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THE TOTAL ECONOMIC VALUE OF MAASAI MAU, TRANS MARA AND EASTERN MAU FOREST BLOCKS, OF THE MAU FOREST, KENYA

Lake Victoria Basin Commission Secretariat

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Executive Summary

The Mau Forest Complex is the largest closed-canopy forest ecosystem in Kenya comprising different forest blocks under different management regimes. The study covered three of the Mau Forest Complex blocks, i.e. Eastern Mau, Maasai Mau and Trans Mara. Of the three blocks, the Maasai Mau Forest is a trust land managed by the Narok County Council, and the other two are gazetted forests managed by the Kenya Forest Service (KFS) on behalf of the central government and they form the main catchment for the Mara River. The Mara River is the lifeline to a complex mosaic of ecological and economic systems that cut across its entire basin. The Mara River is a transboundary resource that serves key conservation areas both in Kenya and in Tanzania. Apart from serving the world famous Mara and Serengeti wildlife sanctuaries, the Mara River Basin provides critical ecological services in form of water storage; river flow regulation; flood mitigation; recharge of groundwater; reduced soil erosion and siltation; water purification; conservation of biodiversity; and microclimate regulation. The Mara River Basin and associated forests support key economic sectors such as energy, tourism, agriculture, industry and urban sanitation. The upper catchment also hosts the last group of hunter-gatherer forest dwelling communities, the Ogiek, and supports the livelihoods of communities living adjacent to forests through provision of material goods such as food; wood fuel; fodder; and building materials. The basin also generates global public goods/services such as wildlife conservation, carbon sequestration and biodiversity.

Demonstration of total economic value of the forests is important to ensure that forest ecosystems are accorded appropriate priority in policy-making levels including central budgets and resource allocations. The values will also strengthen the arguments of agencies promoting forest conservation and rehabilitation activities. Often, the value of the forests is grossly under-estimated for two reasons. The first is because valuations only consider the direct uses, mostly commercially marketed goods. Second is the fallacy that economic players acting in their own interest to assess the value of the forests resources do not take into consideration the interests of other stakeholders at local, national and international levels.

It is with such reality that some actors have entered the agenda to support government and other local initiatives on conservation of key forest resources in East Africa. One such institution is the East African Community/Lake Victoria Basin Commission (LVBC) Secretariat. The body coordinates the Trans-boundary Water for Biodiversity and Human Health in Mara River Basin Project. The project aims to enhance the capacity of

the Mara Basin to sustainably contribute to the economic activities of the East Africa region. The Secretariat aims to demonstrate the total economic value of the three forest blocks, to inform, influence, and strengthen the processes of implementing forest conservation measures.

This study estimated the total annual economic value of the three blocks to be KES 17 billion (US$ 238 million). This value is spread throughout the economy with the direct use values accounting for 12.4% of the value of the forests. The opportunity cost of changing forest into other land uses will lead to total economic loss to the economy. It is imperative that incentive packages be designed to positively influence community interests and attitudes towards forest conservation. The loss of changing to commercial agriculture or changing the forest to other vegetation forms could be up to 9 times.

Acronyms

EAE	Equal annual equivalent
EMCA	Environmental Management Act
EQIP	Environmental Quality Incentives Programs
IPCC	Intergovernmental Panel on Climate Change
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature
KEFRI	Kenya Forestry Research Institute
KenGen	Kenya Electricity Generating Company
KES	Kenya Shillings
KFS	Kenya Forest Service
KFWG	Kenya Forest Working Group
KIFCON	Kenya Indigenous Forest Conservation
KWS	Kenya Wildlife Service
LVBC	Lake Victoria Basin Commission
MGR	Mara Game Reserve
MRB	Mara River Basin
MTF	Mau Forest Task force
NEMA	National Environment Management Authority
PES	Payment for environmental services
SENAPA	Serengeti National Park
UNDP-GEF	United Nations Development Programme-Global Environment Facility
UNEP	United Nations Environmental Program
URT	United Republic of Tanzania
US $	United States Dollar
USAID	United States Agency for International Development
wta/WTA	Willingness to accept compensation
wtp/WTP	Willingness to pay
WWF	World Wildlife Fund

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Table of contents

Executive Summary ... 3

Acronyms ... 5

Acknowledgements ... 6

Table of contents ... 7

List of figures ... 10

List of tables ... 10

1.0 INTRODUCTION ... 12

1.1 Background to the Mau Forests ... 12

1.2 Economic Importance of Selected Forest Blocks ... 13

1.3 Economic Value of Forests ... 14

1.4 Significance of the Valuation Study ... 15

1.5 Objectives of the Consultancy ... 16

2.0 METHODS FOR ESTIMATING ECONOMIC VALUE OF FORESTS ... 17

2.1 Methods for Valuing Forest Products ... 17

2.1.1 Market Prices ... 17

2.1.2 Replacement Cost ... 18

2.1.3 Prices of Substitutes ... 19

2.1.4 Benefit Transfer Approach ... 19

a) Valuing Forest for Carbon Sequestration ... 19

b) Valuing Forest Ecosystems for Biodiversity Conservation ... 20

2.1.5 Physical Effects Approach ... 22

2.1.6 Watershed Functions ... 22

2.2 Study Area 23

2.3 Data Sources 25

3.0 THE TOTAL ECONOMIC VALUE OF THREE FOREST BLOCKS OF THE MAU COMPLEX 27

3.1 Direct Use Values 27

3.1.1 Direst use by Forest Adjacent Communities 27

3.1.2 Direct Use by the Ogiek Community 31

3.1.3 Direct Use Value by Timber Extractors 31

3.2 Downstream Values of the Forest Blocks 32

3.3 The Value of Forest for Water Supply in Urban Centres 34

3.4 Forest Functions for Soil Conservation and Water Regulation 35

3.5 Value from Tourism 36

3.6 Values of Forest Biodiversity 37

3.7 Valuation of Forest for Carbon Sequestration 37

3.8 Valuing the Forest for Major Economic Contribution to Tea Production 39

3.9 Value of the Forest Blocks for Hydro-power Generation 39

4.0 ASSESSING THE DISTRIBUTION OF THE BENEFITS OF THE MAASAI MAU, TRANS MARA AND EASTERN MAU FOREST BLOCKS 42

4.1 Key Interest Group 42

4.2 Distribution of Benefits to Different Stakeholders 43

5.0 DETERMINING, IN ECONOMIC TERMS, THE VIABILITY OF THE MAASAI MAU, TRANS MARA AND EASTERN MAU FOREST BLOCKS ECOSYSTEM 49

5.1 The Forest Block Capacity to generate benefits to cover management costs 51

6.0 POLICY IMPLICATIONS OF THE CURRENT STATUS OF THE FOREST BLOCKS IN RELATION TO TOTAL ECONOMIC VALUE 54

6.1 Policy Implications of the Current Status 54

6.1.1 Community Direct Use 54

6.1.2 Biodiversity 55

6.1.3 Carbon Sequestration 56

6.1.4 Water Provisioning for Human, Livestock and Agriculture 57

6.1.5 Wetlands 59

6.2 The Impacts of Current Status on the Total Economic Values 59

6.3 Recommended Actions by Narok County Council on Maasai Mau Forest 60

6.4 Recommended Actions by KFS, Trans Mara and Eastern Mau Forests 61

7.0 THE INCENTIVES/DISINCENTIVES FOR CONSERVATION AND MANAGEMENT OF THE FOREST BLOCKS 63

7.1 Incentives for Community Participation in Management of Forests 63

7.2 Market Based Incentives 65

7.3 Others Incentives 67

7.4 Disincentives 69

8.0 Conclusion 71

9.0 References 73

APPENDICES 77

Appendix 1: Terms of reference (ToR) for the consultancy services to undertake total economic valuation of the Maasai Mau forest, Trans Mara and Eastern Mau forest blocks 77

Appendix 2: Calculations for direct use values by households 81

Appendix 3: The checklist of data collection on the total benefits in Mau Complex 84

Appendix 4: List of contacted and interviewed experts and staff 85

Appendix 5: Cover factor (c) for crops 87

Appendix 6: Relationship between to psoil loss and yield loss 88

Appendix 7: Tourism industry performance in Tanzania 89

Appendix 8: Rapid result questionnaire for households adjacent to the Mara Forest Complex 90

Appendix 9: Economic values of forest watershed functions........ 91

Appendix 10: Categorization of stakeholders........ 92

Appendix 11: People and livestock population adjacent for forest and calculation of direct values 93

Appendix 12: The Mara River Basin........ 94

Appendix 13: The linkages between stakeholders and target ecosystems 95

Appendix 14: Valuation approaches for forest products 96

List of figures

Figure 1: Conceptualizing forest valuation techniques. 17

Figure 2: Distribution of direct use value of forest products and services. 43

Figure 3: Percent value of water used by different sectors at the Mara River Basin. 45

Figure 4: The share of the benefit among key beneficiaries. 47

Figure 5: Distribution of benefits among government ministries. 48

List of tables

Table 1: Literature reviewed for the valuation of the forest blocks 25

Table 2: Value of the direct benefits of the forest blocks (annual value)........ 28

Table 3: The value of forest to the Ogiek community 31

Table 4: Roundwood production from East Mau Forest in 2009 32

Table 5: Total cost for constructing boreholes to supply water for domestic use in the Mara River Basin 34

Table 6: Total annual cost of running a borehole 35

Table 7: Carbon sequestered in Maasai Mau, Trans Mara and Eastern Mara forest blocks..... 38

Table 8: Summary of the total economic annual value of forest goods and services from three forest blocks of Mau Forest Complex..... 41

Table 9: Potential net incomes for the three forest blocks of Mara River Basin for selected enterprises..... 51

Table 10: The expenditure in direct administration costs of the forest blocks 52

Table 11: The impacts of current status of Eastern Mau Forest Ecosystem on total economic values..... 60

1.0 INTRODUCTION

1.1 Background to the Mau Forests

The Mau complex forms the largest closed canopy forest ecosystem in Kenya covering approximately 400,000ha making it one of the critical water towers in the country. It is situated at 0°30′ South, 35°20′ East within the Rift Valley Province and spans eight administrative districts: Baringo, Bomet, Bureti, Keiyo, Kericho, Nakuru, Nandi, and Narok. It is a source of major rivers and streams that make up the hydrological systems of Lakes Baringo, Bogoria, Nakuru, Naivasha, Natron and Victoria. The original vegetation pattern of the Mau complex followed an altitudinal gradient with local topographical ecoclines. The closed canopy moist pomontane forest at lower altitudes becomes increasingly intermixed with bamboo from 2,200m above sea level. Pure bamboo (*Arundinaria alpina*) swathes are commonly found between 2,300 and 2,500 m. above 2,500m the bamboo gives way to mixed bamboo/tree stands, both associated with grass clearings that usually represent a sub-climax resulting from burning and cutting of bamboo. A marginal type of montane sclerophyll forest occupies the highest altitudes of the Mau complex.

The Mau forest complex is under immense pressure. The threats facing the forests are: extensive clearing of natural forest for exotic plantations; conversion of natural forests to agricultural land and human settlements; extensive excisions; and forest fires. The underlying causes of deforestation and degradation of forests have been identified as:

- Inadequate recognition of the real value and the integral role forests play in the life support system.
- Poor implementation of existing laws and policies particularly in respect to providing incentives to communities’ to participate in conserving forests.
- Major focus on investment in macro-economic policies such as the desire to increase the growing of cash crop for export.
- Population growth—the growing population and the shrinking productive agricultural land has forced people to migrate from densely populated regions/less productive areas to forests.
- Emergences of the value of products products that formerly were unmarketable and poverty that have driven poor households into biomass energy sources, e.g. firewood and charcoal.

- Widespread perception on resource scarcity including land that have made forest adjacent communities and those for far to encroach on forests and extract forest resources to secure their present and future livelihoods

1.2 Economic Importance of Selected Forest Blocks

The three forest blocks of the Mau complex, Eastern Mau (66,000ha), Trans-Mara (34,400ha), and Maasai Mau (46,000ha), hereafter referred to as 'the forest blocks', form the catchment of many rivers that flow into the Rift Valley and Western Kenya including the transboundary Mara River. The forest blocks are multi-functional, providing an array of goods and services. The benefits of the forest blocks are reflected in provision of ecological and hydrological services and support to rural livelihoods, within the proximity of the forest blocks and downstream. Based on the existing literature, the market value of goods and services in support of the tourism and tea sectors from various forest blocks of the Mau complex is estimated at about KES 20 billion per year (MTF, 2008). In addition, an estimated 5 million people directly or indirectly depend on services and goods arising from the Mau complex. The forest blocks have huge potential to support the national energy needs through hydropower generation. The estimated potential of hydropower generation associated with the conservation of the forest complex is approximately 535MW, or 47% of the current total electricity generation in Kenya (UNEP, 2008; MTF 2009).

The forest blocks also generate a wide range of other non-tangible, although equally important, goods and services of economic value such as ecological functions, tourist attractions, biodiversity support, water regulation and cultural significance. In addition, the blocks have naturally occurring fauna and flora whose economic value is yet to be identified, signifying some 'option values'. This implies that the forest blocks could have a higher premium than what is actually known. The various stakeholders must therefore determine the real benefits and costs associated with the conservation of the forests, especially and for future generations. Prospects exist that indeed some of these forest option values may be realized in the immediate future. An example of potential actualization of such a vision is the collaborative bio-prospecting arrangement entered between the Tanzania Government and the US National Cancer Institute on biodiversity. The work involves prospecting concession arrangements regarding the search for naturally occurring biochemical compounds with commercial values. Environmental stability and secured provision of ecological goods and services in the Mau complex in its entirety will remain essential for sustainable development in Kenya and for attaining food self-sufficiency and poverty alleviation in the Lake Basin region.

The communities that rely on the forest goods and services are characterized by high population growth rate, low income per capita and low technological innovations. This results in an increasing demand for land to produce basic needs. The areas are experiencing unprecedented deforestation, declining soil fertility and a high level of dependency on natural resources. This explains why over the last decade, about 25–40% of the forestland have undergone extensive degradation as a result of encroachment, excisions and illegal extraction of forest resources. This degradation is a major threat to water resources, biodiversity, livelihoods of forest dependent communities and other goods and services that can be sustainably harnessed from the forest blocks. The destruction of the forest reached such high levels that it prompted the government to initiate programmes to save the Mau (MTF, 2008). The dynamics of forest degradation have not only contributed to increased domestic costs of declining food productivity and increasing poverty, but also to vegetation degradation resulting in the loss of globally significant biodiversity, genetic resources, a significant reduction in carbon storage, and increased sedimentation of rivers and lakes. Forest degradation has serious implications on agricultural production systems and conservation of the environment and biodiversity in the region. Indeed, much human settlement, wildlife and economic activities would be impossible (or very costly) without the services these forests provide.

1.3 Economic Value of Forests

The economic value of forest refers to the instrumental value derived from the objectives of economic players. Economic value is anthropocentric (value for humans) and it is preference based, i.e. because the main subject is the human being, economic value is related to the maximization of human well being or at least improving human welfare. The notion of value is closely related to the consumer theory in which the objective is to maximize utility subject to available resources. Because of scarcity, resources are not available in quantities adequate to meet all human wants and hence the need to make choice (trade-offs). Philosophers consider moral value as important in determining the object of value which results in such values having intrinsic or inherent value. If moral value is subjective, then moral value is whatever the valuer thinks it is. Some values relate to cultural or religious beliefs that do not lend themselves to valuation although they are very important to the society. Since the notion of economic value is based on human preferences, the value placed on a good or service will depend on the motivation economic players have, e.g. that of intrinsic, cultural, social and spiritual value.

Economic valuation of forest goods and services is based on the notion of willingness to pay that assesses individual preferences. Willingness to pay is determined by motivation, which may vary from pure self-interest to altruism, concern for future generations and environmental stewardship. Survey techniques in environmental economics reveal that motivations vary significantly between individuals, but that self-interest is only one of many motives for environmental valuation. Market prices reflect willingness to pay. Because some consumers are willing to pay more than the price offered by the market, there is always a consumer surplus in market transactions.

The types of economic value to be found in forests are *use values* and *non-use values*. Use values refer to willingness to pay to make use of forest goods and services. Such uses may be *direct*, e.g. extractive uses or *indirec*t, e.g. watershed protection or carbon storage. Use values may also contain *option values*, willingness to pay to conserve the option for future use even though no use is made of the forest now. Such options may be retained for one's own use or for another generation (sometimes called a 'bequest' value). Non-use values relate to willingness to pay, which is independent of any use made of the forest now or any use in the future. The sum of individual use and non-use values is the *total economic value*.

1.4 Significance of the Valuation Study

The development challenge facing the Mara River Basin includes raising the living standards of the local communities while reversing degradation and depletion of natural resources so as to guarantee similar or better living standards for future generations. The valuation process of the forest ecosystem is critical to identifying the main beneficiaries, cost bearers, the magnitude of benefits and costs, funding sources, equity and even gender issues. The distribution of benefits from forest products exhibits an inequitable situation. Local communities bear the brunt of forest degradation while populations living further away from forests, tourists, city-dwellers and industries often benefit the most from forest goods and services free of charge or for very low prices. Valuation of forest resources and analysis of benefit distribution help to equitably apportion the cost of forest conservation among the stakeholders, and provide them with incentives to conserve forests, to limit their consumption of forest resources to sustainable levels, to halt forest clearance for other economic activities and to exploit forest resource sustainably. In spite of their central role in conservation of forest resources, government departments seldom raise adequate funds to administer the forests effectively.

The Lake Victoria Basin Commission (LVBC) contracted the Environmental Research and Policy Analysis (K) to determine the total economic value of the three forest blocks. The need to understand the total economic value of the forests arose from concerns about the estimated high rates of loss of forest area and, hence, the stock and flow of forest goods and services. Demonstrating the total economic value of the forests blocks will inform government of the value of forest resources that form the basis for allocation of a fair share of the central budget and other resources to the forest sector. The value also highlights the contrary actions of groups participating in forest destruction and those promoting conservation. Often, the value of the forests is grossly under-estimated because most valuations only consider the commercial, marketed output of forest products whereas forests yield a wide range of non-timber forest products, many of which are consumed only at the household level. For example, forests are estimated to provide basic subsistence for more than a quarter of the Kenya's population, supplying products worth more than US$ 100 million a year (Emerton 1995). The Mau Forest complex has saved Kenya's economy a lot of money through protecting the catchments of numerous rivers and making production of food and cash crops possible. More benefits also accumulate to the entire world, through generation of global public goods/services such as wildlife conservation, carbon sequestration and biodiversity.

1.5 Objectives of the Consultancy

1.5.1 General objective. The general objective of this consultancy was to inform the planning process and decision-making organs on the role of the forest in sustaining local livelihoods, the national economy as well as sustenance of ecosystem stability. Informed stakeholders are expected to play a more crucial role in the conservation and sustainable management of the Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks.

1.5.2 Specific objectives

The specific objective of the consultancy was:

(a) To demonstrate the total economic value of the forest blocks based on a clearly identified chain of stakeholders or beneficiaries;
(b) To demonstrate the linkages (using various economic tools) between the stakeholders and the target ecosystem; and
(c) To recommend and provide feasible incentive packages and implementation mechanisms aimed at promoting sustainable conservation and management of the Mara River.

2.0 METHODS FOR ESTIMATING ECONOMIC VALUE OF FORESTS

A number of techniques can be used to value forest products and services but no single techniques can value all the products and services. The expert chooses the appropriate mix of techniques to measure the stock and flow of resources of a forest. Figure 1 shows the techniques that can be used to measure different categories of forest resources.

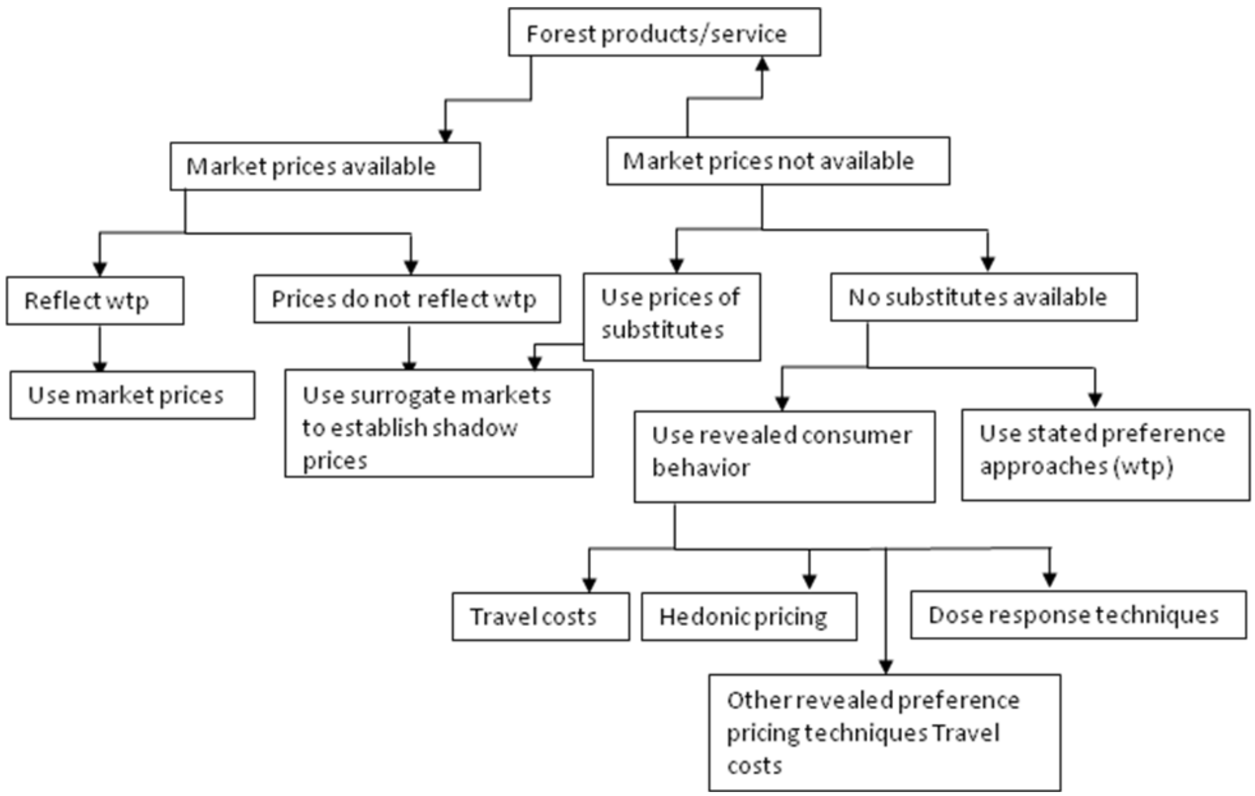


Figure 1: Conceptualizing forest valuation techniques.

2.1 Methods for Valuing Forest Products

2.1.1 Market Prices

Forest products such as timber, poles, charcoal and firewood are marketed; market prices reflect willingness to pay by consumers. The total value of forest product marketed is estimated using the own reported values and use of the market price less transaction costs, i.e.

$$T_v = Q_m (P_m) - C \qquad (1)$$

where, T = total values of forest products marketed; Q_m = quantity of good extracted; P_m = the forest gate price of good; and C = transaction costs.

The mean quantities of own reported values (Q_m) for extractable products from each household per period are converted to annual values. This was done by multiplying quantities extracted (Q_m) by market price of the product (P_m) less transaction costs (Equation 1 above). The total value of the product(s) was the aggregate of the total number of households surveyed and extrapolated for the total population adjacent to the forest. The method is used in direct use values of forest products such as firewood, timber, poles, water, honey etc. See Appendix 2 for details on calculation procedures.

2.1.2 Replacement Cost

The main service the downstream communities obtain from the forest is water. The communities use water for domestic use, livestock, for irrigation, mining, and in lodges and for wildlife. The catchment area determines the water quantity and quality. We calculate the value of provision of water by the forest by calculating the cost of the alternative source of water if the Mara River was not to continue supplying the water. The Forests regulate water flows by absorbing and retaining rainwater during the rain season. The stored water is released slowly that guarantee continuous flow of water in the rivers. Without the forest, rainwater would flow as flash floods. The alternative source of water is from boreholes. The cost of sinking a borehole is given in market rates and reflects willingness to pay by the community. According to IUCN (2002) one borehole should sustain 300 people and 276 head of livestock (cow equivalent). The cost of sinking boreholes was assumed to be equal to the average of the cost of drilling boreholes in six districts of the Mt. Elgon region (Obiri et al., 2009) as US$ 21,185.

Annual cost of a borehole = replacement cost + annual borehole maintenance cost

Replacement cost = cost of construction/life of a borehole

Annual maintenance cost = cost of water point administration + annual licence fee for water extraction

IUCN (2002) provides that boreholes should be depreciated over a five-year period.

2.1.3 Prices of Substitutes

The prices of substitutes methods are used to impute value for a good or service when there is no developed market or when the market fails to capture its total value (Hufschmidt et al., 1983; Emerton, 2001). The valuation of grazing values used the substitute methods of hay equivalent. The same method was also used in the contribution of the forest soil fertility maintenance in agricultural farms. Because forests provide firewood, they give households the opportunity to recycle organic matter in their farms and thus inorganic fertilizers sold in the market are used to value farmyard manure.

2.1.4 Benefit Transfer Approach

The benefit transfer approach of valuing forests was used to estimate the value of forest for biodiversity conservation and carbon sequestration using values deduced from studies elsewhere. The values used in the benefits transfer approaches were derived from studies done under similar conditions as those of the Mau Forest Complex.

a) Valuing Forest for Carbon Sequestration

The threat of deforestation increases the chances of the carbon stored in the three forest blocks being lost. Under the 'Kyoto rules', plantations would not count as contributing to carbon sequestration if they would have been undertaken anyway as a profitable venture. The government and a local logging company, Timsales, have planted new plantations in the Eastern Mau. The new forests could be used for carbon trading as they qualify under the recently adopted REDD+ memorandum signed in Copenhagen in December 2009. These forests have various vegetation cover types: indigenous forests (84%), exotic plantations (7%), grassland and bushlands (6%) and other vegetation types including bamboo (3%). Carbon estimates by Brown and Pearce (1994) show that closed primary forests have approximately 280 tC/ha, closed secondary forest 115 tC/ha while agricultural and grassland areas have 63 tC/ha of carbon. These values are lower than the estimates of IPCC (2006) and Gibbs (2006), who estimated 618 and 314 tC/ha respectively for Kenyan forests. Because some pockets of the Mau forest complex have been degraded, although it may appear intact, we used estimates by Gibbs (2006) for Kenya of 314 tC/ha for primary forest. The Mau forest blocks can be divided into three areas. These include areas with primary forests intact, degraded areas and those that have been turned or are in the process of being turned into permanent agricultural or grazing lands. Degraded areas have lower carbon levels than the primary areas but higher levels than the agricultural land (UNEP 2006). No estimations exist for degraded forest; we therefore used an average of secondary forest (115 tC/ha) and agricultural and grasslands (63 tC/ha) from the estimates of Brown and Pearce (1994). We obtained 89 tC/ha for degraded forests.

The Kyoto Protocol of 1997suggests that, if there are no limitations placed on worldwide carbon trading, carbon credits will exchange at about US$ 10 per tC (Zhang, 2000). Clarkson (2000) suggested a consensus value of US$ 34 per tC while Tol et al. (2000) suggested a higher value of up to US$ 50 per tC that produces very high estimates of the value of forests as carbon stores. The three forest blocks can attract these high values because they are under threat of conversion that has attracted both national and international discussions for deforestation avoidance agreements. The higher prices will require a lot of negotiations with possible buyers. The value of carbon increases when there are additional values such as biodiversity conservation in the voluntary market. Otherwise, the ruling market price of carbon may change slightly with good negotiation. The price used in Uganda for carbon trading ranges for US$ 4–8 per t (Personal communication with Nature Harness Initiative staff, Annah Agasha, Uganda, July 2009). We used 8 tC in this study because the forest is threatened.

Managing the forest as a carbon store would need to be compared with the efficiency of alternate forms of carbon capture or storage (replacing the forest with carbon dioxide-absorbing plantations or establishing compensatory fast-growing plantations) and with the values foregone by not exploiting other forest values, such as timber. The forest carbon relevant to carbon trade is the amount of carbon sequestered by the forests. Clearing the forest to start plantation agriculture may lead to substantial release of carbon dioxide into the atmosphere. The use of forest for carbon sequestration can be estimated using the following formula proposed by Emerton and Muramira (1999).

$$V_{annual} = \frac{1}{T}\sum_{t=1}^{t=T}\frac{V}{T}(1+r^{T-1}) \qquad (2)$$

Where T = overall period; V = overall value of carbon; r = discount rate (10%); t = years; and V_{annual} = value of carbon sequestration per year.

b) Valuing Forest Ecosystems for Biodiversity Conservation

The forest provides a habitat for a wide range flora and fauna with current or future potential or actual values. The future value attracts the attention of environmentalists with interest ranging from the impact of deforestation on biodiversity and climate change to the aesthetic value of a forested landscape. Such interest groups would like to see the forests maintained or enhanced such that the stream of values can be sustained. Many environmentalists consider that such values cannot be satisfactorily reflected in economic or monetary terms. Indeed they argue that placing economic values on forests always under-estimates their true value.

Defining the role of the forest for biodiversity conservation is a complex exercise because of uncertainties about just how many species actually exist and the documentation of the role of each of the species in serving the present and the future humankind. Moreover, species diversity is one, albeit convenient, indicator of overall biological diversity. The documentation of each of the mammals, insects, plants etc. present in the Mau complex is yet to be documented.

Biodiversity is the natural assets of the country with potential to provide a wide range of goods and services, including phamaceutical products, cultural, research and training opportunities for the benefit of humankind. The value of *known* information is therefore only a par, of the total value of the information stock. Retaining the stock in the event that it will be useful later represents an 'option value' for the known element, and a 'quasi option value' for the currently unknown element.

Agricultural crops become vulnerable to pests and genetic erosion that affect their productivity capacity mainly because their genetic make-up is based on very few plant families. This is because 80% of research and development (R&D) studies are based on commercial cultivars as compared 6.5% that are on relatively unknown species. Though the R&D based on unknown species appears small but if we assume that new research on the species is initiated every three years, then it means that the germplasm of these species in the forest will drop by 6.5% every three years, an alarming situation. It reinforces why as much biodiversity as possible should be maintained to keep abreast with demand from R&D institutions.

Biodiversity is also relied upon to maintain the agricultural system where germplasm is estimated to be lost at the rate of 8% per year. The forest values arise from the potential of some of the forest products attaining commercial value because their uses are discovered, e.g. if currently unused species might combat some new disease or existing health problem more effectively. Forests thus tend to have some *existence value*, i.e. value that people place on forest existence independent of the values of particular uses.

This value is assessed using the institutions' investment in research on biodiversity resources.

We used the benefit transfer approach based on studies by Pearce et al. (1993) that suggests that tropical forests have biodiversity values that range between US$ 0.01 and US$ 21 per hectare. The Mau complex cannot be compared with the tropical rain forest countries of South America in terms of biodiversity, where the South American forests are rich in biodiversity. Hence, the value will be lower than the high value ranges. The biodiversity index for the Mau forest was assumed to be half that of the South American forests, i.e. a medium richness: a value of US$ 10/ha was assumed for Mau Forest complex.

2.1.5 Physical Effects Approach

The environmental effects of projects manifest themselves in changes in output of marketable goods or production. For optimum tea growth, three climatic conditions must be met: constant moisture, soil temperature between 16°C and 25°C and air temperature between 10°C and 30°C. These climatic conditions are found in areas adjacent to forests. It is estimated that two-thirds of the tea produced in western Kenya is grown in areas that benefit from the ecological functions of the Mau forest complex (ICS, 2009). Lack of adequate data makes it impossible to develop a production function to decompose factors influencing tea production in order to assess the contribution of the forest to yield. Wind breaking and the microclimate ideal for tea production are important contributions of the forest to tea production. The loss of forest results in the loss of its windbreak function. In such circumstances, the value of unintended benefits and costs are estimated through valuing a change in output:

$$\text{Benefit from the forest to tea} = P_t(Y_f - Y_n) \quad (3)$$

where Y_f = average tea yield within forest proximity; Y_n = average tea yields in distant tea plantations; and P_t = price of tea/kg in US$.

2.1.6 Watershed Functions

The three forest blocks play numerous watershed regulation functions: soil conservation—control of siltation and sedimentation; water flow regulation (flood and storm protection); river catchment; and water quality regulation—including nutrient outflow. The effects of the removal of forest cover can have adverse effects on the communities living near the forest and those downstream. Economic studies of watershed protection functions are few in Kenya is limited but some global findings are presented in in Appedix 8. Mau forest complex watershed functions are important for the entire region since they support various economic sectors. The forest blocks play an important role in preventing sedimentation in Lakes Nakuru, NaivashaNatron and Victoria. Flooding and sedimentation in the area is uncommon. Data on the influence of the forest for watershed functions are not significant.

Rainstorms are usually associated with increased turbidity and total suspended sediments (TSS) levels in the Mara River. Other factors such as deforestation and insufficient soil conservation practices in agricultural regions (Bugenyi and Balirwa, 2003) cause increased turbidity and TSS values. Increased fertilizer use and runoff has contributed to widespread eutrophication in Lake Victoria, as indicated by the low levels of dissolved oxygen at the mouth of the Mara River at Lake Victoria (Bugenyi and Balirwa, 2003). Conservation of the catchment areas will reduce flash floods and thus regulate the erosivity of the river. The erosivity of the Mara River could be assessed based on the potential flash floods without the forest (whose role is to allow water infiltration) and associate this with the abatement cost.

The impacts of change in forest cover on watershed functions include erosion of soil cover, altered downstream water flows, flooding and sedimentation, and consequent damage to agriculture, fisheries, dam storage, and power generation. These can be valued in terms of incremental production or avoided costs. Only effects at points where decisions can be made are important. Data on the watershed function in terms of flood control, sedimentation and eutrophication were not available and we estimated the value of forest in controlling soil erosion as shown in Section 3.4.

2.2 Study Area

The Maasai Mau Forest is the upper catchment area the Ewaso Ngiro River, while the most western part of the forest is part of the upper catchment of the Mara River. The Ewaso Ngiro River flows into Lake Natron, the main breeding ground for flamingos in the Rift Valley. The Mara River crosses the Maasai Mara National Reserve and the Serengeti National Park, both world famous for big game. Both are also Important Bird Areas (IBA) with 450 and 540 bird species respectively. The Ewaso Ngiro and Mara rivers provide much needed water to pastoralist communities, agriculture and urban areas in Narok and Kajiado districts. Narok District is known for wheat production. This crop, and others, benefits from the essential environmental services provided by the Maasai Mau Forest in terms of water from the streams and rivers flowing from the forest and favourable microclimatic conditions around the forest. The Maasai Mau provides non-timber forest products, including medicinal plants, wild honey and wild fruits, many of which are consumed locally. Local communities also use the forest as dry season pasture.

The Maasai Mau Forest block is estimated at 46,373ha most of which has been settled by cultivators, especially in the eastern and western sections. The Maasai Mau is a trust land forest belonging to the Narok County Council. Between 1986 and 2003 it is estimated to have lost 20,330ha to settlements. The UNEP Status Report 2005 shows that approximately 11,095ha in the western part of the Maasai Mau Forest (Narok South Constituency) has been destroyed or heavily affected by settlements. It was further observed that the forest was being actively cleared as evidenced by numerous plumes of smoke billowing from the remaining forest canopy. The areas most affected by destruction include approximately 6,500ha in Olokurto area, 11,000ha in Sierra Leone in the Narok South Constituency few kilometres from the Amala River and 1,800ha in the Nkareta area.

The Trans Mara Forest Reserve is located in Narok South District and is managed by the Kenya Forest Service (KFS). The reserve, located at 2,500m to 2,348m above sea level, was gazetted (legal notice no.102/41) under trust land and covers an area of 35,270ha of indigenous forest. It borders the larger South West Mau forest to the North and Olposimoru and Maasai Mau to the south-east. It is part of the upper catchment of Mara River as many tributaries that feed into the Nyangores River start from the forest. The Nyangores River flows through the Trans Mara Forest and enters the private smallholder farms near Tenwek Hospital in Bomet District. It flows through Bomet town and joins the Amala River at Kaboson. The forest reserve is a relatively intact forest, but some illegal logging of indigenous trees is expanding along the north-east mostly emanating from the densely encroached areas in Maasai Mau and Ol Pusimoru Forest reserves. Approximately 1,000ha were allocated to Kiptagich tea estate in 1988 and recent reports indicate that the tea estate extends to the South West Mau and Tran Mara forest reserves.

The Eastern Mau Forest block is located in Nakuru District and is managed by KFS. It was one of the two largest forest blocks in the Mau Complex, covering about 66,000ha, of which 35,301ha were excised in 2001 for human settlements. It is the main upper catchment of the four rivers (Makalia, Naishi, Nderit and Njoro) that flow into Lake

Nakuru. The south-western watershed that drains into the Mara Rivers Basin, the subject of our study, consists of the Baraget, Kiptunga, and Marashioni forests. Recent excisions affected the main catchments that covered main ridges and peaks along the top of the Mau Escarpment, including areas between 2,800 and 3,000m above sea level that were covered with bamboo forests, vegetation cover with high catchment value. The forest has very high soil erodibility factors thus, a risk of siltation of water structure downstream. The Eastern Mau forest block host most of the Ogiek people, whose hunter-gatherer lifestyle is historical. The Ogiek community subsisted on sustainable hunting of wild game and gathering of wild fruits, however, new settlers in forest adjacent farms have influenced their lifestyles including adoption of subsistence farming activities.

2.3 Data Sources

This study obtained data from different sources in undertaking the total economic valuation (TEV) of the forest blocks. This included review of previous studies, participatory rural appraisal meetings, key interviews, focus group discussions, observation through field visits and maps analysis. A checklist of information to be collected is appended as Appendix 3. The study also involved literature review (Table 1).

Table 1: Literature reviewed for the valuation of the forest blocks

Category	**Type**	**Sources**
Methodology review	Scientific journals, reports, books and publications including reports from ongoing efforts on the restoration of Mau Forest	UNEP, International Union for Conservation of Nature, journals, Kenya Forestry Research Institute, the Mau Secretariat (http:www.maurestoration.go.ke, July 2010; the Kenya Forest Working Group (www.kenyaforests.org, July 2010);
Policy analysis and review	✓ Policies related to forestry and environment ✓ Legal frameworks related to forestry and environment ✓ National development plans	Government ministries, KFS, Ministry of Environment and Natural Resources

	✓ Environmental action plans ✓ Research plans ✓ Operational plans and procedures for Kenya Wildlife Service and KFS. ✓ East African Community plans on forestry and environment	Government Ministries, LVBC, KFS, Kenya Forestry Research Institute
	✓ District development plans	Districts neighbouring the three Mau forest blocks
	✓ Natural Resource related non-governmental organizations and community based organization programmes	Non-governmental organizations, community based organizations

Other sources of information were key informant interviews (the list of key informants is appended Appendix 4 in this document) and direct observations.

3.0 THE TOTAL ECONOMIC VALUE OF THREE FOREST BLOCKS OF THE MAU COMPLEX

3.1 Direct Use Values

3.1.1 Direst use by Forest Adjacent Communities

The households living adjacent to the Maasai Mau are mostly livestock keepers who are increasingly involved in both subsistence and commercial crop production mostly wheat, maize and potato growing. The households settled inside the forest were hostile, probably because extraction of forest products is illegal. They were therefore not included in our survey. Households living adjacent to the forest blocks extract various products and services from the forest for subsistence and sale. According to Langat and Cheboiwo (2010), although these households are medium-scale landowners, they are still highly dependent on the forest for firewood, construction poles, water and grazing. Charcoal production is also a significant income generating activity based on the forest trees. A household's dependence on the forest depends on the product, e.g. nearly all the households obtain water from the forests while 16% of the households obtain grass for thatching houses. Thus, the value attached to the forest by the household is the function of the household's dependence on the extracted resources. The total value of the products extracted from the forest blocks by households is approximately KES 1.7 billion (US$ 227 million) per year with firewood accounting for up to 70% of the value of direct forest benefits (Table 2).

Table 2: Value of the direct benefits of the forest blocks (annual value)[1]

Product/ service	Firewood (headlots)	Poles in pieces	Timber (m³)	Medicine[a]	Water for livestock (m³)	Water per household (m³)	Grazing (bales)	Thatch grass (per headlot)	Honey (kg)	Charcoal (bags)	Cultural sites[a]
Eastern Mau											
Response (%)	80	60	47	69	100	100	87	16	40	5	2
Average/year	277	188	0.06	-	14.6	14.6	11	4	4	18.29	-
Estimated population	47,802	47,802	47,802		13,099	47,802	13,099	47,802	47,802.3	47,802.3	
Unit price	100	100	15,700		1,000	1,000	200	50	150	200	-
Collection/ processing labour	38	7	9500	-	950	950	-	8	50	50	-
Maasai Mau											
Response(%)	85	29	40	47	80	80	66	56	12	20	2
Average/year	154	33	0.06	-	12.8	7.3	11	9	5	19	-
Estimated population	25,234	25,234	25,234	25,234	43,200	25,234	43,200	25,234	25,234	25,234	-

[1] See Appendix 2 for the detailed derivation of these figures.

Unit price	100	100	15,700		1,000	1,000	200	50	150	200	-
Collection/ processing labour	38	7	9,500	-	950	950	-	8	50	50	-
Trans Mara											
Response(%)	60	30	12	47	86	86	15	5	10	8	2
Average/year	136	32	0.01	-	12.8	7.3	11	8	3	5	-
Estimated population	25,234	25,234	25,234	25,234	43,200	25,234	43,200	25,234	25,234	25,234	
Unit price	100	100	15,700		1000	1000	200	50	150	200	-
Collection/ processing labour	38	7	9500	-	950	950	-	8	50	50	
Value of direct use of the forests											
Eastern Mau	656,765,360	501,465,248	7,112,982	0	9,562,708	34,895,679	25,151,232	1,040,178	5,736,276	6,557,281	0
Maasai Mau	202,134,434	20,377,313	3,754,819	0	22118605	9,136,717	62,208,576	4,324,098	1,211,232	14,538,191	0
Trans Mara	133,055,442	21,970,243	195,670	0	3,133,207	8,255,476	1,821,632	441835	394,496	5,772,258	
Total values of the forest	991,955,236	500,676,009	11,063,471	0	33,635,556	33,071,643	89,181,440	5,721,952	7,342,004	26,867,729	0

blocks											

N refers to the sample size.

[a] These values were negligible.

3.1.2 Direct Use by the Ogiek Community

The East Mau Forest hosts the Ogiek community whose livelihoods depend entirely on the forest. The Ogiek are forest dwellers who argue that they may not survive outside the forest. They rarely farm any crops, but keep livestock. The Eastern Mau hosts approximately 600 Ogiek households; most of the households are located at Marishoni while about 80 are at Kiptunga, the source of the Mara River. Other Ogiek households are found in Likia, Logman and Nessuit. According to Langat and Cheboiwo (2010), the Ogiek are wholly dependent on forests for their livelihoods through subsistence cultivation and livestock keeping (mostly sheep and few cattle).[2] The results in Table 3 show that the value of direct use of forest resources by the Ogiek in the East Mau Forest is approximately KES 10 million (US$ 1.3 million), mostly in firewood (48%), poles (17%) and grazing (13%).

Table 3: The value of forest to the Ogiek community

Product/ service	Firewood (headlots)	Poles (pieces)	Timber (m^3)	Medicine	Water for livestock (m^3)	Water for households (m^3)	Grazing (bales)	Thatch grass (per headlot)	Honey (kg)	Charcoal (bags)	Cultural sites
Average/year	136	32.76	0.01	-	12.8	7.3	11	8	6	8	-
Unit price	100	100	15,700		1,000	1,000	200	50	150	200	-
Collection and processing labour	38	7	9,500		950	950	-	8	50	50	-
Net value (KES)	5,059,200	1,828,008	37,200	-	384,000	219,000	1,320,000	201,600	360,000	720,000	360,000
Proportion (%)	48	17	0	0	4	2	13	2	3	7	3

3.1.3 Direct Use Value by Timber Extractors

The Eastern Mau forest, with about 3000ha under pine and cypress plantations, is the most exploited forest in terms of timber extraction, mostly by two forest based industries, Timsales and Comply. The Eastern Mau forest produced 34,399.74m^3 of

[2] Each Ogiek community has an average of 30 sheep and 0.5 cows.

wood in 2009 valued at KES 86 million (US$ 1,146,667) (Table 4). The projected annual revenue generation from plantations in the forest reserve is estimated on the assumption that the 3,000ha currently under plantation will be sustainably managed on a 25-year rotation. Thus 120ha will be available for harvesting annually on the assumed final stem density of 420 per hectare each yielding 1.2m^3 of roundwood. The Eastern Mau Forest Reserve can produce an estimated stump volume of 60,000m^3. At the current price of KES 2,800/m^3, this would generate an annual revenue of KES 168 million (US$ 2.24 million).

The Trans Mara forest comprises natural vegetation that does not allow any logging concession to be made. According to the Narok Zonal Forest Office the Trans Mara Forest Reserve is a protected forest with minimal extraction allowed, mostly for subsistence firewood collection. Thus, the revenue generation from Trans Mara forest by KFS is minimal. The revenue generated by KFS in 2009 was KES 215,050 (US$ 2,868) with firewood and confiscated charcoal accounting for 42% each.

According to the Narok County Council Office there is no legal extraction of tree products from the Maasai Mau Forest Reserve. Most of the forest is extensively encroached and no record of any products being harvested is available. However, the forest is undergoing serious logging and charcoal burning, and is heavily grazed by livestock. It was not possible to collect any data on extraction rates for various products from the Maasai Mau Forest Reserve because of the hostility of suspicious settlers.
The revenue generated by the forest blocks in 2009 is KES 89,502,085 (US$ 1,193,361) with revenue from plantations accounting for 96% of this amount.

Table 4: Roundwood production from East Mau Forest in 2009

Station/quantity	**Volume produced (m^3)**	**Value (KES)**
Kiptunga	17,313.04	43,282,602
Baraget	16,404.26	41,010,638
Logman	682.44	1,706,100
Total	34,399.74	85,999,340

3.2 Downstream Values of the Forest Blocks

The upper catchment of the Mara River Basin comprises a section characterized by large-scale agricultural farms, some of which are irrigated using water from the river. In the lower section, the Mara River runs through the open savannah grassland protected by the Maasai Mara Reserve on the Kenyan side and the Serengeti National Park on the Tanzanian side. Just before the Mara River drains into Lake Victoria, there is a flood plain. The downstream value of the forests results principally from the support to the wildlife that attracts foreign currency and incomes to the country through tourism, irrigated agriculture and livestock support. The value of water to wildlife and the lodges has been captured through the value of the catchment to tourism.

The Mara River Basin is critical for the supply of water to populations in Kenya and Tanzania. The total consumptive water demand in the basin is estimated at 24 million cubic metres per year where large-scale irrigation accounts for 51%, human domestic demand 20% and livestock 17% (Hoffman, 2007). Using these proportions, 6,505,175m^3 of water are required to support livestock in the area. Hoffman (2007) reported that the population living in the Kenyan and Tanzanian part of the Mara River Basin was 556,497 and 282,204 people respectively. Using proportional basis the demand for water for households in the basin is 4.8 million cubic metres.

A single borehole can provide water for 300 persons (IUCN, 2002). The total cost of constructing boreholes is assumed to be uniform in all areas of the river basin and include the cost of hydrological survey, borehole drilling, and annual borehole maintenance and permit charges. The annual cost of drilling a borehole was estimated as an average of the cost of drilling boreholes in six districts of the Mt. Elgon region (Obiri et al., 2009) as US$ 21,185. Annual borehole maintenance cost was US$ 1,476. The boreholes would fall under class D type for licensing and thus the owners must pay the Water Resource Management Authority an additional US$ 533 as assessment cost and US$ 667 as permit charges for using the water. Using the replacement cost method, the lifespan of a borehole is 30 years (www.nationaldriller.com) and the cost incurred as replacement cost of boreholes is US$ 1,237,984. Thus the total cost of boreholes to supply water for domestic purposes in the Mara River Basin was estimated at US$ 4,733,674 (Table 5).

During the dry season, there is hardly any water in the river basin. Up to 30% of the animals can be lost without the water provided by the Mara River. Indeed, in 2000 pastoralists lost 35% of their cattle due to drought (Ottichilo et al., 2001; Reid et al., 2003). The demand for water by livestock was estimated based on the Hoffman (2007) study at 4.08 million cubic metres. With a daily demand of 40 litres of water per cattle equivalent, using this estimate we can calculate backwards to obtain a cattle equivalent population of 276,000 cattle in the basin. According IUCN (2002) a borehole can support 276 cattle equivalent. This would require 1,490 boreholes costing a total of US$ 4,023, 623.

The Water Resource Management Authority licenses water users for use of water as per the different permit classes. Irrigation consumes 51% of the water in the Mara River Basin with an annual water demand of 12, 240,000m^3 (Table 5). If the catchment area is degraded such that the water supply is not synchronized with the demand, then 4,470 boreholes will be required to meet water demand for irrigation at an annual cost of US$ 12, 070,869 (Table 5).

The mining activities in the Kenyan and Tanzanian parts of the Mara Basin use about 3% of the Mara River water. The total annual water demand by the mining sector is 720,000m^3. This would require 263 boreholes to be constructed and maintained at a cost of US$ 710,051 if the catchment area is degraded to the point where it cannot supply the water for the mining activities.

Table 5: Total cost for constructing boreholes to supply water for domestic use in the Mara River Basin

Sector	Households	Livestock	Irrigation	Mining
Proportion of the total demand (%)	20	17	51	3
Demand for water (m^3)	4,800,000	4,080,000	12,240,000	720,000
Number of boreholes	1,753	1,490	4,470	263
Replacement cost (US$)	1,237,984	1,052,286	3,156,859	185,698
Annual borehole maintenance cost (US$)	3,495,690	2,971,337	8,914,010	524,354
Total annual cost of running a borehole (US$)	4,733,674	4,023,623	12,070,869	710,051

3.3 The Value of Forest for Water Supply in Urban Centres

In the upper zone of the Mara River especially its tributary the Amala River there is minimal water extraction activities because it flows through protected forests. In the in the middle and lower zones there is direct collection by households, urbanizing centres and irrigation schemes. The Nyongeres River provides water for Tenwek Hospital, Silibwet and Bomet Town. A new water project, Sigor, is being developed on the Nyangores River. This new project will target Siongiroi and other urban centres along the river. Because we did not obtain data on the capacity of the water project under construction, we assumed that the Sigor water project would provide water to a population equal to that of Narok town. The water supply to Narok town was thus used as a proxy for measuring the water demand in the Nyangores River. The two major urban centres of Narok and Bomet respectively consume about 18,000m^3 and 6000m^3 of water per day. Thus, the annual demand for water by the population is 8,760,000m^3. With a price of KES 200 for the first 6m^3 or KES 33.3 per cubic metre, the urban centres will accumulate KES 291,708,000 (US$ 3,889,440) as gross annual revenue. The total cost of running a borehole for a year is given in Table 6.

Table 6: Total annual cost of running a borehole

	Households	Livestock	Irrigation	Mining
Proportion of the total demand	20	17	51	3
demand for water (m^3)	4,800,000	4,080,000	12,240,000	720,000
Number of boreholes	1,753	1,490	4,470	263
Cost of constructing a borehole	21,185	21,185	21,185	21,185
Total cost of boreholes	37,139,518	31,568,590	94,705,771	5,570,928
Annual cost of boreholes (US$)	**1,237,984**	**1,052,286**	**3,156,859**	**185,698**
Annual cost of borehole maintenance	**1,994**	**1,994**	**1,994**	**1,994**
Total annual cost of running a borehole	1,239,978	1,054,280	3,158,853	187,692

3.4 Forest Functions for Soil Conservation and Water Regulation

Forests play a major role in soil and water conservation, particularly regulation of water flows and control of floods and erosion. Currently, there is scanty information and data to enable quantification of the contribution of forests to soil stabilization and water regulation in the upper catchment areas of Kenya. Soil erosion is affected by many factors including rain intensity and periodicity, soil type, slope, vegetation cover and agricultural practices prevailing in the site. It was not possible to estimate the soil conservation functions of the forests due to lack of quantitative data and hence the use benefit transfer method. Langat and Cheboiwo (2010) used data and information from FAO/IISA (1991) to evaluate the potential protective cover of Tindiret Forest as compared to land under maize crop using the yield loss method. Tindiret Forest is part of Mau Forest Complex so similarity is assumed that justified the use the method to estimate values for the forest blocks.

Key assumptions for estimation of soil conservation values were the natural forests have at least 50mm of litter layer and canopy of 75% with 90% of the area covered by at least 50mm of litter. In the case of conversion to maize fields a maize cover of 80% and soil loss due to rain of 0.5cm of topsoil per annum is assumed. According FAO/IISA the cover factor for the humid forest is 0.0001 and the soil loss is estimated by multiplying the cover factors by litter layer hence 0.0001x 0.5 cm to obtain 0.005cm (Appendix 5). On conversion to maize, cover factor (c) = 0.30 (see Appendix 5) and the soil loss per annum for this cover type is 0.3 multiplied by 0.5 = 0.15 cm, therefore soil loss measured in terms of incremental top soil eroded due to rain induced erosion is 0.15 less 0.005 = 0.145 cm.

The soils productivity loss due to change of land use from natural forest to maize is estimated on the assumption that 40 bags of 90kg maize per hectare is harvested from a cleared forestland. The gross value of maize harvested assuming the market price of KES 1600 (farm gate price) is KES 72,000.
The formula used to derive yield loss associated with soil erosion is Y = 0.6X (see Appendix 12), assuming least susceptibility of soils in the forests) where, Y is the productivity loss in percent; and X = is soil loss in cm. Thus, with a soil loss of 0.145cm occasioned by change in land use, the reduction in yields is 0.6 × 0.145 = 0.087 (8.7%) or KES 6,264 (US$ 83.5) per annum.

The forest cover and other soils related factors are not similar in the three forest blocks and based on the degradation level we have estimated soil conservation factors based the forest cover. We assumed that East Mau could have a factor of 75%, Trans Mara 79% and Maasai Mau 50% to reflect the changes from the original forest structure and the soil layer conservation capacity.

Using the above conservation values and the sizes of the three forest blocks the values for the three forest block were calculated as follows:
Forest soil conservation value = 6264 × F ×S, where F is the assumed forest effective factor and S is the size of the forest in hectares.
Thus the values for each of the forest blocks are:

1. Eastern Mau 6,264 ×0.75 ×66,000 = 310,068,000
2. Trans Mara 6,264 ×0.80 ×34,400 = 170,230,464
3. Maasai Mau 6,264 ×0.5 ×46,000 = 144,072,000

The total value of the soil prevented from loss by retaining the land under forestcover conservation is KES 624 million (US$ 8.3 million) per annum.

3.5 Value from Tourism

The role of the Mara Basin in tourism and wildlife support was estimated using the willingness to pay by tourists estimated using the travel cost method as the expenditure of touring the game reserves that are supported by the forest blocks. The Serengeti National Park receives up to 130,000 tourists a year paying US$ 6 million in gate charges (TSB, 2000). With about 20% of these guests staying in the park for one or more nights and each spending each US$ 200,[3] an additional US$ 5,200,000 accrues to hoteliers and other facilitators including the cottage industries.

The Kenyan part of the Mara Basin houses the Mara National Reserve with about 80 hotels, mostly used by tourists (see Appendix 7). The total bed capacity of the hotels is 3,466 with an occupancy rate of about 56% (if we assume the hotel bed occupancy of about 56%, the same as that reported for Serengeti; see Appendix 7; URT, 2001). Thus, on average, 1,941 visitors spend the one or more nights in the Mara National Reserve spending about US$ 200 per day. The cumulated earnings at the Mara spent by 708,450 tourists who spend the night in the Kenyan hotels are US$ 141 million. Another KES 650 million (US$ 8,666,667) is collected as gate charges to the reserve.

The total value of the forest blocks did not include extra benefits that accrue from the Eastern part of the forest in influencing tourism activities at the Lake Nakuru and Lake Naivasha national parks.

3.6 Values of Forest Biodiversity

Using the benefit transfer method, the option value for the rich flora and fauna was estimated using the benefit transfer method. Using the value of US$ 10/ha by assuming a medium biodiversity compared with the South American forests, the forest blocks are valued at KES 109.8 million (US$ 1,464,000).

3.7 Valuation of Forest for Carbon Sequestration

The three forest blocks provide two dimensions in carbon storage: (i) the amount of carbon stored in the standing forest (carbon balance); and (ii) the carbon sequestered in a growing forest. The carbon stored in the standing forests would be lost if the trees are logged. Carbon markets have existed since 1989 and refer to the sums of money that

[3] According to Tanzania tourism ministry, the average daily expenditure per tourist has been increasing over time. For example, in 1991 the average expenditure per day was US$ 72.42 which increased to US$ 152.00 in 1999. Based on this trend and from information obtained through interaction with key informers, we assumed that tourists spend US$ 200 per day at the Serengeti or the Maasai Mara.

corporations and governments have been willing to invest in order to sequester carbon or prevent its emission. Several hundred 'carbon offset' investments of this kind exist, all of them voluntary and unrelated to global warming legislation. Based on the forest composition the estimated value of the forests for carbon sequestration is US$ 1,761,333 per annum (Table 7).

Table 7: Carbon sequestered in Maasai Mau, Trans Mara and Eastern Mara forest blocks

Forest type	% of total forest	Size	Carbon (t/ha)	Total carbon	Carbon sequestered per year (tons)	Value of sequestered carbon (US$)
			Maasai Mau			
Primary	40	18,400	280	5,152,000	35,778	286,222
Degraded	10	4600	89	409,400	2,843	22,744
Agricultural[a]	40	18400	63	1,159,200	8,050	64,400
Total		0		6,720,600	46,671	373,367
			Trans Mara			
Primary	92	31,280	280	8,758,400	121,644	973,156
Degraded	9	3060	89	272,340	1,891	15,130
Agricultural[a]	3	1020	63	64,260	446	3,570
Total		0		9,095,000	123,982	991,856
			Eastern Mau			
Primary	40	18400	280	5,152,000	35,778	286,222
Degraded	20	9200	89	818,800	5,686	45,489
Agricultural[a]	40	18400	63	1,159,200	8,050	64,400
Total				7,130,000	49,514	396,111
Total for the three forest blocks					220,167	1,761,333

[a] Includes bushlands and grasslands.
Source: Anuthors' estimates.

The value of the carbon stock outlined in Table 7 can be realized only under the Reducing Emissions from Deforestation and Degradation (REDD) plan. The amount of incremental carbon that can be readily sold in the market is given in Table 7.

3.8 Valuing the Forest for Major Economic Contribution to Tea Production

Through field sampling and interviews with keynote informers, the yields of tea in farms within the proximity of the forest and far from the forest were collected. Comparing the production per hectare of tea produced near the forest and that away from the forest revealed that tea within the proximity of the forest yield 8–20% more tea/ha (an increase in yield of about 200kg/month per hectare). The A tea growing area, estimated at 36,000ha, benefits from the climate attributed to the Trans Mara and Ol Posimori forests. If it is assumed to share the influence on a 50:50 basis, the forest blocks accumulate a KES 253.5 million (US $ 3.38 million) increase in tea production.

3.9 Value of the Forest Blocks for Hydro-power Generation

The estimated potential hydropower generation in the Mau Forest complex catchments is approximately 535MW, representing 47% of the total installed electricity generation capacity in Kenya (MTF 2009). The Sondu and Ewaso Ngiro rivers have the largest hydropower potential estimated at 209 and 220MW respectively. The tea estates at Kericho are estimated to have a capacity to produce up to 4MW. The power plants of the Sondu River and the tea estates of Kericho have their catchments on the South-west Mau Forest Reserve which is not part of this study. The value of the power generated from Ewaso Ngiro River is based on the willingness to pay as investment in the project by the development partners or government, i.e. the development cost using the Sondu River project as a reference. The Sondu-Miriu Scheme was financed by the Japan Bank for International Cooperation and cost KES 15 billion (US$ 238 million) or about US $ 1.14 million per megawatt. The value of the investment is KES 18,789 billion (US$ 251 million), but is not included in this valuation. The area of interest, the Amalo and Nyangores rivers have the potential of about 8MW valued at US$ 11.12 million. This money will accrue to the economy as is likely to be funded from external sources.

The information in Table 8 summarizes the values of the forest blocks to different users of the forest products and services.

Table 8: Summary of the total economic annual value of forest goods and services from three forest blocks of Mau Forest Complex

Forest good/service	Major beneficiary	Value (KES /year)	Value (US $/year)	Value (US $/year/ha)
		Direct use values		
Firewood	Households/KFS	991,955,236	13,226,070	90.3
Poles	Households/timber traders	500,676,009	6,675,680	45.6
Timber	Households/timber traders	11,063,471	147,513	1.0
Water	Households	33,635,556	448,474	3.1
Grazing	Households	33,071,643	440,955	3.0
Grass for thatching	Households	89,181,440	1,189,086	8.1
Honey	Households	5,721,952	76,293	0.5
Charcoal	Households/KFS	7,342,004	97,893	0.7
Stumpage (timber)	Timber sellers	254,000,000	3,386,667	23.1
Ogiek community	Subsistence support	10,489,008	139,853	1.0
Water supply	Urban water suppliers	291,708,000	3,889,440	26.6
Total		2,228,844,319	29,717,924	203.0
		Indirect benefits		
Water supply	Downstream community	1,615,366,326	21,538,218	147.1
Watershed management	Soil fertility replenishment	624,000,000	8,320,000	56.8
Biodiversity	Wildlife, Research institution	109,800,000	1,464,000	10.0
Carbon sequestration	International community	132,099,975	1,761,333	12.0
Tourism (including eco-tourism), recreation, training	KWS, Tanzania tourism, employment opportunities, County council	12,065,000,025	160,866,667	1,098.8
Hydropower generation	KenGen, Tea estates (Mara has potential of 200MW)	834,000,000	11,120,000	76.0
Agricultural support (tea microclimate)	Communities, household, large scale farmers—tea sector, forex, irrigation schemes,	253,500,000	3,380,000	23.1
Total value of indirect benefits		15,633,766,326	208,450,218	1,423.8
Total value		17,862,610,645	238,168,142	1,626.8

4.0 ASSESSING THE DISTRIBUTION OF THE BENEFITS OF THE MAASAI MAU, TRANS MARA AND EASTERN MAU FOREST BLOCKS

Forest resources have a standing stock of trees and other biological resources (plants and animals) with both flow and stock (capital) values. The values are relevant in considering proposed changes in forest use. It is assumed that the decrease in forests stocks and flows will affect the welfare of the people living near the forests and those who live further away that depend on the forest's directly or indirectly for various goods and services. Thus forest degradation will not only reduce the welfare of the human dependence on forests but as the biological resources found in forests.

4.1 Key Interest Group

Five categories of forest resource users were identified for this valuation:

1. Commercial users of forest products. These groups are interested in the market values associated with uses of forest products. The groups include saw millers and wood fuel vendors.

2. Local communities that rely on forests for survival values. These groups are interested in the forest for maintenance of their animals, to collect fruits and critical food and as a source of fuel.

3. Non-consumptive users. These groups include environmentalists and other institutions whose activities are directly affected by the forest such as the Kenya Wildlife Service (KWS) that is interested in the forest as an ecosystem or in providing food for wild animals. Educational and research institutions are interested in the forest as it provides experimental sites and specimens. The local community depends on the forests for cultural and spiritual values. The forests also provide recreational facilities for many groups of people.

4. International community. This group is interested in the forest for biodiversity and carbon sequestration and for some potential value for R&D.

5. Conservationists and environmental lovers. These groups of people are interested in maintaining the status quo of the forests because they believe the forests have some intrinsic values in their current form (option values) or should be maintained for future generations who may use the resources for functions that are currently unknown (bequest value).

4.2 Distribution of Benefits to Different Stakeholders

Most of the forest values are indirect values that accrue to communities living outside the proximity of the three forest blocks. Of the total economic value of the forest blocks, only 12% accrues as direct values. The local communities accrue 46% of the direct benefits by grazing their animals in the forestland for a fee paid to KFS. Water, poles and timber contribute 14%, 22% and 12% respectively to the total economic value of the forests. Of all the direct benefits from the forest, timber is the only product that is consumed by the industry, particularly the sawmills and accounts for only 0.5% of the current total direct use value of the forest.

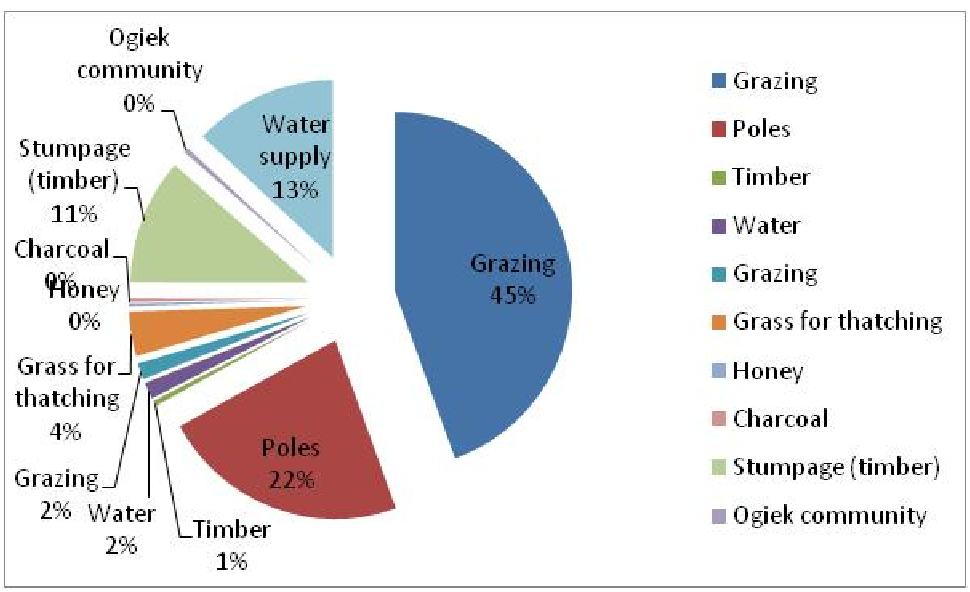
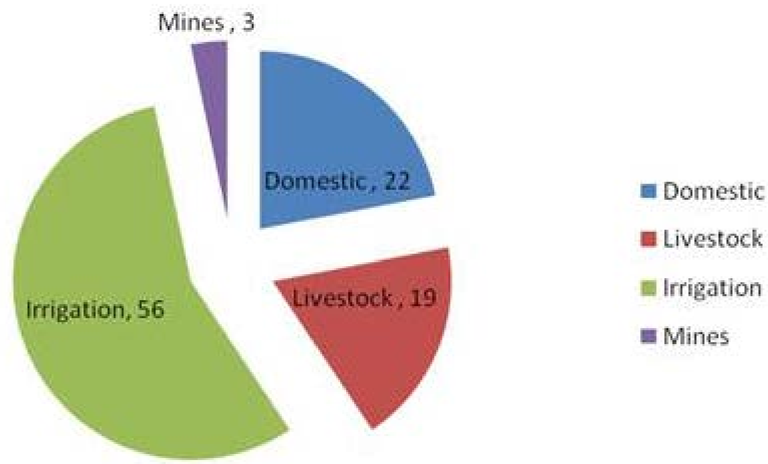


Figure 2: Distribution of direct use value of forest products and services.

We obtained an estimated number of households living within 5km from the 94,911ha forest. With the total economic benefit of KES 2,217,780,848, each household accrues KES 23,367 (US$ 312) per year. This amount can be interpreted as the amount they would be required to obtain from elsewhere in order to obtain the products and services offered by the forest. Individuals who can access the forest can only obtain the direct use values.

The forest dwellers, the Ogiek community, only gets 0.5% of direct benefits of forest and almost a negligible percentage of the total value of the forest. This is as a result of their small population and low extraction levels of forest products. The community has long argued that they do not destroy the forest and their utilization strategy is consistent with sustainable use of the forest.

The indirect benefits accrue to the off-site population. Tourism is the single major contributor to the total economic value of the forest blocks accounting for 67.5%. Indeed tourism cannot be possible without the supply of water from the Mara River. The water is so critical that wildlife could either migrate or perish without the water. Most of the



benefits from the tourism sector accrue to Kenya (93%).

Figure 3: Percent value of water used by different sectors at the Mara River Basin.

Kenya and Tanzania share the downstream benefits of conserving the forest blocks. Provision of water to the Mara basin contributes 10.3% of the indirect benefits of the forest. These benefits accrue directly to households through support of their critical livelihoods of livestock and domestic water supply. The commercial agriculturalists accrue 56% of the value of water from the catchment used in the Mara basin. Of all the indirect forest values, Kenya takes about 90% of the total value.

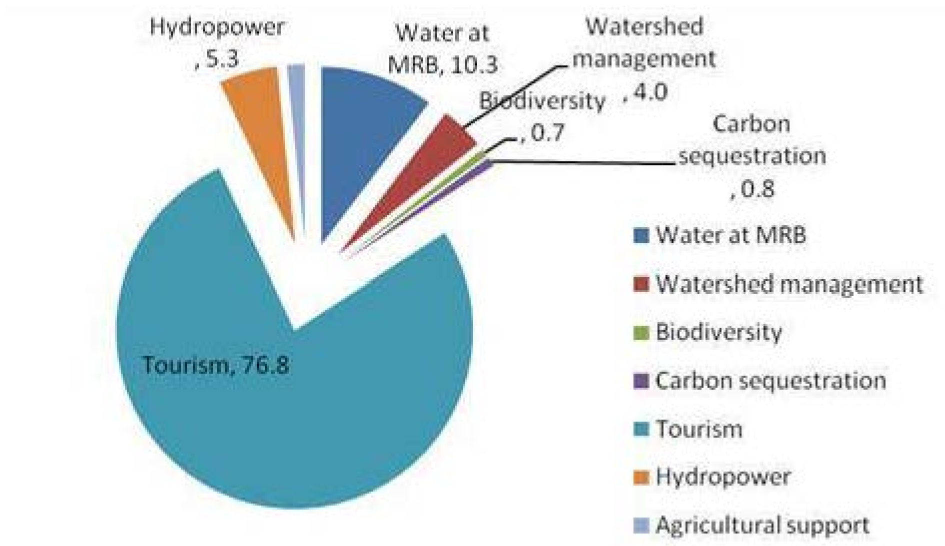


Figure 4: The distribution of the indirect forest benefits.

Among the direct uses of the forest, 80% of the benefit accrues to government (KFS) through the sale of forest products such as firewood, poles, grazing rights and timber. The communities obtain products and services that account for 21% of the total direct value of the forest without paying for them. An attempt is made to align each of the benefits based on the beneficiaries (Figure 4). There are various government agencies that manage and collect revenue from of sale forest products and services that make it the main beneficiary of the conservation of the forest.

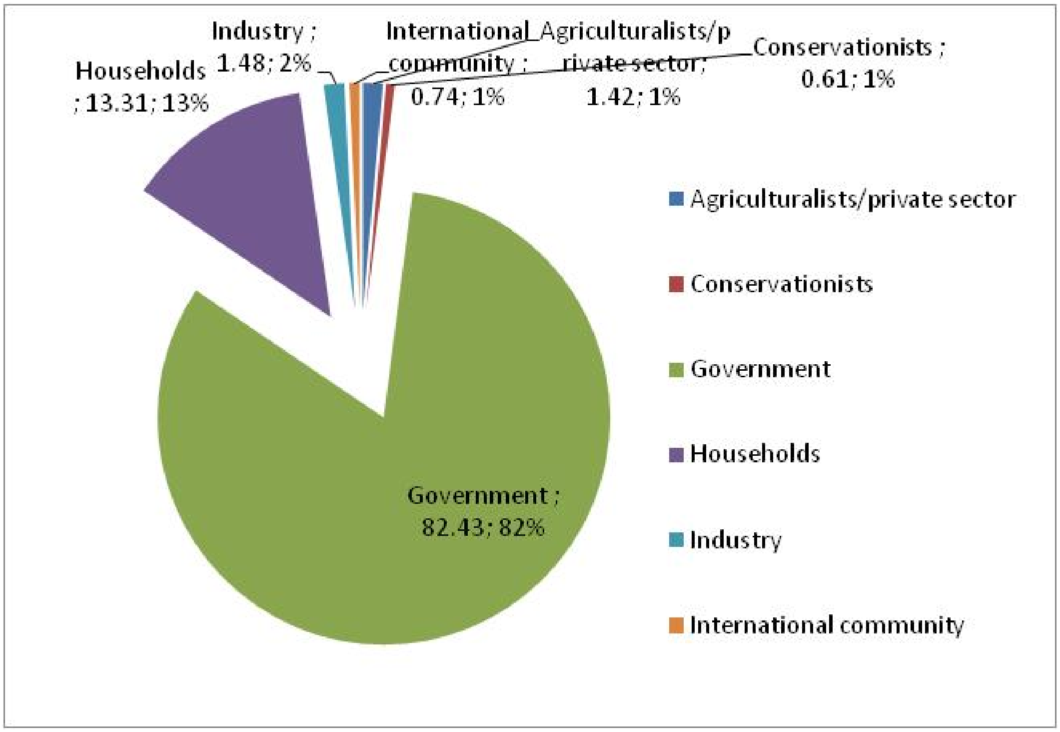


Figure 4: The share of the benefit among key beneficiaries.

The government ministries that receive the major share of the revenue are tourism that accounts for 67.5% followed by water with 13.4% (Figure 5). Other significant departments are livestock energy and agriculture all with a share of about 5%. Health and housing represent a small proportion of the value of the forests (Figure 5).

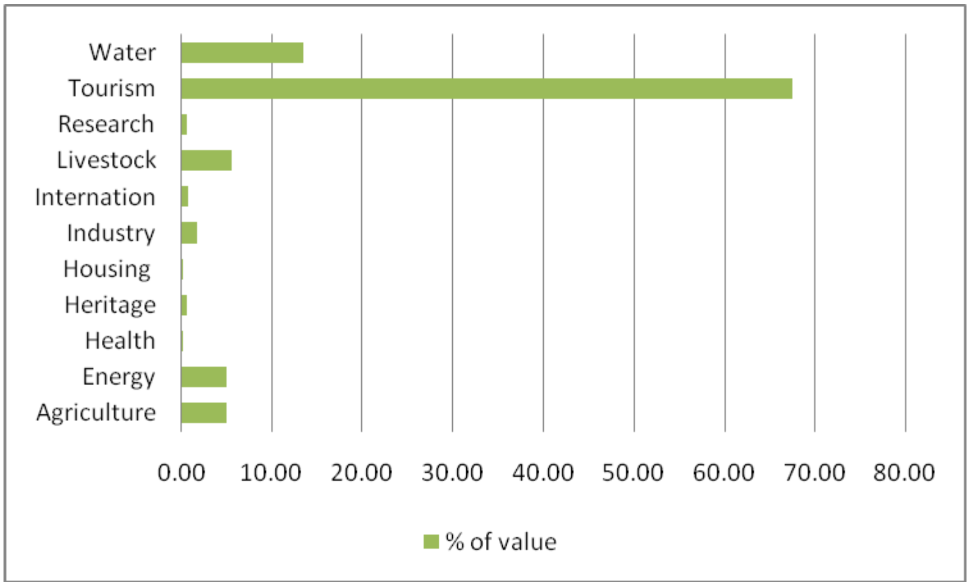


Figure 5: Distribution of benefits among government ministries.

5.0 DETERMINING, IN ECONOMIC TERMS, THE VIABILITY OF THE MAASAI MAU, TRANS MARA AND EASTERN MAU FOREST BLOCKS ECOSYSTEM

The economic viability of a forest can be assessed in terms of its ability to accrue adequate benefits to offset the costs of maintaining it. Cost–benefit analysis is an analytical tool, similar to financial decision making in the private sector, that can be modified to take into account the broader set of benefits and costs of the forest blocks. The benefit and cost approach is rooted in the theory of welfare economics that is based on the Kaldor-Hicks principle of potential compensation. The principle states that if the gainers from an action could compensate the losers, the action is an improvement regardless of whether compensation is actually paid (Dasgupta and Pearce, 1986).
The willingness to pay estimates were derived using various pricing techniques presented in Section 3 of this report as annual values. The annual values could remain steady if the forest stock is not changed, but if degradation continues the likelihood exists that the marginal willingness to pay would increase. Another factor that would increase willingness to pay in future is the incomes, i.e. when incomes increase, the willingness to pay increases across all income groups. Kriström and Riera (1996) note elasticity values should range from 0.2 and 0.3. For benefits with long analysis periods, their values could be adjusted for the long-term income effect. For this study, the income effect was assumed to be too negligible to affect the final conclusion of this study and was therefore not considered.

Values assigned to the three forest blocks should reflect the best alternative use for resources or the true willingness to pay for the provision of all the goods and services the community desires. The three forest blocks are legally established as gazetted government forests (Trans Mara and Eastern Mau forests) and trust land (Maasai Mau forest). This means that under the current laws, the alternatives to forest use do not include the possibility of turning them into agricultural land or making them available for logging and selling timber based on demand and supply of timber products. Although the real opportunity costs associated with options that are permitted by law, agricultural land provides the best opportunity cost because it is the desire of the local community that the forestland be made available for settlement. The area has also attracted a large number of illegal settlers who clear the forests and settle illegally. Indeed the options for the use of the Mau Forest Complex seem not to be directed by law as such, but by political processes and impunity of the communities.

For the local communities living near the forest blocks, the main value of the forests is hidden in the productive potential of the land that is under the trees. To this group, the value of the forest can be measured by the capital value of the land in the other intended uses. This can be captured using the present value of the annual or periodic net returns from using the land for those other purposes, minus the cost of clearing the forest and planting the new crop. The most important crops are wheat in the southern part of the Maasai Mau and tea growing in the other part of the forest blocks. The main argument in the valuation using opportunity cost is that when the forests are converted into agricultural land, the community loses all other benefits. The decision will involve cost and benefit analysis of the alternative uses of the forests.

Forests have been the main source of land for various land uses for the community and are part of way of life practised over many years. The settlements and encroachment into most of the three forest blocks currently taking place in most cases is for crop production for subsistence and cash generation. Thus the opportunity cost of conserving the Mau Forest complex is measured realistically by the foregone conversion into alternative land use currently undertaken in adjacent farms.

The land use currently practised by farmers and companies operating in farms adjacent to the selected forest blocks is farming, mostly tea, maize and potatoes. For this study we take tea and maize as the best alternative uses to the three forest blocks. To bring in the forest angle we shall consider the *Eucalyptus grandis* that is currently the remunerative forestland use adopted by many farmers in the region. Comparative land use studies by Cheboiwo and Langat (2008) using discounted cost–benefit analysis showed range of performance of the three land uses:

$$\text{NPV}= \sum_{t=1}^{n} \frac{(B_t - C_t)}{(1+r)^t} \qquad (4)$$

Where, NPV is the net benefit present value of the enterprise under consideration; B_t is the benefit generated in each year in KES; C_t = Cost in each year in KES; n is the rotation of the selected crop; r is the discount rate used to bring the benefits to the current values; and t is the time series under consideration.

For ease in comparison another tool equal annual equivalent is introduced as follows:

$$\text{EAE} = \text{NPV} \times \text{annuity factor} \qquad (5)$$

where annuity factor = $r\,(1 + r)^t/(I + r)^{t-1}$ (6)

The results in adjusted equal annual equivalent (EAE) per hectare based on a 10-year cycle are shown in Table 9. Tea is the most profitable land use followed by transmission poles, maize and firewood in that order. Thus farmers, *ceteris paribus*, if the objective is financial gain are likely to select tea farming as a priority farming enterprise given any extra land to utilize.

The opportunity cost of the conservation of the three forest blocks, instead of placing them under the selected competing enterprises, is shown in Table 9. The comparative analysis indicate that tea farming generated higher incomes as compared to the other potential farm enterprises that were are likely to compete for forestland.

Table 9: Potential net incomes for the three forest blocks of Mara River Basin for selected enterprises

Alternative investments	EAE in KES	Value (US $)	Benefit/Cost for change
Medium maize	22,325	41,967,547	3:17
Eucalyptus firewood	42,952	25,979,462	6:55
Eucalyptus poles	13,820	80,743,117	20:59
Tea farming	63,322	119,035,566	1:2

Note: The costs are interpreted to mean the value of forest that has to be lost when the land currently under forest is used for the alternatives uses.

Introduction of alternative enterprises provides opportunities and costs in foregone revenue. Tea farming strongly competes with the forest as it results in the reduction of total economic value by half. In any case, the forest remains viable compared to other alternative land uses.

5.1 The Forest Block Capacity to generate benefits to cover management costs

To assess the ability of the three forests block to be sustainably managed from revenue generated by use of its resources was not possible. However, current revenue generation from the forest blocks and direct expenditure by KFS on the administration of the three forest blocks were used as a proxy to evaluate their ability to sustainably to meet their management costs. The staff breakdown for two zonal offices that directly manage the Eastern Mau and Trans Mara forests was undertaken. The staff salaries and annual operational costs were estimated. The results indicate Nakuru had a total 294 staff in coordination, management and security that translates to 202ha per person or 380ha per forest ranger. This compares with 441 and 618 for Narok in the administration of gazetted forests (Table 10). It is assumed that 30% of the salary is needed to cover materials, daily subsistence, fuel and maintenance of vehicles and plants. Nakuru District is estimated to spend KES 1,127 per hectare per annum as compared to Narok District KES 590 per hectare per annum in direct administration forests excluding forest plantation and restoration expenditures.

From the revenue base, Nakuru that generated over KES 86 million would be able to cover its direct administration and development costs if the current land under plantations is sustainably managed. The Trans Mara Forest block, the only gazetted forest under KFS in Narok District, generated insignificant revenue as compared to the direct administrative costs. Therefore KFS was subsidizing its direct administrative operations from direct government payments or revenues generated from other forest blocks. The ability of the Masai Mau Forest to cover its direct costs is worse given that the Narok County Council did not generate any revenue from the forest in 2009 and covered the costs through transfer of funds from other sources including the Mara Game Reserve. The Council has been actively recruiting and training forest rangers and management staff to manage the Maasai Mau Forest.

Table 10: The expenditure in direct administration costs of the forest blocks

Staff category	Nakuru	Estimate costs/year (KES)	Narok	Estimate cost/year (KES)
	Number			
Zonal manager	1	960,000	1	960,000
Assistant zonal manager	1	816,000	1	816,000
Foresters (Station & Extension)	28	8,736,000	6	1,872,000
Account assistant	1	432,000	1	432,000
Clerical officer 1	2	456,000	1	456,000
Senior clerical officer	1	228,000	2	456,000
Typist	1	168,000	0	-
Senior store man	2	552,000	0	-
Subordinate staffs	94	12,408,000	11	1,452,000
Drivers	4	52,000	0	-
Plant operator	1	144,000	0	
Artisans	2	288,000	0	-
Forest rangers	156	26,208,000	57	9,576,000
TOTAL	294	51,448,000	80	16,020,000
Lorry	1		0	
Landrovers	2		0	
Pick ups	8		3	
Tractor	1		1	
Motor bikes	13		3	

From the above synthesis it is clear that cost–benefit analysis of the capacity of the forest blocks to generate revenues that cover the direct administrative and development costs is only possible for the Eastern Mau forest block due to the presence of mature plantations currently being harvested. It may not be possible to generate similar revenues on an annual basis because the age distribution of mature plantation trees is tilted to the presence of large portions under mature and young plantations. On support infrastructure, we observed that the offices and staff houses in the forest stations were in very poor conditions and unfit for use. The only vehicles available were stationed in the zonal offices and few, if any, in the stations at the three forest blocks. For efficient administration and conservation of the three forests nothing short of infusion of large amounts of funds from sources other than revenue is recommended since their ability to generate sufficient revenue from non-destructive sources is limited.

6.0 POLICY IMPLICATIONS OF THE CURRENT STATUS OF THE FOREST BLOCKS IN RELATION TO TOTAL ECONOMIC VALUE

6.1 Policy Implications of the Current Status

1. The current forest status in the three forest blocks is a product of seven factors that must be overcome in order to realize development of the three blocks to restore their ecological and economic functions:The history of institutional failures related to exclusivity in land tenure and property rights that have not been attractive to participation of the local people in conservation and management of forests.
2. Poor administration by under-funded KFS and the Narok County Council.
3. Poor policy and legal framework for conservation of the forests.
4. Favourable agricultural policies that have subsidized agriculture and developed highly remunerative marketing infrastructure.
5. Inadequate forest policy and legal framework that has provided insufficient incentives for forest conservation to thrive.
6. High population rates that have led to land scarcity and high poverty prevalence hence the push towards encroaching and dependence on forests for land and direct extraction of forest products and services for subsistence and livelihood.
7. Market failures that have consistently not priced or under-priced or forests goods and services that have made forests less competitive as compared to other land uses

6.1.1 Community Direct Use

The Mara River Basin upper catchment areas represented by the three forest blocks have undergone tremendous land use transformation over the last 25 years. The population living within 5 km of public forests account for 10% of the country's population and will increase at 2.5% per year, as will the direct demand on forest goods such as firewood, construction poles, timber, grazing and land for subsistence agriculture. The inadequate administrative capacity of KFS and the Narok County Council will make it difficult to effectively manage the three forest blocks and ensure sustainable extraction of various forest goods and services by the communities that live adjacent to the forest. The partnership structures with local communities are still in their infancy stages, hence forest management is still the exclusive duty of government agencies that are too thinly spread and under-funded to effectively manage large forest estates.

6.1.2 Biodiversity

The Maasai, Mau and Trans Mara forests are part of the 22 forest blocks mainly comprising plantation and indigenous forests that have been progressively excised over decades to make way for human settlement; what remains now is restricted to the crest of the escarpment. Generally, the forest used to consist of heterogeneous patterns of vegetation cover over the full stretch of the Mau Forest. Vascular plant species recorded in the forest are 280,200 genera and 95 families. A total of 64 tree species, 38 shrubs, 46 climbers and 132 herbaceous species have been recorded in the forest (Mutungah and Mwangi, 2006). Within this area, four distinct vegetation zones are obvious: bamboo zone; mixed bamboo/forest transition; relatively closed canopy forest zone of *Podocarpus latifolius, Prunus africana, Albizia gummifera* and *Olea capensis* species; and open canopy zone of *Neoboutonia* species habitat.

The flora of the Mau forest has been greatly disturbed by humans through unsustainable logging, bark stripping and other forms of harvesting. Recent individual landholding allocation has induced tree felling and land clearing for agriculture.

The Mau Forest fauna is reported to be unique owing to the high altitude, proximity to the Guineo-Congolian biogeographical realm and savannah grassland (KIFCON, 1993). The savannah species consist of spotted hyena, rare golden cat, and yellow backed duiker. The bongo is also present, especially within the South-west Mau Reserve. A range of forest primates such as the red-tailed blue monkey, bush babies, and white and black colobus monkeys and carnivores such as leopards are also present. Among the larger mammals, only elephants are present and they are restricted mainly to the Western Mau, South-west Mau and Trans Mara. The Mau Forest Complex has a rich and diverse invertebrate fauna. A total of 29 orders have been identified. Over 200 species of butterflies are found in the forest, at least 20 of which are known to be forest dependent species (KIFCON, 1993).

The Mau forest contains a rich diversity of bird fauna and has been accorded the Important Bird Areas status. Forty-nine of Kenya's 67 Afro-tropical highland bird species are known to occur in the Mau Forest Complex, including the grey throated barbet, bush shrike, Equatorial Akalat, red-chested owlet, Banded Prinia and Black-faced Rufous warbler. Of these bird species, 11 are listed in CITES I and II category, including the Verreaux eagle, Amani sunbird and Taita thrush. Others include regional endemic species, such as Hartlaubs turaco, the restricted range Hunter's Cisticola and Jackson's Francolin.

The Mau Forest Complex hosts great biodiversity that could be of great value to the future generations. The Convention on Biological Diversity provides an international foundation in which the societal and private benefits arising from its conservation can be equitably optimized. The value of biological resources as raw materials in the pharmaceutical and biotechnology sectors though in total economic value may change upwards with growing interests in commercial exploitation of biological resources. There is potential for some forest biological resources attaining commercial values when their uses are discovered. For example, currently unused species might combat some new disease or attack existing health problems more effectively. Thus the rich biological diversity can generate a series of benefits through bio-prospecting fees, site entrance fees, patent application fees, patent processing fees, annual user fees, transfer payments and royalties.

The biological diversity potential for the Mau Forest Complex is under severe threat from settlements and other human induced land uses changes currently taking place. These developments threaten to wipe out the future prospects for biodiversity exploitation and even the existence values that people place on forest existence independent of the values of particular uses. This value is assessed using the institutions investment in research on biodiversity resources.

6.1.3 Carbon Sequestration

Forest, by virtue of photosynthesis, absorbs carbon dioxide from the atmosphere to build its biomass, hence reducing the amount of atmospheric carbon dioxide in a process common referred to as carbon sequestration. For the forest to sequester carbon it is essential that the fixed carbon dioxide gas is not released into the atmosphere through burning or rotting when the trees die. Thus forests need to be managed in perpetuity to minimize release of the stored carbon into the atmosphere. Forest soils form an important store of carbon and leaving them intact makes them an effective carbon sink, offsetting significant amounts of carbon dioxide emissions annually. However, the capacity for carbon sequestration and storage in the Mau forest blocks has been reduced by forest clearing and burning that have released large amounts of carbon dioxide into the atmosphere. This negates the carbon sequestration balance sheet and the chances of benefiting from carbon trade facility. The current developments in the three forest blocks reduces the amount of carbon stored in biomass by releasing more carbon into the atmosphere mostly through forest clearing by burning. Thus the current activities lowers the capacity of the three forest blocks will to store carbon and hence the potential carbon stock values.

6.1.4 Water Provisioning for Human, Livestock and Agriculture

The excisions, encroachments and illegal logging have continued to destroy large areas of the forest blocks in the upper catchments of the Mara River Basin. For example, between 1986 and 2003 the closed canopy forest decreased by 23% whereas agricultural activities expanded by 55%. The conversion of the forests into agricultural land and expansion of land under intensive agriculture has increased soil erosion and reduced the water flow regulation capacity of the forests and other vegetation. The current threats to water resources in the Mara River Basin are related to rapid population growth and the associated intensification of small-scale agricultural activities in the headwater catchments of the basin. These developments have significantly changed the quality and quantity of water flowing in the river. Current farming practices facilitate soil erosion that carries along with it chemical fertilizers from farms. Current farming practices also diminish the rate of rainfall infiltration into soils and thus recharging of groundwater aquifers. This leads to more intensive storm runoff during the rainy months and reduced base flows during dry months.

The implications of these developments are felt mostly in water processing and in the economic sectors that rely heavily on the extraction from the Mara River Basin. The cost of implementing water sedimentation and purifying facilities to produce water fit for domestic and industrial uses can be very high. For example, the processing of water from the sediment loaded Sabaki River by the Sabaki River Water Works that provide water to Malindi is estimated to cost over US$ 1 million in primary settling basins and clarifiers. Furthermore, it was estimated that US$ 1.5 million was required to replace the pumpsets whose lifespan was reduced to half the planned working period due to unexpected sedimentation loads (Mogaka, 2005). The abrasion by stones, sand and logs moved by floods have also affected water works and widened river courses, thus increasing water loss through evaporation.

The same cost implications may apply to major urbanizing centres along the river basin such as Bomet, Mulot and Musoma which have to purify water, especially from the heavily sediment loaded Amala River. These costs can be minimized if proper conservation strategies are implemented along the basin. The small portion of the expected saving in avoided costs can be used in conservation activities in the key forests that serve the river. The water that flows from the upper catchments during the critical dry season have been decreasing and thus affecting ability of the Mara River Basin to provide adequate water to various economic sectors in the lower zones. These sectors include the fast growing population along the rivers, urbanizing centres and irrigated agriculture. The combined costs of seeking alterative water sources and purification of heavily polluted water can be substantial. These costs could be minimized using best land use practices including conservation of the upper catchments. These high costs of purification will increase the costs of water provision to the stakeholders while decreasing the real value to the water as a commodity as a proportion of the paid up rates thus relegating the catchment conservation benefit as most of the costs are taken up by processing costs. .

6.1.6. Tourism

Tourism is one of the leading sectors in the Kenyan economy, accounting for 12% of the gross domestic product and 9% of the wage employment. The sector generated KES 65.4 billion (US$ 872,000) in 2007. It is one of the major economic drivers in the Vision 2030 strategy due to its potential to generate revenue for government with the multiplier effects of supporting various commercial enterprises while creating demand for locally produced goods and services.

The two prime tourist attractions for Kenya and Tanzania are tied to the ability of the Mara River Basin to provide sufficient water to keep the animals within the protected areas. The demand for water continues to increase in the upper and middle zones of the river basin and is therefore likely to affect the downstream wildlife sanctuaries of Mara and Serengeti. The famous wildlife migration in the Serengeti/Mara plains is driven by the search for pasture and water. The spectacular scene of large numbers of wildlife crossing the Mara River has been classified as one of the wonders of the world. Significant changes in water supplies from the Mara River and the Mara River Basin ecosystems would seriously affect the wildlife sectors of Trans Mara and Serengeti which generate large amounts of foreign exchange, support many enterprises and create employment opportunities.

6.1.5 Wetlands

The land use changes in the upper Mara River catchments (mostly increased settlements and agricultural activities) have increased flooding frequency and peaks with subsequent build up of sediments in the lower end of the flood plains. The increased sedimentation on the flood plains increased the area under wetlands by 38% between 1986 and 2003 to 1,394.4 km^2 and displaced many people, adversely affecting their livelihood based agricultural activities (Khroda, 2010)

6.2 The Impacts of Current Status on the Total Economic Values

Results in Table 11 show that in general the current activities in the three forest blocks will reduce the ecosystem stocks and flows hence their total economic values if no urgent intervention to reverse the trend is undertaken. The impacts of the current status on the total economic values of the forest blocks are similar and therefore are crosscutting. Except for the status of wetlands, most factors will negatively affect the stock and flows of goods and hence the elements of the aggregated goods and services outlined in TEV.

Table 11: The impacts of current status of Eastern Mau Forest Ecosystem on total economic values

Current status/ impact on TEV	Illegal logging	Settlement expansion	Over-grazing	Weak KFS capacity	Weak community linkage	Plantations	Ogiek
Firewood	-	-	-	-	-	+/-	-
Poles	-	-	-	-	-	+/-	-
Watersheds	-	-	-	-	-	-	-
Tourism	-	-	-	-	-	-	-
Biodiversity	-	-	-	-	-	-	-
Carbon sequestration	-	-	-	-	-	-	-
Wetlands status	+	+	+	-	+	+	+
Water provision	-	-	-	-	-	-	-

(-) Negative impacts of current activities in the forest on the economic values of key ecosystem goods and services.
(+) Positive contribution of current activities in the forest on the economic values of key ecosystem goods and services.

6.3 Recommended Actions by Narok County Council on Maasai Mau Forest

The implication of the above activities is that the Narok County Council will have to put a lot of efforts in the administration and restoration of the Maasai Mau Forest. This will enhance the flow of goods and services that contribute to the total economic values accruing to the local people and offside economic sectors such as water provisioning and tourism.

For the County Council to effectively manage the Maasai Mau Forest block, several activities need to be attended to urgently including:

1. Adoption of relevant national and international policies and legal instruments that will ensure the attainment of standards for conservation, development and equitable sharing of costs and benefits.
2. Adoption and implementation of the forest management plan prepared by the Forest Working Group in 2009.

3. The Council needs to restructure its environment department to include recruitment and training of forest professionals and forest rangers. This will enable the Council to effectively administer the forest block.
4. Public institutions such as the KFS, KWS and LVBC and private sector agencies need to provide technical and financial support to County Council to enable it build its institutional capacity through training of skilled manpower, provision of infrastructure, equipment and financial resources for effective management of the Maasai Mau Forest block.
5. Provision of support to the Council to restore the forest status and to enhance its ecological functions and economic values by reclaiming and rehabilitating degraded forest areas.

6.4 Recommended Actions by KFS, Trans Mara and Eastern Mau Forests

For effective management of the Eastern Mau and Trans Mara forest blocks to enhance their ecosystem goods and services several activities need to be undertaken urgently by KFS with support for other partners:

1. Development of a comprehensive management plan for the forest that prioritizes the provision of key environmental goods and services to the adjacent communities and offside economic sectors that are key in total economic values of the ecosystem.
2. Conducting a comprehensive survey and mark the forest boundary.
3. Relocation of settlers that have encroached into the forest blocks.
4. The government needs to increase investment in KFS capacity in terms manpower, infrastructure, equipment and community support in order to enhance effective management of the Trans Mara Forest block and halt the degradation process.
5. Creating awareness among the local people on the importance of the forest resources and build their capacity to effectively participate in forest management through community based instruments outlined in several natural resources legislations.
6. Creating awareness among the local people who have been allocated land in the catchments to adopt best land use practices that are compatible with watershed management standards.
7. Provide some incentives to local people so that they forego land use practices that negatively affect provision and flow of quality water from farms.

8. Resettling the Ogiek community and empowering it them to adopt to the best land use practices compatible with sustainable flow of ecosystem goods and services from the forests.

7.0 THE INCENTIVES/DISINCENTIVES FOR CONSERVATION AND MANAGEMENT OF THE FOREST BLOCKS

7.1 Incentives for Community Participation in Management of Forests

Recent studies have shown that individuals with large natural forests on their farms in Narok and Marakwet districts continue to replace them with profitable alternative land uses till such a time that the forests accrue benefits that can exceed the competing land uses (Langat and Cheboiwo, 2010). This has been the case despite using such forests for grazing, firewood, and charcoal and timber extraction both for domestic use and sale. Since the main drivers of degradation in these forests are the local people, some package of incentives that will guarantee their livelihoods and motivate them to participate in their conservation and management will be one of the best options to consider. Thus payment for environmental services and access to direct use of forest products and services is an opportunity that the government and other agencies can use to motivate communities to participate in forest conservation.

Promotion of Sustainable Extraction of Forests Products

Communities living adjacent to the forests experience high levels of poverty, employment opportunities are scarce and the people have small land pieces that make them exploit the various forest resources for subsistence and income generation. Such people, despite stringent policing, may not forfeit such privileges easily, but will remain a feature in the forest management for a long time. These include access to firewood, grazing rights, water, medicine and grass. To ensure sustainable extraction of these products use of existing structures such community forest associations to prepare rules as provided by the Forest Act 2005 to limit extraction to agreed quotas that will not compromise the ability of the forests to generate expected goods and services as outlined in their management objectives. This will require capacity building to enable the local communities, the associations and KFS work together to manage such extractions under their joint supervision. The structures and procedures are provided for in the Forest Act 2005. They need trial operationalization along the borders of the three forest blocks. Experience has shown that access to specific products has provided sufficient economic incentives for communities to participate in conservation of forests; efforts must therefore include additional measures aimed at making sure that adequate economic conditions exist for local populations to gain from conservation activities (Emerton, 1999).

Forest products substitutions projects

The approach aims to provide the forest dependent populations with alternative sources of materials to substitute for those extracted from the forests. In Maasai Mau, the Ewaso Ngiro South Development Authority with donor support have implemented such projects among the stakeholders who live adjacent to the forest, mostly farmers and schools, to establish tree nurseries and to plant trees on farms. The support aims to enable such people to grow their own trees for sustenance and income generation. Making available or strengthening these non-forest alternative sources of forest products will reduce the dependence of the local population on forest resources, although it may not completely substitute demand for local forest utilization.

7.1.3 Income generating forest based activities

Communities are supported to generate sustainable and competitive incomes through the sustainable use of forest resources. The aim of such incentive packages is to address poverty while promoting people to support forest conservation, mostly by utilizing non-destructive exploitation of forest based resources. Classical examples of such projects that have been piloted in Kenya include the United Nations Development Programme-Global Environment Facility (UNDP-GEF) project that targeted the globally significant, biodiversity-rich forest sites of Arabuko-Sokoke, Kakamega and Mwingi. The project supports communities living adjacent to these reserves to commercially rear insects to provide communities with economic incentives to participate in collaborative forest management. The adjacent villages are supported to undertake gathering, cultivating and marketing of traditional commercial insect products, such as silk and honey, and to set up butterfly farms. The approach can be piloted in the study forest blocks through close integration of investment into productive rural infrastructure, forest resources, human and institutional development, in a way designed to reduce pressure on forests, their biodiversity and resources.

Devolution of management and benefits

The state has been the only stakeholder with monopoly of authority over public forest resources and benefits to the exclusion of all other stakeholders. The Forest Act 2005 has provided a framework for devolution of forest authority and benefits, but it may be difficult for government to offer a sufficient degree of autonomy to the devolved structures, especially giving a larger stake to local people. The exclusion of local communities from the property rights from public forests ensures that local people are denied an economic stake in forest resources. This explains the historical resentment of local people to talks on forest conservation. The recognition of local people's property rights and economic interests in forest resources will be sufficient incentive for them to participate in forest conservation that involves sharing of costs and benefits. The devolution should be in line with the counties in the current constitution: the state establishes well defined secure and transferable rights over forest resources and their management to include leasing, concessions, franchises or other arrangements. The devolved structures should aim at scaling down to the lowest level of government that will enable such entities to invest, manage and exploit sustainable forest income generating opportunities in partnerships under the supervisory role of the higher structures including the state.

The devolved property rights and benefits will provide sufficient economic incentive for conservation of forest resources driven by local people. The promulgated constitution of Kenya and the Forest Act 2005 (with some minor amendments) provide a sufficient framework for such a devolution process to be implemented.

7.2 Market Based Incentives

The concept is based on promoting voluntary efforts by land owners who control specific areas that are of interest to ecosystem conservation. This is done through regulatory assurances and incentives that encourage land owners to manage target land in accordance with the conservation and owner objectives. The market based incentives concept is based on the user pay principle that aims at remedying the common practice where the downstream stakeholders benefit from the ecosystems services, but those who bear the cost are not properly compensated for their efforts. The market-based tools are shaped such that they make landowners become better stewards of their land while realizing new income opportunities.

Innovative conservation incentives will turn forests into an even greater asset by encouraging sustainable land use and improvement of ecosystems that serve water flows. The concept involves identifying conservation areas, bringing on board various stakeholders, trial runs of various market based incentives, selection of independent implementing agencies, and adoption of conservation schemes that compensate landowners affected by expected developments. It involves a collaborative network of organizations and agencies that are actively involved in the development of market-based strategies and tools aimed at the conservation and restoration of ecosystems like forests, water basins, wetlands, and others services. The development of such models will involve stakeholder profiling, consultative processes, information exchange, favourable policy and legal regimes, guidelines for market operation, and development of market-based approaches. Like easement and zonation, use of independent institutions to facilitate the payment of incentives to conservation agents and the collection of revenues from beneficiaries is integral part of the framework.

7.2.1 Payment of Environmental services

The major drivers of forest degradation and subsequent loss of ecosystems service stock and flows are mainly the local people. Those that enjoy the benefits of better-managed watershed services should give incentives to communities adjacent to the forests to participate in management of forest resources. In short, the upstream stakeholders become sellers of environmental services while the downstream users become buyers. Such links and payments are commonly referred to as the payment for environmental services (PES). A recent study in the Mara River Basin that evaluated the water condition, PES contexts, and the process of developing PES and roles and responsibilities of key stakeholders (Bhat, et al, 2006) provide some useful information for further discussion.

The report showed that the legal framework in Kenya is robust enough to accommodate PES under the Water Act 2000, the Environmental Management Act (EMCA, 1999) and the Physical Planning Act 1996 among others. The institutional framework for PES schemes are fairly well developed in Kenya and Tanzania with various players created under the above legal set ups being present within the Mara River Basin. These include

Water Resources Management Authority, Lake Victoria Basin Water Office, water catchment area advisory committees, water resources user associations and water users associations. Furthermore, WWF (which has been instrumental in initiating various institutional capacity development activities in the Mara River Basin) has facilitated formation of the Mara River Water Users Association and the Mara catchment committees in both Kenya and Tanzania. The report notes that despite accelerated reforms in the water sector and in particular the existing institutions in both financial and skilled human manpower, ineffective enforcement of conservation laws, general lack of awareness on the importance of watershed among upstream stakeholders, inadequate consultative process to bring together key players among others still remain problematic. All these problems cut across the national and transboundary water resources such as the Mara River Basin. However, the transboundary management structures are also being developed specifically for the Mara River Basin by the LVBC to provide a potential platform for watershed conservation groups and beneficiaries to establish a legal framework for incentives schemes.

Because many ecosystem payments will provide only supplemental income, it makes sense to consider their role as a catalyst or enabling mechanism for adopting better management practices. Even a modest level of payment, reliably paid over many years, can provide the increment to net income that makes a sustainable forest enterprise viable, justify the restoration of degraded forest, or increase resource-use efficiency.

7.3 Others Incentives

The environmental easements

The water catchments areas of the three forest blocks are mostly protected areas. They ensure that key features of the Mara River Basin including vegetation cover, inflow quality, sedimentation loading, riverine ecosystems and the ability of the basin to provide quality water resources are sustained. These forests can be conserved through use of innovative incentives such as environmental easements. An easement is a legal right to control certain uses of a piece of land; a conservation easement gives the holder of the easement, usually a conservation organization or a government agency, the right to restrict or forbid future development on a parcel of land, even though the original owner may continue to make some use of the property.

The concept is well developed in the USA and England. The African Wild Life Foundation and the Kenya Land Conservation Trust are evaluating its potential in negotiating for wildlife corridors that run through private owned land. EMCA (1999) sections 112–116 provide for the creation of environmental easements to facilitate the conservation and enhancement of environment, by imposing one or more obligations on land uses.

At global level many land trusts have been established to help private landowners achieve permanent protection of lands that contain valuable wildlife habitat or that are of historical, agricultural, recreational or scenic importance. The land trusts assist both private landowners and government agencies, either by facilitating the transfer of land to the public or by managing the land in accordance with the purpose of the charitable donation.

Zoning for environment services

This concept is based on land planning where some areas of land, irrespective of ownership, are zoned for specific activities depending on the local and national priorities or any criteria approved through consultative or legal processes. The zoned land areas are considered for a range of incentives by the state and local governments to motivate landowners to adopt the recommended specific land use practices that meet the specified criteria. The zonation planning is cognizant that rights to property are protected under the constitution and legal tools and the only options available are fair market compensations through outright purchase or incentives that satisfy the resource owners. The implementation process and players are similar to those outlined in conservations easements. The concept can be applied for both private and public forests.

Environmental Quality Incentives Programs (EQIP)

This is a volunteer based scheme that offers landowners financial and technical help to adopt conservation practices that have been approved for specific activities. It involves signing contracts for specified periods that will enable financial assistance to develop conservation plans and implement conservation practices. The programme promotes land use practices that meet the standards set by the EQIP plan of operations developed in conjunction with the land owners that undertake appropriate conservation practice or measures needed to address identified natural resource concerns. The practices are subjected to technical standards adapted for local conditions. The land owners are paid up to a maximum based on a valuations framework that ensures that fair prices are paid to participating landowners and that avoids excessive or wastage of resources.

7.4 Disincentives

The promotion of land use practices that conserve ecosystems services in most cases are backed by strong policy and legislative frameworks with strong punitive measures that tend to discourage adoption of practices that conserve and protect ecosystems. Legal sections usually present a series of consultations and penalties that will be meted out to landowners who do not conform to specified practices. Such regulations tend to antagonize local people who might otherwise cooperate with conservation efforts. Thus, regulations that impose costs on the local people with minimal benefits may prove to be counterproductive and may not attain the intended outputs. Before any conservation scheme is implemented, therefore, the potential impacts of such activities on the economic bottom lines of the local people should be fully evaluated. Recent studies have shown that most regulations impose high costs on local people without compensating benefits for their participation in forest conservation. The ultimate reactions have been to adopt strategies that minimize such exposure through well calculated plans that negate the achievement of the desired conservation values.

Such experiences indicate that equitable negotiated voluntary schemes may be more effective than punitive regulations in winning the support of local people in conservation projects. It is expected that modest financial incentives can produce significant ecological gains at modest cost and can motivate local people to participate in ecosystems conservation efforts. It is advisable that less emphasis should be placed on punitive actions that are likely to create perverse incentives that work against effective ecosystem conservation of forests.

Potential Role of LVBC Incentives Schemes

These incentives schemes can be piloted in the three forests through voluntary agreements with KFS or the Narok County Council to determine which conservation practices would be best for some key catchment areas or the entire forests block. LVBC in collaboration with other stakeholders can facilitate structural development to host such a facility and mobilize funds from local beneficiaries and global environmental market facilities to pay for the conservation efforts and foregone benefits. The payments for foregone benefits can be directed to supporting forest administration agencies and forest adjacent local people. The market based and voluntary incentives tools could be extended to private landowners who have put in place land use practices that have enhanced the environmental services in their properties.

Incentive delivery systems range from income and non-income benefits from ecosystems discussed above that can be facilitated by LVBC within the Mara River Basin in collaboration with relevant institutions and stakeholders. These incentives include allowing households to collect various forest products mostly firewood for domestic use; and support to forest restoration in catchment areas to reduce landslides and control soil erosion and sedimentation. Others include financial and technical support for community projects such as provision of social services, ecotourism and infrastructure.

8.0 Conclusion

This study estimated the total economic value of three forest blocks of the Mau Forest Complex. The total annual economic value of the three blocks is estimated at KES 17 billion (US$ 238 million) spread throughout the economy with the direct use values accounting for 12.4% of the value of the forest.

The opportunity cost of changing forest into other land uses will lead to economic loss to the economy. Incentives must therefore be given to the community and capacity building provided at all fronts and levels of forest conservation, especially for the community to recognize the true economic value of forest conservation.

The losses that would be experienced by changing the forests to commercial agriculture or to other vegetation forms could be up to two times, demonstrating that the values of the benefits of the forest are immense.

Private benefits to households are significantly smaller than those which accrue to the wider society. There is need to influence the community to appreciate the benefits of the forests in order to encourage sustainable use of forest resources.

The policies and legal instruments, though sectoral in nature, were found to be adequate for encouraging conservation and development of ecosystems for environmental services, especially the comprehensive Environmental and Coordination Act (EMCA, 1999). The weakness of these instruments is their segregation into sectoral set ups that fail to deal with the holistic nature of ecosystem services. An integrated approach to the management of the Mar River Basin forest blocks may need to be forged from the many institutions that are currently interested in the Mau Forest Complex.

Responsibility for conserving the forest blocks should be commensurate with the potential or actual benefits derived. Thus, the Government of Kenya should take the lead in investing in this activity and facilitating the transfer of part of the social benefits that accrue downstream to those that incur costs in undertaking conservations practices along the MRB. There are various incentives schemes that can be can be used to support conservation measures. The three forest blocks can be used as a model project to test such schemes with the support of various instruments such as REDD+ among other specific international conventions given the national and regional significance of Mau Forest Complex. Benefit transfer, however, raises fundamental issues of ownership regimes of the forests. In order to transfer the benefits, it may be more beneficial to give forest adjacent communities more rights of ownership of the forests.

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APPENDICES

Appendix 1: Terms of reference (ToR) for the consultancy services to undertake total economic valuation of the Maasai Mau forest, Trans Mara and Eastern Mau forest blocks

1. Introduction

1.1 Background

The East African Community/Lake Victoria Basin Commission (LVBC) has received funds from the USAID East Africa to support Sustainable Development of the Mara River Basin. The project is jointly implemented by both the Republic of Kenya and the United Republic of Tanzania. It is coordinated by LVBC Secretariat and implemented by key stakeholders in Mara River Basin.

The overall objective of the project is to promote harmonized Mara River Basin management practices for sustainability. The specific objectives are to:

(a) Develop and promote the implementation of an appropriate trans-boundary management framework for Mara River Basin;
(b) Improve the protection and management of Maasai Mau Forest Blocks resources and Mara riverine forests;
(c) Enhance sustainable management of the protected areas of Maasai Mara and Serengeti ecosystems;
(d) Improve water resources management in the basin; and
(e) Enhance institutional capacity of the Lake Victoria Basin Commission to undertake its regional mandate.

The role of the LVBC Secretariat is principally to provide the regional inputs expected and identify regional projects/Programme, institutions in the Lake Basin and providing them with the necessary regional supports.

1.2 Need for consultancy

The Mau Forest Complex Blocks form part of the five crucial water catchments or "water towers" in Kenya. It is the source of some of the large rivers in Kenya that drain and sustain Lakes Nakuru, Baringo, Victoria and Natron. It has a big potential in environmental sustainability, social and economic development. In respect to direct use in terms of timber, fuel-wood, and other uses, Mau has contributed significantly to the national income and livelihood of people living around. The Complex is an important warehouse of biodiversity.

The Mau forest complex falls under three ownership regimes; Government Gazetted Forest, Trust land Forest - under County Council and Private farms/groups ranches. The Mara River originates from the Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks. Maasai Mau, Trans Mara and Eastern Mau Forests are estimated to serve more than three million people in Kenya and Tanzania through the Mara River, as well as supporting large Maasai Mara –Serengeti ecosystems. In spite of the important role that the Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks are playing in ecological stability, rural, national and regional economies, this mosaic of ecosystems is under threat from a series of sources leading into destruction and loss of its key functions. The major threats to the Mau forests include encroachment by settlers, unclear forest boundaries, and ownership conflicts, including issuing of fake titles, illegal logging and inadequate law enforcement. The situation has been complicated by political interference and uncoordinated ownerships of the forests mentioned above.

In order to sustainably manage these forests as source of the Mara River, the governments of Kenya and Tanzania as well as the communities aroundd these forests need to be well informed on the dynamics of the forest management and its functions. The economic value of these forests will add value to not only the need to conserve these forests; but also encourage communities to participate in their management.

2. Objectives of the consultancy

2.1 General objective

The general objective of this consultancy is to inform the planning process and decision-making organs on the role of the forest in sustaining local livelihoods, national economy as well as sustenance of ecosystem stability. Informed stakeholders are expected to play a more crucial role in the conservation and sustainable management of the Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks.

2.2 Specific objectives

The specific objective of the consultancy is:

(a) To demonstrate the total economic value of the forest blocks based on clearly identified chain of stakeholders or beneficiaries
(b) To demonstrate the linkages (using various economic tools) between the stakeholders and the target ecosystem and

(c) To recommend and provide feasible incentive-packages and implementation mechanisms aimed at promoting sustainable conservation and management of the Mara River.

3. Scope and tasks of the consultancy

The consultant(s) will undertake a study on the Total Economic Value of all Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks.

4. Tasks of the consultant(s)

The tasks of the consultant(s) will include, but not limited to the following:

(a) Determining the Total Economic Value of the Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks ecosystem

(b) Assessing the distribution of the benefits of the Maasai Mau Forest, TransMara and Eastern Mau Forest Blocks ecosystem

(c) Determining in economic terms, the viability of the Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks ecosystem;

(d) Determining the policy implications of the current status of the Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks Conservation in relation to the Total Economic Value.

(e) Recommending the incentives/disincentives for the conservation and management of the Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks ecosystem.

5. Methodology

This shall involve literature review and interviewing key stakeholders here including projects and institutions dealing with Forest, wildlife and Water management in or working within or around Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks. Detailed methodology and action plan shall be provided by the consultant and agreed with the client.

6. Deliverables from Consultant(s)

a) A comprehensive report on Total Economic Value of the Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks;

b) A comprehensive report on the policies, legislations and institutional recommendations for the sustainable management of Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks to optimize the Total Economic Value of the Maasai Mau Forest, Trans Mara and Eastern Mau Forest Blocks.

7. Duration of Assignment

The consultancy is expected to take 20 consultancy days. The final report should be produced not later than 31st August 2010.

8. Qualifications and Experience required of Consultants

The study will require consultant(s) with a team of Specialists having the following skills and experience:

(a) The Team Leader shall have a post graduate degree and professional experience in Natural Resources Economics or Environmental Economics of at least five years;

(b) Other team members have post graduate degrees in Forest management, Economist to cover other sectors (energy, tourism, agriculture, livestock etc),Water resources management and a Socio-economist; and

(c) The team members must demonstrate working experience of at least five years with multi-stakeholders, institutions; and interactions with the local communities, protected area managers, local leaders, politicians and policymakers.

9. Reporting

The consultant will report to the Executive Secretary, LVBC but on a day to day basis work closely with the Mara River Basin Project Coordinator. Consultant (s) will be required to produce the following:

i. Inception report to be delivered **one (1)** week after the date of signing the contract.

ii. Draft Report to be delivered **three (3)** weeks after presentation of acceptable inception report

iii. Final report to be delivered **two (2)** weeks after submission of the draft report

All reports will be submitted in six hard copies and a soft copy in a CD.

Appendix 2: Calculations for direct use values by households

1.1 Firewood: Using the residual value

The household surveys carried out showed that on average sample households used 277 headlots of firewood per year. The amount collected was more than double that of other forests blocks because the collections are sold in the vibrant firewood markets in Molo and Elburgon. It takes two person hours to collect one headlot; an 8 hour wage is KES 150. The collection costs = (1/8*150 = 38). The local price per headlot is KES 100. The proportion of the households that depended on the forest for firewood was 80%.

The annual value of firewood extracted = (0.8x277x47802.3x (100-38)= KES 656,765,360.

The same is straight from the table: 0.8×277×47802.3x (100-38) = KES 656,765,360.

1.2 Poles

The household surveys carried out showed that, on average, sample households used 188 construction poles per year. The amount collected was higher for the Eastern Mau as some of the poles were sold to urban traders in Molo and Elburgon. It takes 22 minutes to collect 1 pole; an 8 hour wage is KES 150. The collection costs = (150×22/8×60 =KES 7). The local price per pole is KES 100. The proportion of the households that depended on the forest for firewood was 60%. The annual value of poles extracted = (0.6×188×47802.3x (100-7) = KES 501,465,248.

1.3 Timber: Residual costs

The household surveys carried out showed that, on average, sample households used 0.06$m^3$of sawn wood timber per year in Eastern Mau. Processing 1m^3 of sawn wood by power saw costs KES 9,500. The local price of 1$m^3$of sawn wood is KES 15,700. The proportion of the households that processed sawn wood was 47%. The annual value of sawn wood processed from the forest =(0.47X X 0.06X (15700-9500) = KES 7,112,982.

1.4 Water for livestock

All the households within 5 km Eastern Mau all watered their animals from streams inside or emerging from the forest. The livestock unit equivalent of the livestock kept was 47,802.3. We assumed that each livestock units (LU) consumes 35 litres per day. The water demand per LU per year = 40×365 days/1000 =14.6m^3. To take the animals to the river and back takes 2 person hours and hence the cost = 2/8×150 = KES 38 per day for 40 litres of water equivalent to (38/40 = KES 0.95/l). The cost of delivering a 20 litre jerrican of water by donkey is KES 20. The value of the water consumed by livestock per household = (14.6×13,099.6 ×1000-950) = 9562708

1.5 Household water consumption

The numbers of households within the 5 km perimeter of East Mau are 47,802.3. We assumed that households need 40 litres per day for their operations and its takes 2 person hours to collect the water per day. The cost = 2/8×150 = KES 38 per day for 40 litres of water equivalent to (38/40 = KES 0.95/litre). The cost of delivering a 20 litre jerrican of water by donkey is KES 20. The value of the water consumed by a household = (47802.3 × 14.6 ×1000-950)= 34,895,679.

1.5 Timber: Using Residual value

The annual amount of timber extracted = (0.4×0.06×47802.3x (15,700-9500) = 7,112,982

1.3 Grazing values: Using market price equivalent

One LU requires 9kg of dry matter per day. It is further assumed the 10% of the feedstuff are derived from forests. Total for the year = (0.9×360 = 324kg) of grass. Using a market price for 30kg of hay of KES 200 the value of the grass consumed per livestock unit per year =(KES200/30kg×324kg = 2,160). The number of bales equivalent per year = 324/30kg = 11bales/year. Our survey indicated that of the 13,099 LU within the 5km perimeter Eastern Mau and 64% the households were dependent on forest grazing The annual hay equivalent extracted from the forest = (0.64×13099.6×11×200) =25,151,232 or 0.6×11×13099.6×200.

1.6 Honey collection

We assumed that collecting 10kg of honey requires 1 man-day and each household, on average, collected 10 kg of raw honey per year. The 10kg of raw honey produces 3 kg of clean honey and hence cost per kg = 150/3 = KES 50. The local price of 1 kg of honey is KES 150. The value of honey extracted by 40% households = (0.4×3× 47802.3x(150-50) = 5,736,275.

1.7 Charcoal processing

A total of 5% of the households reported that they process charcoal; the market rate for charcoal processing in the areas is KES 50 per bag. Each bag of charcoal sells at KES 200 at the farm gate. The value of charcoal processed from the forest = (0.05×18.29×47802.3x (200-50) = 6,557,280.

Appendix 3: The checklist of data collection on the total benefits in Mau Complex

1. **Direct Benefits**

   - Plantations located in Mau Forests: Size (ha), age distribution, harvesting rates, industries
   - Poles extracted from Mau Forest: annual extraction, unit price, buyers
   - Firewood extraction by industry and households: annual industrial extraction, unit prices, household licensees, revenue generated by KFS from household
   - Forest types and sizes of each forest (natural, grassland, bamboo, degraded, settled)
   - Grazing dependence: seasonal: dry season and wet season: number of cattle, goats, sheep grazed in forests blocks in Mau
   - Water extraction undertakers dependent on Mau Complex: Water Resource Management Authority, water resources user associations: municipalities

2. **Indirect Benefits**

   - Tourism: visitors: gate charges, bed occupancy: Maasai Mara Game Reserve: KWS, Narok Council, KFS

4. Threats to the three forest blocks (encroachment, excision, grazing, fires, charcoal burning)

Appendix 4: List of contacted and interviewed experts and staff

Person/office	Place	Issues discussed
Assistant Zonal Manager and Zonal staff	Elburgon	Direct uses of forests, excisions, infrastructure, water extraction, forest administration
Forester Marioshoni	Marashioni	Forest status, excision, Ogiek issues
Ogiek Council Members	Marashioni	Ogiek issues, direct uses of the forest
Forester Kiptunga	Kiptunga	Forest status, Ogiek issues, water catchment, grazing
Settler groups	Sierra Leone	History of the settlement, settlers, views on conservation
Head teacher	Olposimoru Primary School	History of the area, forest degradation, conservation efforts
Zonal Manager office	Narok	Forest excision, encroachment, direct uses, conservation efforts, , forest administration
Water Resource Management Authority office	Narok	Water resource development, key users, hydrological zones, irrigation, seasonality, impact o degradation
WWF-Mara River Initiative	Narok	Mara River information, development issues, networking, achievements
Narok County Council	Narok	Maasai Mau, direct forest uses, encroachment, conservation efforts, forest administration
Narok Town Council	Narok	Water issues, Maasai Mau Forest importance, conservation efforts
Tea Research Foundation	Kericho	Tea production, impacts of microclimate on tea production and quality, forest conservation efforts
Kenya Forestry Research Institute	Londiani	Research activities in Mau, forest restoration information, livelihoods of forest adjacent communities, natural succession, forest ecology
Sokoine University of Agriculture (SUA),	Faculty of Forest and Nature	Research activities in Mara Basin

Tanzania	Conservation, SUA National Agricultural Library	

Appendix 5: Cover factor (c) for crops

Vegetation cover (%)		Soil loss (in proportion to loss from base soil)
0	1.0	1.00
10	1.0	0.33
20	1.0	0.20
30	1.0	0.15
40	0.86	0.10
50	0.72	0.07
60	0.58	0.042
70	0.44	0.024
80	0.30	0.013
90	0.16	0.008
100	0.02	0.003

Source: FAO/IISA (1991).

Appendix 6: Relationship between to psoil loss and yield loss

Soil Susceptibility ranking	Level of inputs	Equation
Least susceptible	Low	Y = 1.0X
	Intermediate	Y = 0.6X
	High	Y = 0.2X
Intermediate susceptible	Low	Y = 2.0X
	Intermediate	Y = 1.2X
	High	Y = 0.4X
Most susceptible	Low	Y = 7.0X
	Intermediate	Y = 5.0X
	High	Y = 3.0X

Appendix 7: Tourism industry performance in Tanzania

Item	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	153.0	186.8	201.7	230.2	261.6	295.3	326.2	360.0	482.3	627.3	502.0
2		171.8	187.6	216.3	238.5	268.2	296.2	345.0	457.3	564.6	
3	65.0	94.73	120.04	146.84	192.10	259.44	322.37	392.41	570.00	733.3	739,1
4		507.0	595.0	637.9	734.3	878.5	1090.0	1181.6	1169.0		
5		7.0	7.0	7.1	7.1	7.2	7.3	7.5	7.6	7.7	
6		72.42	85.00	89.80	103.40	122.00	135.00	145.00	155.50	152.00	
7		205	207	198	208	210	212	213	215	321	
8		5,484	6,150	6,100	6,335	6,935	6,970	7,470	7,500	9,575	
9		1.03	1.13	1.32	1. 45	1.67	1.87	2.25	2.94	3.38	
10		9,878	10,963	10,860	11,335	12,145	12,348	13,248	13,400	17,235	
11		56	56	56	56	57	56	56	60	64	
12		45.0	50.0	86.0	86.0	96.0	100.0	110.0	132.0	148.0	

Source: URT (2001). The Planning Commission.

Key:
1 = Total number of tourists (thousands)
2 = Number of tourists in hotels (thousands)
3 = Total earnings (in US$ millions)
4 = Average earnings per tourist (in US$)
5 = Average number of bed nights per visit (in days)
6 = Average daily expenditure per tourist (in US$)
7 = Number of hotels (number)
8 = Number of hotel rooms (number)
9 = Tourist bednights in hotels (millions)
10 =Number of hotel beds (number)
11 = Average hotel occupancy rate per year
12 = Number of employees in the tourist industry (thousands)

Appendix 8: Rapid result questionnaire for households adjacent to the Mara Forest Complex

Direct use of products and services

Home consumption and sale

Product	Unit measure	Quantity/ season	Annual estimates	Current market price in KES	Annual value in KES
Poles	No				
Fencing posts	No				
Sawn wood	M3				
Firewood	Headlot				
Thatching grass	Headlot				
Charcoal					
Honey	Kg				
Forest soils	Tonnes				
Medicinal					
Grazing	No. of animals				
Water	Litres				
Others specify					

Appendix 9: Economic values of forest watershed functions

Study	Watershed function valued	Results ($/ha per year)
Ammour et al. (2000), Guatemala forest	Prevention of soil erosion.	Negligible
	Prevention of nutrient loss. Nutrients in aerial biomass valued at fertilizer prices.	12–30
Kumari (1996), Malaysian forest	Protection of irrigation water for crops.	15
	Protection of domestic water supplies. Valued at treatment cost for improved quality	0
Yaron (2001), Mt. Cameroun	Flood protection valued at value of avoidable crop and tree losses.	0–24
Pattanayak and Kramer (2001), Eastern Indonesia	Drought mitigation from forest protection and regrowth.	3–35 per household
Bann (1998), Turkey	Soil erosion valued by replacement cost of nutrients.	46
Adger et al. (1995), Mexico	Sedimentation effects on infrastructure.	Negligible
Hodgson and Dixon (1988), Philippines	Fisheries protection from avoided logging.	268
Anon (2001), Venezuela	Avoided sedimentation of hydro-reservoir. Urban water supply. Protection of irrigation.	14–21 6–13 1–6

Source: Secretariat of the Convention on Biodiversity (2001).

Appendix 10: Categorization of stakeholders

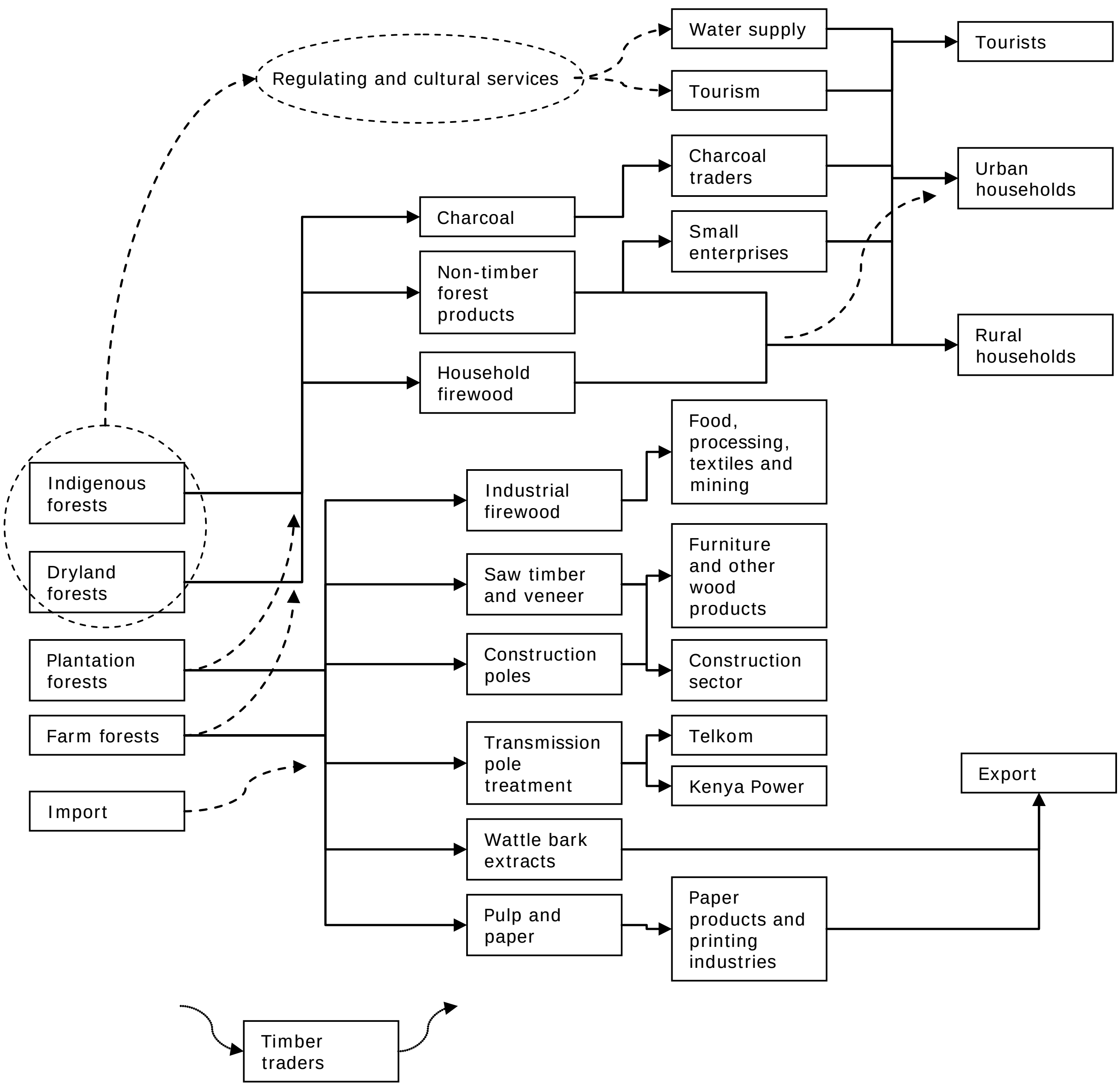
Forest product/service	Beneficiary(s)	Corresponding government department
Firewood	Government	Energy
Poles	Industry	Industry
Timber	Industry	Industry
Water	Government	Water
Grazing	Government	Livestock
Grass for thatching	Households	Housing
Honey	Households	Health
Charcoal	Government	Energy
Stumpage (timber)	Households	Industry
Ogiek community	Households	Heritage
Water supply (urban)	Government	Water
Water supply (downstream)	Households, Industry, Private sector	Water
Watershed management	Households	Agriculture
Biodiversity	Conservationists	Research and technology
Carbon sequestration	International community	International
Tourism (including eco-tourism), recreation, training	Government	Tourism
Hydropower generation	Government	Energy
Agricultural support (tea microclimate)	Agriculturalists/private sector	Agriculture

Appendix 11: People and livestock population adjacent for forest and calculation of direct values

Forest block	Location	Area in km²	Population	HH	HH/km²	Perimeter in km	HH 5km	TLU 5km
Eastern Mau								
	Mau Narok	160	20,888	3,481	22	123	13,410	2,773
	Lare	36	10,748	1,791	50	32	7,867	1,400.67
	Marioshoni	301	4,306	718	2	115	1,368	1,510.86
	Elburgon	60	15,741	2,623	44	41	8,930	2,424.87
	Kiambogo	348	21,712	3,618	10	143	7,416	2,875.16
	Nyota	68	12,775	2,129	31	56	8,810	2,374.16
	Total			14360			47,802	13,360.6
Maasai Mau	Olorropil	294	8,474	1412	4.8	112	2,682	5,762
	Olkurto	462	10,014	1,669	3.6	117	2117	6,809
	Entinyani	102	5,582	930	9	45	2041	3,795
	Olpusimoru	240	9,864	1,644	7	115	3919	6,707
	Sogoo	85	17,437	2,906	34	69	11723	11,857
	Sagamian	417	12,159	2,027	5	113	2750	8,268
	Total			10,588			25,234	43,200.4
Trans Mara	Chemaner	33	8,840	1,473	45	40	9,000	1,547
	Kiptagich	29	8,232	1,372	47	28	6,510	1,440.6
	Nyota	68	12,775	2,129	31	57	8,810	2,235
	Silibwet	31	2682	447	14	28	1978	469
	Total			5,421			26,300	5,692.6

Appendix 12: The Mara River Basin

Appendix 13: The linkages between stakeholders and target ecosystems



Appendix 14: Valuation approaches for forest products

Valuation techniques	Forest product
Direct market pricing	
Market prices	Timber products, commercial wood fuel, charcoal and poles
Indirect market pricing techniques	
Revealed preference approaches	
Residual values	Stumpage value for timber is derived by looking at market prices for finished lumber less costs, i.e. lumber sale
Surrogate prices	Wood fuel, fodder and grass thatch used in households was estimated on the basis of kerosene and roofing iron sheets respectively
Incremental production	The market value of crop production over what it would have been without the micro-climate created by forest, water used for irrigation, and as windbreaks near tea plantations
Opportunity cost	The value of the forest stands is valued based on market price of tea production foregone
Cost avoided	The value of sediment load filtered by the forest that would otherwise cause siltation in dams and lakes downstream equal to market cost of cleaning the dams/lakes
Travel cost	Value the nature-based tourism and educational function of the forest based on the costs institutions and individuals incur tourism or to obtain educational materials or during educational trips respectively
Stated value from surveys of willingness to pay (non-market price techniques)	
Contingent valuation	Value of wildlife and vegetation endemic to the forests, clean water for domestic use, tourism, cultural/religious activities and flood control that reflect the community's willingness to pay to conserve the populations
Benefit transfer	Carbon sequestration value of the forest