VALUING THE ENVIRONMENT: CASE STUDIES FROM KENYA

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AWF

AFRICAN WILDLIFE FOUNDATION

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INTRODUCTION - USING ECONOMIC VALUATION FOR THE ENVIRONMENT IN EAST AFRICA

The case studies

This report reproduces some of the papers which were used at FEAS training seminars and workshops to illustrate the real-world uses of environmental economics in an East African context. Although the papers report on real places and issues, they do not necessarily include 'real' figures or reflect the views of any government, non-government or donor agency involved in environment or development in the region. They are examples of applied environmental economics produced for training purposes only, and the figures they cite are merely indicative of the high value that environmental resources can have.

Economic values and environmental conservation

Economics is an important tool for environmental management and conservation. It can be applied to any sector of the environment, including forests, savannahs, wetlands, deserts, coastal zones, protected areas and endangered species. Economic analysis of environmental conditions is also important for activities which take place outside the environmental sector such as agricultural, urban and industrial developments, and for macroeconomic planning and development.

Valuation forms a key part of environmental economics. One of the most important messages we can gain from environmental economics is the importance of recognising the full value of the environment in terms of the support it gives to human economic activities by:

- Providing the raw materials for production and subsistence;
- Supporting ecological services which protect natural and human resources as a sink for wastes and residues, and maintain essential life support functions;
- Giving aesthetic pleasure and holding cultural significance.

If the environment is conserved it will continue to provide these benefits in the future. If it is destroyed or environmental quality declines, such values will be lost. Through valuation, economics can help to quantify the importance of environmental benefits and costs, it can help to incorporate them into decisions, it can also help to conserve the environment.

Economists have developed a wide range of methods for valuing environmental benefits and costs and for incorporating these values into economic decisions. Valuation however has a wider application than simply quantifying the environmental effects of carrying out different activities. The information generated by environmental valuation is especially important in guiding wider economic decisions and activities, in developing instruments and incentives for environmental conservation, financing environmental conservation and reflecting environmental stocks and flows in countries' national incomes.

Developing economic instruments for environmental conservation

Many environmental goods and services are currently free, or are underpriced. The prices of goods which use a lot of environmental resources or contribute to environmental degradation are lower than they should be, because these environmental costs or environmental consumption are not charged for. If people deplete or damage the environment, they do not pay these costs, society at large bears them now and in the future.

Economic instruments such as property rights, market creation, fiscal instruments, financial instruments, liability instruments, charge systems, performance bonds and deposit systems all encourage agents to conserve the environment in the course of their economic activity. By instituting 'full-cost pricing' – making the prices people pay for goods and services reflect the environmental value of resources used or degraded in their production and consumption – economic instruments make sure that producers and consumers take into account the real value of the environment and the real cost of environmental damage when they make decisions. Valuing environmental costs and benefits provides important information for developing and implementing economic instruments which encourage conservation.

Financing environmental conservation

Environmental costs and benefits are unequally distributed. The people who receive the benefits of environmental resources – including those whose activities deplete or degrade the environment as well as those who enjoy the advantages and gains from a well-kept environment, frequently do not pay for this damage or this privilege. Simultaneously people who bear the costs of environmental degradation, or to whom the direct or implicit costs of environmental conservation accrue, may receive few net benefits. As well as being inequitable and presenting disincentives for people to preserve the environment, this raises problems of how to finance environmental conservation.

A range of mechanisms can be employed to compensate people who bear the costs of environmental degradation and conservation, and to generate funds for environmental conservation. Most involve the transfer or redistribution of funds between environmental beneficiaries and environmental cost-bearers. Mechanisms at the global, national and local level can be employed to raise revenues to finance environmental conservation, including economic instruments such as subsidies, taxes, charges and user fees as well as green funds, loans, grants and technology transfer. Valuing environmental costs and benefits provides important information for assessing the magnitude of such transfers and determining mechanisms for financing.

Integrating economic and environmental accounts

National accounts are the most widely used indicators of a country's income, economic performance and growth. National accounts have traditionally ignored natural resource scarcity and environmental degradation when assessing income and production.

Integrating environmental values into national accounts attempts to give a more realistic definition of income and growth which takes account of resource depletion and environmental degradation as economic costs, environmental conservation as an economic benefit and states natural resource stocks as economic capital. 'Green' accounting provides measures of national welfare in environmental terms, and gives information which can be used to design policies to ensure sustainable growth in the future. Valuing environmental goods and services provides important information for greening countries' systems of national accounts and incorporating environmental values into measures of national income.

1. THE ECONOMIC COSTS AND BENEFITS OF INDIGENOUS FORESTS

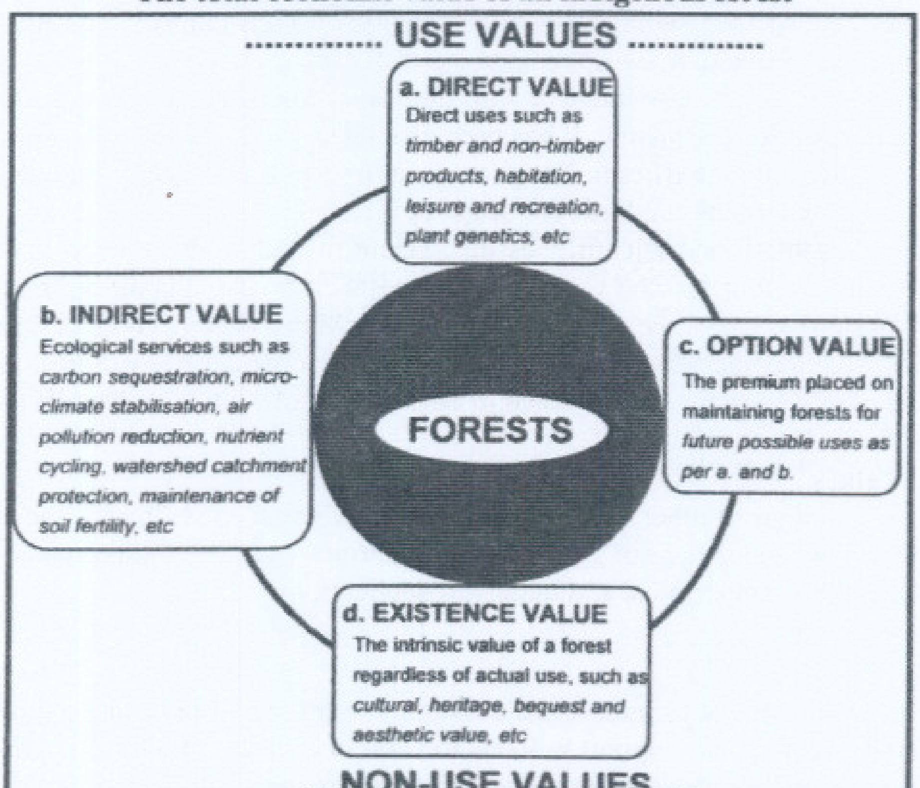
Introduction

Forests have traditionally been seen as valuable resources because they provide timber. The main focus of forest management has been on commercial logging, and a major objective of forest valuation has been to calculate potential timber revenues and profits and to balance these against the physical costs of forestry. As forest conservation has become a priority, economists have begun to rethink the profitability of forests. They now realise that the costs and benefits of forests extend far beyond the profits of commercial logging. Timber is only one component of forest values, and is often not the most important benefit yielded by forests. Although forests are still only seen as profitable if the benefits they yield are in excess of the costs they incur, economic definitions of 'benefits' and 'costs' have expanded.

The benefits of forests

Forests provide a wide range of benefits other than timber. It is only recently that economic methods have been developed to value these benefits, and that the resulting figures have begun to be incorporated into forest management decisions. The *total economic value* of a forest is the sum of its direct values, indirect values and option values (which are all *use* values), plus its existence values (a *non-use* value). These values are summarised in the table below.

The total economic value of an indigenous forest



Direct values

The direct value of an indigenous forest comprises the total value of the direct uses which are made of it by various groups and individuals. These include the extraction of wood and non-wood products as well as non-extractive activities such as recreation, education and habitation.

Timber and non-wood products

A range of timber and non-wood products are extracted from forests. Timber values are sometimes high, if forests contain a large stock of commercially valuable tree species. For many forests, especially open areas of woodland and bush, the commercial timber value of forests is negligible. For example, the value of indigenous timber extracted from Kenya's forests was estimated at KSh 365 million a year in 1994. Nearly all this value accrued from moist forests lying in central and western Kenya.

However, almost all forests yield a range of non-timber forest products. The value of these products is often much higher than timber, and forms a vital component of local peoples' livelihoods. They include fuelwood, bushmeats, wild fruits and vegetables, medicines, honey, grass, resins, barks and fibres. In Kenya, over half a million people, or about one tenth of the country's population, live within 5 km of indigenous forests, and most depend on the use of forest resources in some way for their livelihoods. In 1991 the total value of this use was estimated at more than KSh 2.2 billion, more than six times as much as the value of timber in Kenya's forests.

Human interest in forest species

The plant and animal species found in forests also yield non-consumptive use values. These uses include tourism, recreation, education and scientific research. For example, Kenya's forests contain a wide and diverse range of wild flora and fauna, many of which are threatened or rare, and some endemic. It has been estimated that 40% of larger mammals, 30% of birds and 35% of butterflies in Kenya occur in forest habitats, and over half of Kenya's threatened mammals and birds are found in forest. These species are attractive to human beings for aesthetic and scientific reasons. Scientific and aesthetic value is reflected in the growing number of tourists who visit Kenya's forests each year, and the amount of local earnings and foreign exchange they bring to the country. Many visitors come to Kenya's forests to see the natural species and habitat they contain, for Mount Kenya forest alone the potential value of this tourism was estimated to be in excess of KSh 10 million in 1993.

Other direct values

Forests also yield a range of other direct values. These include the use of indigenous forests for human habitation, and the use of genetic materials from plant and animal species for modern food crops, pharmaceutical and industrial applications.

Biodiversity

Biodiversity is an attribute of forests. It is the *diversity*, or range, of plant and animals. The value of biodiversity lies in its support to forest use and to ecology. Biodiversity ensures a range of choices and alternatives for the direct use of forests, and loss of this diversity may lead to knock-on effects destroying other, dependent species or habitats. By this variety and interdependence, it also supports the provision of ecological functions.

Indirect values

The indirect value of indigenous forests comprises the ecological goods and services they provide. These include regulating the micro-climate of forest-adjacent regions, cycling nutrients and maintaining soil fertility. These services benefit both local and national populations. Forests also provide watershed catchment protection for Kenya's major rivers – such as the Tana, the Athi and the Ewaso Nyiro, as well as a range of smaller streams and watercourses. Millions of people depend on this water for home use, for agriculture and for industry. Forests act as carbon sinks, which affects international environmental quality and may help to avoid global warming. The total ecological value of Kenya's indigenous forests is not yet known but for a single forest, the Mau forest, watershed catchment protection alone was estimated to have a net present economic value of nearly KSh 6 million in 1992.

Option values

Option value is the premium that people put on conserving a forest for future uses which are not carried out now, over and above the direct use values involved. By definition, it is impossible to identify all these future uses, but they might include providing the raw materials for pharmaceutical, industrial and agricultural applications which have not yet been discovered, for eco-tourism development, and for ensuring a permanent range of goods forest products known and used at commercial and subsistence levels.

Existence values

The existence value of a forest relates to its intrinsic worth, regardless of actual use – it is the value people derive from simply knowing that a forest exists, even if they never visit it. This includes the cultural and religious significance of particular forests for certain communities, the aesthetic pleasure people derive from forests and the heritage and bequest importance of forests as a legacy for future generations.

The costs of forests

The costs incurred by indigenous forests relate to the direct costs of management, and to the non-management costs incurred to people by the existence of forests. The latter has two aspects – firstly, the costs arising from the existence of forest species (most significantly, the damage caused to local farms by forest-dwelling animals), and secondly, the opportunity cost of the alternative land-uses foregone by maintaining land under forest cover. Whereas many of the benefits of forest conservation accrue globally and nationally, costs of forests tend to be borne by the people who live near to them and to the individuals or institutions who are responsible for their management.

Management costs

The direct financial costs of indigenous forest management consist of capital expenditure on the buildings, plant and equipment necessary to maintain forests, plus recurrent expenditure such as staffing, maintenance and running costs. In Kenya, these costs have been estimated to have an annual value of KSh 118 million expenditure on natural forests by the government Forest Department, or KSh 64 per hectare of indigenous forest.

Animal damage

The presence of forests incurs costs on local populations through the damage they suffer from forest-dwelling animals who destroy their crops, buildings and other farm structures. These costs can be significant. In Kenya, for example, households living adjacent to Shimba Hills National Reserve, which contains indigenous forest, claimed a total of KSh 2.5 million in 1987/88 as compensation for the damage caused to their crops by wildlife. In the area lying around the Aberdares Forest, an estimated 36% of adjacent households lost crops to wildlife in 1991, and 61% suffered damage to fencing and farm buildings. Households living on the south western side of Mount Kenya Reserve regularly suffer crop damage from wild animals, and lost between 50% and 83% of their harvest in 1993. In all these areas, households were estimated to suffer substantial financial losses as a result of wild animal damage.

Opportunity costs

Keeping land under forest cover precludes the possibility of alternative land uses. The range of possible uses of forest land is extensive. However, it is reasonable to assume that the most likely alternative land-use in Kenya would be smallholder agriculture. Taking variations in agro-ecological zone and different farming systems into account, the value of arable production on land currently occupied by indigenous forest was estimated to be KSh 16 billion a year in 1994.

2. MARKET-BASED METHODS FOR VALUING FOREST BENEFITS

Introduction

The simplest way of assessing the value of a product is to look at how much people pay to buy or sell it – its market price. This is the way in which economists value most commodities. However for the case of most environmental goods and services, including those from forests, there are no direct market prices to act as the basis of valuation. Many non-timber forest products and ecological benefits are not bought and sold, and therefore have no price to act as a basis for valuation. Economists have begun to realise that it is necessary to find new ways of estimating these values.

The aim of valuation is to determine human preferences: how much better or worse off people would consider themselves to be as a result of changes in the supply of a commodity. For forest benefits, this can be assessed by a range of methods including looking at the prices people pay to buy and sell forest products in the market; by looking at the price of goods that are alternatives or substitutes for forest products; by their expenditure on goods and services that are directly linked to forest benefits; and by the way that forest benefits affect the value of other market goods.

We will examine a range of market-based methods which economists commonly use to value forest benefits, summarised in the table below.

Method	Valuation technique	Applicability
Market prices	The price of forest products	Direct forest uses
Substitute prices	The price of alternatives to forest products	Direct forest uses
Contingent valuation	Willingness to pay for forest goods and services if they could be bought and sold	Direct, ecological, option and existence values
Effect on production	The value of production supported by forest goods and services	Ecological values
Replacement cost/ avertive expenditure	The cost of replacing forest benefits, or averting their loss	Ecological values
Travel cost	The time and cost incurred in travelling to a forest	Recreation and leisure values

The market price of forest products

When forest products are bought and sold, we can look at their market price in order to assess their value. This price reflects what people are willing to pay for a forest product, i.e. the value that they place on it. For example, the price of timber per cubic metre, how much a stack of fuelwood costs, the price of a sack of charcoal.

Looking at market prices is a good way of valuing forest products which are widely bought and sold. It is commonly used to value the *direct use values* people obtain from forests.

The market price of substitutes for forest products

Forest products often have no market, they are not directly bought and sold. We cannot value them by looking at their price. However if they have close substitutes which are readily available in markets, we can use the prices of these substitute goods as a proxy for forest values. We can look at the price of what it would cost to buy the next-best alternative if forest products were not available. This represents the amount of money that forest use is worth in terms of the expenditure saved on alternative items. Examples include using the cost of iron sheeting instead of thatching grass, the cost of kerosene instead of fuelwood or charcoal, the cost of sugar instead of honey.

Looking at the price of market alternatives is a good way of valuing forest products which themselves have no market, but have close substitutes which people use when forest products are not available. It is commonly used to value the *direct use values* people obtain from forests.

Hypothetical markets: contingent valuation techniques

Many forest benefits have no market and no close market substitutes. It is particularly difficult to find any realistic market-based price for minor forest products, for the ecological services forests provide and for the option and existence value of forests.

Contingent valuation methods (CVM) have come into the foreground over the last decade and are now one of the most widely-used methods for assessing the value of environmental goods and services which have no market. CVM are not based on observed market behaviour but instead infer people's willingness to pay by eliciting bids for a good or service in a hypothetical market where it would be available for purchase. They ask people such questions as "If charges were introduced, how much would you be willing to pay to carry out medicine collection in the forest?", "If the forest ceased to protect your water catchment, how much compensation would you be willing to accept when the streams and rivers coming from the forest were no longer clean and their flow well-regulated?" or "What would you pay to know that forest biodiversity is being maintained?".

CVM are a good way of valuing forest goods and services which have no market or market substitutes but provide clear and tangible benefits to people. They are commonly used to value the *ecological, option and existence values* people obtain from forests.

Effect on production

When forest benefits themselves have no value but affect market-based activities, we can look at the value of these other activities in order to gauge the value of forest goods and services. For example if a forest provides watershed catchment protection it prevents downstream siltation and flooding which might lead to the seasonal destruction of farmland, to a decline in riverine fish yields and to the siltation of reservoirs. We can calculate the value of farm production losses resulting from flooding, of the loss of fish catches and power arising because of siltation.

Looking at the effect on production of forest benefits is a good way of valuing forest benefits which have no market or substitutes but upon which other market-based outputs depend. It is commonly used to value the *ecological values* people obtain from forests.

Replacement cost/avertive expenditure

It is possible to value forest services by looking at what it would cost to replace them if they were no longer produced by forests, or to avert the resulting effects. For example, the cost of *ex-situ* preservation of wild forest species – a replacement cost for the benefits forests provide in terms of natural habitat; the cost of instituting downstream flood control structures or carrying out reforestation in degraded forest land – the avertive expenditure necessary to mitigate and reverse the effects of lack of forest watershed protection.

Looking at the replacement cost or avertive expenditure attached to forest benefits is a good way of valuing non-market forest benefits which can at least be partially replicated by man-made or technological means. They are commonly used to value the *ecological values* supported by forests.

Travel cost

The value people place on a forest can be inferred from what they spend travelling to it in terms of time, travel and entry fees. By calculating different people's travel costs, a demand function for a forest can be constructed relating visitation rates to travel expenditure, and visitors' consumer surplus measured.

Calculating travel costs is a particularly useful way of assessing the *tourism, recreation or leisure value* of forests which charge no direct entry fee.

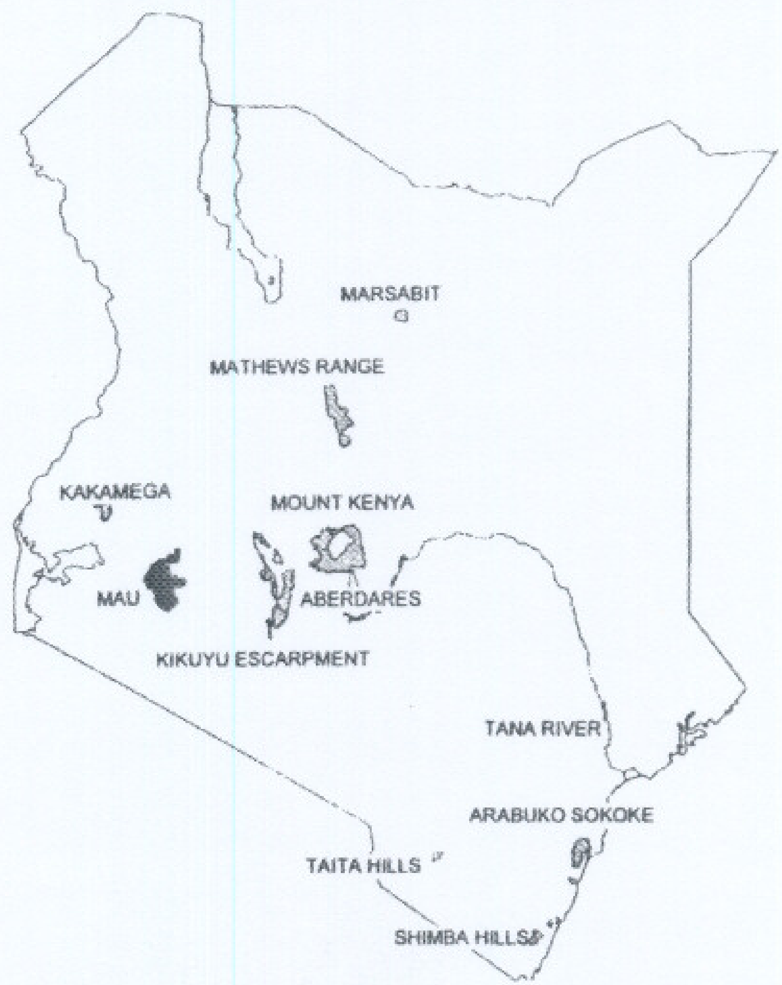
3. THE DIRECT AND INDIRECT USE VALUES OF THE MAU FOREST

Introduction

This chapter presents an example of forest benefits valuation. using market-based methods. It uses a range of methods described in Chapter 2, including market prices, substitute prices, effect on production, replacement cost, avertive expenditure and travel costs.

The Mau Forest

The Mau Forest complex is the largest remaining contiguous block of indigenous forest in Kenya, covering an area of 119 100 ha. The forest plays an important role in catchment protection, supports a wide range of timber and non-timber uses and contains biodiversity of considerable national and international importance. It contains a variety of habitats (afromontane, bamboo and natural glades) which support an unusual mix of West African and Afromontane faunal species. Endangered mammals that continue to survive there include the yellow-backed duiker, the golden cat, the bongo and the giant forest hog, which live in close proximity to significant numbers of elephant, buffalo and leopard.



Location of the Mau Forest in Kenya

The total economic value of the Mau Forest

The total economic value of the Mau Forest can be seen as the sum of direct values, indirect values, option values and existence values, as illustrated below. The major values of the Mau Forest are italicised.

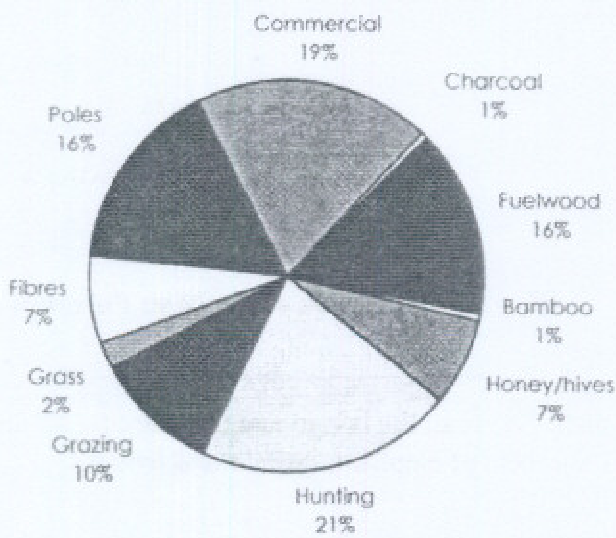
DIRECT VALUE	INDIRECT VALUE	OPTION VALUE	EXISTENCE VALUE
Direct forest uses	Environmental functions	Premium to ensure future use	Intrinsic value
eg.	eg.	eg.	eg.
Timber	Carbon store	*Future direct and indirect uses*	*Cultural*
Non-wood products	Air pollution reduction		*Aesthetic*
Recreation	*Catchment protection*		*Heritage*
Education	Nutrient cycling		*Bequest*
Habitation	Micro-climate regulation		
Biodiversity			
Genetic materials			

The economic valuation concentrated on the major components of the total economic value of the Mau forest. These are direct use of timber and non-timber products, and the service the forest provides in protecting a major watershed.

Direct use values

The major direct values supported by the Mau forest are commercial timber extraction and the use of wood and non-wood forest products by forest-dwelling and forest-adjacent households. We will see below that total direct forest uses may be worth up to KSh 55 million a year at current levels of extraction. Commercial timber and charcoal extraction account for under a fifth of this figure – the vast majority of direct use values accrue to local households who live beside and inside the forest.

The composition of direct use values for the Mau Forest



Forest dwellers

Over 2 000 households live inside the Mau forest. The Okiek Dorobo are traditionally hunter-gatherers subsisting on bushmeat, honey and wild fruits and vegetables. More recently they have begun to grow crops and keep livestock. The forest is still extremely important to them as a source of income and subsistence. All forest-dwelling Okíek rely on the forest for fuelwood, furniture and construction materials, and the majority also carry out other forest uses such as collecting materials for bow and arrow making, medicines, fibres, honey gathering, hunting and grazing.

"Forest's edge" value of direct use for forest dwellers

Activity	% of households	Total value of use (KSh '000/year)
Fuelwood	100	4 415
Bamboo	100	322
Grass	80	336
Honey and hives	70	1 716
Hunting	80	3 145
Grazing	78	3 904
Fibres	30	772
Poles	100	3 611
Charcoal	5	13
Weapons	70	65
Furniture	100	235
Cultivation	100	231
Medicines	80	na
	TOTAL	18 765

Surveys demonstrated the proportion of forest dwellers using different forest products, and indicated the volume of products they used. These were then valued by using the market price of products, or of their close substitutes, and deducting time, labour and other inputs used in their production to obtain a "forest's edge" price for forest products.

Forest-adjacent dwellers

Nearly 16 000 households live within 2 km of the edge of the Mau forest. Previous forest use surveys have found that they are the primary users of the forest – households living further away from the forest have less reliance on it. Forest-adjacent households rely on the Mau for a wide range of items, including fuelwood, charcoal, hunting, wild foods, medicines, poles, fibres and honey.

"Forest's edge" value of direct use for forest-adjacent dwellers

Activity	% of households	Total value of use (KSh '000/year)
Fuelwood	41	4 250
Honey and hives	25	370
Hunting	16	8 725
Grazing	37	2 000
Fibres	75	3 398
Poles	42	5 429
Charcoal	4	300
Wild foods	67	na
Medicines	22	na
	TOTAL	24 472

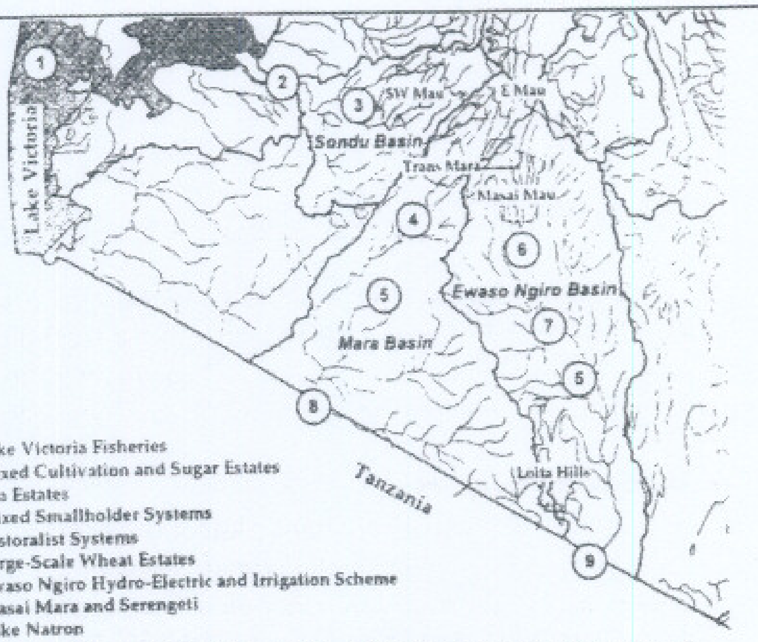
Surveys demonstrated the proportion of forest-adjacent dwellers using different forest products, and indicated the volume of products they use. These were then valued by using the market price of products, or of their close substitutes, and deducting time, labour and other inputs used in their production to obtain a "forest's edge" price for forest products.

Commercial timber and charcoal

The commercial timber industry is well-developed around the Mau forest. There are a number of large sawmills as well as groups of small-scale pitsawyers. Although it is illegal to fell indigenous trees, there is still a large local and national market for timber from indigenous species such as *Fagara macrophylla*, *Olea capensis*, *Podocarpus latifolius* and *Ekerbergia capensis*, and parts of the natural forest have been heavily logged. Surveys found that approximately 1 300 m^3 of indigenous timber and 22 000 sacks of charcoal may be extracted from the Mau forest each year, with a value of KSh 11 million, calculated at their market price less inputs used in production

Indirect values - watershed catchment protection

The main ecological value of the Mau forest lies in its function in providing protection to a major watershed catchment area. It covers the upper catchment of the Sondu, Mara and Ewaso Ngiro Rivers, major river systems rising on the Mau Escarpment and flowing southwards and westwards. These rivers support a range of production systems, including fisheries, agriculture, hydro-electric and irrigation schemes and protected areas and parks.



Mau Forest Catchment - Major River Systems and Downstream Production Systems

Forest degradation or clearance would trigger changes on downstream systems by increasing sediment loads within streams and increasing river flow and seasonal river fluctuations. This would have major impacts on downstream systems, many of which can be valued at replacement cost, avertive expenditure or effect on production as described in the following paragraphs. All these values were calculated over a 100 year period, because ecological services and effects are long-term in nature. These costs foregone effectively represent the current value of the Mau forest in providing watershed catchment protection.

- Siltation of dams in downstream tea estates used to generate electricity for tea drying and factory use. This was valued by looking at the cost of silt traps, and their replacement intervals, and gave an average annual value of KSh 1.1 million.

- Siltation of downstream hydro-electric dams and reduced waterflow to accompanying irrigation schemes. This was valued by looking at the costs and frequency of dam desiltation and at the production losses accruing to irrigated agriculture, and gave an average annual value of KSh 1.7 million for dams and KSh 0.25 million for irrigation.

- Change in waterflow to downstream parks and reserves and change in vegetation and wildlife species balance and diversity. This was valued by looking at possible decreases in tourist numbers to the Maasai Mara and Serengeti Parks which might occur if wildlife composition and densities changed, and valuing this loss in terms of travel costs, and gave an average annual value of KSh 2.8 million.

- Siltation of lake fisheries and decrease in catch. This was valued by looking at the decline in fish yields which might result from siltation, and gave an average annual value of KSh 0.75 million.

4. FOREST VALUATION METHODS FOR NON-MARKET SITUATIONS

Introduction

Forest products provide a range of income-generating possibilities for local people, but their primary value usually lies in domestic and subsistence use within the household. Alternative sources of goods such as fuelwood, polewood, plant medicines, forest foods, fibres for making bags, baskets and ropes, fodder and livestock grazing may be unavailable or unaffordable elsewhere to forest-adjacent communities, and forests may be the only supply of these items.

The subsistence use of forest products by local households is an area which has often been ignored in past attempts to value forest resources, and yet is of great importance to forest management and development decisions. The central role of forest utilisation in the local household economy is commonly underemphasised, despite the fact that local communities are often the primary users of forest resources, and key players in the conservation process.

By failing to fully value subsistence forest use, a large proportion of the value of forests is disregarded, and the vital role of forest products in the household economy is ignored. This underestimates the total economic value of forests. Failing to value subsistence forest use also leads to the danger that forest management systems will unfairly penalise local households by cutting off vital sources of subsistence and livelihoods.

Problems in valuing household forest use

Attempts to assess the value of subsistence use of forest products involve problems concerning just how such a valuation exercise should be carried out. We need some way of taking local perceptions and values into account while still ending up with a figure that can be expressed in cash terms, the medium in which decision-makers, planners and managers calculate costs and benefits.

The value of forest resources has traditionally been calculated by using their market prices as a guide (for example, the market price of fuelwood or building poles), or by taking the price of the next best alternative available to forest goods as a proxy (for example the price of kerosene instead of fuelwood, metal sheets instead of thatch, bought medicines instead of herbal remedies).

Yet finding suitable prices to use as a basis for valuation is often impossible in the case of forest products which are used domestically, for the following reasons:

- There is no market or price for them: they are only consumed within the household and are not bought or sold.
- In a non-cash or subsistence economy, market prices may not even be an appropriate indicator of value.

- There are often no close substitutes available for forest products, either because of certain unique characteristics they may hold, or because the provision of non-forest alternatives are unlikely to ever be a realistic option in forest adjacent areas.

- Forest products may hold an additional value for local people over and above the price they fetch when traded because of the vital part they play in the household socio-economy, for cultural or traditional reasons, or because goods originating in forests are preferred above those coming from other sources.

For these reasons, it is not always possible to simply cost forest products in terms of market prices, and alternative methods of valuation must be found. The following paragraphs describe a way of valuing forest goods which have no realistic market price. The problem of valuation encompasses the joint difficulties of calculating a suitable price for non-traded forest products, of including people's own perceptions of the value of such resources, and of ultimately finding some way of expressing this value in monetary terms. There have been several attempts to do this, and most rely on some form of the *contingent valuation* method.

Use of contingent valuation methodologies

Contingent valuation is an economic procedure which is used when it is impossible to find a market price for a good or service, and has wide applications in the valuation of environmental resources. It involves setting up a hypothetical market for a product, and eliciting bids from users in order to ascertain their willingness to pay for the commodity in this imaginary situation where it is available for purchase. Alternatively, people may be asked what financial compensation they would be willing to accept for the loss of a non-marketed good or service. Such methods have primarily been developed and applied in the West, and have rarely been employed in the case of developing or non-cash economies.

Thus, although contingent valuation provides a useful framework for valuing the use of forest products, it must be modified in order to be appropriate to the case of rural households in developing countries. Whereas most contingent valuation relies on asking people to state the amount of cash they would be willing to pay for a good or service, the use of monetary bids is not relevant when looking at the subsistence use of forest products in a non-cash economy, where cash sums do not directly enter forest use. To date there have been few applications of the contingent valuation methodology to household use of environmental resources in developing countries.

Valuing household use of forest products

Much domestic forest utilisation by local households takes place outside the licensing system, and is therefore perceived to be illegal. Consequently it is often difficult to obtain direct information about forest use from households. People are much more willing to elaborate on their use of the forest, and to become involved in discussions about forest activities, when questions are not posed directly. Therefore a methodology involving the use of 'games' has been developed in order to elicit information about forest utilisation and perceptions of the values provided to the household from forest products. This methodology carried out as follows:

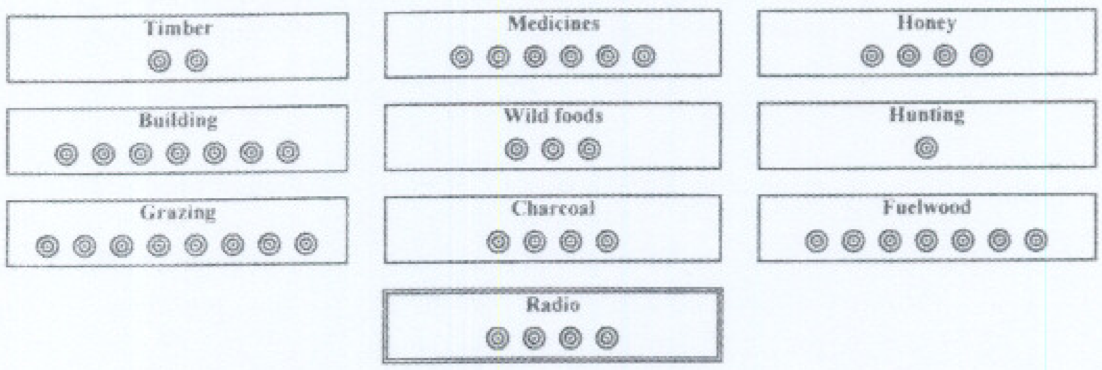
- In order to get an idea of the relative importance of different forest activities, a ranking exercise is performed, using pictorial cards representing the major forest products households use. Respondents are given these cards and asked to put them in order in terms of their importance to the household.

- After ascertaining the importance of different forest products to the household, their value must also be found. If cash sums are not used as a measure of value, it is necessary to find an alternative indicator of worth. This is done by selecting locally important wealth items which can easily be converted into monetary values, which are widely owned by households, and of which respondents have a clear idea of the market price.

- To evaluate the overall worth of different forest products to the household, counters are allocated as 'points' or 'value indicators', and distributed by the respondent between the pictorial cards representing forest products, and additional cards representing the chosen wealth items. This gives an idea of the value of use of different forest products relative to the perceived value of locally important wealth items. Respondents are asked to state the purchase price for the wealth items, which provides the means for forest products to be translated into wealth item equivalents, and ultimately into cash amounts which can be discounted to give an average annual household use value at today's prices.

AN EXAMPLE OF FOREST VALUE CALCULATIONS

- Chosen wealth item: radio
- Value of radio: KSh 10 000
- Lifespan of radio: 10 years
- Discount rate: 10%



Picture card	Points Allocated	Points in radio equivalents	Value (KSh)	Annual Value (KSh)*
Timber	2	2/4 = 0.5	0.5X10 000 = 5000	877
Medicines	6	6/4 = 1.5	1.5X10 000 = 15000	2 630
Honey	4	4/4 = 1	1X10 000 = 10000	1 753
Building	7	7/4 = 1.75	1.75X10 000 = 17500	3 068
Wild foods	3	3/4 = 0.75	0.75X10 000 = 7500	1 315
Hunting	1	2/4 = 0.25	0.25X10 000 = 2500	438
Grazing	8	8/4 = 2	2X10 000 = 20000	3 506
Charcoal	4	24/4 = 1	1X10 000 = 10000	1 753
Fuelwood	7	7/4 = 1.75	1.75X10 000 = 17500	3 068
Radio	4	-	10 000	

* From table below

Using the formula $\frac{1}{T}\sum_{t=1}^{t=T}\frac{V}{T}(1+r^{(T-t)})$, where T is the total lifetime of the wealth item, V the value of the forest activity, r the discount rate and t the year:

	$\frac{V}{T}(1+r^{(T-t)})$										$\frac{1}{T}\sum_{t=1}^{t=T}\frac{V}{T}(1+r^{(T-t)})$
	Year 9	Year 8	Year 7	Year 6	Year 5	Year 4	Year 3	Year 2	Year 1	Year 0	Average annual value
Timber	550	605	666	732	805	886	974	1 072	1 179	1 297	877
Medicines	1 650	1 815	1 997	2 196	2 416	2 657	2 923	3 215	3 537	3 891	2 630
Honey	1 100	1 210	1 331	1 464	1 611	1 772	1 949	2 144	2 358	2 594	1 753
Building	1 925	2 118	2 329	2 562	2 818	3 100	3 410	3 751	4 126	4 539	3 068
Wild foods	825	908	998	1 098	1 208	1 329	1 462	1 608	1 768	1 945	1 315
Hunting	275	303	333	366	403	443	487	536	589	648	438
Grazing	2 200	2 420	2 662	2 928	3 221	3 543	3 897	4 287	4 716	5 187	3 506
Charcoal	1 100	1 210	1 331	1 464	1 611	1 772	1 949	2 144	2 358	2 594	1 753
Fuelwood	1 925	2 118	2 329	2 562	2 818	3 100	3 410	3 751	4 126	4 539	3 068
TOTAL											18 408

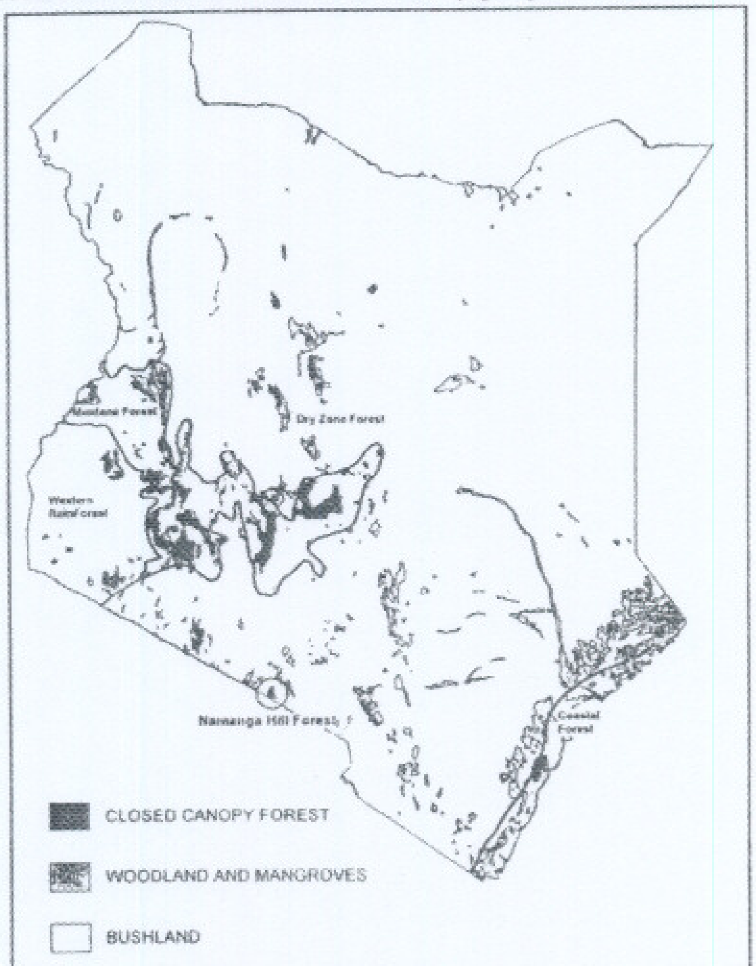
5. VALUING SUBSISTENCE USE OF OLDONYO OROK FOREST

Introduction

This chapter presents an example of forest benefits valuation in a situation where it was difficult to apply market-based methods. It describes an environmental economic analysis carried out to assess the worth of a forest in subsistence terms for nearby people which used the methods outlined in Chapter 4. The aim of the analysis was to provide a justification for conserving the forest, and to highlight ways in which local communities could be involved in forest conservation.

Oldonyo Orok forest and the surrounding area

Oldonyo Orok forest covers an area of 11 783 ha and lies on the slopes of Oldonyo Orok (*'the black mountain'*), a hill rising to 2 548 m which straddles the central Kenya-Tanzania border. At lower levels, *Acacia* woodland merges into the dry bush and scrub of the forest-adjacent area, and it is only on the higher parts of the hill that thicker forest and larger tree species are found. The upper forest is dominated by *Drypetes gerrardii* and *Diospyros abyssinica*, with *Calodendrum spp.*, *Croton megalocarpus*, *Olea capensis*, *Cassipourea spp.* and *Nuxia congesta*.



The Location of Oldonyo Orok Forest in Kenya

The forest lies in the semi-arid rangelands of southern Kenya, where population density is low at an average of 10 persons/km^2. Although only about 500 people regularly depend on the forest for their daily needs, over 1 000 households rely on the forest as a source of dry-season grazing, and many more enter the area in times of severe drought. Virtually all of the rural forest-adjacent population are members of the *Ilmatapato* section of the Maasai, a Nilotic pastoralist people who live in the Rift Valley area of southern Kenya and northern Tanzania. The area around the forest is mainly occupied by three Group Ranches – areas where a group of people have a joint freehold title to land but maintain individual livestock ownership – Meto, Mailua and Oldonyo Orok.

Pastoralism forms the basis of livelihoods in the Oldonyo Orok region. There is little or no settled agriculture. Few households have non-livestock income sources, and although labour outmigration is increasing among the male youth, only a small proportion of forest-adjacent households currently contain members engaged in employment. Forest use is carried out almost entirely for subsistence purposes; to date there has been virtually no commercial exploitation of the forest, although in the last few years small quantities of charcoal and polewood have started to be extracted for sale in the area near to Namanga town.

With the exception of Namanga Town and nearby settlements and trading centres, the forest-adjacent area is primarily a subsistence economy, where cash exchange and trade are poorly-developed and the monetary economy plays little role in local production and consumption systems. Although small amounts of charcoal and polewood originating from the forest are sold in Namanga Town, the rural population make no use of these goods and do not participate in their extraction. None of the products obtained from the forest by adjacent households have a local market or price, and there are no close market substitutes for forest resources available in the forest-adjacent area.

Thus the overriding difficulty in valuing domestic forest use in Oldonyo Orok forest is the absence of any prices which can be applied to forest products because they are used for subsistence purposes only and are never bought or sold. Oldonyo Orok is an area where markets are undeveloped and cash prices are not a useful frame of reference for most households, and it is therefore necessary to use valuation methods which do not depend on a market paradigm.

The value of forest use

Participatory environmental valuation methods were used in order to value subsistence forest use among the Maasai living around Oldonyo Orok. The best local indicator of value was considered by the local population to be a young castrated bullock. This was a good numeraire to use for valuation. Almost all households own cattle, which are seen as a basic indicator of wealth as well as being readily convertible to cash income. When households need cash, this is the type of stock they most commonly sell, and local market prices are well known.

There is no licensing system in Oldonyo Orok and so there is technically no legitimate use of the forest. Despite this, the forest plays a central role in local subsistence by providing a range of products used for fuel, shelter, foods and medicines to nearby households. However, the major significance of forest use for the adjacent population lies in its importance as the only local source of dry-season refuge for livestock in an arid and climatically uncertain area.

Forest values for a household in Oldonyo Orok

Mzee Ole Kapatto lives on Meto Group Ranch, and he thinks that his permanent *manyatta* is probably right on the edge of Oldonyo Orok forest. Because there is no physical demarcation of the forest boundary, nobody is quite sure where the forest reserve starts. He lives with his three wives, and his married sons and their children. None of his grandchildren attend school because the schools are expensive and far away, and their labour is needed within the household. The family manage about 100 livestock, of which three quarters are cattle and the remainder goats. About a tenth of the herd belong to Mzee Ole Kapatto's brother, who lives on the other side of the Tanzania border.

For the last three months, Mzee Ole Kapatto's younger son and grandsons have been in the forest grazing the mature cattle, leaving most of the smallstock, young animals and milk cows in the permanent *manyatta*. They have remained in the forest for the entire period without coming down, and will return once the 'grass rains' start. While grazing the herders are reliant on the forest to provide all their pasture, shelter, fuel and medicines, because they take very little with them. There are not many game animals in the forest, but small birds and mammals provide a welcome supplement to their diet.

Although the rains were due last month, the area is still dry, and Mzee Ole Kapatto fears that his animals are getting very thin and may soon die. There are no permanent rivers in the area and the nearest water source, a stream about 2 km from the *manyatta*, is beginning to dry up. In case the rains fail, as they did last year, he has been discussing with neighbouring *manyattas* the possibility of moving the whole family into the forest so as to be near pasture and water. This would be an emergency solution, because of the distance and trouble involved, and because in the past the Forest Department has evicted whole families who have gone to stay in the forest.

It is the responsibility of Mzee Ole Kapatto's wives to feed, cook and provide shelter for the family. His primary responsibility is to maintain his livestock. His wives cook with fuelwood, and use small saplings to build the family's houses. These are obtained both from the forest reserve and from the surrounding bush. However it is getting more difficult to find trees suitable for construction purposes, and every year they are going further up the hill to look for saplings. For less serious human and livestock illnesses, the family uses plant-based remedies. Most of these can be obtained from the surrounding bush, but there are a few rare species which need to be fetched from high in the forest. When animals or humans are seriously ill, the family prefers to seek outside help from local specialists, who use a combination of bought drugs and herbal medicines.

Mzee Ole Kapatto chose a cow as the numeraire for valuation because he said that wealth is seen in terms of cattle in the area. It was important to define in local terms exactly which type of cow was used as an indicator, because households differentiate minutely between different species, ages and types of cattle. Although he rarely sells cattle, Mzee Ole Kapatto knows exactly what their price would be in regional markets.

1. Grazing 12 points KSh 8 000 total KSh 1 402 per year	**2. Water** 12 points KSh 8 000 total KSh 1 402 per year	**3. Construction** 5 points KSh 3 333 total KSh 584 per year
4. Fuelwood 5 points KSh 3 333 total KSh 584 per year	**5. Medicines** 4 points KSh 2 667 total KSh 467 per year	**6. Wild foods** 3 points KSh 2 000 total KSh 351 per year
7. Utility items 2 points KSh 1 333 total KSh 234 per year	**8. Honey** 1 point KSh 667 total KSh 117 per year	**9. Hunting** 1 point KSh 667 total KSh 117 per year

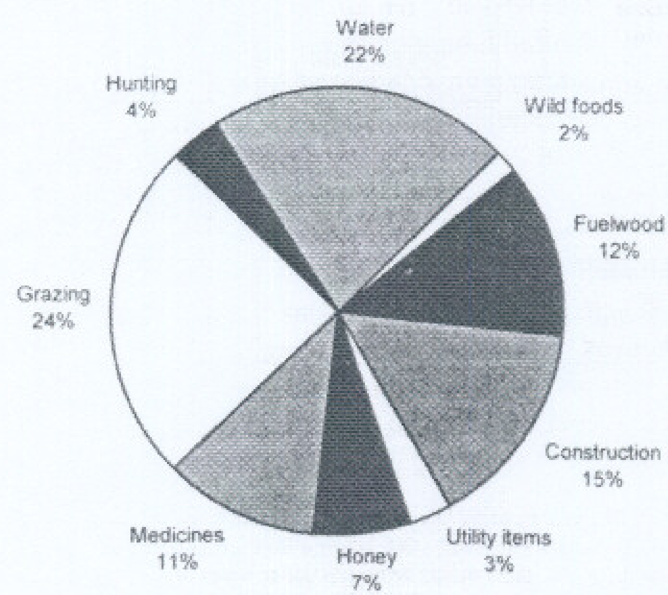
Milk Cow 15 points KSh 10 000 total

Overall, forest use is worth KSh 5 259 a year to Mzee Ole Kapatto. Mzee Ole Kapatto and his wives unambiguously state that grazing and water are the most important forest activities, because they are central to livestock production, which form the basis of their survival. Without the forest, there would be no pasture or water in times of drought, and livestock and people would die. Although fuelwood, construction materials and medicines also support the household, they are of secondary importance to livestock, and can be obtained from the surrounding bush area. Forest honey, wild foods and hunting have little significance for the household or its livestock, and are of low value.

Use of Oldonyo Orok Forest

The vast majority of local households use forest products for their subsistence. Domestic forest use is worth an estimated KSh 5 000 a year for an average forest-adjacent household in Oldonyo Orok, and most values lie close to this average. For more distant households, only forest grazing and water are valued, giving an average worth of approximately KSh 2 000 a year. Forest resources can be divided into three broad categories according to their value and importance. The major components of forest value for nearly all surrounding households are grazing and water, which together account for almost half of forest value. Construction materials, fuelwood and medicines are also important, but tend to be obtained from the forest only by directly adjacent households; and honey, hunting, materials for utility items and wild foods are of less importance even for directly adjacent households.

The weighted value of forest use for Oldonyo Orok Forest



The major value of the forest is as dry-season refuge for a wide area. The forest lies in an arid region where rainfall is uncertain, and although Group Ranches were originally supposed to be self-sufficient in resources all year round, Meto, Mailua and Oldonyo Orok all face seasonal water and pasture deficits, and contain no operating pans, dams or boreholes. The forest represents the only local source of dry-season refuge for surrounding livestock herds and thus forms a central part of local pastoralist production and livelihoods. Nearly all households in Meto, Mailua and Oldonyo Orok place a similar, high value on forest grazing and water collection because, although individual households vary in terms of wealth and other attributes, all depend on a system of livestock production which is based on the availability of pasture and water. As households have common access to Group Ranch resources they all suffer seasonal deficits and drought.

Other forest products are less important. Virtually all house construction and domestic energy sources are wood-based, and plant medicines are a common way of treating human and livestock disease because bought drugs are expensive and in short supply. Construction materials, fuelwood and medicines are important household needs and the forest is valued as a source of these items by directly-adjacent households. More distant households place no particular premium on forest use because trees are plentiful in the forest-adjacent region, and the vegetation of the more accessible lower slopes of the forest replicates that of the adjacent area. It is only on the higher, less accessible slopes of the forest that larger and more unique tree species are found, and these are rarely utilised. Honey, wild foods and hunting are considered to be of little importance to household subsistence, are widely available outside the forest reserve, and forest products are therefore considered to be of minimal value, even by households living directly adjacent to the forest.

Forest conservation and forest values

Justifying conservation: the need to maintain Oldonyo Orok under forest

Until recently there have been thought to be few reasons for actively implementing conservation measures in Oldonyo Orok forest, because it has faced few threats. However a number of on-going changes in the forest-adjacent area are beginning to exert pressure on the forest, and have prompted conservation planning.

Because of widespread dissatisfaction with the institution and organisation of Group Ranches, combined with an increasing desire for individual land ownership, rangeland throughout southern Kenya is currently being sub-divided, and small parcels of land allocated to individual members. The three Group Ranches around Oldonyo Orok forest have been demarcated and it is thought that individual title deeds will soon be issued. In other parts of Maasailand where sub-division has already occurred, and in individually owned plots around Oldonyo Orok, land consolidation has encouraged a trend for pastoralists to become more sedentary and many plots have been sold to settled agriculturalists. This has in turn prompted bush clearance for arable agriculture and more intensive livestock production.

As well as removing non-forest woodland, these processes have generated an increased demand for wood products for construction, fencing and fuel. Such changes have been especially marked on the better developed, wetter and more accessible eastern side of the forest, where commercial markets for fuel and polewood are already beginning to develop.

Rising local wood demands will put increased pressure on Oldonyo Orok forest as agricultural production systems are transformed by changes in land tenure, Namanga Town spreads, and local areas of woodland decline.

The major value of the forest lies in the goods and services it supplies to surrounding populations. Forest degradation would limit the local availability of trees for shelter, fuel, medicines and foods, and changes in land-use might destroy dry-season forest refuge for livestock herds. The annual benefits of forest use have been seen to be as high as KSh 5 000 per directly-adjacent household in terms of domestic use, equal to about a third of the net annual value of subsistence livestock production, and may give a total annual value of KSh 2.4 million to the forest-adjacent population as a whole[1]. Maintaining these values provides an important justification for conserving the forest.

Conservation strategies: managed grazing

Given the importance of forest use for local livelihoods, there are strong grounds to argue that future conservation strategies in Oldonyo Orok forest should be based on continued grazing. The importance of the forest as a source of dry-season refuge is likely to increase as rangelands decline in size and landholdings become more intensively used. Excluding access to forest grazing and water could impose a cost of up to KSh 2 million a year on local households by taking away a vital source of fallback for livestock production. Losing this dry-season refuge will also have wider effects on local pastoralist livelihoods and their capacity to cope with drought.

Sustaining conservation: building on customary resource management systems

Although control over the resources in Oldonyo Orok forest is formally vested in the Forest Department, on-the-ground government management is virtually non-existent and the *de facto* managers of the forest have been its local users. The high value of forest use in local livelihoods has been translated into an effective customary forest management system composed of a number of rules and prohibitions restricting forest use and users. However, although there are well-developed local systems of resource management, the forest is not wholly subject to customary mechanisms of control because of the breakdown of traditional authority structures and changes in resource ownership.

In practice the use of forest resources is governed by a number of systems, rooted in customary practice but mediated by the institution of the Group Ranch Committee and influenced by local perceptions of government forestry policy. This has led to a somewhat ambiguous system of forest management where no one group has clear control over the forest and the resources it contains, and a number of sometimes contradictory rulings and management mechanisms co-exist. No single institution has proper authority over forest use, the Group Ranch Committee and Forest Department because they lack customary legitimacy, and local systems because they have no legal power or formal rights to impose customary mechanisms of control on government forest land.

Effective forest management in Oldonyo Orok is closely linked to the values obtained from the forest. Any system which denies access to these important forest values is unlikely to

[1] Taking into account both directly-adjacent households and occasional grazers.

generate local co-operation and authority. Although traditional resource management systems have undergone a number of changes since the formation of Group Ranches, and are likely to be transformed still further as land is sub-divided, they provide locally authoritative mechanisms for regulating the use of highly valued forest resources. Integrating these practices with Forest Department conservation systems could impose a legitimate and effective means of implementing conservation in Oldonyo Orok.

Implications of forest use values for forest management in Oldonyo Orok

The preceding paragraphs have described the value of Oldonyo Orok forest as a source of support to local livelihoods, especially as dry-season refuge for livestock herds. These values provide the major rationale for conserving the forest, and findings have implications for future forest management planning and practice:

- The high value of Oldonyo Orok forest as a source of dry-season refuge for local pastoralist populations provides an important justification for conservation. Conservation should be based on a strategy of managed grazing in order to support sustainable local livelihoods;

- Production systems are being transformed in the forest-adjacent area and are becoming more diverse. This may increase conflict over scarce resources, including the forest. The opportunity cost of forest land is rising as people start to carry out arable agriculture. Local wood demands will also rise sharply in the future because of expanding urban and commercial markets and due to changing production systems. Although sustainable forest exploitation can meet some of these demands, alternatives sources of wood-based products will also be required, especially for fuel and construction. Priorities may continue to change, and forest management should be responsive to these changes;

- High local forest values have been translated into a series of effective customary forest management mechanisms. The role of local practices and knowledge in future conservation systems should be recognised, and channels of authority clarified. Forest management must be integrated with local constraints and practices, and be flexible to adapt to meet changing circumstances.

6. ENVIRONMENTAL VALUATION IN PROJECT ASSESSMENT

Introduction

Economic assessment has always had a central role in project analysis. Economic considerations are important determinants of how projects are identified, planned and chosen, and influence decisions about whether and how to implement, modify or cancel projects. Economic project analysis has traditionally tended to ignore environmental costs and benefits, because they are so difficult to quantify or to express in monetary terms. This failure to consider environmental impacts has sometimes resulted in projects being implemented which have a negative impact on the environment.

As environmental issues have gained in importance, economic methods have been refined so as to be able to deal with them. We now realise that it is important to incorporate environmental costs and benefits into the economic analysis of all projects, whether or not they are directly concerned with the environment. Today, environmental considerations form a part of most economic project analyses.

Addressing environmental considerations within economic project analysis has a range of aims, including:

- Understanding the economic implications of environmental damage and gain so as to inform policy, decision-making and practice;
- Highlighting the full value of environmental damage as a project cost which must be weighed against project benefits in environmentally damaging projects.
- Highlighting the full value of environmental gains as project benefits which can be weighed against project costs in environmentally beneficial projects;
- Indicating the true economic value of environmental resources which are considered 'free' or have no market. Helping to price environmental goods and services;
- Designing economic and policy instruments to encourage more careful environmental use, to compensate environmental cost-bearers and penalise those who incur environmental costs.

Environmental aspects of project analysis

The project cycle

All projects, whether environmental or non-environmental, go through a number of stages in their lifetime. These stages are known as the project cycle. They include:

- **Identification** - Finding a niche for a project;
- **Planning** - Choosing the best project option;
- **Appraisal** - Assessing whether the project is feasible;
- **Implementation** - Carrying out the project;
- **Monitoring** - Examining how the project is being carried out;
- **Evaluation** - Judging whether the project has been successful;
- **Impact assessment** - Looking at changes resulting from the project.

Environmental analysis in the project cycle

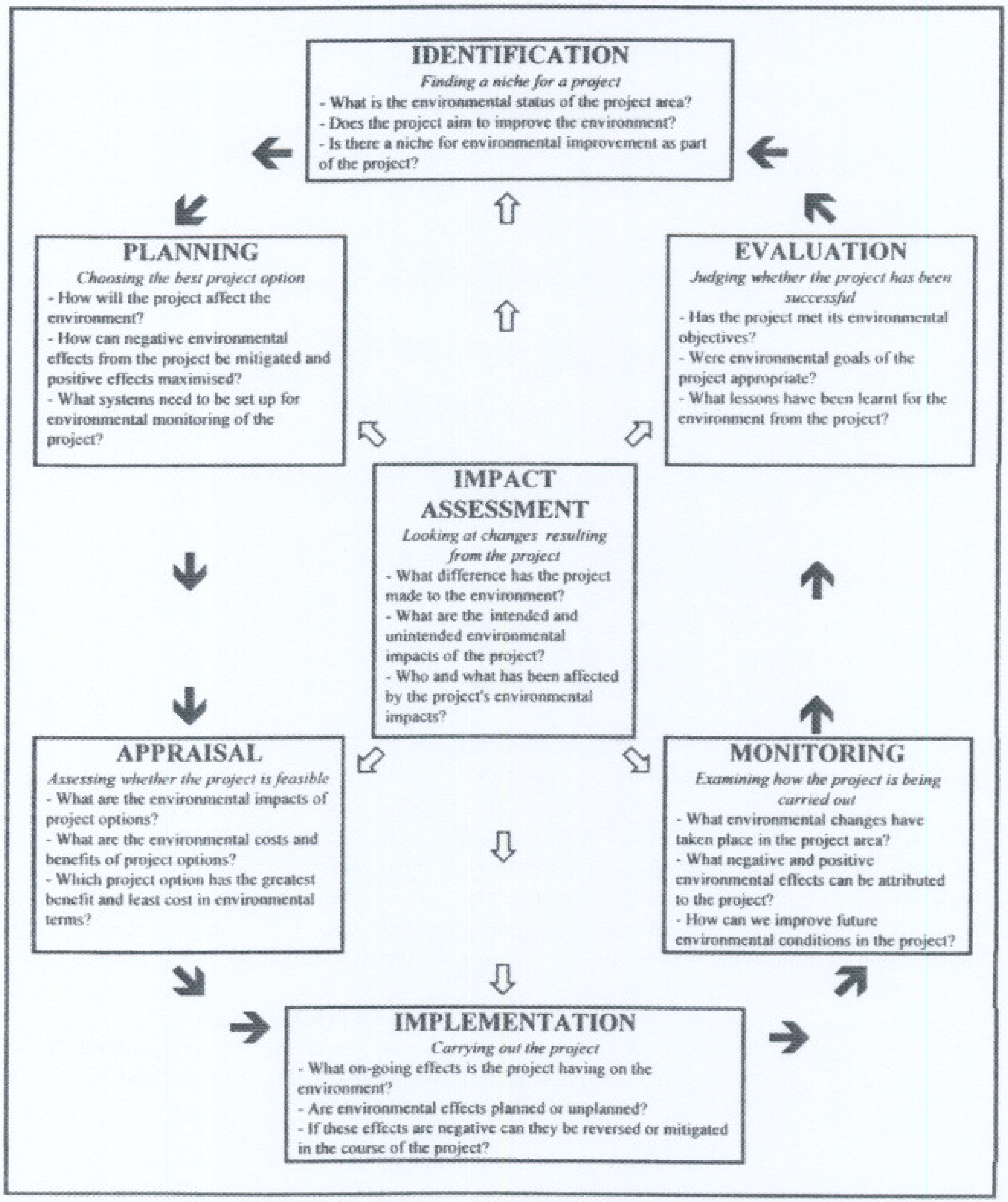
Every stage of a project requires analysis in a number of areas – financial, economic, technical, social, institutional, and so on – including environmental analysis. We need to know how a project affects the environment at every stage, from its identification, through its planning and appraisal, to its actual implementation and review. We need to ask such questions as:

Will projects harm or benefit the environment?
Are we choosing a project alternative which is best in environmental terms?
How do we carry out project activities in such a way as to minimise negative environmental impacts and maximise environmental benefits?
What changes in the environment have taken place as a result of the project?
What environmental lessons can we learn from the project?

Environmental considerations should form an important part of which projects we choose, how we plan and implement them, and how successful they can be considered to have been.

The ultimate aim of environmental aspects of project analysis is to consider the full environmental implications of projects we carry out, and to try and ensure that we make the best and most fully-informed choices in terms of their impact on the environment. Below we will look at how we can use economics as a tool to measure and analyse environmental project impacts.

Environmental Aspects of Project Analysis



Economic assessment of environmental impacts

The components of environmental economic assessment

Environmental economic aspects of project analysis start by identifying the environmental impacts of projects, and go on to attempt to measure and value them in monetary terms. This information is then applied to wider aspects of project decision-making and practice.

Environmental economic assessment includes:

- **Identifying** environmental impacts - what they are and where they occur;
- **Measuring** and **valuing** environmental impacts - what is their magnitude;
- Assessing the **distribution** of environmental impacts - to whom do they accrue;
- **Mitigating** negative environmental impacts and **maximising** positive environmental impacts - how we can ensure the project has the best impact in environmental terms.

Environmental economic assessment as a decision-making tool

The economic assessment of environmental impacts is more than a simple quantification exercise. It is a decision-making tool which yields information about what to do and how to act in projects. It is of little practical use to merely identify and measure environmental costs and benefits as an end in itself. The purpose of calculating environmental values is to provide indicators and inform practical decisions about how to minimise environmental costs and maximise environmental benefits, and to contribute to wider objectives such as equity or development goals.

Limits to environmental economic assessment

It is rarely possible to measure or value all the environmental impacts of a project. Available knowledge and data constrains choice of valuation method and limits the scope of environmental valuation. Some environmental impacts can never be quantified. Environmental valuation is inevitably partial and to a large degree hypothetical. Its results should be treated with extreme caution – they are rarely 'real' figures, but rather indicative estimates which are useful insofar as they can inform project decisions.

Projects are decided upon according to a range of criteria – for political, technical, institutional, development and other reasons. Environmental and economic factors are rarely the only consideration in choosing a project and deciding how it will be implemented.

Economic Assessment of Environmental Impacts

Identifying environmental impacts

- What environmental impacts, will or might, occur?
- What causes these impacts and what are their effects?
- What secondary or knock-on effects arise from environmental impacts?
- When do environmental impacts occur and where, who and what do they affect?

↓

Measuring and valuing environmental impacts

- What is the nature of environmental impacts?
- Do they produce measurable changes in environmental variables?
- Do they produce measurable changes in other outputs or systems?
- What kind of valuation technique does our data permit?
- Which environmental impacts can be valued?
- What is the positive or negative economic value of environmental impacts?
- Is the overall environmental impact positive or negative in economic terms?

↓

Assessing the distribution of environmental impacts

- To whom do environmental impacts accrue?
- How do environmental impacts affect different groups and individuals?
- Who bears negative environmental impacts?
- Who receives positive environmental impacts?
- How do environmental impacts affect different people economically?
- Who gains and who loses from environmental impacts, how much do they gain and lose in economic terms?

↙ ↘

Mitigating negative environmental impacts

- What are the economic costs and benefits of avoiding negative environmental impacts?
- Does the economic cost of negative environmental impacts justify putting mitigative measures into place?
- What are the economic costs and benefits of different mitigative measures?
- Can environmental cost-bearers be compensated for the negative impacts they receive and those causing the costs charged for the damage they cause?

Maximising positive environmental impacts

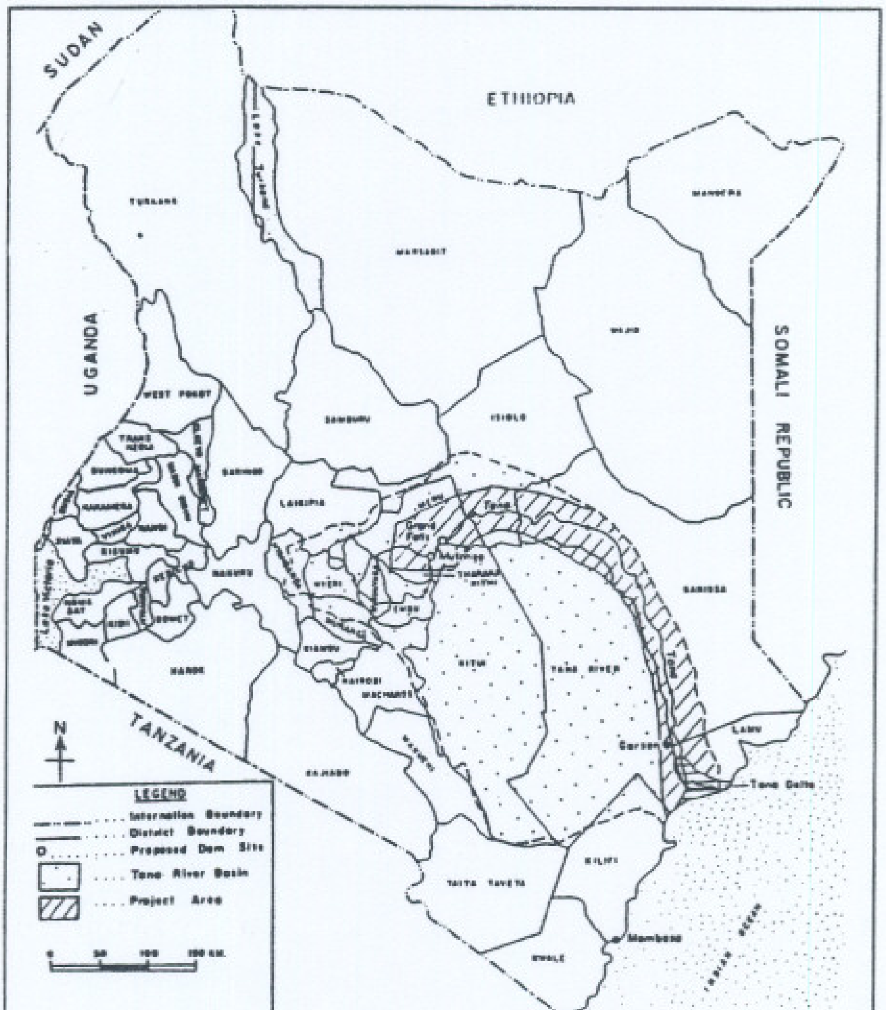
- Can positive environmental impacts be increased?
- What are the economic benefits and costs of generating additional environmental impacts?
- How can the economic value of positive environmental impacts be captured?
- How can the economic value of positive environmental impacts be distributed?
- What additional economic tools and instruments can be used to maximise positive environmental impacts?

7. ENVIRONMENTAL ECONOMIC ASSESSMENT OF THE TANA RIVER HYDRO-ELECTRIC SCHEME

Introduction

This chapter presents an example of the use of economics in environmental project assessment. It describes how economics was used to assess the likely environmental impacts of different design options for a hydro-electric scheme and to find out whether, in economic terms, it would be justifiable to incorporate measures into the design of the dam which would mitigate or avert its negative environmental impacts.

Following the steps described in Chapter 7, this economic assessment first identified the likely environmental impacts of the dam. Having assessed the economic value of these impacts, it analysed how different groups and individuals would feel them. The ultimate aim of the assessment was to see whether the environmental impacts of building the dam were acceptable in economic terms, and to identify ways in which any negative impacts could be mitigated or minimised.



The Tana River and dam sites

The Tana River

The Tana is one of Kenya's major river systems. It stretches for some 1 000 km, rising in the Aberdares and Mount Kenya ranges of central Kenya.

It runs for most of its length through the arid and semi-arid lands of eastern Kenya to enter the Indian Ocean just south of Lamu Island through a fan-shaped Delta which covers approximately 1 300 km^2. The Tana catchment covers an area of more than 100 000 km^2, where nearly 5 million people live.

The Tana river area is a unique ecosystem in East Africa, containing a range of ecological habitats which support a number of rare and endemic plant, bird and animal species.

Tana River hydro-electric schemes

Five hydro-electric dams and reservoirs have been built on the upper reaches of the Tana River since the late 1960s. These contribute nearly three quarters of Kenya's total electricity requirements. A new hydropower project, the Grand Falls Scheme, has been proposed for construction on the Tana River below existing dams. The Grand Falls Scheme would constitute one of the largest dams in Africa.

The proposed Grand Falls Hydro-electric Scheme

Reservoir vol ($10^6 m^3$)	7 730
Construction (years)	8.5
Impounding (months)	30.0
Surface area (km^2)	220
Power output (MW)	180

Although the attributes of the Tana River partially depend on the rainfall regime of its upper catchment, dam construction has influenced its downstream flow and physical characteristics, most notably through regulating waterflow and decreasing natural flooding regimes. Prior to dam construction, the downstream Tana River used to regularly flood its banks, often twice a year. These biannual floods would inundate the floodplain and Delta area up to a depth of 3 metres, providing water to sustain agriculture, pasture, wetlands and natural vegetation. Since the dams were commissioned, flooding has decreased dramatically. Downstream from the dams the Tana is the only permanent river in an extremely arid area. Its flooding cycle provides vital water for domestic, urban, agricultural and ecological consumers in the floodplain and Delta area. As flooding decreases, human and natural production systems have been slowly degenerating.

The Grand Falls Scheme could be the last stage in complete control of the Tana waters. After the dam is constructed it is likely that there would be no flooding except in extreme cases, occurring every 5 or 10 years. Dam construction would effectively end the bi-annual flooding regime of the Tana, which would cut off most of the floodplain and Delta areas from water, and may lower the local water table. These changes could have a major impact on downstream human and natural systems, and impose significant local, national and international costs in terms of losses to human production and biodiversity.

Economic methods used to quantify the environmental impacts of dam construction

When the Grand Falls Scheme was being planned, a design option was to build the dam in such a way as to simulate bi-annual flooding and effectively reverse the negative downstream impacts of previous dam construction. This option was assessed during the pre-feasibility stage of the project. An important factor in the decision to build the scheme with or without a flooding simulation option was an exercise to estimate the likely economic and environmental impacts of the two alternatives. This involved finding out the difference that flood simulation would make to downstream areas in economic and environmental terms.

The economic analysis compared a situation where flooding of the Tana river ceased completely over the next decade – the possible worst case scenario of constructing the dam, with a situation where bi-annual floods occurred – the possible best case scenario of constructing the dam.

To quantify downstream environmental impacts of dam construction the analysis looked at the ways in which a decrease in flooding would affect key downstream human and natural production systems. It measured these changes in terms of physical production losses, or the costs of replacing or averting lost production or benefits, because these are the economic methods permitted by available data.

The economic analysis looked only at some of the use values affected by dam construction which could be easily calculated from available data. For this reason, the values it calculated were a minimum estimate of the environmental costs of dam construction. It is also important to note that downstream production systems on the Tana are in a continuous state of flux, and have undergone changes because of factors which are unrelated to dam construction. These include widespread and recurrent drought, civil insecurity and local infrastructure developments.

Environmental economic impacts for downstream systems

The downstream population of the Tana River

The dams are placed where the agro-ecological zone of the river-adjacent area changes from high potential agricultural land to arid and semi-arid rangelands and desert. Although sparsely populated, the river-adjacent area downstream from the dams covers an area of 18 000 km^2 and contains over 36 000 pastoralist, agriculturalist and fisherfolk households. In dry season and drought, this population increases substantially.

The Tana-adjacent population

	Households
River-adjacent population:	
Agriculturalists/fisherfolk	23 000
Pastoralists	5 000
TOTAL	28 000
Delta-adjacent population:	
Agriculturalists/fisherfolk	4 800
Pastoralists	3 200
TOTAL	8 000
Total Tana-adjacent population:	36 000

The key groups and systems who are affected by the flooding of the Tana River are agriculturalists (pastoralists, arable farmers and irrigators), fisheries (riverine, wetlands and marine) and wild habitats and species (protected areas, wildlife resources, forested areas, freshwater wetlands and mangroves).

Pastoralist production

Up to 170 000 pastoralist households, herding over 2.4 million stock, depend on the Tana River floodplains, wetlands and delta as a source of dry season grazing and water. Up to 4 million cubic metres of water and 350 000 ha of pasture may be provided every dry season as a result of flooding. There are no other sources of dry season grazing

Dry-season livestock water supplied by the Tana flooding

	Number	Water used $(10m^6/yr^3)$
Cattle	1 071 000	3.6
Sheep & Goats	1 286 000	0.3
Camels	84 000	0.01
TOTAL	2 441 000	3.91

in the region. In times of drought, livestock numbers around the river may triple.

Since dam construction, dry season water and grasslands have decreased, and some surface water resources have been exhausted as a result of falling water tables. In the absence of this dry season refuge it would be necessary to construct wells, reservoirs, pans and boreholes, and maintain irrigated grassland. This involves an estimated capital cost of KSh 1.9 billion, and annual maintenance costs of KSh 26 million.

Flood recession agriculture

Up to 23 000 households cultivate a total area of 34 500 ha on the floodplain of the Tana River, growing rice, maize, grams, cowpeas and bananas. An average farm of 1.5 ha realises an estimated net annual return of KSh 62 500, meaning that floodplain agriculture contributes up to KSh 14 million a year.

Since dam construction flooding has decreased, and the consequent decline in floodwater and sediments has limited the potential for floodplain agriculture. Floodplain farmers are becoming increasingly reliant on very small flooded areas around local streams, and farming systems have changed to focus on crops with very low water requirements.

Average floodplain farm budget

	Area (Ha)	Net Income (KSh/yr)
Maize	0.5	11 573
Rice	0.5	27 652
Cowpeas	0.25	10 172
Grams	0.25	4 659
Bananas	–	8 168
TOTAL	1.5	62 222

Irrigated agriculture

There are currently nearly 3 000 ha of rice and vegetables on small and large-scale irrigation schemes fed by the Tana River, supporting up to 2 000 households. These may generate net returns of KSh 140 million a year. The water used to irrigate these crops is however pumped directly from the Tana River, it does not rely on the Tana's flooding regime. Dam construction has negligible impacts on irrigated agriculture.

Riverine, wetlands and marine fisheries

The Tana River supports both subsistence and commercial fisheries, providing food and income to an estimated 55 000 people. Fishing is carried out in the river and delta themselves, and in nearby wetlands and lakes fed by the river's floods. Marine fishing is carried out in the mangrove swamps of the delta region and nearby areas of the Indian Ocean. In total, wetland and lake fisheries yield an estimated 850 tonnes of fish a year, with a value of KSh 20 million a year, riverine fishing up to 500 tonnes a year with a value of KSh 10 million a year and marine fisheries produce up to 50 tonnes of fish and crustaceans with an annual value of KSh 2.3 million.

Tana fisheries revenues

	Catch (t/yr)	Value (KSh m/yr)
Wetlands	850	20
Riverine	500	10
Marine	50	2.3
TOTAL	1 400	32.3

As a result of dam construction, lakes and wetlands fed by the Tana's floods have declined and fish catches decreased accordingly. Riverine fishing has also been affected by changes in hydrology, which have led to reductions in the fish population and changes in ecology.

Mangrove degradation has also occurred as a result of lower flooding, affecting the breeding cycle of, and refuge provided to, fish and crustaceans.

Prawn farms

There are three planned or operating prawn farms in the Tana Delta area. These rely on prawn larvae collected from mangrove swamps, which are matured in a series of ponds fed from the sea. Earning a net income of over KSh 208 000 a hectare, commercial prawn fisheries are worth an estimated KSh 285 million a year.

Returns to prawn farming

Yield (Kg/ha)	1 800
Price (KSh/Kg)	300
Gross income (KSh/ha)	540 000
Total costs (KSh/ha)	341 320
Net income (KSh/ha)	208 680

The changes in hydrology resulting from dam construction have led to mangrove degradation. This has in turn decreased the supply of prawn larvae, affecting commercial prawn farming yields.

Protected areas and wildlife

Six protected areas lie alongside the Tana River below the dams – the Tana River National Primate Reserve, Arawale National Reserve, Rahole National Reserve, Kora National Park, Meru National Park and the proposed Tana Delta National Wetlands Reserve. These biodiverse areas provide habitat to a range of plant, animal and bird species, including four endemic plant species, three of the four primates endemic to Kenya and at least two endemic bird species, and are also important areas for large mammal conservation.

The effect of dam construction on vegetation and animal populations in parks and reserves has been small and is unlikely to be significant in the future.

Forest areas

Patches of riverine forest are found within 2 km of the banks of the Tana, and total 3 658 ha. As well as supporting rare and endemic plant and animal species, the forests provide significant economic benefits to local households who make use of a range of wood and non-wood products. Up to 1 700 households live adjacent to forests and may use them in some way. Forest use is worth an estimated of KSh 6.5 million to surrounding households each year.

Use of Tana riverine forest

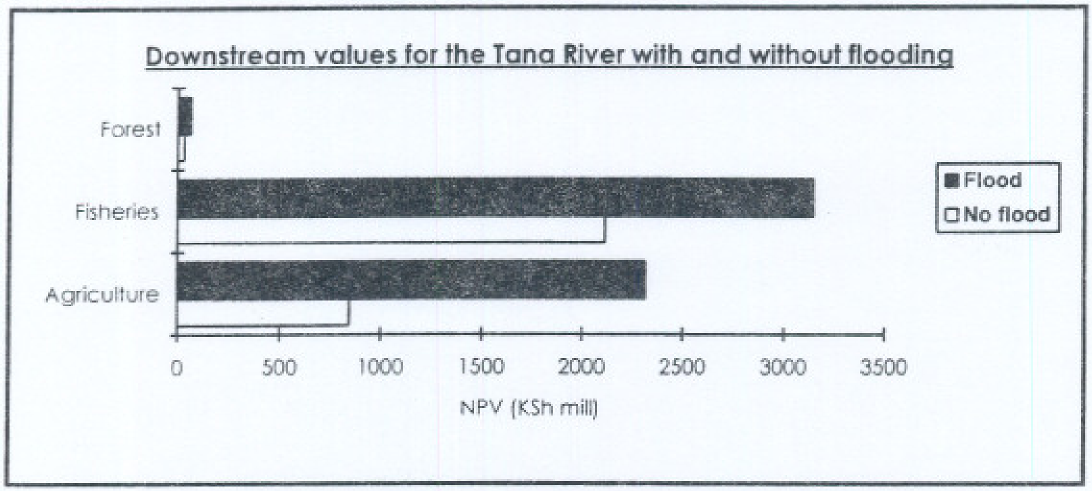
	% hholds	Use/hhold year	Total value (KSh '000/yr)
Fuel	52	2 993 kg	2 839
Saplings	48	51*	2 272
Poles	48	8*	297
Palm fronds	48	96*	429
Canoes	30	0.24*	170
Honey	30	17.5 kg	450
Beehives	30	0.24*	7
		TOTAL	6 464

* Have a 5 year lifespan

Riverine forest regeneration depends on overbank flooding, and its growth and phrenology are closely related to fluctuations in the river level. Decreased flooding regimes have reduced the biological diversity of riverine forest areas, as well as affecting their regeneration. Changed river flow has also hastened the loss of mature forest and senescence of riverine forest has been caused by reductions in groundwater.

Costs of the environmental impacts of dam construction and their mitigation

Having calculated the value of downstream flood-dependent production systems on the Tana, the economic analysis estimated the impact that flood decline would have on these systems. Without flooding, it was assumed that flood-dependent systems, already degraded, would continue to decline over the next ten years to a level which could be supported without flooding. The analysis used this information to calculate the net present value of downstream production with and without flooding over a 50 year period starting at the date of construction of the Grand Falls Scheme.



The net present value of downstream systems with and without flooding (KSh million)

	Method of calculation	Effect of dam over 10 years	Flood value	No flood value	Cost of dam construction
Dry season pasture	Replacement cost	Grazing and water decline to a tenth of original	2 177	803	1 374
Floodplain agriculture	Effect on production	Cultivated areas declines to a tenth of original	139	42	97
Commercial fisheries	Effect on production	Non-river freshwater fisheries yields decline to	77	42	35
Subsistence fisheries	Effect on production	a quarter of original, riverine and marine to	221	121	100
Marine fisheries	Effect on production	half of original	23	15	8
Prawn farms	Effect on production	Prawn yields decline to half of original	2 826	1 935	891
Forest utilisation	Effect on production	Forest yields decline to a quarter of original	64	32	32
		TOTAL	5 527	**2 990**	**2 537**

The economic analysis found that the net present environmental cost of flooding decline was as high as KSh 2.5 billion. The majority of these costs would accrue to downstream agriculturalists, pastoralists, and fisherfolk who can ill afford to bear them and who will receive few benefits from electricity generated by the scheme. Quantified values only represented a small proportion of the total environmental costs of a decline in the Tana River's flooding. The social costs of a large human population facing destitution as well as ecological costs related to the loss of wild species numbers, diversity and habitats and the degradation or destruction of a unique ecosystem would be huge. The high calculated environmental cost and the major unquantified losses resulting from a decline in flooding presented a strong economic justification for incorporating flooding simulation into the design of the Grand Falls Scheme, and attempting to reverse some of the negative environmental impacts already caused by hydro-electric scheme construction to date.

VALUING THE ENVIRONMENT: CASE STUDIES FROM KENYA

The **FAO/UNDP Institutional Support for the Protection of East African Biodiversity Project** includes one of the first components in a GEF project concerned with the use of economics for the environment. The component is called **Forestry Environmental Accounting Services (FEAS)**. It focuses on the application of environmental or natural resource economics in Kenya, Tanzania and Uganda.

FEAS is implemented by the **African Wildlife Foundation**, an international non-governmental organisation working for conservation and development in Africa. AWF works in partnership with national governments, non-governmental organisations, research and training institutions, community groups, associations and donor agencies. AWF has thematic interests in the institutional, ecological, social and economic challenges facing Africa linked around four cornerstone programmes: Training, Institutional Development and Education; Species and Ecosystem Conservation; Community Conservation; and Conservation, Economics and Commerce.

This report has been produced as part of FEAS. A number of seminars and workshops were held during the course of the project. This is a collection of some of the papers which were presented at these seminars and workshops, looking at aspects of environmental economics as they have been applied to real-world situations in East Africa. In line with the focus of FEAS, most of the papers relate to forestry.

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