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PLANNING FOR RESILIENCE IN EAST AFRICA THROUGH POLICY, ADAPTATION, RESEARCH, AND ECONOMIC DEVELOPMENT (PREPARED) PROJECT

ECONOMIC VALUATION OF SANGO BAY – MINZIRO ECOSYSTEM

DECEMBER 2016

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ACRONYMS AND ABBREVIATIONS

BSA	Biologically Significant Area
CIP	Conservation Investment Plan
CFR	Central Forest Reserve
FAO	Food and Agriculture Organisation
FD	Forest Department
GEF	Global Environmental Facility
IUCN	International Union for the Conservation of Nature
MEA	Millennium Ecosystem Assessment
MNRT	Ministry of Natural Resources and Tourism
MUIENR	Makerere University Institute of Environment and Natural Resources
NFA	National Forestry Authority
PREPARED	Planning for Resilience in East Africa Through Policy, Adaptation, Research, and Economic Development
TEV	Total Economic Value
TLU	Tropical Livestock Unit
TShs	Tanzania Shillings
TZ	Tanzania
UG	Uganda
UGX	Uganda Shillings
UNDP	United Nations Development Programme
US$	United States Dollar[1]

[1] *At the time of analysing data for this report (December 2015) rates used: 1 US$ = UGX 3,300 and 1 US$ = TShs 2,100*

EXECUTIVE SUMMARY

This report highlights findings of a study carried out to estimate the actual or potential contribution to livelihoods by biodiversity and ecosystem services of the Sango Bay-Minziro area, an important trans-boundary ecosystem shared by Uganda and Tanzania. Previous surveys conducted have identified the Sango Bay-Minziro area as one of the biologically significant trans-boundary ecosystems in East Africa. The overall aim of this economic valuation study was to provide baseline data on the benefits derived from different ecosystem goods and services from the area; which includes forests and wetlands, and their associated habitats.

The rapid assessment was conducted over a period of 13 days, and involved field visits; stakeholder and expert consultations at various levels; literature review; collation of existing national and district statistics; data entry, analysis and reporting. A range of techniques were used to estimate the economic value of the various ecosystem services, including:

- market prices paid to buy and sell different products and services;
- prices of goods that are alternatives or substitutes for environmental services;
- expenditure on goods and services directly linked to environmental benefits; and
- considering how a particular ecosystem service affects the value of other market goods.

For this study, primary users and beneficiary population were considered based on the dependency on ecosystem services from the Sango Bay-Minziro area. The coverage was set to administrative units and populations that are considered as the main users of ecosystem services (at least provisioning), and for whom values are calculated. For Uganda, the administrative units considered were eight sub-counties and two Town Councils in Rakai District (population: 219,788); while all the 20 wards in Missenyi District were considered for Tanzania (population: 202,632).

In terms of *provisioning* ecosystem services, the total value of water used for human domestic purposes in Sango Bay was estimated at US$ 1.7 million per year; while the value for use of water by cattle was US$ 4.6 million per year; a figure that would be considerably higher if all other livestock were included. Contributions to fuel wood consumption, grass for grazing and mulching grass were estimated at US$ 11.0 million, US$ 4.7 million and US$ 2.8 million per year, respectively. Crop farming and irrigation was estimated at US$ 636,364 per year. However, indications are that poor farming practices may have adverse consequences on the hydrological ecosystem services of the Sango Bay area, jeopardizing most of the benefits.

Other provisioning services included crafts from palm leaves, sedges and grasses: estimated at US$ 1.6 million per year; timber and charcoal (although illegal): estimated at US$ 5.2 million per year; poles for wall construction, roofing and fencing: estimated at US$ 5.6 million per year; honey production: estimated at US$ 6.6 million per year and grasshoppers and white ants: estimated at US$ 3.6 million per year.

Plant-based wild foods (vegetables, fruits and mushrooms) were estimated at US$ 340,909 per year, while traditional medicine was estimated at US$ 4.2 million per year. Game meat was valued at US$ 1.1 million per year; fisheries from the lake, wetlands and rivers at US$ 7.0 million per year and snail shells from Lake Victoria were estimated at US$ 18,909 per year.

The Sango Bay area also plays an important role by providing *regulating services* and supporting ecosystem processes such as creating conditions for balancing the dynamics of ecological and hydrological systems for the waters entering Lake Victoria. The value of regulating services was estimated, using value transfers, at US$ 49.9 million per year. Using value transfers, the value of

cultural services; in form of aesthetic, spiritual, recreation and ecotourism was estimated, at US$ US$ 5.4 million per year.

Regarding Minziro, *provisioning* services were valued as: water for domestic use by humans estimated at US$ 1.1 million per year, while that for livestock was estimated at US$ 3.3 million per year. Fodder grass for livestock was valued at US$ 7.0 million per year. Crop irrigation was estimated at US$ 1.3 million per year; with due consideration that the potential is enormous. Crafts from palm leaves, papyrus and grass were estimated at US$ 68,600 per year. Plant-based wild foods (vegetables, fruits and mushrooms) contributed US$ 388,571 per year and medicinal plants about US$ 537,600 per year. Fuel wood was valued at US$ 8.9 million per year, fisheries at US$ 4.6 million per year and, honey production: at US$ 172,597 per year.

The *regulating* services of the Minziro area was estimated, using value transfers, at US$ 82.0 million. This underscores the fundamental role it plays in maintaining ecological balance and ensuring the integrity of natural ecosystem processes, including supporting the existence of local plants and animals, and providing an array of regulating and supporting ecosystem services. *Cultural services*, in terms of the scenic beauty from the natural landscape, provides aesthetic values and tourism estimated, using value transfers, at US$ 8.9 million per year. The Minziro area also hosts historic sites that are a central tourist attraction.

A synthesis of findings from this study estimated that the Sango Bay – Minziro BSA provide ecosystem services worth about 236 million US$ per year. The ecosystem services contribute to livelihoods through income, food and nutrition security and supporting different sub-sectors such as crop and livestock farming and through purification of the water and air. The benefits provide incentives that can strengthen conservation efforts. Results from the economic valuation for Sango Bay – Minziro ecosystem should be used as a clear justification for financing management and conservation of the BSA.

1 INTRODUCTION

1.1 STUDY BACKGROUND AND OBJECTIVES

This report has been produced for the USAID-funded Planning for Resilience in East Africa through Policy, Adaptation, Research, and Economic Development (PREPARED) project. The assignment is being carried out as a short-term consultancy contract by LTS International.

Under the PREPARED project, Conservation Investment Plans (CIPs) are being prepared for three biologically significant areas (BSAs) in the Lake Victoria Basin, including Sango Bay-Minziro. The project envisages that each CIP should contain a section on the economic benefits associated with conserving biodiversity and/or the economic costs associated with biodiversity degradation and loss in that BSA. This assumes that information about the value of biodiversity and ecosystem services will help to justify and make the case for the conservation interventions and investment packages that are being proposed in the CIPs, and assist in better mainstreaming biodiversity priorities into government policies and budgets.

The current document reports on a task to "complete the valuation of Sango Bay-Minziro BSA". Towards the overall objective of providing information that can be used to provide an economic justification for the CIP, the rapid assessment of ecosystem service values seeks to answer three key questions:

(1) How and for whom does the Sango Bay-Minziro complex generate economic benefits?

(2) What is the current value of biodiversity and ecosystem services?

(3) What are the gains, costs-avoided and economic justification for taking steps to invest in enhanced BSA conservation?

The rapid assessment was conducted over a period of 13 days, and involved field visits to Sango Bay-Minziro; stakeholder and expert consultations at various levels; literature review; collation of existing national and district statistics; data entry, analysis and reporting.

1.2 IMPORTANCE OF NATURAL RESOURCES VALUATION

Globally, natural resources play a critical role in the livelihoods of people by providing employment, energy, nutritious foods, clean water and air, and a wide range of other ecosystem services. As the world experiments with approaches to achieve sustainable development and a greener economy, a tremendous potential lies with sustainable management of natural resources. However, there is a general lack of clear evidence of the magnitude of the contributions that natural resources make to livelihoods. The evidence for how much ecosystem services contribute is critical to inform planners, policy makers and implementers, and politicians of the importance of natural resources and why they should recognize them in the post-2015 development agenda at the local, national, regional and global level, not only from the perspective of environmental management; but also for their contributions to broader social and economic issues.

Traditionally, the approach used to decide on areas to be designated as Protected Areas, was to select areas where the human population was low and wildlife was considered to be almost synonymous with "big game." However, as the human population grows, nature continues to play a large role in the livelihoods and wellbeing of human beings by providing both tangible and intangible benefits. In addition, although dependency on nature has often been equated with lack of progress, nature provides

important services that improve the lives of people at all levels of society, such as carbon storage, provisioning of clean water and filtering pollutants.

The criteria for consideration of important areas for protection have also changed, with an increasing focus on new holistic concepts, such as BSAs, which consider an area based on the services it provides to humanity. This new approach focuses strongly on the benefits that are derived from the different ecosystems, which are sometimes referred to as "natural capital." To demonstrate the magnitude of benefits from natural capital, it is necessary to express the benefits from nature in monetary terms, which makes their value more easily understood and considered by planners, policy makers and politicians. This is why it is important to conduct economic valuation studies, to help identify relevant areas that require protection, and provide justification for the need for concerted efforts of investment in management and conservation.

This report highlights findings of a study carried out to estimate the contribution to livelihoods by the Sango Bay-Minziro BSA, an important trans-boundary ecosystem shared by Uganda and Tanzania. The overall aim of this economic valuation study was therefore to provide baseline data on the benefits derived from different ecosystem services from the Sango Bay-Minziro area, which includes forests and wetlands, and their associated habitats; and which has been identified as one of the biologically significant trans-boundary ecosystems in East Africa.

1.3 THE TOTAL ECONOMIC VALUE CONCEPT

There is an overall consensus that underestimation of the value of the many goods and services provided by ecosystems have been recognized as one of the major causes of the failure to protect and manage them in a sustainable way. The concept of Total Economic Valuation (TEV) is used as one of the tools to solve the problem by guiding how to attach monetary values to the natural capital. Therefore, the monetary contribution of the natural capital of the Sango Bay-Minziro BSA and their surroundings to the local, national and global community is important to provide a basis for conservation efforts.

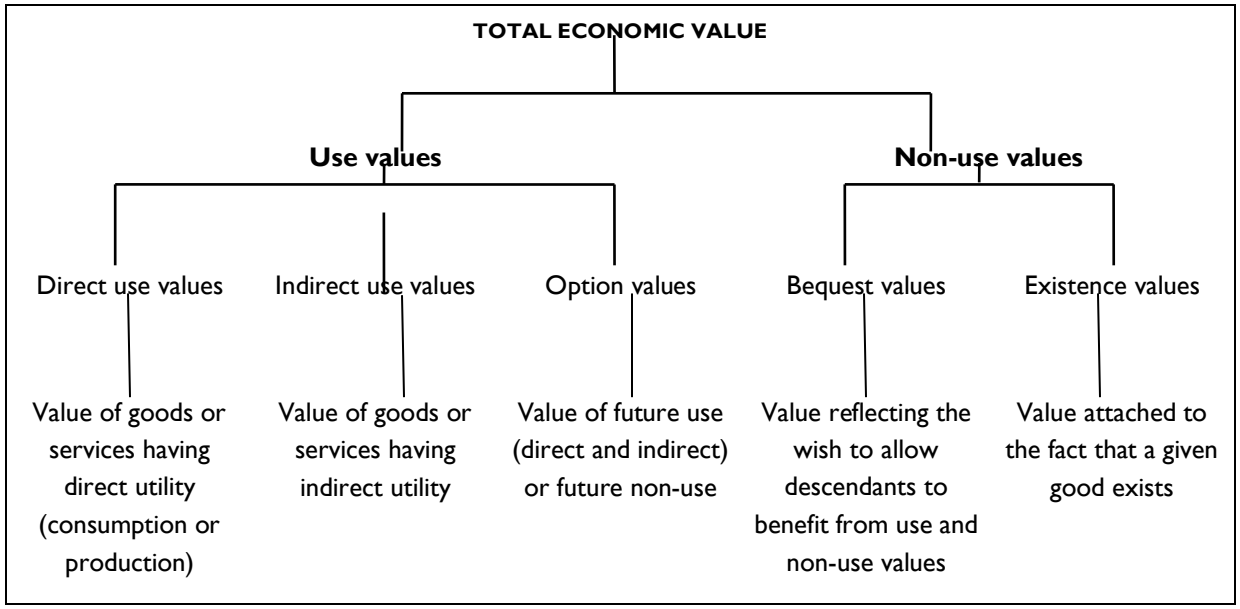
This information should be packaged in a way that can be appreciated by all stakeholders for appropriate actions including:

- Scientists and researchers for conservation planning;
- Planners to allocate adequate resources;
- Policy makers to support appropriate policy;
- Local communities to enable them to protect their natural assets;
- Financiers to provide logistical support; and
- Other decision makers to support management and conservation efforts.

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 can provide prices that are a true reflection of the values society places on that good or service (although, in many cases, subsidies or other policy and market distortions mean that the prices people pay or receive are not in fact an accurate indication of "true" social value). For other goods and services, such as water purification and storage and scenic

beauty, market prices either do not exist or only capture a small part of the total value. To ease the task of analysis, therefore, it is often useful to disaggregate any environmental impact into individual components of value. One approach to do 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 1).

Figure 1: Synthesis of the benefits from ecosystems according to the TEV concept



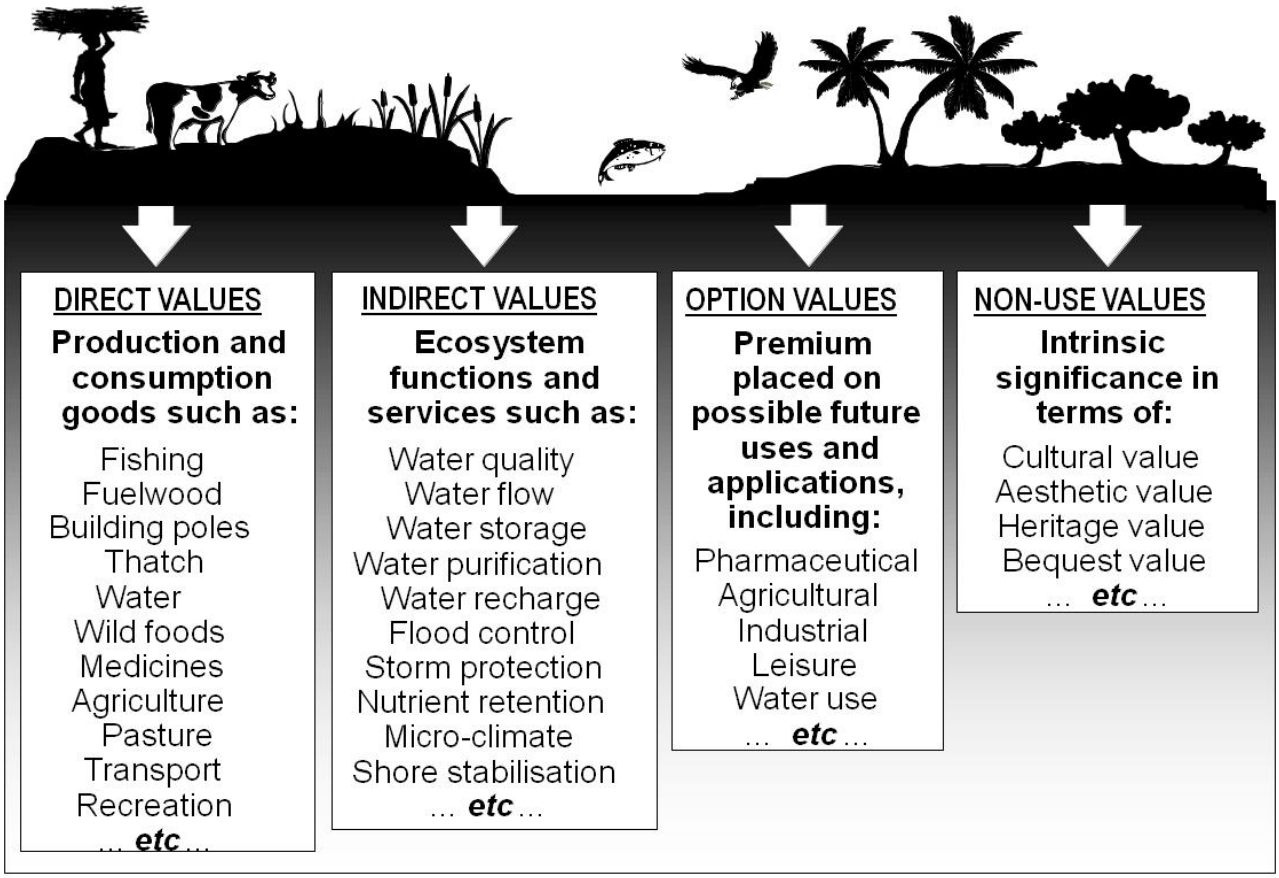
The idea behind the TEV approach is that any good or service is composed of various attributes, some of which are concrete and easily measured, while others may be more difficult to quantify. The TEV therefore reflects the sum of *all* of these components, not just those that can be easily measured. The concept of TEV is premised on the different benefits that are derived from the ecosystem services as being use or non-use values indicated in Figure 2.

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 first two are generally referred to as "use values". Each is often further subdivided into additional categories.

Figure 2: A wide range of environmental benefits for society and livelihoods



Source: Emerton & Muramira (1999)

Direct use value **-** Direct use value, also known as extractive, consumptive, or structural use value, derive 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 fruits, herbs, 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 catching of fish, or the non-consumptive use of the reef by scuba divers. All of these benefits are real, can be measured, and have values. 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 **-** Indirect use value, also known as non-extractive use value or functional value, mainly derives from the ecological *services* the environment provides. For example, forests 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.

Option value **-** Option value 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 future use value, similar to an insurance policy; whose benefits can be derived in future. One 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 its value.

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 such benefit is **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 become 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.

TEV is therefore made up of the combination of actual use values, option values and existence values. The outcome of TEV is sometimes referred as natural capital as it represents the entire value of the environmental resources.

The concept of TEV is used to aggregate the different benefits from the natural capital by expressing the estimated change in the well-being of different natural resource beneficiaries if the natural resources they depend on were to disappear. The most commonly used formula in TEV is that of the Net Present Value (NPV), which can be expressed in discrete terms as:

$$NPV = \sum_{t=1}^{T} BD_t - CD_t \; / \; (1+r)^t$$

Where BD_t and CD_t represent respectively the direct benefits and costs of different natural resource use options for periods t from 1 to T (the term of the planning period) and r is the discount rate.

1.4 CAUSES OF UNDERVALUATION OF FORESTS AND NATURE

Despite the enormous importance of natural resources to the livelihoods of people and economic development, there is a tendency for undervaluation, which can lead to over extraction. It is therefore extremely important to understand the causes of undervaluation because this may help policy and implementation-level decision-makers to tackle some of the problems related to undervaluation, such as deforestation.

Market failure has been identified as one of the major 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 ecosystems, 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, sometimes called *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. First, the government may be influenced by powerful pressure groups. Second, it may find it difficult to obtain the right information. Third, 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 natural resources.

1.5 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). The Millennium Ecosystem Assessment (MEA) also provided a classification system for ecosystem services, with four main categories: provisioning, regulating, and cultural services; which directly affect people, and supporting services needed to maintain the other services (Table 1). The ecosystem services outlined in the MEA contribute to livelihoods, food and nutrition security and economic development and hence deserve particular attention. The MEA classification of ecosystem services has been generally adopted and is now widely used within both conservation and development communities. It has also been adapted and applied by a variety of other global assessments and analyses (for example The Economics of Ecosystems and Biodiversity/ TEEB and the Common International Classification of Ecosystem Services – see TEEB 2008, 2010; Maes *et al.* 2013).

Table 1: Millennium Ecosystem Assessment classification of ecosystem services

ECOSYSTEM SERVICES	
	Provisioning Services Food (crops, livestock, wild foods, etc…) Fiber (timber, cotton/hemp/silk, wood fuel) Genetic resources Biochemicals, natural medicines, pharmaceuticals Fresh water
Supporting Services Nutrient cycling Soil formation Primary production	**Regulating Services** Air quality regulation Climate regulation (global, regional, and local) Water regulation Erosion regulation Water purification and waste treatment Disease regulation Pest regulation Pollination Natural hazard regulation
	Cultural Services Aesthetic values Spiritual and religious values Recreation and ecotourism

Source: MEA (2003)

1.5.1 Provisioning Services

These are the products obtained from ecosystems, including:

- *Food and fiber,* including the vast range of food products derived from plants, animals, and microbes, as well as materials such as wood, fruits, vegetables, ropes, and many other products derived from ecosystems.
- *Fuel wood*, *dung*, and other biological materials that serve as sources of energy.
- *Genetic resources* including the genes and genetic information used for animal and plant breeding and biotechnology.
- *Bio-chemicals, 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,* which is an 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 also an example of linkages between the categories of ecosystem services.

1.5.2 Regulating Services

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

- *Air quality maintenance* - ecosystems both contribute chemicals to 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 sequestering 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 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 (such as bees and birds).
- *Storm protection* - the presence of ecosystems such as forests can dramatically reduce the damage caused by storms and winds.

1.5.3 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* (traditional and formal) - ecosystems influence the types of 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 drives," 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.

1.5.4 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/or 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, whereas 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 BACKGROUND INFORMATION ON THE STUDY AREA

2.1 UNIQUENESS AND RARITY OF THE SANGO BAY-MINZIRO ECOSYSTEM

2.1.1 Bio-geographical significance of Sango Bay and Minziro areas

The Sango Bay-Minziro area is situated predominantly in the Lake Victoria Regional Mosaic and is considered to be of high bio-geographic importance because they are located in the transition zone between the East and West African vegetation zones. The Sango Bay-Minziro area therefore has unique features and rich biodiversity due to its bio-geographical ecotone location in the Guinea-Congolian biome. This means that forests in the Sango Bay-Minziro area have plants and animals characteristic of Congo and Guinea, that reach their eastern range limit within the Sango Bay- Minziro area. Most studies of plants and animals have given evidence that the Sango Bay area therefore qualifies as a Pleistocene refugium of the Guinea-Congo lowland forests (Davenport and Howard, 996; Kasoma and Pomeroy, 1996; Bakamwesiga, 2000; Byaruhanga, 2002).

Being at the transition zone, the Sango Bay-Minziro ecosystem is home to rare and endemic forest swamp tree species, several of which are known to be relics of the Albertine Rift. The predominant natural vegetation is wooded savanna with medium-low altitude rainforest. The Sango Bay-Minziro forests occurring closer to the alluvial deposits of the mouth of the River Kagera are unique in tropical Africa, as they are composed of an equal proportion of lowland (mainly western Guinea-Congolian) forest species and highland (afro-montane) forest species. Undisturbed forests in these areas are dominated by the Guinea-Congolian *Baikiaea insignis* and the afro-montane *Afrocarpus dawei.* Other Guinea-Congolian species are*: Canariun schweinfurthii, Klainedoxa gabonensis, Maesopsis eminii, Pseudospondias microcarpa, Pycnanthus angolensis and Symphonia globulifera.* Main afro-montane trees are*: Apodytes dimidiata, Croton megalocarpus, Ilex mitis, Podocarpus latifolius, Strombosia scheffleri, Trichocladus ellipticus and Warburgia salutaris.* One notable endemic tree species of Sango Bay-Minziro forests is the swamp *Podocarpus*, which is recognised as a distinct species *Afrocarpus dawei.*

2.1.2 Importance of Kagera River to the Sango Bay-Minziro ecosystem

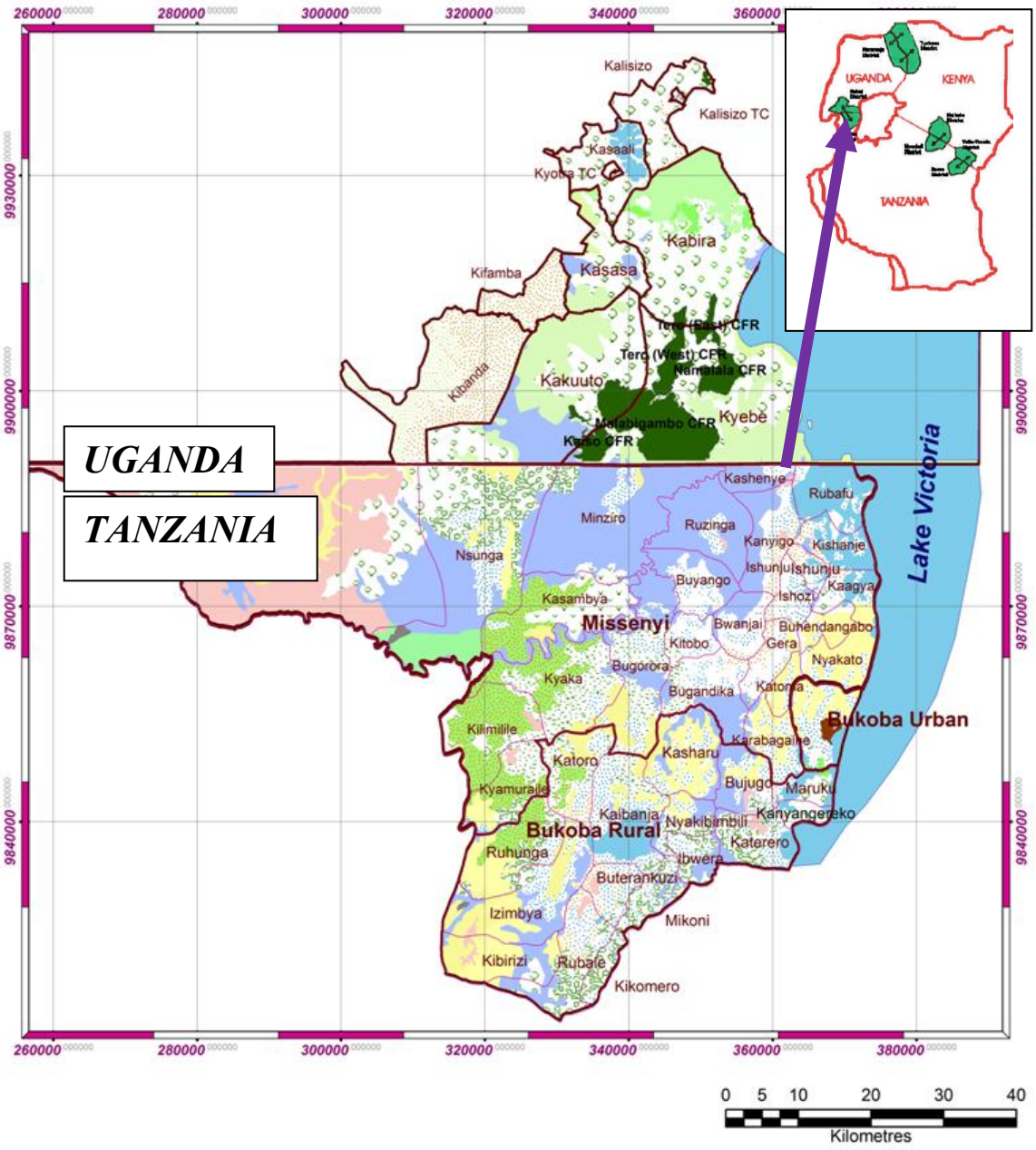
The importance of Kagera, and other rivers such as Bukora, Kibale and Kisoma in Uganda and Ngono in Tanzania, to the Sango Bay-Minziro areas is best described by Baker (2001) and Byaruhanga (2002); who explain that the topography and drainage has an effect on the flora and fauna of the area. In particular, following rains over the catchment areas in Uganda, Rwanda and Burundi; Kagera River rises and floods downstream areas near Lake Victoria. Most of the Sango Bay-Minziro ecosystem, a wetland by definition, is therefore greatly affected by the Kagera River and seasonal flooding often results in several feet of water covering the floor of most of the low lying landscape. This leads to seasonal flooding in most of the areas, which alters the conditions within the forest and affects much of the ground dwelling flora and fauna. The resident flora and fauna that occur in Sango Bay and Minziro are thus comprised of unique assemblages of species which are tolerant to such extreme conditions.

2.1.3 Trans-boundary nature of the Sango Bay-Minziro Study area

The Sango Bay-Minziro ecosystem has a peculiar transboundary aspect (Figure 3). The characteristic Sango Bay forest blocks of Malabigambo and Kaiso are contiguous with Minziro Nature Forest Reserve, over the Uganda-Tanzania border, without any distinct geographical features separating the ecosystems

in the 2 countries. Most of the Sango Bay and Minziro area is a flood zone of Kagera and some other rivers, which pour in the same bay along Lake Victoria. Within the Sango Bay area, the Kagera River flows largely within Tanzanian territory, apart from a small section, which flows through Uganda, where it enters Lake Victoria.

Figure 3: The Sango Bay-Minziro Trans-boundary ecosystem



Source: Map drawn as one of the data outputs from this study derived from MUIENR Biodiversity Databank

A historical management and conservation challenge in the Sango Bay-Minziro area is extensive logging, particularly targeting valuable tree species such as *Podocarpus*, *Beilshchemiedia* and *Baiekia*. This has

greatly affected the species composition of the forested areas with these three species having become scarce. However, reports from this study indicate that the forest management authorities in the Sango Bay-Minziro area have been successful in reducing illegal logging with only a few isolated cases being reported in the two countries. However, estimating the scale of the current levels of illegal logging remains a challenge, which makes it difficult for the management authorities to estimate the investment effort required to manage the problem.

In addition, reports from technical teams interviewed during this study indicate that the Uganda and Tanzania natural resource management agencies implement their work with minimal interactions between the two country teams. This creates a situation where national boundaries separate the planning, management and law enforcement activities within the area, with activities being implemented in isolation in Uganda and Tanzania. This is a challenge for overall management, as the wildlife and water moves across the two countries without recognition of any boundary or border. This strongly justifies the need for trans-boundary cooperation and collaboration for the management of the Sango Bay-Minziro area, which has been initiated by the East African Community through the Lake Victoria Basin Commission and the PREPARED Project.

2.2 SANGO BAY STUDY AREA

2.2.1 Location

The name Sango Bay is derived from the geographical feature of a body of water forming an indentation along Lake Victoria's north-western shoreline, some 15 kilometers north of the Tanzanian border. Previous surveys and studies in the area have used a common reference point of 'Sango Bay', which consists of the Central Forest Reserves (CFRs) of Kaiso, Malabigambo, Tero East and West, and Namalala and the nearby Lake Victoria area.

The Sango Bay study area lies in the eastern part of the Rakai District and the southern part of the Masaka District. The boundaries of Sango Bay area for this study were defined using the Sango Bay-Musambwa Kagera Ramsar site. Reference points used include Lake Victoria to the east; the main road from Kampala to the Mutukula Tanzania border to the west, and the Uganda-Tanzania border, to the south. The area covers parts of four counties in the two districts (Figure 4).

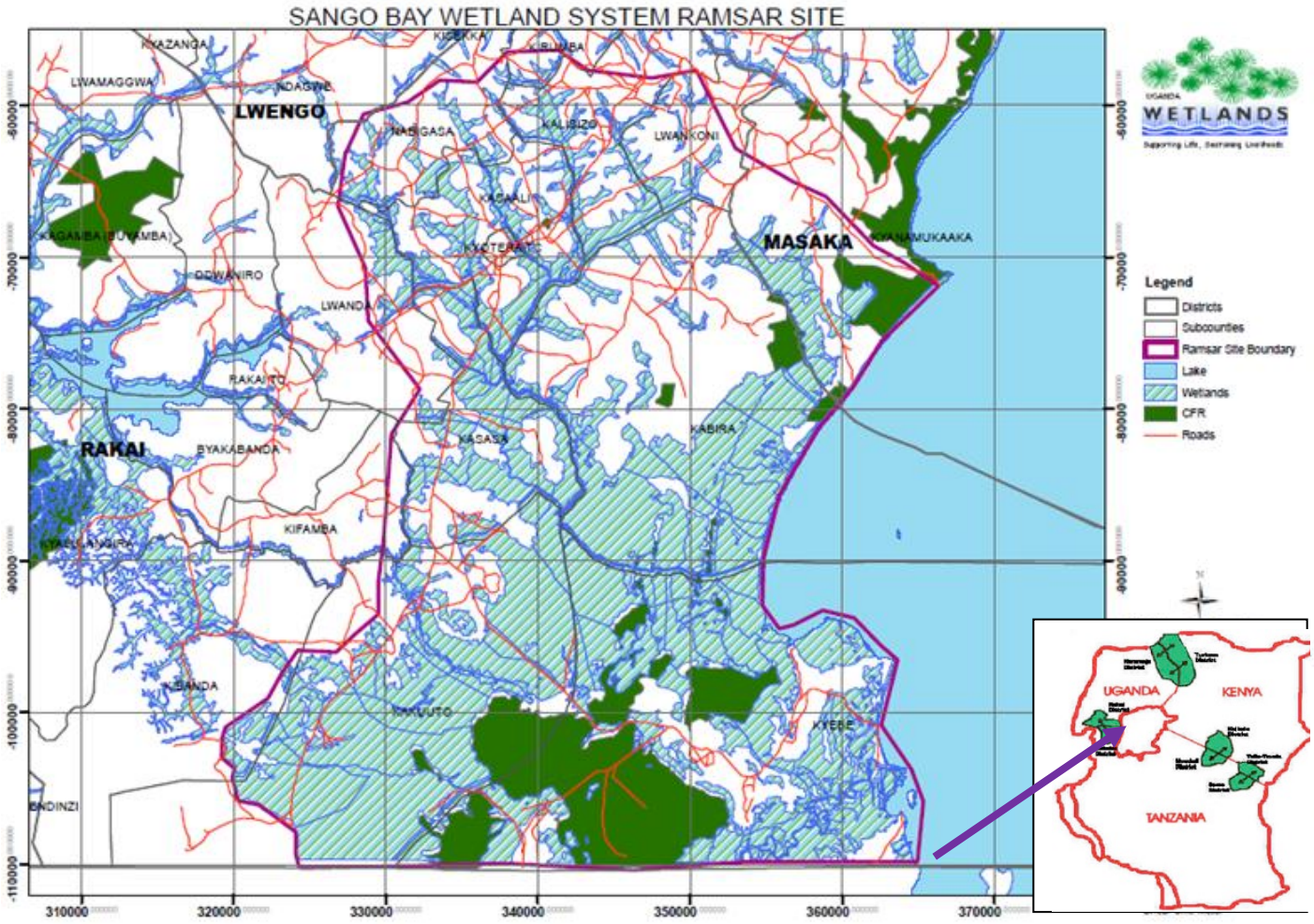
2.2.2 Sango Bay Forest Reserves

The Sango Bay area consists of extensive seasonal flood plains and permanent riverine and lakeshore wetlands; with moist swamp forests, mainly in the five gazetted CFRs. The five CFRs of Sango Bay are located near the shores of Lake Victoria, in the Rakai District of southern Uganda, and cover a total of approximately 151 square-kilometers. The southern blocks of Kaiso and Malabigambo are spread along the international border with Tanzania, and are contiguous with Tanzania's Minziro Nature Forest Reserve; without any defined demarcation on the administrative border. All the Sango Bay forests are located in flat land at approximately 1,160 meters above sea level.

The Sango Bay forests are of a relatively homogeneous nature, with the dominant vegetation in forested areas broadly classified as *Baikiaea-Podocarpus* seasonal swamp forest. The Uganda Forest Department (FD) biodiversity surveys (Davenport and Howard, 1996) report that the five separate reserves of Kaiso, Malabigambo, Namalala, Tero West and Tero East (Figure 5) are close enough and similar enough (on a national scale) to be considered as a single unit. The five forests were classified by

Davenport and Howard (1996) as consisting exclusively of secondary forests but having relatively high biodiversity and being of high conservation importance, in spite of the water logging conditions, which would have been expected to limit a number of plant species.

Figure 4: Sango Bay – Musambwa Kagera Ramsar Site



Source: Wetland Management Department; National Wetlands Information Systems

2.2.3 Biodiversity status of Sango Bay forests

Results from an FD survey of biodiversity in Ugandan forests, indicate that Sango Bay forests are relatively biodiverse, compared with other Ugandan forests (Table 2). The study indicated that Sango Bay forests ranked among the most diverse sites visited for large moths and were above average for butterflies, trees and shrubs (Davenport and Howard, 1996). In terms of species diversity; Sango Bay was ranked to be among the top 10% of Ugandan forests (based on the FD biodiversity inventory's index of species richness per unit area, adjusted for sampling intensity). In terms of the "conservation value" of the species represented (based on knowledge of their world-wide distributions and occurrence in Ugandan forests), Sango Bay was also ranked to be above average for butterflies, large moths and birds, while having average scores for the diversity for the remaining taxa. As a basis for further comparison with other sites, 104 species were also classified as being of restricted-range

(recorded from no more than five Ugandan forests). Information collected from Sango Bay forests contained in Davenport and Howard (1996) and Kasoma and Pomeroy (1996) can be useful for analysis of national conservation priorities and the development of appropriate management and conservation measures and actions.

Figure 5: Gazetted CFRs of the Sango Bay Area

Source: Kasoma and Pomeroy (1996)

Unfortunately, since the 1996 surveys reported above, no more recent detailed, field-based biodiversity studies have been carried out to give a more comprehensive account of the updated status of the flora and fauna of the Sango Bay. Background information on the Sango Bay-Minziro area is particularly useful for evaluating the effectiveness of management interventions, especially where the ecosystem services concerned is subject to sustainable utilization. This justifies the need for efforts that the PREPARED project has initiated, which can be operationalized through detailed Conservation Investment Plans (CIPs).

Table 2: Summary of biodiversity and conservation importance of five indicator taxa in Sango Bay Forests

	Trees and Shrubs	***Birds***	***Small Mammals***	***Butterflies***	***Large Moths***

Total No. of Species known from the forests	244	317	26	258	94
No. of restricted-range species (known from 5 forests)	12	51	0	29	12
No. of regional endemics	-	2	0	1	1
No. of species recorded by current inventory	188	144	19	192	72

Source: Howard and Davenport (1996)

2.2.4 Dominant vegetation

Most of the Sango Bay area is in a low lying area that is a flood zone of the River Kagera and other rivers that flow into Lake Victoria. This has created extensive swamp areas, many of which are either permanently or seasonally water logged. During the rainy seasons, extensive areas in the Sango Bay area get heavily water logged. During drought periods, the water stays long enough to provide opportunities for grazing and watering areas. One of the common economic activities in the area therefore includes livestock farming. Given the extensive wetland areas and Lake Victoria, fishing is also a common economic activity.

The vegetation of the Sango Bay-Minziro area is composed of a mosaic of wetlands, grasslands and forests. The wetlands include permanent and seasonal swamp-forests, papyrus (*Cyperus papyrus*) swamps, herbaceous swamps interspersed with palms (*Phoenix reclinata* and *Raphia farinifirea*), and seasonally flooded grasslands. The Sango Bay wetlands are extensive with a variety of characteristics, and stretch along a number of rivers, including the Kagera, Bukora, Kibale, Kisoma and others, that flow into their flood plains, and into the shores of Lake Victoria and the lake itself. The edge of the wetlands is varied; with sandy, rocky and forested shores and some vegetation zones modified by human impacts from fishing villages. The CFRs are of a rather homogeneous nature; broadly classified as swamp-forest, which were formerly of high economic importance due to the presence of *Podocarpus*, *Beilshchemiedia* and *Baiekia* timber species, most of which have now been logged.

The lake shoreline along the Sango Bay-Minziro area is fringed by different wetland zones such as papyrus, merging into extensive flood-plains of the different river inflow zones to the lake; which in most areas have beautiful deltas. Most of the bay and lakeshore area is relatively unsheltered and experiences some level of wave action, which affects the aquatic diversity. At the mouth of the Kagera and other rivers, the shore is relatively exposed, with mainly sandy shores merging into papyrus swamp.

In a study conducted by the Makerere University Institute of Environment and Natural Resources (MUIENR), the Sango Bay area (including Nabugabo, but without data from the Sango Bay Forest Reserves) was found to have a total of 901 plant species; which were estimated to contain 20% of Uganda's approximately 4,500 total species. A total of 276 wetland plant species were also recorded in the Sango Bay area.

2.2.5 Tree species

A total of 188 tree and shrub species (15% of Uganda's total) were recorded from the five Sango Bay Forest Reserves by the FD biodiversity inventory team (Davenport and Howard, 1996). This was in addition to the 56 tree and shrub species recorded from previous studies. During the FD inventory,

12 plant species that had not previously been found in the Sango Bay area were recorded. Twelve restricted-range species (found in less than five of the 65 forests sampled) were also recorded in Sango Bay; including three species *Euphorbia grantii*, *Heisteria parvifolia* and *Pseudagrostistachys ugandensis*. Apart from Uganda, *Pseudagrostistachys ugandensis* has only been recorded in Zaire, making Sango Bay an important forest for the conservation of this species. Twelve other identified restricted-range tree and shrub species indicate that Sango Bay is of some conservation significance. Data from the FD biodiversity inventory also suggest that Sango Bay has a moderate ranking in terms of conservation of Uganda's floral diversity, including *Euphorbia grantii* noted above.

2.2.6 Birds

During the MUIENR surveys, a total of 387 species were recorded, representing 39% of the total 1,008 species recorded in Uganda. The birds included four montane species, found only in the Sango Bay area, including Chubb's Cisticola (*Cisticola chubbi),* the Cinnamon-chested Bee-eater (*Merops oreobates*), the African Black Duck (*Anas sponsa*) and Equatoria Akalat (*Sheppardia aequatorialis*).

The FD biodiversity inventory recorded a total of 144 bird species; which gives an overall total of 317, when combined with previous records (Davenport and Howard, 1996). Of particular note is the Blue Swallow (*Hirundo atrocaerulea*), a globally threatened species. The Shoebill (*Balaeniceps rex*), which is classified as vulnerable according to the International Union for Conservation of Nature (IUCN) Red List, can also be found in the seasonally flooded swamps in the Sango Bay area and is thought to be found in large numbers in the Kagera extensive wetlands. According to Byaruhanga (2002); the Sango Bay wetland system also contains 14 regionally threatened bird species and huge congregations of migratory species have been recorded in the area, especially the White-winged Black Tern (*Chlidonias leucopterus*).

Byaruhanga (2002) established that the Sango Bay area is important for bird conservation. He found that there are in fact 417 species of birds, including the globally threatened Shoebill, Papyrus Gonolek and vulnerable Blue Swallows. The area is also prized for having huge congregations of migratory species, especially the White-winged Black Tern. One of the valuable sites in the Sango Bay area, the Musambwa islands contains the largest known breeding colony of Grey-headed Gulls and is recognized as the only known breeding area for Little Egrets and Long-tailed Cormorants in Uganda.

2.2.7 Mammals

A number of unique fauna have been recorded in the Sango Bay area. The African Elephant (*Loxodonta africana*) and the Sitatunga (*Tragelaphus spekii*) is the only globally threatened mammal species found in the area. The subspecies *adolfi-friederici* of the Black and White Colobus Monkey (*Colobus guereza*) is restricted to Sango Bay in the Ugandan part of its range. In addition, Sango Bay is part of the limited range in southwestern Uganda of the Blue Monkey (*Cercopithecus mitis*) *doggetti* sub-species.

During the MUIENR Global Environment Fund (GEF) biodiversity surveys, a total of 68 species, representing 20% of Uganda's total of 330 mammal species, were recorded (Kasoma and Pomeroy, 1996). Mammals recorded included bats, shrews, rodents, primates, hares, large herbivores and carnivores. The study reported that bats and rodents are the most numerous, while hares and carnivores were the least common mammals. By the time of this economic valuation study in 2015, it was also confirmed that hippos still survive in the Sango Bay area, and are sometimes seen in wetlands along the shores of Lake Victoria, which acts as a refuge. The Malabigambo and Kaiso forests also

harbor an unspecified number of elephants. The frequency of use of an area by elephants depends on the amount of human disturbance. The presence of tsetse flies renders the area unattractive to humans and has increased the potential for use by the elephants.

2.2.8 Key biodiversity species of conservation concern

Table 3 shows some of the key biodiversity species of conservation concern in the Sango Bay area. Plants of conservation interest include *Podocarpus usambaransis vardawei*, an endemic variety that was a target for logging for many years, and *Pseudagrostistachys ugandensis*, a grass not found elsewhere in Uganda.

Among the large mammals, special concern has been placed on the elephants (*Loxodonta africana*), which are globally threatened. Other mammals of conservation concern, which can be classified as being near-endemic, include *Colobus guereza adolfi-friederici*, which is restricted to Sango Bay in the Ugandan part of its range and *Cercopithecus mitis* doggetti, which occurs in Sango Bay area; as part of a limited range in south-western Uganda.

Table 3: ***Key biodiversity species of conservation concern in Sango Bay area***

Ecosystem/ Species of conservation concern	***Conservation status***
Evergreen swamp forest-grassland system	
Podocarpus (*Afrocarpus dawei*), a coniferous timber tree	Endemic
Pseudagrostachys ugandensis shrub	Near Endemic
Wild Coffee shrub *Coffea canephora*	Globally Rare
Blue swallow bird (*Hirundo atrocaerulea*)	Globally Endangered
Forest francolin bird(*Francolinus lathami*)	Restricted Range
Grey-cheeked Mangabey primate (*Lophocebus albigena)*	Only site in Tanzania
Thomas' galago primate (*Galagoides thomasi*)	Only site in Tanzania

2.2.9 Butterflies and dragon flies

According to the MUIENR studies, the Sango Bay area is important for dragonflies and butterflies, some of which are rare in Uganda and East Africa more generally. A total of 259 species of butterflies were encountered during the MUIENR study; approximately one-third of Uganda's total *Papilionoidea*, including *Macromia bispina,* which is only found in Uganda. During the GEF project surveys by MUIENR, 67 species of dragonflies were also recorded; approximately 30% of Uganda's total 210 species.

2.2.10 Fish species

According to Ogutu-Ohwayo (1993), two tilapine species (*Oreochromis esculentus* and *O. variabilis)* are known to be endemic to Lake Victoria, Nabugabo and some nearby small lakes. However, Nile Perch predation is considered to have reduced or decimated the population of these fish species in Lakes Victoria and Nabugabo.

2.2.11 Land ownership and tenure

Most of land in the Sango Bay area, especially outside the protected areas, has customary ownership; with small holdings of between one and three hectares. In pastoral areas, the grazing and livestock watering areas are mainly communally owned. Communal land ownership is considered to be

destructive in terms of environmental conservation, often leading to overgrazing and the spread of diseases. Moreover, communal ownership does not relegate responsibility for promotion of good land management practices, leading to "the tragedy of the commons."

The small landholdings found in both Sango Bay and Minziro are used mainly for crop farming and responses during this study indicate that the land is continuously cultivated and has lost fertility and general productivity. Cases of land degradation through soil erosion were also reported and evident especially in sloping land areas. Declining land productivity creates a disincentive for agricultural land use and it was reported that in most cases people have had to seek alternative livelihood options, often through increased use of natural resources, such as fishing and the collection and sale of forest and wetland products.

According to the Rakai district planner, the peripheral areas of the Sango Bay wetlands are under a *mailo* land tenure system (a land tenure system where registered land is held in perpetuity). It was also reported that approximately 12,000 hectares west of the Kaiso Forest Reserve are under a leasehold land tenure system.

2.2.12 Human activities and their impacts

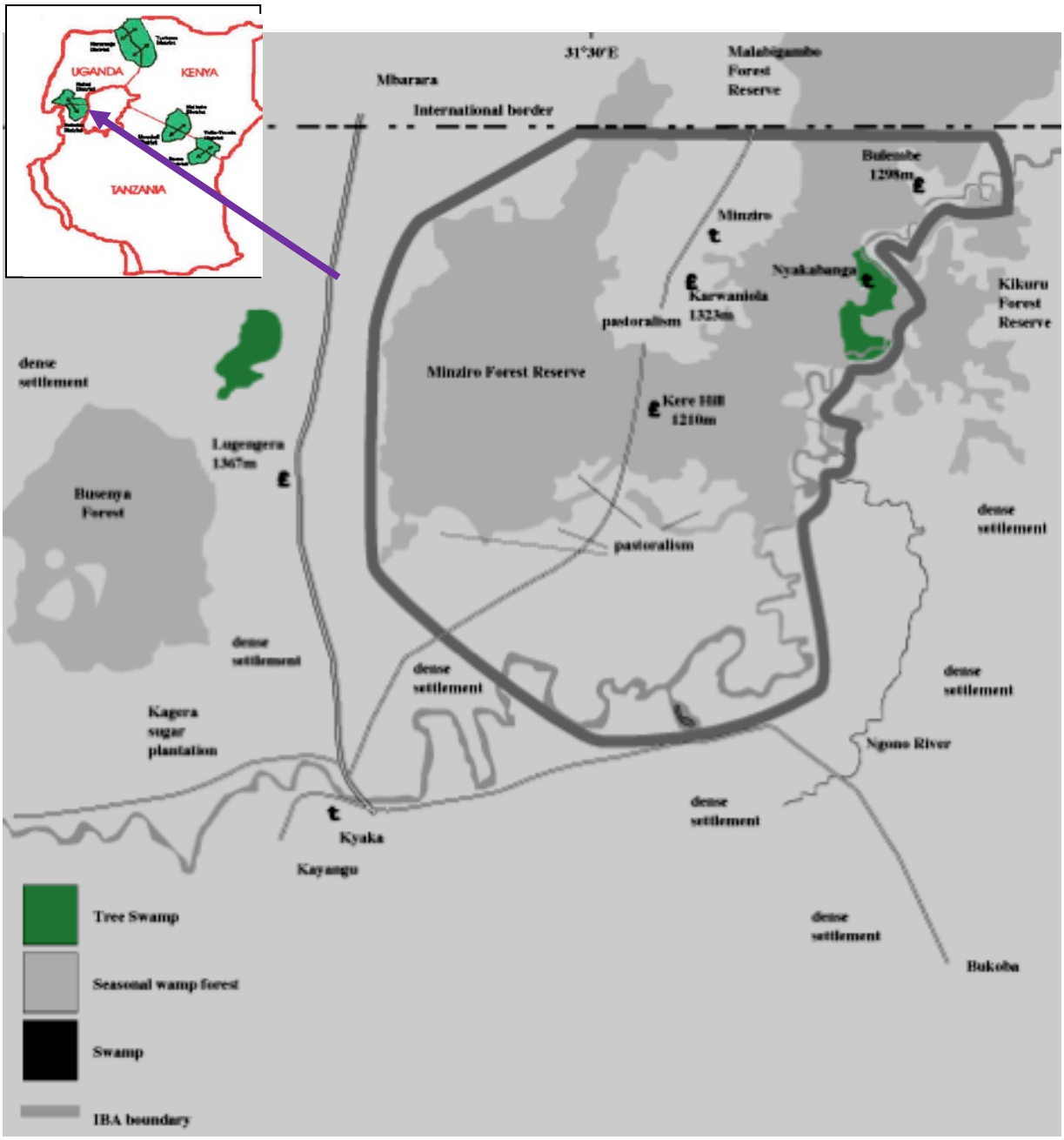
The main agricultural areas in Sango Bay have a climate that is mild and moist, with reasonably fertile soils, offering a high agricultural potential in many areas. The extensive seasonal and permanent wetlands, whose soils are moist for most of the year, have pastures and reliable water and support large numbers of livestock from the Sango Bay area and far off places. The wetlands and rivers and streams also support fishing for subsistence and commercial purposes. The wetland and river fisheries supplement fishing from Lake Victoria.

2.3 MINZIRO STUDY AREA

2.3.1 Location of the study area

The Minziro study area for this economic valuation was defined with reference to the Minziro Nature Forest Reserve in Tanzania. Minziro Nature Forest Reserve is located in Missenyi District, in the northern part of Kagera Region and is contiguous with the forests of Malabigambo and Kaiso along the Uganda border. The boundaries of the study area were also defined with reference to the Minziro Important Bird Area (Figure 6). The Minziro IBA includes an area enclosed by the Mutukula (Uganda-Tanzania border town) through Kyaka to Bukoba Town including the adjacent part of Lake Victoria. The study therefore covered Missenyi District and Rural Bukoba, Kagera Region, north-western Tanzania.

Figure 6: Map of Minziro Important Bird Area (IBA) showing the Minziro Nature Forest Reserve



Minziro forest is situated about 4.0 kilometers east of Mutukula village and also 80.0 kilometers from Bukoba Municipality. The forest can be easily reached by road from Bunazi, a distance of 15 kilometers via Kakindo village. It is surrounded by eight villages namely: Kalagala, Minziro, Kakindo, Mabuye, Kigazi, Igayaza, Byamtemba and Mutukula. Minziro Nature Forest Reserve borders Karagwe district to the west; Bukoba District to the east and south. In the northern side, it borders Uganda and is adjoining to Kaiso and Malabigambo forests. The village of Minziro is an enclave on the higher ground of the area, with the Forest Reserve extending around it. To the south and east is the Kagera River; while the northern boundary is formed by the international border with Uganda.

Minziro Nature Forest Reserve covers a total area of about 25,717 ha and is a gazetted conservation area. It is located in Kagera Region, north-western Tanzania, in Missenyi District (Figure 6). The forest is contiguous with Malabigambo Forest Reserve in Uganda and is one of the largest forests in Tanzania, and probably largest forested area in north-west Tanzania and is essentially an outlier of the Guinea–Congo lowland forests. According to Baker (2001), Minziro Nature Forest Reserve is the only forest in Tanzania where significant numbers of Guinea-Congo biome restricted bird species have been recorded.

A few kilometres to the south the vegetation changes dramatically on the higher plateau country of Kagera Region, making the Minziro forest to have a habitat-type, which has unique characteristics within Tanzania. Minziro forest is therefore recognised for having a forest type that is unique in the country. It was gazetted as a forest reserve in 1947 and is situated at around 1,150 metres a.s.l.; in a fairly level terrain. The area is also recognised as one of Tanzania's 77 Important Bird Areas (IBAs), due to the presence of one globally threatened species.

2.3.2 Topography, soils and climate of Missenyi District

The area of the district is between 1,000 to 1,400 meters above sea level, ranging from the Lake Victoria shores with some few hills. The district has a range of soil mainly sandy and loam types which support plant life, survival of people, livestock and wildlife.

The district receives a bimodal type of rainfall; with enough precipitation that favour growing of crops and trees and livestock production. The bimodal rains have peaks of short rains between September and December and heavy rains between March and May. Minimum and maximum temperatures range between 15°C and 28°C, respectively; with an average temperature of about 20°C. In effect, the main economic activities are crop and livestock farming and some limited fishing.

2.3.3 Dominant vegetation

Minziro Forest largely consists of two dominant vegetation zones; the *Baikiaea–Podocarpus* seasonal swamp forest and flooded *Acacia* woodlands. More that 75% of the total area of 25,717 ha for Minziro forest, can be broadly classified as *Baikiaea-Podocarpus* seasonal swamp forest. The rest of the area is mainly seasonally flooded grassland, with pockets of predominantly *Acacia polycantha* woodland and papyrus dominated wetlands on the river edges (Davenport & Howard 1996). Previous tree inventory studies indicate that the canopy is generally lower than that of medium-altitude mixed evergreen forest, although many of the component species are the same. Most of Minziro forest is low-lying and flat and large areas are regularly inundated by the flooding of the Kagera River to the south.

The major tree and shrub species in the Minziro area include: *Baikiaea insignis, Afrocarpus dawei (Podocarpus usambaresis), Warburgia ugandensis, Syzygium guineense, Mimusops bagshwawei, Beilshmedia ugandensis, Manilkara obovata, Syzygium cordatum, Maesopsis eminii, Maytenus undata, Albizzia gumifera, Sapium ellipticum and Gardenia imperiallis*. Exotic trees have also been planted in some areas mainly *Eucalyptus* spp., *Grevillea robusta, Pinus caribaea*, *Persia americana, Terminalia mentalis, Terminalia superba and Terminalia cattapa.*

2.3.4 Species Diversity in Minziro Forests

Minziro forest is habitat for a variety of flora and fauna, some of them being endemic to the area. The forest also has different types of animals such as white and red Colobus monkeys, buffalos, elephants,

leopards, bush babies, rhino vipers and other snakes. Previous surveys have identified about 603 different types of butterflies. Minziro Forest is considered to rank very high in terms of butterflies, with more than 600 butterfly species identified, surpassing any other forests in Africa. In terms of birds, Minziro forest is ranked to be of high significance with 58 of the 245 bird species recorded in the reserve not found outside Kagera in Tanzania, while 56 of these have only been seen in Minziro.

In recognition of its biodiversity and conservation importance, the Government of the United Republic of Tanzania upgraded Minziro's conservation status from forest reserve to nature reserve. This is in line with National Forest Policy on the protection of unique ecosystems and biodiversity in Tanzania.

2.3.5 Management history and the challenge of illegal logging in Minziro forest

Studies carried out around Minziro Forests such as Baker (2001) identified the main threats to include agricultural encroachment, illegal and excessive timber extraction and uncontrolled burning of the grassland for improved cattle grazing. Minziro forest has had a history of illegal logging, especially in search of the high value Podocarpus species, which had a high demand in Tanzania and the neighbouring Uganda. By the time of this study, it was reported that a very small number of trees in Minziro forest have a harvestable size for timber. It was also reported that some cases of illegal logging have been reported in the area, with some allegations of pitsawyers who illegally enter from Uganda.

In the past, legal commercial logging occurred under license; the royalties were collected by Bukoba District, and were then sent to the treasury in Dar-es-Salaam. Illegal harvesting of Podocarpus has been reported for shipment to Bukoba. A considerable amount of Podocarpus was taken out in the past and thus few large Podocarpus remain in Minziro.

3 METHODOLOGY

3.1 DATA COLLECTION TEAM

The field data collection team involved representatives of the PREPARED Project team of experts from Uganda and Tanzania (Annex I). The team of experts were supplemented by representatives from local government including Regional Technical Officers from Kagera Province (TZ); District Technical Officers from Masaka and Rakai (UG) and Missenyi (TZ); Sub-County (UG) and Ward Extension Officers (TZ) and local community leaders.

This study was used as an opportunity to strengthen the capacity of the team of experts and some Local Government Officers in conducting economic valuations for natural resources, building on previous work carried out by the PREPARED project. The first activity in preparation for the field data collection exercise was therefore a capacity building workshop involving the data collection team. During the workshop, which was facilitated by the consultant, presentations were made on the principles of economic valuation and the relevant methods to be used for field data collection. The team reviewed tools to be used for data collection, which were pre-tested in a selected area and updated accordingly.

During the workshop, a general inventory was made of the ecosystem services to be considered for economic valuation and this guided the data collection plan. The decision of the selection of the study sites was made by using a purposive sampling method; where sites were chosen based on specific criteria. Some of the criteria used included areas where specific resources or ecosystem services are commonly used and where some materials or products are harvested, processed or marketed.

The field planning team developed an inventory of the key ecosystem services in the Sango Bay-Minziro area. This was used as the basis for the data collection plan, which identified the different sites to visit. At each site, information about the use of different ecosystem services was collected, such as water and firewood collection and selling points, local trade centres and periodic markets. The field data collection plan was modified as fieldwork progressed to take advantage of field conditions, local knowledge and access routes. Flexibility was incorporated, to enable time for collecting data on some commonly used ecosystem services that were mentioned during data collection, even if they were not part of the original plan. Some information about ecosystem services was also collected from Central Government and Local Government offices.

3.2 DOCUMENT REVIEW

Before field data collection, a review was carried out on previous studies and surveys carried out in the Sango Bay and Minziro areas, including surveys by the GEF supported "East Africa cross-border biodiversity surveys" project, government department surveys, academic studies and BirdLife partners' reports.

This study also uses information from additional detailed studies, surveys and inventories conducted in the Sango Bay and Minziro areas such as Howard (1991); the FD inventory (Davenport and Howard, 1996); Makerere University Institute of Environment and Natural Resources (Kasoma and Pomeroy, 1996) and a number of academic and other studies conducted in the area such as Francis and Penford (1991), Hamilton (1981), Kabi (2001), Kalibakate Kagwa (1995), Kabi (2001), Namara (2001), Nanyunja (2000), Ochieng (2000), Tumushabe (2001).

Information was also gathered from national and local level statistical reports and planning frameworks that can be used in economic valuation. This included data from Uganda and Tanzania on human population and housing census, agricultural and livestock census and natural resources statistics, including for water and forests. Fisheries statistics of Lake Victoria and other areas was also used. Information gathered from the district profiles and development plans of Masaka and Rakai (Uganda) and Missenyi (Tanzania) was also important.

3.3 ON-SITE FIELD VISITS AND INTERVIEWS

Specialist knowledge was collected from different resource user groups and individual ecosystem service resource users. This included people who benefit from the natural resources such as crop and livestock farmers, fishermen, and craft makers. Interviews were also conducted with other beneficiaries along the value chain of the natural resources including processors, transporters and traders; who earn a livelihood from different resources. In addition to providing estimates of the quantities of resources used and prices, the resource users also provided insights on their perspectives of the future of the different resources.

3.4 DATA COLLECTION

Standard socio-economic survey methods were used to evaluate use of different ecosystem services and the nature and problems faced by resource users. The socio-economic surveys were also concerned with demographic characteristics, the social environment, opinions and attitudes of users of different ecosystem services. The economic valuation also used standard tools for market surveys and opinion research, and to a considerable extent, sociological research.

3.5 KEY INFORMANT INTERVIEWS

Information about use of ecosystem services from the Sango Bay-Minziro ecosystem was also gathered from key informants. The Key Informant Interviews involved getting information from knowledgeable people about resource use. These included community group leaders, Local Council officials, farmer group representatives, business people, local government administration officials, religious leaders and technical officers.

3.6 OVERVIEW OF THE ECONOMIC VALUATION TECHNIQUES USED

During this study, a series of techniques were employed to conduct the economic valuation. The aim of valuation was 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 people pay to buy and sell different products and services in the market;
- looking at the price of goods that are alternatives or substitutes for environmental services;
- expenditure on goods and services that are directly linked to environmental benefits; and
- considering how a particular ecosystem service affects the value of other market goods.

The simplest way of assessing the value of a product is to look at how much people pay to buy or sell it, which is normally referred to as the market price. This is one of the common approaches that economists use to value most commodities. However, 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 area are not bought or 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. For example consideration can be given to the price of alternatives that can be used if the non-marketed ecosystem services were to be purchased.

A range of market and non-market based methods which were used to value benefits from Sango Bay and Minziro are presented. Methods that were used are based on similar economic valuation studies, such as Adamowicz (1995); Constanza *et al.* (1997); Emerton (1999); Emerton and Muramira (1999); Karanja *et al.* 2001; Kiwazi *et al.* 2004; Akwetaireho (2009); Kakuru *et al.* (2013); Wasswa *et al.* (2013); Kateyo *et al.* (2014) and Emerton (2014). For some data and information, direct observations were made in different areas to supplement interviews.

3.6.1 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 market prices were considered with reference to areas near the relevant natural resources of harvest such as forest or wetland. 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 meter, how much a stack of fuel wood costs, the price of a sack of charcoal and the price for a kilo of honey.

Looking at market prices is 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 Sango Bay-Minziro ecosystem services.

3.6.2 The market price of substitutes for environmental products

Some products, such as firewood and grass, were mostly collected at no financial cost and often had no market, since they were not directly bought and sold by the local communities. It was therefore not possible to value them by looking at their market price. However, these products had close substitutes which were readily available on the market. In this situation, the price was set based on the cost of buying the next-best alternative if the environmental product was not available. This represents the value of the forest use in terms of expenditure saved on alternative items. Examples included the cost of iron sheets instead of thatching grass, the cost of kerosene instead of fuel wood 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. The market price of substitutes was therefore also used to value the direct benefits that people get from the Sango Bay-Minziro ecosystem.

3.6.3 Effort/price of labour

Because the majority of people in Sango Bay and Minziro are poor, they often cannot afford to pay for environmental goods and services all the time they want to use them. However, they may be willing to invest in time to travel and collect relevant resources and this can be considered as 'payment' for the access and collection of the goods and services in the form of time invested or labour. For example, family members collect firewood and water from the forests and woodlands or different watering

points such as streams, wetlands and the lake. The labour and effort invested in traveling and collecting the relevant resource can therefore be estimated using the local wage equivalent that would have been paid to local communities for working on farms.

3.6.4 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 goods and services. For example, if a forest provided watershed catchment protection, it prevents downstream siltation and flooding, which would have otherwise led to seasonal destruction of farmland, properties and livestock and at times led to a decline in riverine fish yields and to siltation of reservoirs. For the Sango Bay-Minziro ecosystem, we calculated the value of losses resulting from flooding, for example to properties, livestock, farm production, loss of fish catches.

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 the Sango Bay-Minziro ecosystem.

3.6.5 Replacement value

It was possible to value some 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 negative impact if the service was no longer provided. 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 lands, the avertive expenditure necessary to mitigate and reverse the effects of lack of forest watershed protection services.

Looking at replacement costs or avertive 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.

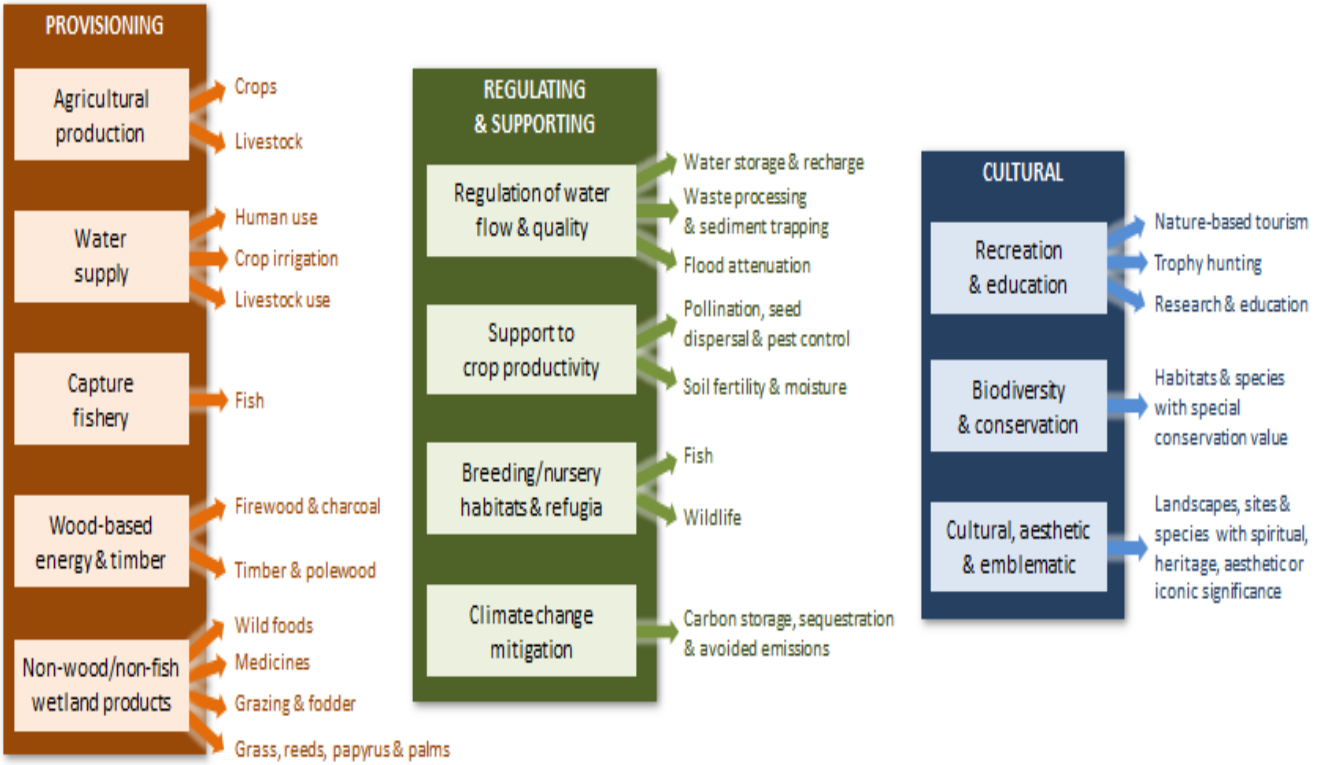
3.6.6 Value Transfers

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 related 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 advantage 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 services to be valued have not yet been created so that there are no users to survey. However, the value transfer approach has some limits. For example, estimates derived in one situation may not be appropriate for all situations. A consensus seems to be emerging that value transfer can provide a valid and reliable order-of-magnitude estimate under certain conditions. In particular, 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; and, the populations affected must be similar.

3.7 DATA ANALYSIS AND PRESENTATION

The collected data was cleaned, coded and entered in a Microsoft Excel data sheets to synthesise the economic returns to resource users for each of the resources. The data was validated by the team that had participated in the field work and used to compute returns from each of the resources from the different areas. Using background information on number of resource users for the respective ecosystem services, the total economic values were computed. The computed data was validated before final analysis for consideration for expressing the TEV for different goods and services. The data was also related to background information such as the human population and household census, agricultural and livestock census, fisheries statistics and water supply data to extrapolate benefits accrued over the study areas. Findings from this study are presented according to the grouping of categories of the different ecosystem proposed by Emerton, 2014 (Figure 7).

Figure 7: Categories of ecosystem services in Sango Bay-Minziro considered during the study



Source: Emerton, 2014

4 FINDINGS ON ECONOMIC VALUES OF ECOSYSTEM SERVICES FROM SANGO BAY

4.1 PRIMARY USERS AND BENEFICIARIES OF ECOSYSTEM SERVICES FROM SANGO BAY AND MINZIRO

4.1.1 Administrative Units considered for both Sango Bay and Minziro

For this study, primary users and beneficiary population were considered based on the dependency on ecosystem services from the Sango Bay-Minziro area. The coverage was set to administrative units and populations that are considered as the main users of (at least provisioning) ecosystem services, and for whom values are calculated. For Uganda, the administrative units considered were sub-counties in Rakai District; while wards in Missenyi District were considered for Tanzania.

4.1.2 Profile of Rakai District, Uganda

Sango Bay District is located in south western Uganda, west of Lake Victoria, with its southern boundaries being part of international boundary between Uganda and Tanzania. It is bordered by Lyantonde and Lwengo Districts in the north-west, Masaka district in the East, Kalangala district in the south-east and Mbarara and Isingiro districts in the west. Rakai District has 4 town councils of Rakai, Mutukula, Kyotera and Kalisizo (Figure 8).

With a growth rate of approximately 3%, the population of Rakai is 518,008 persons; 264,954 of them females, and 253,054 males (Table 4). For this study, the boundaries of Sango Bay study area were defined using the sub-county administrative units of Rakai District. This was done to ensure a systematic way of using background demographic data, such as human and livestock populations, when estimating economic values. A total of 10 out of 20 administrative units relating to the Sango Bay Ramsar site were used.

Reports from the district indicate that most of the people in Rakai District live in rural areas and depend on agriculture. The economy is basically reliant on crop and livestock production. The huge percentage of the population that is engaged in agriculture implies that people's economic livelihoods are dependent on exploitation of natural resources such as wetlands, fisheries and forest resources; with all its attendant degradation. For this study the primary users and beneficiaries of the Sango Bay area were considered to be from the 8 sub-counties adjacent to Sango Bay area identified in Table 4; namely Kakuuto, Kasasa, Kibanda, Kifamba, Kyebe, Kabira, Kasaali and Kalisizo and 2 town councils of Kyotera and Kalisizo; with a total human population of 219,788 households.

Figure 8: Map of Rakai District showing administrative units

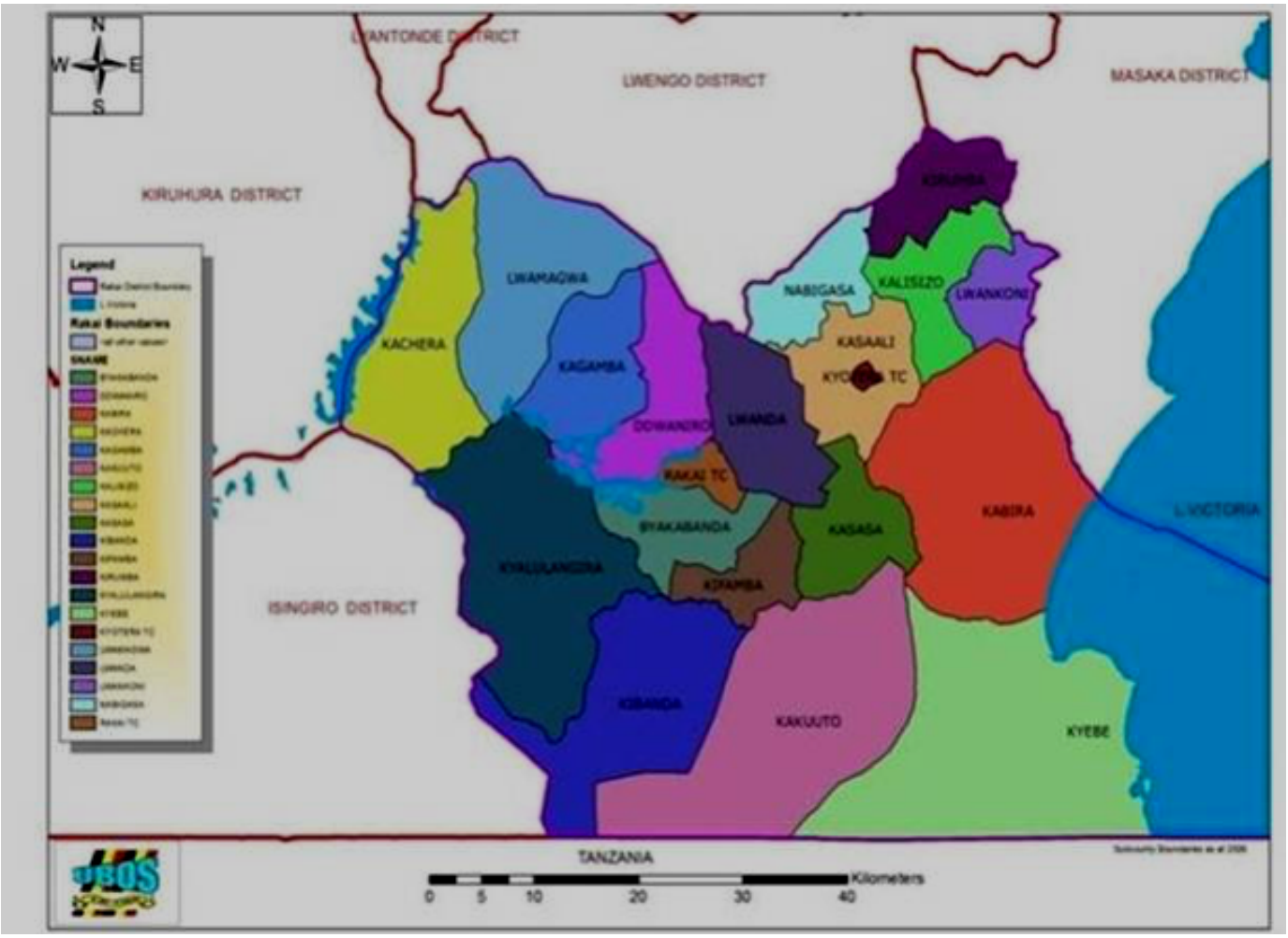


Table 4: Rakai District Human Population Census Results for 2014

Sub-county	Households	Males	Females	Total
Kakuuto **	9,366	19,798	20,038	39,827
Kasasa*	3,925	8,357	8,830	17,187
Kibanda*	5,427	12,818	13,159	25977
Kifamba*	3,131	7,187	7,410	14,597
Kyebe*	5,507	10,410	10,203	20,613
Byakabanda	4,057	9,228	9,257	18,485
Ddwaniro	7,149	16,015	17,006	33,021
Kacheera	5,041	11,656	12,033	23,689
Kagamba	7,196	16,308	17,550	33,858
Kiziba	4,131	9,999	10,621	20,620
Kyalulangira	6,022	13,478	14,342	27,820
Lwamaggwa	9,494	21,534	22,663	44,197
Lwanda	6,427	14,049	14,558	28,607
Rakai T/C	1,645	3,708	3,884	7,592
Kabira*	6,738	15,613	15,381	30,994
Kalisizo*	4,095	8,804	9,191	17,975
Kalisizo T/C*	3,589	6,110	7,354	13,464
Kasaali*	6,224	13,020	13,345	26,365
Kirumba	5,852	11,943	12,879	24,822
Kyotera T/C*	3,949	5,665	7,124	12,789
Lwankoni	3,397	7,306	7,587	14,893
Nabigasa	4,715	10,057	10,559	20,616
District total	**117,077**	**253,054**	**264,954**	**518,008**

** *The 8 Sub-counties and 2 Town Councils used to define Sango Bay area for this study with a total of* 219,788 *persons*

4.1.3 Location and Demography of Missenyi District, Tanzania

Missenyi District is one of the eight local authorities in Kagera region situated on the west of Lake Victoria and is among the districts that were carved out of Bukoba District in 2007. It covers an area of approximately 2,700 square-kilometers (270,875 hectares) and borders the Republic of Uganda on its northern-side, Lake Victoria and a part of Bukoba District Rural on the East, Bukoba District on the South and Karagwe District on the West. The District is composed of two divisions, Kiziba and Missenyi, which are sub-divided into 20 wards and 77 Villages; with 352 hamlets (Vitongoji) and 35,690 households (Table 5).

Table 5: Population and Settlement in Missenyi District Council as per Division

Divisions	Kiziba	Missenyi	Total
Population 2012	90,126	112,506	202,632
Households	14,079	21611	35,690
Average HH size	4.5	4.5	5.0
Growth rate % per year			1.4
Total area (Ha)	74,175	196,700	270,875
Population density per km^2	84	46	65
Population density per effective area	171	49	110

Source: Tanzania Population census, 2012

According to the 2012 population census, Missenyi District has a total human population of about 202,632 people, with a projected growth rate of 1.4% per year (Table 5). The population density varies per division in terms of population per total area.

Missenyi District has forests, which fall under four management categories, including:

(i) ***Central Government Forest Reserves:*** The nine Forest Reserves of Minziro, Rwasina, Munene, Kiikuru, Ruchwezi, Kantare, Kankuma, Kikongoro, and Kyau; which are important to Tanzania's economy due to their biodiversity and productivity roles.

(ii) ***Local Government Forest Reserves:*** These are managed on behalf of the Central Government by delegated local authorities**.** These are important for their provision of water catchment services, they are also recognized for their environmental stabilization and production, such as timber, firewood and medicine, values.

(iii) ***Village Forests:*** These are managed by village governments and are recognized for their catchment values and production purposes and are normally small in size (1 to 5 hectares). In Missenyi District, there are around 25 village forests.

(iv) ***Individual Forests:*** Are under the management of individual community members and are subject to common land tenure, where the land is acquired through inheritance, along generations.

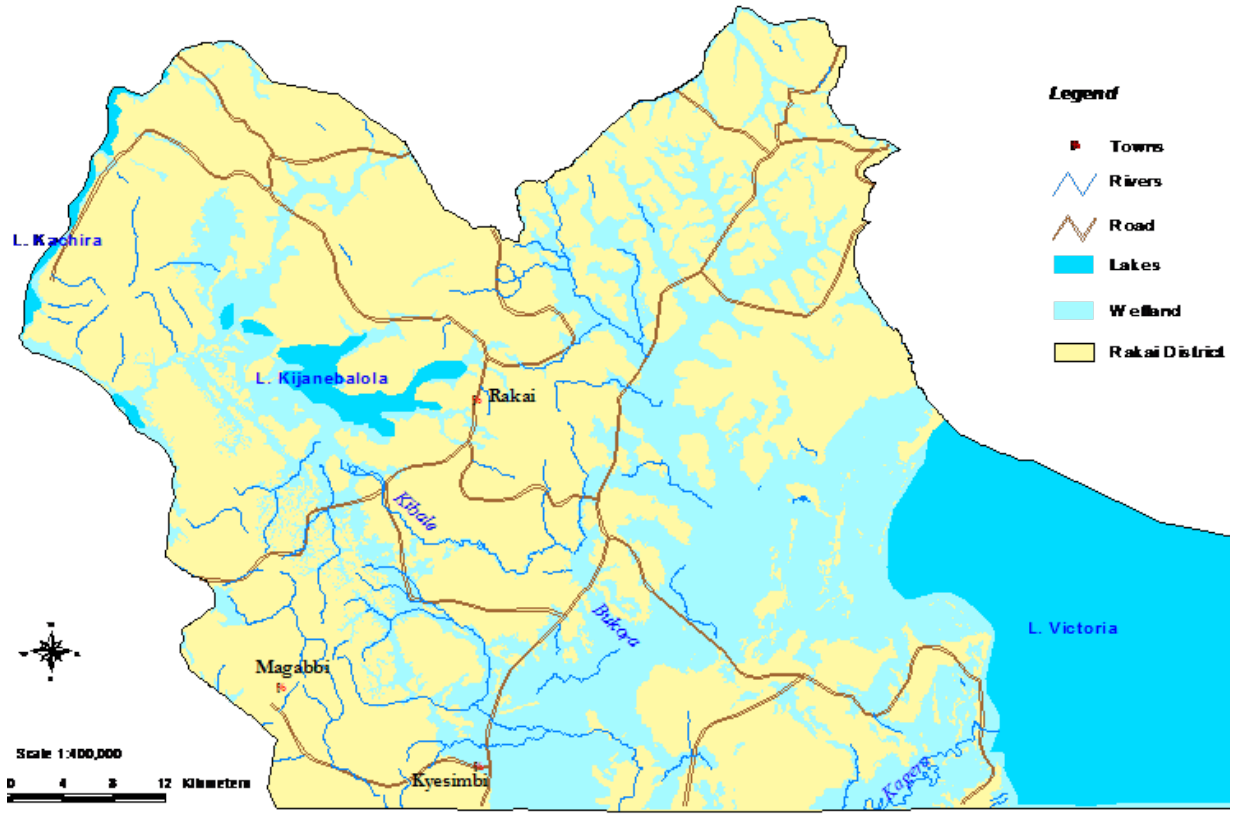
The different categories of forests offer significant ecosystem services. The Kagera River also meanders through most of Missenyi District, before joining Lake Victoria via Uganda. The whole district of Missenyi was therefore considered under this study.

4.2 PROVISIONING SERVICES FROM SANGO BAY

4.2.1 Water for domestic use for humans

Part of the Sango Bay area has reliable water sources that provide water for domestic use and for livestock watering in most seasons of the year (Figure 9). However, some of the water sources have been affected by wetland drainage. During this study, it was reported that about 10 per cent of the water sources in the district dry up, especially during the dry seasons; and this is attributed to degradation of the environment, especially wetland drainage.

Figure 9: Natural Water Sources in Rakai District



According to the socio-economic survey report for Rakai (UBOS, 2012), the majority of households in Rakai District mainly collect water for drinking and for other household uses from unprotected and protected springs (46%); lakes, streams and ponds (21%); and boreholes (10%). As indicated in Figure 10, the main source of water for drinking and for other household uses in the district was unprotected springs used by nearly half of the households (46%).

The socio-economic survey report (UBOS, 2012) indicated that only 35% of households could access water in the radius of one to one and a half kilometers. The report also indicated that on the average, 63% of households had to wait at the water source for a period of at least 30 minutes to access water for use at home. This has implications on the family and labor, since a lot of the time that would have been devoted to productive labor is spent in water collection.

During this study, respondents reported that on average, a household uses about four jerrycans of 20 liters each per day; for home chores such as bathing, cleaning, washing and cooking. Considering a total human population of 219,788 households in the 8 sub-counties and two Town Councils of the Sango Bay area; and at an average price of UGX 6,000 per cubic meter of water, the total value of water for humans in the Sango Bay area was estimated at UGX 5.6 billion (US$ 1.7 million) per year. This is equivalent to an economic value of UGX 107,748 (US$ 26) per household per year. It should be noted that the value of US$ 26 per household per year is the replacement cost that would be incurred if the service of water provision from natural sources were no longer available, that is if people were no longer able to access water directly and easily, and instead had to buy water at the stipulated cost.

The economic value is also more pronounced under the regulatory services of water storage, purification and filtration.

Figure 10: Major sources of water in Rakai District

Source: UBOS (2012)

4.2.2 Water for Livestock

In Rakai District, water for livestock is rarely collected from unprotected and protected springs (18%); with the main sources being natural systems such as lakes, streams, ponds and boreholes (82%). Compared to the water for other domestic purposes, use of water for livestock watering mainly involves driving the free range livestock to the respective sites. During this study, it was reported that during dry seasons, the Sango Bay area serves as a watering area for cattle from as far as 100 kilometers away in neighboring, relatively drier districts, such as Lyantonde and Lwengo.

In effect, large numbers of livestock, exceeding the areas' carrying capacity are brought to sites near watering points; where they have to graze after the watering. During this study, cases of overgrazing were reported in most surveyed pastoral areas, mainly attributed to instances where people from as far as 100 kilometers away herd their cows to the Sango Bay area in search of water and pastures, especially during drought periods.

For this study, a conservative estimate for the use of water for livestock watering has been used, which only considers cattle that are resident in the Sango Bay area. The data was then used to compute average daily Tropical Livestock Units (TLUs), which was then used to determine the average daily water consumption rates, with the assumption of a minimum water consumption rate of 20 liters per day per TLU. Based on an average purchase price of UGX 200 for a 20-liter jerrycan; the Sango Bay area was estimated to contribute a total of UGX 15.3 billion (US$ 4.6 million) per year. This translates in a value of UGX 141,099 (US$ 43) per TLU per year. The figure is based on cattle but can be even higher if other forms of livestock such as goats, sheep, pigs and poultry are considered.

4.2.3 Water for crop Irrigation

In the Sango Bay area, water is also used for crop irrigation purposes, especially for horticultural crops such as cabbages, tomatoes, passion fruits and onions. The major source of water for irrigation was reported to be wetlands, rivers, lakes and ponds. The survey found that one of the major sources for irrigation water was from rain water, with some cases of households using boreholes or other sources.

It was reported that for some cases where the crop gardens are not near a permanent source, the water is fetched from unprotected springs and protected springs and other sources such as rivers, lakes and ponds. Water for crop irrigation in the Sango Bay area is mainly used during the dry season. Given that the use of water for irrigation is of seasonal nature, the economic value for this study has been considered as a component of the water storage and recharge, which is estimated under the regulating services. Use of water for irrigation in Sango Bay can be considered as a resource with a higher potential value, if more effort is invested in harnessing the available water resource for optimum irrigation and crop production. Moreover, respondents interviewed reported that there is a high demand from Rwanda and Tanzania for most of the food crops grown in the Sango Bay area. This study derived the value of water for irrigation using a similar estimate for valuation of dry season farming giving a total of UGX 2.1 billion (US$ 636,364).

4.2.4 Fuel wood consumption

Data from Ugandan household surveys by the Uganda National Bureau of Statistics indicate that more than 95% of households in Rakai use firewood as their basic fuel for cooking and lighting; which is comparable to the national average use of fuel wood of 93%. However, during this study, one of the identified key threats to the Sango Bay area was unregulated harvesting of tree products, especially firewood and poles; this highlights the need to consider the economic value of firewood to the local economy, as an indicator of the need to have the resource well managed and protected.

The current use of firewood has been consistently high over an extended period, as indicated by findings by Kasoma and Pomeroy (1996), which showed that fuel consumption in the Sango Bay area is predominantly wood fuel, with 93.2% using firewood as the only source of cooking fuel. The study by Kasoma and Pomeroy (1996) also found that only 7.5% of the population collect wood from their own woodlot, 9.5% from other people's woodlot and 55.1% of all wood users collect firewood from Forest Reserves. During this study, respondents reported that the local communities still largely depend on firewood from natural forests and wetlands with very few on-farm sources. This study also found out that the consumption of firewood is still high with estimates of above 96%.

Reports from the local communities indicate that the next most commonly used source of energy is charcoal, which is locally produced. However, much of the produced charcoal is sold to traders and transporters, who take it to Kampala and Masaka, charcoal is therefore considered a key source of income.

Considering that at least 96% of the households in Sango Bay use fuel wood as their major source of energy for cooking and lighting, at an average price of UGX 3,000 per bundle; the economic value of firewood for household consumption alone in the Sango Bay area was estimated at a total value of UGX 36.4 billion (US$ 11.0 million) per year, translating to an average value of US$ 221 per household per year.

It was also reported that the local people on the islands, such as Musambwa, and the fish landing sites located on the mainland require a lot of firewood for cooking and smoking fish. However, there is limited wood and vegetation on the islands since the landscape of most of the island is generally rocky.

4.2.5 Grass for grazing

This study found out that the Sango Bay ecosystem has a significant value for supporting livestock production by providing fodder grass for grazing. The fodder was reported to be more valuable during the dry season, when most of the upland areas have no grass and the low lying plains are the only areas left for grazing. This is in line with previous studies which found that wetlands are indeed valuable as grazing areas during drought times (Emerton and Muramira, 1999; Kabi, 2001; Kakuru *et al*., 2013 and Turyahabwe *et al*., 2013). Based on an estimate of about 20% of the 212,444 cattle which use Sango Bay for grazing (42,489); and at a market price for grass of about UGX 1,000 for a bag of pasture used per day, the value of Sango Bay area for fodder grass for cattle grazing was estimated at a total of UGX 15.5 billion (US$ 4.7 million) per year. The value is equivalent to US$ 186 per household per year or US$ 24 per TLU per year.

Livestock farmers interviewed during this study expressed a deep worry that there is a challenge of high competition, especially during the dry season, when big numbers of livestock are driven in the Sango Bay area from neighboring districts in search of water and fodder; leading to overgrazing and increased diseases. Current trends in weather patterns due to climate change, characterized by unpredictable rainfall and prolonged droughts in the semi-arid lands of Uganda, notably the "cattle corridor", which extends to part of Rakai and its neighboring districts, makes it inevitable for communities to rely on wetlands for livestock grazing, as observed by Kakuru *et al*., (2013) and Turyahabwe *et al*., (2013). To sustain the continued benefits of fodder grazing from the use of Sango Bay, there is therefore a need for further research to generate information on the carrying capacity of the area. This can be used to manage access by livestock owners and managers that utilize the area in order to minimize degradation.

4.2.6 Mulching grass

One of the common agricultural systems in the Sango Bay area is the growing of bananas intercropped with coffee and other crops, such as maize and beans. During this study, respondents reported that bananas are grown by every household and that they are one of the crops that generate reasonable revenue and contribute a lot to incomes and food security in the Sango Bay area. To sustain banana production, one of the good farming practices in the area is to use mulch to control moisture loss, increase fertility and control soil erosion. The mulching grass is also packed and sold in the neighboring districts. The mulch used is mainly from seasonal and permanent wetland areas in the Sango Bay area. To estimate the value of grass for mulching, the area under banana growing in Rakai was used, with an estimate that each of the households owns at least half a hectare of bananas. Based on an estimate of using at least 700 bundles per hectare per year, at an average price of UGX 500 per bundle; mulching grass from the Sango Bay area was estimated to contribute a total value of UGX 9.1 billion (US$ 2.8 million) per year. This contributes an economic unit value of US$ 53 per household per year.

4.2.7 Crop farming in Sango Bay

During this study, reports indicated that, within Sango Bay, flood plains, wetlands and river banks are used for small holder crop farming; especially during the dry season. The seasonal and permanent wetlands are used for dry season farming, because they have some reliable moisture to sustain crops and may continue to be used as climate change challenges intensify. Despite strong reservations from the Wetlands Management Department and District Environment Offices on whether dry season crop farming can be considered as a wise use of wetlands even with guidelines, the local communities expressed a need for some guidelines. Reports from the Rakai Production Department indicate that approximately 25% of the 51,951 households in Sango Bay area (12,988) carry out their farming in wetland areas. The total economic value of use of wetlands in the Sango Bay area was estimated at UGX 2.1 billion (US$ 636,364) per year. This is equivalent to about US$ 49 per household per year.

It should be noted that poor farming practices in wetlands and along river banks always has adverse consequences on hydrological ecosystem services, such as water storage and purification. Impacts of poor farming in wetlands have been noted to affect water sources in many parts of Uganda (Karanja *et al*., 2009; Kakuru *et al*., 2013). The drainage of wetlands and river banks is likely to be one of the factors contributing to the reported drying of water sources in Rakai District and should be addressed.

The district has started a project to promote rice growing in the Sango Bay area and initial trials were reported to have been successful. Rice growing is likely to increase impacts on the hydrology of the Sango Bay area. Experiences should be borrowed from Eastern Uganda on the impacts of rice growing (Turyahabwe *et al*., 2013); and how guidelines for rice growing can be considered to address impacts on the wetlands.

A project of large scale farming has also started in the Sango Bay area for sugar cane growing, which has replaced about 300 hectares of woodlands and forests, clearing forest and wetland areas. The proprietors of the sugar estate (Sango Bay Industries Limited), who have leased around 12,000 acres of land for sugar cane growing, were very elusive when contacted during this study. They only said that they do not want to indulge in any discussions about their private business and do not want to have a repeat of the Mabira Forest saga; where proposed clearing of a natural forest to grow sugar cane caused conflict and led to the loss of lives (Moyini and Masiga, 2008).

4.2.8 Crafts from palm leaves, sedges and grasses

The local communities use palm leaves, sedges and grasses from the Sango Bay wetlands and forests for making mats and other handicrafts. The palms used include *Phoenix reclinata* and *Raphia farinifera* (Byaruhanga *et al*., 2003). The sedges and grasses used for crafts include *Cyperus papyrus* and *Marantacloa* spp. The crafts are appreciated as an important income generating activity; especially to women, who use their time at home to make mats, alongside other household chores such as during cooking and drying agricultural produce. In recognition of this, the district has worked closely with the Kabira Wetland Management Association (KAWEMA) women's group; who are well organized and have trained other women and youth in Rakai and other neighboring districts in crafts making (Figure 11).

During this study, it was estimated that at least 10% of households in the Sango Bay area are engaged in making crafts from materials collected from wetland and forest areas. The economic value of crafts was estimated by considering an average price of a hat at UGX 1,000 and a mat at UGX 3,000. Crafts from

palm leaves, sedges and grasses from the Sango Bay area were estimated to have an economic value of UGX 5.2 billion (US$ 1.6 million); equivalent to UGX 1.0 million (US$ 304) per household per year.

Promotion, value addition and marketing of crafts from the Sango Bay area can act as a big incentive to the local communities to contribute to conservation efforts in the area. Moreover, such an initiative would build on earlier efforts by Rakai District, the Wetland Management Department and other partners to promote sustainable use of wetland resources to generate income and improve livelihoods; as an incentive for conservation. During this study, respondents from Rakai District expressed interest in crafts promotion; particularly as they considered that it could also add to tourism promotion initiatives.

Figure 11: Crafts made by the Kabira Wetland Management Association group

4.2.9 Timber and charcoal

The Sango Bay area has a history of timber harvesting and trade in valuable species, such as *Podocarpus*, that dates back to colonial times (1910). This has created a class of local people, whose ancestral enterprise is based on logging and who continue to carry out illegal logging and trade code named "*magendo*" in Swahili. The local leaders narrated a classical smuggling scenario that even when Uganda placed a ban on logging in Sango Bay in the 1990s, the illegal logging teams would harvest valuable *Podocarpus* timber from Sango Bay, smuggle it by bicycles and motor cycles to Tanzania, where there was no logging ban; and re-import it to Uganda officially, through the Mutukula border. This literally indicated a scenario of officially "re-importing Ugandan goods", which had been illegally acquired and smuggled to Tanzania and are later presented as genuine imports from Tanzania. Moreover, the contiguous forests of Sango Bay and Minziro are never jointly patrolled, creating a porous border that

links Uganda and Tanzania, without any barrier. This is an obvious justification for the need for joint management efforts for the valuable Sango Bay-Minziro trans-boundary resource.

The NFA and District respondents interviewed during this study admitted that there are still some isolated cases of illegal logging and charcoal production in the Sango Bay forest reserves. These were confirmed with some instances where illegally logged timber from the Sango Bay forests has been confiscated. Anonymous reports indicated that corrupt officials capitalize on the nature of such valuable resources and the porous borders. Against this backdrop, this study has sought to attach a value to the timber and charcoal resources in the Sango Bay forests. Using value transfers from situation similar to Sango Bay such as Bush *et al.* (2004), Turpie *et al.* (2006); Kipkoech *et al.* (2011); and Emerton (2014), the value of timber and charcoal in the Sango Bay forests was estimated at UGX 17.3 billion (US$ 5.2 million) per annum; equivalent to a habitat value of UGX 1.1 million (US$ 348) per hectare per year.

4.2.10 Poles for wall construction, roofing and fencing

According to the Rakai Community Information Systems, more than 95% of the households use poles for construction, either for building walls or for roofing (UBOS, 2012). During this study, respondents reported that most of the materials used for construction and fencing (at least 80%) were harvested from Sango Bay area forests and wetlands. The rest are sourced from individual plantations and woodlots.

Based on the pricing of poles of different sizes from local plantations and woodlots, the total value of poles for wall construction, roofing and fencing was estimated at UGX 18.3 billion (US$ 5.6 million) per year. This is equivalent to an average unit value of US$ 109 per household per year.

4.2.11 Honey production

Responses received from honey producers during this study highlighted an appreciation for the direct and indirect contribution made by the Sango Bay forests, grasslands and wetlands to the apiary industry in the area. In addition to providing nectar from different plants, the forests and wetlands are used for citing local and exotic beehives. With a total of more than 8,000 hives, the apiary industry was reported to be growing very fast and to have a market within and outside Rakai District. The total economic value of honey was estimated at UGX 21.7 billion (US$ 6.6 million) per year. This translated to a unit production return of US$ 127 per household per year.

4.2.12 Plant-based wild foods (vegetables, fruits and mushrooms)

The Sango Bay area forests and wetlands supplement diets of local communities with nutritious foods such as vegetables, fruits, tubers and mushrooms. These not only contribute to the food and nutrition security, but also provide incomes to some people, who collect and sell the food items in urban centers in Rakai, Masaka and Kampala. These food items, which constitute an integral part of the household food diet and are appreciated as a local delicacy, are gathered for immediate consumption or, when preserved, may be used as a drought, dry-season or emergency food supply (Kabi, 2001).

The common wild vegetables harvested in the Sango Bay area include *Amarathus dodos*, *Solanum* spp., peas and climbing beans. It was reported that approximately 50 people from the Sango Bay area earn a living from the collection and sale of wild vegetables. The respondents indicated that all the rural households in Sango Bay area (85% of the total households) partly depend on wild vegetables, which

are harvested by women and children, usually on their way from doing other chores such as collection of water and firewood. Based on an average price of UGX 500 per kilo, wild vegetables from the Sango Bay area were valued at a total of UGX 150 million (US$ 45,455) per year.

Wild fruits, which include *Passiflora* spp. (Passion fruits), *Afromomum sanguinium* (Amatungulu), *Saba commoroensis* (Amabungo), *Carissa edulis*, and *Physallis* spp. (*Entutunu*) were also reported to be harvested from the Sango Bay area. It was estimated that a total of around 50 people in the Sango Bay area collect wild fruits, mainly from forests and wetlands, for commercial purposes and for sale in rural and urban areas. At an average farm gate price of UGX 500 per kilo, the total economic value of wild fruits was estimated at UGX 375 million (US$ 113,636) per year.

Mushrooms were most appreciated as a delicacy and are commonly used in some cultural functions (Kabi, 2001). It was reported that most of the mushrooms collected from Sango Bay forests are marketed in Rakai and far off towns. Given the seasonality of abundant mushrooms, even the rural communities were reported to often buy them, especially for traditional ceremonies such as wedding parties. At an average price of UGX 1,000 per kilo, wild mushrooms were estimated to have an economic value of UGX 600 million (US$ 181,818) per year.

The value of commonly marketed plant based wild foods was therefore computed using monetary returns from vegetables, wild fruits and mushrooms and was estimated at a total value of UGX 1.1 billion (US$ 340,909).

4.2.13 Traditional medicine

During this study, the Sango Bay forests, grasslands and forests were highly prized for providing valuable sources of medicine that are used by a large number of local communities. Estimates made by respondents indicated that more than 80% of the local communities still rely heavily on wild plants for traditional medicine. This is in line with estimates from FAO (2014), which estimated that more than 80% of the population from Africa still relies on traditional medicine from forest plants. The need for traditional medicine in Uganda is exacerbated by the fact that the available government medical facilities are not well equipped and stocked with medicines and most people cannot afford to buy medicine from a private clinic. It was reported that in the Sango Bay area approximately 15 people are recognized as traditional medicine men/women; who harvest, process and sell medicines for different ailments to the local communities. Using an average price of UGX 2,000 per kilo of processed medicinal plants; the economic value of the Sango Bay area for traditional medicine was estimated at UGX 13.9 billion (US$ 4.2 million) per year. This translates in to a unit economic value of about US$ 17 per household per year.

4.2.14 Game meat from wild animals

One of the controversial benefits from the Sango Bay forests is game meat, which is acquired through illegal hunting. The game meat is mainly from animals such as sitatunga, hippopotamus, and buffalos. The local communities reported that hunting of animals in Sango Bay is still a serious problem and on average, at least one animal is killed every weekend by illegal hunters. The illegal hunters most often burn wetlands to scare animals so that they can easily hunt them, which is a big problem to the biodiversity and ecosystem at large.

The Uganda Wildlife Authority is in the process of promoting sport hunting as an income generating source that can discourage illegal hunting. Although the team of experts had reservations on including

the value of game meat from illegal sources, it was agreed that this can be presented as an indication of the income that can potentially be generated from wildlife utilization through legal means, and it should therefore also be included. Fortunately, some of the pastoral communities in the Sango Bay area do not eat wild meat, which keeps the price of game meat low. It was reported that only about 20% of the households normally eat wild meat from the Sango Bay area. At an average price of UGX 1,750 per kilo, the total value of game meat was estimated at UGX 3.7 billion (US$ 1.1 million).

4.2.15 Fish from Lake Victoria

Capture fisheries are directly linked to people's livelihoods, and are one of the key natural resources that people think of in relation to the Sango Bay area and its relationship to Lake Victoria. During this study, all respondents in the Sango Bay area seemed to appreciate that their livelihood has been directly or indirectly improved by local fisheries resources in the neighboring Lake Victoria and the lakeshore areas. Even the pastoral Bahima, who traditionally believe that eating fish can lead to a decline in milk for their cows, responded positively to questions related to the importance of fish and testified that they eat fish.

The total economic value of capture fisheries, based on the two main species harvested from Lake Victoria (Nile Perch and Tilapia) were estimated at UGX 16.7 billion (US$5.1 million) per year (Table 6). Most respondents (90%) appreciated the importance of natural resources such as forests, wetlands and grasslands to the continued availability of fish from Lake Victoria and therefore supported the need to contribute to the management efforts for lake shore areas. The fishing community also testified that specific fish breeding zones are mainly located where there are wetlands and therefore appreciated the contribution that forests and wetlands near Lake Victoria make to fisheries resources in the lake.

Table 6: Lake Victoria Rakai area fish catch for Nile Perch and Tilapia in 2013 and 2014

Year	*Nile Perch catch (tons/yr)*	*Tilapia catch (tons/yr)*	*Total catch (tons/yr)*	*Farm Gate Price (UGX/ton)*	*Total Returns (UGX/yr)*	*Total Returns (US$/yr)*
2013	2,300	450	2,750	6,000,000	16,500,000,000	5,000,000
2014	2,350	470	2,820	6,000,000	16,920,000,000	5,127,273
Average					***16,710,000,000***	***5,063,636***

Source: Directorate of Fisheries Department, Ministry of Agriculture, Animal Industry and Fisheries, Entebbe

4.2.16 Fish from wetlands and rivers

In addition to capture fisheries from Lake Victoria, respondents reported that significant quantities of fish are harvested from lake shore wetlands and rivers. The main fish species harvested from the wetlands and rivers include *Clarias alluadi* (Nsonzi) and *Clarias gariepinus* (male), which are locally consumed in the area and a large number of which are used as bait for catching Nile Perch (*Lates niloticus*) from Lake Victoria. A large number of local community members were reported to be involved in the fisheries of Lake Victoria, which are dependent on bait from Sango Bay wetlands. In addition to the *Clarias* spp. for bait, there are huge catches of *Protopterus aethiopicus* (Mamba), a local delicacy, mainly from wetlands adjacent to the Kagera and other streams and rivers.

During this study, respondents indicated that there is over fishing and common cases of wetland degradation, resulting from wetland and river fisheries. To access the species, which burrow in the mud, the fishermen dig channels through the wetlands, which are continuously deepened and end up

affecting the water levels and acting as opportunities and entry points for wetland drainage for crop farming. Considering that at least 80% of the households eat fish and using an average price of UGX 6,000 per kilo, the economic value from wetland and river fisheries was estimated at UGX 6.4 billion (US$ 1.9 million) per year.

4.2.17 Fish from aquaculture

Fish farming / aquaculture in the Rakai District is a handy supplementary source of fisheries to the capture fisheries from the natural lakes and rivers. During this study, the district administration reported that fish farming is one of the priority enterprises that they consider profitable and in need of financial support, if resources were to be available. However, the interviewed private fish farmers indicated that the big challenge they have faced with fish farming is that it is capital intensive and takes a long time to reap profits.

It was reported that there are more than 130 fishponds in Rakai district and two commercial fish farms have been established by the private sector to service the aquaculture sector. However, local fish farmers noted that one of the challenges of aquaculture has been the frequent, prolonged droughts, which reduce water supply to the ponds.

4.2.18 Snail shells from Lake Victoria

In addition to fish, local communities along the shores of Lake Victoria in the Sango Bay area harvest snail shells, which are sold for use as a food supplement to livestock feeds. The snail shells are packed and are mainly transported to Masaka and Kampala; where there are large scale livestock feed manufacturing industries. During this study, it was reported that from Malembo landing site alone, at least two 8 ton truck loads full of snail shells are sold off to Kampala and Masaka traders every week.

About 80 people, with 94% of them being women, were reported to be fulltime employed in collection and packing of snail shells. Using a price of UGX 100 per kilo; snail shells were estimated to have a total economic value of UGX 62.4 million (US$ 18,909) per year, translating into returns of US$ 236 per household per year. Although snail shells may appear to be a minor product, and therefore not worthy of attention for conservation efforts, considering the returns per resource user, it may be worth considering their value. Particularly as they add value to other sectors such as the livestock industry and creates employment for some fishing community members.

4.2.19 Grass hoppers and white ants

The western part of Lake Victoria shores, including the Sango Bay area, are known for their production of high numbers of grasshoppers and white ants, which are considered a delicacy in most of the local communities. During this study, it was reported that harvesting of grasshoppers and ants, and selling them to other towns such as Masaka, Mbarara and Kampala, makes a significant contribution to the incomes of the people in Rakai and the neighboring Masaka District. Of more significant value is the nutritional value of these insects, which can be easily collected from the forests, woodlands and grasslands, as a form of animal protein. Moreover, alternative sources of animal protein such as beef and poultry are expensive and not affordable for most local communities. The respondents also noted that in areas where forests, grasslands and wetlands have been cleared, they only get grasshoppers moving from the intact areas, which are the breeding sites.

Based on an average price of UGX 2,000 per kilo and assuming that approximately 10% of the population in the Sango Bay area actively collect grasshoppers and ants for commercial purposes, the total economic value of grasshoppers and white ants was estimated at UGX 12.0 billion (US$ 3.6 million); equivalent to US$ 70 per household per year. However, it should be noted that grasshoppers are available and harvested only during the months of November and December. Nevertheless, the local communities confirmed that grasshoppers and ants are indeed a natural source of protein, and that their nutritional value and the increased income they provide can motivate conservation efforts for forests, grasslands and wetlands in the Sango Bay area; particularly if more markets are explored and conservation initiatives made.

4.2.20 Aggregate economic value from Sango Bay Provisioning Services

Considering the sampled resources from the Sango Bay area (Table 7); it was estimated that they provide a total aggregated economic value of UGX 202.4 billion (US$ 61.3 million) per year.

Table 7: Economic value of provisioning services from Sango Bay

Ecosystem Service	***Total (UGX/yr)***	***Total (US$/yr)***
Water for domestic use	5,597,616,348	1,696,247
Water for Livestock	15,260,277,408	4,624,326
Water for crop Irrigation	2,100,000,000	636,364
Fuel wood consumption	36,426,000,000	11,038,182
Grass for grazing	15,508,412,000	4,699,519
Mulching grass	9,091,425,000	2,754,977
Crop farming in Sango Bay	2,100,000,000	636,364
Crafts	5,208,000,000	1,578,182
Timber and charcoal	17,314,000,000	5,246,667
Poles	18,348,000,000	5,560,000
Honey production	21,695,256,000	6,574,320
Grass hoppers and ants	12,000,000,000	3,636,364
Plant-based wild foods	1,125,000,000	340,909
Traditional medicine	13,858,350,000	4,189,500
Game meat	3,675,000,000	1,113,636
Fish from Lake Victoria and wetlands	16,710,000,000	5,063,636
Fish from wetlands and rivers	6,400,000,000	1,939,394
Snail shells from Lake Victoria	62,400,000	18,909
Total	***202,479,736,756***	***61,357,496***

4.3 REGULATING AND SUPPORTING ECOSYSTEM SERVICES FROM SANGO BAY

The Sango Bay area plays an important role by providing regulating services and supporting ecosystem processes such as creating conditions for balancing the dynamics of ecological and hydrological systems for the waters entering Lake Victoria. It is therefore considered to provide a vital service. The main hydrological functions of the system include water storage, flood control, groundwater recharge, lake shore stabilization and water purification. During the dry season, the system maintains a steady discharge of water stored in the natural ecosystem and supplements the water supply to the surrounding areas, including Lake Victoria.

Within the catchment of Lake Victoria, a number of land uses such as crop and livestock farming generate run off, which in addition to high sediment loads has residues of agrochemicals and acaricides from crop and livestock farming. The Sango Bay system also plays an important role in trapping the sediments and effluents from surrounding catchments; and hence reduces the level of sediments carried to Lake Victoria, thereby helping to maintain the natural clean water conditions important for the survival of fish and many other aquatic living organisms in the lake. The forests, wetlands and wetlands also help to control the speed of the water flowing along the streams and rivers that flow into Lake Victoria, therefore helping to manage flooding.

It should also be noted that the natural resources and ecosystems play an important role as habitats to important flora and fauna that add to the Sango Bay area importance as a conservation area. The Sango Bay ecosystem is an important breeding site for both land-based and water-living organisms. For example, many of the fish that are found in the deep waters of Lake Victoria breed in the intact lakeshore wetlands. Through a number of ecosystem processes, the Sango Bay area also contributes to local, regional and global climate regulation and moderation. The health of the Sango Bay ecosystem is therefore also of global importance at a time when climate change and its impacts are an increasing challenge.

The Sango Bay ecosystem also contributes to crop productivity in the surrounding areas and beyond in a number of ways. For example, insects from the Sango Bay contribute to pollination; mammals and birds contribute to seed dispersal and other fauna contribute to pest control. The natural systems also contribute to soil fertility and moisture control, therefore contributing to crop productivity.

During this study, the economic value of the regulating ecosystem services was estimated using value transfers synthesized and used in studies such as Kakuru *et al.* (2013) and Emerton (2014). Table 8 provides a summary of the economic values for the Sango Bay area for the different ecosystem services. In aggregate terms, Sango Bay area provides a total economic value estimated at approximately UGX 164.6 billion (US$ 49.9 million) per year.

During this study, all respondents reported that they clearly appreciate the contribution of products and goods that they directly harvest from Sango Bay and either use at their home or sell in markets and the contribution they make to their livelihoods and income. However, most respondents were not convinced about the high value that is derived from indirect regulating ecosystem services and the likely challenges they can face in the event of their degradation or loss. Efforts are therefore needed to make the different stakeholders appreciate the importance of regulating ecosystem services.

Table 8: Economic value of regulating and supporting ecosystem services from the Sango Bay area

Ecosystem Services	*Average Habitat Value Transfer (US$/ha/yr)*	*Habitat Value Transfer (UGX/ha/yr)*	*Sango Bay Total Value (UGX/yr)*	*Sango Bay Total Value (US$/yr)*
Carbon Storage and Sequestration	39	128,700	1,943,370,000	588,900
Soil moisture and fertility	443	1,461,900	22,074,690,000	6,689,300
Pharmaceutical value	2	4,950	74,745,000	22,650
Flood control and attenuation	164	541,200	8,172,120,000	2,476,400
Pollination, seed dispersal and pest control	205	676,500	10,215,150,000	3,095,500
Water storage and recharge	755	2,491,500	37,621,650,000	11,400,500
Water quality regulation	1256	4,144,800	62,586,480,000	18,965,600
Habitat / Refugia	439	1,448,700	21,875,370,000	6,628,900
Sub-Total			***164,563,575,000***	***49,867,750***

4.4 CULTURAL SERVICES FROM SANGO BAY

The Sango Bay area, and Rakai District as a whole, has a very high cultural ecosystem service value; in form of aesthetic, spiritual, recreation and ecotourism values. This includes the beautiful scenery of the different areas and Lake Victoria. The major tourist attractions in the Sango Bay area and Rakai District include:

1. Forests, natural glades and unique riverine vegetation, which can be utilized through nature walks and camping;
2. Kibale waterfalls and other cascading waterfalls that are good for sight-seeing;
3. The meandering Kagera River as it enters Lake Victoria;
4. Activities on the Kagera River (river rafting and boat riding/racing);
5. Diverse bird species, some of which are seasonal and migratory, including popular birds sought by tourists and bird watchers, such as the Shoe Bill and Grey Headed Gulls at Musambwa Island;
6. The ostrich farm in Kakuuto;
7. Fish species varieties that can service sport fishing;
8. The variety of butterfly species that can be watched and can be considered for butterfly farming;
9. Important fauna – mammals, reptiles and amphibians – which are good for wildlife viewing and photography;
10. Hotel services in Rakai, Kyotera, Mutukula and Kalisizo.

An example of the cultural and spiritual value that the Sango Bay area provides can also be found at the Kansensero Landing Site in Rakai District. During the Rwanda genocide of 1994, in which more than an estimated 800,000 people were killed; some bodies were dumped in the Kagera River and floated to Lake Victoria. The dead bodies were picked up and buried at Kasensero Landing Site and the memorial and mass graves have been maintained (Figure 12); which are regularly visited by Rwandese, who lost their relatives. This is one of the important spiritual values that Sango Bay area provides.

Figure 12: Rwanda genocide memorial mass grave; one of the ecosystem services as a spiritual site

Another tourist site is Musambwa islands, where women are not allowed to stay overnight, and which have a long history of cultural attachment. The Musambwa islands are some of the smallest islands located in Lake Victoria, in Rakai District. Despite their size, they support large populations of congregatory breeding birds of the African race like the Grey Headed Gull, Greater Cormorant, Little Egret and the Long-Tailed Cormorant; among others. Due to the importance for birds of global significance, the Musambwa islands have been recognized as an Important Bird Area. The islands are known to be the largest breeding site in Africa for African Grey Headed Gulls. During this study, it was reported that tourists have started visiting Musambwa Island for Bird Watching and in recognition of the cultural values.

The Sango Bay area also contains one of the world's Stone Age sites, which is of archaeological and religious importance, and is a significant tourist attraction. The area, internationally known as the Sangoan archaeological site, is located both in wetland and woodland forest areas and includes tools that were used approximately 200,000 years ago.

In consideration of the importance of the Sango Bay area and using value transfers from Kakuru et al. (2013) and Emerton (2014); the economic value for cultural ecosystem services was estimated at UGX 17.9 billion (US$ 5.4 million) per year; with a habitat value of US$ 360 per hectare per year. Respondents from district authorities reported that they have been trying to link up with the Uganda Tourist Board to market the Sango Bay area as an important tourist destination, which could be included in the existing tourist circuits. In addition to government efforts, it was reported that other actors are coming in to develop the tourist potential for the area. For example, one innovative private entrepreneur has set up an ostrich centre in Kakuuto sub-county, which was reported to be attracting some tourists.

4.5 PROVISIONING SERVICES FROM MINZIRO

4.5.1 Water for domestic use by humans

Most of the Minziro area is drained by several streams flowing into the Kagera and Ngono Rivers, whose waters ultimately end up in Lake Victoria. According to the District Plan, 62% of total population has access to clean water using different technologies, which include shallow wells, piped water supplies, protected springs, rain water facilities and small dams (Table 9).

Table 9: Water Supply with different Technologies in Missenyi District

Technologies	Water points
Improvement of traditional water sources	141
Shallow wells	114
Rain water jars	86
Rain water tanks (households)	48
Bore holes	43
Rain water tanks institution $46m^3$ - $55m^3$	12
Chalcol Dam	5
Piped schemes	3
Solar w/supply	1
Hydram w/supply	1

The district plan shows that most of the rural population continues to walk long distances to fetch water from natural springs and ponds, which places a large burden on women and children. Considering that approximately 75% of the population gets water from natural sources (streams, rivers and the lake), and at an average price of TShs 4,000 per cubic metre; the economic value of the Minziro area for provision of water for domestic use was estimated at a total of TShs 2.3 billion (US$ 1.1 million) per year. This translates into a unit value of TShs 65,700 (US$ 31) per household per year.

4.5.2 Water for Livestock

Despite the existence of different protected water sources in the Minziro area indicated in Table 8, respondents reported that most livestock farmers use natural sources (streams, rivers and the lake). The respondents indicated that natural sources are preferred due to their convenience of access during the time when livestock are out grazing. They also reported that watering from natural sources does not attract a cost, while a fee is charged for the use of most of the protected sources.

Reports from Missenyi District indicate that at least 75% of the total 160,545 cattle (120,409) are watered from natural sources (streams, rivers and the lake). Based on an average price of TShs 4,000 per cubic metre of water, the total value of livestock watering from the Minziro area was estimated at TShs 7.0 billion (US$ 3.3 million) per year. With an estimated 145,950 TLUs in the Minziro area, this translates into a unit value of TShs 48,180 (US$ 23) per TLU per year.

4.5.3 Fodder Grass for Livestock

Grasslands and wetlands in the Minziro area, especially along the River Kagera and Ngono flood plains, are used for livestock grazing. The natural grasslands areas, called "Rweya" in local language, are mainly communally used for cattle grazing. Grazing also includes sheep and goats. During this study, reports

from respondents indicated that the communal use of grazing land has resulted in people from Uganda illegally bringing their cattle to graze during the dry season; leading to overgrazing and the transfer of livestock diseases.

Reports from Missenyi District indicate that about 25% of the cattle in the Minziro area (40,136 of the 160,545) depend on pastures from the Kagera and Ngono wetland areas. Based on an average value of TSHs 800 of pasture consumed per day per animal; the total economic value for use of the Minziro area for cattle grazing was estimated at TShs 14.6 billion (US$ 7.0 million) per year. This is equivalent to TShs 63,875 (US$ 30) per TLU per year.

4.5.4 Water for Irrigation

Missenyi District also has a large span of tributaries and vast groundwater potential that feed the Kagera and Ngono Rivers, which hold water even during the dry seasons. This provides an enormous potential area for irrigation in the Minziro area. However, during this study, respondents reported that crop irrigation potential is not optimally used, apart from a few cases of watering horticultural crops during the dry season. Although this has resulted in Missenyi ranking as one of the key producers of tomatoes and cabbages in the Kagera region (Figures 13 and 14), the only significant level of irrigation that has been carried out is at Kagera Sugar Company, to enhance the production of sugar cane. During this study, the economic importance of water for irrigation was therefore reflected by valuating dry season farming.

Figure 13: Area planted with tomatoes in the Kagera Region

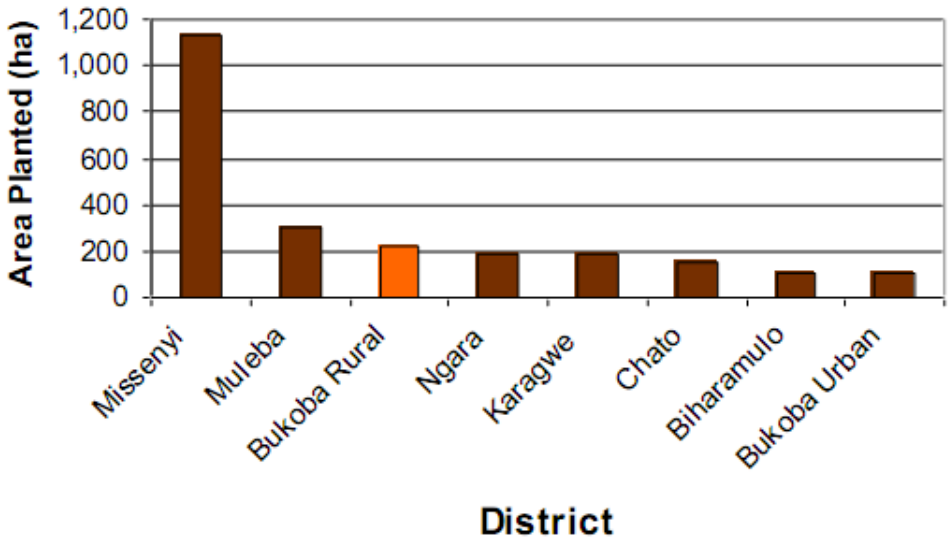
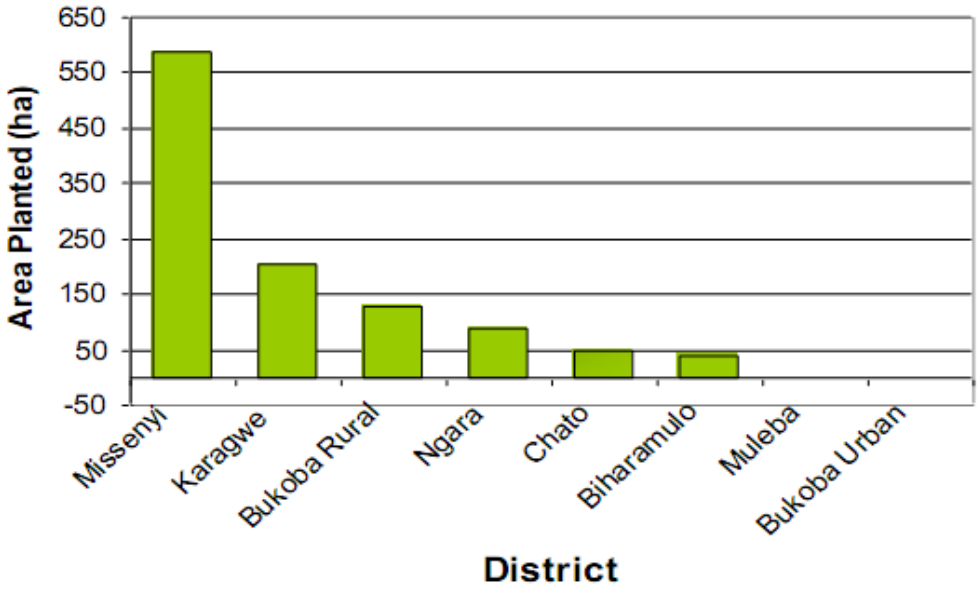


Figure 14: Area planted with cabbages by district in the Kagera Region



Details of crop farming from 2012 (from the district profile for Missenyi) were used to value crop farming in Minziro area. Approximately 87% of the population of Missenyi District is engaged in agriculture and livestock activities. Most agricultural practices are carried out using mixed farming; whereby the main crops (banana and coffee) are inter-cropped with beans, maize, sweet potatoes and cassava. The intercropping system is commonly referred to as Kibanja farming system. During the dry season, crops are grown in wetland areas; especially yams, tomatoes, cabbages, vegetables and onions.

Reports from Missenyi indicated that about 30% of the households in the Minziro area depend on wetlands for crop farming. Using an average farm gate price of TShs 180,000 per ton; the economic value of seasonal crop farming, especially in wetlands, was estimated at a total value of TShs 1.7 billion (US$ 816,000) per year. This translates into a unit value of US$ 76 per household per year.

4.5.5 Crafts from palm leaves, papyrus and grass

Compared to the Sango Bay area, craft making was not so common in the Minziro area. However, palm leaves, especially *Raphia farinifera*, are harvested from the lakeshore wetlands and the strings are used for a number of crafts. Papyrus mats are also used within the Missenyi area; but mainly at subsistence level.

Respondents reported that about 5% of the households in Minziro are engaged in the production of crafts. Based on an average price of TShs 700 per craft item; the economic value of crafts from palms, papyrus and grass was estimated at TShs 144.1 million (US$ 68,600) per year. This is equivalent to a unit value of US$ 38 per household per year.

4.5.6 Plant-based wild foods (vegetables, fruits and mushrooms)

Respondents interviewed during this study indicated that the local communities do not rely heavily on wild vegetables, fruits and mushrooms. However, the local communities indicated that they use the

plant-based wild foods during the dry season and periods of famine. About 25 people were reported to be engaged in the collection and sale of wild vegetables and a similar number was also estimated to be engaged in the collection and sale of wild fruits from the Minziro area. The wild vegetables and fruits were also reported to be collected at a subsistence level; especially by women as they carry out their other duties such as farming, collection of water and firewood. Mushrooms were reported to be a traditional delicacy and it was estimated that about 20 people earn a living from the collection and trade of wild mushrooms.

Using an average farm gate price of TShs 400 per kilo of vegetables and wild fruits and TShs 1,200 per kilo for mushrooms, the total aggregate economic value from the plant-based wild foods was estimated at TShs 816 million (US$ 388,571) per year; equivalent to a unit value of US$ 11 per household per year.

4.5.7 Medicinal plants

The use of traditional medicine from Minziro area was reported to be significant and was estimated to be used by at least 80% of the local communities. This is in line with Nkya *et al.* (2014) and FAO (2015) who also gave similar estimates to the use of traditional medicine from forests in Minziro and Africa, respectively.

This study estimated that at least 12 people are fully engaged in the collection, processing and trade in medicinal plants from the Minziro area. It was also reported that the local communities, especially women, collect and administer plant-based medicine to their family members and only refer fairly complicated cases to the local traditional medicine practitioners. Based on an average price of TShs 1,400 per kilo of processed traditional medicine, the economic value of using plant-based medicine from Minziro was estimated at TShs 1.1 billion (US$ 537,600) per year; translating into a unit value of US$ 15 per household per year.

4.5.8 Fuel wood from Minziro

Most of the population in the Minziro area use firewood and charcoal for lighting and cooking. Estimates from this study indicated that at least 94% of the people use firewood and charcoal for cooking and lighting and it was reported that the demand for fuel wood is increasing. The respondents indicated that most of the people mainly use trees from the Minziro forest and other forest reserves and natural woodlands and wetland areas. It was reported that a very small (insignificant) percentage of people rely on fuel wood from their own woodlots. The optional on-farm trees used are eucalyptus and pine, which are fast growing and easy to maintain. The Forestry and Beekeeping Division have initiated the concept of Participatory Forest Management (PFM) in the district through development programmes, where the forests and woodland are managed jointly by the district in collaboration with the community and this is expected to help control degradation of forests from firewood collection.

Considering a total population of 34,262 (as the 94% of the population that depends on fuel wood as their source of energy), it was estimated that each household uses an average of one bundle per day for their energy demands. Based on an average price of TShs 1,500 per bundle, results from this study estimated the economic value of fuel wood at TShs 18.8 billion (US$ 8.9 million). This is equivalent to a unit economic value of US$ 261 per household per year.

4.5.9 Fisheries in Minziro

Fishing is mainly carried out in Lake Victoria, with some low level of fishing within the rivers and wetlands of the Kagera and Ngono. Details about fishing are available in the Missenyi District profile. There are two main commercial fish landing sites and one fish breeding area known as Kabindi and Kaishebo near Lake Victoria. The main fish species harvested are Nile Perch, Tilapia and Dagaa (*Restrineobola argentea*). Fishing is carried out using gill nets, scoop nets and long lines. Nile Perch from Missenyi District shores is mainly processed at Kagera Fish Company and VicFish Limited, while some fish is transported in cold trucks to Mwanza Fish Processing factories and is then exported to Europe. Some dried fish is also exported to neighboring countries, while other fish is sold in local markets. The major fish processing companies, which are a source of foreign exchange earnings and employment in Tanzania, are:

1. Kagera Fish Company located in Kemondo, Bukoba rural; which processes fish fillets and exports to European markets; and employs 80 workers.
2. VicFish Ltd (Kagera), a branch of VickFish Ltd (Mwanza), located at Bukoba Municipal along the lake shore and involved in fish processing for export in European markets and employing 350 workers.

Villages along the shores of Lake Victoria are also involved in fisheries activities as a very important supplement to cash income and their daily diet. An increasing number of farmers, especially young people, are also involved in fishing activity as an important source of employment. More and more fish, especially Nile perch, are sold to private fish marketing and processing companies that export fish products to Europe and other countries. Based on an average price of TShs 5,500 per kilo; the total economic value of fish was estimated at TShs 9.7 billion (US$ 4.6 million) per year.

4.5.10 Honey production

Local communities in the Minziro area are involved in honey production; which is most productive when located in/near forests and wetlands with favorable weather conditions of moderate rainfall throughout the year. Reports from the district indicate that honey producers appreciate the potential for beekeeping investment and the Government of the Republic of Tanzania has invested in considerable efforts to promote apiary. This has been enhanced by the introduction and use of modern beehives and modern honey harvesting and processing methods, which has made honey and beeswax a significant generator of income for many residents in the Kagera region. It was also reported that Tanzania's honey is ranked among the best in the world in terms of quality.

It was estimated that within the Minziro area, at least 40 people are engaged in apiary as a full time enterprise. Based on an average price of TShs 3,500 per kilo; the economic value of honey in the Minziro area was estimated at TShs 362 million (US$ 172,597) per year translating into a unit value of US$ 52 per household per year.

4.5.11 Crop farming

The study found out that the Minziro wetland and forest ecosystems have a big contribution to crop farming. This involves planting of different crops, especially during the dry season, when there is limited moisture in upland areas and the farmers rely more on wetland areas. The value of crop farming from Minziro wetlands and forests was estimated at TShs 2.7 billion (US$ 1.3 million) per year.

4.5.12 Aggregate economic value from Minziro Provisioning Services

Considering the sampled resources from the Minziro area (Table 10); it was estimated that they provide a total aggregated economic value of TShs 59.4 billion (US$ 28.3 million) per year.

Table 10: Economic value of provisioning services from Minziro area

Ecosystem Service	Total *(TShs/yr)*	Total (US$/yr)
Water for domestic use by humans	2,344,833,000	1,116,587
Water for Livestock	7,031,871,000	3,348,510
Fodder Grass for Livestock	14,649,731,250	6,976,063
Water for Irrigation	1,713,600,000	816,000
Crafts	144,060,000	68,600
Plant-based wild foods	816,000,000	388,571
Medicinal plants	1,128,960,000	537,600
Fuel wood from Minziro	18,784,080,000	8,944,800
Fisheries in Minziro	9,709,140,000	4,623,400
Honey production	362,453,700	172,597
Crop farming	2,688,000,000	1,280,000
Sub-total	***59,372,728,950***	***28,272,728***

4.6 REGULATING AND SUPPORTING ECOSYSTEM SERVICES FROM MINZIRO

The Minziro area plays a fundamental role in maintaining ecological balance and ensuring the integrity of natural ecosystem, including supporting the existence of local plants and animals, and providing an array of regulating and supporting ecosystem services. Despite the obvious appreciation of the provisioning ecosystem services, which are sourced locally and are usually tangible and therefore easily appreciated, the regulating and supporting services are usually less tangible and are less easily appreciated. There benefits are therefore often only appreciated when they disappear.

The Minziro forest, wetland and grasslands normally store and hold the bulk of water runoff from Tanzania and upstream waterways as distant as Burundi and Rwanda. This water is then released slowly throughout the year, including dry season periods, supporting different life processes. In the process of storage, the water is purified and filtered, while the Minziro forest, wetland and grassland area retains the sediments and effluents. The water is stored and released steadily; more fresh and cleaned to the different users.

As described in Section 2, the Minziro area is an ecologically special habitat, and is refugia to a number of plant and animal species, some of which are of special conservation concern at the local and global level. Such a regulating service is extended to both large plants and animals and the small/micro organisms, which are linked to the complex ecological dynamics. Without the forest, wetland and grassland areas, some of the small and big plants and animals could not survive, which in turn could affect the livelihoods of the local people.

One of the important services provided by the Minziro forests and wetlands, which was appreciated by most of the respondents, is the support it provides to crop productivity, provided in different forms such as through pollination, seed dispersal and pest and disease control. The respondents also appreciated that the Minziro forests contribute to the maintenance of soil moisture and fertility that in turn contributes to agricultural productivity.

Particularly given increasing challenges related to climate change challenges, most respondents indicated that they appreciate the role natural ecosystems such as Minziro play in the carbon storage, sequestration and avoided emissions. The role of the Minziro area in climate change mitigation is therefore of immense value to the local, regional and global life support systems.

During this study, the regulating and supporting ecosystem services for Minziro were estimated, mainly using habitat value transfers of the different services from reports made on related areas. The total economic value of the regulating and supporting services was estimated at TShs 172.3 billion (US$ 82.0 million). Estimates of the different regulating and supporting ecosystem services from the area are summarized in Table 11.

Table 11: Minziro regulating and supporting Ecosystem Services

Ecosystem Services	***Average Habitat Value Transfer (US$/ha/yr)***	***Habitat Value Transfer (TShs/ha/yr)***	***Minziro Forest Total Value (TShs/yr)***	***Minziro Forest Total Value (US$/yr)***
Carbon Storage and Sequestration	39	81,900	2,034,477,900	968,799
Soil moisture and fertility	443	930,300	23,109,582,300	11,004,563
Pharmaceutical value	2	3,150	78,249,150	37,262
Flood control and attenuation	164	344,400	8,555,240,400	4,073,924
Pollination, seed dispersal and pest control	205	430,500	10,694,050,500	5,092,405
Water storage and recharge	755	1,585,500	39,385,405,500	18,754,955
Water quality regulation	1256	2,637,600	65,520,621,600	31,200,296
Habitat/Refugia	439	921,900	22,900,917,900	10,905,199
Sub-Total			***172,278,545,250***	***82,037,403***

4.7 CULTURAL SERVICES

The scenic beauty from the natural landscape, including a variety of vegetation zones, the view of the full Kagera and Ngono Rivers, and beautiful plants and animals from Minziro provide cultural services in the form of aesthetic values and tourism. The Minziro area is also host to some historic sites such as the memorial religious buildings and monuments that are a central of tourist attraction.

Tourism is one of the most important and a viable economic sector in the Minziro area and this has the potential of attracting investors, who can spur economic development in the region. The Minziro ecosystem includes the Kagera and Ngono Rivers, which harbor many tourist attraction centers, the most obvious one being Lake Victoria (the second largest fresh water lake in the world), whose tourism potential was reported by most respondents to be still not optimally promoted.

In addition, a number of historical sites available in the Minziro area include a historical church, at Kyaka Missenye, which is amongst the oldest in Africa to be built by the first missionaries and attracts Christian pilgrims from Africa, Europe and across the world. There are also other sites such as the Heroes Monuments at Mutukula and Missenyi and the Kagera museum at Bukoba; which are historical and archeological archives.

Using value transfers from related and similar ecosystems, cited and used in Emerton (2014); the aesthetic value and nature based tourism in Minziro area was as estimated at TShs 18.8 billion (US$ 8.9 million) per year; with a habitat value of US$ 360 per hectare per year.

4.8 SYNTHESIZED ECONOMIC VALUES FROM THE SANGO BAY MINZIRO BSA

A synthesis of findings from the study indicate that the Sango Bay – Minziro BSA provide ecosystem services estimated at a grand total of about 236 million US$ per year (Table 12). The ecosystem services contribute to livelihoods through direct cash incomes and indirect contributions to different sub-sectors such as crop and livestock farming. The benefits provide incentives that can strengthen conservation efforts.

Table 12: Synthesized economic values from the Sango Bay - Minziro BSA

Ecosystem service	*Total Value for Sango Bay Area (US$/ yr)*	*Total Value for Minziro Area (US$/ yr)*	*Total Value for the Sango Bay-Minziro BSA (US$/ yr)*
Provisioning Services	***61,347,496***	***28,272,728***	***89,620,224***
Capture fishery and other aquatic organisms	7,021,939	4,623,400	11,645,339
Wood-based energy & construction material	21,844,848	8,944,800	30,789,648
Water for domestic use	1,696,247	1,116,587	2,812,835
Water and grass for livestock production	9,323,845	10,324,573	19,648,418
Crop farming, irrigation and mulching	4,027,705	2,096,000	6,123,705
Other non-wood/ non-fish wetland products	17,432,911	1,167,368	18,600,279
Regulating and Supporting Services	***49,867,750***	***82,037,403***	***131,905,153***
Soil fertility & moisture	6,689,300	11,004,563	17,693,863
Pollination, seed dispersal & pest control	3,095,500	5,092,405	8,187,905
Water storage & recharge	11,400,500	18,754,955	30,155,455
Regulation of water quality	18,965,600	31,200,296	50,165,896
Flood attenuation	2,476,400	4,073,924	6,550,324
Carbon storage & sequestration	588,900	968,799	1,557,699

Ecosystem service	*Total Value for Sango Bay Area (US$/ yr)*	*Total Value for Minziro Area (US$/ yr)*	*Total Value for the Sango Bay-Minziro BSA (US$/ yr)*
Habitat/ Refugia	6,628,900	10,905,199	17,534,099
Pharmaceutical value	22,650	37,262	59,912
Cultural Services	***5,436,000***	***8,942,760***	***14,378,760***
Nature-based tourism and cultural values	5,436,000	8,942,760	14,378,760
Total	***116,651,246***	***119,252,891***	***235,904,137***

5 CONCLUSION

This study provides a clear picture of the importance of the Sango-Bay Minziro ecosystem to the local communities and other actors, who use different resources for their cash and non-cash benefits. The benefits provide incentives that can motivate participation of the different actors in sustainable use and conservation. In essence, the benefits are a big component of the natural capital that should have deliberate efforts for sustainable use. Articulation of the economic value for Sango Bay – Minziro ecosystem should be used as a clear justification for financing the management and conservation of the BSA. The process of development of a Conservation Investment Plan (CIP) and other management tools should use findings from this study as a basis to justify the need to invest resources for management and conservation of resources from the Sango Bay-Minziro BSA.

During the study, responses from interviewed regional, district and leaders indicated appreciation of natural resources within Sango Bay and Minziro, including habitat values for important biodiversity, regulating ecosystem services among others. The leaders appreciated that the natural resources can contribute to local economies and expressed strong willingness to work together within Tanzania and with the Uganda authorities to jointly manage the Sango Bay Minziro forests, given their importance and need for sustainable utilization. The respondents appreciated the fact that for effective management of the forests, there is need to bring the Tanzania and Uganda teams on board.

6 REFERENCES

Akwetaireho, S. (2009) Economic Valuation of Mabamba Bay Wetland System of International Importance, Wakiso District, Uganda. Alps-Adriatic University of Klagenfurt.

Baker, Marc (2001). A survey of the avifauna of Minziro Forest Reserve, Bukoba District, North-West Tanzania. Unpublished report to the East African Cross-Border Biodiversity Project" Reducing biodiversity loss at cross-border sites in east Africa."

Byaruhanga, A. 2002. Information for listing Proposed Ramsar Wetland Sites in Uganda.

Byaruhanga, A.; Kaganzi E.; Busulwa H.; Kyambadde R. and Kiwazi F. (2003). Sango Bay Wetlands Site Profile. Wetlands Inspection Division, Kampala, Uganda

Bush, G., Nampindo, S., Aguti, C., Plumptre, A. (2004) The value of Uganda's forests. a livelihoods and ecosystems approach. Wildlife Conservation Society, Albertine Rift Programme, EU Forest Resources Management and Conservation Programme & National Forest Authority, Kampala.

Davenport, T. and Howard, P. (Eds). 1996. Sango Bay Forest Reserves Biodiversity Report. Forest Department, Kampala, Uganda, 114pp.

Davenport, T. 1993. An annotated checklist of the butterflies of Uganda. The Uganda Forest Department, Kampala.

Davenport, T. and Howard, P. 1996 (Eds.). Sango Bay Forests Biodiversity Report. Biodiversity Inventory Reports by the Forest Department, Kampala, Uganda.

Emerton, L. (1999) Balancing the Opportunity Costs of Wildlife Conservation for Communities Around Lake Mburo National Park, Uganda. Evaluating Eden Series Discussion Paper No. 5, International Institute for Environment and Development (IIED), London.

Emerton, L. and Muramira, E. (1999) Uganda Biodiversity: Economic Assessment. National Environment Management Authority, Kampala.

Emerton, L. (2014). The economic value of biodiversity and ecosystem services in Lake Nabugabo Wetland Complex, Uganda. Report to the LTS International.

Etyang, P. 1996. Diversity and Abundance of Dragonflies in the Sango Bay area, MSc. Thesis. Makerere University; unpublished.

FAO (2014). State of the World's Forests: Enhancing the socioeconomic benefits from forests. Global Forestry Resource Assessment Publications by FAO. Italy, Rome.

Hamilton, A. (1981). A Field Guide to Uganda Forest Trees. 279 pp. Makerere University Press, Kampala. Howard, P. C. (1991). Nature Conservation in Uganda's Tropical Forest Reserves. IUCN Gland, Switzerland. Howard, P. C. (1994). An Annotated Checklist of Uganda's Indigenous Trees and Shrubs. Uganda Forest Department, Kampala.

Howard, P. C. (1991). *Nature conservation in Uganda's Tropical Forest Reserves*. WWF, IUCN, FD, Ministry of Environmental Protection.

Kakuru, W., Turyahabwe, N. and Mugisha, J. (2013) Total Economic Value of Wetlands Products and Services in Uganda. The Scientific World Journal vol. 2013

Kalibakate, D. 1995. Diversity and Abundance of Butterflies in the Sango Bay area. MSc. Thesis, Makerere University; unpublished.

Karanja, F., Emerton, L., Mafumbo, J. and Kakuru, W. (2001) Assessment of the economic value of Pallisa District Wetlands, Uganda. IUCN Eastern Africa Regional Office, Nairobi.

Kasoma, P. and Pomeroy, D. (eds) (1996). *Biodiversity of the Sango Bay Area*. A report to the GEF Institutional Support for the Protection of East African Biodiversity. MUIENR, Kampala.

Kateyo, E., Nsereko, P. and Kansiime, F. (2014) Contribution of Wetland Resources to Household Incomes of Riparian Communities of Katonga Wetland in Mpigi District, Uganda. International Journal of Sciences: Basic and Applied Research 13(1): 274-286.

Kipkoech, A., Mogaka, H., Cheboiywo and Kimaro, D. (2011) The Total Economic Value of Maasai Mau, Trans Mara and Eastern Mau Forest Blocks, of the Mau Forest, Kenya. Lake Moyini, Y. and Masiga, M. (2011) The Economic Valuation of the Proposed Degazettement of Mabira Central Forest Reserve. NatureUganda, Kampala.

Maes J., Teller A., Erhard M., Liquete C., Braat L., Berry P., Egoh B., Puydarrieux P., Fiorina C., Santos F., Paracchini M., Keune H., Wittmer H., Hauck J., Fiala I., Verburg P., Condé S., Schägner J., San Miguel J., Estreguil C., Ostermann O., Barredo J., Pereira HM., Stott A., Laporte V., Meiner A., Olah B., Royo Gelabert E., Spyropoulou R., Petersen J., Maguire C., Zal N., Achilleos E., Rubin A., Ledoux L., Brown C., Raes C., Jacobs S., Vandewalle M., Connor D., and G. Bidoglio (2013). Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Publications office of the European Union, Luxembourg.

Nkya,J., W.; Zekeya, N. and Maggid, A., D. (2014). Ethnomedicine of the Plants used in Villages' Adjacent Minziro Forest Reserve in Missenyi District, Kagera Region, Northern Tanzania. International Journal of Ethnobiology & Ethnomedicine, Volume: 1; Issue: 1

Ochola W. (2006). Land degradation, land cover, land use change and related issues in the Lake Victoria basin: States, drivers, future trends and impacts on environment and human livelihoods. In Odada *et.al (*Eds.).

Ogutu-Ohwayo, R. 1993. The effects of predation of Nile perch, Lates niloticus L., on the fish in Lake Nabugabo, widi suggestions for conservation of endangered endemic cichlids. Conservation Biology. 7: 701-711.

Prime Minister's Office (20913). Kagera Regional Investment Profile. Report by the Regional Administration and Local Government, United Republic of Tanzania.

Rogers, A.; Tukahirwa, E. and Pomeroy D. E. (2002). Economic Valuation of the Sango Bay Forest Resources. A Community Level Approach. UNDP/GEF – East African Cross-border Biodiversity Project.

Rogers, A.; Tukahirwa, E. and Pomeroy D. E. (2002). Economic Valuation of the Sango Bay Forest Resources. A Community Level Approach. UNDP/GEF – East African Cross-border Biodiversity Project

TEEB (2008). The Economics of Ecosystems and Biodiversity: An interim report. European Communities, Brussels.

TEEB (2010). The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.

Turyahabwe, N., Kakuru, W., Tweheyo, M., & Tumusiime, D. M. (2013). Contribution of wetland resources to household food security in Uganda. Agriculture & Food Security. 2 (5) 1-12.

Turpie, J., Barnes, J., Arntzen, J., Nherera, B., Lange, G. and Buzwani, B. (2006) Economic value of the Okavango Delta, Botswana, and implications for management. IUCN Southern Africa Regional Office, Harare.

UBOS (2012). Sub county development programme implementation of the Community Information System (CIS). Rakai District socio economic report by the Uganda Bureau of Statistics.

UBOS (2012). Higher Local Government Statistical District for Rakai District. Report by the Uganda Bureau of Statistics.

Wasswa, H., Mugagga, F. and Kakembo, V. (2013) Economic Implications of Wetland Conversion to Local People's Livelihoods: The Case of Kampala- Mukono Corridor (KMC) Wetlands in Uganda. Academia Journal of Environmental Sciences 1(4): 66-77.

APPENDICES

APPENDIX I: FIELD WORK TEAM; INCLUDING TEAM OF EXPERTS AND LOCAL GOVERNMENT STAFF FROM UGANDA AND TANZANIA

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APPENDIX II: SANGO BAY AND MINZIRO BENEFITS THROUGH THE LENS

Plate 1 and 2: The range of beneficiaries from the Fisheries resources from Lake Victoria

Plate 3 and 4: Promotion of Honey production and Marketing in Minziro area

Plate 5 and 6: The field Team and Minziro Police Officers assess porous artificial borders between Uganda and Tanzania

Plate 7 and 8: Use of wetland materials for construction in Sango Bay and Minziro

Plate 9 and 10: Livestock grazing and watering expeditions in Sango Bay and Minziro area

Plate 11 and 12: Sango Bay and Minziro Scenic Beauty

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