TRAINING MANUAL

ECONOMIC VALUATION

AND

ENVIRONMENTAL ASSESSMENT

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Preface

This training manual is aimed at policy-makers and practitioners involved in the conservation and management of natural resources. It is meant to equip senior and mid-level ministerial personnel, staff members of conservation state corporations and representatives of NGOs and CBOs in Kenya with basic principles of environmental economics and valuation techniques in order to endow them with the necessary skills for assessing and justifying the importance of biodiversity conservation.

The manual is organized in three parts. Part A consists of the first three chapters and provides an introduction to basic ecological and economic concepts that are relevant to valuation and assessment of natural resources. Part B offers a detailed discussion of valuation concepts and methods or techniques applied in economic valuation, while part C delineates decision-making criteria that can be applied in environmental assessment. These include environmental impact assessment (EIA), a number of cost-based methods as well as cost-benefit analysis, which considers both benefit and cost streams.

The primary emphasis of this manual has been placed on natural resources (forests, wildlife, wetlands, etc.) and the biodiversity within them, but it can also be applied to all renewable and non-renewable resources as well as to environmental aspects such as pollution control, water and sanitation, and general public health. Although the manual is not exhaustive, it offers a catalogue of several important approaches to economic valuation and practical decision-making, providing empirical examples that support the theoretical discussions. It is hoped that the manual will positively contribute towards understanding the economic value of natural resources and biodiversity and hence promote their conservation and sustainable use.

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Part A: Introduction to Ecological and Economical Concepts

1. Natural Resources and Biodiversity

1.1 Types and definitions of natural resource

The resources of land, forests, savannahs and seas fall into several categories. Two main types of natural resource can be distinguished

(a) Non-renewable natural resources

(b) Renewable natural resources

Non-renewable natural resources are those of fixed supply such as oil, coal, gold or iron – that is, their continued use will inevitably result in exhaustion. Renewable natural resources are those that have the capacity to regenerate themselves, and are therefore potentially inexhaustible when used appropriately, e.g. fish, forests, solar energy, water, and the atmosphere.

Economists think of the world as consisting of 'goods' (physical components) and 'services' (non-physical components). Both non-renewable and renewable natural resources are 'goods' i.e. they are tangible and exist as physical 'stock' within a limited area. As such, they can be privately, communally, or governmentally owned and/or managed. And since they are tangible in nature, they are also generally recognised to have market value, although the market values do not always reflect their true value to society.

Environmental resources, on the other hand, are those that are of benefit to humankind but are difficult, if not impossible, to own: what economists refer to as 'public goods'. Many of these are based on a functioning ecosystem. Examples include clean air, flowing rivers, the existence of particularly plants and scenic beauty.

1.2 The significance of differing resource characteristics

The primary reason why economists distinguish between non-renewable, renewable and environmental resources is that the overall management challenge of each differs. The primary question for non-renewable resource management is: "at what rate should a resource of fixed supply be depleted?". By contrast, the main consideration in managing renewable resources is that they have the potential to be inexhaustible. The primary question then becomes: "what balance should be maintained between the rate of use and the rate of resource regeneration?". Whilst the primary question in managing environmental resources becomes "what are the costs to society of diminished ecosystem functions as a result of renewable and/or non-renewable resource depletion?" or, alternatively, "what are the benefits to society of enhanced ecosystem functions as a result of renewable and/or non-renewable resource increase or enrichment?".

1.3 Definition of biological diversity (biodiversity)

In terms of the discussion so far, non-renewable, renewable, and environmental resources combine to constitute 'biological resources' (the word biodiversity is a contraction of biological diversity). These biological resources are simply the physical manifestation of biological diversity. Biodiversity has varied definitions but this manual defines biodiversity in accordance with the Convention on Biodiversity (CBD) and that is: *biological diversity is the variability among living organisms from all sources including inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexities of which they are part; this includes* ***diversity within species, between species and of ecosystems***[1] (See other definitions in Box 1). These three are the levels of biodiversity. The first one, **genetic** biodiversity, defines the adaptation capacities of the species in the long term by way of evolution, thus species or groups of them with less flexible genomics will tend to become extinct. At **species** level, this is basically supported by a recognized structure (taxonomy), sampling, and derivation of statistical operators; the number and types of species and changes on their populations are used to

[1] See UN, 1992, The Convention on Biological Diversity

give a comprehensive measurement of the health of an ecosystem. The **ecosystem** level, refers to a community whose spatial and temporal boundaries are not defined, as may be

Box 1. What is biological diversity?

Biological diversity is an umbrella term for the degree and extent of nature's variety, including the number and frequency of ecosystems, species, or genes in a given assemblage. It is usually considered at three levels, "genetic diversity", "species diversity", and "ecosystem diversity". Genetic diversity is a concept of the variability within a species, as measured by the variation in genes (chemical units of hereditary information that can be passed from one generation to another) within a particular species, variety, subspecies, or breed. Species diversity is a concept of the variety of living organisms on earth, and is [generally] measured by the total number of species in the world (variously estimated as from 5 to 30 million or more, though only about 1.4 million have actually been described), or in a given area under study.

In general, the larger the population size of a species, the greater the chance of there being high genetic diversity. But population increase in some species may lead to a population decline in other species, and even to a reduction in species diversity. Since it is usually not possible to have both maximum species diversity and maximum genetic diversity, national policy-makers should define the optimum biological diversity consistent with their development objectives; one key element is to ensure that no species falls below the minimum critical population size at which genetic diversity is rapidly lost.

Ecosystem diversity related to the diversity and health of the ecological complexes within which species occur. Ecosystems provide natural cycles of nutrients (from production to consumption to decomposition), of water, of oxygen and carbon dioxide (thereby affecting the climate), and of other chemicals like sulphur, nitrogen, and carbon. Ecological processes govern primary and secondary production (i.e. energy flow), mineralization of organic matter in the soils and sediments, and storage and transport of minerals and biomass. Efforts to conserve species must therefore also conserve the ecosystems of which they are a part.

Source: McNeely (1988), drawn from OTA (1987); Ricklefs, Naveh and Turner (1984)

a fragment of forest or may be the entire biosphere; its study focuses on patterns of distribution of the species and their roles: functions and interactions to maintain the homeostasis of the system

Diversity is a concept, which refers to the range of variation or differences among some set of entities; biological diversity thus refers to variety within the living world. The term biodiversity is therefore used to describe the number, variety and variability of living organisms.

Three examples in the Kenyan context include:

- The genetic diversity of wildebeest versus cheetah, determined through DNA analysis: the genetic variety within the white bearded gnu is greater than between some species of antelope. This is mainly due to their high populations level and

wide distribution, split by the formation of the Rift Valley. By contrast, the cheetah gene 'pool' is relatively narrow, a fact that is believed to have contributed to their decline to a level that is considered to be approaching the 'minimum viable population' threshold.

- The abundance of elephants versus other species: the growth and concentration of elephants in and around Amboseli National Park is thought to have resulted in the demise of many other species, due to the role they play in consuming tree and bush re-growth, in particular. These include primarily the browser and species: black rhino, eland, kudu, impala, duiker, dik-dik together with leopard, which rely on browser species. A similar situation also occurred in Tsavo National Parks during the peak elephant population of the 1970s.
- Local participation of communities in ecosystem diversity: from a biodiversity perspective, the main rationale for the need to include local communities in wildlife management is in order to maintain the functions and services that ecosystems provide, recognising that the survival of most, if not all, Kenya's protected areas are ultimately dependent on the impact of forces outside the protected area boundaries on ecosystem functions.

1.4 Ecological services and functions of biodiversity

The principal biodiversity goods and functions can be summarized as follows:

- Regulation of global processes: atmospheric flow of gases that affect global and local climates and the breathing air;
- Conservation of soil and water: maintenance of the hydrologic cycle and erosion control;
- Cycling of nutrients and energy: photosynthesis, soil renewal, nitrogen fixation, organic matter decomposition, etc.;
- Saving of genetic information: that warrants the permanence of life on earth;
- Maintenance of plant reproduction through pollination and seed dispersal;

- Provision of raw material for sustaining human activities: agriculture, medicine, manufacturing, industry, etc.; and
- Provision of recreation opportunities

Detailed description of these services and functions is indicated in Box 2 below.

Box 2: The services of natural resources and biodiversity	
Type of service or function	**Examples**
1. Raw material	Soil, water, wood and air. They are transformed into consumer products by the production process.
2. Life support	Hospitable surroundings for human and other forms of life. Life as it exists on earth is not possible in other planets.
3. Energy	Energy, which fuels the transformation. Trees tap energy from the sun through photosynthesis. Other sources are fossil fuels, wind and geothermal .
4. Amenity	The environment also provides services indirectly to consumers in form of a variety of amenities for which there are no substitutes, for example, lakes and rivers for recreation, wildlife etc. Natural vegetation and landscapes have innate beauty and are valued by human beings
5. Receptor for waste products	The raw material and energy finally return to the environment in from of waste. For example, micro-organism cause organic residues to decade. Poisonous CO is converted in to less harm CO_2. Equatorial rain forests ecosystem is top on the list for CO_2 sequestration
In sum: Tangible services - 1,2,3: Functional services – 5: Intangible services – 4	

Ecological measurement of biodiversity

From the above discussion, it can be appreciated that the primary interest in measuring biodiversity is that biodiversity level is an indicator of well-being of ecological systems, which also dictate the productivity to humankind of those systems.

Biodiversity has two dimensions: richness (variety) and abundance (number). Ecologists typically utilise three types of biodiversity measure:

- Species richness indices – a measure of the number of species in a defined sampling unit.
- Species abundance indices – compares the level of evenness amongst numbers of each species versus unevenness (unequal). Usually some species are abundant whereas most are not i.e. a few species dominate.
- Proportional abundance indices – which seek to summarise richness and evenness into a single figure e.g. Shannon and Simpson indices.

Ecological and economic importance of biodiversity

As stated earlier, biodiversity is manifested in the form of biological resources. However, the presence of biological resources is only the end result of a set of interrelated ecosystem processes, or functions:

- Water cycle. The status of a water cycle in any given environment ranges from 'ineffective' to 'effective'. An effective water cycle is one that retains and makes available to the system the greatest percentage of rainfall received. One characteristic tends to be higher and longer duration river/stream flows. High levels of plant cover (whether grasses or otherwise) are usually required to facilitate an effective water cycle, which in turn results in higher ecosystem productivity; together with higher biodiversity levels.
- Mineral cycle. Productive systems are dependent on a varied and available supply of minerals for regeneration. Greater biomass levels contribute healthy mineral supplies, which in turn result in higher ecosystem productivity and higher biodiversity levels.
- Energy flow. Energy flow is a measure of the productivity of the system, and is determined by the system's ability to convert sunlight into plant production through photosynthesis, which in turn is dependent on plant cover.

- The three processes act in tandem, and therefore constitute a set of processes. This set can move in three directions: ‘spiralling up’, resulting in greater ecosystem productivity and manifested by greater biodiversity; ‘ spiralling down’, manifested by decreased productivity and biodiversity; and ‘neutral’.

From an **ecological** perspective, the diversity increases the ecosystem's stability (capacity to maintain itself into healthy margins of variation adapting recurrently to changes) and resilience (ability to respond and recover to great stress events), which is an extraordinary quality, because it means that biodiversity is able to maintain itself in the time, owing to the called **biogeochemical cycles**:

1. **Energy**, using the photosynthesis by which green plants convert sunlight, water, nutrients, and carbon dioxide into chemical fuel (carbohydrates), which is the basis of all food webs, and is the foremost important source of energy (even including the fossil one, that derives from it);
2. **Water**, activated by solar energy, the transpiration and evapo-transpiration of the vegetation contribute to the water purification by catching, holding and recycling rainwater; in addition, wetlands and estuaries purify water and prevent and control flooding;
3. **Carbon** and **oxygen** cycles, the carbon dioxide produced by animal respiration, plant decomposition and fuel burning is absorbed by green plants in the biosphere and phytoplankton in the hydrosphere, which later release oxygen back to the atmosphere, in order to get a gaseous equilibrium, that enable almost all forms of life to exist.
4. **Nitrogen** cycle, nitrogen is a key component of all organisms (base of the amino-acid molecules that integrate proteins), on its natural atmospheric form isn’t accessible to most organisms, needs to be available being transformed by some bacteria that live in the roots of legumes.

From **economics** perspective, biodiversity is important in terms of its use or potential use value to society i.e. a ‘utilitarian’ view. These uses, which are discussed further in Chapter 4, include:

Extractive use encompasses direct use of biological resources, for either production or consumption:

- Fuelwood, timber, water, fish, ivory, medicinal plants, fodder, construction material, dyes, etc.
- Employment

Non-extractive use entails use value without extracting the resource ('indirect' use), either for production or consumption:

- Recreation/Tourism
- Education and Research
- Employment opportunities
- Ecosystem services (as opposed to 'goods') provided by ecosystem processes, including:
    - Plant production through photosynthesis
    - Plant reproduction through pollination, cross-fertilization, gene flow, etc.
    - Watershed protection, recharging ground water and buffering extreme conditions (e.g. floods, drought)
    - Production of soil and protection of soil from erosion
    - Supply of essential nutrients
    - Absorption and breakdown of pollutants and organic waste

Non-use values encompass value that is not derived from use:

- Spiritual, historical or cultural value is well-being derived from, for example, a 'sense of belonging'.
- Existence value derived from knowing that a landscape, habitat or species exists, even though an individual may have no intention of ever visiting that area.
- Option value is the value attached to retain the option, or possibility, of having future access to a given landscape, habitat or species. This value reflects an

individual or society's perception of uncertainty, both in terms of future needs or desires; and future threats to the biological resource(s) in question.

- Bequest value is closely related to existence value, and is the value derived from knowing that certain landscapes, habitat or species exist for the benefit of future generations.

1.5 Major threats and challenges to biodiversity conservation

Three major threats are posed to biodiversity:

- Habitat alteration, usually from higher-diverse natural ecosystems to less diverse ('monoculture' in the extreme case). This is perhaps the most important threat to biodiversity and, by extension, system productivity. Two important cases in Kenya concern conversion of forests to cultivation (prevalent in all major forests); and conversion of rangeland to cropland – which is often later abandoned.
- Over-harvesting, that is, an extraction rate that is higher than the regeneration rate, leading to eventual exhaustion of the resource. Again, over-harvesting of trees and grasses are particularly relevant issues in Kenya.
- Climatic change, often related to changing regional-level vegetation patterns, and involving features such as carbon dioxide build-up (global warming) and the El Nino and La Nina phenomena (climate regime reversal).

The importance of natural resource conservation cannot be denied, given that ecosystem processes and services provide the foundation for our current existence, and that future consumption depends, to a great extent, on stock of natural 'capital'. Seen in this light, conservation is a precondition for sustainable development.

A number of broad challenges exist, however:

- Challenge 1: The fundamental problem is that more people earn greater immediate benefits from exploiting biological resources than they do from conserving them.
- Challenge 2: Areas of the world with the greatest levels of biodiversity are often those with fewest economic means to implement conservation. One of the greatest challenges is to reconcile this situation.
- Challenge 3: Whilst over-harvesting and/or depletion of a renewable resource may be a conscious choice, perhaps the greatest need is for resource harvesting to be conducted under efficient management, rather than mismanagement, in order that society can realise the greatest possible gains.

1.6 Discussion questions:

1. Why in essence can we say all natural resources can be termed as renewable and as well as non-renewable?
2. Discuss, giving examples, the main forest functions and services that Kenyans have been enjoying from their forest?
3. What do you consider the main issues underlying each of the challenges 1, 2 & 3 to be?

2. Economic Theory and the Problem of Resource Allocation

2.1 The rational of economic theory

Making ***CHOICES*** is an every day occurrence. Individuals, households, firms producing goods and services, governments and even the international community make choices. Choices have to be made for the simple reason that there is ***SCARCITY***. The best-known scarcity is that of money to buy all the things we desire as individuals, households, or even governments. Time is scarce, therefore we have to make a choice on the way we spend the twenty four hours in a day. Natural resources are scarce. For instance land in the high potential areas of Kenya is only a certain area. Similarly the forest area in Kenya is scarce in the sense we would want to have more forests, but forestland can also be cultivated because food produced is scarce. Scarcity implies that a choice has to be made.

Economics is the science of choices. It can be defined as the social science that studies the choices that we (human beings) make as we cope with scarcity (such as of natural resources) and the institutions (such traditional norms of natural resource use and management or government regulations (such as the pending forest bill) that have evolved and continue to evolve to influence and reconcile our choices. Economic theory is the body of knowledge that has been accumulated by observing human behaviour in the process of making choices imposed by scarcity. This body of knowledge continues to be generated. It is used as one way of analyzing some of the problems that face humanity by identifying and organizing the facts pertaining to a specific problem with a view to suggesting or alternative solutions and evaluating their possible.

Economics is divided into two broad areas: Micro- and Macroeconomics. Microeconomics is the study of the choices the individuals (households) and businesses (firms) in dealing with scarcity, the interaction of these decisions, and the effect of government regulation on these decisions. The effect of individual, households, business firms and government on the national and global economy constitutes the study of Macroeconomics. For example, how will the maize market in Kenya be affected by free trade among the three East African countries? How will reduction on the tax on paraffin and gas?

2.2 Why economics of natural resources

As the twenty-first century begins it is clear that the welfare of humanity is closely linked to the **quantity and quality** of the natural resources. Long ago, natural resources were a free good but today they are a **scarce good**. The relationship is starkly demonstrated by countries in Sub-Saharan Africa and elsewhere in developing countries, where the majority of the people derive their livelihood directly from natural resources as farmers, livestock keepers, fishermen or by harvesting products from forests ecosystems. However, poverty and degradation of natural resources in these countries is on the increase. It is also becoming increasingly clear that although there are natural resources issues that are regional or even country specific, others are of global concern and impact, as clearly demonstrated by the global warming, depletion of the ozone layer, and reduction of the equatorial forests resulting in loss of their irreplaceable benefits and functions such as the Kakamega forest.

It is also evident that governments in specific countries are increasingly being confronted with natural resource linked conflicts. This is because **without consideration of peoples' interests, sustainable natural resources conservation is not possible**. Kenya has a wealth of these conflicts: cultivation in the Mau Escarpment after alleged land purchases; fencing off of some sections of the Aberdare Range to minimize human-wildlife conflict; seemingly idle individually owned prime land in high potential areas amidst many landlessness and jobless people; contentious cultivation and grazing livestock in gazetted forest areas; the pending forest bill; natural resources issues with a historical twist such as treaties governing use of Lake Victoria waters and 99-year colonial land leases versus the current claims of the communities who lost the land.

It is also recognized that natural resources just like other resources such as other capital resources (other forms of capital include human capital, financial capital, social capital, political capital) respond to policies and governance. Economic policies particularly influence the nature of natural resources. It is now acknowledged that natural resources are not merely biophysical entities but are also **economic commodities** essentially dynamic

and embedded in the social and political setting. Therefore, appropriate natural resource management (NRM) systems can only be developed if natural, economic and governance components are appreciated and integrated. This means that appropriated NRM systems are derived by combining inputs from resource characteristics, policies, institutions, technology, skills and economic signals.

The focus on natural resource and environmental issues is current and topical because they are focused on in the global millennium goals as the 7th goal.

Table 3: Millennium Development Goal 7

Millennium Development Goals (8) – Global Target for 2015	
Goal 7 (out of 8 goals) - Ensure environmental sustainability	
Target 9 (out of 18 targets)	**4 Indicators (out of 48 indicators)**
Integrate the principle of sustainable development into country policies and programs and reverse the loss of environmental resources	- Proportion of land area covered by forests - Land area protected to maintain biological diversity - GDP per unit of energy use (as proxy for energy efficiency) - Carbon dioxide emission (per capita) [Plus two figures of atmospheric of global atmospheric pollution ozone depletion and the accumulation of global warming gases]

2.3 Natural resources as scarce resources

Natural resources, often termed as "the free gifts of nature", are neither free nor finite. Therefore, welfare of a society depends on how it allocates its scarce natural resources among the competing needs by making choices. Economics as study of choice can contribute to natural resource and environmental management by:

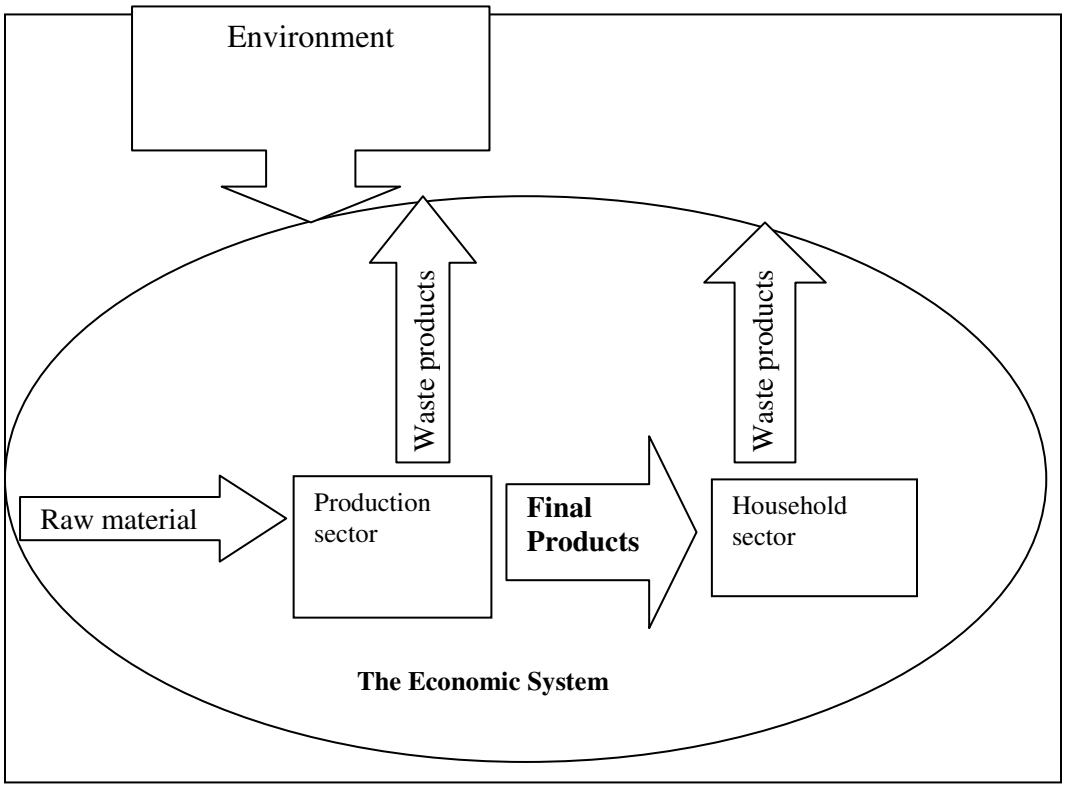
- Identifying circumstances which generate natural resource problems
- Determining the causes of these problems
- Identifying possible solution and comparing their cost and benefits

In making the choices, tradeoffs have to be made, that is giving up one thing in order to get something else. Economists have three main areas where trade-offs are made: what is produced with the available (natural) resources such as land, how much is produced (food crops or forest products) and for whom goods and services are produce (who will enjoy the food crops and the forest products produced from the land resource).

How do economists define the natural resources and the environment (NRE)? Economists are interested in NRE as they affect mankind, directly or indirectly. Therefore their definition and the changes they consider in NRE are human centered. That is, they include not only short-run and direct effects on mankind but indirect and long run effects as well.

- Economist view NRE as non-reproducible composite capital asset or capital good that produces a stream of various services to mankind as show in Figure 1.

Figure 6: The relationship between the economic system and the environment



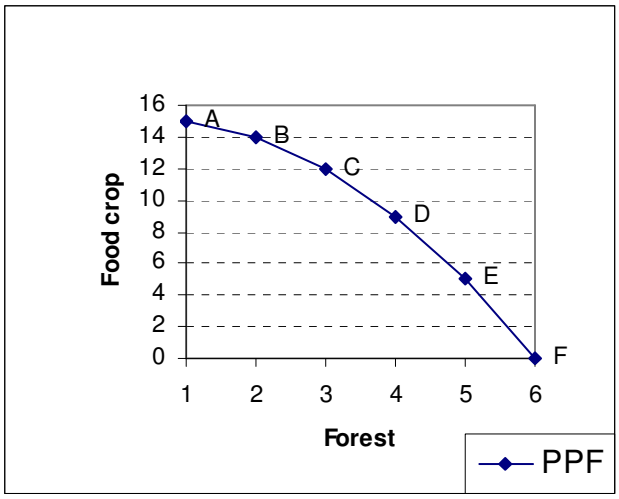
- The services produced by NRE are affected by the production and consumption activities of mankind (extraction of resources) and the way they dispose their residuals or wastes. These activities constitute the economic system.

As with all assets, preventing undue depreciation of the value of the asset, contributes to its efficient use.

2.4 Economic criteria for decision making in solving NR problems

The amount of resource available to a country or a single producer defines the limit of what can be produce given the available technology. Assume that the resource in question is the amount of land and the alternative use is to cultivate food crop or retain forest vegetation. The different combinations of the two alternatives possible can be presented in a graphical model as in Figure 2.

Figure 7: Production Possibility Curve (PPF)

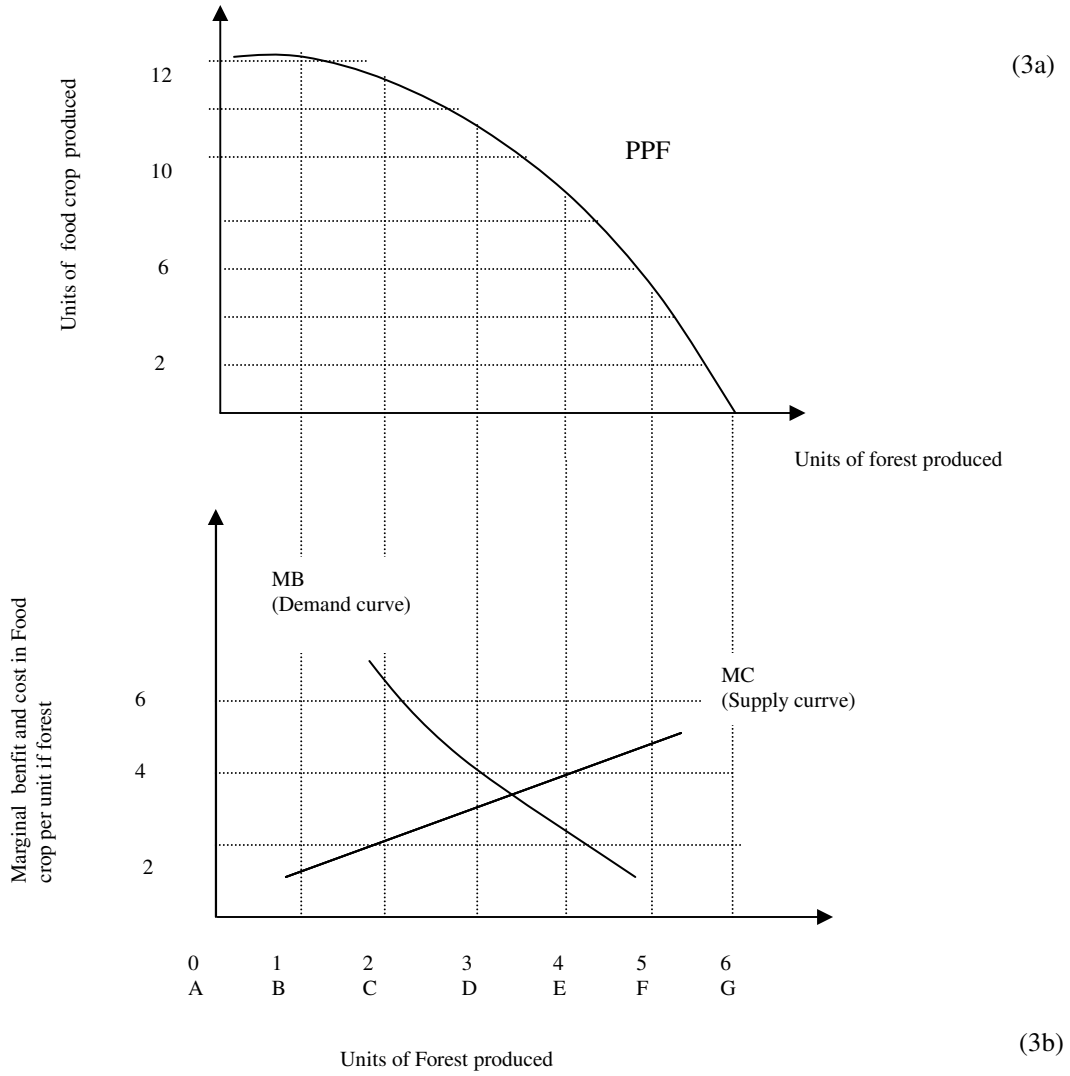


The combination of food crop and forest falling on the production possibility frontier (PPF) is the maximum possible given the resources and technology. Production on this curve constitutes technical efficiency that is maximum physical output given the available resources and technology. Combinations below and to the left of PPF will leave some land idle while combinations above and to the left of the line are unattainable from the land area available.

To produce more food crop we have to give up some forestland (opportunity cost). All economic questions arise because we want more than we can get. We want to keep our forests but we also want land for growing crops. We want an atmosphere devoid of harmful ultraviolet rays and other gases from the sun filtered by the ozone layer, but we also want the good and service whose production process emits gases that destroy the ozone layer.

Every choice involves a cost. Opportunity cost is the highest-valued alternative that is given up to get something. The opportunity cost for forest in terms of food crop increases the less of the food crop we have. From combination A (Figure 2), to get one more unit of forest and move to combination B, we need to give up one unit of food crop. But to get one more unit of forest and move to C we need to give up two units of food crop. This is the increasing marginal cost of production (MC) as shown in Figure 3b. It explains why the supply curve of a commodity is upward sloping increasing from left to right.

Figure 8: Production Possibility Frontier and Optimal Production



The PPF can also be used to illustrate benefits received from the choices made. At B, one unit of forest is worth seven units of food crops. At D however, one unit of forest is only worth two and a quarter units of food crop. This relationship between the value of an additional unit of a good consumed is termed as marginal benefit (MB) and it decreases the more units of the commodity are consumed.

Figure 3b shows what the consumers would be able and willing to pay for the consumption of one more unit of the good, that is the price per unit. The MB curve is downward sloping from left to right. It also explains where the demand is downward

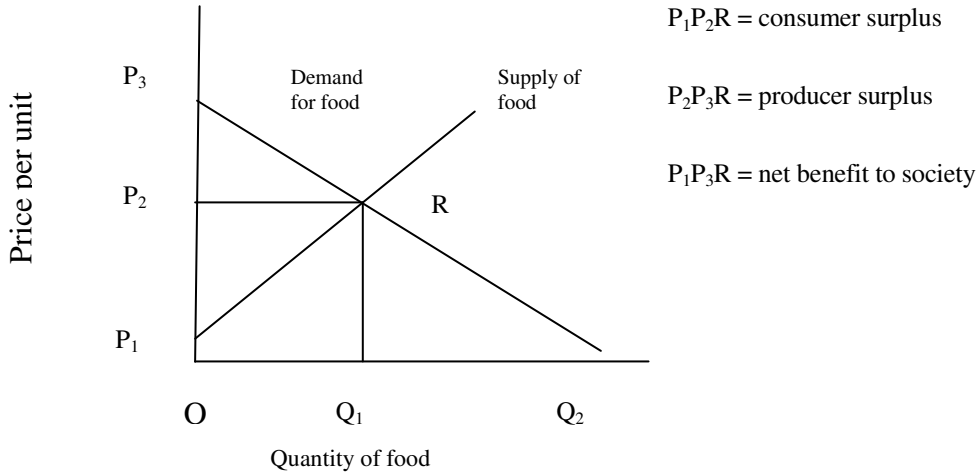
sloping in the same manner. The demand curve (marginal benefit curve) can also be termed as the marginal benefit line or curve because it shows the amount the consumer is willing to pay for an additional unit. The area to the left and below the demand curve shows the total willingness to pay (WTP) for the units consumed.

The combination of forest and food crop that equates MC to MB is allocatively efficient in the sense that we cannot produce more of one of the two goods without giving up a quantity of the other good that we value more highly. Equating MC to MB in use of a resource translates into static efficiency, that is, efficiency considering resource allocation in one time period. The criterion also applies when there is enough resources to met the demand for each time period.

Allocation of scarce resources over different time periods means that scarcity will be manifested in one or more periods. Scarcity imposes an additional opportunity cost. The present value of the forgone opportunity is the additional value created by scarcity. It is termed as marginal user cost. Dynamically, efficient allocation of a scarce resource over time dictates that the MB be equated to the sum of MC and marginal user cost.

The point was made that MB curve can be interpreted as the demand curve and MC as the supply curve. Therefore, the marginal benefit is the price consumers are willing to pay for an additional unit of the good. Similarly the MC is the price minimum price at which the suppliers would be willing to supply an additional unit of the good (Figure 4). Optimal allocation of resource to production of a good requires that quantity demanded and the quantity supplied is equal (OQ_1). The allocation maximizes the total benefit to society (area P_1P_3R), which has two components in relation to the equilibrium price OP_2.

Figure 9: Producer and Consumer Surplus



The optimal quantity OQ_1 is sold at OP_1 price unit which is higher than the MC per unit (P_1R.) Therefore the producer has extra earning (P_1P_2R) above the minimum needed to induce supply. The extra earning is the **producer surplus**. Similarly the consumer has extra satisfaction (P_2P_3R) because of paying a price lower than MB per unit (P_3R). The extra satisfaction is the **consumer surplus**. The sum of producer and consumer surpluses is the **total net benefit to society** and is maximized by optimal resource allocation obtained by ensuring in resource use MB= MC.

2.5 Economic valuation and the demand curve

Most valuation techniques in natural resources and biodiversity involve elicitation of willingness to pay (WTP). WTP has a formal relationship to the notion of a demand curve. Figure 5 shows the usual depiction of a demand curve for an individual. The horizontal axis measures the total number of units that can be bought and the vertical axis measures the price per unit. Points on the individual's demand curve show, for each quantity purchased, how much that individual is willing to pay for that last (or *marginal*) unit.

For example, the individual is WTP £10 for the first ten units, £8 for the second ten units, £6 for the third ten units and so on. The *total* WTP for three units is £(10+8+6) x 10 =

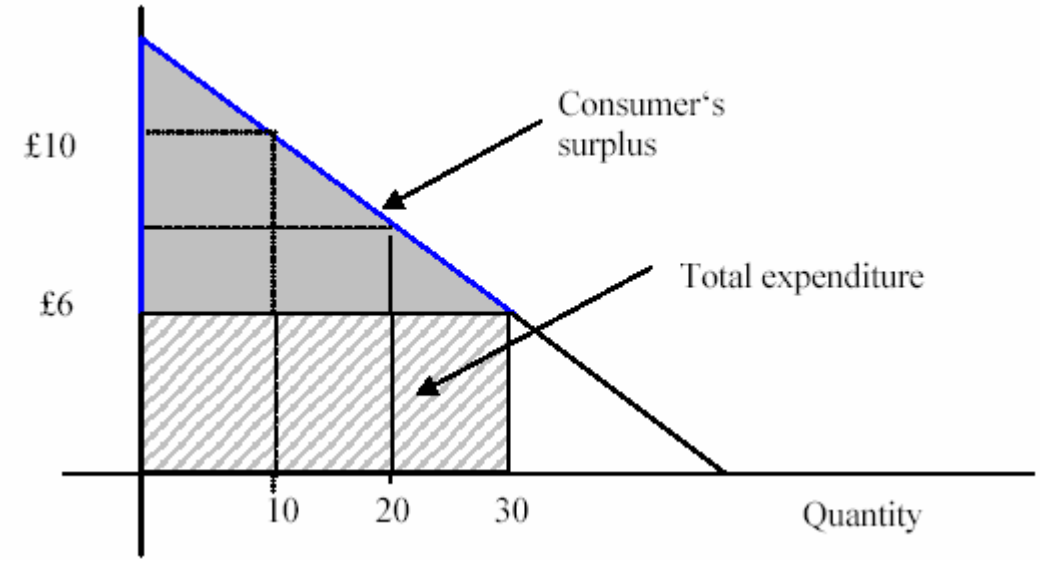
£240. Hence marginal WTP is given by points on the demand curve and total WTP is given by the area under the demand curve.

Suppose the market price settles at £6 per unit, then we see that total expenditure is 30x£6 = £180 and this is less than total WTP of £240. The difference between total WTP and actual expenditure, i.e. £240 – £180 = £60, is the ***consumer's surplus***. Consumer surplus is therefore a measure of the net benefit to the consumer of buying 30 units at the market price since he/she pays out £180 but 'gets back' £240 in the form of well-being as measured by WTP. The £240 in this case is a measure of the *gross* change in well-being (or welfare, or utility) from buying 30 units, and the £60, the consumer surplus, is a measure of the net change in well-being (welfare or utility).

A basic formula, then, is:

Total WTP = Market Price + Consumer's Surplus

Figure 10: Demand and WTP



Efficient resource allocation over different time periods

To compare the benefits received from allocating a quantity of resource to some future period with those of the current period, the future benefits have to be discounted for time to reflect time value of money (see the compounding /discounting formula). With scarce resources involving allocation over different time periods, the marginal benefit (net of cost) of the different time periods have to be discounted for time, to be comparable. Resource allocation is dynamically efficient if the present value of marginal net benefits of different time periods are equal. Allocation of resources across "n" time periods is dynamically efficient if it maximizes the present value of net benefits that could be received from all the possible ways of allocating those resources over the "n" periods. Dynamic efficiency assumes the objective of society is to balance the current and future use of a resource by maximizing the present value of the net benefits derived from the use of the resource. The present value of a stream of benefits (B_1,……,B_n) received over a period of "n" years is computed as

$$PV = \frac{B_1}{(1+r)^1} + \text{.....}, + \frac{B_n}{(1+r)^n}$$

Where

PV = present value of a stream of net benefits (benefit less cost) from resource allocation over "n" period of years

r = appropriate interest rate (usually social discount rate different from market interest rate)

B_1 = amount of net benefits received end of the first year

B_n = amount of net benefits received at the end of the furthest year

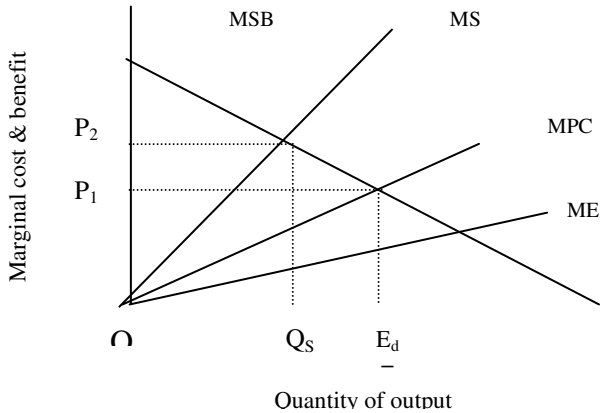
2.6 Negative externalities as a source of natural resource problems.

Profit is the incentive for the entrepreneur embarking on production of any goods and services. Entrepreneurship is one of the factors of production. Other factors of production are obtained from households through incentives to earn income. Capital earns interest,

labour earns wages and land (loosely referred to as “free gives of nature”) earns rent. The income is used to buy the goods and services produced by the firms. Consumers vote by the shilling to indicate the goods they want produced. In this way they reveal their preferences for goods and services that are bought and sold. In doing so, they compare the marginal benefit of each unit with the market price. The process works well for goods and services which have a market and are consumed after paying a price for instance food and clothes. The market price is an indication of the value (utility) consumers attach to the commodity. For other such a clean air, they are not traded in the market and there is no obvious market price. It is therefore more challenging for economist to device ways of determining the value people attaché to clean air and other commodities not traded in the market such as sequestration benefits of forests. The response of the producer to the revealed preferences of the consumers is to compare the market price in relation to cost of production to determine the quantity of the good to be supplied. It is assumed that these costs are fully carried by the producer.

The function of a market is to facilitate buyers and sellers to be in contact to exchange good and services. In an efficiently working market (competitive market) the market price reflects the cost of production and the benefit derived from consumption of the good leading to optimal allocation of resources. However for some types of production the producer does not incur *all the costs of production* (Figure 6). Some of them are borne by a second agent without compensation and are termed as marginal external costs (MEC). For example when forests are cleared for food crop cultivation, soil erosion is increased causing rapid siltation of water reservoir. The cost of generating hydroelectric power is increased and passed on to consumer as higher prices. This cost is not reflected in the price of food crop produced because it is external to the decision process of the farmer. That process only takes into account private marginal cost (MPC). Siltation of water reservoirs is a negative externality generated by food production but the cost is carried by power consumers.

Figure 11: Marginal Costs of Production



MSB = marginal social benefit

MSC = marginal social cost

MPC = marginal private benefit

MEC = marginal external cost

OQ_S = socially optimal level of output

OQ_P = privately optimal level of output

The privately optimal output is OQ_P and the market price is OP_2. The socially optimal level of output is determined by equating marginal social benefit (MPC plus MEC) to the MSB. The socially optimal level of production is OQ_S (lower than the privately optimal out put) and the price OP_2 is higher.

2.7 Discussion Questions

1. Increasing poverty is one of the immediate problems and challenges facing Kenya at the beginning of the twenty-first century. Therefore natural resources and the environment should be among the least concerns of the policy makers". Agree, or disagree giving reasons.

2. One of the roles of government should be to prevail on economic agents to take into account the effect of their negative action as they exploit natural resources (such as natural forests) on other beneficiaries of the resource. State the actions government take and explain the economic reasoning backing them.

3. Policy, Market and Institutional Failures in Natural Resources Conservation

3.1 Introduction

Policy, institutional and market failures are responsible for the difference between actual outcomes and optimal resource use. Policy failure refers to situations where inappropriate government policies, or absence of required policy results in market distortions for natural resources use, aggravated market failures and natural resources degradation by private or public users. Policy provides guidelines for society to act in certain ways or provides a sense of direction to achieve certain goals. Therefore in respect to natural resources, policy usually provides principles or direction as to how society uses the resources to achieve certain national development goals. Resource degradation may result from policy failure in three ways;

- Broad macro-economic and fiscal policies can influence how people use natural resource production inputs. For example the budget allocated to catchment management for specific sites is often used to meet recurrent expenditure. Tana and Athi Rivers Development Authority (TARDA) and Kerio Valley Development Authority (KVDA) for example, receive annually about Kshs. 55 million (US $ 0.69 million) and Ksh 45 million (US $ 0.56 million) for catchment rehabilitation respectively from the Kenya Energy Generating Company (KenGen). The allocations, nevertheless, are largely used to pay staff salaries and/or meet recurrent costs that might not be related to catchment protection (Mogaka et al., 2003).
- Regulatory policies governing natural resources may not be adequate to correct market failure
- Conservation policies may be poorly designed and implemented

3.2 The importance of non-market institutions

Institutions (non-market institutions) are simply defined as rules of conduct that facilitate coordination or govern relationships between individuals or groups in a society. Broadly, they consist of cognitive, normative, and regulative structures and activities that provide stability and meaning to social behaviour. North (1995), an institutional economist, provides a rules-based definition that identifies institutions as the rules of the game of a society, or more formally, as the humanly devised constraints that structure human interaction. According to this definition institutions are composed of both formal rules (constitutions, laws, property rights) and informal constraints (norms of behaviour, sanctions, taboos, codes of conduct)'. To distinguish institutions from organizations, North (1995) explains that the latter are the 'players or groups of individuals (political parties, a regulatory agency, etc) bound by a common purpose to achieve objectives'.

Institutions play an important part in effective natural resource and environmental management. Institutional failure is more often than not a major contributor to natural resources degradation and loss. Legislation usually defines broad issues, sets objectives and definitions, and identifies the legal mandate of the government and other stakeholders in conservation. Supporting regulations define how the legislation will be implemented through specific rules, incentives, fees for users, penalties for non-compliance and technical procedures.

Institutions are also important because they limit human actions in recurring or repeated interaction, in that, particular behaviour is forbidden, encouraged or allowed. They enable reliable expectations on other players and reduce the enforcement and monitoring costs of economic transactions. They also allow development of particular behaviour, which, because of high insecurity, would not otherwise be realized without institutions, e.g. prevention of hunting in protected areas.

Some important formal institutions in natural resource management include l**egislative measures and decrees –** these measures may be in form of legislations (Acts of Parliament) and Presidential Decrees which may have little do with the market forces. Such provisions are adopted as a way of addressing threats to environmental and natural

resources caused by incomplete markets or market failure. In Kenya for example, there are about 76 pieces of legislation that affect environmental and natural resources. Such provisions define penalty levels; uses of specific ecosystems; access, use and control. The Forest Act (CAP 365) for example defines the penalties imposed on illegal forest users, types of forest exploitation while the Wildlife Act bans all extractive activities within protected wildlife conservation areas.

Informal institutions include s**ocio-cultural or traditional norms –** within the context of traditionally governed environmental and natural resources, socio-cultural measures on conservation have been applied for several decades. In this context, traditionally accepted norms, rules and standards have been adopted to regulate access and use of natural resources. Resource allocation and value is hence based local norms. As means of resource allocation, fairness and equity is evident in areas where the social fabric has remained intact while erosion of the traditional system impacts negatively on resources allocation.

Institutions may fail due to;

- Unsupported policy (policies not supported by legislation cannot be legally enforced) – the case of the Forest Policy has been reversed severally since 1994 demonstrates a case in which there is a divergence between policy and the supportive legal framework. The Forest Bill (2004) aimed at supporting the current Forest Policy was rejected by Parliament in 2004 and is yet to be reintroduced for debate in Parliament. The Environmental Management and Coordination Act (EMCA, 1999) is yet to be fully enforced due to the absence of other supporting regulations, standards and guidelines.
- Inadequate legal framework – in some cases, legislation and supporting regulations can also be outdated. Patterns of natural resource use, pressures and conflicts are always changing and it is important that legal instruments and institutions also evolve. The case of the Forest Policy and Bill are still evident cases. The current Forest Policy was under revision for over 10 years (1990 – 2004) while the Bill was last revised in 1982.

3.3 Market failures

In chapter 2, conditions that characterize an efficient allocation were laid out. Efficiency is defined as Pareto optimality – the impossibility of reallocating resources to make one person in the economy better off without making someone else worse of. This implies that if consumers and producers are rational such that they maximize their private net benefits, a set of markets where each person has the opportunity to exchange every good with every other person will generate a socially optimal allocation of resources.

However, an efficient allocation can only be produced given certain ideal circumstances concerning institutions and behaviour. Actual market economies depart from the ideal circumstances in a variety of ways, and the allocations that they produce are not efficient. Economists use welfare economics to identify 'market failures' – **situations where actual circumstances depart from the ideal** –and to recommend policies to correct them so that actual economies perform better in relation to the objective of efficiency. Much of environmental and resource economics is welfare economics of this sort. It is concerned with identifying and correcting market failure in relation to the services that the environment provides to the economy.

To produce efficient allocations, it is necessary that:

1. Markets exist for all goods and services produced and consumed.
2. All markets are perfectly competitive.
3. All transactors have perfect information.
4. Private property rights are fully assigned in all resources and commodities.
5. No externalities exist.
6. All goods and services are private goods. That is, there are no public goods.

Box 3: Consequences of under-pricing water supply

"The provision of water as a basic social service has been either free or highly subsidised. This is because water has been and still is considered to be a non-economic good, hence what the consumers have been paying for are treatment and delivery services only. Consequently, the sector has not been able to meet its obligations on conservation, monitoring, protection and exploration of water resources an obstacle that has constrained integrated water resource management policy. Establishing this policy has been an elusive goal and not easy to attain, and the majority of Kenyans have continued to suffer from lack of access to clean water. Poor management of existing water works and non-existent or poor sewerage systems has compounded the problem further. The diverse nature of players and providers of the commodity has led to uncontrolled utilization of the commodity and to disjointed efforts in management of the resource."

Source: Presentation by Hon Chris Obure, Minister for Finance, during a Conference on Integrated Water Resources Management, 2003

7. All utility and production functions are ‘well behaved’.

8. All agents are maximizers.

Clearly, condition 1 is fundamental in natural resources. If there are goods and services for which markets do not exist, then the market system cannot produce an efficient allocation, as that concept applies to all goods and services that are of interest to any agent, either as utility or production function arguments. Further, condition 4 is necessary for condition 1- a market in a resource or commodity can only exist where there are private property rights in that resource or commodity.

3.4 Sources of market failures

Sources of market failure arise due to the absence of the conditions stated above. Some examples are considered here below:

Externalities: An externality occurs when an agent making a decision does not bear all of the consequences of his action. An example is when forest products processing industries spew emissions into the air. In this case all the benefits are at private level while the social cost is not fully internalised – the pollution brings direct costs to society. Cases of increased respiratory ailments and reduced fisheries resources are evident within and around Webuye and river Nzoia respectively in Western Kenya. Forest plantation exploitation in many occasions exposes soils to erosion. Also, with alluvial gold panning (although of limited quantities in and around Kakamega forest), the market price for gold excludes the environmental costs of river siltation due to poor panning practices and contamination through the use of mercury to separate gold. There are however also positive externalities including; e. g. fishing and tourism benefits after the construction of irrigation dams, bee keeping which impacts on pollination, reduced siltation from woodlot establishment and forestry management. Experience shows that negative externalities are more abundant than positive ones. The focus should be therefore on negative externalities in natural resources planning and development.

Market imperfections: monopoly/oligopoly, lack of access to credit can prevent farmers from conducting investments in soil conservation.

Improperly designed property rights regimes: Property rights are a bundle of entitlements defining owner's rights, privileges, and limitations for the use of a resource.A structure of property rights produces efficient allocations in a well-functioning market economy if it has the following four main characteristics:

1. *Universality:* All resources should be owned or ownable by someone (except resources so plentiful that everyone can consume without reducing availability to others)

2. *Exclusivity:* All benefits and costs accrued as a result of owning and using the resources should accrue to the owner, and only to the owner, either directly or indirectly by sale to others.

3. *Transferability:* All property rights should be transferable from one owner to another in a voluntary exchange.

4. *Enforceability:* Property rights should be secure from involuntary seizure or encroachment by others.

An owner of a resource with such property rights has powerful incentives to manage the resource efficiently because a decline in the value of the resource represents a personal loss.

Most of the natural resources are either open access resources or public goods. Open Access Resources: defined as resources that are not managed or controlled by anyone. Access is not restricted, and therefore, the resources can be exploited on a first-come, first-served basis. Examples: water in rivers and oceans, grazing lands, fisheries, tropical rainforests, migratory animal species, etc. This is common where land has no specific property rights like for example communal grazing areas, overgrazing. Open access situation should be distinguished from *Common property resources.* Many authors confuse this with Hardin's famous 'Tragedy of the commons'. Common property resources are resources owned collectively by a well-defined group of individuals, which may then set up rules to control access to and use of the resource.

Public goods resources are resources which exhibit non-rivalry in consumption and are fully accessible to all (non-excludability). Non-rivalry in consumption: defined as person's consumption of a good does not diminish the amount available to others. E.g.

beautiful landscapes, clean air, global climate, biological diversity in some cases there may be private provision of a public good (e.g., Nature Conservancy, demand for eco-labeled products), but this provision is likely to be less than the efficient amount.

Property rights have to be enforced. When property rights are not enforced this leads to encroachment /illegal access, e.g. in Mau forests and Mount Kenya Forest

They have also to be transferable: lack of legalization of property rights precludes option of selling the land. Incentives for investment are reduced due to 'shorter time horizon' than "social planner".

Divergence of social and private discount rates: Optimal social discount rate is object of much discussion. Reasons why private discount rate may exceed social discount rate include poverty, risks (e.g. if individuals are afraid of expropriation or other harmful government actions), imperfect credit markets. Private discount rates are often higher, leading to faster extraction of resources than socially optimal ones.

Lack of information/knowledge: environmental impacts, alternative technologies, costs and benefits. Market failure occurs because there are no prices at all for natural resources or environmental goods and services. Environmental services that are yet to be directly priced include ecological services, flood control, carbon sequestration, influence on microclimate and provision of genetic material or base.

3.5 Property rights regimes and emergence of different management approaches of natural resources

Property rights systems or regimes comprise of two components: property rights as the bundles of entitlements regarding resource use, and property rules as the rules under which those entitlements are exercised. As we have seen, an important aspect of property rights is whether they are appropriately assigned or are left either undefined or inappropriately specified. Further, as have already seen in the previous section, property rights can only be considered efficient if they satisfy some basic properties, including divisibility, transferability and enforceability. Thus, depending on the assignment of property rights and

the incentives of compliance which induce users to cooperate in the management of natural resources, four property systems or regimes can be distinguished. These systems, as drawn from Bromley (1991: are:

Private property systems: are found where property rights are assigned to individuals and utility is the primary incentive for cooperation. An example here is the private management of forests in privately owned farms. Allocation of property rights to private individuals achieves efficient outcomes because the conditions for efficient property rights structure stated above are satisfied. **But** four important assumptions are often not satisfied **in reality**: (i) zero enforcement costs, (ii) well-defined property rights, (iii) competitive markets (iv) perfect markets. Thus, although the private property system is allegedly regarded as superior to the others, it has been demonstrated that it can also lead to inefficient exploitation of resources (Bromley, 1991; Baland and Platteau, 1996). For example, privatization reforms in East African (e.g. grazing land in wildlife areas) have not only failed to yield an efficient pathway to intensive use of resource, but has also led to the gradual erosion or replacement of the traditional common property systems (e. g., Maasai common use of grazing areas). Thus, there are several associated problems with private property:

Box 4: Case study: Property rights as economic incentives for the local communities.

Property rights are often used as economic incentives for the local communities who use biological resources or live in biodiversity areas. The allocation of community property rights in National Parks and Forest Reserves is particularly widespread. For example, in South Africa, the land upon which Richtersveld National Park lies is owned and occupied by local Nama villages. These communities have leased out the land to the government, while retaining the right to graze an agreed number of livestock in the park and to engage in the controlled harvest of certain natural resources. Lease payments are deposited into a trust that has been appointed by the community to manage this resource. A similar system operates in reverse in a marine protected area in St. Lucia, where communities have been granted the right to manage an area that is owned by the state. Here, a collaborative management agreement has been established between government and a community institution with the capacity to manage the park. Fees raised are placed in a separate government fund, which makes quarterly payments directly to the community institution for the management of the protected area.

Source: Emerton, L., 2000

- Enforcement is costly (remote areas, lack of infrastructure) and weak (weak judiciary and constitutional laws). If resource owners have to self-enforce rights,

they may have an incentive to overexploit to reduce benefits to potential encroachers and thus reduce enforcement costs.

- Privatization does not account for local, regional, or international externalities.
- Forests often need to be managed in their entirety in order to maintain their ecological functioning.
- Common use of a forest may be preferable to reduce the individual users' risks in areas where the location of the most productive zones can vary from year to year (e.g., woodlands in arid areas).
- Privatization usually implies that some former users are excluded, which may have undesirable equity and poverty implications. Evidence in literature indicates that land distribution under common and communal property regimes in several African and Asian countries tended to be more equitable than in private property regimes.

Common property: exist where property rights are assigned to groups or communities, and collective action, based on voluntary or normative incentives is required for the management of the resources. There is a recent trend towards devolution of rights and responsibilities over common pool resources from state to local communities or user groups, resulting in common property (full transfer of property rights).

This system has several advantages:

- Collective management rules, informal courts and sanctions established by user groups can provide a cost-effective alternative to government control.
- Local communities may have better information about local conditions.
- Compared to private property, communities may be better able to deal with local externalities, to exploit risk-sharing benefits from exploiting the forest resource jointly, and to provide a more equitable distribution of benefits.

Problems:

- Community has no incentive to internalize regional and international externalities.
- Devolution is often incomplete in the sense that the state retains some rights over the forest or share of the benefits, leaving communities with reduced or uncertain incentives to consider the long-run effects of their actions.
- It is naïve to think of local communities as homogenous groups, automatically acting in the interest of the whole. Achieving even a locally efficient level of resource management requires collective action on part of individual community members, i.e. their ability to agree on and enforce a cooperative and efficient set of access and use rules (Ostrom, 1990). Otherwise, common property, similar to open access, would result in over-exploitation as each individual does not consider the impact of his action on resource availability to other users. Conditions thought to be conducive to collective action: small group size, social and cultural homogeneity, problem severity, high existing social capital, consistent impacts[2], low discount rates, and low transaction costs are widely seen as conducive for collective action.
- Devolution may lead to rent-seeking activities by community elites and prevent the state from exercising an important role in assuring the inclusion of marginalized groups.

State property exists where property rights are assigned to the state and cooperation is enforced, with sanctions and penalties as the primary incentives. Many forests and wildlife areas in Kenya are traditionally under state property. This gives rise to protected areas.

Advantage:

- centralized management can account for local and regional externalities
- state may have better scientific knowledge about technologies, sustainable management, etc. (controversial since traditional knowledge is also needed)

[2] Consistent impacts refers to a situation where most individuals will be affected in similar ways by the proposed management changes.

Problems:

- Very high transaction costs and information problems associated with the design of effective usage rules, monitoring and enforcement at the local level.
- Governments may optimally tolerate some illegal logging in the face of monitoring and enforcement costs.
- State property often degenerates into *de facto* open access, particularly in frontier areas that are located far from markets and government administrative centers.
- Forest-dependent communities often have customary rights to the forest which cannot be ignored by the state. A lack of formalization of these rights under a state property regime induces a strong degree of tenure insecurity on part of local forest users.
- The failure of governments to enforce property rights is, however, not only due to the costliness associated with monitoring and enforcement, but also with political-economy considerations and policy failure. This is highlighted by recent evidence that illegal activities have not decreased (and may even have increased) in the aftermath of decentralization reforms, although the transfer of forest management responsibilities to local governments should have reduced monitoring and enforcement costs. In general, reasons for policy failure to enforce property rights include the desire to relieve social pressure through settlement policies, strong lobbying potential of large logging companies, as well as rent-seeking and corruption on part of government officials.

Open access system or non-property regime emerges if no property rights have been assigned to the resources (see earlier discussion on open access resources).

It is important to note that the four systems do not exist as opposing types but rather as combinations along a spectrum from open access to private ownership. Although the outcome of open access has acceptably been acknowledged as the "tragedy of the commons", none of the other three systems can singly be prescribed as a remedy (in all situations) to the problem of natural resource management. Thus there has been a tendency to combine the common property and the state property to give raise of partnerships or collaborative management (in short, co-management). Co-management emerges when various

stakeholders agree on sharing among themselves the management functions, rights and responsibilities for a given territory, area, or a set of resources which may or may not have protected area status. It is seen as an arrangement whereby a community, or a group of resource users, and a conservation authority collaborate to jointly manage a resource or an area that has conservation value. Examples in Kenya include the establishment of sanctuaries through wildlife partnerships (e.g. Kimana sanctuary in on the dispersal areas of Amboseli National Park).

3.6 Political economy considerations

Political approaches provide ways to come to grips with the fact that current issues of economic reform are highly charged both politically and ideologically and that any attempt to redesign economic systems must find ways to neutralize or incorporate competing politcal forces. Thus political appraoches are in important since correcting environmental problem has distributional impacts. Policy makers follow their own individual objectives (e.g., own income maximization, re-election, power, survival) rather than social welfare maximization. As a consequence there emerges lobbying by powerful interest groups and rent-seeking/corruption.

3.7 Discussion questions

1. How do you think market failures from the discussed sources can be corrected?
2. Other than property rights' attributes, what do you think would influence achievement of an optimal property regime?
3. Discuss examples in Kenya where state property has often degenerates into *de facto* open access.

PART B: Economic Valuation Concepts and Methods

4. Introduction to Economic Valuation of Natural Resources and Biodiversity

4.1 Definition of economic valuation and its importance

Valuation can simply be defined "*as an attempt to put monetary values or to environmental goods and services or natural resources*". It is a key exercise in economic analysis and its results provide important information about values of environmental goods and services. This information can be used to influence decisions about wise use and conservation of forests and other ecosystems. The basic aim of valuation is to determine people's preferences by gauging how much they are willing to pay (WTP) for given benefits or certain environmental attributes e.g. keep a forest ecosystem intact. In other words, valuation also tries to gauge how much worse off they would consider themselves to be as a result of changes in the state of the environment such as degradation of a forest.

Economic valuation never refers to a stock, but only the change in a stock. If one speaks of the economic value of biodiversity, then one always means the economic value of a change of biodiversity. It is not a question of determining the 'true' value of biodiversity or ecosystems **but valuing changes and comparing them with their alternatives**, e.g. with a golf course vs without a golf course. Thus it is non-sense to ask "how much are the African National Parks worth?". A plausible question in this case would be: 'WWF has proposed a new policy to prevent the huge losses of wildlife species from African National Parks. What is the monetary value of the benefits of this policy (i.e., the economic damages avoided)? Economists thus stress that the valuation should focus **on changes rather than levels** of biodiversity or ecosystem. Non-economists have frequently tried to value biodiversity levels, for instance, the recent example of value assessment of ecosystem services and natural capital for the entire biosphere level (Costanza et al., 1998). However, economic-theoretical support for such a valuation

approach is weak. The reasons are that willingness to pay (WTP), or willingness to accept, are based on **compensation or equivalence variations of a change**, and that change should be relatively small in comparison with income levels.

The policy relevance of valuation information is extensive, but might include:

- demonstrating the value of biodiversity: awareness raising;
- land use decisions: for conservation or other uses;
- setting priorities for biodiversity conservation (within a limited budget);
- limiting biodiversity invasions;
- assessing biodiversity impacts of non-biodiversity investments;
- determining damages for loss of biodiversity: liability regimes;
- limiting or banning trade in endangered species;
- revising the national economic accounts;
- choosing economic instruments for saving biodiversity (e.g. taxes, subsidies).

Valuation has an important role to play in environmental planning and management activities because it helps to answer many questions including the following about any given natural resource:

- What is the value of conserving a certain natural resource (e.g. forest)? (see for example Box 5.
- To whom does the value accrue?
- How does degradation and loss of the natural resource lead to costs to different segments of society?
- Who gains and who loses when a natural resource is conserved or degraded?
- How can natural resource conservation be efficiently and equitably financed?
- How can people be motivated to take into account natural resource benefits and costs of its loss in the course of their economic activities
- How can policy, planning and decision making with regard to natural resources be better influenced?

BOX 5: DIFFERENT ESTIMATES OF ECONOMIC VALUES IN KENYA'S FORESTS

(*Emerton, L., Ndugire, N. and Bokea, C., 1998*), most of the cases refer to the period 1992-1997, and are expressed in 1996 prices:

To the national economy:	
Contribution to GDP	US$ 4 million per year
Foreign exchange earnings	US$ 0.22 million per year
For forest-adjacent households:	
Kenya indigenous forests	US$ 94 million per year
Aberdares forest	US$ 165/hold/year
Arabuko Sokoke forest	US$ 135/hold/year
Kakamega forest	US$ 160/hold/year
Mau forest	US$ 350/hold/year
Mount Kenya forest	US$ 212/hold/year
Oldonyo Orok forest	US$ 100/hold/year
To commercial and industrial firms:	
Formal sector industry	US$ 2 million per year
Indigenous timber, Kenya	US$ 7.3 million per year
Indigenous timber, Kakamega forest	US$ 1.2 million per year
Indigenous timber, Mau and Trans Mara forests	US$ 0.3 million per year
To tourists:	
Forests in National Parks and Reserves	US$ 34.7 million per year
Mount Kenya forest	US$ 0.3 million per year
Watershed catchment protection values:	
South West Mau, Ol Pusimoru, Trans Mara	US$ 0.12 million per year
Mount Kenya	US$ 20.4 million per year
Aberdares	US$ 7.4 million per year
Mount Elgon	US$ 3.7 million per year
Nandi	US$ 1.6 million per year
Cherangani	US$ 0.4 million per year
Loita Hills	US$ 2.1 million per year
Agroforestry values:	
Fuelwood and crop productivity	US$ 330/ha/year
Fuelwood	US$ 0.60/ha/year
Timber	US$ 23/ha/year
Saved chemical inputs	US$ 9/ha/year
Dairy	US$ 144/cow/year

THE ECONOMIC COSTS OF KENYA'S FORESTS

To the Forest Department:	
Development and recurrent expenditure	US$ 1.2 million per year
To local households:	
Animal damage around Shimba Hills National Park	US$ 0.45 million per year
Animal damage around Mount Kenya Forest	US$ 1.04 million per year
Opportunity costs of agriculture foregone, all Kenya's forests	US$ 307 million per year
Opportunity costs of agriculture foregone, Mount Kenya forest	US$ 72 million per year

If a valuation exercise can provide acceptable answers to the above questions, then it goes along way to becoming a useful tool into the environmental assessment and planning for biodiversity conservation with forest ecosystems like Kakamega.

4.2 Historical perspective of economic valuation

Development of economic evaluation of natural resources came from politics and public authorities. It started in US 60 years ago, when the National Resources Board decided in its Flood Control Act of 1936 that intangible follow-up impacts of their projects have to be considered as well .

The conceptual framework for evaluation of 'non-market services' was developed by Ciriacy-Wantrup (1947). His idea of an estimation of social benefits by questioning the public (referendum) (for example in contigent valuation method- CVM) was first put into practice by Davis (1963). In 1950 a report published by the Federal Inter-Agency River Basin Committee and known as the "Green Book" received widespread attention (Hanemann, 1992). The Green Book became a guide for economic evaluation of the effects of river basin projects. It recommends either the use of market prices or, if not possible, the use of alternative methods like accounting the expenditures of a recreationist or his willingness to pay for a further use of the recreation facilities (as developed by Ciriacy-Wantrup (1947).

Interest on the valuation methods expanded from water recreation into other public goods such as wildlife, air quality or human health. However, for the following decades the centre of development of environmental evaluation remained in the USA (mainly due to supportive American legislation). In 1981 the National Environmental Policy Act (NEPA) was modified by the Presidential Executive Order (EO) 12291 which claimed the use of cost-benefit analysis for new regulations. In addition the Comprehensive Environmental Response, Compensation and Liability Act (1980) brought environmental damage assessment to court (Hanley and Spash, 1993).

Guidelines of the US Department of Interior (DOI, 1986) suggested the restoration or opportunity costs as a measure for compensation. A new dimension for this kind of

research was the recognition of the importance of non-use values. They had to be considered in damage assessments according to a verdict from 1989 (State of Ohio).

The Exxon Valdez oil spill in 1989 was the first possibility for a large litigation. For the compensation assessment a vast research project was financed dealing with the CVM, whose funds provided by both the governmental as well as from Exxon. As a consequence of this dispute the NOAA-Panel has developed guidelines for the use of CVM in natural resource damage assessments.

Unlike in USA, environmental valuation is much less common in Europe and other contentinents. For example in Europe, there is a smaller number of studies as well as less political influence. In contrast to the USA where policy evaluations are commonplace the EU has just started in the early 1990s to use formal appraisals to asses costs and benefits of EU Directives (Pearce, 1998). Though much academic research has been done in the last 20 years (Navrud, 1999 counted 457 studies in the period between 1992 and 1999), hardly any results of environmental economic analyses have found their way into politics (Hackel and Pruckner, 2000). What about in Africa in general and Kenya in particular (see the discussion questions).

4.3 Introduction to differents concepts of value

The term 'value' causes much confusion because it is used in different ways by ecologists and economists. The former consider values as ethical measures, while the latter consider them as 'equivalence measures' (value measured in monetary terms). If we are looking for a decision aid for biodiversity conservation (what should be conserved first and how much?) we have to concentrate on the second concept. A value measured in monetary terms will show the importance of a project in a given society and the society's ability to pay for it. It can be seen as the willingness to commit resources to biodiversity conservation. Prices are in this case indicators for the importance of conservation programs. This information is essential for policy evaluation. Dealing with biodiversity or other natural resources, economists cannot rely on market prices, though. The products and resources involved are public goods and therefore non-exclusive and non-rival in consumption. In this case market prices are unreliable indicators of social costs, because

they may not capture all effects of biodiversity use. However, environmental economists have developed methods to reveal values in the presence of market failure which incorporate external effects.

4.3.1 A typology of values

Philosophers dispute the meaning of the word 'value' and whether, however defined, value resides 'in' the objects of interest (objective value) or is conferred upon the object by the entity engaging in the act of valuation (subjective value). Any attempt to classify 'types' of value will therefore be tendentious, but the following broad categories are often found to be helpful:

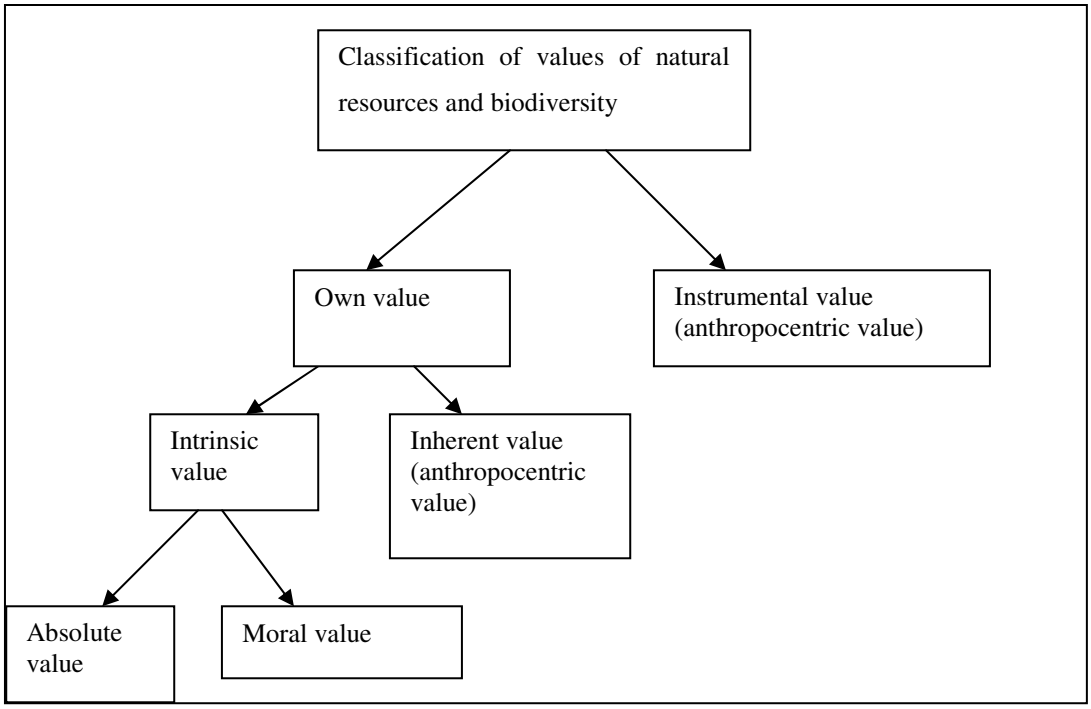
a) Instrumental or functional value (anthropocentric).

b) Intrinsic or (eco-centric)

Instrumental value derives from some objective function, goal or purpose that is being sought. As an example, economic value relates to the goal of maximizing human well-being (or welfare, or utility), where well-being has a particular connotation, namely that someone's well-being is said to be higher in situation A than situation B if they prefer A to B. It is immediately obvious that economic value is *anthropocentric* and it is *preference based*. This value is found in the 'functional' forms and 'aesthetic' nature of natural resources. An instrumental element is found in the aesthetic value of the natural resources since appreciating beauty affords pressure and a sense of well-being.

Intrinsic value is mainly a non-instrumental value. This value can further be divided into absolute and moral values (see Figure 7). Intrinsic value is often regarded as being a value that resides 'in' the asset in question, and especially environmental assets, but which is independent of human preferences.

Figure 12: Classification of values of natural resources and biodiversity



4.4 Measurement of economic value

There are two important gaps in economic valuation are are worth noting:

- The commercial or market value (use value) of any resource is only a portion of the economic value
- The economic value is not the total value of environment or natural resources

How is the value of natural resoruces and biodiversity measured? Two measures are used:

- Willingness to pay (WTP) - reflects the maximum amount of dollars of a good one is willing to give up to get more of another good (relative "value,,)
- Willingness to accept (WTA) compensation- reflects the minimum amount of dollars of a good one is willing to receive to get less of another good.

As indicated in Chapter 2, if money is used as the standard, the measure of benefit is *willingness to pay* (WTP). That is, a benefit to any given person is measured by the maximum amount of money that that person would be willing to pay in return for receiving the benefit. Similarly, the measure of cost is *willingness to accept compensation* (WTA). That is, a cost to any person is measured by the minimum amount of money that that person would be willing to accept as compensation for incurring the cost. These measures of benefit and cost underlie the concept of *economic efficiency*. A reallocation of resources increases economic efficiency if the sum of the benefits to those who gain by that reallocation exceeds the sum of the costs to those who lose. In other words, there is an increase in economic efficiency if the sum of WTP for the gainers exceeds the sum of WTA for the losers, that is, if (in principle) the gainers could compensate the losers without becoming losers themselves. This test is the *efficiency criterion* (or *compensation test*). This economic efficiency rests on the theories of *welfare economics*. It is a theorem of welfare economics that, in any equilibrium state of a competitive economy, resources are allocated in such a way that no further gains of economic efficiency are possible (different measures of welfare such as compensating variation and equivalent variation are not explained as the users of this manual may find them difficult to grasp).

The total economic value

The net sum of all the relevant WTPs and WTAs defines the *total economic value* (TEV) of any change in well-being due to a policy or project. TEV can be characterized differently according to the type of economic value arising. It is usual to divide TEV into *use* and *non-use* (or *passive use*) values. Use values relate to actual use of the good in question (e.g. a visit to a national park). Use values are divided into:

- Direct use value- value from direct utilization of an ecosystem, includes both consumptive and non-consumptive use
- Indirect use value – value from indirect utilization, through ecosystem function and regulation services

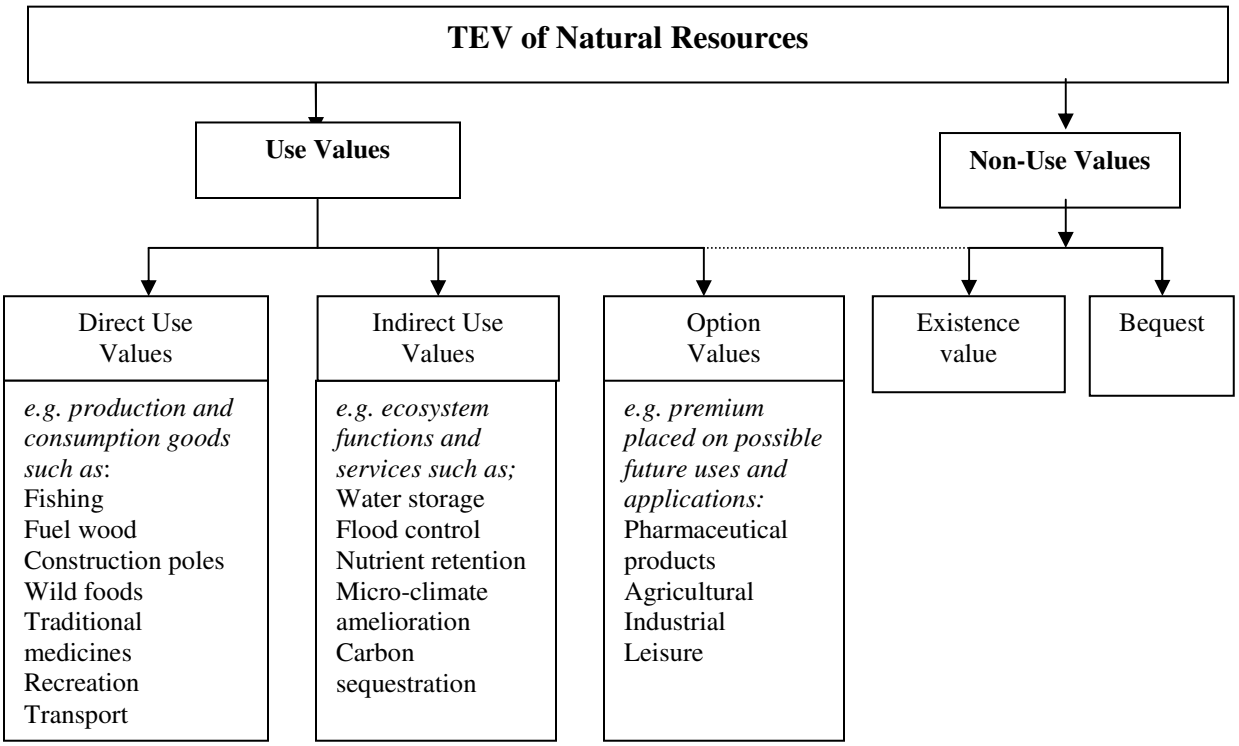
Non-use value refers to willingness to pay to maintain some good in existence even though there is no actual, planned or possible use. The types of non-use value could be various, but a convenient classification is in terms of (a) existence value and (b) bequest value.

- Existence value refers to the WTP to keep a good in existence in a context where the individual expressing the value has no actual or planned use for his/herself or for anyone else. Motivations here could vary and might include having a feeling of concern for the asset itself (e.g. a threatened species) or a 'stewardship' motive whereby the valuer feels some responsibility for the asset. Some people simply want to know that something exists (Alaskan wilderness area), even if they will never see it or use it.
- A bequest value refers to WTP to preserve the environment for the benefit of our children and grandchildren (the next and future generations)

Between the two groups (use and non-use values) one can find the option value- people are not sure about their future demand for a service and they would like to maintain the environment in order to use it at a later time. This value will become a use value in the future, e.g. new sorts or drugs derived form genetic information of wild species.

Thus, TEV =use value +non-use value + option value

Figure 13: Classification of economic values (benefits) of natural resources



The decision on which TEV components to take into account depends on what kind of natural resources will be evaluated. For biotic components (chemical/physical parameters) like water or air quality, direct or indirect use values are of central interest. Non-use values may be neglected. But in the case of nature conservation where species or habitats are involved non-use values are known to make up an important part of the economic value. In this case use and non-use components have to be taken into consideration too in any economic valuation.

4.5 Choice of methods of economic valuation

Broadly, economic approaches to natural resources and biodiversity valuation consist of three procedures:

- Using market prices where the prices occur in the market for the environmental goods and services, and where prices are 'revealed' in some other market- the *revealed preference* approach (also called indirect approach).
- Using willingness to pay estimates derived from questionnaires -the *stated preference* approach (also called direct approach).
- Using values 'borrowed' from existing studies - *benefits transfer.*

Revealed preferrence methods are used where conventional or proxy market prices exist and while stated preference are employed through contructions of hyopthetical markets.

Further, the market-based or revealed preference approaches are divided:

- The observed market value and related goods approach.
- The productivity approach.
- Cost-based methods including replacement cost.

A summmary of valuation approaches and techniques is given in table 2 below.

Table 4: Summary of valuation approaches and techniques used

Approach	Examples of Valuation method/technique	Nature of value
Stated preference approach	Contingent Valuation	All use and non-use values
	Choice Modeling	All use and non-use values
Revealed preference	Market price analysis	Direct values (extractives, inputs, Marketed products
	Cost-based methods	Indirect use values
	Productivity methods	Indirect use values
	Avertive/preventive expenditure	Indirect use values
	Travel Cost Method (TCM)	Use values involving travel cost
	Hedonic Pricing Method (HPM)	Use value associated with change in environmental qualities
Benefit transfer	Use of other empirical studies	All use and non-use values

Box 6: Summary of application of key methods in economic valuation

- Market Price Method: Estimates economic values for ecosystem products or services that are bought and sold in commercial markets
- Productivity Method (net factor method, derived value method, effect on production) : Estimates economic values for ecosystem products or services that contribute to the production of commercially marketed goods
- Hedonic Pricing Method (HPM): Estimates economic values for ecosystem or environmental services that directly affect market prices of some other good. Most commonly applied to variations in housing prices that reflect the value of local environmental attributes.
- Travel Cost Method (TCM): Estimates economic values associated with ecosystems or sites that are used for recreation. Assumes that the value of a site is reflected in how much people are willing to pay to travel to visit the site.
- Damage cost Avoided, Replacement Cost, Substitute Cost Method, Avertive behaviour: Estimate economic values based on costs of avoided damages resulting from lost ecosystem services, costs of replacing ecosystem services, or costs of providing substitute services
- Contingent Valuation Method (CVM): Estimates economic values for virtually any ecosystem or environmental service. The most widely used method for estimating non-use, or "passive use" values. Asks people to directly state their willingness to pay for specific environmental services, based on a hypothetical scenario
- Contingent Choice Method (CM): Estimates economic values for virtually any ecosystem or environmental service. Based on asking people to make tradeoffs among sets of ecosystem or environmental services or characteristics. Does not directly ask for willingness to pay—this is inferred from tradeoffs that include cost as an attribute
- Benefit Transfer Method: Estimates economic values by transferring existing benefit estimates from studies already completed for another location or issue.

The choice of these methods depend on the environmental good or service being valued and its classification in the TEV framework (Figure 8 above).

4.6 Discussion questions

1) Discuss the extent and usefulness of economic valuation in (i) Kenya and (ii) in your ministry, organization or department.

2) Using practical examples, discuss how economic valuation of natural resources and biodiverty could be applied in policy making processes in Kenya.

3) Explain how TEV is related to the notion of *intrinsic value*

4) Mention several other examples of use and non-use values, other than the ones indicated in this manual, and indicate which method (s) of valuation you would use to value them

5) What do you think are the key differences of direct and indirect approaches of economic valuation?

5. Revealed Preference Methods

This chapter provides training on the theory and practical applications of the following revealed preference methods of valuation of environmental goods/ natural resources. The methods discussed here include:

- Market-based methods
    - Direct market prices
    - Market prices of alternatives or substitutes
- Human capital
- Production function/ productivity method
- Travel cost method
- Hedonic pricing
- Cost based methods
    - Damage avoided
    - Replacement costs
    - Preventive/ averting expenditure

5.1 Market-price based approaches

Introduction

Market prices are the result of interaction between consumers and producers with regards to the demand and supply of goods and services. If this transaction is carried out using currency, the value established within the market is the market price.

The market price method estimates the economic value of ecosystem products or services that are bought and sold in commercial markets. When services are directly tradable in normal markets, the price represents the exchange value. The market price method can be

used to value changes in either the quantity or quality of a good or service. It uses standard economic techniques for measuring the economic benefits from marketed goods, based on the quantity people purchase at different prices, and the quantity supplied at different prices. Application of the market price method requires data to estimate consumer surplus and producer surplus. To estimate consumer surplus, the demand function must be estimated. This requires time series data on the quantity demanded at different prices, plus data on other factors that might affect demand, such as income or other demographic data. To estimate producer surplus, data on variable costs of production and revenues received from the good are required.

a) Direct market prices

The most simple and straightforward way of finding out the value of environmental resources is to look at their market prices – what they cost to buy or are worth to sell. Market prices reflect what people are willing to pay for them – the value that they place on them. All the costs and benefits associated with a proposed or alternative use option can be determined by the prices that are paid, assuming there are no market distortions. However, it is often difficult to apply to environmental resources since many environmental goods have no market at all (e.g. those used for subsistence purposes). Further, it is not always true that market prices reflect economic scarcity and, therefore, are economic efficient prices. Market prices can be distorted because of taxes, subsidies, monopolies, exchange rates or other interventions so they do not reflect the true value of product (see Chapter 3).

Table 3 below shows an example of ccalculating the gross value of crop production in Nakivubo Wetland, Uganda, using Market prices.

Table 3: Calculating the gross value of crop production in Nakivubo Wetland, Uganda, using Market prices (1993)

The gross value of crops grown in Nakivubo wetland was estimated using the yields and market prices as in the following table, giving a gross value of about Ush 200 million a year.			Average per farmer		Total all wetland	
	Yield (Kg/ha/year)	Price (Ush/Kg)	Area (ha)	Value (Ush '000/year)	Area (ha)	Value (Ush million/ year)
Cocoyam	2,625	300	0.14	110.3	68	53.6
Sugarcane	9,000	200	0.14	252	68	122.4
Cassava	5,250	150	0.02	15.8	11	8.7
Sweet potatoes	3,750	150	0.02	11.3	11	6.2
Mixed vegetables	1,500	100	0.02	3	11	1.7
Matooke	6,938	100	0.02	13.9	11	7.6
Total			0.36	406.3	180	200.2

Source: Emerton et al. (1999)

b) Prices of alternative goods or substitutes

Where environmental resources have no direct market themselves, they often have close substitutes, which can be bought and sold. The prices of these substitute goods represent what it would cost to buy the next best alternative if environmental resources were not available. They can be used as proxy/ shadow prices for the value of environmental resources because they reflect the amount of money that they are worth in terms of expenditures saved. Thus, substitute prices estimate implicit values for environmental goods and services by means of the price paid for another good or service which is marketed. This technique uses an actual market price to value a non-marketed quality of the environment, e.g. medicinal plants extracted by local communities from a forest.

Box 7: Value of Medicinal Plants among the Tepeth People in Mount Moroto Forest, Uganda

A study on the use of medicinal plants in this community has revealed that seven species of plants used as local medicines to cure malaria worms, kwashiorkor and diarrhoea. This medicinal value has been valued at Uganda shillings 216 million. This is the financial saving to the community if it had to buy conventional medicines to cure those diseases. The value of medicinal plants for curing livestock diseases was estimated at 369 million Uganda Shillings (1 US $ = 1850 USh in January 2002)

Source: Magumba, D. (2001)

c) Costs of collection and preparation

Even when environmental resources have no market prices and no market substitutes, people spend time and other inputs collecting and preparing them. That people are willing to allocate scarce labour and other resources (e.g. labour and other inputs) to obtaining environmental resources shows that they place a value on them. The labour and other costs spent collecting and preparing environmental resources for consumption can be used to estimate their worth. It represents the value of environmental resources in terms of forgone wages and income – the amount of cash which could have been generated if the time and other resources used for environmental resource utilization had been allocated to other products or consumption items.

Box: 8 Using collection and preparation costs to value forest use in Kakamega

Subsistence forest utilisation in Kakamega forest was valued by looking at the time people spent on collecting and preparing forest products for household use. The prevailing casual agricultural wage rate of Ksh 15 per hour was used to cost this time.

Product	*Labour*	*No. used*	*Total household value*
Firewood	3 hrs/ headload	225 headload/ household / year	10,125
Pole wood	2 hrs/ pole	50 poles/ household/ year	1,500
Thatch	30 hrs/ roof	1.5 roofs/ household/ year	675
Total			12,300

Source: Emerton (1999)

Advantages and limitations of the market price methods

The market price method uses observed data of actual consumer preferences. The method uses standard, accepted economic techniques. However, market data may only be available for a limited number of goods and services provided by an ecological resource and may not reflect the value of all productive uses of a resource- does not measure TEV. Further, the true economic value of goods or services may not be fully reflected in market transactions, due to market imperfections and/or policy failures.

5.2 Human capital approach

'Human capital' here is defined as the quality and ability of the human labour used in the production process, and is mainly a factor of education, training and the accumulation of

knowledge and skills as well as the health status. Degraded environmental quality (e.g. polluted air, contaminated water) can lead to reduced productivity of human capital e.g. due to deteriorated health.

The human capital approach of valuation sees people as units of economic capital, and their earnings as a return on investment. It looks on the impacts of biodiversity degradation on human health, and the effects this has on individual's and society's productive potential. It establishes a direct cause and effect relationship between biodiversity loss and, for example, decreased income, poor nutrition, disease incidence, illness and lower output, and adds up the loss of earnings and costs of medical treatment arising from the loss of biodiversity good and services.

For example, an increase in air borne pollution or water contamination may result into diseases of workers or farmers and hence reduce economic productivity. The value of the loss in productivity is the cost of air pollution or water contamination. On top of this we should add the medical costs used to cure those persons. The reverse would be true i.e. an improvement in sanitation and drinking water quality leads to lower incidences of disease, improvement of health and hence increase economic productivity of the workers or farmers. The value of the increased output resulting from a healthier workforce would represent the benefit of a cleaner environment.

An example of the application of the human capital approach is shown in Box 9.

Box 9: Using human capital methods to calculate the economic cost of pesticide poisoning around Lake Naivasha, Kenya

The human costs associated with pesticide poisoning resulting from horticultural and floricultural activities irrigated from Lake Naivasha were valued using human capital valuation techniques. The frequency of pesticide applications and resulting incidence of illness for different crops was calculated, and valued in terms of the costs of medical consultation, drugs and work days lost. This revealed an average cost of Ksh 1,800 per ha of agricultural production.

Emerton (1999)

5.3 Production function/ Change in productivity method

Introduction

The productivity method is used to estimate the economic value of ecosystem products or services that contribute to the production of commercially marketed goods. It is applied in cases where the products or services of an ecosystem are used, along with other inputs, to produce a marketed good. The method traces impact of change in ecosystem services on produced goods. Environmental services support other economic processes and activities e.g soil fertility improves crop yield, rainforests increase rainfall and crop output, mangrove forests enhance fish breeding etc. Where these other economic activities have a market value, the changes in production and consumption may be used to provide value for integrity of the environmental resource base. These effects on production reflect the indirect contribution of environmental services to economic output. For example, water quality affects the productivity of irrigated agricultural crops, or the costs of purifying municipal drinking water. Thus, economic benefits of improved water quality can be measured by increased revenues from greater agricultural productivity, or by decreased costs of providing clean drinking water.

Environmental goods and services are also linked to other outcomes, for example, they provide raw materials, support ecosystem services, generate income and employment. Environmental goods and services that have no market but support consumption and production processes can be valued by looking at the effect on their production functions. Examples of effect on production include; loss of income, employment and foreign exchange arising from loss of wildlife; flood damage and water shortage caused by loss of forest watershed catchment protection etc.

If a natural resource is a factor of production, then changes in the quantity or quality of the resource will result in changes in production costs, and/or productivity of other inputs. This in turn may affect the price and/or quantity supplied of the final good. It may also affect the economic returns to other inputs.

Applying the Productivity Method

This information needed for this method is used to link the effects of changes in the quantity or quality of the resource to changes in consumer surplus and/or producer surplus, and thus to estimate the economic benefits. There are three steps:

Step 1:

The first step is to specify the production function for the specified good or service. This is the functional relationship between the inputs into producing the good/service and the output (i.e. the physical effects of the environment on economic activity).

Step 2:

The second step is to estimate how the cost of production changes when the environmental quality changes, using the production function estimated in the first step. The researcher would calculate the quantities of inputs needed for different levels of environmental quality, by plugging different levels of environmental quality variables into the production function. These quantities would then be multiplied by their costs. Physical changes in production are valued at market prices (or if necessary shadow prices) for inputs and outputs (i.e. estimating the monetary value of ecological function).

Step 3:

The final step is to estimate the economic benefits of maintaining the environmental quality. For example, where the integrity of the environment is maintained, the cost of production of environmental goods/ services will be low. The difference in production costs is an estimate of the benefits of maintaining environmental quality. The benefits of different levels of improvement in environmental quality can be estimated.

Box 10: Valuation of change in productivity of a wetland ecosystem using the productivity method

The study

The example here is from the Peconic area, Long Island, New York. The study was based on Peconic Estuary, an ecosystem composed of many productive wetlands, including eelgrass, saltmarsh, and intertidal mudflats. It focused on valuing marginal changes in acres of wetlands, in terms of their contribution to the production of crabs, scallops, clams, birds, and waterfowl. It was assumed that wetlands provide both food chain and habitat support for these species.

First, the productivity of different wetlands types in terms of food chain production was estimated and linked to production of the different species of fish. Second, the expected yields of fish and birds per acre of habitat were estimated. Finally, the quantities of expected fish and bird production were valued using commercial values for the fish, viewing values for birds, and hunting values for waterfowl.

The Results

The study results estimated that an acre of eelgrass is worth $1065 per year, an acre of saltmarsh is worth $338 per year, and an acre of intertidal mudflat is worth $68 per year, in terms of increased productivity of crabs, scallops, clams, birds, and waterfowl. Based on the results of this study, managers can calculate the economic value, for productivity services, of preserving or restoring wetlands in the Estuary. These values do not capture the full value of the wetlands, because they only address values in production of commercially and recreationally valuable species. Thus, they are an understatement of the total economic value for the wetlands, which might include other services, such as erosion and storm protection or aesthetics.

Source: Ecosystem valuation website: www.ecosystemvaluation.org

5.4 Travel cost method

Introduction

The travel cost method (TCM) is used to estimate economic use values associated with ecosystems or sites that are used for recreation. The method involves using travel costs as a proxy for the price of visiting outdoor recreational sites.

The basic premise of this method is that the time and travel cost expenses that people incur to visit a site represent the "price" of access to the site. Thus, peoples' willingness to pay to visit the site can be estimated based on the number of trips that they make at different travel costs. This is analogous to estimating peoples' willingness to pay for a marketed good based on the quantity demanded at different prices.

The demand curve is derived by assuming that visitors will respond to increasing entry fees in the same way as they do to increasing travel costs. **Note:** The cost of traveling to a

site is not directly used to value the site but to establish the relationship between the cost of traveling to the site and the visitation rates (no. of visits per time).

Applying the Travel Cost Method

The two most commonly applied methods of TCM s are:

- A simple zonal travel cost approach, using mostly secondary data, with some simple data collected from visitors.
- An individual travel cost approach, using a more detailed survey of visitors.

Application of the Zonal Travel Cost Approach

The zonal travel cost method is applied by collecting information on the number of visits to the site from different distances. Because the travel and time costs will increase with distance, this information allows the researcher to calculate the number of visits "purchased" at different "prices." This information is used to construct the **demand function** for the site, and estimate the **consumer surplus** economic benefits, for the recreational services of the site.

There are 4 general stages in this TCM process.

Step i): Identity travel cost zones

Identify the site to be valued and divide the area around it into zones. These may be defined by concentric circles around the site, or by geographic divisions that make sense, such as metropolitan areas or counties surrounding the site at different distances. Within each zone, individuals are assumed to have equal travel costs to and from the site, while different zones have different travel costs to the site. Furthermore, it is assumed that individuals in each zone have similar preferences.

Step ii) Estimate visitation rates for each zone

Collect information on the number of visitors from each zone (from official records), and the number of visits made in the last year.

Step iii) Estimate travel cost for each zone

Calculate the average round-trip travel distance and travel time to the site for each zone. Assume that people in Zone 0 have zero travel distance and time. Each other zone will have an increasing travel time and distance. Next, using average cost per mile and per hour of travel time, the researcher can calculate the travel cost per trip.

Step iv) Derive aggregate demand function for the site

Estimate using **regression analysis** equation the relation between visitation rates to travel costs and other important variables. From this, the researcher can estimate the demand function for the average visitor. In this simple model, the analysis might include demographic variables, such as age, income, gender, and education levels, using the average values for each zone.

The total visitation under existing travel cost conditions represents one point on the aggregate demand curve for the site. By assuming that an admission fee has the same effect on visitation as an increase in travel cost, other points on the demand curve can be identified.

The final step is to estimate the total economic benefit of the site to visitors by calculating the consumer surplus, or the area under the demand curve. This results in a total estimate of economic benefits from recreational uses of the site. Once the aggregate demand curve has been derived, it can be used to estimate two types of benefits.

a) The total WTP for the site

b) Expected revenues at different levels of entry fee

a) <u>Total WTP for site</u>

The total WTP for the site can be considered an estimate of the recreation benefits of preserving the site. In the example of the park above, the total WTP is the area under the aggregate demand curve. The economic benefit to individuals is often measured by **consumer surplus** (what they are willing to pay over and above what they are already

paying). This is graphically represented by the area under the demand curve for a good, above its price.

The economic benefit to individuals, or consumer surplus, received from a good will change if its price or quality changes. For example, if the price of a good increases, but people's willingness to pay remains the same, the benefit received (maximum willingness to pay minus price) will be less than before. If the quality of a good increases, but price remains the same, people's willingness to pay may increase and thus the benefit received will also increase.

b) <u>Expected revenue</u>

TCM helps predict expected revenues at different levels of gate fee.

Expected revenue = Gate fee x Visitation rates x Population.

This is very important in helping park officials decide at what level to set park entry fee and how well they can cover their costs.

Box 11: Using travel cost method to assess the recreational value of Lake Nakuru, Kenya

The study used travel cost method to determine the annual recreational value of wildlife viewing in Lake Nakuru. A travel cost survey of visitors elicited information about length of stay, travel costs, place of origin and visitation rates, distinguishing between resident and non-resident tourists. The results of these surveys demonstrated that the annual recreational value of wildlife viewing in Lake Nakuru National Park was about US$ 7.5-15 million, of which flamingos accounted for over a third.

Source: Navrud, S. and E. Mungatana (1994), cited in Emerton (1999)

5.5 Hedonic pricing method

Introduction

The method is used to estimate economic values for ecosystem or environmental services that directly affect market prices. It is most commonly applied to variations in housing prices that reflect the value of local environmental attributes. It can be used to estimate economic benefits or costs associated with:

- environmental quality, including air pollution, water pollution, or noise

- environmental amenities, such as aesthetic/ scenic views or proximity to recreational sites

The hedonic price approach is based on the theory that value of a commodity is a bundle of valuable characteristics, one or more of which may be environmental. The basic premise of the hedonic pricing method is that the price of a marketed good is related to its characteristics, or the services it provides. It presupposes that goods and services are defined by the attributes embodied in them, and the values of these goods and services are the sum of the values of the attributes which they contain. When goods or services contain an environmental characteristic, the market value of the environmental characteristic is ‘’ embedded ‘’ in the market price of the good or service which contains the characteristic.

Hedonic pricing approach commonly uses differentials in property values (**property value approach**) and wages (**wage differential approach**) between locations, and isolates the proportion of this difference, which may be attributed to environmental goods and services. Property and land prices and wages are used to place implicit values on environmental factors that are otherwise difficult to value. For example, differences in property values are used to estimate peoples WTP to be near an environmental good, such as a scenic view or parkland etc.

Applying hedonic pricing method

Hedonic pricing approach proceeds through the following stages:

1) Collect data on residential property sales in the region for a specific time period (usually one year). The required data include:

- selling prices and locations of residential properties.
- property characteristics that affect selling prices, such as lot size, number and size of rooms, and number of bathrooms.
- neighbourhood characteristics that affect selling prices, such as property taxes, crime rates, and quality of schools.

- accessibility characteristics that affect prices, such as distances to work and shopping centers, and availability of public transportation.
- environmental characteristics that affect prices

Thus *property prices = f (property variables, neighbourhood variables, accessibility variables, environmental variables)*

("f" means "is a function of" or "is dependent upon")

2) Once the data are collected and compiled, the next step is to statistically estimate a function that relates property values to the property characteristics. The resulting function measures the portion of the property price that is attributable to each characteristic. Thus, the researcher can estimate the value of a given attribute by looking at how the value of the average home changes when the amount of the attribute changes. The data are analyzed using regression analysis of housing or land prices on a group of explanatory variables, such as house age, size, design, construction type etc. and a number of location variables e.g. quiet neighbourhood, low population density etc. and one or more environmental variables such as air quality or proximity to an environmental amenity.

Advantages and Limitations of the Hedonic pricing method:

Data on property sales and characteristics are readily available through many sources, and can be related to other secondary data sources to obtain descriptive variables for the analysis. The method is versatile, and can be adapted to consider several possible interactions between market goods and environmental quality. Choice of functional form - it is not clear which non-linear function should be used for the hedonic pricing equation. The choice of functional form will influence the values that implicit prices take. The method is also relatively complex to implement and interpret, requiring a high degree of statistical expertise. Moreover the results depend heavily on model specification.

5.6 Preventive expenditure/ Damage avoided/ Replacement costs approaches

Introduction

The preventive expenditure, damage costs avoided, replacement cost etc. are related methods that estimate values of ecosystem services based on either the costs of avoiding damages due to lost services, the cost of replacing ecosystem services, or the cost of providing substitute services. These methods assume that the costs of avoiding damages or replacing ecosystems or their services provide useful estimates of the value of these ecosystems or services.

This is based on the assumption that, if people incur costs to avoid damages caused by lost ecosystem services, or to replace the services of ecosystems, then those services must be worth at least what people paid to replace them. Thus, the methods are most appropriately applied in cases where damage avoidance or replacement expenditures have actually been, or will actually be, made. For example, they can be used for valuing the water purification services of a wetland by measuring the cost of filtering and chemically treating water.

Preventive expenditure approach

This method is also called the mitigative or defensive expenditure approach. Environmental services can be valued by looking at how much it would cost to set in place measures to prevent the damage arising from their loss. For example, flood control barriers might be needed to offset or prevent negative impacts associated with the loss of wetland flood control services; water treatment works might be needed to prevent reservoir siltation associated with loss of wetlands silt-trapping functions etc.

Preventive expenditures imply the costs incurred to prevent the damage that would arise if the environmental asset was not there. The preventative expenditure approach identifies the cost or benefit value of environmental impacts by observing how much people, communities, or nations are prepared to spend or pay to fix or avoid related forms of environmental damage thus providing an indirect measure of the benefits derived from a common property resource. This approach may hence be seen as a surrogate measure of

the demand for environmental protection - indirectly measuring the costs of environmental damage by looking at the amount of resources allocated to avoiding them.

Box 12: Mitigative expenditures, Nakivubo Wetland

This study looked at mitigative expenditures required to offset the effects of impaired water quality resulting from the loss of wetland waste treatment and water purification services. The cost involved moving the inflow for Kampala's water supply to an alternative location away from the outlet of waste waters in the wetland and to construct a water treatment plant. This translated into an average annual cost of about Ush 2.7 billion. Investment and recurrent costs of water treatment

Cost item	Cost (Ush million)
Interest on loan	1,585.94
Depreciation of capital	1,078.19
Total annual cost	2,664.13

Source: Emerton et al., 1999

A rational individual should incur mitigating costs as long as: Level of damage after impact is reduced + Mitigation < Original level of perceived damage. S/he will continue to expend on mitigation until the left hand side of the equation is equal to the right hand side.

Examples of the use of preventative expenditure approaches to environmental valuation include:

- the external cost of erosion in an upland area is estimated by measuring the costs incurred by lowland farmers to construct dikes to divert water and waterborne eroded soil from silting up their fields;
- the cost people incur in getting clean water (for example using bottled water and filtration systems) is utilised as a measure of the social benefits to be derived from reduced pathogens in town water supplies (may need to weight and sum data according to population and income distribution).

Damage avoided approach

Environmental services help to avoid economic costs, for example, by maintaining water flow and minimizing flooding or by protecting riverbanks and shorelines. This method estimates economic values based on costs of avoided

Box 13: Using damage avoided approach to value flood control functions of Tana Delta wetlands, Kenya

This study estimated the value of damage avoided to roads and bridges through floods and storm control functions of wetlands and mangroves on the Tana Delta. It demonstrated that a total present value of Ksh 275 million was avoided in terms of re-establishment and maintenance of infrastructure.

Source: Cited in Emerton (1999)

damages resulting from lost ecosystem services.

The damage cost avoided method uses either the value of property protected, or the cost of actions taken to avoid damages, as a measure of the benefits provided by an ecosystem. For example, if a wetland protects adjacent property from flooding, the flood protection benefits may be estimated by the damages avoided if the flooding does not occur or by the expenditures property owners make to protect their property from flooding. The value of environmental services in terms of losses avoided and costs saved may be determined by calculating the value of damage occurring as a result of the loss or irrevocable degradation of the environment (for example, the costs of destruction to houses, roads, bridges and farms caused by flooding).

Replacement or repair expenditure

The replacement cost approach can be seen as an accounting approach which estimates the value of environmental benefits by examining the potential costs of restoring or replacing productive assets lost or degraded due to project impacts or improper management. The method estimates economic values based on costs of replacing ecosystem services, or costs of restoring the ecosystem so that it again provides the service. The method uses the cost of replacing an ecosystem or its services as an estimate of the value of the ecosystem or its services. These replacement costs represent the value of environmental services that can be replicated by artificial or technological means. They represent expenditures saved by the presence of naturally occurring ecosystems, and their associated functions and services. The method can be used to estimate, for example, the benefits of implementing improved agricultural practices in upland soil areas can be reflected in the cost of replacing soil and nutrients that would be lost through erosion.

Box 14: Replacement cost of forest ecosystem erosion control and watershed protection services in Kenya

The benefits of watershed protection and soil erosion control of a large area of natural forest, the Mount Kenya Forest Reserve, was valued by using replacement cost techniques. The cost of replacing these ecosystem functions was assessed by looking at their provision by artificial means under the next most likely alternative land use to forestland use. This involved calculating the costs of developing and maintaining on farm and soil conservation measures over the area occupied by the forest. The resulting value was some K Sh 768 million a year, or KSh 12 per hectare represents a minimum estimate of the indirect value of selected forest ecological services.

Source: *Emerton, L. (1998), Economic tools for valuing wetlands in Eastern Africa. Nairobi: IUCN p. 13)*

5.7 Discussion questions

Why would the use of labour and extraction costs of forest products fail to provide their accurate market value?

1) Explain the difficulties one would be faced with when trying to apply the travel cost method in Kenya.

2) Pick an evironment service that you have been dealing with in your organization or department. Explain how it can be valued using any of the preventive expenditure, damage avoided, replacement costs approaches disscussed in this mannual.

6. Stated or Expressed WTP Methods and Benefits Transfer

Stated preference methods/techniques can be divided into the contingent valuation method (CVM or simply CV) and choice modeling or choice experiment. Both rely on a 'constructed market' - i.e. a hypothetical market which is presented to a respondent in a questionnaire.

A big advantage of stated preference methods is that we can ask respondents for their WTP regardless of whether they make use of the hypothetical commodity or not - in other words we can obtain use and non-use values. When the respondent has property rights over the resource we ask 'what are you willing to pay'. Without such property rights then we ask 'what is the minimum compensation you would accept to put up with this loss' in contexts where the loser has the rights to the prior situation.

6.1 Contingent Valuation

The structure of the CV questionnaire

The contingent valuation (CV) methodology involves asking a random sample of respondents for their WTP (or WTA) for a clearly defined good. CV involves a *direct elicitation* by asking questions that take the form: 'what is the maximum amount you are willing to pay?' or 'are you willing to pay X?'

Design of a CVM study

In designing a CVM study, one has to answer a number of questions relevant to contingent valuation research in general. These include:

- What change in environmental quality should respondents be asked to value, and how should this change be described to them?
- What type of interview format should be used in the survey (i.e. face to face, telephone, or mail)?
- What type of questions (elicitation procedure) should be used to elicit respondents' valuation of the change in environmental quality?

- Exactly how should respondents be told that they would have to pay for the change in environmental quality?
- How can we increase our confidence that respondents in the contingent valuation survey are actually valuing the specific change in environmental quality described and not some other environmental quality change, and furthermore, that the values found are correct?

Hypothetical market

The respondents presented with a hypothetical market which has the following components

- The good itself or service flow (an improved view, better water quality, etc)
- Institutional context in which the good would be provided
- The way in which it would be financed-the bid vehicle (property taxes, income tax, utility bills, entry fees, trust fund payments, etc.

The hypothetical market must as close as possible to a real market. Provide some pictures, photos, info maps, etc to improve the description of the good or service.

Elicitation

Start by stating the purpose of the CVM questionnaire. Explain *why the questionnaire is being undertaken*. The context should be as realistic as possible. Explain who the interviewer is (e.g. conducting on behalf of what organization). Explain that answers are confidential.

Start by eliciting respondents' attitudes to general issues concerning the good and then to the good in question before presenting the hypothetical market and eliciting the WTP.

Box 15: Example
Which of the following problems do you regard as being most important for government to tackle?

Then:

Tell me with which of the following statements about Kakamega forest you strongly agree, agree, disagree, or strongly disagree (scale may be shown, e.g. 1 for strongly disagree, 5 for strongly agree)

The respondent is asked questions to determine how much s/he would value a good or service if confronted with the opportunity to obtain it under the specified terms and conditions. Respondents are often reminded of the need to make compensating adjustments in other types of expenditure to accommodate this additional financial transaction. The respondent's choice or preference can be elicited in a number of ways:

The simplest is to ask the respondent a direct question about how much s/he would be willing to pay for the good or service - known **as continuous or open-ended questions**. High rates of non-responses and zero responses can be a problem with this approach.

Alternatively, a respondent can be asked whether or not s/he would want to purchase the service if it cost a specified amount. These are known as **discrete, dichotomous choice, or referendum questions**, and receive favour because they give the respondent no incentive not to answer truthfully, that is, the approach is incentive compatible.

The discrete choice approach can be extended to have multiple bounds, although a double-bounded format has been found to have some efficient properties in terms of minimising the tendency for the respondent to say yes continuously. Open-ended questions, as well as single and double-bounded closed-ended questions are now the most frequently used formats in contingent valuation. **Payment cards and iterative bidding** formats used to be popular but are less so now since they are thought to introduce specific biases.

Value elicitation question

- The formulation of the question designed to elicit WTP is also crucial to a CV questionnaire.
- It is crucial to elicit the **maximum WTP** or the **minimum WTA** to be consistent with the underlying economic theory of valuation. This requirement also helps to determine the elicitation format. The most widely used elicitation formats are shown in table 4 below:

Table 4: Examples of Elicitation formats

Open-ended	*What is the maximum amount that you would be prepared to pay every year from your household income, to implement the Kakamega conservation program as it has just been described?*
Bidding game	*Would you pay KSh50 every year, from your household income, to implement the Kakamega conservation program as it has just been described?* If Yes: Interviewer keeps increasing the bid until the respondent answers - No. Then maximum WTP is elicited. If No: Interviewer keeps decreasing the bid until respondent answers -Yes. Then maximum WTP is elicited.
Payment card	*Which of the amounts listed below best describes your maximum willingness to pay every year, from your household income, to implement the Kakamega conservation program as it has just been described?* KSh, 0, 5, 10,---150, 200……..
Single-bounded dichotomous choice	*Would you pay KSh50 every year, from your household income, to implement the Kakamega conservation program as it has just been described?* (the price is varied randomly across the sample). Yes/No
Double-bounded dichotomous choice	*Would you pay KSh50 every year, from your household income to implement the Kakamega conservation program as it has just been described?* (the price is varied randomly across the sample) If Yes: *And would you pay KSh100?* If No: *And would you pay KSh10?*

Note: It is important to constrain WTP answers in all approaches. Respondents must be reminded of **substitute goods**. This reminds respondents that the good in question may not be unique and that this has implications for its value; and they must be reminded of their **budget constraints** and hence the related need to make compensating adjustments in other types of expenditure to accommodate the additional financial transaction implied by the survey. This reminds respondents of their limited incomes and of the need to trade-off money for environmental improvements. Follow-up questions are also conducted to improve the WTP values.

Tests of the reliability, bias and validity of the CVM.

Reliability concerns the degree to which the variance of WTP responses can be attributed to random error. The greater is the degree of non-randomness, the less the reliability of the study, such that mean WTP answers are of little significance. The variance arises as a consequence of true random error, sampling procedure, and the questionnaire/interview itself. The first of these is essential to the statistical process, while the second can be minimized by ensuring a **sufficiently large sample size**. The third relates to the issue of bias, they are considered in turn. Bias refers to non-randomness in the variance of valuation responses.

Bias can be caused by a number of factors that introduce bias into respondent behavior. Well-documented biases include:

- strategic bias - respondents deliberately misstate their WTP;
- payment vehicle bias - WTP varies with the instrument suggested for payment;
- hypothetical bias - WTP is over or understated relative to what would be paid in a real market;
- starting point bias - WTP is 'anchored' on the first suggested bid price;
- insensitivity to scope - WTP is not affected by the scale of the good being offered;
- aggregation bias - aggregate WTP is sensitive to the number of people over which WTPs are aggregated.

Mean or median WTP?

- The final summary statistic for WTP will be either a mean or a median, and often both will be reported.
- The mean will be relevant if the context of the valuation exercise is cost-benefit analysis.
- The median is relevant in the context of public choice since it corresponds to that amount which would just receive a majority approval.

- Means will tend to be larger than medians for most WTP distributions where a significant proportion of people may have low WTP for the good.

Box 16: Using contingent valuation and travel cost methods to assess the recreational value of Lake Nakuru, Kenya

Lake Nakuru is renowned as an important international tourist destination. Although fees are charged to enter the park, these underestimate the total value that tourists place on this ecosystem, especially the opportunity to view flamingos in large numbers. The contingent valuation survey asked visitors how large their personal travel total costs were, how much willing they would be to increase their expenditures to visit the park, how much they would be willing to contribute to a fund to clean up and control the urban pollution which threatens the park, and how much they would be willing to a project to conserve flamingos, (a measure of willingness to pay); and the minimum reduction in trip costs they would be willing to accept should there be no flamingos (a measure of willingness to accept compensation). The results demonstrated that the annual recreational value of wildlife viewing in Lake Nakuru National Park was between US$ 7.5 15 million, of which over a third was accounted for by flamingos.
1 US $ = 78 KSh in January 2002

Source: Emerton, L., 1998.

PARTICIPATORY ENVIRONMENTAL VALUATION (PEV)

Participatory valuation shares some characteristics with contingent valuation, but the main difference is that it does not use cash amounts directly to express forest values. It has been applied in communities that do not use cash as a means of exchange to a large extent. Instead it asks people to value forest products in terms of other locally important products or categories of value. It allows respondents to choose a *numerâire* (a common measure of value) for comparing values. A marketed and valued product for example a cow, a radio or a sack of maize is used to express the worth of different forests products in terms of this *numerâire* using PRA techniques such as ranking or proportional piling.

Participatory valuation has been applied in East Africa to value forest products in Oldonyo Orok Forest at the Kenya/Tanzania Border and in Tharaka[3]. In that study, contingent valuation technique was modified and used to assign monetary values to non-traded forest products. Individual respondents were asked to rank forest products in order of importance and then to use counters to score both the products and a comparative

[3] Emerton, L (1996). Valuing the subsistence use of forest products in Oldonyo Orok Forest, Kenya. Rural Development Forestry Network Paper 19e p. 21-30 and Mogaka, H. (2001).Valuation of local forest conservation costs and benefits: The Case of Tharaka. *Innovation 8 (2), p.20-23*

numerâire (yardstick used to measure value) of their choice, which could be any traded commodity of local significance. The *numeraire* used was a young castrated bullock.

The method uses a three-stage approach. The first is to get an idea of the relative importance of different forest products through a ranking exercise. The ranking is done using pictures of various products. The second stage is to establish value by asking respondents to distribute counters such as beans, stones or other items used for this purpose, between the cards representing different forest products and the *numeraire* commodity (in this case the bullock). The third stage is to ask respondents to state the purchase price of the bullock, which provides the means for forest products to be translated into cash.

Local residents were found to place a particularly high value on water and grazing resources in Oldonyo Orok forest in Kenya. Altogether, annual benefits of forest use were estimated at almost KSh 5000 per household, which provided a convincing justification for conservation.

6.2 Choice Experiments

The term Choice Experiment (CE) encompasses a range of stated preference techniques that take a similar approach to valuing environmental goods. The term includes Choice Modeling (CM), Contingent ranking, Contingent rating, and the method of Paired Comparisons.

The elements of CE that are common with contingent valuation are that the attribute scenarios are hypothetical choice sets. The questionnaire formats are also broadly similar. The differences are that the CE variants can be far more complicated to administer and, crucially, that the WTP is only elicited indirectly through a process of observed trade-offs made by respondents. Thus, whereas CV directly asks for WTP, Choice Experiments infer WTP from rankings or ratings of choice sets.

CE approaches are based around the idea that any good can be described in terms of its attributes and the levels that these take. For example, a forest can be described in terms of its species diversity, age structure, recreation facilities and an entry price or transport

cost. Changing attribute levels will essentially result in a different “good” being produced and it is on the value of such changes in attributes that choice experiments focus. By choosing over these different “goods” including the implicit price attribute, respondents reveal the value of the other attributes indirectly.

CE convey four pieces of information that may be of use in a policy context:

- ✓ The attributes that are significant determinants of the values people place on non-market goods.
- ✓ The implied ranking of these attributes amongst the relevant population. For example, in Kakamega forest, how indigenous trees are ranked relative to exotic ones and how these are both ranked relative to rare bird species.
- ✓ The value of changing more than one of the attributes at once (for instance, if a management plan results in a given increase in wildlife protection but reduction in collection of timber and non-timber forest products).
- ✓ As an extension of this, the total economic value of a resource or good.

However, it is important to note that not all CE approaches are equal in this respect. In fact, only two of them (choice modeling and contingent ranking) have demonstrably close links with economic theory, which allows the results to be interpreted as being equal to marginal (or total) values for use in CBA or in other contexts

Choice Modeling Technique

In C*hoice Modeling* (CM) we do not ask a valuation question directly. Instead we ask people to choose alternative 'bundles' of attributes. Imagine a forest where there are many different kinds of birds. We might ask visitors to rank alternative options each of which contains the same attributes but with different 'levels'. Option 1 might have no bird hides, more diverse birds, an information centre, and have an entry charge of KShX. The second option might have two hides, no information centre, less diverse birds and a charge of KSh0.2X. Respondents choose their most preferred alternatives. Their choices can be used to infer a WTP because they are effectively trading off between the entry price and different levels of the attributes. But the respondents do not state a WTP.

Common design features

All the above stated preference techniques share common design features. There are some similarities to the CV process, but with key differences in a design process that allows WTP to be elicited in an indirect way. There are five important design stages:

Stage 1: Identification of relevant attributes to include in choice sets.

Stage 2: Assignment of levels to attributes including the price attribute.

Stage 3: Determining the factorial design set of matrices combining attributes and levels to be presented to respondents.

Stage 4: Determining an efficient subset of the matrices to present to a sample of respondents.

Stage 5: Administering the survey in a face-to-face format.

Analysing CM data

The design and analysis of CM surveys is complicated relative to CV. However, the design and analysis draws on the random utility framework that characterizes the models used to analyze closed-ended CV. In the design stage, the main challenge arises in determining the essential attributes that define the good to be valued and their appropriate levels. Because price is one of the attributes, this problem is similar to the bid vector design problem encountered in closed-ended CV. The literature provides guidance on the number of attributes and levels that is psychologically acceptable for the average respondent. Design algorithms can then aid in the task of reducing a complex factorial design down to the smallest set of combinations – depending on whether main effects are of interest or both main effects and interactions. The final combination of options then typically requires the respondent to choose between sets of options (made up of attributes at varying levels) such that multiple choice observations are made for each individual. To model this information some assumption is necessary about the form of the indirect utility function that underlies the choice decision. Ordered logit models are then normally used to estimate the parameters of the choice from which marginal rates of substitution can be calculated.

6.3 Choice modeling versus contingent valuation

CM places the respondent in much the same situation as a CV survey. The key difference is that the cognitive process is somewhat circumscribed by the attributes and the levels a respondent must choose between. For some goods, this may prevent the respondent making default assumptions. However, this depends on the amount of background information provided in what is already a cognitively burdensome task. There is a small body of studies testing whether there is applicability of CM to biological resources. It can be argued that the constrained attribute design requirement of CM is even more limiting than CV. Moreover, the selection and representation of these attributes and their levels simply adds to the design problems already associated with hypothetical surveys. A strong advantage of the CM over CV is that the method can reveal something about the sum of the parts of a resource rather than the total value. In many circumstances, the policy question to be answered by a valuation study concerns the improvement of a specific attribute. Other advantages of using CM are:

i. CM provides a richer description of the attribute trade offs that individuals are willing to make.

ii. The welfare values from the CM generally have smaller variances (relative to their means) than the CV estimates

iii. CM avoids compliance bias or "yeah saying" problem of dichotomous choice surveys as respondents are not faced with the same "all or nothing" choice

iv. CM helps avoid the potential "embedding problem" present in CV when WTP for a good varies depending on whether it is evaluated on its own or as part of a more inclusive category

v. By allowing some attributes to take on levels both above and below the status quo level, it is possible to estimate both WTP and WTA

If resources are sufficient, both CV and CM studies can be undertaken to permit some form of convergent validity. Rarely, however, resources allow for the application of more than one technique and a choice has to be made.

6.4 Benefits transfer method

Benefits transfer method refers to the use of valuation estimates in one context to estimate values in a different context. Alternatively, the relationship used to estimate the benefits in one case might be applied in another case. Thus, this method is used to estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/or context. For example, an estimate of the benefits obtained by tourists viewing wildlife in one park may be used to estimate the benefits obtained from viewing wildlife in another park.

The simplest type of benefit transfer is the unit day approach, where existing values for activity days are used to value the same activity at other sites. These estimates are based on expert judgment in combining and averaging benefit estimates from a number of existing studies. These "unit day values" may be adjusted for characteristics of the study site when they are applied.

A more rigorous approach involves transferring a benefit function from another study. The benefit function statistically relates peoples' willingness to pay to characteristics of the ecosystem and the people whose values were elicited. When a benefit function is transferred, adjustments can be made for differences in these characteristics, thus allowing for more precision in transferring benefit estimates between contexts.

Conditions for applying benefits transfer method

- The commodity or service being valued should be very similar at the site where the original estimates were made and the new site where they are to be applied
- The populations affected should have very similar characteristics at the two sites

In Applying benefits transfer method, the following steps are necessary:

1. The first step is to identify existing studies or values that can be used for the transfer.

2. The second step is to decide whether the existing values are transferable. The existing values or studies would be evaluated based on several criteria, e.g., service attributes, site comparability, qualities of sites, population characteristics, etc.

3. The next step is to evaluate the quality of studies to be transferred. .

4. The final step is to adjust the existing values to better reflect the values for the site under consideration, using whatever information is available and relevant.

Advantages and limitations of the benefits transfer Method

Benefit transfer is typically less costly than conducting an original valuation study. Economic benefits can be estimated more quickly than when undertaking an original valuation study. The method can be used as a screening technique to determine if a more detailed, original valuation study should be conducted. The method can easily and quickly be applied for making gross estimates of recreational values. The more similar the sites and the recreational experiences, the fewer biases will result. However, benefit transfer may not be accurate, except for making gross estimates of recreational values, unless the sites share all of the site, location, and user specific characteristics. It may there be unreliable for policy making.

6.5 Dicussion questions

1) In conducting telephone surveys, some respondents always refuse to participate, saying they 'don't have time' or 'can't be bothered'. If researchers accept these inevitable non-responses and base their study on other households, those who patiently answer each question, what biases are likely to be built into the sample? Can you think of a way to deal with this type of problem?

2) Pierre is a software engineer, working in a heavily polluted part of Nairobi (probably Eastlands). He does not like the pollution but the pay is good and housing is relatively cheap. He is considering taking a job with a different software company in another part of the city with very low pollution levels. Unfortunately, he discovers that housing is very expensive there; many people wish to live there and this has bid up the price of housing. Pierre tells his prospective employer that he will need a higher

wage to compensate for the higher cost of living. Is Pierre justified in making this request? Why or why not?

3) The literature suggests that substitutability can affect demand for public goods and bads in the same way that it does for private goods and bads. To be more concrete, consider trying to estimate damages from an oil spill that caused the closure of several beaches along a coastal area. Why is it important to consider whether other local beaches where left uncontaminated and therefore did not close?

7. Measuring Costs of Conserving Natural Resources and Biodiversity

Conservation of natural resources and biodiversity, just like any project investment, is characterized of both inflows (benefits) and outflows (costs). The costs could sometimes be of considerable magnitude. The need to quantify these costs is of utmost importance when dealing conservation project or initiative. This is because of the asymmetrical way benefits and costs are distributed: while a considerable amount of benefits accrue to the global community at large, costs fall almost entirely on local communities who may have an interest in degrading the natural resources in order to generate direct income.

Costs associated with conservation of natural resources can be divided into the following categories: management costs, costs to other activities (external costs) and opportunity costs of land used for conservation.

7.1 Management costs

These costs are associated with the initial investment and day-to-day operations in the conservation area. They consist mainly of direct physical expenditures on equipments, fences, infrastructure and human resources (e.g. salaries) required to manage forests. They are quantified using a questionnaire and evaluating reports in offices. An example of these costs is shown in Table 5.

However, management costs could also be incurred indirectly as opportunity costs of effort, time and other resources employed in conservation initiatives. This is particularly the case if local communities are involved. In estimating these indirect costs it is important to distinguish between production costs and transaction costs. To this one has to consider natural resource conservation as a "production" of services and goods such as maintenance of biological diversity. This "production process" requires certain institutional arrangements such as changing the property rights for the areas to be protected and various technical measures, e.g., constructing fences. The costs arising from the technical measures are regarded as production costs, while the costs arising from creating and implementing the institutional arrangements are regarded as transaction

costs. It is this latter category which is mainly incurred as opportunity costs participation in conservation activities. Mburu et al. (2003) estimated these costs and found that they may not play a significant role in the management of wildlife when they are compared with production costs (Table 5 & 6 below). However, the analysis of these costs is quite rare and probably they could be important in other cases.

Table 5: Landowners' and other stakeholders' production and transaction costs of co-management (per participating household[a])

	Ex ante stage		Ex post stage [b]	
	Production Costs in US$	Transaction costs in US$	Production costs in US$	Transaction costs in US$
Kimana Landowners	0	11	27	20
Other Kimana stakeholde	19	13	17	0
Total for Kimana	19	24	44	20
GM Landowners	31	18	12	9
Other GM stakeholders	423	166	140	11
Total for GM	454	184	153	20

[a] Only the estimated total number of participating households is considered (1302 in Kimana and 664 in GM). Participating landowners or households are those that were involved in any of the activities (mostly meetings, training and tours) during the creation and operation of the sanctuaries. This definition excludes involvement in production activities such as fence maintenance.

[b] Since direct management costs are shared by all of the stakeholders, they are not included in this table. Mburu & Birner (2002) found that these costs were US$ 32 per participating household in Kimana and US$ 48 in GM. Costs that would also accrue to landowners even in the absence of sanctuaries (e.g., guarding costs, losses of crops and livestock, land opportunity costs) are also not included.

Mburu and Birner (2002) calculated the direct management costs of conserving two protected areas (Amboseli National Park and Shimba Hills National Reserve) and their adjacent community conservation areas (Kimana and Golini-Mwaluganje sanctuaries. They found that these costs can range from $300-1600/km2 depending on the amount of revenue targeted.

Table 6: Direct management costs and revenues of the four conservation areas in Kenya

Park (or Reserve) and Sanctuaries	Area (km^2)	Direct management costs/km^2/ year (US$)	Revenue/ km^2/year (US$)	Ratio: Revenue /direct management costs (US$)
Amboseli National Park.	390	550	5,848	10.63
Kimana Sanctuary (BL)[a]	60	394	295	0.75
Kimana Sanctuary (AL)[a]	60	698	884	1.27
Shimba Hills National Reserve	217	718	1,340	1.87

7.2 Opportunity costs of conservation

The definition of opportunity costs of conservation encompasses any benefits generated by alternative land uses which are foregone due to conservation of the forest. Since most of the conservation areas (with exception of a few, e.g. Nairobi National Park) the opportunity costs represent income forgone from agricultural uses. These costs can simply be quantified by applying the effect on production and estimating gross margins (represents financial opportunity costs). Such opportunity costs of land would depend on the agricultural potential of the conservation areas.

Mwau (1995) calculated opportunity costs of land after classifying wildlife dispersal areas of Kenya into the relevant agricultural potentials based on agro-ecological zones. His study, which was authorised by USAID and KWS, later formed the basis of the current wildlife utilisation policy in Kenya. He found conservation areas that could be used for cash crops and irrigated vegetables had the potential of generating as much as $33, 405/Km^2/year.

Box 17: Potential returns from different types of agricultural land use in Kenya

Alternative land use	Financial returns/km^2 (US$)/year
Irrigation (horticulture)	33,405
Small scale mixed farming (medium potential)	24,417
Pastoralism	406
Small scale mixed farming (low potential)	227

Source: Mwau (1995)

However, due to market distortions, any economic analysis would require that the shadow-price of land be estimated. Shadow prices give the *marginal value* of resources such as land, labor, and capital and can be used to help determine how much we should be willing to pay to acquire those resources. Linear programming (LP) could be used for this purpose.

7.3 Other (external) costs

Local communities living adjacent to forest areas and other stakeholders often incur losses due to the presence the wildlife and effects of other attributes of conservation.

These costs arise from conflicts of conservation and other economic activities. In the case of wildlife conservation the term human-wildlife conflicts is used. Such conflicts include human injuries, crop damages, disease transmission, livestock predation and destruction farm structures (fences, houses, etc.). They are valued using either effect on production or human capital approaches. While the former is particularly applicable to the costs associated with crop and livestock damages from forest bird and animal pests, the latter is specifically focused on human health and productivity.

Box 18: Costs of wildlife crop damages in Uganda, 1998

In Uganda, the costs of wildlife to crops over the 841 kilometers boundaries of protected areas to be 97 million USh in 1998 (Emerton and Muramira, 1999). Thus the damage per km of boundary was USh 116 million.

Region	Boundary (km)	Value of crops lost (USh)
Central	167	33,633
Eastern	309	17,546
Northern	95	12,247
Western	270	33,803
TOTAL	841	97,199

Source: Emerton, L. and E. Muramira (1999), Uganda Biodiversity Economic Assessment. Nairobi: IUCN-EARO.

Another approach is the dose-response approach. This method begins by first establishing cause-effect relationship, linking for example the prevalence of water-borne illness or the incidence of injuries and death to forests or natural habitats. Then the loss of earnings and costs of medical treatment and health care arising from forests are estimated through the application of human capital approach.

7.4 Discussion questions:

1. In some natural resource conservation project local communities' participation costs can be considerably higher. Discuss how you could empirically measures these costs for a case study that you have ever dealt with or is handled in your organization.

2. What difficulties would you face in measuring direct management costs of conservation initiatives in Kenya?

3. Why do you think opportunity costs of conservation are rarely considered in policy making processes in Kenya?

4. Benefits from natural resources like the Kakamega Forest are enjoyed by humanity well beyond the vicinity of the resource and national boundaries. Should the cost of sustaining the resource be carried by the communities living around the forest and the specific nation alone? If the answer is no, discuss the options available and the problems likely to be experienced in implementing them.

Part C: Decision Criteria in Practice

Introduction

Conservation of natural resources and biodiversity involves many stakeholders (for example local communities, the local authorities, the central government, organizations that are involved in conservation and others). Any conservation policy is likely to have different impacts on different stakeholders. Therefore, it is important to identify and weigh the different impacts of any given environmental policy and determine how it impacts the different stakeholders (See Chapter 5). Later dollar or monetary values should be attached to these impacts and gauge their effects in a financial or economic analysis.

Regulation of conservation and environmental policies involves high magnitudes of costs and therefore it's important to weigh the costs incurred against benefits accrued to arrive at an informed decision. Decision making process involves identifying the likely impacts (positive & negative), weighing them in a standardized way (for example by attaching a monetary value to them), and finally applying a certain decision criteria. In the following sections tools available for decision making in a natural resource management setting are described:

8. Environmental Impact Assessment (EIA)

8.1 Introduction to Environmental Impact assessment (EIA)

As indicted in Chapter 5, EIA involves description and quantification of impacts of given policy options. However, EIA does not require full information about costs and benefits; impacts are not expressed in monetary terms. The onus of decision-making is left with policy makers to weigh different impacts against each other. EIA is a very important aid to CBA.

Definition of EIA and its Importance

Environmental Impact Assessment (EIA) is a policy and management tool for both planning and decision-making. It is a systematic process that assists to identify predict and evaluate the foreseeable environmental consequences of proposed development projects, plans and policies. The process is applied prior to major decisions and commitments being done. The outcome of an EIA study assists the decision maker and the general public to determine whether a project should be implemented and in what form.

EIA involves description and quantification of impacts of given policy options. However, it does not require full information about costs and benefits; impacts are not expressed in monetary terms. The onus of decision-making is left with policy makers to weigh different impacts against each other. EIA is a very important aid to CBA.

EIA is not restricted to or biased to the examination and mitigation of negative impacts alone. EIA can also look into the possible positive issues due to the developmental projects and explore or suggest ways of enhancing them further by carrying out modifications in the project.

The purpose of EIA is to:

- Provide information for decision making on the environmental consequences of proposed actions; and
- Promote environmentally sound and sustainable development through the identification of appropriate enhancement and mitigation measures

Reducing the burden of environmental impacts is necessary if development is to become sustainable. The role of EIA is formally recognized in Principle 17 of the Rio Declaration on Environment and Development:

"Environmental Impact Assessment as a national instrument shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority"

In practice, EIA is applied to prevent or minimize the adverse effects of major development proposals.

The immediate aim of EIA is to inform the process of decision-making by identifying the potentially significant environmental effects and risks of development proposals. The ultimate or long term aim of EIA is to promote sustainable development by ensuring that development proposals do not undermine critical resource and ecological function or the well being, lifestyle and livelihood of the communities and people who depend on them.

Immediate objectives of EIA:

- improve the environmental design of the proposal
- ensure that resources are used appropriately and efficiently;
- identify appropriate measures for mitigating the potential impacts of the proposal;
- facilitate informed decision making including setting the environmental terms and conditions for implementing the proposal

Long term objectives of EIA:

- protect human health and safety
- avoid irreversible changes and serious damage to the environment
- safeguard valued resources, natural areas and ecosystem components and
- enhance the social aspects of the proposal

The benefits of EIA can be direct, such as the improved design or location of a project, or indirect such as better quality EIA work or raised environmental awareness of the personnel involved in the project. Specific benefits may include:

- Better environmental planning and design of a proposal- carrying out an EIA entails an analysis of alternatives in the design and location of projects. This can result in the selection of an improved technology which lowers waste outputs or an environmentally optimum location for a project. A well designed project can minimize risks and impacts on the environment and people and thereby avoid associated costs of remedial treatment or compensation for damage

- Ensuring compliance with environmental standards – compliance with environmental standards reduces damage to the environment and disruption to communities. It also avoids the likelihood of penalties, fines and loss of trust and credibility
- Savings in capital and operating costs – EIA can avoid the undue costs of unanticipated impacts. These can escalate if environmental problems have not been considered from the start of proposal design and require rectification later
- Reduced time and costs of approval of development applications: if all environmental concerns have been taken into account properly before submission for project approval, then it is unlikely that delays will occur as a result of decision makers asking for additional information or alterations to mitigation measures
- Increased project acceptance by the public – this is achieved by an open and transparent EIA process with provision of opportunities for public involvement that are most directly affected by and interested in the proposal.

8.2 Overview of EIA Processes

EIA is generally conducted in tiers. In most cases, the process falls into four tiers, as explained in the figure below. Conducting EIA in tiers helps optimize the resources as well as to increase the effectiveness of the exercise by maintaining a better focus.

1. **Screening**

This is a process to decide whether the EIA process is applicable at all to the development project. It aims to clear all those projects where there are no major negative impact issues. Screening criteria generally involve the specification of the *location, type* and *size* of the project. (In Kenya, the regulations set by EMCA 2000 also stipulate the nature of projects that require EIA).

Screening thresholds are generally set considering the project type, size and location. The project type and size are used to estimate the extent of the impacts while the

thresholds of the project size depend on the project type. Financial institutions also have specific guidelines for screening projects to ascertain whether an EIA is required or not – e.g. ADB, USAID, WB.

2. Scoping

If screening does not automatically clear a project, then the developer is asked to undertake a scooping exercise. This step helps in understanding the extent of environmental impacts and identifies significant environmental issues for further study. It involves sufficient research and expert advice to identify the project's key impacts on the local environment in terms of impact issues and to evaluate briefly the importance of the critical issues to the various stakeholders apart from the decision makers. Setting the boundaries of the assessment is the most important step of the entire EIA. Too narrow a scope will likely leave out an important factor or effect, but too broad a scope may make the analysis unwieldy or take too long a time. Other aspects of scooping are to choose the important issues to be resolved and to agree on responsibilities for performing the EIA.

The scooping exercise should involve:

- review of all written materials on the purpose, need or prospectus for the project
- perform field reconnaissance of the desired site or sites for the project
- interview local residents and affected communities that use resources;
- consult with other agencies that have expertise, jurisdiction, or influence on the decision to approve, design, or site a project;
- consult with local or regional scientists at colleges, universities, institutes or field stations;
- visit local political leaders where the project may be sited

3. The Initial Environmental Examination (IEE)

IEE is a process of further enquiry into the impact assessment, taking clues from the exercise of scooping. IEE focuses on the assessment of impacts and identification of obvious mitigation measures. This is done by conducting baseline information and by

collecting any available secondary data. This assessment aims to grade the impacts in terms of significance. Significance of the impact is expressed in terms of "highly significant" or "of minor significance" or in terms of additional descriptors such as "reversible", "irreversible" "short-term" or "long-term" etc. The idea of assessing the significance of impacts is to identify suitable mitigation measures. The level of mitigation measures suggested is based on the understanding o the severity of the impacts.

The IEE results in:

- a brief description of the expected or predicted environmental changes due to the project
- measures or procedures that could be implemented to avoid or reduce the impacts on the environment;
- examination of alternatives, including the proposed action and no action;
- additional study requirements, regulatory requirements and other coordination requirements for the detailed EIA, if required.

Alternatives should be feasible and substantially different from each other

4. Detailed or Comprehensive EIA

In this step, a detailed examination of impacts is carried out by conducting relevant surveys along the lines of IEE.

All significant impacts are examined once again in the formal framework of identification, prediction, and assessment and all issues previously dealt in the IEE level are reassessed for adequacy. The final recommendations in the detailed EIA extend beyond the mitigation measures to include the necessary institutional set up for the support of the overall environmental management system.

Prediction scientifically characterizes the impact's causes and effects, and its secondary and synergetic consequences for the environment and the local community. Prediction draws on physical, biological, socio-economic and anthropological data and techniques.

In quantifying impacts, it may employ mathematical models, photomontages, physical models, socio-cultural models, economic models, experiments or expert judgments.

Assessment evaluates the predicted adverse impacts to determine whether they are significant enough to need mitigation. The judgment of significance can be based on:

- Comparison with laws, regulations, or accepted standards;
- Consultation with the relevant decision makers;
- Reference to pre-set criteria such as protected sites, features or species
- Consistence with government policy objectives;
- Acceptability to the local community or the general public.

If the impacts matter, the next step is to answer what can be done about them. A range of measures are proposed to prevent, reduce, remedy or compensate each of the adverse impacts evaluated as significant. Possible mitigation measures may include:

- changing project site, routes, processes, raw materials, operating methods, waste disposal routes or locations or engineering designs.
- Introducing pollution controls, monitoring, phased implementation, landscaping, personnel training, involving social services or public education.
- Offering as compensation, restoration of damaged resources, money to affected persons, concessions on other issues, or fit site programs to enhance some other aspects of the environment or quality of life for the community.

At the end of a detailed EIA, an evaluation is performed considering all the project costs and project benefits to establish an overall cost effectiveness of the modified project.

Mitigation measures are implemented as part of impact management. This process is accompanied by monitoring to check that impacts are as predicted. When unforeseen impacts or problems occur, they can require corrective action to keep them within acceptable levels, thereby changing mitigation measures recommended in an EIA or set out in an environmental management report.

5. Reporting

The EIA report or impact statement is a primary document for decision making. It organizes the information obtained and synthesizes the results of the studies and consultations undertaken. A full yet concise account of the likely environmental impacts of a proposal are given as well as the recommended measures for mitigating and managing them and their significance of any residual effects.

The audience of an EIA report includes the authorising and implementing agencies, other interested parties and the affected public. Because of its importance as a communications tool, the EIA report needs to be well organized and clearly written. An effective report will be written both in plain language for non-experts but also to appropriate technical standards.

Different names are used for the report that is prepared on the findings of the EIA process. Some call it *EIA Report,* others *Environmental Impact Statement (EIS)* or *Environmental Statement (ES).*

The proponent is responsible for the preparation of the EIA report. A successful EIA report should be:

- Actionable – a document that can be applied by the proponent to achieve environmentally sound planning and design;
- Decision-relevant – a document that organizes and presents the information necessary for project authorization and if applicable, permitting and licensing; and
- User-friendly – a document that communicates the technical issues to all parties in a clear and comprehensible way.

6. Review of EIA Quality

The purpose of review is to assure the completeness and quality of the information gathered in an EIA. The review marks the final check of quality of the EIA report

submitted to obtain a project authorization. The key objectives of the review are: to assess the adequacy and quality of an EIA report; to take account of public comment; and to identify as necessary, the deficiencies that must be addressed before the report can be submitted.

In many EIA systems, the review stage is the major opportunity for public involvement. They range from notification of a period for receiving written comments on the EIA report to holding public hearings.

7. Decision Making

Decision-making is the process of choosing between alternative courses of action. The process is essentially political in nature. It involves weighing the benefits and costs and making trade-offs among a range of considerations. The views of interested parties are presented directly and decisions are made through an incremental process of negotiation, bargaining and compromise. The process culminates in a final decision on whether or not a proposal is acceptable and under what conditions.

8. Implementation and Follow up

Without appropriate implementation and follow up to decision-making, EIA becomes a paper exercise to secure an approval, rather than a practical exercise to achieve environmental benefits. The purpose of EIA implementation and follow up is to ensure that the condition attached to project approval are carried out and function effectively, and to gain information that can be used to improve EIA practice.

When used systematically, EIA implementation and follow up help optimize environmental benefits at each stage of project development.

8.3 EIA Methods And Tools

EIA methods are usually taken to include the means of gathering and analyzing data, the sequence of steps in preparing a report and the procedure (who does what and when). While the key components of the EIA process are universally agreed upon, EIA

techniques vary widely due to the complexity of the interacting systems that constitute the environment and the infinite variety of possible impacting actions.

The four fundamental methods which are commonly used for conducting an EIA are checklists, matrices, networks and overlays. Tools for EIA support the application of the above basic methods. Some common tools include prediction models, geographic information systems and expert systems. These tools can be used for purposes other than EIA.

i) Checklists

Checklists serve as a reminder of all possible relationships and impacts out of which a set tailored for the specific assignment may be chosen. They are designed to establish whether a proposed project is likely to have negative impacts on the environment. They help people in key positions to become more aware of what they should be looking for when assessing a proposed project. They may also help to develop a higher degree of awareness of the environmental aspects of a project.

There are two types of checklists: Descriptive checklists and weight-scale checklists.

The purpose of a descriptive checklist is to provide a list of important issues for the purpose of identification and scooping.

Weighted Scale checklists are used to: recognize the relative differences between the importance of environmental issues; allow for scoring and aggregation of impacts arising from the issues on the environmental components; and permit a quantitative comparison between alternatives.

Box 19: Example of Questions in a Checklist used for screening

Will the project:

i. Lead to substantial pollution of water, air, or soil?
ii. Create waster disposal problems?
iii. Affect areas which support animal and plant life worthy of protection or affect an especially vulnerable ecosystem?
iv. Create a risk of accidents, which may have serious consequences for the local population and the natural environment?
v. Change the way of life of the local population in such a way that it lead to considerably increased pressure on the natural resource base?
vi. Lead to major conflicts with regard to existing land use and ownership of land?
vii. Obstruct or lead to considerable changes in the local population's exploitation or use of natural resources other than those directly affected by the project?

ii) Matrix

Matrices relate activities to environmental components so that the box at each intersection can be used to indicate a possible impact. The matrix is used to identify impacts by systematically checking each development activity against each environmental component. Matrix is therefore an extension of the basic checklist.

There are three commonly used types of matrices: Descriptive matrices; symbolic and presentation matrices; and scaled/weighted or numeric matrices.

iii) Networks

Investigation of higher order linkages in two dimensions can be carried out by using directional diagrams called networks. Networks are developed to explicitly consider the secondary, tertiary and higher order impacts that can arise from an initial impact. The objective of network approach is to display, in an easily understood format, the intermediate link between a project and its ultimate impacts.

iv) Overlays

The overlay approach to impact assessment involves the use of a series of transparencies to identify, predict, assign relation significance to and communicate impacts in a geographical reference frame larger in scale than a localized action would require. A set of transparent maps, each of which represents the spatial variation of an environmental parameter are prepared. The maps are shaded to show three degrees of parameter compatibility with the proposed project. A composite picture of the overall social cost of affecting any particular area is approximated by superimposing all the transparent maps. Any number of project alternatives can be located on the final map to investigate the degree of associated impacts.

As a guiding principle of EIA good practice, the EIA process should be Purposive, Focused, Adaptive, Participative, Transparent, Rigorous, Practical, Credible and Efficient.

8.4 EIA and Biodiversity

Biodiversity matters to everyone. Its loss impoverishes the environment and reduces its capacity to support people now and in the future. Impact assessment can help to ensure development is compatible with the conservation and sustainable use of biodiversity.

The first World Summit on Environment and Development in Rio de Janeiro (1992) emphasized the importance of biodiversity as the basis of our very existence, to be used wisely and sustainably and conserved for current and future generations. The main threats to global biodiversity are associated with human activities causing habitat loss or damage.

Box 20: Areas with important Biodiversity

Areas with important biodiversity" are those that:

- Support endemic, rare, declining habitats/ species/ genotypes.
- Support genotypes and species whose presence is a prerequisite for the persistence of other species.
- Act as a buffer, linking habitat or ecological corridor, or play an important part in maintaining environmental quality.
- Have important seasonal uses or are critical for migration.
- Support habitats, species populations, ecosystems that are vulnerable, threatened throughout their range and slow to recover.
- Support particularly large or continuous areas of previously undisturbed habitat.
- Act as refugia for biodiversity during climate change, enabling persistence and continuation of evolutionary processes.
- Support biodiversity for which mitigation is difficult or its effectiveness unproven including habitats that take a long time to develop characteristic biodiversity.
- Are currently poor in biodiversity but have potential to develop high biodiversity with appropriate intervention.

Source: IAIA 2005. Special Publication Series No. 3: . – http:www.iaia.org

The Convention on Biological Diversity (CBD), the Ramsar Convention, and the Convention on Migratory Species (CMS) recognize impacts assessment as an important decision-support tool to help plan and implement development with biodiversity "in mind." The Conventions require Signatories ("Parties") to apply EIA and SEA to proposals with potential negative impacts on biodiversity to help meet their objectives, so that development proposals respect mechanisms for the **conservation** of biodiversity, result in **sustainable use** of

biodiversity resources, and ensure **fair and equitable sharing** of the benefits arising from use of biodiversity.

Impact assessment provides opportunities to ensure that biodiversity values are recognized and taken into account in decision-making. Importantly, this involves a participatory approach with people who might be affected by a proposal.

Operating principles

1. Screening.

Use biodiversity inclusive screening criteria to determine whether important biodiversity resources may be affected. Biodiversity screening "triggers" for EIA should include:

- Potential impacts on protected areas and areas supporting protected species.
- Impacts on other areas that are not protected but are important for biodiversity
- Activities posing a particular threat to biodiversity (in terms of their type, magnitude, location, duration, timing, reversibility).
- Areas that provide important biodiversity services including extractive reserves, indigenous people's territories, wetlands, fish breeding grounds, soils prone to erosion, relatively undisturbed or characteristic habitat, flood storage areas, groundwater recharge areas, etc.

Encourage development of a biodiversity screening map indicating important biodiversity values and ecosystem services. If possible, integrate this activity with the development of a National Biodiversity Strategy and Action Plan (NBSAP) and/or biodiversity planning at sub-national levels (e.g., regions, local authorities, towns) to identify conservation priorities and targets.

2. Scoping.

Use scoping as an opportunity to raise awareness of biodiversity concerns and discuss alternatives to avoid or minimize negative impacts on biodiversity.

The scooping report should address the following issues (on the basis of existing information and any preliminary surveys or discussions):

1. The type of project, program, plan or policy, possible alternatives and a summary of activities likely to affect biodiversity;
2. An analysis of opportunities and constraints for biodiversity (include "no net biodiversity loss" or "biodiversity restoration" alternatives)
3. Expected biophysical changes (in soil, water, air, flora, fauna) resulting from proposed activities or induced by any socioeconomic changes;
4. Spatial and temporal scale of influence, identifying effects on connectivity between ecosystems, and potential cumulative effects
5. Available information on baseline conditions and any anticipated trends in biodiversity in the absence of the proposal
6. Likely biodiversity impacts associated with the proposal in terms of composition, structure and function
7. Biodiversity services and values identified in consultation with stakeholders and anticipated changes in these (highlight any irreversible impacts)
8. Possible measures to avoid, minimize, or compensate for significant biodiversity damage or loss, making reference to any legal requirements
9. Information required to support decision making and summary of important gaps.
10. Proposed IA methodology and timescale

3. Impact study and preparation of EIA Report

Address biodiversity at al appropriate levels and allow for enough survey time to take seasonal features into account. Focus on processes and services, which are critical to

human well-being and the integrity of ecosystems. Explain the main risks and opportunities for biodiversity. Questions to ask include:

At the gene level,
To what extent will the proposal have significant effects on:

- Genetic diversity of species, particularly rare and declining species and those with identified as priorities in NBSAPs and/or sub-national biodiversity plans?
- Opportunities for species populations to interact, e.g., by increasing habitat fragmentation and isolation?
- Risk of extinction?
- Persistence of locally-adapted populations?

At the species level,

To what extent will the proposal:

- Alter the species-richness or species-composition of habitats in the study area?
- Alter the species-composition of communities?
- Cause some species to be lost from the area?
- Affect species identified as priorities in NBSAPs and/or sub-national biodiversity plans?
- Increase the risk of invasion by alien species?

At the ecosystem level,

To what extent will the proposal:

- Change the amount, quality or spatial organization of habitat?
- Affect plans to enhance habitat availability or quality?
- Damage ecosystem processes and services, particularly those on which local communities rely?

Finally:

- If habitats will be lost or altered, is alternative habitat available to support associated species populations?
- Are there opportunities to consolidate or connect habitats?

Take an ecosystem approach and involve relevant stakeholders (including local communities). Consider the full range of factors affecting biodiversity. These include direct drivers of change associated with a proposal (e.g., land conversion and vegetation removal leading to loss of habitat—a key driver of biodiversity loss, emissions, disturbance, introduction of alien and genetically modified species, etc.); and indirect drivers of change which are harder to quantify, including demographic, economic, socio-political, cultural and technological processes or interventions.

Evaluate impacts of alternatives with reference to the baseline situation. Compare against thresholds and objectives for biodiversity. Use NBSAPs, sub-national biodiversity plans and other conservation reports for information and objectives. Take into account cumulative threats and impacts resulting either from repeated impacts of projects of the same or different nature over space and time, and/or from proposed plans, programs or policies.

Biodiversity is influenced by cultural, social, economic and biophysical factors. Cooperation between different specialists in the IA team is thus essential, as is the integration of findings which have bearing on biodiversity. Provide insight into cause-effect chains. If possible, quantify the changes in quality and amount of biodiversity. Explain the expected consequences of any biodiversity losses associated with the proposal, including the costs of replacing biodiversity services if they will be damaged by a proposal.

How do these relate to relevant biodiversity priorities and objectives or any legal obligations? Indicate the legal issues that create the boundary conditions for decision-making.

4. Mitigation.

Remedial action can take several forms, i.e., avoidance (or prevention), mitigation (including restoration and rehabilitation of sites), and compensation. Apply the "positive planning approach," where avoidance has priority and compensation is used as a last resort measure.

Avoid “excuse”-type compensation. Look for opportunities to positively enhance biodiversity. Acknowledge that compensation will not always be possible; there will still be cases where it is appropriate to say “no” to development proposals on grounds of irreversible damage to biodiversity.

5. Review for decision-making.

Peer review of environmental reports with regard to biodiversity should be undertaken by a specialist with appropriate expertise, where biodiversity impacts are significant.

Depending on the level of confidentiality of public decision-making, consideration should be given to the involvement of affected groups and civil society.

6. Decision-making.

Avoid pitting conservation goals against development goals; balance conservation with sustainable use for economically viable, and socially and ecologically sustainable solutions. For important biodiversity issues, apply the precautionary principle where information is insufficient and the no net loss principle in relation to irreversible losses associated with the proposal.

7. Management, monitoring, evaluation and auditing.

It is important to recognize that all prediction of biodiversity response to perturbation is uncertain, especially over long time frames. Management systems and programs, including clear management targets (or Limits of Acceptable Change (LC)) and appropriate monitoring, should be set in place to ensure that mitigation is effectively implemented, unforeseen negative effects are detected and addressed, and any negative trends are detected. Provision is made for regular auditing of impacts on biodiversity. Provision should be made for emergency response measures and/or contingency plans where upset or accident conditions could threaten biodiversity.

8.5 Environmental Audits

An environmental audit is a systematic, documented, periodic and objective evaluation of activities and processes of an on-going project carried out to determine how gar these activities and programs conform with the approved environmental management plan of that specific project and sound environmental management practices.

A comprehensive EA promotes safe and healthy environment at all stages of a project operations as well as decommissioning. The goal of EA is to establish if proponents of a project are complying with the environmental requirements and enforcing legislation.

An EA seeks to appraise all project activities, including production of goods and services, taking into consideration environmental regulatory frameworks, environmental standards, environmental health and safety measures and sustainable use of natural resources.

In Kenya, EA is mandatory for all on-going projects commenced and or have been in operation prior to the coming into force of the Environmental (Impact Assessment and Audit) Regulations, 2003 as well as new projects undertaken after completion of an EIA study report and a license issued.

8.6 Environmental Impact Assessment: Case Studies

Case One: Thai National Fertilizer Corporation Project.

Source: Modak P and Asit. K. B., 1999

Project background

This was an ammonia and phosphate fertilizer manufacturing complex. It would produce nitrogen-phosphorus (NP) granules, nitrogen-phosphorus-potassiun (NPK) granules, urea granules with small amounts of ammonia phosphoric acid, mono-ammonium phosphate (MAP) and di-ammonium phosphate (DAP). The project complex would occupy an area of approximately 1.6 km^2 on the Gulf of Thailand and would require an additional area of more than 1km^2 to the east of the main plant location, for phosphogypsum storage. The complex would employ a work force of about 3,000 workers during the construction stage and approximately 700 during operation. Most of the complex output would be

shipped to domestic dealers for further distribution. Solid raw materials required by the complex would be brought to the complex by ship. Products would be distributed by barge and by truck, or rail. Wate would be supplied from Dok Krai reservoir. Power would be available from the Provincial Electricity Authority.

Environmental Effects from the Project:

a) Adverse effects on physical resources

- Potential impacts to surface water quality during construction could arise from dust emissions (from vehicles and disturbance of soil cover), high suspended solids (from storm water run-off) and sanitary waster (from construction personnel).
- Discharge of wastewater from the fertilizer complex, under all-flow conditions, would increase the concentration of sea water contaminants in the area near the discharge point. Sea water within a short distance from the discharge point will be hazardous to marine life.
- The topography would be affected temporarily during the construction phase
- Construction and operation activities would generate localized sources of high noise level.

b) Adverse effects on ecological resources

- Impacts on fresh water ecology in the two nearby streams due to increase in total dissolved solids and turbidity of the water from erosion and run off. Sedimentation from erosion and surface run of will also affect living conditions such as respiratory processes and feeding habits of benthic organisms and some fish.

c) Adverse effects on human use values

- The project complex would change the existing land use pattern in the project area from agricultural areas, villages etc to the fertilizer plant and gymsum stack.

Houses and the crops in the plant site would be removed and the land owners will have to find a new place to settle.

- Tow unpaved roads located in the plant site area and used b local commuters would be eliminated by plant construction. Traffic volumes would generally increase near the project area.

Some suggested measures for offsetting adverse effects

- Shifting the complex in an area where many of the existing environmental resources/values are not of prime importance
- Procedures in the construction period to involve preferential use of local labour to minimize the number of workers who migrate to the area; use of dust suppressant spraying to minimize fugitive dust during construction activities; use of temporary dams to control erosion and promote settling of particles from storm-water run-off to prevent damage to surface waters and aquatic ecosystems; provision of sanitary waste facilities for workers and cooperation with local and provincial public health authorities.
- Plant operational procedures that utilize evaporation from the gypsum cooling pond to minimize wastewater discharge.
- Application of noise criteria that will meet the standards for occupational noise within the plant boundary.
- Commitment by the project to conduct environmental monitoring activities during construction and operation of the complex so as to verify the protection of the health and welfare of workers, nearby population and the surrounding environment.

Case two: EIA of Common Salt Production on Mangrove Wetlands.

Mangrove wetlands are complex ecosystems comprising mangrove, other plants, animals, micro-organisms, water and soils. They occur mainly in tropical climates and in some warm temperate regions. As mangrove ecosystems are influenced by both fresh and sea water, the main hydrographic factors areas river and water input and tides.

Mangrove wetlands provide habitat for fish and other animals. They protect the coast from erosion, reduce siltation in corals, provide recreational, educational and scientific research grounds, support biodiversity, control pollution, provide man with food, fuel and medicinal products as well building materials. In order for these uses to be realized, many complex physical, chemical and biological process take place in the wetlands.

Common salt is one of the most widespread minerals in the coast of East Africa. In Kenya for instance, extensive salt works cover over 5,000 hectares of the Gongeni-Fundisa and Kurawa areas. Mangrove wetlands cover about 4.2% of the land in Gongeni-Fundisa and Kurawa areas.

Some reported environmental impacts of common salt production in Kenya:

- Displacement of local inhabitants and associate problems – inadequate compensation, high cost of settling in new land; limited access to mangrove wetland resources and other marine resources.
- Coastal erosion and ecosystems disturbance due to clearance of mangroves – mainly due to vegetation clearance and hence exposure of the coastline to eroding forces of the sea.
- Discharge of final water (after extraction of common salt) into ecosystems without first reducing their high salinity – this has been observed to result in drying up of some vegetation living only those tolerant to such hyper-saline water;
- Abandonment of projects leaving behind an altered landscape

8.7 Discussion questions

a) What role can EIA play in the management of natural resources in Kenya?

b) What obstacles are hindering realization of this role?

c) What strategies can be formulated to promote use of EIA in the management of natural resources in Kenya?

9. Cost-Benefit Analysis (CBA)

Cost-benefit analysis (CBA) is applied by economists to test the economic viability of an existing or proposed activity, and/or compare two or more ways of carrying out the activity. In a natural resource management context cost-benefit analysis involves subtracting the discounted monetary cost of a given project/activity from the discounted monetary value of all the benefits generated by the same development to obtain a net benefit or cost streams for the proposed activity.

CBA can either be carried out *ex ante* (before the actual implementation of a project) or *ex post* (after implementation of the project). CBA always involves with and without project comparisons to calculate the net incremental benefits that accrue from a given project. The final decision is based on one of the three possible criteria of maximum net present value (NPV), benefit-cost ratio or positive net present value.

Carrying out a cost-benefit analysis involves the following stages:

9.1 Stages of conducting cost

Defining the project

The first step involves defining the project in terms of the resources being re-allocated, for example, clearing of a given forest to create human settlement and secondly the population that stands to gain or loose from the project over which costs and at which level (local, national or global). This stage is important because a project cannot be appraised unless what is to be appraised is known.

Identifying Project Impacts

Once the project is identified, the next step involves identifying all the impacts that result from its implementation. From the example of settlement given in stage 1 above, this stage would involve listing all resources used e.g. (labor costs, material costs, costs of loss of forest), impacts on agricultural production, employment opportunities e.t.c. Two concepts are important at this stage; *additionality* and *displacement*. Additionality refers

to the net impacts of the project, for example additional agricultural production arising from cultivating the cleared forest. Displacement is often important when applied by development authorities at regional level. A question arises of whether the project will displace output from an already existing project in another region.

Identifying Impacts that are of Economic Relevance

This step involves identification of all impacts including the non-priced impacts (those not traded in the market). The positive impacts are classified as benefits, these impacts either increase the quantity or quality of goods that generate positive effects or reduce the price at which they occur. Negative impacts are counted as costs will include any decrease in the quantity or quality of such goods or increase their prices. The negative effects also include the using-up of resources (inputs of production) in a project (including the opportunity costs). The actual physical amounts of impacts and the time when they occur in the project life are determined at this stage. All transfer payments such as taxes or income transfers are excluded since they are not real impacts but merely redistribution from one group in the economy to another.

Physical Quantification of Relevant Impacts

This stage involves determining the physical amounts of costs and benefit flows for a project, and identifying when in time they will occur. In the forest settlement example, likely future agricultural production, the disrupted ecological services arising from forest clearing will be considered. The likely environmental impacts can be well captured by using an environmental impact assessment (described in more details in the consequent section). It is important to note that at this stage all calculations are carried out with varying levels of uncertainty.

Monetary Valuation of Relevance Effects

The identified physical measures of impact must be valued in common units. The common unit in CBA is money, whether in Kshs, dollars, pounds or any other appropriate currency. Markets generate relative values of all traded goods and services as relative prices. The other tasks of CBA at this stage include; predicting prices for value

flows extending into the future, correcting for market prices where necessary and generating prices where none exist.

Discounting of Costs and Benefits Flows

After expressing all the relevant costs and benefits in monetary terms, then they have to be converted into present value (PV) terms. Why is this important? Because of the time value of money or time preference aspect. Taking a simple example, holding all other things constant (*ceteris paribus*), an individual would differentiate between receiving Kshs 1,000 today and receiving the same amount in one year's time. The more immediate sum might be preferred due to impatience, alternatively the individual might not want to spend money now but he or she could invest it in a bank at an interest say 10% and have Kshs 1,100 at the end of the year. So, this time effect has to be taken into account by discounting all costs and benefit flows by using a discount rate which can be assumed for now to be the interest rate (i). The present value of a cost or benefit (X) received in time t is calculated as following:

$PV\ (X_t) = X_t\ [(1+i)^{-t}]$ or $PV\ (X_t) = X_t\ [1/\ (1+i)^{t}]$

Applying the Net Present Value Test

The main purpose of CBA is to help select projects which are efficient in terms of their use of resources. Therefore, after carrying out a CBA the criterion of Net Present Value (NPV) is used. This criterion simply asks whether the sum of discounted gains exceeds the sum of discounted losses. If the sum of discounted gains exceeds the sum of discounted losses, then the project is said to represent an efficient shift in resource allocation. The NPV of a project is calculated as follows:

$$\mathbf{NPV} = \sum B_t (1+i)^{-t} - \sum C_t (1+i)^{t}$$

The summation run from t =0 (the first year of the project) to t =T (the last year of the project. The criterion for project acceptance is; accept if and only if NPV>0. Given two project with positive NPV the one with a higher NPV should be selected.

There are a number of alternatives to NPV, such as internal rate of return (IRR) and benefit-cost ratio. IRR is a measure frequently applied in financial investment. It is the rate of return if used as the discount rate of the project would yield a NPV of zero. It is interpreted as the rate of return on the resources used up in the project, be compared with the opportunity cost of funds (the prevailing interest rate). However, IRR is criticized as a measure of resources allocation for two main reasons: first many projects can generate multiple IRRs for the same data set hence the analyst does not know which criteria to select as the decision-making criterion. Second IRR is unreliable when comparing performances across many projects in a portfolio because it compares the returns on one project to the opportunity cost of funds. Benefit-cost ratio is another way of presenting NPV. The decision rule is; accept the project if the ratio is above unity.

Conduct sensitivity analysis

As noted in stage 4 above, calculations of physical quantification of impacts are carried out with varying level of uncertainty. Therefore, it becomes necessary to conduct a sensitivity analysis to capture the different likely future scenarios. In all ex ante cases of CBA the analyst must make predictions concerning future physical flows (e.g. agricultural production) and future relative values. None of these predictions can be mde with perfect foresight. Therefore, NPV values must be recalculated when certain key parameters are key parameters are changed. Such parameters include: discount rate, physical quantities and qualities of inputs, shadow prices of these inputs, physical quantities and qualities of outputs, shadow prices of these outputs and project life span.

9.2 Major challenges of conducting CBA

The following main problems arise in applying CBA to environmental issues:

a) Valuation of non-market goods such as wildlife and landscapes. How do we do it and how much reliance should place on estimates generated? Are we acting immorally by placing money value on such things (environmental ethic)?

b) Ecosystem complexity

c) Discounting and discount rate; should society discount? If yes, at what rate? Does discounting jeopardize the rights of future generation?

d) Is CBA a truly objective way of making decision or can institutions capture it for their own ends

e) Uncertainty and irreversibility. How can these important concepts be included in a CBA

9.3 Social or distributive analysis in CBA

The distributive analysis of a conservation project should involve the following questions: who will benefit from the project and by how much? Who will pay for the project and how much will they pay? Project sustainability is heavily impacted by which party in the project's sphere of influence gains or loses. If an influential group is expected to bear the burden of losses, then the successful implementation of the project may be hindered. The risk of a strong political opposition to the project mobilized by the losing party is a contingency that the project implementers should be prepared to tackle.

Another aspect of distributive analysis is concerned with cases in which projects will facilitate or hinder the process of helping society address its basic needs. For example, a road project may not only reduce transportation costs, but also increase the level of security in a village or allow more children to attend school, both of which are viewed positively by society. In such cases, society may want to credit a net social external benefit to the project.

9.4 Examples of Application on CBA in natural resources

Collaborative wildlife management in Kenya

This study by Mburu and Birner (2002) applied CBA to compare interorganizational efficiency of two different collaborative governance structures for wildlife management both at landowner's perspective (financial analysis) as well as at the society level (economic analysis). The study used two collaborative wildlife management sanctuaries; Kimana community wildlife sanctuary (of Amboseli national park) and Golini-Mwaluganje community wildlife service (of Shimba hills national reserve). The results of

financial analysis showed that net present value of show that the net present value for the local management committee arrangement (Kimana BL) is negative while that of the lease arrangement (Kimana AL) is positive. The financial net present value for the local management committee was estimated at $ -207,700 while that of lease arrangement was estimated at $ 45, 600. The marked difference was attributed to the increased benefits from tourism created by the new management. Economic analysis follows a somewhat similar pattern. The Kimana BL, had a benefit-cost ratio of less than unity (0.83) while the Kimana AL had a benefit-cost ratio of 1.52.

Deforestation in Brazil

A study by Andersen (1997), compares the total economic value of standing Amazonian rain forest with net present value of alternative agricultural land uses. It is shown that, at the current level of deforestation, the potential benefits of deforestation are higher than the expected costs. However, as the current level of deforestation increases, the global costs of deforestation will rise and eventually surpass the value of agricultural land. At that point the international community will have to provide incentive to Brazil to conserve the remaining forest. When a discount rate of 6% was applied costs of deforestation was estimated at $ 3,059 per hectare while benefits were estimated at $ 60,255 per hectare. At a lower discount rate of 2 %, a similar pattern was observed; costs of deforestation were estimated at $ 9,230 per hectare while the benefits were estimated at $ 121, 900 per hectare.

10. Other Decision-Making criteria

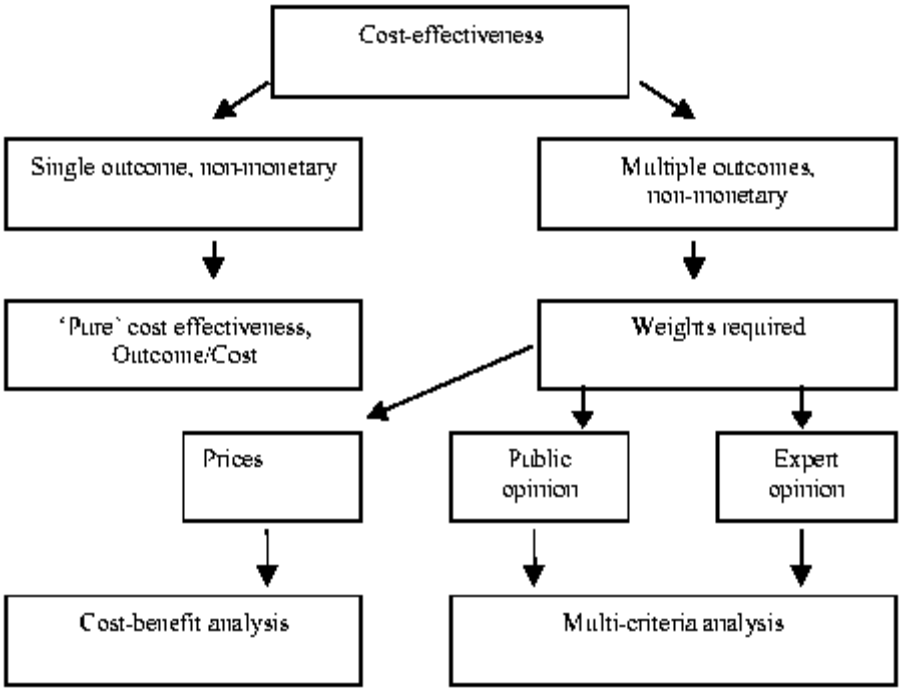
10.1 Cost-Effectiveness Analysis

Cost effectiveness analysis (CEA) is another method for decision-making in environmental valuation situation but it's rarely used. For a given objective, CEA focuses on least costly method. CEA requires data on costs only. Cost-minimization may therefore be seen as a goal, or cost may be viewed as a constraint on securing the biodiversity goals. Figure 9 below gives a classification of decision approaches from the perspective of cost effectiveness.

If two projects are to be compared, it would be assumed that the benefit stream remains the same. It cannot therefore be used for projects producing different kinds of benefits. In Chile, Isaza *et al.,* 2004 applied CEA in analyzing the protection of an endangered species (deer) in Chile.

A variation of CEA is the goals-alternatives matrix. Such a matrix sets out the hypothetical relationships between goals and the means of achieving those goals. An example is shown in Box 21.

Figure 9: A classification of decision approaches from the perspective of cost-effectiveness



A good first and quick step for making most decisions is to adopt cost-effectiveness. But cost-effectiveness will suffice if there is only a single 'outcome' (say biodiversity gain) and the choices relate directly to that outcome. Cost-effectiveness becomes more complex when there are multiple outcomes since the outcomes have to be weighted. If the weights are prices, cost-effectiveness is formally transposed into *cost-benefit analysis*. If the weights are not in price form, cost-effectiveness becomes *multi-criteria analysis*.

Box 21: An example of goals-alternatives matrix

Goals ↓ Alternatives →	**Establish protected area**	**Community involvement**	**Financial incentives, tax harmful activities**	**Weights**
Improve an indicator of biodiversity	+ 5 %	+ 1 %	+ 8 %	3
Employment	- 1 %	+ 2 %	- 1 %	1.5
Other environmental benefits	+ 2 %	0 %	+ 7 %	1
Cost	$1m	$0.4m	$2m	-
Weighted score of benefits	15.5	6.0	29.5	-
'Cost-effectiveness' indicator	15.5	15.0	14.75	-

Box 21…..Continued.

The matrix is to be read as follows.
There are three 'goals' in biodiversity conservation: increasing biodiversity, as measured by some selected indicator of diversity, increasing employment and securing some other set of environmental benefits. These goals are not equally important, so weights are applied to each of them. Taking 'other' environmental benefits as a numeraire, conserving biodiversity is three times as important and hence has a weight of 3, and employment is 1.5 times as important and hence has a weight of 1.5.

There are three different ways of securing the goals: establishing a protected area, adopting a community involvement scheme, or some tax on harmful activity. Each option or 'instrument' is evaluated according to the extent to which it secures the relevant goals. Thus, a protected area is estimated to improve the biodiversity index by 5% but to reduce employment (say in the local area) by 1%. The weighted scores of benefits are then obtained by summing the achievement scores (the percentages) weighted by the importance weights. For example, the protected area option scores (+5x3)-(1x1.5)+(2x1) = 15.5. Finally, consideration is given to cost. The weighted scores can then be divided by cost to secure a cost-effectiveness indicator. This shows that the protected area scores the highest. The matrix reveals that there are multiple goals and that the different approaches to achieving them have different costs. The issue of deciding which of the methods to use (or, additionally, how they might be combined) becomes one of comparing costs and the extent to which the goals are achieved. Taking biodiversity conservation alone, the most effective measure is the tax on harmful activities but it is also the most expensive measure. In terms of cost-effectiveness, the 'best' option is the protected area. Both the tax and the protected area option actually reduce employment. Only the community options involve an increase in employment. Thus, the matrix reveals that, on the basis of the information provided, no alternative is clearly superior to the others. Only the weighted score approach produces a ranking.

10.2 Multi-criteria analysis

This decision approach is preferred by most ecological specialist. The Multi-criteria analysis (MCA) process for ranking options has several variants, but the basic steps in conducting the variants are similar: These are

ii. specify objectives and project alternatives for meeting objectives;

iii. select criteria for assessing or ranking alternatives;

iv. specify the selection system to be used as the basis for making decisions, i.e. the relative priorities or weights to be attached to the criteria selected in (ii);

v. identify global performance of alternatives using some method to combine the weights into a final score for each alternative (Nijkamp *et al.,* 1990).

Why would decision-makers prefer MCA?

i) Environmental changes are sometimes perceived as being too complex and multidimensional to be reduced to single criteria such as economic efficiency.

ii) The concept of economic efficiency itself can seem too abstract for decision-makers. Third, the absence of valuation

iii) The absence of valuation information may necessitate an alternative weighting approach.

10.3 Precautionary approaches

These are decision-making tools or processes that stress the uncertainty of decisions about biodiversity, i.e. the difficulty of knowing what may be being lost. Namely the precautionary principle (PP) and safe minimum standards (SMS) imply that biodiversity has substantial value even if that value is not known in any precise form.

Neither approach produces a notion of the quantitative scale of conservation that is justified, but both invert the usual notion that conservation and loss of biodiversity have equal status, or that 'development' is superior to conservation. Both argue that the presumption of policy should be that biodiversity should be conserved. In the case of the SMS approach, this presumption should be relaxed if and only if the opportunity cost of conservation is, in some sense, very large. The latter requires that, since we know so little about the importance of biodiversity, this uncertainty should dictate a very cautious attitude towards its destruction.

Safe minimum standards

Strictly, SMS refers to the minimum level of preservation that ensures survival. While the full value of a species or an ecosystem function may not itself be measurable, it is known to be positive on the grounds that species or functions previously thought to be 'useless' have proved to be 'useful'. Hence something that has positive value should be sacrificed only if the benefits of that sacrifice are considerable. The burden of proof thus falls on

those who wish to destroy biodiversity to demonstrate that the sacrifice is worthwhile. The SMS principle states that biodiversity should be conserved unless the cost of conservation is, in some sense, 'too high'. Thus, the SMS principle is not quite a 'cost-free' notion since it does acknowledge the trade-off context. The implicit value judgement, however, is that biodiversity has very large values, even if they are not currently known. Along with strong risk aversion, the SMS approach would make risk increasing activities more difficult to accept.

The precautionary principle

The precautionary principle, like the SMS approach, offers a different perspective but not one that deals with the scale of conservation. The exact nature of the principle is unclear, however. It emphasises prevention rather than cure, and it implies a significant degree of *risk aversion*, especially to change that is irreversible. Waiting for better information is also widely regarded in the precautionary principle literature as not a reason for tolerating risks. In these formulations, cost plays no role. Risk should be avoided whatever the cost of doing so. In other formulations, the principle comes closer to a risk-benefit assessment, i.e. risks are reduced if the costs of reducing them are tolerable or acceptable.

The PP itself is defined very differently in different contexts. In its strictest interpretation it suggests that no action should be taken if there is any likelihood at all, however small, that significant biodiversity loss could occur. This likelihood may be independent of the scientific evidence. That is, unless there is certainty that there are no losses, actions should not be taken which, for example, release harmful pollutants into the environment. Perhaps the closest form of the strict PP in practice is the German *Vorsorgeprinzip* – widely translated as the precautionary principle - which is designed to secure *Umweltschutz*, environmental protection.

A second interpretation of the PP requires that there be a presumption in favour of not harming the environment unless the opportunity costs of that action are 'very high', i.e. the safe minimum standards rule identified above.

Box 22*: Umweltschutz*

Umweltschutz is a constitutional obligation in some German states, but not a Federal obligation. *Vorsorge* developed as a justification for state intervention as part of the social democratic movement and as a counter to the prevailing 1970s philosophy that limited environmental protection on cost grounds. *Vorsorge* requires that environmental risks be detected early (the research focus), that action be taken even without proof of damage when irreversibility is feared, that technology should be developed for preventive action, and that the state has the obligation of environmental protection. There appears to be no mention of cost in this interpretation of the *Vorsorgeprinzip*. Construed in this way, the precautionary principle can be thought of as one approach to the 'zero-infinity' problem in which the probability of damage is small or unknown, but the consequences are potentially very large. As such, the precautionary principle can be held to apply to both risk and uncertainty contexts, the former being one where probabilities are known, the latter where they are not known.

10.4 Moral Approaches and Environmental Ethics in Decision Making

Approaches to value based on moral value may help determine preferences, but if applied in an absolute sense tend not to be cost-based. The justification for ignoring cost in this case is that what is 'right' or 'good' cannot depend on where society is willing to allocate resources. The difficulty with this approach is that cost is effectively the command over some other good which may also be the subject of a moral view.

Environmental ethics studies the moral relationship of human beings to, and also the value and moral status of, the environment and its non-human contents. Environmental ethical philosophies can be grouped in different ways. Discussed below are some three main approaches; instrumental approach, the axiological approach and the anthropological approach.

The *instrumental* approach is anthropocentric in the sense that it views an improvement in humankind's relationship with nature as having importance for humankind alone (human-centered). Instrumental approach views nature and the protection of nature as only having instrumental value for humankind. This position has the consequence that if humankind has no instrumental use for nature then nature has no ground for protection.

In contrast, the *axiological* approach argues that nature has intrinsic value and that we should protect nature *because* of its intrinsic value. Hence this approach has to establish what this intrinsic value consists in and where it comes from. The *anthropological* approach is primarily concerned with what being human is or what being human ought to be, and it links this understanding of the nature of humanity to what the relationship between the human self and nature ought to be. This approach argues that humankind will engage in a relationship of respect with nature *if humankind feels that* nature has intrinsic value. This approach does not require the self's feeling or sense of nature's intrinsic value to have the epistemic status of knowledge.

10.5 Discussion questions

1. How should we generate the discount rate for discounting net benefits for different stakeholders in environmental valuation?

2. a) Has CBA been applied in any environmental problems in your institution?
   b) How can we avoid institutions using the results of CBA for their own ends?

3. Monetary values should be attached to natural resources in decision-making: Agree or disagree

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Appendix 1: Evaluating the welfare effects of improved water quality using the choice experiment method (Abou-Ali and Carlsson, 2004)

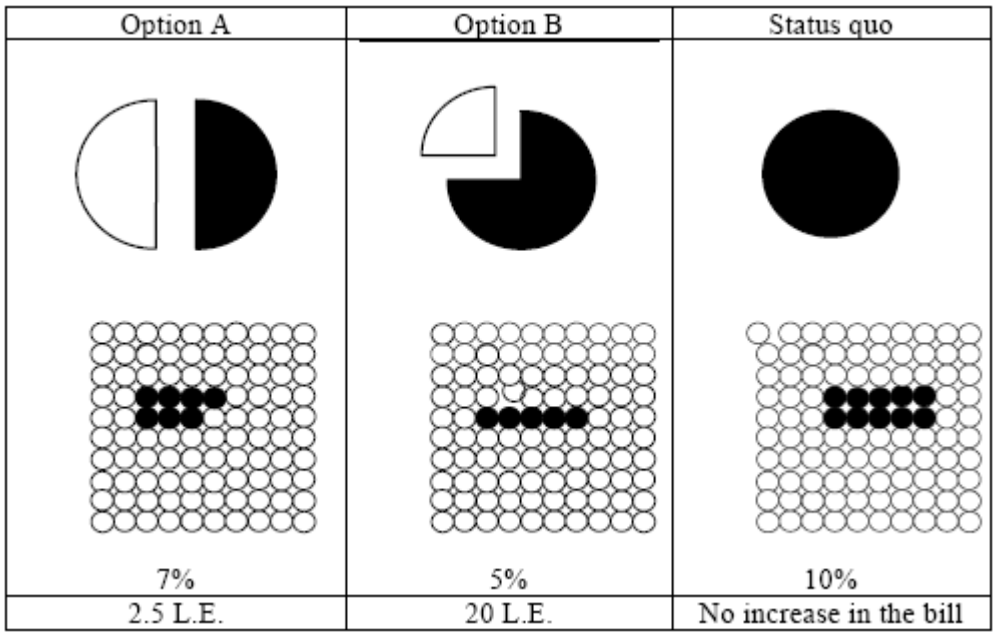
The purpose of this study was to estimate the benefits of water quality improvement programs related to health in metropolitan Cairo, Egypt. This was deemed important in order to compare these benefits to the cost of water management programs and for policy makers to design tariff schemes. The focus of the study is on the magnitude and socio-economic determinants of the willingness to pay (WTP) to improve health through enhanced water quality.

In January of 2002, an in-person survey concerning waterborne illness and the value of clean water was administered to about 750 households in metropolitan Cairo. The questionnaire contained a number of sections, other than the choice experiment, including questions about the socio-economic characteristics of the household and questions about the water quality and health status of the household.

Three attributes were identified: (1) Short run health effect. This was described as the number of ill days caused by waterborne diseases during the year, e.g. diarrhoea. This attribute was related to the current level of the household's health status, so the actual levels varied among the households. (2) Long run health effect. This was related to the risk of contracting a dangerous disease in the future. (3) The cost attribute was formulated as an increase in the water bill due to the program. The attributes and their levels are presented in the following table.

Attribute	Levels
Short-run health effect: number of ill days	Same as today 5% decrease 25% decrease 50% decrease
Long run health effect	10% risk of contracting a disease 7% risk of contracting a disease 5% risk of contracting a disease 2% risk of contracting a disease
Price: increase in water bill	0, 2.5, 10, 20 L.E. or 0, 5, 20, 40 L.E.

An example of one of the choice sets is presented in the following Figure:



Due to the big illiteracy rate among the respondents it was considered necessary to use visual aids. Together with the use of focus groups and pilot testing, the authors chose to describe the short run health effect by means of pie charts where the black circles indicate the number of ill days per year. The offered improvement was illustrated by the white part of the pie chart. The long run risk was represented by the aid of an array of dots, where black dots indicated the risk of contracting a disease.

Results

The econometric analysis showed that households in metropolitan Cairo have a positive WTP to reduce health risks related to water quality. The mean WTP concerning a 50% decrease in the short run health effect due to poor water quality, and a reduction in the probability of contracting waterborne diseases in the long run to 2% was found to be almost 15 Egyptian pounds per every second month. This corresponds to around 2.6% of the mean monthly income. The study also finds significant heterogeneity among the households, both in terms of observed characteristics such as whether they had contracted diarrhea in the last year or not, educational level, whether the household is female headed or not, but also in terms of unobserved characteristics.

Contingent valuation of community plantations in Ethiopia: a look into value elicitation formats and intra-household preference variations (Carlsson et al., 2004)

This study used the contingent valuation (CV) method to examine the determinants of rural households' willingness to pay (WTP) for the establishment of community plantations that would be financed, managed and used by the communities themselves. Introduction of new plantations in Ethiopia is seen as major strategy to satisfy the increasing demand for woody biomass.

The data for this study came from a rural household survey in the Ethiopian highlands conducted in 2000. The survey covered a total of 1520 households from two zones, South Wollo and East Gojam in the Amhara region of Ethiopia. Twelve research sites were identified while households within each site were selected at random.

The scenario was presented to the respondents followed by value elicitation questions. In order not to make the scenario too hypothetical a suitable area of land was identified for each site for the establishment of the proposed community plantations. The head of the household (typically the husband) and another member of the household (usually the spouse) were both asked the willingness to pay questions. This was done to check for gender differences in WTP and to test the 'common preference model' according to which the household maximizes a single utility function subject to a single budget constraint.

Five different starting prices were randomly assigned to respondents. The closed-ended question was followed by an open-ended question (What is your maximum willingness to pay for the proposed plantation?) This design facilitates the analysis of what is called inconsistent answers, whereby the 'Yes' response to the closed-ended question is followed by a willingness to pay amount for the open ended question lower than the amount respondents said yes to in the closed ended question.

The mean WTP (calculated at sample mean) was estimated to 10 Birr for the closed-ended responses. The share of yes responses decreased as the bid increased ranging between 0.92% and 0.34%. Regarding gender effects, there were large differences in WTP between males and females. A female respondent had a mean WTP that was more than three Birr lower than a male respondent. Comparing the results from the closed-ended analysis with the open-ended results, the authors find a familiar pattern: mean WTP from the closed-ended format is much higher than that from the open-ended format; in this case more than 3 times higher. A follow up question, asked to investigate the reasons for this inconsistency, indicated that about 70% of these responses can be attributed to 'yea saying' bias.

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APPENDIX 2: A Financial and economic model for estimating annual use values of forest resources.

A study on the use and value of natural resources on the Rufiji Plain and Delta in Tanzania is summarised here as an example of practical application of valuation[4].

A combination of Participatory Rural Appraisal and regular household questionnaires was used to elicit information on the uses, types and quantities of various resources in each eco-region the study area. The data were then fitted into the following model for analytical purposes. Underlined items are the final values required by the model from the data.

1. **Total production and gross income**:

Annual production was estimated on the basis of the percentage of households involved in the activity and average output per producer household. The annual production was multiplied by the average price per unit of output to yield **annual gross financial value of production.**

2. **Estimate of the cash income**:

Cash income was calculated as the average amount sold multiplied by the **average price.**

3. **Capital input costs**

Capital costs were estimated for each enterprise. This included domestic items such as canoes and tradable items such as nets. Annual costs of capital were calculated on the basis of price and durability of each item, as well as how may other purposes the item is used for. Where one input e.g. a canoe, was used for more than one activity (e.g. fishing and collection of reeds), then the value was divided among the different activities

[4] For details see Turpie, Jane K. (2000), The use and value of natural resources of the Rufiji flood plain and Delta, Tanzania. A consultancy report submitted to the Rufiji environmental Management Project and IUCN- Eastern Africa Office. November.

accordingly. The annual cost of capital assets was estimated using the straight-line method of depreciation, based on the average durability of the item.

4. Variable input costs

These include tradable items such as seed and domestic items such as bundles of firewood. Labour costs were estimated on the basis of average time taken to produce a unit of output.

5. **Calculation of financial and economic returns**

In the financial model, **annual net financial value** is calculated as gross income less fixed and variable costs. Labour time is not included as a cost. Thus net financial value reflects the net private or household benefit of the activity and includes both cash returns and consumption.

In the economic model, annual net **economic value** reflects the ***net value added to national income***. This economic measure is mostly derived from financial data, to which shadow prices or the real scarcity values of the resources are applied to determine social costs and benefits at the national level. **Here labour costs are included.** The net economic value is obtained by taking gross income, less economic costs (all at shadow prices) and this provides a measure of economic efficiency. In this case interest, taxes and subsidies are ignored as transfers, while labour prices are adjusted to take account of unemployment (20 % of minimum is taken as the shadow price of labour in Tanzania, estimated at 2000 TSh per day), a foreign exchange premium (20%) is applied to tradable items to reflect the excess demand for foreign exchange, foreign inflows and outflows are treated as benefits and costs, respectively, and the costs of land and government sectoral expenditures and working capital are excluded.