out the partial or total valuation study
- **Link physical changes in ecosystem status and integrity to changes in these economic values:** tracing the effects of different decisions on the provision of wetland goods and services, and determining the impacts of these changes on economic values
- **Express the results as indicators or measures that can be integrated into broader economic appraisal or analysis processes:** expressing the results of value changes as quantitative indicators or measures that can be integrated into wider decision-support frameworks

The next two sub-sections look at two of the most commonly used techniques for expressing wetland values in decision-making: cost-benefit analysis and multi-criteria analysis.

E7.2 Cost-benefit analysis

Cost-benefit analysis (CBA) remains the most commonly-used decision-making framework for using the results of a wetland

Jens Kipping

The Zambezi River below Victoria Falls

valuation study in order to assess and compare economic and financial trade-offs. It is the standard tool for appraising and evaluating programmes, projects and policies and one that is a required part of many government and donor decision-making procedures. CBA is a decision tool that judges alternative courses of action by comparing their costs and benefits. It assesses profitability or desirability according to net present benefits – the total annual benefits minus total annual costs for each year of analysis or project lifetime, expressed as a single measure of value in today's terms.

In order to bring a project's benefits and costs over time to their present value, each is discounted. Discounting is essentially the inverse of applying a compound interest rate, and gives values relatively less weight the further into the future they accrue. It accounts for the fact that people generally prefer to enjoy benefits now and costs later, and that any funds tied up in a project could be used productively to generate returns or profits elsewhere. In most cases, the discount rate is therefore based on the opportunity cost of capital – the prevailing rate of return on investments elsewhere in the economy.

CBA presents three basic measures of worth, which allow different projects, programmes or policies to be assessed and compared with each other:

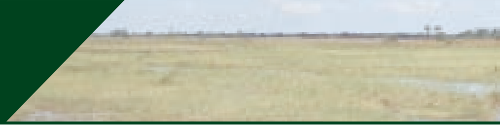
- **Net Present Value (NPV)** is the sum of discounted net benefits (i.e. benefits minus costs), and shows whether a project generates more benefits than it incurs costs
- **Benefit Cost Ratio (BCR)** is the ratio between discounted total benefits and costs, and shows the extent to which project benefits exceed costs
- **Internal Rate of Return (IRR)** is the discount rate at which a project's NPV becomes zero

In general, a project can be considered to be worthwhile if its NPV is positive and its BCR is greater than one and if its IRR exceeds the discount rate. A positive NPV and a BCR greater than one means the project generates benefits that are greater than its costs. An IRR above the discount rate means that the project generates returns in excess of those which could be expected from alternative investments.

There are basically two types of Cost-Benefit Analyses: financial and economic. Financial CBAs look only at the private returns accruing to a particular individual or group. They calculate costs and benefits at market prices, reflecting the actual cash profits and expenditures that people face. A financial CBA might for example measure and compare the relative profitability of different dam design options for a hydropower company, the returns to improved water and sanitation facilities for urban consumers, or the highest earning mix of irrigated crops for a farmer. Here, wetland values will primarily be incorporated into CBA calculations as they influence private costs and benefits, affect investments and are expressed through market prices.

In contrast, economic CBAs examine the effects of projects, programmes and policies on society as a whole. They consider all costs and benefits, for all affected groups. Sometimes weights are assigned to prioritise particular groups, benefits or costs that are considered to be of particular importance in economic terms. As such, economic CBAs are mainly carried out by public sector and donor agencies, who are concerned with broad development impacts. For example, an economic CBA would consider the total costs and benefits of different hydropower design options, such as relocation costs and loss of production incurred by reservoir flooding, income from increased employment in the power sector, and benefits associated with improved earning opportunities arising from electrification. An economic CBA of different irrigated crop mixes might include consideration of the premium attached to foreign exchange earnings from export crops, improved food security benefits, and revenues in agro-processing and value-added industries.

Because economic CBAs assess the desirability of a given course of action from the perspective of society as a whole, they usually adjust financial costs and benefits to account for the various imperfections and distortions in the market. They recognise that market prices are not a good indicator of the true social and economic value of goods and services. This means that wetland values should form an integral component of economic CBAs.



E7.3 Other economic decision-support tools

CBA remains the most widely-used tool for the financial and economic appraisal of projects, programmes and policies. Other, less commonly-used, value-based measures of profitability or economic/financial desirability include:

- **Cost-effectiveness analysis:** this decision-support tool judges the minimum cost way of attaining a particular objective. It is useful where a project has no measurable benefits, or where a particular goal has already been set (for example maintaining a certain water quality level). It involves calculating all the costs of attaining the given objective, discounting them, and pointing to the option with the lowest NPV
- **Risk-benefit analysis:** this decision-support tool focuses on the prevention of events carrying serious risks (for example investing in flood prevention). It assesses the costs of inaction as the likelihood of the specified risk occurring. The benefit of inaction is the saving in the cost of preventive measures. This is useful where risk is a major consideration in projects, and can be captured via monetary values
- **Decision analysis:** this decision-support tool weights the expected values of a given course of action (in other words, the sum of possible values weighted by their probability of occurring) by attitudes to risk, to give expected utilities. It draws up and assesses decision makers' preferences, judgements and trade-offs in order to obtain weights that are attached to outcomes carrying different levels of risk
- **Multi-criteria analysis:** multi-criteria analysis provides one of the most useful and increasingly common tools for integrating different types of monetary and non-monetary decision criteria. It has been developed to deal with situations where decisions must be made taking into account multiple objectives, which cannot be reduced to a single dimension. Multi-criteria analysis is usually clustered into three dimensions: the ecological, the economic and the social. Within each of these dimensions certain criteria are set, so that decision-makers can weigh the importance of one element in association with the others. Here, monetary values and CBA measures can be incorporated as one of the criteria to be considered, and weighed against the others in decision-making

Step 8: Presenting management and decision-making conclusions
In summary, this step involves relating the findings of the valuation study to ongoing management issues, and targeting this to particular audiences and aims. It should result in a convincing report on the economic status and value of the wetland as it relates to management priorities and threats.

However good the results of a valuation study are, they will have little impact on decision-making if nobody sees, reads or is persuaded by them. There is an art to presenting information, and communicating it effectively. In many cases, the technical experts who carry out the valuation study itself may not be the best placed to do this – there is often a need for professional communicators and a properly-designed communications strategy.

Information about wetland values will be easiest to communicate when decision-makers find it useful, and it helps them to address or better understand a particular situation or problem. Many people are involved in shaping decision-making, and communication of the results of valuation studies must usually take place at many levels of scale. Making the results of valuation convincing to these different groups requires different types of communications strategies, different messages and different ways of presenting information.

In a perfect world where all decisions were made for the good of society, merely making valuation information available might be enough to ensure that water decisions took fair account of ecosystems. Unfortunately this is not usually the case. There exist multiple, and often competing, interests in wetlands. Fostering cooperation and balancing these competing interests is critical when the results and recommendations of wetland valuation studies are presented. Here, it is important to be tactical and work with the different constituencies who actually have the political will, and power, to influence wetlands. Just as wetland valuation aims to articulate particular costs and benefits that have traditionally been ignored in decision-making, it also represents the interests of many of the groups who have often been excluded from these decisions.

Further reading

Turner, R.K, Georgiou, S., and Fisher, B. 2008. *Valuing Ecosystem Services: The case of multi-functional wetlands*. Earthscan, London, UK.

Barbier, E.B., Acreman M.C. and Knowler, D. 1997. *Economic valuation of wetlands: a guide for policy makers and planners*. Ramsar Convention Bureau, Gland, Switzerland

[1] A market can be said to be competitive when there are a large number of buyers and sellers, there are no restrictions on market entry, buyers and sellers have no advantage over each other, and everyone is fully informed about the price of goods.

[2] Marginal value is the change in value resulting from one more unit produced or consumed.

[3] A public good is characterized by the non-excludability of its benefits – each unit can be consumed by everyone, and does not reduce the amount left for others. Many ecosystem services are pure or partial public goods – for example scenic beauty (a pure public good), or water quality (which has many of the characteristics of a public good). In contrast a private good is one from which others can be excluded, where each unit is consumed by only one individual. Most natural resources are private goods.

[4] A substitute good or service is one which is used in place of another – for example kerosene instead of firewood, or bottled water instead of tap water.

[5] A complementary good is one which is used in conjunction with another – for example between other products and fishing activities such as the collection of reeds for fishing baskets or firewood for fish smoking.

[6] Consumer surplus is the difference between the value of a good and its price, in other words the benefit over and above what is paid that is obtained by a consumer who is willing to pay more for a good or service than is actually charged. When a benefit is obtained free, all of its value is consumer surplus.