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THE TOTAL ECONOMIC VALUE (TEV) OF MUKURA LANDSCAPE, RWANDA

December
2014

ALBERTINE RIFT CONSERVATION SOCIETY





Albertine Rift Conservation Society (ARCOS)

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ACRONYMS AND ABBREVIATIONS

ARCOS:	Albertine Rift Conservation Society
ARECO:	Association Rwandaise des Ecologiste
CBA:	Cost Benefit Analysis
CBD:	Convention on Biodiversity
CFM:	Collaborative Forest Management
CSO:	Civil Society Organisations
CVM:	Contingent Valuation Method
FRW:	Rwanda Francs
IBA:	Important Bird Area
IUCN:	International Union for Conservation of Nature
NTFPs:	Non Timber Forest Products
ORTPN:	Office Rwandais de Tourisme et Parc Nationaux
PFM:	Participatory Forest Management
TEV:	Total Economic Value
WCS:	Wildlife Conservation Society

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The natural environment supports the great range of endemic biodiversity, moreover it has served people for daily subsistence, providing their livelihood and development since the appearance of human kind. It played a key role as the source of ecosystem services i.e. regulating the climate, supporting lives and supplying direct goods such as water, firewood, medicinal plants, etc. With the increase of human population and unregulated use of natural resources, these were deprecated and destroyed by both natural events and human activities such as resettlement, agriculture, infrastructure and other development-related activities which in return were the main drivers of climate change. Since its creation in 1995 to date, ARCOS has noted the increasing unregulated exploitation of the remaining natural forests in the Albertine Rift. Despite their importance for survival and welfare of the adjacent communities, especially unprotected resources have been harmed.

The regulation and sustainable use of natural resources was at the forefront of different governments' strategies and the implementation of the United Nations programs. National policies and environmental laws elaborated, international treaties were established, trans-boundary directives imposed to ensure a sustainable use of the threatened natural ecosystems. As far as the natural ecosystems in Rwanda are

concerned, National Parks, the RAMSAR site, forest reserves and agroecosystems are well conserved by the national policies, environmental laws and international treaties. Wetlands and remnant mountain forests are also protected under the organic laws on the protection of the environment, wetland and forests policies, etc.

However, some of the ecosystems, as in other parts of the Albertine Rift, have not been considered in decision-making and mechanisms for sustainable harvesting. Unprotected ecosystems are threatened by poverty, reliance on the forest products, unregulated use, underestimation of their value, lack of awareness for policies and law implementation at local level and limited appreciation of their contribution to the economy and social well-being of the population. Mukura Forest Reserve is negatively affected by the uncontrolled harvesting of its natural resources, unregulated mining and overgrazing. The Total Economic Valuation study of Mukura Forest contributes to the understanding of the annual monetary value of the landscape for the local and national economy. We consider this work as a big inputs to the conservation of natural resources in general and Mukura Forest in particular. The results provide sufficient arguments for increasing protection of the forest and limits on the damaging activities currently taking place. It will be considered in the natural capital accounting in the Rwandan economy.

By protecting Mukura forest, its value will not only be maintained but through careful management the value can be increased and if sustainably managed the forest can support many future generations of Rwanda and the region.



Dr Sam Kanyamibwa
Executive Director
Albertine Rift Conservation Society (ARCOS)

Mukura Forest is a highland forest located in the West of Rwanda covering 1,798 ha. The forest is located in a densely populated landscape (668 inhabitants per km²) with more than 85% of the population living below the international poverty line. Administratively, the Mukura landscape extends three sectors: Mukura and Rusebeya in Rutsiro District, and Ndaro in Ngororero District. The forest is an important habitat for birds and provides various ecosystem services to surrounding communities. The Total Economic Valuation (TEV) study for Mukura Forest was carried out to determine economic values of the ecosystem services and their contribution to livelihoods. This was achieved by quantifying their economic benefits and costs and determining the economic value of marketed and non-marketed goods and services derived by local communities in the Mukura landscape.

The study was carried out in the Mukura landscape as part of a regional project on “Enhancing Ecosystem Services Resilience and Sustainable Benefits to Local Communities in the Albertine Rift Region” implemented by ARCOS with funding support from the John D. and Catherine T. MacArthur Foundation and additional support from the Swiss Agency for Development and Cooperation (SDC) as part of a regional project on “Sustainable Mountain Development for Global Change (SMD4GC)”.

The study was conducted in collaboration with government authorities, particularly the Forest and Nature Conservation Department, Natural Resources Authority, Ministry of Natural Resources, Districts of Rutsiro and Ngororero Districts and Western Province and involved communities surrounding Mukura Forest as well as national NGOs interested in Mukura Forest.

Before field data collection, a two day planning workshop involving the data collection team was conducted. The workshop was also used to build capacity for the data collection team on the key economic valuation concepts and approaches to be used during data collection, understanding and pretesting of tools for data collection. With a good understanding of the TEV approaches and data collection tools,

participants were grouped in four teams to conduct interviews in the Sectors of Bwira, Ndaro, Rusebeya and Mukura. The investigations focused on identifying key ecosystem services and monetary returns from the relevant benefits. The data collection lasted for three days and was conducted through visualising and predicting situations, where the well being or utility of individual benefits are derived by a production process, in which natural resources are used as inputs. Estimates were made of the contribution of different resources to such utility or well-being, commonly referred to as the production function approach. The Market Prices Method was used to calculate direct use values, and most important for valuation of products whereby the value was estimated from the price in commercial markets, considering the law of supply and demand. The Productivity Method was used for specific goods and services. The Contingent Valuation Method (CVM) was used for tourism and non use values. As an approach to estimate the non-use values, this method involved asking people directly how much they would be willing to pay for specific environmental services. Results from the study indicate that Mukura Forest contributes a lot to the livelihoods of the local communities and in form of ecosystem services that benefit other people even beyond the landscape such as water catchment protection and carbon storage and sequestration.

The TEV of Mukura Forest was estimated at a total of 998,383,560 FRW, equivalent to US\$ 1,468,211. The monetary benefits from Mukura translate in a value of US\$ 817 per hectare per year, a value comparable to most productive forest landscapes. Notable among the key benefits valued from Mukura Forest was water, which is used for domestic purposes and for livestock watering and contributes a total of up to 477,469,000 FRW (US\$ 702,160). The high value of such a resource is enough justification for investment in the management and conservation of Mukura Landscape. Other important resources valued that have very significant importance are wild fruits, vegetables and mushrooms that do not only contribute to cash income for some communities, but also contribute a lot to food and nutrition security for the local communities. Results from the TEV demonstrate that Mukura Forest and its surrounding landscape have important resources that contribute to income, livelihoods,

food and nutrition security for the Rwandan citizens. As indicated by the monetary estimates, it is clear that the ecosystem services can be important inputs to national development and are recognized as natural capital. The study recommends that

the TEV results should be used to inform policy and decision makers to prioritize investments management and conservation as a way of protecting the natural capital that is important for economic development.

1. GENERAL INTRODUCTION



Rwanda is a landlocked country that occupies an area of 26,333 km² and a population density of 321 people/km², which is one of the highest in Sub-Saharan Africa. Amidst the high population densities and limited land, particularly in the areas neighboring protected areas, Rwanda has put considerable effort in conserving the remaining forests. Conservation in Rwanda started in early 1918 and out of five protected ecosystems in Rwanda, four are mountain forest ecosystems found on the Congo-Nile ridge, one of the blocks in the Albertine Rift which is globally known as a biodiversity hotspot. These protected areas, along with their local, national and global importance for conservation, make the government of Rwanda justify the need to conserve them.

Nonetheless, Rwanda has experienced significant environmental degradation and reduction in protected areas (Rutagarama, 2003). For example almost 97.9% of Gishwati Forest and 73.3% of Mukura Forest were lost due to refugee resettlement in a short period of time. What exacerbated this impact was the human pressure resulting from a very high population growth rate of 3.1% per annum.

Concern over rapid depletion and degradation

of Rwanda's biological resources including forest ecosystems and the implications of this loss has been growing recently, not only for global conservation values but also for human welfare. Recently, Rwanda has lost some of its ecological services due to deforestation. For example the sudden fall of the water table was reported to have significantly reduced the country's capacity to generate hydropower.

To reverse this trend, the government of Rwanda has put efforts on establishing mechanisms to protect the environment, particularly conserving existing forest ecosystems. In this regard, the government through the administration of Western Province and the Districts of Rutsirio and Ngororero initiated programs to protect Mukura forest as one of the most important mountain forest ecosystems of Rwanda. In recognition of the importance of Mukura, ARCOS initiated a project aimed to detect community benefits from the ecosystem services. To determine the value and status of the environmental goods and services as well as the threats to these resources, a biological and socioeconomic surveys were undertaken.

1.1. PROBLEM SETTING

Despite the initiatives to conserve Mukura forest and the enhanced local appreciation of the forest, its long-term viability remains threatened by land pressure exacerbated by the high population density. It is recognized that the forest provides significant benefits which to date have received little attention, either due to the lack of knowledge or difficulty in quantification. Primary amongst these, is the value of the ecological services provided by the forests – for example the benefits of agricultural production to climate control, regulation of water flow and soil retention or the wider benefits of atmospheric pollution control. Other less obvious but highly valued benefits include amongst others: biodiversity value (including flora and fauna), aesthetic value, value to future generations and ethical value. In spite of the biodiversity and socioeconomic surveys in the Mukura landscape and the attendant threats, no attempt has been made to estimate the economic value of the forest and its landscape. However, there is an overall consensus that underestimation of the value, goods and services provided by forests and natural resources within has been recognised as one of the major causes of the failure to protect and manage them in a sustainable way.

The Total Economic Valuation is used as one of the tools to solve the problem by attaching a monetary value to the natural capital. Therefore, the monetary contribution of the natural capital of Mukura forest and its surroundings to the local, national and global community is important to provide a basis for conservation efforts. This information should be packaged in a way that can be appreciated by all stakeholders for appropriate actions including:

- Scientists and researchers for conservation planning
- Planners to allocate adequate resources
- Policymakers to support appropriate policy
- Local community to eagerly guard the natural assets
- Financiers to provide logistical support
- Other decision makers to support management and conservation efforts.

This study is expected to narrow the gap between the economic value of the forest and the degradation of environmental resources and services in Mukura landscape and this will hopefully shed some light on how to incorporate environmental considerations into economic decision making.

1.2. CAUSES OF UNDERVALUATION OF FORESTS AND NATURE

Despite the enormous importance of forests and nature to livelihoods of people and economic development, undervaluation was and still is the order of the day. It is therefore extremely important to understand the causes of undervaluation because this may help policy makers and implementers to tackle some of the problems related to undervaluation, such as deforestation.

Market failure has been identified as one of the major



Figure 1: Undervaluation is among the causes of deforestation. Photo by ARCOS

causes of undervaluation. Whenever determining the economic value of a certain ecosystem, decision makers usually only take into account the easily quantifiable financial costs and benefits related to goods and services traded on the market. However, there are numerous functions of nature for which markets malfunction, are distorted or simply do not exist. Economists refer to this as market failure. Markets only exist for some of the production functions of forests and nature, such as for timber, fuel wood and non-timber products. However, even if markets exist, market prices for these goods may not reflect their real value, since markets can be distorted, for example by subsidies (which we would call a policy failure). Furthermore, the market price of a particular good may not reflect



all the costs involved in producing that good. There may be benefits or costs enjoyed or borne by others not directly involved in the production of a good. Economists refer to these costs or benefits as externalities .

Where markets fail, as in the case of the valuation of functions generated by forests, the government –in principle– can adjust and influence them in order to create an environment in which the long-term interests of society as a whole are better protected. However, there are numerous reasons why governments may fail to do this. They may be influenced by powerful pressure groups, or find it difficult to obtain the right information. Moreover bureaucracy, inadequate use of power, corruption or lack of co ordination may hamper the implementation of good intentions. This so-called policy failure also contributes to the undervaluation of forests and nature areas.

1.3. THE CONCEPT OF TOTAL ECONOMIC VALUE (TEV)

Economic valuation is still an evolving science. For some goods and services (for example, a kilo of rice or fish, or a cubic meter of timber) the market provides prices that are good reflections of the values society places on that good or service. For other goods and services, market prices either do

not exist or only capture a small part of the total value. Examples of such goods and services include endangered species and scenic vistas. To ease in the task of analysis it is often useful to disaggregate any environmental impact into individual components of value. One approach to doing this is called the Total Economic Value (TEV) approach, whereby an impact of a resource is disaggregated into a number of categories of values (Figure 2). The idea behind the TEV approach is that any good or service is composed of various attributes, some of which are concrete and easily measured, while others may be more difficult to quantify. The total economic value is therefore the sum of all of these components, not just those that can be easily measured. The breakdown and terminology for the components of TEV vary slightly from analyst to analyst, but generally include (i) direct use value, (ii) indirect use value, and (iii) non-use value. The former two are generally referred to together as “use value”. Each is often further subdivided into additional categories.

Direct use value - also known as extractive, consumptive, or structural use value, derives from goods which can be extracted, consumed, or are directly enjoyed. In the context of a forest, for example, extractive use value would be derived from timber, from harvest of minor forest products such as fruit, herbs,

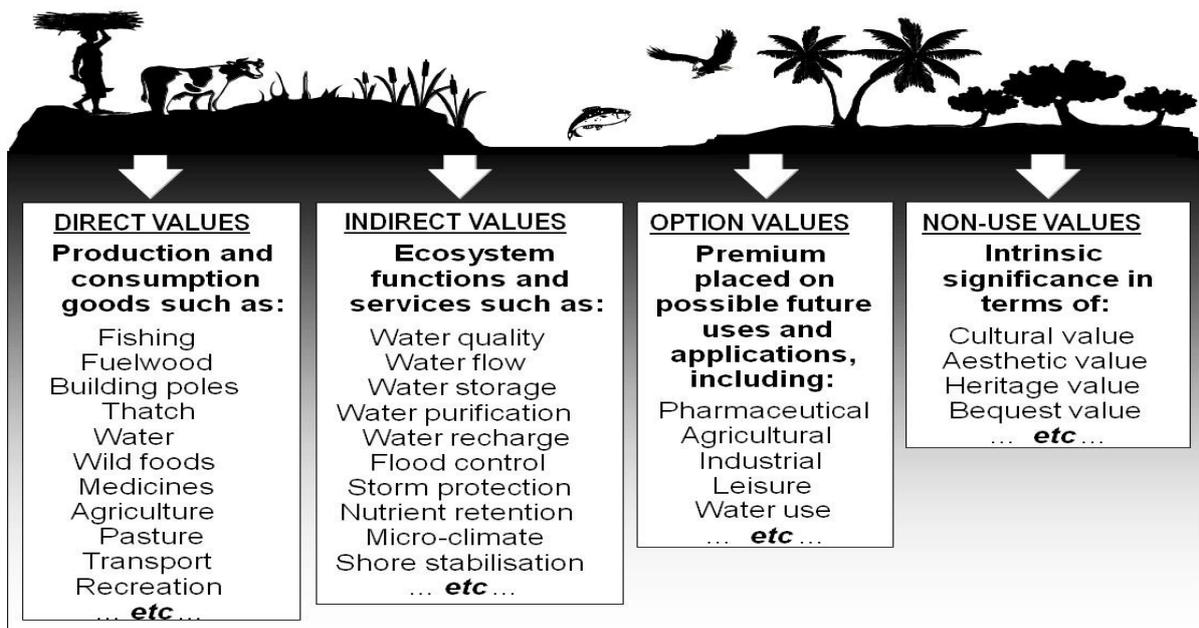


Figure 2: A wide range of environmental benefits for society and livelihoods (Emerton & Muramira (1999))



or mushrooms and from hunting and fishing. In addition to these directly consumed goods, direct use values can also be non consumptive. For example, people who enjoy hiking or camping in the same forest receive a direct use value but do not actually “consume” any of the forest resource. Similarly, in a coral reef direct use values can include the harvesting of shells and fishing or the non consumptive use of the reef by scuba divers. All of these benefits are real, can be measured, and have values, even if the consumption by one individual does not reduce the consumption by another (economists call this non-rival consumption, and these goods are classified as public goods). Consumptive use is generally the easiest to value, since it usually involves observable quantities of products whose prices can usually also be observed. Non-consumptive use is often more difficult to value since both quantities and prices may not be observed.

Indirect use value - also known as non-extractive use value or functional value, mainly derives from the ecological services the environment provides. For example, forest provide water catchment services storing and supplying clean water to downstream users; wetlands often filter water, improving water quality for downstream users and national parks provide opportunities for recreation. These services have economic value but do not require any good to be harvested, although they may require someone’s physical presence. Measuring indirect use value is often considerably more difficult than measuring direct use value. The quantities of the service being provided are often hard to measure. Moreover, many of these services often do not enter markets at all, so that their price is also extremely difficult to establish. The visual aesthetic benefits provided by a landscape, for example, are non-rival in consumption, meaning that they can be enjoyed by many people without detracting from the enjoyment of others.

Option value - it is the value obtained from maintaining the option of taking advantage of something’s use value (whether extractive

or non-extractive) at a later date. It is therefore a special case of use value, akin to an insurance policy. One related concept of economic value of conservation importance is the Quasi option value which derives from the possibility that even though something appears unimportant now, information received later might lead us to reevaluate it.

Existence and bequest value - In contrast to use value, non-use value derives from the benefits the environment may provide which do not involve using it in any way, whether directly or indirectly. In many cases, the most important is the existence value; which reflects the value that people derive from the knowledge that something exists, even if they never plan to use it. Thus, people place a value on the existence of mountain gorillas or of elephants, even if they have never seen one and probably never will; if elephants became extinct, many people would feel a definite sense of loss. The other category includes Bequest value, which is the value derived from the desire to pass on values to future generations. Non use values are the most difficult type of value to estimate, since in most cases they are not by definition reflected in people’s behavior and are thus wholly unobservable.

Total economic value (TEV) is therefore made up of actual use value plus option value plus existence value. The outcome of TEV is sometimes referred as the natural capital as it represents the entire value of the environmental resources.

1.4. THE COSTS OF ENVIRONMENTAL GOODS

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



1.5. COST-BENEFIT ANALYSIS AND ITS APPLICATION TO CONSERVATION

Cost-benefit analysis (CBA) aims to compare the monetary costs and the monetary benefits of any conservation project to determine whether the benefits outweigh the costs. The assumption is that if benefits are greater than costs then the project should proceed, but if the costs outweigh the benefits then it should not proceed. The underlying justification for CBA lies within the theory of welfare economics. It is founded on a directly utilitarian approach to decision-making that should under certain circumstances, enable the selection of projects that maximize social welfare i.e. do what is best for the whole society, even if some groups suffer the costs.

1.6. MILLENNIUM ECOSYSTEM ASSESSMENT CLASSIFICATION OF ECOSYSTEM SERVICES

As part of a global natural resource management initiative, an assessment was made that provided a standard definition for Ecosystem services as benefits people obtain from ecosystems (MEA, 2003). These include provisioning, regulating, and cultural services that directly affect people and supporting services needed to maintain the other services (Figure 2). The survey also provided a classification system for ecosystem services that is now commonly used. It contains four main categories based on the important tasks provided by nature for livelihoods through provisioning, regulating, cultural and supporting roles (Table 1). The ecosystem services outlined in the millennium ecosystem assessment contribute to livelihoods, food and nutrition security and economic development and hence deserve particular attention.

1.6.1 Provisioning Services

The following enumeration names the the products obtained from ecosystems:

- **Food and fiber** including the vast range of food products derived from plants, animals, and microbes, as well as materials such as wood, jute, hemp, silk, and many other products derived from ecosystems.
- **Fuel** - wood, dung, and other biological materials

serve as sources of energy.

- **Genetic resources** including the genes and genetic information used for animal and plant breeding and biotechnology.
- **Biochemicals**, natural medicines, and pharmaceuticals derived from ecosystems, including a range of medicines, biocides, food additives such as alginates, and biological materials.
- **Ornamental resources** including animal products, such as skins and shells, and flowers used as ornaments.
- **Fresh water** is another example of linkages between categories, in this case, between provisioning and regulating services.

It should be noted that the value of these resources is often culturally determined, which is an example of linkages between the categories of ecosystem services.

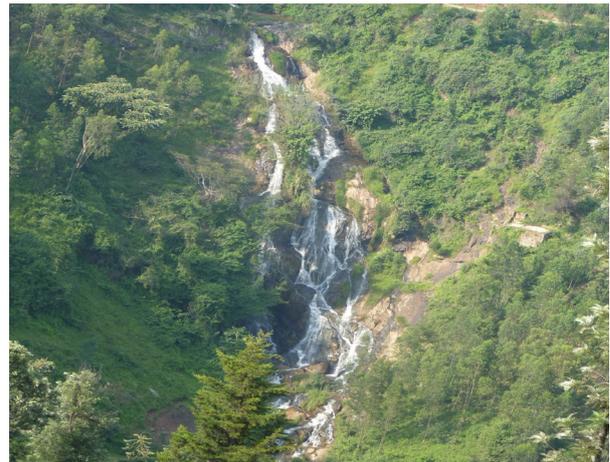


Figure 3: Freshwater is the linkage between provisioning and regulating services

1.6.2 Regulating Services

These are the benefits obtained from the regulation of ecosystem processes, including:

- **Air quality maintenance** - ecosystems both contribute and extract chemicals from the atmosphere, influencing many aspects of air quality.
- **Climate regulation** - ecosystems influence climate both locally and globally. For example, at a local scale changes in land cover can affect both temperature and precipitation. At the global scale, ecosystems play an important role in climate by either absorbing or emitting green-house gases.
- **Water regulation** - the timing and magnitude



of runoff, flooding and aquifer recharge can be strongly influenced by changes in land cover, including in particular alterations that change the water storage potential of the system, such as the conversion of wetlands or the replacement of forests with croplands or croplands with urban areas.

- **Erosion control** - Vegetative cover plays an important role in soil retention and the prevention of landslides.
- **Water purification and waste treatment** - Ecosystems can be a source of impurities in fresh water but also can help to filter out and decompose organic wastes introduced into inland waters and coastal and marine ecosystems.
- **Regulation of human diseases** - changes in ecosystems can directly change the abundance of human pathogens, such as cholera and can alter the abundance of disease vectors, such as mosquitoes.
- **Biological control** - ecosystem changes affect the prevalence of crop and livestock pests and diseases.
- **Pollination** - ecosystem changes affect the distribution, abundance, and effectiveness of pollinators.
- **Storm protection** - the presence of ecosystems such as forests can dramatically reduce the damage caused by storms and winds.

1.6.3 Cultural Services

These are the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences, including:

- **Cultural diversity** - The diversity of ecosystems is one factor influencing the diversity of cultures.
- **Spiritual and religious values** - many religions attach spiritual and religious values to ecosystems or their components.
- **Knowledge systems** - ecosystems influence the types of traditional and formal knowledge systems developed by different cultures.
- **Educational values** - ecosystems and their components and processes provide the basis for both formal and informal education in

many societies.

- **Inspiration** - Ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, and advertising.
- **Aesthetic values** - Many people find beauty or aesthetic value in various aspects of ecosystems, as reflected in the support for parks, scenic views and the selection of housing locations.
- **Social relations** - ecosystems influence the types of social relations that are established in particular cultures. Fishing societies, for example, differ in many respects in their social relations from nomadic herding or agricultural societies.
- **Sense of place** - many people value the sense of place that is associated with recognized features of their environment, including aspects of the ecosystem.
- **Cultural heritage values** - many societies place high value on the maintenance of either historically important landscapes (“cultural landscapes”) or culturally significant species.
- **Recreation and ecotourism** - People often choose where to spend their leisure time based in part on the characteristics of the natural or cultivated landscapes in a particular area.

Cultural services are tightly bound to human values and behavior, as well as to human institutions and patterns of social, economic, and political organization. Thus, perceptions of cultural services are more likely to differ among individuals and communities than say, perceptions of the importance of food production.

1.6.4 Supporting Services

Supporting services are those that are necessary for sustaining the production of all other ecosystem services. They differ from provisioning, regulating and cultural services in that their impacts on people are either indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people. Some services, like erosion control, can be categorized as both supporting and regulating services, depending on the time scale and immediacy of their impact on people. For example, humans do not directly use soil formation services, although changes in this would indirectly affect people through the impact on the provisioning service of food production. Similarly, climate regulation is



categorized as a regulating service since ecosystem changes can have an impact on local or global climate over time scales (decades or centuries) relevant to human decision-making. Thus the production of oxygen gas through photosynthesis is categorized as a supporting service since any

impacts on the concentration of oxygen in the atmosphere would only occur over an extremely long time. Some other examples of supporting services are primary production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.



2. METHODOLOGY

2.1. AN OVERVIEW OF THE VALUATION TECHNIQUES

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

For the case of most environmental goods and services, there are no direct market prices to act as the basis of valuation. Many environmental goods and services such as firewood and water in a rural set up are not bought and sold, and therefore have no price to act as a basis for valuation. Economists have begun to realise that it is necessary to find new ways of estimating these values. As previously mentioned, consideration can be given to the price of alternatives that can be used if the non-marketed ecosystem services were to be purchased.

We present a range of market and non-market based methods which we used to value benefits from Mukura landscape in Rwanda that were used based on similar studies such as Adamowicz (1995), Constanza et al. (1997), Kakuru et al. (2013).

2.1.1 Marketable goods

In many cases, environmental goods such as honey and charcoal were sold in the local markets. When environmental products were bought and sold, we looked at their market price in order to assess their value. The prices reflected what people are

willing to pay for an environmental product, indicating the value that they placed on the particular ecosystem service. For example, the price of timber per cubic metre, how much a stack of fuelwood costs, the price of a sack of charcoal and a kilo of honey.

Looking at market prices was a good way of valuing environmental products which were widely bought and sold. It was used to value the direct use values people obtain from the Mukura landscape.

2.1.2 The market price of substitutes for environmental products

Some environmental products such as firewood and grass often had no market as they were not directly bought and sold. We could not value them by looking at their price. However, they had close substitutes which were readily available in markets. We looked at the price of what it costs to buy the next best alternative if environmental products were not available. This represented the amount of money that forest use is worth in terms of the expenditure saved on alternative items. Examples included the cost of iron sheeting instead of thatching grass, the cost of kerosene instead of fuelwood or charcoal, the cost of sugar instead of honey.

Looking at the price of market alternatives was a good way of valuing environmental products which themselves had no market, but have close substitutes which people use when forest products were not available. It was used to value the direct benefits that people get from the landscape.

2.1.3 Contingent value or willingness to pay

Many environmental benefits from Mukura forest had no market and no close market substitutes. For example, it was difficult to find any realistic market-based price for ecological services provided by forests and for option and existence value of forests. Contingent Valuation Method (CVM) was used to assess the value of environmental goods and services that have no direct market. The CVM estimates were not based on observed market behavior but instead infer people's willingness to pay by eliciting bids for a good or service in a hypothetical market where it could be available for purchase. People were asked questions such as "if the forest ceased to protect your catchment, how much compensation would you be willing to accept when streams and rivers coming from the forest were no longer clean and their flow well-regulated?" or "what would you pay to know that forest biodiversity is being maintained?"

The CVM was a good way of valuing environmental goods and services which had no market or market substitutes but provided clear and tangible benefits to people. A detailed description of the goods involved is provided, along with details about how it will be provided. The actual valuation can be obtained in a number of ways, such as asking respondents to name a figure, having them choose from a number of options, or asking them whether they would pay a specific amount in which case, follow-up questions with higher or lower amounts are often used. Use of CVM can in principle, be used to value any environmental benefit. For this study CVM was used to value the ecological, option and existence values people obtained from Mukura landscape.

2.1.4 Effort/price for labour

Because majority of the people in Mukura landscape are very poor, they cannot afford to pay for environmental goods and services. However they were willing to pay in the form of working or labour for the goods and services. For example, family members collect firewood and water manually from the landscape. The labour and effort was compared to the local wages paid to community for working for the better off members of the community.

2.1.5 Damage avoided

When environmental benefits themselves had no value but were affecting market-based activities, we looked at the values of these other activities in order to gauge the value of forest goods and services. For example, if a forest provided watershed catchment protection it prevented downstream siltation and flooding which would have otherwise led to seasonal destruction of farmland and ultimately to a decline in riverine fish yields and to siltation of reservoirs. For Mukura forest, we calculated the value of losses resulting from flooding such as properties, farm production, loss of fish catches and power arising because of siltation. Looking at the effect on production of environmental benefits was a good way of valuing environmental benefits which have no market or substitutes but upon which other market-based outputs depend. It was used to value the ecological values people obtained from Mukura landscape.

2.1.6 Replacement value

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

Looking at replacement cost or averse expenditure attached to environmental benefits was a good way of valuing non-market forest benefits which could at least be partially replicated by man-made or technological means. They were used to value the ecological values supported by the environment.

2.1.7 Value Transfers

Value transfer is not a methodology per se, but rather refers to the use of estimates obtained (by whatever method) in one context to estimate values in a different context. For example, an estimate of the benefit obtained by people using an environmental resource in one area might be used to estimate the benefit obtained from using the same environmental



resources in a different area. The main attraction of value transfer is that it provides a low-cost way of estimating values when time or resources do not allow complete valuation studies, or when the good or service to be valued has not yet been created so that there are no users to survey. This approach also has considerable risks. For many reasons, estimates derived in one situation may not be inappropriate for all situations. As a result, value transfer has been the subject of considerable controversy in the economics literature. A consensus seems to be emerging that value transfer can provide a valid and reliable order of magnitude estimates under certain conditions. The commodity or service being valued has to be related at the site where the estimates were made and at the site where they are applied; furthermore the populations affected must be similar. The original estimates being transferred must themselves be reliable for any attempt at transfer to be meaningful.

2.2 DETERMINING THE TOTAL ECONOMIC VALUE (TEV) OF MUKURA LANDSCAPE



The Total Economic Valuation (TEV) study for Mukura Forest was carried out to determine economic values of the ecosystem services and their contribution to livelihoods; quantify economic benefits and costs; and determine the economic value of marketed and non marketed goods and services derived by local communities in the Mukura landscape. The results highlight economic benefits in monetary terms for some key goods and services that contribute to livelihoods of communities around Mukura landscape. Previous studies by ARCOS identified the main ecosystem services of Mukura forest, their main users and threats they are facing. The studies included a survey of biodiversity and socio-economics of the communities around the Mukura landscape. The Total Economic Valuation (TEV) study for Mukura landscape was used to add value to the previous surveys by attaching monetary values to different ecosystem services using participatory tools and approaches.

2.3 METHODOLOGY AND PROCESS

The study was carried out in the Mukura landscape, one of the few protected areas in the western Rwanda, which is characterised by existence of a natural forest and a plantation that provide valuable benefits. Mukura forest (1798 ha) is surrounded by a high human population density, with one of the poorest communities in Rwanda. The local residents directly depend on ecosystem services provided by the landscape, for most part of their life. The study involved communities of Bwira and Ndaro Sectors of Ngororero District and Mukura and Rusebeya Sectors of Rutsiro District. Some opportunistic surveys were also carried out in Karongi District, especially on the water supply using a gravity water scheme from Mukura Forest. The process of TEV in Mukura landscape involved participants from the local stakeholders, including an Agronomist from each Sector adjacent to Mukura Forest and representatives of Government District Officers from Rutsiro and Ngororero. Before field data collection, a two day planning workshop involving the data collection team was conducted. The workshop was also used to build capacity for the data collection team on the key economic valuation concepts and approaches to be used during data collection, understanding and pretesting of tools for data collection.

2.4 DATA COLLECTION AND ANALYSIS

With a good understanding of the TEV approaches and data collection tools, participants were grouped in four teams to conduct interviews in the Sectors of Bwira, Ndaro, Rusebeya and Mukura. The tools focused on identified key ecosystem services and monetary returns from the relevant benefits and were administered to different resource users.

The data collection lasted for three days and was conducted through visualizing and predicting situations, where the well being or utility of individual benefits are derived by a production process, in which natural resources are used as

inputs. Estimates were made of the contribution of different resources to such utility or well-being; commonly referred to as the production function approach. The Market Prices Method was used to value direct use values, and most important for valuation of products, whereby the value was estimated from the price in



Figure 4: Resource Users share their experiences with the study team. Photo by ARCOS

commercial markets, considering the law of supply and demand. The Productivity Method was used for specific goods and services. The Contingent Valuation Method (CVM) was used for tourism and Non-Use values. This method involved asking people directly how much they would be willing to pay for specific environmental services, as one of the ways to estimate the Non Use values.

After field data collection, preliminary data computation was carried out and a basic analysis was done to generate monetary values from the benefits. Detailed computation and data analysis was carried out to produce the report on TEV of resources from Mukura Landscape.

2.5 LIMITATIONS TO THE STUDY METHODS

Although the techniques applied to value the resources are theoretically well founded, there are limitations to the economic measurement of environmental goods in general and the various uses of forests in particular. Valuation of forest resources poses difficulties such as lack of knowledge regarding value and utility of some forest functions and the difficulties in

isolating the benefits of interrelated functions. Other issues such as the value of biodiversity, cultural significance, etc. raise intractable questions of measurement. The hypothetical nature of questions used in the survey and the grossing up of the results may also pose problems since respondents may have little incentive to provide accurate answers concerning their use of the forest. In addition, the option value as well the benefits enjoyed by people who never actually visit Mukura forest were not fully incorporated.

Despite the limitations for the study, the methods are believed to estimate values that are accurate at least within an order of magnitude.

2.6 DESCRIPTION OF MUKURA FOREST

Details of the background information on Mukura forest is contained in a baseline survey conducted by ARCOS and a biodiversity survey by ARECO (ARECO, 2006 and ARCOS, 2012). Mukura Forest is a high altitude forest located in the west of Rwanda (Figure 5). It covers 1,798 ha in a densely populated landscape (about 668 inhabitants per km²) with more than 85% of the population living below the poverty line at US\$ 1.25 a day. Administratively, the Mukura landscape extends to three sectors: Mukura and Rusebeya in Rutsiro District, and Ndaro in Ngororero District.

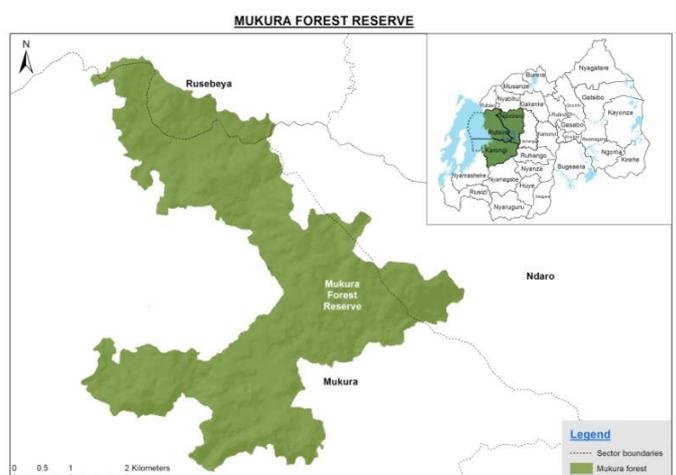


Figure 5: Location of Mukura Forest Reserve (Source: ARCOS (2012))

Mukura Reserve suffered from human threats including forest clearing for agriculture, human settlement, wood cutting, animal grazing, poaching and mining. These threats led to a reduction of the reserve from 3,000 ha in 1960 to 1,798 ha in 2005.



Currently, the forest physiognomy is described as: secondary forest (58.8%); closed forest (27.45%); degraded forest with open spaces in formerly agricultural impacted sites (9.8%); and wetland/marshes (1.9%). According to ARECO (2006) and ARCOS (2012) Mukura forest has a rich biodiversity with 243 plant species, 59 bird species, including 7 species that are endemic to the Albertine Rift and 3 species that are of conservation concern according to the IUCN Red Data Book. These include the Grauer's Swamp Warbler and Grey Crowned Crane (endangered) and Kivu Ground Thrush (vulnerable). The number of mammal species was reduced from 14 to 4 due to hunting and encroachment. This rich biodiversity is threatened by human resettlement and farming, unsustainable use of natural resources, illegal mining, cattle grazing, hunting/poaching, tree cutting and fuelwood collection.

Most of the local communities living around Mukura forest depend on it for livelihoods by accessing resources such as water, firewood,

stones, fodder for animals, medicinal plants, honey and handcraft material because these resources have increasingly become scarce outside the reserve. A majority of the local people think the resources within the resource are also declining as they have to move longer distances and/or spend more time looking for the resources than in the past.

Available water sources in the landscape include gravity water schemes, protected springs, bore holes and open water sources (streams, rivers and wells). The latter is still used by a big proportion of the population (46%) around Mukura and the water quality at these sources is affected by wetland degradation, illegal mining and intensive agriculture.

The major source of fuelwood is the Mukura natural forest and some private woodlots. A small proportion of the local communities use charcoal, maize cobs and husks and other crop residues as alternative fuel wood sources.

3. RESULTS



The TEV of Mukura Forest was estimated at a total of RFW 1.150.649.800 (US\$ 1.692.132).

Results of the study indicate that Mukura Forest contributes a lot to the livelihoods of the local communities in form of different ecosystem services that benefit local communities for water, food and nutrition security. Some ecosystem services such as water catchment protection, carbon storage and sequestration also benefit other people beyond the Mukura landscape. An example used was the gravity water supply for communities in Karongi sector, which is not adjacent to Mukura forest but has benefited from using Mukura as a clean water supply source. The TEV of Mukura Forest was estimated at a total of RFW 1,150,649,800 (US\$ 1,692,132).

3.1 USE VALUES

Notable among the key benefits valued from Mukura Forest was water, which is used for domestic purposes and for livestock watering and contributes a total of up to 477,469,000 FRW (US\$ 702,160).

The respondents reported that the use of water from Mukura forest has contributed to their livelihoods by reducing water borne disease, given that some of the water sources previously used were providing unclean water (Figure 6). They also reported that in addition to providing clean water Mukura forest water supply has provided an opportunity to have water collected from sources near their homes, which saves time for children and women, who are the responsible family members in water collection (Figure 6).



Figure 6: Children collect water from varied sources: clean water (A) and unclean water (B). Photo by ARCOS



Figure 7: Water supply in Karongi Sector with a source in Mukura Forest. Photo by ARCOS





Important resources such as water which are used by all communities around Mukura and beyond should provide an opportunity to illustrate the need for commitment to the conservation and management of the landscape. This would even be more recognised, if the local communities are directly benefiting from such a resource for example through supply of clean water by gravity closer to their homes. Firewood was reported to be one of the resources from Mukura forest that benefits most of the local communities. The respondents indicated that most of them do not have enough trees either as woodlots or planted on their farms. They therefore use Mukura as an important sole source of firewood (Figure 8). Other important plant resources that support food security include bean stakes and honey.



Figure 8: Collection of firewood from Mukura Forest. Photo by ARCOS

However, the respondents reported that firewood from Mukura forest has been declining over time and they currently face a serious firewood crisis that makes them use any available alternative source of fuel, including crop residues (Figure 9).



Figure 9: Children near Mukura Forest carrying some alternative fuel materials. Photo by ARCOS

Given the increasing population, the challenge of firewood supply is likely to continue and should be used as an opportunity to promote tree planting, which will provide benefits to local people and help enhance provision of the landscape ecosystem services from Mukura.

Other important resources valued in Mukura that have very significant importance are wild fruits, vegetables and mushrooms that do not only contribute to cash income for some communities, but also contribute a lot to food and nutrition security for the local communities. During the study, respondents reported that in some periods of the year, the forest serves as a source of such food items that would otherwise be purchased from surrounding areas. They also believe that the fruits and vegetables from the forest have special nutritional values and indicated that local communities around Mukura forest have successfully attempted to domesticate some of the plants.

One important livelihood ecosystem service that was reported to be important from Mukura forest was harvesting of medicinal plants. Respondents indicated that more than 50% of the local communities rely on use of medicinal plants from Mukura Forest as their first line of treatment, before going to health centres. They had a strong belief that most medicinal plants are more effective than the western medicine from health centres. Use of Mukura Forest for medicinal plants was manifested by a lot of debarking of trees, mainly along the trails within the forest.

The total monetary returns from use values were estimated at RFW 621,858,000 (US\$ 914,497). The high total economic value of Mukura Forest is enough justification for the need to invest in the management and conservation of the important watershed, whose benefits should be sustained. This is strengthened by the fact that benefits from Mukura contribute to livelihoods and incomes of the local people and benefits other stakeholders away from the forest.

Table2: Monetary Benefits from some goods/products from Mukura Forest

Resources from Mukura	Districts surveyed	Sectors/ Areas surveyed	Gross returns from the resource (FRW)	Gross returns from the resource (US\$)
Water for domestic use	Ngororero, Rutsiro	Ndaro, Rusebeya,	349,305,000	513,684
Water Urban supply/ Gravity Scheme	Karongi	Kageyo, Rubengera	42,924,000	63,124
Water for Livestock	Ngororero, Rutsiro	Ndaro, Mukura	85,240,000	125,353
Firewood	Ngororero, Rutsiro	Ndaro, Mukura, Rusebeya,	70,393,000	103,519
Bean stakes	Ngororero	Ndaro	8,540,000	12,559
Honey	Rutsiro, Karongi	Rubengera, Mukura, Ruronde, Kageyo, Mwendu	6,115,200	8,993
Obuhura	Rutsiro	Rusebeya	875,000	1,287
Grass for grazing and beds for cattle	Ngororero, Rutsiro	Ndaro, Mukura	3,001,300	4,414
Ropes and fibres	Rutsiro	Rusebeya, Mukura	2,975,000	4,375
Wild fruits	Rutsiro	Mukura	5,720,000	8,412
Vegetables	Rutsiro	Mukura, Rusebeya	2,160,000	3,176
Mushrooms	Rutsiro	Mukura	2,250,000	3,309
Medicinal plants	Ngororero, Rutsiro	Ndaro, Mukura	5,200,000	7,647
Bush meat	Ngororero, Rutsiro	Ndaro, Rusebeya	6,300,000	9,265
Poles for fencing	Ngororero, Rutsiro	Ndaro, Mukura	11,375,000	16,728
Hand sticks	Rutsiro	Mukura	1,137,500	1,673
Handicrafts	Rutsiro	Mukura	875,000	1,287
Timber	Rutsiro	Mukura	17,472,000	25,694
Sub-Total Use Values			621,858,000	914,497

3.2 NON-USE VALUES

In addition to use values, Mukura Forest was strongly recognised by the respondents as being important by providing a number of non-use values that do not only benefit the local communities but people downstream and the global community. Estimates made of the non-use values put the benefits from non-use values at a total of RFW 545,908,760 equivalent to US\$ 802,807 (Table 3).

Table 3: Non-use values from Mukura Forest

Non-use values	Gross returns from the resource (FRW)	Gross returns from the resource (US\$)
Aesthetic Value/ Ecotourism	440,150,400	647,280
Carbon Storage & Sequestration	26,898,080	39,556
Existence Value	2,445,280	3,596
Pharmaceutical value	1,833,960	2,697
Landslide and flood control	57,464,080	84,506
Pollination	17,116,960	25,172
Sub-Total	545,908,760	802,807



3.3 THE COSTS OF INVESTMENT TO MAINTAIN MUKURA FOREST

3.3.1 Management costs

The direct financial costs of Mukura forest management consist of capital expenditures on infrastructure necessary to maintain the forest, plus recurrent expenditure on staffing. These costs were estimated at RFW 10,440,000 (US\$ 15,353) expenditure by the government on Mukura forest (Table 2).

3.3.2 Animal damage

The presence of a forest incurs costs on local communities through damage they suffer from forest-dwelling animals that destroy their mainly crops. These costs are significant for Mukura landscape. Households were estimated to suffer RFW 100,256,480 (US\$ 147,436) in financial losses as a result of wild animal damage. This was the highest cost of maintaining Mukura under forest cover.

3.3.3 Opportunity cost

Keeping the land under forest cover precludes the possibility of alternative land uses. The range of possible uses is extensive. However, it is reasonable to assume that the most likely alternative land-use in Mukura landscape would be smallholder agriculture. Using value transfers from Echuya Forest in Uganda, the option value of Mukura forest was estimated to be RFW 58,686,720 (US\$ 86,304). Considering the infrastructure and staff costs, opportunity costs and crop raids, the total costs of managing Mukura forest were estimated at RFW 169,383,200 equivalent to US\$ 249,043 (Table 4).

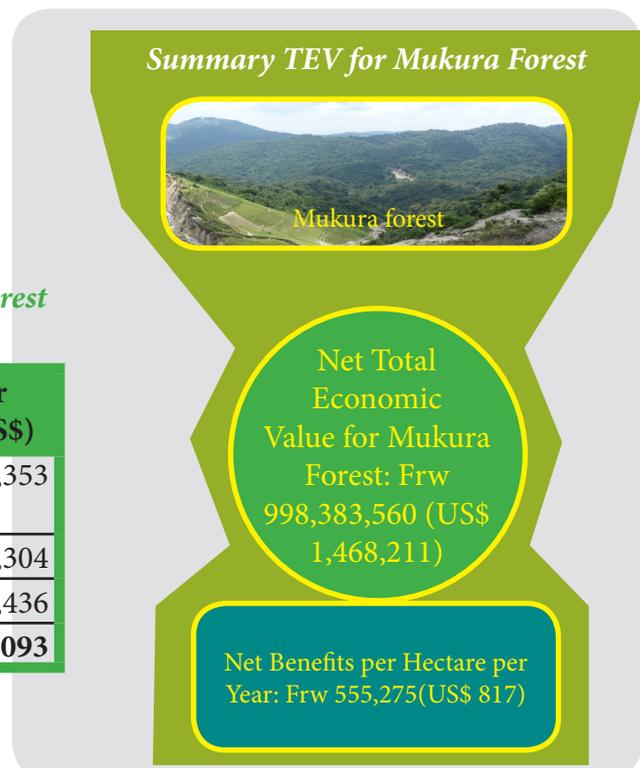
Table 4: Costs for investment to maintain Mukura Forest

Cost Item	Cost per year (FRW)	Cost per year (US\$)
Infrastructure and staff costs	10,440,000	15,353
Opportunity Costs	58,686,720	86,304
Crop raids	100,256,480	147,436
Sub-Total	169,383,200	249,093

3.1 SYNTHESIS OF THE TEV AND COST-BENEFIT ANALYSIS

The entire value for all the resources that the local communities benefit from Mukura landscape were estimated at RFW 1,150,649,800 (US\$ 692,132), while total of maintaining Mukura as a forest were valued at RFW 169,383,200 (US\$ 249,093). Since the benefits outweighed the costs by RFW 981,266,600 (US\$ 1,443,039) or RFW 545,755 (US\$ 803) per hectare per year (Table 5). These should be regarded as best as minimum estimates of benefits. The use and non-use values are more likely to be higher than what was estimated in this study, if the management and conservation is stepped up in the area.

Mukura should be managed and maintained as a natural forest. This would be the most cost effective way of managing Mukura landscape. The local communities gain more by Mukura forest being maintained under natural vegetation cover than if it was for example, converted into arable land. Much as there is high demand to convert the forest into agricultural land because of high population, should be discouraged by presenting the results of this study the local communities, national government, policy makers and other stakeholders.



4. CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

This study estimated the economic value for Mukura at a total of 998,383,560 FRW per year, equivalent to US\$ 1,468,211. The study results from the TEV demonstrate that Mukura Forest and surrounding landscape have important resources that contribute to income, livelihoods and food and nutrition security for surrounding local communities and stakeholders away from Mukura such as Ndaró sector. The study also provided the following information:

- The study validated the fact that Mukura forest provides valuable resources to different sectors of society, and have a big potential for contribution to the economic development;
- Mukura landscape contributes a lot to the livelihoods of local communities by providing tangible benefits like water, food, fibre and shelter;
- The local communities also appreciate the importance of Mukura for providing non-tangible benefits that contribute to the availability of water improvement for agriculture and a good climate;
- The respondents have noticed decline in availability of the benefits from Mukura over time and this study provides a justification for better future planning for the forest;
- Less destructive use of ecosystem services such as tourism potential have not been fully used;
- As indicated by the monetary estimates, it is clear that the ecosystem services can be important inputs to national development and are recognised as natural capital.

4.2 RECOMMENDATIONS

Considering the conservation importance of Mukura and the issues raised by resource users about the decline of most resources, the following recommendations are proposed for sustaining the benefits:

- The TEV results should be used to inform policy and decision makers to prioritise investments in management and conservation, as a way of protecting the natural capital accruing from Mukura Forest which is important for economic development;
- The benefits of conservation efforts will be measured as returns from the natural capital that is important for economic development;
- The local communities should be mobilised into resource user groups which can contribute to the conservation and management efforts of natural resource agencies;
- Resource users should be involved in monitoring the levels of benefits and status of the resources overtime;
- The resource users should provide information on the economic losses associated with the degradation and loss of the resources;
- TEV results should be used to have a system of prioritizing resource analysis and interventions to address the degradation of resources in Mukura;
- Incentives that provide direct benefits to resource users and can increase commitment to conservation such as clean water supply should be promoted;
- To increase incentives to resource users, high value markets for the products should be explored;
- Value addition for some products should be strengthened for increased benefits from ecosystem services;
- Promote tourism development around Mukura, which has a high potential of generating income and increasing development, with minimal impacts on other ecosystem services;
- TEV results should be used with more assessments to develop a system of Payment for Ecosystem Services (PES) through:
 - Evaluating the land use systems in the Mukura landscape and how different on-site and off-site resource users carry out respective activities that provide different benefits and how this affects different ecosystem services;
 - Analysing the conditions under which resource users would consider changing some of their practices that promote degradation;
 - Identifying, testing, and validating the management practises that are necessary to reduce the degradation threat to Mukura;
 - Providing financial and technical support to resource users, who are willing to enter the programme to reduce degradation of the catchment;
 - Estimating royalties that can be paid for different ecosystem services to manage the landscape for sustainable use of the resources.

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