3 TOOLS FOR VALUATION AND APPRAISAL OF ECOSYSTEM SERVICES IN POLICY MAKING

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Content of this chapter

Key Messages

- **It's time to acknowledge what we do.** We commonly make decisions that implicitly involve trading off nature protection against the production or consumption of marketed goods.
- **Nature often does not have a market price but 'priceless' isn't the same as 'worthless'.** Financial appraisal often implicitly assumes that ecosystem services are 'free', making nature's benefits invisible. Monetary valuation explicitly values ecosystems and biodiversity so that their services (and the loss of them) can be taken into account by decision makers.
- **It's worth it.** Ecosystems are complicated. Fortunately, however, many tools have already been developed, and the rationale for using them is simple: a considered (and comprehensive) valuation of ecosystem services benefits everyone – from industry, to fisher, to farmer, to citizen.
- **Use the right tool for the job.** There are a variety of environmental valuation tools available. They vary in terms of their complexity, underlying assumptions and reliance on resources. Cost Benefit Analysis (CBA) is a widely-used performance yard stick that uses valuation estimates. Multi-criteria analysis (MCA) and Participatory Appraisal (PA) do not require monetary valuation. They are designed to help decision makers integrate complex actions and multiple opinions into a single framework.
- **If nature is valuable, input in invaluable:** There is a diversity of experts – from village leaders to scientists to analysts. Every participant has something to offer. The frameworks presented in this chapter offer tools for listening – tools for translating complicated and divergent expertise into success at grass-roots level.

> "A cynic is a man who knows the price of everything and the value of nothing."
>
> Oscar Wilde

This chapter's aim is to present several methodological tools for balancing the ambitions of development and conservation. It begins with an overview and rationale for placing monetary values on ecosystem services and biodiversity (sections 3.1 and 3.2). It presents an overview of different analytical frameworks such as Cost-Benefit Analysis (CBA) and Cost-Effectiveness Analysis (CEA) to which non-market values can be applied (3.3). Finally, the chapter discusses tools and frameworks for decision making that do not rely primarily on monetized values; we focus on participatory approaches to project evaluation as well as multi-criteria analysis (3.4).

The intention of this chapter is to present options; it is not a 'how to' manual. Many aspects are complicated and controversial. The aim is to present a snapshot of the key framework features, not to assess the controversy or explain the finer details. For greater detail and strategies for implementation, an annotated bibliography is included at the end of the chapter.

3.1 THE RATIONALE FOR VALUING ECOSYSTEM SERVICES AND BIODIVERSITY

This section presents valuation methods. In essence, it describes methods for putting a 'price-tag' on services that nature provides. The underlying premise of non-market valuation is that, despite a lack of market, the flow of ecosystem services affects our well-being in many ways. The main reason for applying valuation is that if we fail to value these services, the economic systems we rely on will remain biased toward ecosystem degradation and over-exploitation.

Of course, pricing such commodities is often challenging. For this reason, there are many different methods – accompanied by debate over their effectiveness and applicability. While the inherent value of ecosystems services is uncontested, placing a monetary value on ecosystems and biodiversity may be controversial for three broad reasons:

1. It is deemed **unethical**;
2. **Less biodiversity** may be conserved;
3. **There is no price** – for a good reason.

These concerns are valid. The monetary valuation of nature takes place for pragmatic reasons: it is necessary to avoid placing an implicit value of $0 on ecosystem services that are essential to our well-being. Since transactions in the market generally take place in a monetized domain, a decision not to value nature in monetary terms for **ethical** reasons can imply that it has no value – rather than being 'priceless', it is 'worthless.' Furthermore, we often make decisions that involve trading the benefits of nature for the benefits of production and consumption. Marketed goods have a monetary value and can be traded. We may even trade more valuable ecosystem services for less valuable marketed goods; for instance, deforestation creates a marketed income from timber sales but might reduce flood protection.

Another concern is that placing a value on a particular site may imply that the site is 'for sale.' As a consequence **less biodiversity may be preserved**. If a conservation site has a monetary value, a developer can buy it. Putting a price on ecosystem services makes them marketable. While this is a valid point, this scenario is likely to occur much less frequently than the alternative, that is, an essential ecosystem service is traded for nothing, with an implicit price of $0. Typically, placing a monetary value on ecosystem services supports conservation and avoids destructive extraction, which eventually incurs economic costs.

Concerns raised over **whether or not it is possible to arrive at a Dollar figure** for nature's services have some validity. If we're just estimating the value, how can we know that our estimate is right? Most ecosystem services are not directly traded and thus do not have a 'true' price. Further, when a service is traded, we don't have foolproof mechanisms for evaluating whether it was traded at the 'right' price.

Non-market valuation responds to these concerns by 'mimicking' what would happen if there were a market. These methods are outlined in the following section.

3.2 VALUATION METHODS

Environmental valuation methodologies have developed markedly in the last two decades. While there are detractors, **valuation may play an increasing role in policy making**. Valuation methodologies are typically presented in typologies (groups). Some methods work better for some services. This chapter broadly appraises whether a given method requires statistical analysis (including software and trained people). In some cases, the best option may not be feasible: resource constraints may limit the choice of valuation methods. Another constraint, considered throughout, is the appropriateness and limitations of certain methods for given ecosystem services. This section presents and discusses the pros and cons of each method. Valuation methods can broadly be split into 6 categories, as in Table 3.1.

MARKET PRICES

Certain ecosystem goods and services have a market. Timber and fish, for example, have economic values that can be calculated with little statistical analysis. Markets for less tangible ecosystem services are also emerging, such as mitigation of greenhouse gas emissions.

Most ecosystem goods and services, however, do not have readily observable market prices. When they are available, they may be either undervalued or distorted. Distortions in the market (subsidies, price regulations, taxes) may produce incorrect values which must be accounted for in an effective valuation analysis.

Table 3.1 Comparison of valuation methods

Group	Methods	Summary	Statistical analysis?	Which services valued?
1. Direct market prices	Market prices	Observe market prices	Simple	Provisioning services
2. Market alternative	i. Replacement costs	Finding a man-made solution as an alternative to the ecosystem service	Simple	Pollination, water purification
	ii. Damage cost avoided	How much spending was avoided because of the ecosystem service provided?	Simple	Damage mitigation, carbon sequestration
	iii. Production function	How much is the value-added by the ecosystem service based on its input to production processes?	Complex	Water purification, freshwater availability, provisioning services
3. Surrogate markets	i. Hedonic Price Method	Consider housing market and the extra amount paid for higher environmental quality	Very complex	Use values only, recreation and leisure, air quality
	ii. Travel Cost Method	Cost of visiting a site: travel costs (fares, car use etc.) and also value of leisure time expended	Complex	Use values only, recreation and leisure
4. Stated preference	i. Contingent valuation method	How much is the survey respondent willing-to-pay to have more of a particular ecosystem service?	Complex	All services
	ii. Choice experiments	Given a 'menu' of options with differing levels of ecosystem services and differing costs, which is preferred?	Very complex	All services
5. Participatory	Participatory environmental valuation	Asking members of a community to determine the importance of a non-marketed ecosystem service relative to goods or services that are marketed	Simple	All services
6. Benefits transfer	Benefits transfer (mean value, adjusted mean value, benefit function)	'Borrowing' or transferring a value from an existing study to provide a ballpark estimate for current decision	Can be simple, can be complex	Whatever services were valued in the original study

Source: own representation

While in many ways this method is the most appealing, alternate valuation techniques usually need to be used. Often, market prices are not available.

MARKET ALTERNATIVES

When direct market prices are not available, indirect market prices may be. Valuation based on market alternatives can take three forms:

1. **Replacement cost:** What does the alternative cost? (The value of fish habitat can be determined by measuring the cost of artificial fish breeding and stocking programs);
2. **Damage costs avoided:** What protection is being provided by ecosystems, and what is this protection worth? (A healthy mangrove forest protects against storm damage. What would be the costs of damages if the mangrove didn't exist?);
3. **Production function:** If nature is providing inputs to production, what are the monetary implications of changing the quantity or quality of these inputs? (Changes in land-use practices may alter the flow of ecosystem services).

The underlying premise of the **replacement cost** method is that replacement costs can be used as a proxy for the value of ecosystem services. Services provided by healthy ecosystems 'for free' might be replaced by human-engineered alternatives. The value of ecosystem services is estimated based on the cost of replacing them. This method is particularly useful for valuing services that have direct manufactured or artificial equivalents, such as coastal protection or water storage and purification.

This method is relatively easy to apply and does not require complicated data analysis. Its limitation is that it is often **difficult to find human-made equivalents** for 'natural' services. Because this method is based on hypothetical choices (or preferences), it may result in an overestimation of value (see TEEB Foundations Chapter 5).

Ecosystems protect economically valuable assets. The **damage costs avoided** method uses quantifiable costs and scales of damages to price ecosystem benefits. This approach identifies the extent to which an ecosystem's protective services would change due to a proposed or business-as-usual scenario.

Box 3.1 Replacement costs in Fynbos biome wetlands, Western Cape, South Africa

Wetlands purify wastewater and retain nutrients. Wetlands buffer much of Western Cape province's industrial and domestic waste. Waste passes through the wetlands before being discharged into water bodies. A replacement cost approach was used to estimate the value of the wetlands' services. This involved quantifying the removal of pollutants by the wetlands and estimating the equivalent cost of performing this service with treatment plants.

The results of a valuation estimated the average value of the wetlands' water treatment service to be US$ 12,385/ha annually. The values are high enough to compete with alternative land uses.

Source: Wastewater treatment by wetland, South Africa, TEEBcase based on Turpie et al. (see TEEBweb.org)

If mangroves protect shores from erosion, shore protection benefits may be measured by calculating the monetary value of damages avoided. This method applies to situations where it is possible to avoid damage costs. It has the advantage of using tangible data – and the cost of damages are often more apparent to the public than benefits.

Production functions outlines how a marginal change in the management of an ecosystem, for instance changing a land use, will alter the provision of ecosystem functions and ecosystem services that can then be valued. This alteration is measured in order to value the services. For instance, blasting a coral reef alters coastal protection services. To arrive at a monetary value, this method requires identifying a link between a change in ecosystem management and ecosystem function. This method is complicated. In the above case, evaluation requires an understanding of hydrology and ecology – not just economics.

SURROGATE MARKETS

In the absence of clearly defined markets for ecosystems services, surrogate markets can be used to ascertain value. People's preferences and actions in related (surrogate) markets are measured to determine

Box 3.2 Mangrove rehabilitation: Damage costs avoided in Vietnam

Every year, an average of four typhoons and many more storms wreak havoc on Vietnam's coastline. A system of sea dykes has been established behind mangroves. Rehabilitation of the mangroves protects the sea dyke and helps avoid sea dyke maintenance expenses. Generally, the larger the mangroves stand, the more damage costs are avoided. Mangrove stands provide a physical barrier that dissipates wave energy. They also stabilize the sea floor and trap sediment.

In financial terms, the planning and protection of 12,000 hectares of mangroves cost Vietnam around US$ 1.1 million. The cost of dyke maintenance, however, has been reduced by US$ 7.3 million annually. In addition, a typhoon (Wukong) in October of 2000 damaged three northern provinces but did not damage the dykes behind regenerated mangroves. For this reason, there were no deaths inland.

Source: Mangrove rehabilitation for coastal protection, Vietnam, TEEBcase based on World Disaster Report (see TEEBweb.org)

the value of the ecosystem service in question. Two common valuation methods are:

1. **Hedonic price method:** The price of a marketed good relates to its services and characteristics;
2. **Travel cost method:** How much people are willing to spend to travel to and use a given ecosystem service (such as a park) reflects how much the service is worth.

The **hedonic price method** commonly uses the real estate market as a surrogate market. The price of a house with a view of the ocean is likely to cost more than the same house with a view to a landfill site. In theory, the hedonic price method **identifies how much of a price differential is due to a specific environmental attribute**. Once this price differential is determined, it is used to obtain willingness-to-pay for a particular environmental attribute.

This method is useful when there are obvious and direct correlations between the value of a marketed good and its surroundings. The price, however, may also depend on several non environmental factors (for example, crime rates, amenities). Hedonic valuation tends to require significant data collection, data handling and statistical analysis. Generally, it requires a large sample and complex analysis to isolate and analyze the economic effect of a single ecological service.

The **travel cost method** (TCM) uses data from visitors to determine the value of an area's ecosystem services. The underlying principle is that there is a direct **correlation between travel expenses and a site's value**. This method uses questionnaires to determine who visitors are (how old they are, where they come from); how much they spend (to get to the site, to get into the site, while they're there); what their motivations for visiting are; and how often they visit. This information is used to estimate the demand curve. The quantity demanded is expected to decrease as price increases.

Estimating the 'true' cost of travel can be difficult (should the calculation include wear and tear on cars? What costs do people actually report?) and the method places a numerical value on leisure time. While most people would agree that leisure time is inherently valuable, measuring it in terms of foregone income is controversial. This method has limited use beyond valuing recreational sites. It is dependent on a relatively large data set and requires both time and complex statistical modeling.

STATED PREFERENCE

This method can capture cultural and spiritual values. Stated preference methods evaluate people's preferences and choices to determine 'willingness-to-pay' for services that are difficult to place a monetary value on. Why people choose or prefer what they do is complicated. Stated preference valuation, as a consequence, is also complex. There are two broad categories:

1. **Contingent valuation** method (CVM): Respondents place values on hypothetical environmental

Box 3.3 The recreational value of coral reefs in Hawaii

Some 200,000 divers and more than 3 million snorkelers enjoy the Hawaiian reefs every year. They pay a substantial amount to admire the state's unique marine life, supporting a large aquatic tourist industry which benefits the rest of the economy.

A TCM valuation study revealed that the total benefit associated with the reef was estimated at around US$ 97 million every year.

Approximately 450 people were surveyed (face-to-face, on-line) using a questionnaire that first outlined the causes of the current decline in the health of the reef and how it could be improved.

Tourists were categorized into 14 different zones based on travel distance from the Hawaiian coral reefs. Travel costs were estimated, considering the costs of transportation, local expenditures, and costs related to travel time. Respondents filled in travel and local spending amounts in the survey. To estimate the value of costs related to travel time, a value of 1/3 of respondents' wage was used.

Source: Recreational value of coral reefs, Hawaii, TEEBcase based on Cesar and Beukering (see TEEBweb.org)

changes. For example, they are asked what they would be willing to pay to maintain a forested area or what they would be willing to accept as compensation for its loss.

2. **Choice Modeling:** Respondents choose preferences. Instead of determining willingness-to-pay, people chose between different situations. Given a 'menu' of options with differing levels of ecosystem services and differing costs, which is preferred?

In **contingent valuation**, a detailed description of an environmental change is presented to a group of respondents who answer a series of questions. The valuation attempts to ensure that the group is 'representative' (i.e. the characteristics of the sample – gender, income, education levels etc. – is representative of the wider population) and that certain known biases are avoided. Biases arise because what happens in the 'real' and 'hypothetical' world may be quite different. **What a person would hypothetically pay** to preserve a national park might be very different from what a person would actually pay. The challenge for CVM is to ensure that respondents give realistic willingness-to-pay (or willingness-to-accept) estimates.

Another challenge is making sure that respondents understand what is at stake. A respondent may be asked to choose between a 'nature reserve' and 'grazing land,' without knowing what the ecological differences between these choices are. Being clear and avoiding jargon means that surveys are accessible.

Some issues to bear in mind when evaluating data are:

1. **Zero Bids:** If a respondent says they are willing to pay $0, this could mean many things. It could mean they don't think the change is valuable. It could mean they think it's valuable, but that they shouldn't be the one to pay for it (the state should pay). It could even mean that they think it's so valuable that it is priceless.
2. **Exaggerated willingness-to-pay and yea-saying:** Respondents may want to please the surveyor or appear charitable. Since CVM is hypothetical in nature, people may agree with questions regardless of content. They are, after all, only stating what they would hypothetically pay.
3. **Bidding format:** The way the question is posed can influence the results, for example a one-off question 'are you willing-to-pay $x?' versus an open-ended question 'How much are you willing-to-pay?'

Box 3.4 Conservation of Asian Elephants in Sri Lanka – A contingent valuation study

Crop-raiding is a source of human-elephant conflict in Sri Lanka. A CVM was conducted with 300 people living in urban areas in Colombo to determine willingness to pay to conserve the Asian elephant.

The survey gave respondents some context (the status of the elephant and limitations to the protected area network). The survey asked what they would be willing to contribute to a trust fund to mitigate conflict between humans and elephants.

The proposed fund would compensate farmers for crop damage in exchange for giving elephants some access to crops and refraining from killing them. It would also finance increased protection of existing parks, the relocation of troublesome elephants and the creation of recreation centers and elephant-based eco-tourism.

Based on willingness-to-pay estimates, there is a strong economic case for the trust fund. What people are willing to pay significantly exceeds the economic losses caused by the elephant.

Source: Human-elephant conflict mitigation through insurance scheme, Sri Lanka, TEEBcase based on Bandara and Tisdell (see TEEBweb.org)

Instead of stating willingness-to-pay directly, people choose their favoured option across a 'menu' of options, each with differing levels of ecosystem services and differing costs. Each set has three or more alternatives, one of which has a known monetary value. Some sets may have non-monetary values (social, cultural, spiritual). Respondents **choose between different choice sets**. Implicitly, as they choose, they make **trade-offs** between the attributes of each set. Choice modeling requires complex data analysis and collection.

PARTICIPATORY VALUATION

Participatory valuation is often carried out after a focus group exercise where stakeholders voice concerns and table issues to **infer values indirectly**. For instance, participants may be asked to use counters

Box 3.5 Oku-Aizu Forest Ecosystem Reserve in Japan

There are 29 forest ecosystem reserves in Japan, including world heritage sites designated by the Forestry Agency. The Oku-Aizu forest ecosystem reserve is the largest. However, in comparison with other forest ecosystem reserves in Japan, its buffer zone is larger to allow for the use of forest ecosystem services by locals (mushroom and wild plant harvesting, for example).

Choice experiments were used to estimate the economic value of Oku-Aizu forest ecosystem reserve. A choice set consisted of three profiles (hypothetical protected area) and one status-quo scenario (keeping things as they are). Each profile had four area attributes and one price attribute.

The data were collected through two identical surveys – a regional mail survey and a nationwide internet survey. After analysis, the results showed a higher willingness-to-pay (US$ 89/year) for stricter protection of the ecosystem as compared with maintaining the status quo (US$ 12/year).

Source: Valuing forests for different protection strategies, Japan, TEEBcase based on Kentaro Yoshida (see TEEBweb.org)

Box 3.6 Valuation of non-timber forest products in Sekong Province, Laos

As part of a wider study to support conservation of natural forests, a Participatory Environmental Valuation (PEV) technique was used to ascertain the value of non-timber forest products (NFTP). Villagers were asked to express the value of NTFPs in the context of their own perceptions, needs and priorities.

Villagers used rice to rank all the products extracted from the forest by placing counters on each product harvested. The number of counters signified how important a particular product was to them. The value of each product was then expressed relative to the value placed on rice. The wider study (which used other data as well), concluded that NFTP were worth US$ 398 – 525/household annually.

Source: Participatory valuation of forests in subsistence economy, Lao PDR, TEEBcase based on Rosales et al. (see TEEBweb.org)

(pebbles, rice) to represent the significance of certain factors that are important to them. Some of these factors may be difficult to value using market prices alone (security of water supply). Others may have a direct market value (fuel prices, for example).

While determining causation is difficult, this process can elicit the significance of certain factors relative to others. If a respondent uses six grains of rice to describe impediments caused by irregularity of water supply and four to describe obstacles created by fuel prices, something can be inferred about the significance of water security in relation to fuel prices. One important advantage of this methodology is that it can be used with respondents who are illiterate or not used to expressing preferences in monetary terms.

BENEFITS TRANSFER

Benefits transfer (BT) is not a methodology per se and it includes several variations. BT uses primary valuation **studies from other sites to inform decision making**. This method is inexpensive and expedient. It is, however, not as precise as a primary valuation. An in-depth benefits transfer valuation requires significant expertise and statistical analysis (see TEEB Foundations, Chapter 5).

There are different approaches. Perhaps the most accurate approach is to assign 'benefit functions' – screening studies in terms of variables such as habitat types and income levels. Another method, perhaps less accurate, is to look for studies carried out on sites that are similar (ecologically or socio-ecologically). The willingness-to-pay in the studied site is then adjusted to best suit the new site. Adjustments might allow for inflation and exchange rates. The least ideal implementation of a BT would be to use values from a previous study without adjusting them. BT must be used with caution, and only to provide a 'ballpark' estimate of value.

The following are the general steps to be followed when using benefits transfer:

1. **Identify** existing similar studies;
2. **Examine** how transferable they are. To be transferable, the sites should have the same environmental services and service quality. Ideally, they should be comparable in terms of the kind of people who use them and the kinds of institutions that govern them;
3. **Screen** studies to make sure they are theoretically and methodologically robust;
4. **Adjust** existing values to reflect the values of the site under consideration – using relevant, available supplemental information.

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Box 3.7 Economic value of world's wetlands

The total economic value of 63 million hectares of wetland around the world is estimated to be US$ 3.4 billion per year.

A benefits transfer method was used to arrive at this estimate by extrapolating from 89 wetland studies. Studies were screened for methodological robustness. Data were expressed in the same currency with standardized values.

Once the value of certain kinds of wetlands was determined, a benefits transfer method was used to estimate and predict the value of wetlands that had not been valued. The benefit function has been estimated using the following variables: wetland type, size, location, population density and income per capita. Using the estimated function values were transferred to approximately 3,800 wetlands around the world.

	Mangrove	Unvegetated Segment	Salt/Brackish Marsh	Fresh-water Marsh	Freshwater woodland	Total
N. America	30,014	550,980	29,810	1,728	64,315	**676,846**
Latin America	8,445	104,782	3,129	531	6,125	**123,012**
Europe	0	268,333	12,051	253	19,503	**300,141**
Asia	27,519	1,617,518	23,806	29	149,597	**1,818,534**
Africa	84,994	159,118	2,466	334	9,775	**256,687**
Australasia	34,696	147,779	2,120	960	83,907	**269,462**
Total	**185,667**	**2,848,575**	**73,382**	**3,836**	**333,223**	**3,444,682**

Amounts in US$ 1,000s.

Source: The economic value of the World's wetlands, TEEBcase based on WWF (see TEEBweb.org)

3.3 DECISION-SUPPORT FRAMEWORKS: COST-BENEFIT ANALYSIS

Contrasting benefits and costs is an important input to systematically consider the consequences of different options in decision making. In theory, cost-benefit analysis (CBA) is simple. All the benefits and costs of a proposed policy or project are valued, added and compared. When the benefits outweigh the costs (the 'net benefit' is positive), the proposed change is considered to be economically efficient.

CBA arguably **dominates economic decision making** because it allows decision makers to justify expenditures (important in an atmosphere where resources are constrained); appears uncontroversial (mirrors the way people today make consumption choices) and is often either legislated or given preference at powerful levels of government.

A CBA follows six stages:

1. **Project definition:** What is the project's scope and who are the stakeholders?
2. **Classification of impacts:** What are the expected incremental costs and benefits of the project (such as administration and implementation) and when are they likely to occur?
3. **Conversion of physical impacts into monetary values:** How can non-monetized services be described in monetary terms?
4. **Discounting:** A process that puts more weight on costs and benefits that arise earlier in the project.
5. **Net Present Value assessment:** Given the information gathered, is this project economically advantageous?
6. **Sensitivity analysis:** How reliable are the numbers used in the study?

PROJECT DEFINITION

The project's time frame, scope and key stakeholders need to be identified. A local biodiversity preservation project may affect local, national and international communities, but stakeholders that do not directly contribute (financially, legally) to the project, often fall outside the project's boundary. Typically, only costs and benefits for agents directly involved in the project are considered.

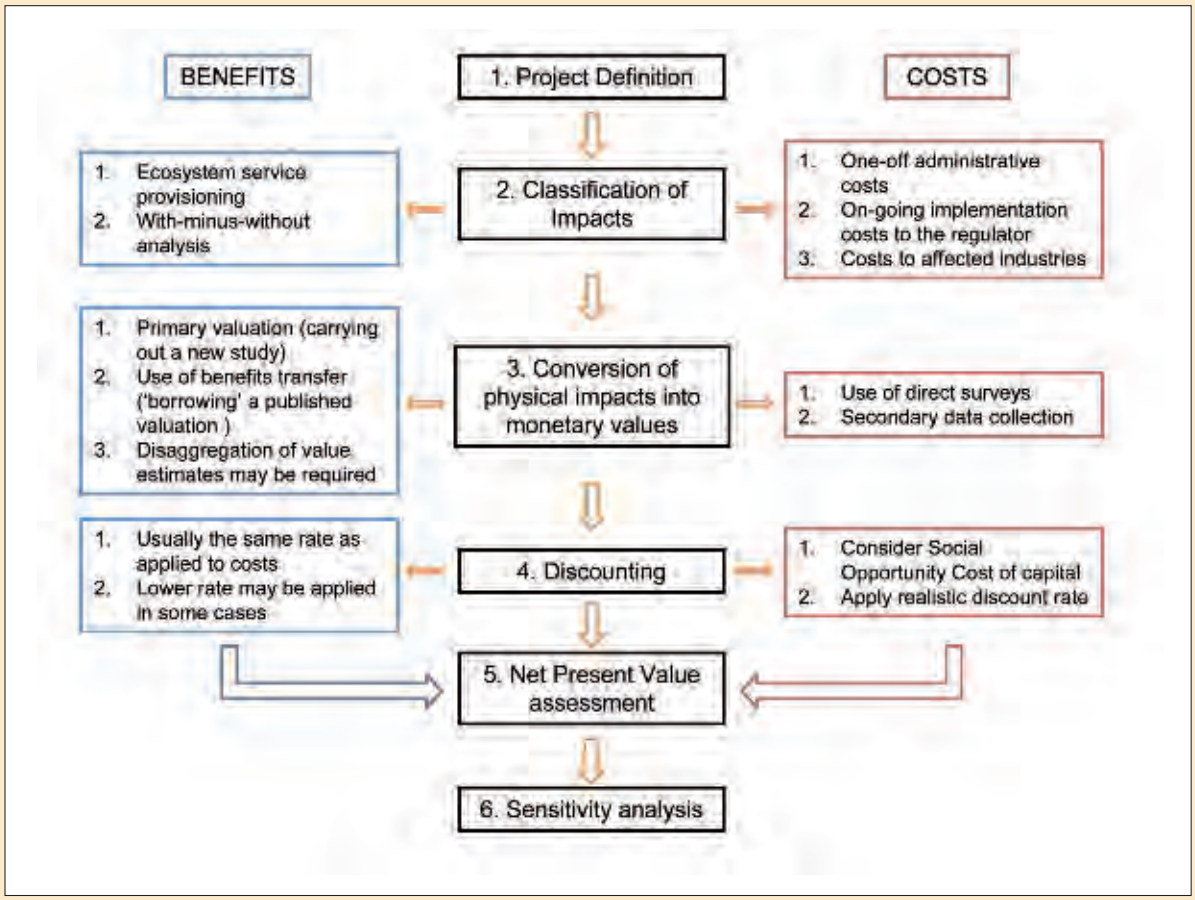
Analysts ask 'What will happen with or without the project or policy?' In other words, what's the outcome 'with' the project, and what's the outcome 'without' it? This is called the **'with-minus-without' principle**. Analysts need to know which costs and benefits stem from the project, and which ones would have occurred anyway. If the proposed project addresses freshwater supply, analysts determine if freshwater supply, under current conditions, is expected to decline, increase or stay the same. Once this has been determined, they evaluate the expected outcomes with the project.

If future water demand rises due to population growth, a project to 'merely' maintain water availability at current levels is beneficial. Similarly, if a project proposes to extend the boundaries of a national park, it is important to determine whether certain infrastructures (such as warden's offices and toilet facilities) are sufficient. Some costs may already be covered by other budgets. Only additional costs should be inputted into a CBA.

CLASSIFICATION OF IMPACTS

The next stage identifies the incremental costs and benefits that are expected to occur and when they are likely to occur.

Figure 3.1 Cost-Benefit Analysis methodology as applied to ecosystem services



Source: own representation

In an example for implementing a biodiversity conservation policy, the probable economic costs are:

1. **One-off administrative costs** to the state regulator (constructing a building for the policy administration) or to other stakeholders (industry hiring consultants for guidance on adapting business practices);
2. **On-going implementation costs** for monitoring, enforcement and stakeholder consultation, as well as compensation to affected stakeholders such as industries, landowners and farmers (for lost production or cost burdens in meeting imposed regulations).

Biases at this stage can lead to inflated cost projections. Regulated costs may overstate the cost of compliance because these are privately borne (by firms, industry) while social benefits are publicly borne. Industry also has little incentive to report under-estimation of incurred costs or reduced overhead from improved technologies.

Benefits can also be measured in terms of **'avoided costs.'** A key benefit of installing solar power cells is avoiding greenhouse gas emissions. Benefits might be measured in terms of the avoidance of biodiversity loss, or maintaining access to clean water. Costs and benefits also include non-environmental factors; re-establishing a wetland for flood protection involves paying laborers, and buying raw materials.

CONVERSION OF PHYSICAL IMPACTS INTO MONETARY VALUES

This can be the most time-consuming and resource-intense task for conservation projects, depending on which valuation method is used.

A host of costs and benefits need to be monetized – from ecosystem services to far more **abstract benefits** (such as improved quality of life). In many cases, market prices are used to account for price distortions. For example, an oil subsidy would make the market price for oil lower than its 'actual' price.

While hotly debated, morbidity and mortality may be included at this stage. Certain projects and policies directly impact human lives and rate of injury. Conversion of a wilderness space for a mining operation, for example, may create a risk of injury or death to miners. The mine itself may pose health risks for nearby communities if the mine disperses toxins directly or indirectly.

DISCOUNTING

Discounting describes the practice of placing more value on **immediate costs or benefits** as compared with those that occur in the future. People tend to value future costs and benefits less than immediate ones; when stakeholders are asked why they choose overexploitation (harvesting timber at a rate higher

Box 3.8 Considerations for choosing an appropriate discount rate

- The choice of discount rate affects how future costs and benefits are valued in terms of present values ('today's money').
- In some cases, interest rates are used. The opportunity cost of capital, as measured by the interest rate needed to fund the project or policy, is used to determine the discount rate.
- The Stern Review of Climate Change argues for a differential rate to be applied for climate change. This may be an appropriate benchmark for the conservation of ecosystems and biodiversity if such conservation has a long-term impact.
- There are good reasons to use lower discount rates (1-4%) for projects affecting natural capital as we can not assume we will have more of this resource available in the future.
- If people are very poor, immediate needs may be so pressing that higher discount rates may be appropriate.
- Primary extractive industries (agriculture, forestry and fisheries) might have low rates of return compared to other industries, causing them to fail a CBA test if a high discount rate is applied.

(see TEEB 2008; TEEB Foundations 2010, Chapter 6)

than the growth rate), they respond that they do so in order to meet immediate needs.

A CBA attempts to find an appropriate, consistently applied, **discount rate** – a means of converting costs and benefits that occur at different times in the study period into 'present value-equivalents', i.e. what they are 'worth' to us were they to occur today. Discounting is routinely applied but has a big impact. For example, a US$ 1000 cost or benefit incurred in 20 years time is equivalent to around US$ 150 today, if we apply a 10% discount rate. In purely mechanical terms, discounting is the inverse of compound interest: If I place US$ 150 in a bank today and earn 10% interest per year then I will have around US$ 1000 in 20 years time.

OVERALL POLICY OR PROJECT APPRAISAL

There are two standard ways in which a project or policy might be evaluated using CBA: **Net Present Value** (NPV) and the **Internal Rate of Return** (IRR).

Net present value expresses all costs and benefits in terms of 'today's money.' In mathematical terms, this is the sum of the discounted benefits minus the sum of the discounted costs. The theory is that if the NPV is positive, the project or policy is expected to improve social welfare.

The **internal rate of return** tells us the 'return on investment.' In situations where funding is limited, this can be a useful complementary performance indicator alongside NPV. (IRR is the discount rate that brings the NPV to 0.) IRR and NPV can both be calculated in Excel or equivalent spreadsheet programs. Neither measure, however, tells us anything about the distribution of beneficiaries and losers. For this reason, it is possible to apply a further step in the CBA to capture the **distribution of winners and losers**. This is called a **social CBA**. A social CBA can help to plot who benefits most and who benefits least.

Supposing that two projects A and B have different benefits and costs to the rich and the poor. Using social CBA one could choose between the projects by using various distributional weights to the rich and the poor.

SENSITIVITY ANALYSIS

Estimations, and thus uncertainties, pervade CBA frameworks. Some would argue that the potential for error is increased when non-market goods are monetized. Assuming that a policy maker has opted to monetize ecosystem services, the key question for the policy maker is: how do I ensure my numbers are as accurate as possible? Certain steps must be built into the analysis to test the extent to which the outcome depends on the figures used. This is called sensitivity analysis.

Essentially, at this stage, analysts assess the **robustness of the analysis**. They make changes to key variables to see the effect of these changes. For example, if a strong NPV outcome depends on an estimate that is imprecise or uncertain, the CBA is more sensitive to error. This observation triggers caution, highlighting a potential need for further research. If the CBA relies on data collected through a less robust method, the conclusions are also sensitive to error. While uncertainty always exists in the realm of hypothesis and estimation, the greatest amount of certainty is optimal.

CRITICISMS OF COST-BENEFIT ANALYSIS

While there is a strong rationale for applying CBA in an environmental context, there are criticisms. These are valid but we would argue that they do not constitute a reason to not apply the framework. They should prompt caution, transparency and analytical rigor. Criticism reminds analysts to document assumptions, rationales and known limitations meticulously. Below is a list of common criticisms:

1. There is uncertainty and inaccuracy in estimation, especially with benefits such as →*'resilience.'*
2. CBA does not generally consider the distribution of winners and losers.
3. Discounting presumes that we value costs and benefits that occur today more than those that occur in the future.
4. It is difficult (or impossible) to apply CBA in situations where there is an irreversible change, such as species extinction.
5. CBA is only as transparent and objective as its practitioners make it. Since the methodology is

Box 3.9 Cost-Benefit Analysis, UK Marine Protected Areas

Marine ecosystems contribute to approximately two-thirds of global ecosystem services (Costanza et al. 1997). Recent studies report that the cumulative impact of widespread human activity on these ecosystems is likely to cause a decline in many of the ecosystem provisions that human beings rely on (Halpern et al. 2008).

In response, a number of national marine conservation agendas are emerging. In the UK, legislation (the UK Marine and Coastal Access Bill, 2009) has designated a network of marine protected areas. The government used a CBA to test which sites would be designated as Marine Conservation Zones (MCZ). It also used previously published studies (benefits transfer) to make estimates.

Two separate studies were commissioned, one to assess the benefits of implementation, and one to address the costs (www.defra.gov.uk/environment/marine/legislation/mcaa/research.htm).

Defining the project boundaries

In order to define the project boundaries, the study looked at three different MCZ network scenarios. They considered what kind of restrictions they would impose on the areas (who would be allowed access, which resources could still be exploited). They made projections with a scope of 20 years, deciding that beyond that (2027), uncertainty about the provision of ecosystem service benefits was too great.

The analysis made predications about the impact of humans on marine ecosystems over time and considered measures already in place to mitigate these impacts (the with-minus-without condition). They evaluated the expected impacts of these measures in order to make sure that the proposed measures would not duplicate protection measures already underway.

Current measures were 3 statutory marine nature reserves, 76 Special Areas of Conservation (for marine habitats and species) and 72 Special Protection Areas (marine habitats for birds).

Classifying the impacts

In order to classify the impacts, analysts used ecosystem services as defined by the Millennium Ecosystem Assessment (see section 2.3). They highlighted 11 ecosystem services and determined for each combination of marine habitat-type/ecosystem service what the impact of a protected area designation would be. The authors considered, for example, the impact of reef protection in terms of gas and climate regulation. Each combination was scored or coded by marine ecologists, who classified the impacts in terms of significance and the amount of time it would take for the impact to occur.

Converting impacts into monetary values

In order to describe ecosystem services in monetary terms, a benefit estimate was carried out using the benefits transfer method, ensuring that the studies used were applicable – ecosystems similar to the UK's temperate marine ecosystems.

Application of discounting

A standard discount rate of 3.5% was applied to both cost and benefit estimates. Choosing the same discount rate is a requirement of the UK Impact Assessment guidelines, and a common procedure for many OECD countries.

The net present value of the assessment

The present value (PV) of **benefits** ranged between US$ 16.4 to US$ 36.1 billion.

The **cost** estimate relied on secondary data and interviews with affected stakeholders. Six industrial sectors were considered: marine aggregates extraction; cables (telecommunications and power); renewable energy (offshore wind, wave, tidal); oil and gas; fisheries; and recreation. Estimates were also made for administration costs to the voluntary and non-profit sector. While costs are voluntarily borne by such institutions, the argument for placing a monetary value on voluntary services is that, without these sectors, the government (in effect, society) would bear these costs. The PV of costs ranged between US$ 0.6 to US$ 1.9 billion. The net present value (NPV) is thus at least US$ 14.5 billion.

Testing the values using the sensitivity analysis

A sensitivity analysis reduced the range of the present value of benefits to between US$ 10.2 to US$ 24.0 billion. Hence, even in the worst case NPV is US$ 8.3 billion.

Conclusions

A cost-benefit analysis was a significant factor in creating legislation (the formation of the UK Marine and Coastal Access Bill). Using the ecosystem perspective was useful in terms of justifying conservation on economic grounds. It also demonstrated that the cost-benefit ratio of marine conservation in this case was 10:1.

For further information see Hussain et al. 2010

presented as being objective, the outcomes are perhaps less likely to be challenged than 'softer,' more qualitative evaluations.

6. Estimating the monetary worth of a human being (in disaster mitigation, for example) is controversial.

COST-EFFECTIVENESS ANALYSIS (CEA)

CEA is linked to CBA. It is a decision-support tool for policy appraisal. Unlike CBA, this analysis does not evaluate benefits. It evaluates the costs of implementing a given plan. CEA is useful in circumstances where a policy decision has been made but several implementation options exist.

CEA is especially useful when decision makers are legally obliged to meet a broad policy objective. For example, following the Rio Earth Summit (1992), local policy makers in the UK were required to implement Agenda 21, a sustainable development agenda (see Chapter 4). Using CEA helped them determine the most **economical ways to implement changes to meet new legislation**. It is possible, in the future, that as climate change concerns are translated into law, more policy makers will make use of CEA. Rather than having to decide whether biodiversity or conservation agendas should be considered, the main concern may shift to determining which options most cost-effectively meet biodiversity and conservation targets.

3.4 ALTERNATIVE DECISION-SUPPORT FRAMEWORKS AND TOOLS

There are situations where the quantification of costs and benefits of ecosystem services is perceived to be inappropriate or not possible. Policy makers may choose to avoid monetized valuation for a number of reasons. They may feel it is unethical or not the will of the community they are accountable to.

In such cases, an appropriate alternative can **integrate monetary values without monetizing** a certain set of benefits (such as the value of a sacred site). Alternative decision-support tools and frameworks tend to be stakeholder-focused, and ideally generate scenarios that address the particularities of certain community contexts and conflicts. There are a number of appraisal techniques to collect qualitative information. Table 3.3 gives an overview and uses an example from Kenya to illustrate different appraisal techniques.

Table 3.3 Consultative appraisal techniques

The dilemma: The Maasai people, who have had access to Lake Naivasha (Kenya) for centuries, are now unable to access it due to the development of agriculture around the lake's border. The Maasai argue that their cattle should be able to use the water for spiritual reasons and that they are entitled to lake access for fresh water. While providing bore holes might solve the issue of freshwater availability, this would not address the spiritual concerns of the Maasai. There are a range of consultative appraisal approaches a policy maker might choose to employ to understand different stakeholder concerns and explore solutions.

Individual stakeholder viewpoints

Questionnaires are often the main survey instrument for both monetary and non-monetary techniques. A well-designed questionnaire paints a clear picture of the local context for proposed changes. They glean both quantitative and qualitative information from people. Structured questionnaires record respondents' perceptions, attitudes, experiences or expectations. They can be filled out on the phone, by post, using the internet or face to face.

Semi structured, narrative or in-depth interviews are typically carried out face-to-face. This method is flexible, allowing the interviewer to pursue lines of questioning in response to the answers they receive. This method of determining different stakeholder viewpoints is especially useful in contexts where there are conflicts created by a diversity of views and the interviewer needs to establish the source of the disagreement.

Farmers organized in the Lake Naivasha Riparian Association and the Maasai community could be given questionnaires designed to ascertain key governance issues, identify water access changes that both groups might agree to, identify costs, compensation opportunities and usage patterns. Semi-structured interviews could provide a platform for industry and Maasai representatives to voice concerns and make comments.

Group stakeholder viewpoints

Focus groups aim to elicit the positions of participants regarding a pre-defined issue or idea. Focus groups are useful for gaining insight about institutional linkages and relationships as well as identifying spiritual and cultural values.

In some cases it may help to have separate focus group sessions with opposing parties, in this case industry and Maasai, so that differences of opinion within each party can be discussed. Once internal differences have been clarified, parties are in a better position to negotiate with each other (perhaps facilitated or mediated by an outside person).

Citizen's juries are a means to obtain carefully deliberated and informed opinions of the public regarding an issue or alternative proposals. Experts and stakeholders present evidence and answer questions – the jury (usually composed of citizens) then deliberates and come to a view.

A citizen's juries could be formed to hear the position of the Maasai presented by NGO and advocacy groups, along with views from hydrologists, industry bodies and local government and national government. Document findings and reasons for decision taken by the jury.

Participatory appraisal creates a platform for local and indigenous knowledge and circumstances to play a role in decision making, facilitating the involvement of stakeholders from an early stage, ideally making it possible for stakeholders to perform appraisal, analysis and develop plans that are relevant to their community or jurisdiction. It offers a large array of tools explained below.

Participatory appraisal could involve asking Maasai representatives to map the lake, identifying key areas of spiritual or community significance.

Group stakeholder viewpoints (requiring in-depth statistical analysis)

Q-methodology aims to determine the nature of individual relationships to and **perceptions of environmental problems and solutions**. In the first step, large sets of statements regarding specific issues are identified. Secondly, a smaller number of statements are selected from the larger set (usually 20-50). They are sorted according to what participants identify as least and most important. The data is then statistically analyzed.

Both stakeholder groups could be asked to clarify their concerns. Agribusiness may raise concerns that changes in land access might lead to job-loss, inefficiency and crop damage. The Maasai might assert that they have ownership rights to the water. Analysts could ask each group to rank their views. These views could be sorted for significance. This method may unveil unanticipated 'clusters' of both problems and solutions.

Multi-Criteria Analysis (MCA) can help structure decisions characterized by trade-offs between conflicting objectives, interests, and values. MCA is particularly useful when stakeholders identify non-negotiable outcome (explained below)

Individual expert views

Delphi surveys do not directly appraise stakeholder views. A set of **experts** is selected to make group judgments. This is particularly useful when existing knowledge is limited. This is an iterative process, involving a series of deliberations.

Hydrologists, engineers and advocacy groups may be asked to provide expertise. This expertise can be used to reach a solution or compromise that is technically and socially feasible.

Adapted from Christie 2008

PARTICIPATORY APPRAISAL

Participatory Appraisal is an umbrella term that describes a variety of techniques that incorporate data relating to the **interrelationships between people's livelihoods and socioeconomic and ecological factors**. Participatory frameworks attempt to account for the fact that different policy and community-contexts require different approaches. There are a number of slightly different approaches. Participatory Rural Appraisal (PRA) focuses on the concerns of rural stakeholders. Participatory Learning and Action (PLA) is more ambitious in scope. Its aim is to enhance the participation of ordinary people in local, regional, national and international decision making. Rather than an 'approach' it may even be argued that it is a 'position.'

Participatory Appraisals **usually involve a facilitator** who provides an 'entry point,' for stakeholders to get together and discuss relevant opportunities and dilemmas. To prepare, a facilitator seeks out primary and secondary information to establish the best way to facilitate a process to elicit people's ideas and concerns and get them involved.

Reviewing and familiarizing with the context: Having a sense of the socio-economic, cultural and demographic background of the land and people affected by a current political, economic and ecological landscape is necessary. The facilitator can familiarize him/herself by reading reports, emailing or talking to people and reading relevant books.

Initial stakeholder meetings: The issue is articulated and stakeholders are enabled to take ownership of both the issues and their subsequent analysis. There are a number of ways for the facilitator to try to 'cover all the bases,' from using formal to semi-structured interviews.

Once both the context and relationships have been established, the participatory appraisal method selects from a host of techniques for gleaning the information needed for a robust analysis. Some techniques, relevant to appraising ecosystems services, are presented below.

Participatory mapping and transect walking

Participatory maps differ from conventional maps. Stakeholders are requested to indicate resource availability, boundaries around services (education, resources, health), or opportunities and conflicts that are relevant to their circumstances. These maps help to illustrate many things: where cultural activities take place; where resources are and who manages or uses them; how availabilities have changed over time, and a host of data around people's perceptions regarding their geography.

Differences between maps drawn by people sharing the same community and resources can help clarify key sources of conflict. The facilitator may ask participants to debate differences as well as help determine what needs to be included and excluded in the maps. Several participatory maps can be converged/superimposed on one another to get a sense of how different issues and boundaries overlap and interrelate.

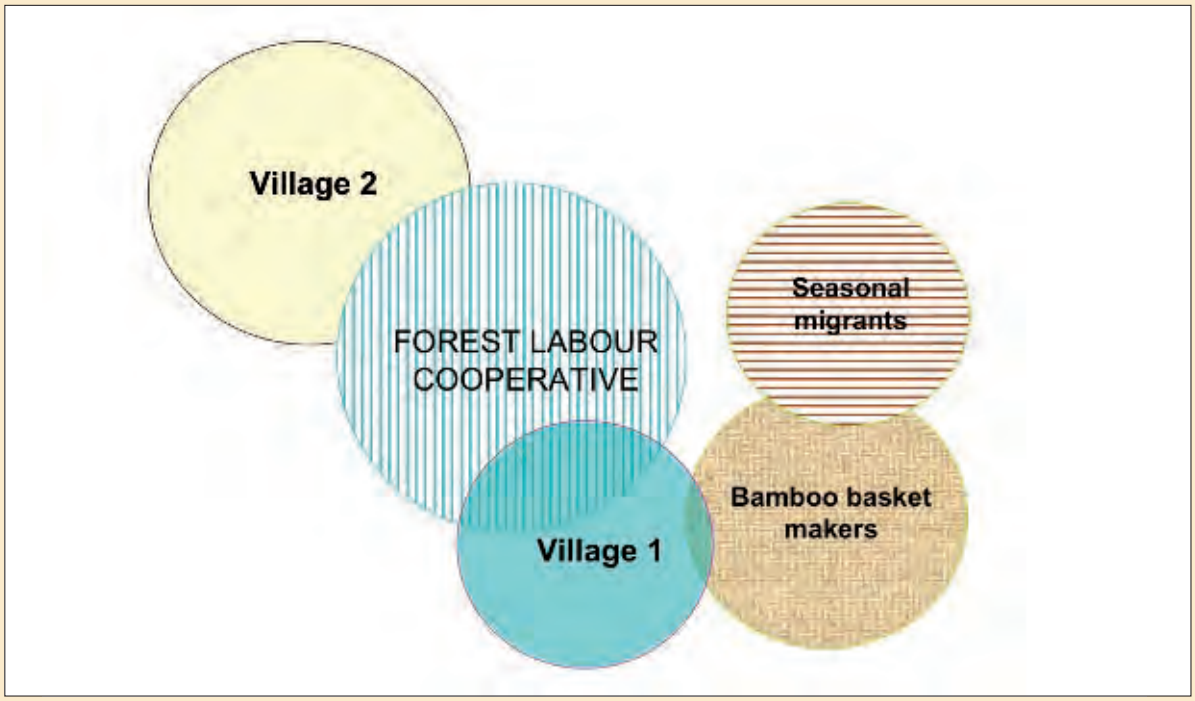
Transect walks can aid in the process of knowledge exchange and engagement. Villagers guide a facilitator or a decision maker through a study area identifying (for example) natural resources, soil-types and vegetation, farming practices, ecological patterns. Transect walks can help cross-reference and verify information on participatory maps. They can also highlight services not indicated on the maps and how resource availability has changed over time (indicating previous forest cover or river flow). Transect walks also create a social space – while walking, stakeholders may bring up new discussion points and ideas that may be useful in further policy related discussion.

Venn Diagrams

The concept behind Venn diagrams is that **issues and services are interconnected**. A Venn diagram attempts to draw-up a holistic view on a given situation – linking sequences, causes and effects. In theory, seeing the relationships between issues can help elicit solutions.

The diagram below illustrates that both seasonal migrants and permanent villagers make bamboo baskets. People from both Village 1 and 2 participate in forest labor cooperatives while the migrant workers

Figure 3.2 Venn diagram



Source: adapted from Participatory Rural Appraisal for Community Forest Management. Tools and Techniques. Asia Forest Network (www.asiaforestnetwork.org/pub/pub20.pdf).

do not. In terms of ecosystem services provision, the Venn diagram may identify sources of resource conflict. If the seasonal migrants extract resources for basket-making without participating in the cooperative, tension may arise between the migrants and the people in both Village 1 and Village 2. This diagram could also be expanded to encompass governance and property rights, effects of services on livelihoods, and how ecosystem services are shared.

Temporal analysis: seasonal calendars and trend analysis

Ecosystems and the services they deliver change seasonally and over time. Seasonal changes take place over the course of a year. Trends may take place over a much longer period of time.

Seasonal calendars show annual schedules of activity and variation. This calendar may provide an overview of harvesting activity and the availability of certain resources at certain times of year. Seasonal calendars allow for the inclusion of many cultural and socio-economic factors in an analysis of the interrelationship between people and their environment. They can highlight certain activities that take place at certain times of year. Overharvesting of fish, irrigation, the dependence on wild food and human-wildlife conflicts often take place at a predictable moment in the passage of the seasons.

Trend analysis aims to ascertain how services have changed (such as water availability) in a community over the years. Participants identify and prioritize (perhaps using counters) the most significant changes that have affected their community. Both tools are particularly useful in analyzing the importance of ecosystem services for livelihoods (see Chapter 2).

Ranking

This technique gives stakeholders an opportunity to prioritize their preferences. Possible changes are identified, quantified and compared to alternatives. Options for ranking are:

Pair-wise: Two items or attributes are compared. The participant identifies which service (or combination of services) is of greater significance.

Direct matrix: A list of services or priorities is given to a participant who gives each item a numerical value (out of ten, out of 100 etc.).

Splitting a total: Participants are given a fixed number of tokens (10, 100 etc.) that they can assign to a variety of choices. A person may choose to assign all tokens to a given attribute or divide their tokens. The participant assigns as much or as little value to the items as he or she deems appropriate.

Strengths and limitations of Participatory Appraisal

The **strengths** of Participatory Appraisal are that it is flexible, adaptable and can capture (quantitatively and qualitatively) a range of data types and levels of information from individuals, households, communities and industry. This approach can assist with sketching out issues related to or underlying conflict and resource use in a relative short period of time (usually between 3-21 days). Significantly, the **knowledge and skills of local people** are used to understand situations and systems in a local context. Not only can this 'shed light' on why things work they way they do, but it can also serve to give people autonomy over their own resources. This has significant implications for improved local governance and project and resource management.

In addition, while Participatory Appraisal need not involve the monetization of environmental values, certain proposed changes may have direct or indirect market value. It can be used as a source of information for other valuation analyses.

Like any framework, Participatory Appraisal also has **limitations**. It is location and context-specific. In effect, this means that results are not easily transferable to other settings. In addition, while many government bodies welcome participation and for some decisions it is even mandatory, some governments may limit the ability for their constituents to voice their perspectives. The robustness of the results depends on the selection of the participants. Typical biases include: who is in the room? Who is allowed to/dares to make a statement? Inhabitants of remote areas, minority groups, young people or women might not be in a position to voice their concerns. This method of appraisal also comes with high expectations on the part of the community.

For this reason, it is generally important that the goals and the objectives of the appraisal are made clear from the outset in order to avoid the risk of disappointment regarding unmet expectations.

MULTI-CRITERIA ANALYSIS

Our final focus in this chapter is on MCA. This method requires the application of statistical expertise and often complements a CBA, particularly in situations where a decision involves implications that are difficult to monetize or even quantify. MCA is a decision-making tool that allows decision makers to **include a full range of social, environmental, technical, economic and financial criteria** in their decision making. While CBA focuses on economic efficiency, an MCA can evaluate a project based on values expressed in different terms.

MCA may differ from CBA in terms of appraising the same agro-forestry venture, for example. Such a venture would affect (either positively or negatively) the flow of ecosystem services to local people. This, in turn, could affect livelihoods. An analysis of costs and benefits would assign all services a monetary value to capture the services' value. Under MCA, the decision maker (or consulted stakeholders) would determine how important each service is relative to other services. Central to the framework of MCA is the concept of 'trade-offs.' The applications of MCA are vast in both scope and type.

MCA, like CBA, is useful for establishing scope, context and options appraisal. Completed analyses also translate human assumptions and values into a readable format, indicating which alternatives carry the most weight (socially, economically etc).

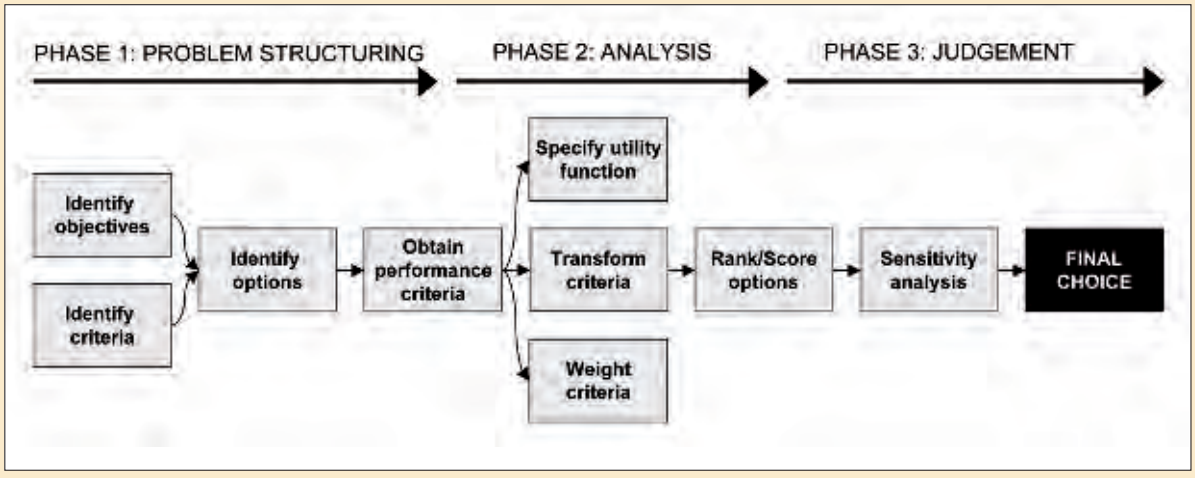
MCA has three (broad) phases with subsections:

1. **Problem structuring:** Identifying the objectives, criteria and options for a project. Who and what is involved – and how?
2. **Analysis:** Analysts look at all the data gathered in the first stage and organize it. What are the most important issues? What are the different options and solutions? What are the ramifications of different actions?
3. **Judgment:** All of the solutions are evaluated, checked for sensitivity and a choice is made about the best plan or policy.

This section will go through each phase of an MCA, using a case study to guide the reader through the process.

The Nairobi River Basin in **Kenya** faces high levels of degradation and it provides a number of ecosystem services to a wide range of people – farmers, residential property owners, large scale industry and smaller enterprises. The diverse group of people that benefit from it often have different and conflicting objectives concerning its management. The catchment areas of the main rivers are wetlands (Ondiri swamp)

Figure 3.3 Steps involved in MCA



Source: adapted from Hajkowicz, 2008

or forest (the Dagoretti forest). While the stakeholders have a diversity of objectives, all of them, in one way or another, benefit from the catchment areas. An MCA was used to find a compromise and create a land-use policy that harmonized a diversity of interests – land tenure, legalities, administration, institutional and other land use needs (TEEBcase Multi-Criteria-Analysis for resolving conflicting river basin uses, based on Makathimo and Guthiga).

Phase 1 Problem structuring

The first stage involves **establishing the decision context**. Analysts identify governance issues, ascertain who the affected stakeholders are and identify various appraisal options. Stakeholders might include policy makers, planners, local administrators, organizations, and both commercial and subsistence users of a natural resources.

In the case of the Nairobi River Basin, the goal of the program was to improve the management of the basin. In order to do this, **management options appraisal were identified**:

1. Strict protection of land close to water (riparian zone and catchment areas);
2. Regulating land use (introducing extraction permits);
3. Not making any changes (open access).

Under the first option, strict **protection**, a riparian reserve would be created. Individuals would not be allowed to extract resources from the river. In the second, **regulated** use would entail establishing regulations and fees for extracting river resources. Direct extractive uses would be enhanced, while uses that reduced water quality would be prohibited or minimized. The third and final option would value all methods of extraction equally. Each stakeholder would be free to extract from the river **without regulations, restrictions or fees**.

After all of the options are defined, the relevant **criteria for decision making are identified**. This can include costs, benefits as well as qualitative criteria. Criteria can be grouped into economic, social and environmental categories or arranged hierarchically. In the case of the Nairobi River Basin, analysts chose to focus on economic viability, social acceptability and ecological health.

Identifying criteria is followed by an **analysis of the impacts** of various actions. These estimates can be made quantitatively or qualitatively (using 'performance' and 'effects' matrices). Rows in a matrix represent options and columns represent each option's performance under the proposed criterion. Impacts can be presented in various ways – numerically, in bulleted lists or with color coded charts.

In the Nairobi River Basin, all criteria were measured using the same set of indicators. The criteria were as follows: domestic water supply; water for irrigation; water for livestock; commercial water supply; recreational services; and waste disposal (dumping).

Phase 2 Analysis

Ranking involves learning more from experts and stakeholders about the relative importance of each criterion. The views, priorities and expertise of stakeholders are given weight. Experts may be asked to rank various criteria on a scale of 1 to 10 (cardinal ranking), or in terms of importance (ordinal ranking).

In the Nairobi River Basin, the performance matrix was calculated based on responses from stakeholder interviews. 141 people (53% farmers, 30% commercial users, 17% residential users) ranked the river's attributes in perceived order of importance.

After the importance of the criteria has been established, it is necessary to **transform the criteria into common measurable units**. There are various approaches. This is a technical, statistical issue which we do not pursue further here. Further details can be found below in 'for further information'.

Once all of the criteria have been weighted and given a common measurable unit, the overall performance of **each option is assessed and scored**. Analysts are interested in finding out how well the options perform relative to one another. There are many ways to do this such as creating a weighted average, an analytical hierarchy and compromise programming. Again, we do not present further details here as most of these processes are statistically complicated. There is also the option of not aggregating, called multi-criteria mapping. This allows the options to be illustrated

Table 3.2 Comparing water management options			
	Management option		
Criteria	Total protection	Regulated Use	Open access
Domestic water supply	0.166	0.25	0.10
Water for irrigation	0.166	0.25	0.10
Water for livestock	0.166	0.25	0.10
Commercial water supply	0.166	0.10	0.05
Recreational services	0.166	0.10	0.60
Waste Disposal (dumping)	0.166	0.05	0.05

Please note that in scenario 'total protection' all values are weighted equal.
Source: TEEBcase Multi criteria analysis for resolving conflicting river basin uses, Kenya. (see TEEBweb.org)

and leaves it to the stakeholders or policy makers to decide on ranking.

Judgment and overall appraisal is the final step. The best option is selected based on scores and a sensitivity analysis.

In the Nairobi River Basin, the option for regulated use emerged as the most preferred type of river management. 75% of respondents preferred this option. The MCA made it possible for the conflicting preferences of a variety of stakeholders to enter the same analysis. Importantly, a solution that satisfied the majority of interests was reached.

As the case in Kenya demonstrates, an MCA allows for the **combination of divergent interests and methods**. It can be a very useful decision-support tool in complex situations. It does not require that every value receives a monetary weight, and can thus in-corporate social issues, cultural and spiritual values. It can more easily incorporate different aspects in the analysis than CBA. Yet, MCA also has **limitations**. It relies on the judgment of stakeholders and experts; results may therefore not be representative. CBA, if price distortions are adjusted, is more appropriate to determine cost-effectiveness.

3.5 CONCLUSIONS AND ACTION POINTS

Valuation illustrates the importance of ecosystem services. Because many governments use cost-benefit analysis to make important decisions, valuation is an appropriate tool for including the value of ecosystem services in decision making and action. A careful application of valuation does not only seek out the 'right numbers' to input; it is also sensitive to peoples' cultural and spiritual values. A robust ecosystem valuation is likely one that reconciles economic and non-economic values.

Ecosystem valuation is often instrumental as a decision-support tool. The Republic of Maldives is the second nation to have announced blanket protection for sharks, using valuation to choose dramatic protection measures. Their valuation determined that protection was in the country's economic interest. Single gray reef sharks were valued at US$ 3,300/year to the tourism industry in contrast to US$ 32 for a single catch. (TEEBcase Tourism more valuable than fishing, Maldives)

Ecosystem services valuation can be applied in natural resource management, urban and spatial planning, the development of appropriate certification schemes and standards and the creation of well-managed,

economically-feasible protected areas. Take the following aspects into account:

- Consider whether valuation might be used as an input to your decision at local level, even if it is partial and does not cover all ecosystem services.
- Use the section on valuation to filter your options and find how-to manuals in 'for further information' below.
- Valuation fits into both the conventional economic decision-making framework of Cost-Benefit Analysis and also in alternatives such as Multi-Criteria approaches.
- The purpose of valuation determines which method is most appropriate. Consider the options based on who the end-users of the analysis will be, who the affected stakeholders are, and what resources are available.
- Apply as much rigor to estimating qualitative changes as quantitative ones – they should be well-researched and 'grounded'.
- Be aware of subjectivity in your analysis and be transparent in setting out the assumptions made.
- Always carry out a sensitivity analysis to determine how sensitive your results are to changes in certain variables.

FOR FURTHER INFORMATION

General Valuation

Pearce et al. (2002) Handbook of Biodiversity Valuation: A Guide for Policy Makers. This OECD handbook for practitioners provides guidance on biodiversity valuation, points out tradeoffs and contrasts economic and non-economic valuation.

World Bank; IUCN; TNC (2004) How much is an ecosystem worth? Assessing the economic value of conservation. This brochure introduces the approach of ecosystem services and compares different valuation methods in an easily accessible format. http://biodiversityeconomics.org/document.rm?id=710

A easily understandable introduction on ecosystem service valuation, along with essentials, 'the bigger picture' and an overview of existing valuation methods is available at www.ecosystemvaluation.org

Valuation at different scales

IUCN (1998) Economic Values of Protected Areas: Guidelines for Protected Area Managers. No. 2. Using the example of 16 case studies from around the globe, this report compares existing valuation methods. www.iucn.org/dbtw-wpd/edocs/PAG-002.pdf

SCBD (2001) The Value of Forest Ecosystems (CBD Technical Series, no. 4). This report highlights the multiple values of forest and points out causes of forest loss. www.biodiv.org/doc/publications/cbd-ts-04.pdf

Barbier et al. (1997) Economic Valuation of Wetlands, a guide for policy makers and planners. The handbook provides an introduction to wetland valuation, presents 6 case studies and illustrates – step-by-step – how to conduct a valuation. http://liveassets.iucn.getunik.net/downloads/03e_economic_valuation_of_wetlands.pdf

Bann (2003) The Economic Valuation of Mangroves: A Manual for Researchers. This academic how-to guide points out how to conduct a Cost-Benefit-Analysis of mangroves and presents possible management options. http://network.idrc.ca/uploads/user-S/10305674900acf30c.html

van Beukering et al. (2007) Valuing the Environment in Small Islands: An Environmental Economics Toolkit. This easily accessible report addresses the issues of stakeholders engagement, economic valuation, data collection, and supporting and influencing decision making. www.jncc.gov.uk/page-4065

Multi-Criteria-Analysis

Mendoza et al. (1999) Guidelines for Applying Multi-Criteria Analysis to the Assessment of Criteria and Indicators. As part of the 'toolbox series' this report gives a first introduction (incl. a case study) of the Multi-Criteria-Analysis, an approach for highly unstructured decision contexts. www.cifor.cgiar.org/acm/download/toolbox9.zip

DTLR (2001) Multi Criteria Analysis: A Manual. This comprehensive and detailed manual presents Multi-Criteria-Analysis techniques and approaches for integration in decision making. http://iatools.jrc.ec.europa.eu/public/IQTool/MCA/DTLR_MCA_manual.pdf

On his website Andy Stirling introduces his interactive appraisal technique of multi-criteria mapping. General Information and software tools are available at www.multicriteriamapping.org

Participatory Rural Appraisal

The Participatory Learning and Action website provides extensive resources on participatory rural appraisal. www.planotes.org

Partners for Development (2000) Field Manual for Participatory Rural Appraisal. This manual provides a chronological introduction to Participatory Rural Appraisal and explains the PRA toolkit more detailed. www.foodsecurity.gov.kh/docs/ALL/FullDoc-PRA%20Field%20Manual-ENG.pdf