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BURNSIDE

Bujagali Interconnection Project, Uganda
Social and Environmental Assessment
Terms of Reference

Prepared by

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292 Speedvale Avenue West Unit 7 Guelph ON N1H 1C4 Canada

In association with

Dillon Consulting Limited, Canada
Ecological Writings #1, Inc., Canada
Enviro and Industrial Consult (U) Ltd, Uganda
Frederic Giovannetti, Consultant, France
Tonkin & Taylor International Ltd., New Zealand

June 2006

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1.0 Introduction

1.1 Preface

The Uganda Electricity Transmission Company Limited (UETCL) is proposing to develop the Bujagali Interconnection Project ("Bujagali IP") to interconnect the proposed Bujagali Hydro Power Project (hereinafter "Bujagali HPP" or "HPP") to the national grid in Uganda. The Bujagali IP will also support other planned initiatives to expand and strengthen the national grid in future.

The Bujagali HPP is being developed by Bujagali Energy Ltd. (BEL), a project-specific partnership of Sithe Global Power (USA) and IPS Limited (Kenya). BEL is the proponent for the hydropower dam and related facilities that are within the boundary of the hydropower site located on the Victoria Nile River about 8km north of Jinja. BEL is also managing the development and construction of the Bujagali IP on behalf of UETCL.

The Bujagali HPP was first initiated by AES Nile Power Ltd., (AESNP) in the late 1990's. Among other things, AESNP prepared Social and Environmental Assessment (SEA) documentation for the Hydropower project and for the associated transmission system facilities that AES was also developing. The overall project (both hydropower and transmission facilities) was approved by the Government of Uganda's (GoU) National Environmental Management Authority (NEMA) in 1999/2001, and by the World Bank and African Development Bank Boards in December 2001. However, in 2003 AESNP withdrew from the Project. Subsequent to AESNP pullout, the GoU initiated an international tendering for the development of the hydropower project, which was awarded to BEL. To facilitate completion of the Bujagali IP, UETCL has selected BEL to manage the planning and approvals and construction activities of the transmission facilities on UETCL's behalf. The current planned transmission facilities are very similar to the previously approved scheme that was proposed by AESNP, and BEL plans to build on the previous development work as appropriate.

The Board approvals by the lenders for AESNP's project, and the permits issued by NEMA to AESNP, are both no longer valid. Thus, UETCL and BEL will be required to prepare and submit for approvals new SEA documentation. The SEA documentation shall need to address the requirements of NEMA, the World Bank Group, and other lenders. Each of these entities has its own nomenclature for SEA documentation including "Environmental Impact Assessment", "Environmental Impact Statement" "Environmental and Social Impact assessment", and "Social and Environmental Assessment". For the purposes of this project, the term Social and Environmental Assessment (SEA) is considered to be synonymous with the different terms used by NEMA and the various lenders for the documentation of the social and environmental impacts of the project, as well as their management. A concordance analysis will specify how each institution's environmental and social requirements are met through the integrated SEA documentation.

This document provides a draft Terms of Reference (ToR) for the SEA of the new transmission system required to evacuate electricity from the Bujagali HPP. The objective of this draft ToR is that, when finalized, it will serve as the basis for conducting an SEA process, and producing SEA documentation, for the Bujagali IP that will comply with all of the GoU and international lender social and environmental legislation, regulations, and policies.

UETCL has based its preparation of this draft ToR broadly on the guidance provided in "A Common Framework for Environmental Assessment – A Good Practice Note" (Multilateral Finance Institutions Working Group on Environment, 2005). For this SEA assignment, BEL has appointed a consulting team lead by R.J. Burnside International Limited of Canada (henceforth referred to as the "Consultant") to conduct and oversee the SEA tasks proposed in this ToR, manage the SEA process on behalf of UETCL, and author the SEA documentation to comply with GoU and international lender requirements. An organogram of the Consultant's proposed SEA team is provided in Figure 1.

1.2 Brief Project Description

1.2.1 Preferred Transmission System Plan

UETCL evaluated multiple alternative schemes, each designed to evacuate power from the Bujagali HPP. The preferred system plan, which is similar to the system plan that was proposed by AESNP, and which is the subject of this SEA, involves the following:

i. Construct a new 132 kV line between the proposed switchyard at the Bujagali HPP site to a new substation site in Kawanda. This line would be built as a double circuit 220 kV line (as previously proposed by AESNP), but would be operated at 132 kV initially;

ii. Construct a new 132 kV line from the new substation site in Kawanda to the existing Mutundwe substation. This line would be built as a double circuit line but only one circuit would be installed initially;

iii. Breaking the existing 132 kV double circuit line between Nalubaale (Owen Falls) and Tororo and building two new double circuit lines to run through the Bujagali substation; and,

The SEA report will provide a summary description of the system planning alternative analyses.

1.2.2 Transmission Line Routing

The proposed transmission lines will, for the most part, follow the routes previously approved for AESNP. The exceptions are:

- Portions of the 132 kV line between Kawanda and Mutundwe. Preliminary analysis completed as part of development of this ToR indicates that routing adjustments may be required to address changes to land use, consisting primarily of in-filling by new housing, along the previous AESNP routing; and,
- There is a single circuit 132 kV line Bujagali-Nalubaale that was not part of the AESNP system plan. A routing exercise will be completed for that line as part of the SEA activities.

The general location of the overall project is provided in Figure 2. The proposed routing of the transmission system is provided in Figure 3.

1.2.3 Site for Kawanda Substation

A site for the Kawanda substation was identified and obtained by AESNP. The Government of Uganda currently holds title for the land. UETCL proposes to use the same site for the facility to be developed as part of the project. The general location for the substation site is shown on Figure 2.

1.2.4 Associated Facilities

As indicated above, the proposed transmission system facilities are needed, in part, to interconnect the Bujagali HPP to the national grid. In brief, the Bujagali HPP involves construction and operation of a new hydro dam structure with associated ancillary facilities including a powerhouse and switchyard on the Victoria Nile at Dumbbell Island, approximately 8 km north of Jinja. By the IFC terminology, the transmission system will be an "associated facility" of the Bujagali HPP. A complementary ToR for the SEA work associated with the proposed HPP accompanies this ToR for the Bujagali IP. Separate SEA's shall be prepared for the two projects although they will be closely interconnected.

Detailed descriptions of the projects shall be provided in the SEA documents, so that all interested parties will know exactly what UETCL is proposing and seeking approval for as well as what BEL is proposing and seeking approval for. The detailed descriptions will include all project components directly required for, and ancillary to, the projects, and this will be done for both the electrical transmission and hydropower generation components of the project.

1.3 Project Context

Uganda is currently experiencing a significant electricity shortage. All electricity customers in the country experience regular, rotating 24-hour blackouts every 48 hours, locally referred to as "load shedding." The need for new sources of electricity to satisfy growing demand is acute. Whilst the demand for electricity in the country is steadily growing, the ability of the country's two major hydropower plants, the Nalubaale and Kiira power stations located on the Victoria Nile at Jinja, to meet the demand is decreasing, given the present low lake levels in Lake Victoria, upon which the Nalubaale and Kiira power stations rely. Uganda is also in discussions with Kenya and Tanzania for the development of an East African Power Pool to be shared and jointly managed by the three nations.

As part of its SEA documentation, UETCL shall demonstrate the need for the project, evaluating other potential methods and routing options of power evacuation from the Bujagali HPP. UETCL shall also review the current existing electricity system in Uganda. The intent of this exercise will be to provide the justification for the proposed electricity transmission system.

1.4 Applicable Laws, Regulations and Policies to the Project

There are a number of legislative and regulatory instruments in Uganda that deal with environmental management in Uganda that are relevant to the Bujagali IP SEA. The most important of these is the Constitution of the Republic of Uganda (1995), which is the supreme law in Uganda, but other relevant instruments are provided below. Those instruments that are new or have been updated and/or revised recently are asterisked:

- The National Environment Act, CAP. 153, and its Environmental Impact Assessment Regulations (1998), Waste Management Regulations (1999), Standards for Discharge of Effluent into Water or on Land Regulations (1999), Wetlands, Riverbanks, and Lake Shores Management Regulations (1999), Minimum Standards for Management of Soil Quality Regulations (2001)*, Noise Standards and Control Regulations (2003)*, and Conduct and Certification of Environmental Practitioners Regulations (2003)*;
- The Water Act, CAP. 152, and its Waste Discharge Regulations (1998), Water Supply Regulations (1999) and Sewerage Regulations (1999);
- The Rivers Act, CAP. 347;
- The Electricity Act, 1999;
- The Town and Country Planning Act, CAP 30;
- The Public Health Act;
- The Land Act (1998) and the Land Regulations, 2001*;
- The Factories Act, CAP 198;
- The Workers Compensation Act, 2000;
- The Investment Code, 1991;
- The Uganda Wildlife Act, CAP 200;

- The National Wetlands Policy, 1995;
- The Traffic and Road Safety Act, 1998;
- The Fish Act, CAP 197 and the Fish (Beach Management) Rules, 2003*; and,
- The National Forestry and Tree Planting Act, 2003*.

In addition to the GoU requirements that will apply to the project, there are international institutions that may be directly involved with the financing of the project, such as the International Development Agency (IDA), which is a member of the World Bank Group, and indirectly through the financing of the HPP, such as the International Finance Corporation (IFC) and Multilateral Insurance Guarantee Agency (MIGA), both members of the World Bank Group, as well as other lenders. Thus, the project is being planned to address, among other requirements:

The World Bank Group (IDA, IFC and MIGA) including specific reference to:

- World Bank 'Safeguard' Policies;
- World Bank Pollution, Prevention and Abatement Handbook (1998);
- IFC 'Safeguard' Policies and Performance Standards; and,
- IFC's Environmental Guidelines for Electric Power Transmission and Distribution.

Lenders and others that may be involved with the project's financing have their own environmental and social due diligence requirements. The SEA will address the relevant GoU legislation and standards and international lender polices, standards and guidelines that apply to the Bujagali IP. Confirmation of these requirements with pertinent agencies, lenders and external stakeholders will serve as the basis for the projects due diligence work on legislative, regulatory and policy compliance related to the project. As noted above, UETCL will conduct one SEA process and produce one SEA document for the proposed transmission system facilities that complies with all of the GoU and lender requirements. To achieve this, the Consultant will undertake a Concordance Analysis of the various requirements to demonstrate how each has been complied with.

2.0 Key SEA Issues to be Addressed and Tasks to be Carried Out

Building on relevant work conducted to date, UETCL shall prepare comprehensive SEA documentation designed to meet the environmental and social requirements of the GoU and all international lenders and funders of the transmission system facilities. The SEA will assess the Bujagali IP, including any 'legacy' issues or concerns attributable to the project in its previously proposed configuration. Public consultations will engage all potentially affected communities and will be designed with the objective of providing the information required to facilitate decision making about the status of broad community support for the project, as currently proposed. The SEA documentation will include, as necessary, work on project contextual issues such as routing alternatives, the "do nothing" alternative and alternative methods of carrying out the project, cumulative effects, decommissioning, strategic implications, and regional-level impacts, including regional development and poverty alleviation.

The following sections outline the key issues to be addressed in the SEA and provide details on the proposed tasks and scope of work for each task that UETCL proposes to address these key issues.

2.1 Provide Detailed Project Description

The Consultant shall provide a detailed description of the proposed Bujagali IP, so that all interested parties will know exactly what UETCL is seeking approval for from NEMA and financing for from international lending institutions. The detailed description will include all project components directly required for the electrical transmission requirements for the project. The Consultant will undertake this project description in consultation with UETCL and the GoU, and UETCL's technical transmission system consultant so that no proposed project components for the Bujagali HPP's transmission system are left unidentified.

The SEA will also demonstrate the need for the transmission system component of the project, evaluating all other reasonable transmission system alternatives (e.g., in terms of routing, voltage, double stringing of lines on one series of towers) to evacuate the power from the Bujagali HPP, including the null, or "do nothing," alternative. The intention of this alternatives analysis will be to provide the justification for the transmission system's development.

2.2 Bio-Physical Environment

2.2.1 Forest Resources

The Consultant shall engage the Makerere University Institute of Environment and Natural Resources (MUIENR), or similarly qualified Uganda-based specialists, to carry out surveys to update the terrestrial ecological assessments of the Mabira, Namyoya and Kifu (Mwola) Forest Reserves, which were included in the 2001 Transmission System Environmental Impact Statement. The scope of these surveys shall include, but not be limited to:

- Transect surveys of plant species at the sites used for the 2001 EIS, including species presence/absence, size (dbh) and species accumulation curves for plant species at each transect site;
- Timed species counts for birds at each transect;
- Assessment of terrestrial vertebrates and associated habitats at each transect; and,
- Assessment of ecological values of affected habitats and species, including;
    - Identification of any Critically Endangered or Endangered Species, as defined in the IUCN Red List of Threatened Species; and,

- Identification of any Critical Habitat as defined in the International Finance Corporation's Performance Standard 6 (Biodiversity Conservation and Sustainable Natural Resource Management).

The Consultant shall assess the impacts of the project on the features identified during the field surveys, and incorporate appropriate measures for avoidance and mitigation of adverse effects into the SEA's Environmental Action Plan (EAP). As far as practicable, these measures shall be integrated with any measures that are formulated to mitigate effects on the Mabira CFR, and/or to enhance and manage the Kalagala-Itanda Offset. These will include updating of the proposed framework and selection criteria for a compensation forest area to replace the area of Mabira Forest Reserve that will be occupied by any widening of the transmission line wayleave. The Consultant shall integrate any community development measures (e.g., capacity building, community-based natural resource management initiatives) into the EAP.

2.2.2 Lubigi Swamp

The proposed routing may result in the potential for effects to Lubigi Swamp. The Consultant shall assess the ecological values of the Lubigi Swamp. This assessment shall include:

- Consultation with Wetlands Inspectorate Division, to ascertain conservation status of the swamp, and obtain and review available data on ecological conditions;
- Field surveys of plants, birds, mammals, reptiles, amphibians and invertebrates within six quadrats; two quadrats will be selected on the western side of Lubigi Swamp, two quadrats on the eastern side; and, two quadrats adjacent to the mid-point of the existing road causeways on Masaka and Hoima Roads; the field surveys shall be completed in second quarter of 2006;
- Identify species of economic or conservation importance, including:
    - Identification of any Critically Endangered or Endangered Species, as defined in the IUCN Red List of Threatened Species; and,
    - Identification of any Critical Habitat as defined in the International Finance Corporation's Performance Standard 6 (Biodiversity Conservation and Sustainable Natural Resource Management).

The Consultant shall assess the impacts of the project on the features identified during the field surveys, and incorporate appropriate measures for avoidance and mitigation of adverse effects into the SEA's Environmental Action Plan (EAP). The Consultant shall integrate any community development measures (e.g., capacity building, community-based natural resource management initiatives) into the EAP.

2.2.3 Forest Economic Impact Assessment and Mitigation Plan

The Consultant shall carry out a forest economic impact assessment, and formulate a mitigation plan, including the following tasks:

Phase 1: Economic Assessment

- Review of Ecological Status;
- NFA Management Objectives/Issues Identification;
- Standing Stock Assessment (Field Survey) – including tree ID and measurements at sample plots; and,
- Calculation of Economic Values.

Phase 2: Mitigation Plan

- Stakeholder Analysis/Identification;
- Develop Options, e.g.;
    - Improve/enhance Mabira FR;
    - Improve/enhance Bujagali riverbanks and islands;
    - Improve Kalagala/Nile Bank FRs;
    - Purchase private forest and gazette; and,
    - 'Mixture' option(s).

Assess pros/cons of various options and determine preferred option in consultation with identified stakeholders (including UETCL, NFA and communities).

2.2.4 Socio-economic Baseline Studies

UETCL will complete a socio-economic baseline study for the proposed transmission system way leaves. This will build upon and supplement the socio-economic baseline work completed in 2000 by AESNP for the way leaves that it identified for the transmission system. The socio-economic baseline will be based on a household survey questionnaire similar to that administered by AESNP in 2001, which will use a representative sample size, rather than being exhaustive. Information on the current status of public services in the project area will also be supplemented based on direct observations and interviews with local council representatives. The Consultant will present the current information in the SEA.

2.2.5 Resettlement and Compensation

Houses and other permanent structures shall not be allowed within the way leaves that will be required for the transmission lines, and vegetation is generally limited to less than a few meters in height. Agricultural activities including most annual crops and low perennial crops, such as tea, are permitted. The specific width of the way leaves will be 40 m for 220kV lines and 30 m for 132 kV lines.

In 2000, AESNP prepared a Resettlement Action Plan (RAP) to address resettlement and compensation issues along the way leaves identified by AESNP. The resulting RAP that was disclosed to the World Bank Infoshop with the rest of the Bujagali Project documentation submitted by AESNP in March 2001. However AESNP did not implement the RAP, and thus no actual way leaves were acquired. That said, AESNP did compensate households affected by the proposed Kawanda sub-station, including resettlement of some households to a nearby site in Nansana.

In the ensuing approximate 6 years since AESNP prepared its RAP there have been changes to land values and land use along the ROW. In some cases the alignment of the line will differ, in particular, between the proposed Kawanda substation and the existing Mutundwe substation. In this area many new buildings and homes have been developed. For this reason, a routing exercise will be completed to determine if there are any alternative routes that could be taken to minimize resettlement.

A comprehensive Resettlement Action Plan (RAP) is to be completed by UETCL on behalf of the UETCL. Details are provided in Section 2.3.4.

2.2.6 Broad Community Support

Certain lenders to the Bujagali HPP have an expectation that a "broad community support" decision can be made on the project before they decide to participate in the financing of the project. According to IFC, as one example:

> *Broad Community Support is a collection of expressions by the affected communities, through individuals or their recognized representatives, in support of the project.*

UETCL commits to consultation with the lenders and other stakeholders, as appropriate, in order to provide the information it reasonably can to assist the lenders in their "broad community support" decision-making through the Bujagali HPP SEA process and documentation, including the transmission system SEA, as applicable.

2.2.7 Assessment of Impacts

For each of the biophysical and socio-economic remits of work for the Bujagali HPP's transmission system, described above, the assessment of effects will need to be categorized into short-term vs. long-term effects, construction versus operation effects, irreversible versus mitigable effects, and project-specific versus potentially cumulative effects. The Consultant will undertake this exercise of impact identification and assessment such that appropriate environmental and social action plans (ESAPs) can be developed to address these effects spatially and temporally.

2.3 Preparation of Action Plans to Address Impacts

2.3.1 Public Consultation and Disclosure Plan

Recognizing the different communities potentially affected, the PCDP for the transmission system will be integrated with that prepared for the hydropower site including the schedule for its implementation. The Consultant will be responsible for the PCDP activities, which will be designed to meet all applicable lender and regulatory requirements.

Highlights of the PCDP will include early and regular consultation with affected communities and people; disclosure of draft PCDP and documentation for review and comments with project response; identification of stakeholders and appropriate consultation and engagement methodologies; and documentation of all activities and outcomes. A draft of the PCDP itself will be disclosed early in the process.

2.3.2 Environmental Action Plan

As part of the Bujagali HPP transmission system SEA, UETCL shall prepare an Environmental Action Plan (EAP), consistent with the requirements of NEMA, the IDA and with IFC's Performance Standard 1: Social & Environmental Assessment and Management System. This Action Plan will include measures to avoid, prevent, reduce, mitigate, remedy or compensate any adverse effects on the environment in relation to the construction and operation of the Bujagali HPP transmission system.

The EAP will include, but not be limited to, outlines for the following component plans:

- Traffic Management Plan;
- Dust Management Plan;
- Waste Management Plan;
- Staff Training Plan;
- Pollutant Spill Contingency Plan;
- Emergency Response Plan;
- Monitoring Plan;
- Reporting and Change Management Plan; and,
- Health & Safety Management Plan.

It is recognized that the EPC contractor to be retained by the UETCL, as the party that will be responsible for the majority of day-to-day implementation of the EAP, may need to amend the EAPs or its component plans before or during their implementation. Hence, provisions for a Change Management Plan within the EAP will be included.

2.3.3 Social Management Plan

UETCL shall prepare a Social Action Plan (a sub-plan of the general project EAP), which will be developed to address mitigation of potentially negative social impacts associated with the project and enhancement of positive impacts. In practice; it may include, but is not limited to, the following issues:

- Non-discrimination and Equal Rights Issues, as applicable;
- Employment issues, including labour rights and applicable human resources policies and procedures, which will be consistent with IFC Performance Standard 2 (Labor and Working Conditions) and the various International Labour Organization Conventions cited therein;
- Workers' accommodation;
- Benefits accruing to local communities (e.g., catering and other activities);
- Local governance;
- Vulnerable groups (e.g., elderly and disabled) within affected communities;
- HIV/AIDS prevention and other health-related issues;
- Gender-related impacts;
- Impeded access; and,
- Monitoring and community liaison at construction and operation phases.

The Social Action Plan (SAP) will be based on the same general format as the Environmental Action Plan, described in Section 2.3.2.

2.3.4 Resettlement Action Plan

For the Bujagali HPP transmission system, the rationale for developing a RAP include the following factors:

- All affected assets and affected people need to be properly identified to be able to calculate a budget and assess all implementation requirements;
- Preliminary observations indicate that impacts may be greater in certain locations than anticipated by the 2001 RAP, with significant numbers of residences affected in the Mutundwe and other areas – resulting in the 2001 RAP being inadequate to describe today's expected impacts;
- Good practice is to prepare a RAP wherever people are physically displaced, and this will be the case for the transmission lines; and,
- A full RAP provides the framework for the necessary consultation with affected people and third parties.

UETCL is planning to prepare a full RAP for the transmission system associated with the Bujagali HPP as defined above. It will utilize available information from the 2001 RAP as relevant and provide additional new information as required to complete the RAP requirements to current standards. The RAP will include but not be limited to:

- Legal and institutional framework;
- Socio-economic baseline utilizing 2001 information as relevant supplemented with new information as appropriate (infrastructure, public services, land use);
- Resettlement and compensation approach, including updated compensation rates based on a categorisation of structures and the crops observed in the right of way;
- Census/valuation and socio-economic survey based on preferred option for the transmission lines (centre-line surveys)
- Impact identification based on satellite images with ground confirmation;
- Preliminary identification of resettlement sites;
- Results of consultation on the resettlement and compensation strategy and approach;
- Implementation arrangements documented in detail;
- Monitoring and evaluation;
- Attention to vulnerable people and groups;
- Grievance management; and,
- Budget and schedule.

2.3.5 Community Development Action Plan (CDAP)

UETCL will discuss with its potential lenders, in the context of their Broad Community Support decision-making (see Section 2.2.6, above), the project's complementary Community Development Action Plan needs associated with the transmission system. Action Plan activities will be designed at levels appropriate to those of the identified impacts.

3.0 SEA Institutional Arrangements

3.1 Institutional Arrangements for the Preparation and Review of the SEA

As noted in Section 1.1, the Consultant will conduct the SEA process and prepare the SEA documentation for both the transmission system facilities and the HPP. The Consultant will also undertake integrated public consultation and disclosure activities for the project.

In Uganda, NEMA will coordinate the review of both the ToRs for the SEAs, as well as the SEAs themselves, soliciting review inputs in each case from "lead agency" reviewers, such as DWD, the National Forestry Authority and the Uganda Wildlife Authority. The Executive Director of NEMA has the discretion to require a public hearing for the project before a decision on whether to approve it is made and it is NEMA that, ultimately, has the authority to issue a Certificate of Approval for the project in Uganda.

A Panel of Experts will be established and receive advice from independent environmental and social specialists who will review the HPP project on behalf of BEL. It is expected that this Panel of Experts will visit the HPP site, as well as the Bujagali IP; report on its observations and public and agency consultation activities;

and make recommendations on its findings. These documents will be made publicly available. The Panel of Experts will consult with a broad cross-section of stakeholders regarding the Bujagali project, reviewing environmental and social issues related to the HPP, and as appropriate, the Bujagali IP.

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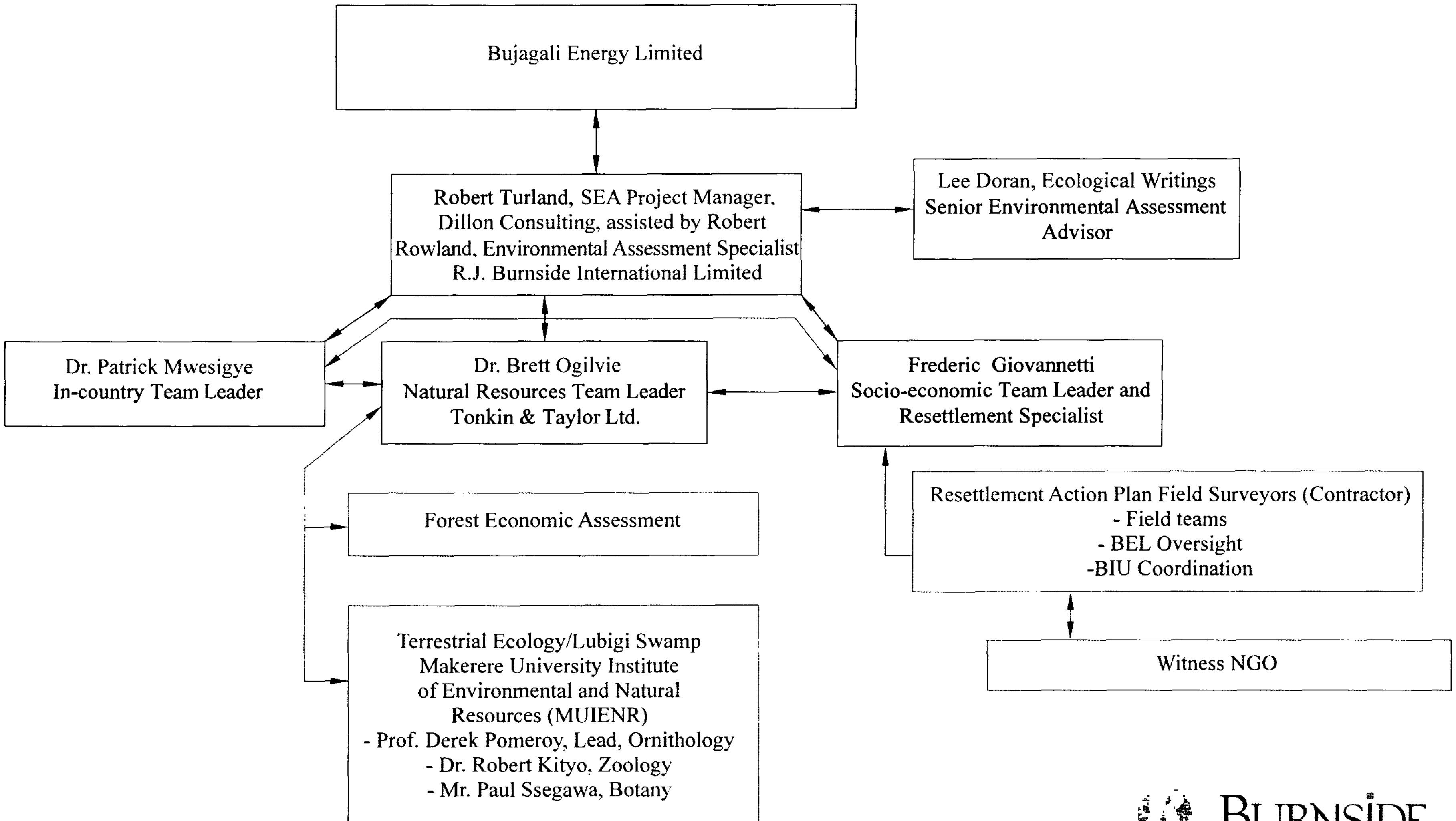
Figures

SEA TEAM REPORTING STRUCTURE
BUJAGALI TRANSMISSION SYSTEM PROJECT, UGANDA

FIGURE 1



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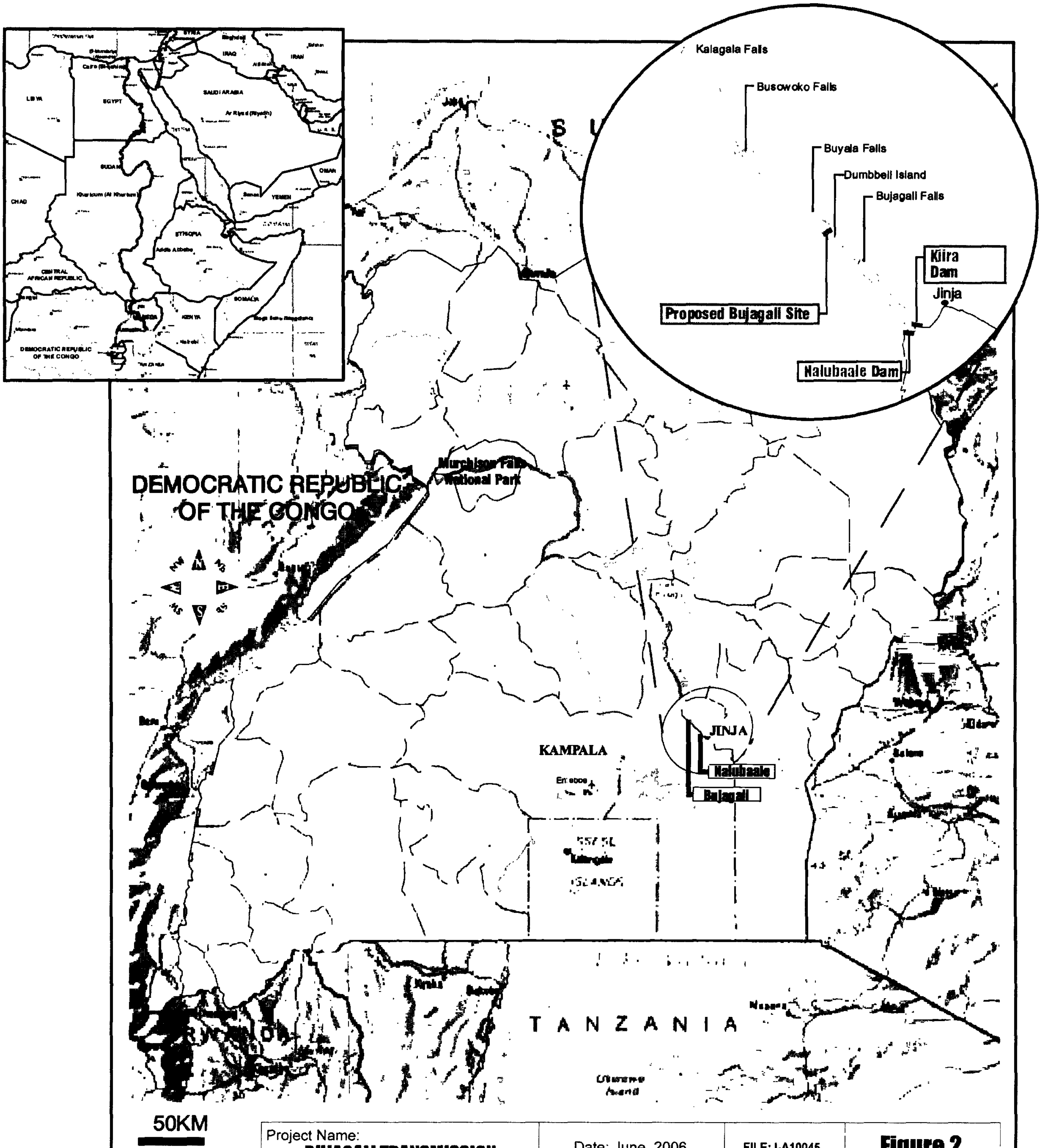

Project Name: **BUJAGALI TRANSMISSION SYSTEM SEA**

Prepared for: **BUJAGALI ENERGY LTD.**

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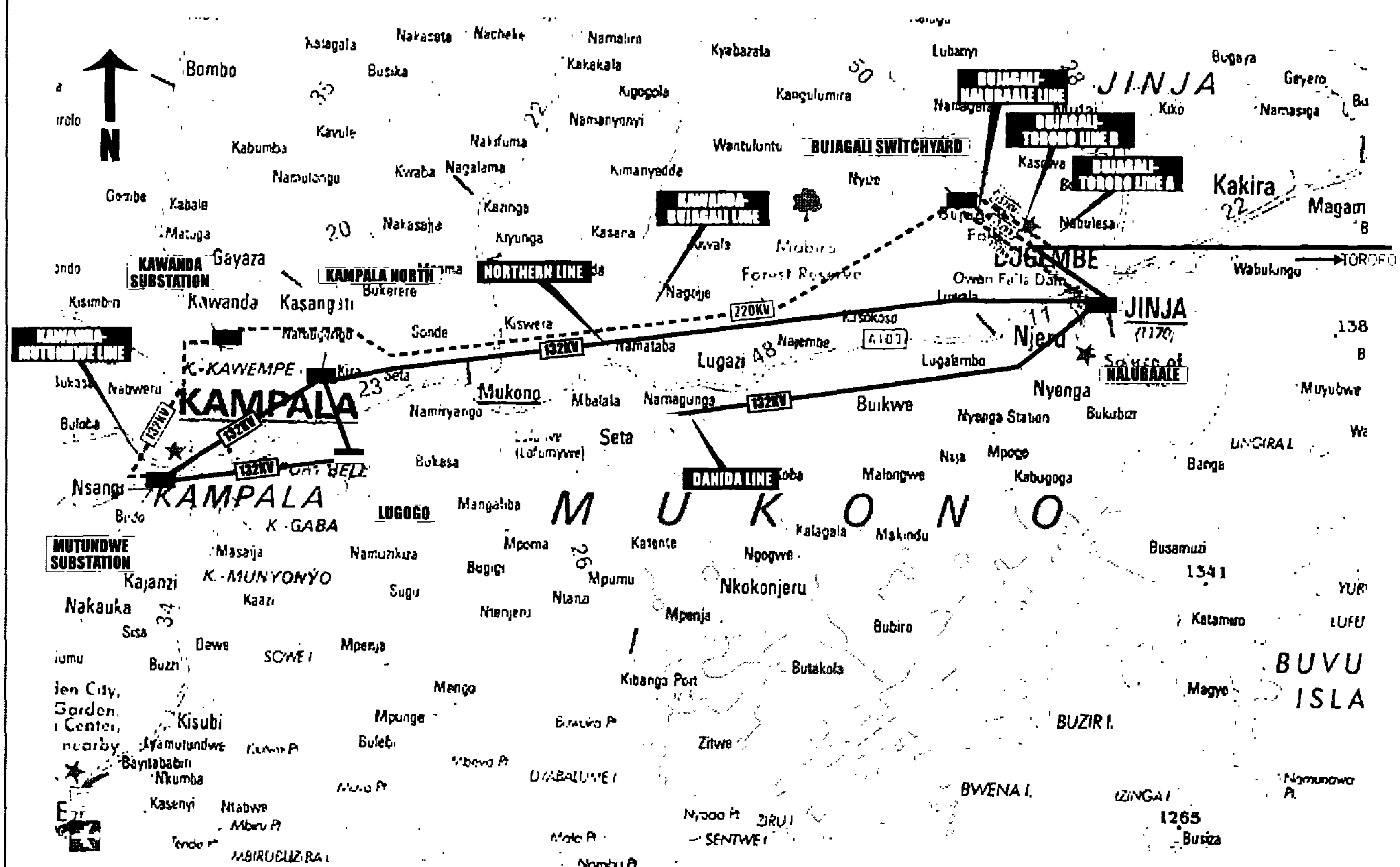
Figure 2

LOCATION OF THE BUJAGALI PROJECT



BUJAGALI TRANSMISSION NETWORK

Existing Substations

New Substations

Existing Lines

New Lines

For illustration purposes only. Not to scale.

Project Name: **BUJAGALI TRANSMISSION SYSTEM SEA**	Date: June, 2006 — FILE: I-A10045 — **Figure 3**
Prepared for: **BUJAGALI ENERGY LTD.**	**EXISTING & PROPOSED ELECTRICAL TRANSMISSION WORKS**

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Appendix A.2
SEA Team Registration

COMMITTEE OF ENVIRONMENTAL PRACTITIONERS

REPUBLIC OF UGANDA

THE NATIONAL ENVIRONMENT
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BURNSIDE

Appendix B.1

Description of Soils Within the Region

(Source: Appendix C.1 – AESNP Transmission System EIS, March 2001)

APPENDIX C.1

DESCRIPTION OF SOILS WITHIN THE REGION

Buganda Catena is characteristic of the Ntenjeru, Buikwe, Seeta and Nakisuga areas. It consists of shallow, skeletal soils developed from either quartzite or ironstone on summits and upper slopes and deep red or red-brown clay loams occurring on pediments. The latter are often associated with truncated and ferruginized soil profiles occurring in the lower sections of the pediments. Frequently, an extensive quartz dyke may be present in the hill summits with sandy or stony soils down slope.

The **Kyebe Catena** occurs in the areas of Ngogwe and south of Buikwe. The soils are closely related to the Buganda soils and particularly to the loamy associates of Buganda Catena. They differ from the latter in respect to relief that consists of hills with rounded summits and generally steeper and shorter pediments, and in short to medium grass savanna expanses of Pennisetum purpoureum. Soils are lighter in texture (sandy loams) being probably derived from fine-grained sandstone and quartzites rather than schists as in the Buganda catena, and are generally shallower. The catena has a greater proportion of the area occupied by shallow, bouldery and excessively drained soils at the summits and steep upper slopes. Soils associated with strongly dissected remnants of the Buganda surface generally occur on gently rolling hills with rounded summits at 1,300 m to 1,500 m ASL. Most of these summits possess broken up and disintegrated boulders of laterite instead of extensive sheets as in the Buganda catena. The pediments are long and more gently inclined, with slope gradients of 5 to 8 percent and dissected by broad valleys.

The parent material of the upland soil series of these catenas is derived predominantly from the weathering products of Basement Complex gneisses and granitic rocks which give rise to red or brown loams with varying quantities of quartz gravel and stones.

The **Mirambi Catena** is common in the area of Lugazi, Nyenga and parts of Ngogwe. The Lugazi and Ngogwe areas are located close to the transmission line alignment. Analytically, the Mirambi soils are much less acidic and less leached than those of the Buganda and Kyebe catenas.

The soils of the **Mabira Catena** are generally ferralitic sandy clay loams with black waterlogged clays in the valley bottoms. The Mabira catena is characteristic of the entire Mabira Forest Reserve and the adjacent villages of Najjembe and Kawolo. The general relief of this series is somewhat steeper and the hills themselves are more ridge-like in appearance with long and generally rounded crests than the catenas previously described.

In this series the upland soil sequence is derived from two different bands of parent material. The summit and upper slopes are developed over relic ironstone and the pediment soils from weathering products of phyllite with minor occurrences of aphibolite, which give rise to red or yellow clays. The red associates of the Mabira Catena are strongly laterized and contain well developed murram horizons. The soil has a high clay content (well over 60 percent in the lower horizons) and generally a good nutrient status, particularly in respect of organic matter (4 to 6 percent carbon) and exchangeable bases.

Agriculturally, Mabira soil series are extensively cultivated and are generally very productive supporting all the commonly grown annual and perennial crops.

The Bujagali area is characterised by heavy loamy soils known as the Nakabango Catena that are generally rich in nutrients. These soils are usually between 0.15 m and 1.0 m deep. A variety of clays, light soils and sandy loamy soils are commonly found in valleys with a well-defined course and shallow alluvium in beds. There are also ferrisol (red) soils formed on basic rocks.

The Nakabango series is also characteristic of the sugarcane plantation area. It is associated with rolling to gently rolling hills with summits 1300 – 1500 m ASL. The general relief, climate and vegetation are very similar to that of the Mabira catena with which the Nakabango Series forms a complex at some points.

The parent material of the pediment soils is derived from weathering products of basic rocks, amphibolite schists and dolerites which on weathering give rise to bright red or reddish brown clays. It may easily be distinguished from all other upland soils in Buganda by its stickiness when wet and the relatively wide and irregular cracking on drying due to the almost complete absence of a quartz sand fraction.

The Nakabango medium soil (upper pediment) is normally well drained. The brown colour of this series may indicate impeded internal drainage; however, a low content of iron oxides, which have not been fully released from ferro-magnesian minerals, may also be a contributing factor.

The Nakabango soils are characteristically fertile and support a wide range of agricultural crops. The most productive coffee farms and the SCOUL sugar estate are situated on these soils.

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Appendix B.2
Climatic Information for the Region

(Source: Appendix C.2 – AESNP Transmission System EIS, March 2001)

APPENDIX C.2
CLIMATIC INFORMATION FOR THE REGION

Table 1: Mean Monthly Rainfall (R) and Potential Evapotrans piration (PET) in Different Parts of Mukono District (mm)

Month	Bbale		Ntenjeru		Nakifuma		Mukono		Buikwe		Buvuma	
	R	PET	R	PET	R	PET	R	PET	R	PET	R	PET
Jan	34	152	46	140	58	138	100	136	88	132	74	13
Feb	54	144	60	134	72	132	108	130	96	126	84	128
Mar	102	152	108	142	120	140	214	138	178	136	150	138
Apr	182	124	182	120	190	118	240	116	224	116	208	118
May	146	118	136	112	134	112	228	110	182	108	170	108
June	78	108	60	106	66	106	100	106	84	104	76	106
July	82	110	70	106	70	106	94	108	78	106	62	106
Aug	122	116	106	114	106	114	104	116	96	112	64	114
Sep	120	124	102	122	106	120	112	122	102	120	76	124
Oct	132	132	132	128	136	126	144	128	150	126	114	130
Nov	114	134	120	126	136	124	196	122	170	122	138	124
Dec	64	142	72	134	84	132	120	128	116	124	116	124
Yearly	1230	1556	1194	1484	1278	1468	1760	1460	1564	1432	1332	1454

Source: Meteorology Department, Kampala

Table 2: Meteorological Measurements at Kituza Agricultural Research Station

Month	Max Temp (^0C)	Min. Temp. (^0C)	Relative Humidity % (0600 hrs)	Relative Humidity % (1200 hrs)	Mean Sunshine Hrs/day	Mean Rainfall (mm)
Jan	27.5	14.5	88	64	7.1	68
Feb	27.2	15.1	92	66	6.0	108
Mar	26.8	15.8	89	72	5.5	175
Apr	26.1	16.0	89	74	5.1	203
May	25.8	15.9	89	75	5.6	165
Jun	25.6	14.9	88	71	6.0	83
Jul	25.1	14.3	91	71	5.3	62
Aug	25.7	14.2	90	71	5.2	81
Sept	26.4	14.7	86	69	5.8	130
Oct	26.8	15.5	86	69	4.9	160
Nov	26.7	15.2	86	70	5.5	243
Dec	26.5	14.7	88	70	6.9	132

Source: Meteorology Department, Kampala

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Appendix B.3
Report on Biodiversity of Proposed Transmission Line

BIODIVERSITY OF KEY SECTIONS OF THE PROPOSED NEW BUJAGALI TO KAMPALA TRANSMISSION LINE

With special reference to Mabira, Kifu and Namyoya Central Forest Reserves, and the Lubigi swamp

Compiled and edited by Robert Kityo and Derek Pomeroy

Makerere University

September 2006

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EXECUTIVE SUMMARY

1. The proposed route of the Bujagali–Kampala transmission line passes through three Central Forest Reserves (CFRs: Mabira, Kifu and Namyoya) and along the edge of a major wetland (Lubigi). In each of these we conducted surveys to assess their biological importance, which included biodiversity, rare or endangered species and important ecosystems. To do this, we surveyed plants, dragonflies, butterflies, frogs, reptiles, birds and mammals at each site. All members of the team are experienced in such work.
2. These surveys repeated and extended those made in the three CFRs in 1999. No significant differences were found, nor are any endangered species likely to be adversely affected by the new line. Nevertheless, Mabira is the only major forest along the northern shores of Lake Victoria and it supports a high biodiversity, including a large number of species of conservation concern. Consequently, it is important to mitigate the forest loss, whether by improving some degraded parts of Mabira, or by reaforestation elsewhere. In either case, it is of course the natural forest which has the most value. It is also important to prevent the fragmentation of the forest preventing species from moving from the southern to the northern blocks, and vice-versa. We therefore propose valley corridors to retain a link between them. The least distributed forest is to the north of the existing wayleave so that, if a way can be found to do so, the new line should be to the south of the existing line.
3. The two smaller forests have already been extensively changed, and such parts as are still forest are almost entirely planted with exotic species, notably eucalyptus. Their biodiversity value is low.
4. Lubigi swamp, despite its proximity to Kampala, has not been extensively altered and its biodiversity value is still high, and we recommend that it should be formally protected. The erection of pylons along its north-western border will not greatly affect the swamp, particularly as a major highway is taking a much longer part of it.
5. Overall, the construction of the proposed transmission line will not have a very serious impact on the biological value of the areas affected: and these impacts can be mitigated fairly easily.
6. The substantial amounts of data collected have been deposited in the National Biodiversity Data Bank in the Makerere University Institute of Environment and Natural Resources and they will provide a valuable basis of comparison for future studies.

1.0 GENERAL INTRODUCTION

Forest Sites

Mabira is the largest Forest Reserve in Central Uganda (Davenport *et al* 1996), found in an area of gently undulating land interrupted by flat-topped hills that are remnants of the ancient African peneplain (Howard 1991). During the cooler, drier parts of the Pleistocene Period, there was no forest in this area. The forests around the northern shores of Lake Victoria originated only 10-12,000 years ago, as the climate became warmer and wetter (Hamilton, 1982).

In a review of the biodiversity importance of 65 of Uganda's forests, the then Forest Department (2002) ranked Mabira 24th (p145), although somewhat higher in terms of rare species. (Neither Namyonya nor Kifu were assessed). The proposed zonation of the forest included a Nature Reserve of 73 km^2, whose southern limits would be some 5 km north of the existing trasmission line.

The vegetation of Mabira is classified as medium-altitude moist semi-deciduous forest (Langdale-Brown *et al*, 1964) and is considered to be of sub-climax stage, highly disturbed and heavily influenced by man. The forest, which covers an area of 306 km^2 is found 54 km east of Kampala and only 26 km west of Jinja. Such proximity to large urban centers and also being located in areas of fairly high human populations, puts considerable strains onto the forest for forest products.

Both the National Forest Authority (NFA) and private owners have replanted a large section of Kifu Central Forest Reserve (CFR) with plantation trees. The southern side of the existing powerline was replanted with *Maesopsis eminii* but other indigenous species still exist, scattered among the *Maesopsis eminii* trees. The common trees include *Funtumia elastica, Alchornea cordifolia, Antiaris toxicaria* and *Celtis mildbraedii.* Shrubs and herbaceous species such as *Glycine wightii, Marantochloa leucantha, Pteris dentata, Renealmia congolana, Acanthus pubescens, Acalypha bipartita, Acalypha ornata, Scutia myrtina* and *Rubus apetalus* characterize the understorey. The northern side has been replanted with *Auraucaria* spp. after clearing the natural vegetation of the area except for the herbaceous vegetation that is regularly weeded out to enable proper growth of the *Auracaria.*

Namyoya CFR. is predominantly *Eucalyptus* woodlots on the northern side of the existing powerline but with a few indigenous tree species still surviving, including for example *Funtumia elastica, Alchornea cordifolia, Sapium ellipticum* and *Erythrina abyssinica.* The southern side of the powerline at the point we conducted the surveys, has gardens and harvested *Eucalyptus* woodlots. Some of the herbaceous plants and shrubs recorded are characteristic of disturbed areas and include *Acanthus pubescens, Ageratum conyzoides, Bidens pilosa, Conyza floribunda* and *Vernonia amygdalina.*

The surveys we are documenting in this report were planned to update the terrestrial ecological assessments of the Mabira, Namyoya (Mwola) and Kifu forest reserves which were included in the 2001 Transmission System Environment Impact Statement (EIS). Consequently, most of the data were collected from the same places, and using similar methods, to the earlier survey, although with additional taxa, as described in Section 1.1.

Wetland sites

Wetlands have distinct vegetation characteristics and in addition the soils found under a wetland are quite different from normal soils because they are formed under low oxygen conditions and are very heavy with clay or have large amounts of plant remains known as peat.

We have not found very much in the way of documentation about Lubigi wetlands except the brief profile of Namakambo (2000). According to Namakambo (2000), Kampala district has numerous wetlands that are closely linked with the topography and drainage of the district. Although very near to Kampala city and Kampala administrative district, Lubigi swamp is currently under the jurisdiction of Wakiso district. Lubigi wetlands are among the largest wetlands in the district, not very far removed from its border with Kampala district. It is permanently waterlogged, being fed by rivers Mayanja, Bwaise, Nabisasiro, Nalukolongo and Kiwunya.

Lubigi wetlands extend through Lubaga and Kawempe subcounties and are located approximately 7.5 km west of Kampala city (Namakambo 2000). The same author indicated that the wetlands could be accessed at several locations on Masaka, Hoima, Mityana and Sentema roads. Several villages, including Busega, Natete, Bulenga, Nakuwadde, Lubanyi, Masanafu, Kawala, Nganda and Namungoona surround the wetlands. All these are suburban villages, which are densely populated with resultant impacts on the condition of the wetland near them.

Namakambo (2000) described the swamp as being dominated by papyrus with patches of *Loudetia* sp., *Typha* sp., *Miscanthedium* sp., *Echinochloa* sp., and *Phoenix* palms. During our surveys we have also found communities of these plants to still be characteristic of the area (Plate 11). At the time of writing the author indicated that the areas adjacent to the wetland were cultivated except the immediate fringe. The only other wildlife that this author mentions is the presence of Sitatunga. At the time Namakambo wrote, the Lubigi swamp had no conservation status and no conservation measures had been proposed. Our consultations with the Wetlands Inspectorate Division revealed that the Lubigi wetland has no conservation status in any part of it. At the present time, the new Northern bypass highway, currently under construction traverses the eastern length of Lubigi wetlands. The road project has resulted in infilling in those sections of the swamp crossed by the highway. The EIA report on that project (2001) does recognize the ecological significance of the swamp, and recommend, the enforcement of wetland regulations.

Wetlands were not incuded in the 2001 transmission line EIS report. We selected six sample sites following a survey along the most accessible parts of the swamp. The locations were selected were chosen because they represented a fair sample of the available microhabitats along the edge of the swamp.

1.1 SCOPE OF WORK

We have conducted surveys to provide answers to question posed by our terms of reference, defined in the scope of work.

1.11 THE FOREST ECOSYSTEMS

1. Transect surveys of plant species at sites used for the 2001 EIS, including species presence/absence, size (dbh), and accumulation curves for plant species at each transect site.
2. Plant stock inventories for conducting stock assessments.

3. Inventories of birds at each of the same transects used for the 2001 EIS.
4. Inventories of terrestrial vertebrates and two groups of invertebrates and associated habitats at each of the transects.

5. Assessment of affected habitats and species including:
   (i) Identification of any Critically Endangered or Endangered species as defined in the IUCN Red list of threatened species.
   (ii) Identification of any critical Habitat as defined in the International Finance Corporation's Performance standard 6 (Biodiversity Conservation and Sustainable Natural Resource Management).
6. Assess impacts of the proposed transmission line construction on the features as identified in 1 – 5 above, and suggest appropriate measures for avoidance and mitigation of adverse effects, which can be incorporated into the SEAs Environment Action Plan (EAP). Such measures would as far as is practicable aim to integrate with any measures that are formulated to mitigate effects on tourism activities, the Mabira CFR management plan, and/or enhance the Kalagala offset plan.
7. Identify and make recommendations for capacity building or community-based natural resource management initiatives.

1.12 THE WETLAND ECOSYSTEMS

We were also required to conduct surveys to enable us to evaluate the ecological values of Lubigi wetlands. Among others, this task required us to: -

1. Consult with the Wetland Inspectorate Division, to ascertain the conservation status of the wetland, obtain and review available data on ecological conditions of the wetland.
2. Conduct detailed surveys of plants, birds, mammals, reptiles, amphibians and invertebrates in six sampling locations along the edge of the wetland.
3. Survey the full length of the edge of the swamp to identify and map the distribution of different ecological communities of the wetland and to use these to produce an ecological communities map detailing their distribution along the western edge of the swamp that will be traversed by the transmission line.
4. Prepare a description of the different ecological communities pointing out the defining characteristics of each.
5. Identify species of economic and conservation importance, including;
   (i) Identification of any critically endangered or endangered species as defined in the IUCN Red list of threatened species.
   (ii) Identification of any critical Habitat as defined in the International Finance Corporation's Performance standard 6 (Biodiversity Conservation and Sustainable Natural Resource Management).
6. Assess impacts of the proposed transmission line construction on the future identified in 1 – 5 above and suggest appropriate measures for avoidance and mitigation of adverse effects, which can be incorporated into the SEAs Environment Action Plan (EAP). Such measures should as far is practicable aim to integrate any community development measures into the EAP.

1.2 FOREST SITES

In the forests (Mabira, Kifu & Namyoya), we revisited the same 10 locations that we used for the 2001 report. Eight transects were located in Mabira, and one each in Kifu and Namyoya

(Appendix G1).

The surveys in Mabira forest were conducted in the area of the forest bounded to the east by pylon 179 and pylon 144 to the west (coordinates are in Appendix G1). This stretch of forest covers a little over 7 km. The stretch of forest between Pylon 179 up to about Pylon 172 covering a distance of a little over 1 km, is largely characterized by paper mulberry. From Pylon 172 until 140 a little before Wasswa village, most of the way except for a short stretch between Pylon 159 & 158, the transmission line runs through more or less secondary forest with a narrow fringe of paper mulberry at the edge.

Starting a short distance after Pylon 140 (N00°26.3183', E032°59.3487'), and continuing westwards, the wayleave is under cultivation growing a variety of crops, including cassava, potatoes, yams, and bananas among others (Plates 3a-d).

The botanical surveys in Kifu CFR were done along a transect at pylon 166, for the other taxa (butterflies, birds and mammals) we moved around to as far as pylon 164. The forest to the north of the transmission line is now a plantation forest growing largely *Auricaria cunninghamii* while that to the south is largely planted with *Maesopsis eminii* but is covered in dense bushes of secondary growth.

Namyoya CFR, as far as could be observed, has been planted with *Eucalyptus*, which in the younger trees is intercropped with subsistence crops including maize, cassava, yams and potatoes. A small stand of trees measuring about 195 x 50 meters survives on the northern side of the transmission line in this area opposite pylon 51 as the only natural enclave. In this area surveys were conducted around the areas adjacent to Pylon 51 and were not restricted to a transect as was the case in Mabira and Kifu Forests.

Appendix G1 presents GPS recordings for those locations in Mabira, Kifu and Namyoya from which or around which data of one sort or another were taken. The GPS units were set for:

1 Map Datum WGS 84,
2 Units – Metric
3 North Ref – Mag.

The pylon GPS readings represent the locations of the transects and all these were taken from the wayleave as far away from the existing transmission lines as we could get without the canopy cover influencing how many satellites the GPS could receive.

Many waterways, potential waterways and/or points were dry at the time we conducted these surveys except for River Waliga in the area of site 3 and in six other locations west of site 5. We made note of these in particular because it seemed they would be important for provision of water for amphibians as well as other wildlife in Mabira to drink for most of the year and as potentilal points for maintaining corridors between the northen and southern parts of the forest for undestorey species. Most of the amphibian records from Mabira were also from these points that had water at the time of these surveys.

The landmarks labeled "stream with water" for Mabira forest (Appendix GI) represent the only other locations that had either standing or running water at the time of the present surveys. The landmark temporary pond had a muddy puddle remaining at the edges of which spoors of two carnivores, the marsh mongoose and serval cat were recorded. All other landmarks had different notable features as are implied in the landmark descriptor.

Field work was conducted at these sites between 30 June and 7 July 2006.

1.3 WETLAND SITES

We conducted a survey along the accessible edge of Lubigi swamp to describe and map the different ecological communities along the edge of the swamp. We also used this exercise to identify the most suitable and representative locations for conducting the detailed biodiversity surveys.

The GPS units were set as described for Section 1.2 for the forest sites. Appendix G2 contains details of the locations that were visited and described for purposes of mapping the ecological communities around the swamp. Six of these locations (sites 1 – 6) were then used for the detailed ecological surveys.
Additional points which were not necessarily along the edge of the swamp to be traversed by the transmission line, were also recorded because they represented areas where the swamp was already being impacted by human activities such as brick making, dumping refuse, burning bones, mining for sand and clay, papyrus harvesting or cultivation.

Field work in the wetlands was conducted between 10 and 14 July 2006.

1.4 CONTRIBUTORS

The following people undertook the field work, whilst the preparation of relevant sections of this report was undertaken by those in bold.

Plants	**Paul Ssegawa**
Invertebrates	**Perpetra Akite** and Andrew Ochama
Amphibians and reptiles	**Stephen Kigoolo**
Birds	Eric Sande, Achilles Byaruhanga and **Derek Pomeroy**
Mammals	**Robert Kityo** and Rebecca Nalunkuma

Robert Kityo also co-ordinated the field work.

2.0 VEGETATION

2.1 FOREST ECOSYSTEMS

2.11 METHODS

The same study sites were used as in the previous survey, which was carried out in 1999 and reported in AESNP (2001). Appendix G1 gives the locations at which transects of 500 m were established.

Along each transect, plots of 0.02 ha. (20 x 10 m) were used. These were located alternately along a transect at a spacing of 50 m. Each transect had ten quadrats located on the northern and southern sides of the existing power line. The transects ran in a north-south direction. Using this approach, a total of 80 plots were sampled at the eight sites located in Mabira forest. Poles and flagging tape were used to mark the plots. Ground distance was measured using a 50-m tape without correcting for the slope. Each woody plant (tree, shrub or climber) of diameter $\leq$ 3 cm encountered in the plots was identified, enumerated and its diameter measured at 1.3 m (diameter at breast height, dbh) using a 5-m diameter tape. The following decisions on which plants to include in the plot were taken: plants branching below 1.3 m, had their individual stem diameters measured and averaged. For trees with large diameters and buttresses extending outside the plot boundaries, only those individuals with the mid point of the base inside the plot were included. Plants whose stems grew into the plot but with their bases outside were not included. This was particularly the case for climbers. Plots of 10 m x 10 m were used to census plants in the wayleave at each study site. Collections were made of plants that could not be identified in the field were brought to the Makerere University Herbarium for identification. Identification was done with the help of taxonomic literature such as Flora of Tropical East Africa (FTEA), and Katende *et al* (1995).

2.12 DATA ANALYSIS

Site similarity

A compilation of the species at site level was done indicating the individual abundances at different sites using the DAFOR scale. The number of times a species appeared in the quadrats gave a good indication of its abundance in a particular study area.

Cluster analysis (Kovach, 1999) was used to group sites according to their respective species assemblage compositions to determine the degree of similarity among them. This was based on the presence/absence data. Cluster analysis is a technique that sorts objects (such as sampling units) into groups or clusters based upon their overall resemblance to one another (Ludwig & Reynolds, 1988). Dendrograms were developed for the sites within Mabira forest and also for comparison of the three forests (i.e. Mabira, Kifu and Namyoya) based on the presence/absence of species.

Species richness estimations

Because observed species (Sobs) as a species richness estimator, underestimates the number of species in any given homogeneous area, statistical methods have been developed to reduce this bias (see Colwell & Coddington, 1994). For tropical tree populations, Chazdon (1998) considered that non-parametric extrapolation methods are the most efficient for predicting population richness from samples. The main non-parametric estimators are the first- and second-order Jackknife (Heltshe & Forrester, 1983). Jackknife 1 (Jack 1) and Jackknife 2 (Jack 2) species richness estimators (Colwell & Coddington, 1994) were used to estimate the species richness. Jackknife 1 and Jackknife 2 are incidence-based non-parametric estimators that were developed to estimate the number of species in a random sample from a single population (Colwell & Coddington, 1994; Guralnick & Van Cleve, 2005). Incidence-based estimators use the relative rarity and commonness of species in subsamples (plots) of the complete sample to estimate richness. Species area curves were also plotted to determine the adequacy of the sampling effort (Bhatt & Sanjit, 2005). Species richness estimations were calculated using the ESTIMATES 6b1a program (Colwell, 2001).

2.2 RESULTS

2.21 MABIRA FOREST RESERVE

A total of 274 species belonging to 242 genera and 76 families were recorded. For the trees, a total of 94 species with 1374 individuals were recorded with a combined basal area of 52.3 m^2 in eighty 0.02 ha. plots. A total of 34 families were represented by one species each, and the others were represented by 2 – 25 species each (Table P1 and Appendix P1). About 48% of the species were categorised as rare because they were recorded in one out of eight sites.

The family Fabaceae had the highest number of species (25) followed by Poaceae and Euphorbiaceae with 18 and 17 respectively. The most represented genus was *Ficus* with 9 species. The commonest species included *Dracaena fragrans, Acalypha neptunica, Argomuellera macrophylla* and *Broussonetia papyrifera*. These were recorded in all eight sites. The total number of trees recorded represented 34.1% of the total species recorded whereas herbs, climbers, grasses and shrubs represented 22.9%, 19.3%, 6.9% and 16.4% respectively. The highest observed number of species was recorded at Site 3 (Towers 167–170) and represented 38.2% of the total species recorded during the Mabira forest survey. The least number of observed species were recorded at Sites 1 (Tower 179) and 2 (Tower 174) representing 25.8% and 26.5% respectively (see Appendix P1).

The estimated total number of species by first-order Jackknife and second-order Jackknife species richness estimators for the eight sites sampled was 419 and 523 species respectively. The shapes of the species-area curves (Figure P1) indicate that continued sampling would yield more species. This is further reinforced by the relatively high estimated species richness, which indicates the presence of many rare species (Figure P1).

Forest stand density and basal area

The eight Mabira forest sites sampled had a stem density of 1374 in 1.6 ha (mean density 859 stems ha^{-1}). Stem density was greatest (1315 stems per ha) in Site 1 and least (630 stems per ha) in Site 7. Stem density was more or less similar in Sites 1 and 2. Basal area was highest in Site 3 representing 20% of basal area per ha for all the study sites while the least was recorded in Site 8 representing 3.9% (see Table P2).

Table P1: Number of species recorded from the Forests Reserves surveyed in the different families of plants

Family	Mabira	Kifu	Namyoya	Family	Mabira	Kifu	Namyoya
Acanthaceae	9	4	1	Marantaceae	1	1	0
Alangiaceae	1	0	0	Melastomataceae	1	0	0
Amaranthaceae	4	1	0	Meliaceae	8	0	0
Anacardiaceae	1	1	0	Menispermaceae	2	0	1
Annonaceae	2	0	0	Moraceae	15	4	4
Apocynaceae	8	2	1	Musaceae	1	0	0
Araceae	2	1	0	Myrsinaceae	2	1	0
Aristolochiaceae	2	0	0	Myrtaceae	3	0	2
Asclepiadaceae	3	1	0	Nyctaginaceae	1	0	0
Aspleniaceae	1	0	0	Ochanaceae	1	0	0
Asteraceae	9	5	6	Oleaceae	1	0	0
Auraucariaceae	0	1	0	Oleandraceae	1	0	0
Balanitaceae	1	0	0	Oxalidaceae	1	0	0
Bignoniaceae	3	1	0	Passifloraceae	3	0	0
Burseraceae	1	0	0	Phytolaccaceae	1	0	0
Capparidaceae	4	0	0	Piperaceae	1	1	0
Cecropiaceae	1	0	0	Plumbaginaceae	1	0	0
Celastraceae	1	1	0	Poaceae	18	8	5
Combretaceae	1	0	0	Pteridaceae	1	1	0
Commelinaceae	4	2	0	Rhamnaceae	3	3	0
Connaraceae	4	0	0	Rosaceae	1	1	0
Convolvulaceae	4	4	2	Rubiaceae	7	2	0
Cucurbitaceae	3	1	0	Rutaceae	9	4	0
Cyperaceae	2	2	2	Sapindaceae	13	3	0
Davalliaceae	2	0	0	Sapotaceae	6	0	0
Dichapetalaceae	1	0	0	Simaroubaceae	1	0	0
Dilleniaceae	1	0	0	Smilacaceae	1	1	0
Dioscoreaceae	1	0	0	Solanaceae	5	1	1
Dracaenaceae	2	0	0	Sterculiaceae	5	0	0
Ebenaceae	1	0	0	Thelypteridaceae	1	1	0
Euphorbiaceae	17	10	6	Thymelaeaceae	0	1	0
Fabaceae	25	10	5	Tiliaceae	3	0	0
Flacourtiaceae	2	0	0	Ulmaceae	9	2	0
Guttiferae	0	1	1	Umbelliferae	1	0	1
Hernandiaceae	1	0	0	Urticaceae	1	0	0
Labiatae	3	0	1	Verbenaceae	6	1	1
Leeaceae	1	1	0	Violaceae	1	0	0
Malpighiaceae	1	0	0	Vitaceae	2	0	0
Malvaceae	5	4	3	Zingiberaceae	4	1	0

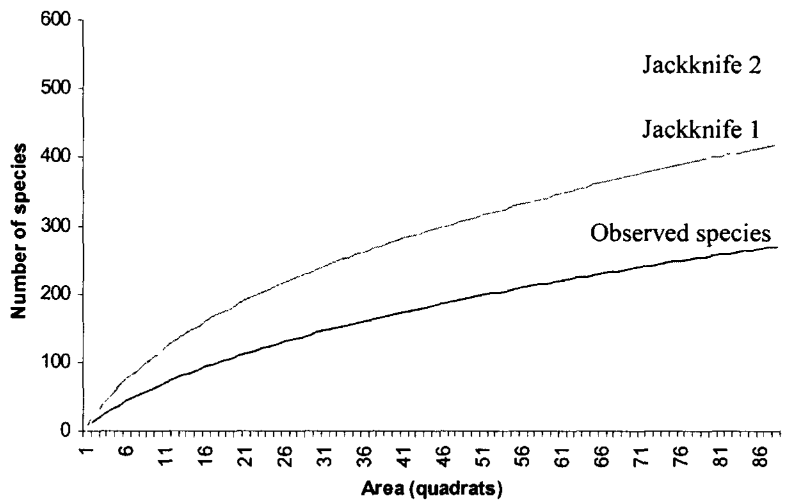

Figure P1: Species-area curves for the combined studied sites in Mabira forest reserve.

Table P2: Diameter class distributions and stem densities for the study sites in Mabira forest.

			Number of stems a each site							
dbh (cm)	**Species richness**	**Stem density**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
3 – 10	80	653	175	115	73	70	65	62	46	47
11 – 20	53	394	61	68	34	55	39	45	49	43
21 – 30	43	168	25	26	14	21	21	24	15	22
31 – 40	33	65	2	5	3	11	17	11	5	11
41 – 50	25	44	0	3	3	9	12	5	6	6
51 – 60	9	14	0	2	0	0	5	2	3	2
Over 60	19	36	0	2	9	4	4	7	2	8
Totals			263	221	136	170	163	156	126	139
Stem density per ha			1315	1105	680	850	815	780	630	695
Basal area (m^2 ha^{-1})			17.3	25.3	52.4	36.4	50.8	44.3	24.8	11.4

Forest stand structure

The population structure of the forest study site stands was reverse J-shaped with dbh frequency and basal area distribution in various size classes having a similar pattern in all the sites except for the largest (i.e.dbh over 60 cm) size class, which was greatest in Site 3 and absent in Site 1 and intermediate in Sites 4 and 5 (Figure P2). Tree species richness and density consistently decreased with increasing stem size classes except in the last class (i.e. Over 60 cm, see Table P2). The lowest size class captured 29% of the species richness, 47.5% of the forest stem density, and there was about a 9-fold decrease in species richness and a 47-fold decrease in stem density in the 51 – 60 cm dbh class.

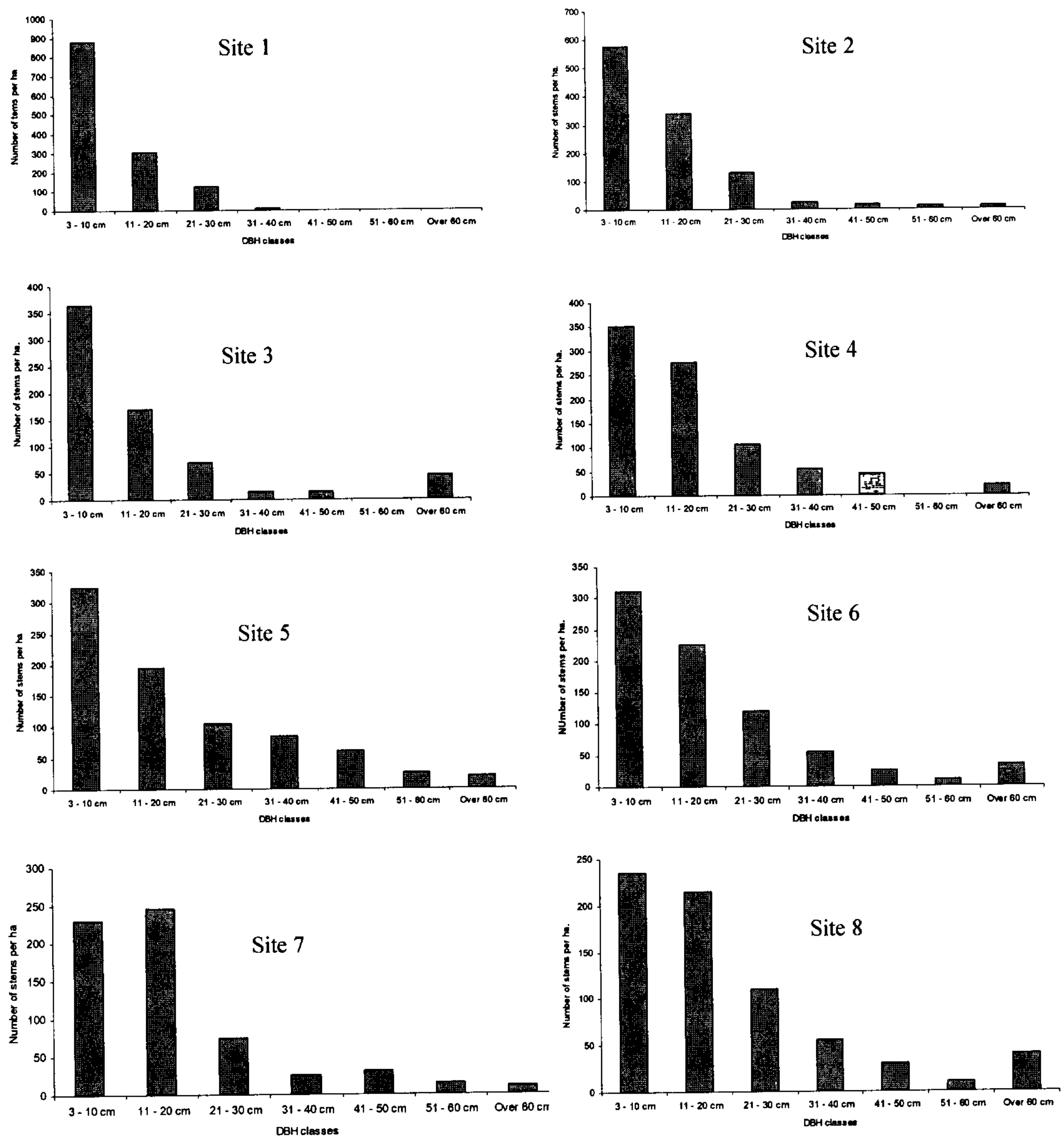

Figure P2: Mabira forest tree dbh distributions for study sites 1 – 8.

Site similarity

Species presence or absence was scored in the 8 sites and provided the basis for cluster analysis, which provides evidence of likeness of species assemblages among the 8 study sites (Figure P3).

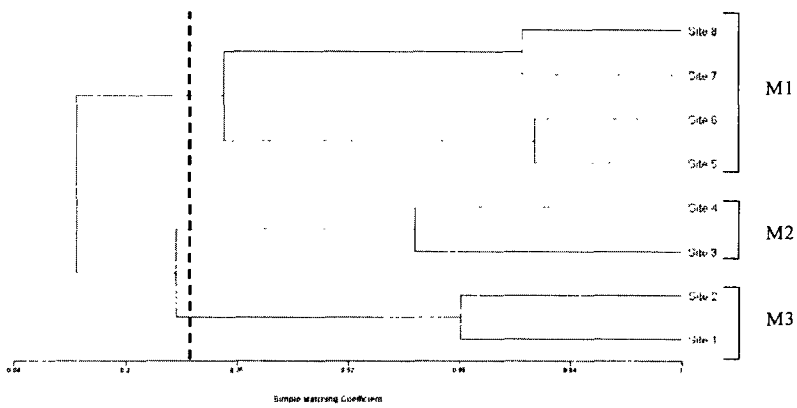

Figure P3: Cluster analysis of 8 sites of Mabira forest based upon the presence or absence of 275 plant species. The cut-off for the classification of sites is the Simple Matching Coefficient (SM) of 0.31, represented by the dotted line.

Sites 5 and 6 had the highest Simple Matching coefficient (SM) of 0.789 followed by Sites 7 and 8 clustering with 0.771 while Sites 1 and 2 clustered at 0.681. Other sites clustered at a lower value, and using a minimum SM of 0.31 for defining clusters (i.e. the dotted line in Figure P3), the analysis produced three distinct groups of sites M1, M2 and M3 (Figure P3).

The cluster analysis in Figure P3 shows that Site pairs 5-6 and 7-8 are similar though not closely, in terms of presence or absence of species. In cluster M2, Site pair 3 and 4 has a lower similarity compared to the site pair 1 and 2. However, in general terms, there is a recognizable east-west gradient in the sites clustering, probably due to the noticeable decrease in levels of disturbance, thus supporting particular species assemblages, as one moves from east to west.

Cluster analysis produced three distinct groups; Cluster M1 consisted of those sites on the western side of Mabira that have experienced less disturbances particularly to the northern side of the existing power transmission line, but which are also less species rich overall (see discussion of M2 cluster below). These sites represent larger diameter size classes with sparse undergrowth on the northern side. They represent part of the buffer zone of Mabira forest. However, the climbers, *Agelaea ugandensis, Acacia pentagona* and *Teramnus labialis* in the undergrowth and fewer large diameter trees dominate the southern plots. *Acalypha neptunica* is also a common understorey shrub. The characteristic tree species in these sites include *Albizia gummifera, Albizia glaberrima, Chrysophyllum albidum, Celtis mildbraedii, Alstonia boonei, Trilepisium madagascariensis* and *Pseudospondias microcarpa.* The southern side had fewer individuals of trees and of lower diameter classes with bigger canopy gaps and dense climber tangles. Commoner trees included *Antiaris toxicaria, Celtis mildbraedii* and *Funtumia elastica. Solanum mauritianum, Acalypha neptunica, Draceana fragrans* and the climber *Acacia pentagona* mainly constituted the shrub layer.

Cluster M2 sites are mainly influenced by the riverine conditions along transect 3. This cluster has the most species rich sites and there are characterised by intermediate diameter class trees. The characteristic tree species include *Celtis durandii, Aphania senegalensis, Teclea nobilis, Chrysophyllum albidum, Ficus polita* and *Blighia unijugata.* The herbs, *Pseuderanthemum ludovicianum* and *Pollia condesata* dominate the forest floor. Cluster M3 consists of sites 1 and 2, which are dominated by *Broussonetia papyrifera.* These are sites that were previously heavily encroached until 1992 when the encroachers were evicted. *Broussonetia papyrifera* prefers open areas that will enhance its regeneration. This, coupled with its invasiveness has enabled it to proliferate in these two sites. However, a few individuals of *Albizia grandibracteata, Celtis mildbraedii* and *Celtis wightii,* with the shrubs, *Acalypha neptunica* and *Argomuellera macrophylla* are struggling underneath the *Broussonetia papyrifera.* This cluster of sites registered the lowest species richness (Appendix P1).

Herbaceous plants that include *Lantana camara, Tithonia diversifolia, Lantana triphylla, Cynodon dactylon, Indigofera spicata* and *Sida rhombifolia* dominate the wayleave. It is regularly used to graze cattle and these species can withstand both the grazing and maintenance pressure.

2.22 KIFU FOREST RESERVE (SITE 9, TOWER 66)

A total of 90 species were recorded in Kifu forest reserve. These belonged to 37 families, of which tree species constituted 27.7% of the total (Appendix P1). Kifu forest reserve has, over the years, been replanted with plantation trees by the National Forestry Authority. The northern side of the existing powerline was replanted with *Araucaria cunninghamii, Araucaria haustenii and Araucaria agathis* between May 2001 and October 2002. Other species planted on the northern side include *Eucalyptus grandis, Eucalyptus odorata* and *Eucalyptus paniculata.* This survey revealed that there was an average stem density of 750 trees $ha^{-1}$of *Araucaria cunninghamii* with dbh ranges of 6.3 – 19.7 cm. The southern side was replanted with *Maesopsis eminii* with an average stem density of 400 stems ha^{-1}.

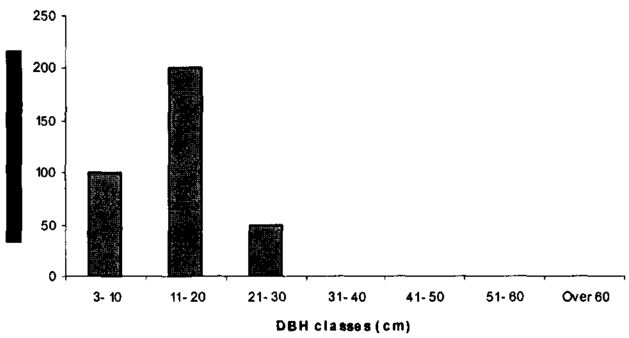

Figure P4: Diameter size classes for the trees found on the southern side of the existing powerline in Kifu forest reserve.

The understorey of the *Maesopsis eminii* plantation is characterised by thick undergrowth and scattered trees of mainly *Funtumia elastica, Alchornea cordifolia, Antiaris toxicaria* and *Celtis mildbraedii.* The relative diameter size distributions of the trees are given in Figure P4. Stem densities ranged from 50 stems ha^{-1} in the 21–30 diameter class to 200 stems ha^{-1} in the 11–20 diameter class. The understorey is characterised by species such as *Phaulopsis angolana, Glycine wightii, Marantochloa leucantha, Pteris dentata, Peddiea fischeri, Renealmia congolana, Acanthus pubescens, Vernonia amygdalina, Acalypha bipartita, Acalypha ornata, Scutia myrtina* and *Rubus apetalus* (Appendix P1).

2.23 NAMYOYA FOREST RESERVE (SITE 10, TOWER 51)

Namyoya forest reserve has, over recent years, been replanted with *Eucalyptus grandis* woodlots and plantations (Plates 12 & 13). However, some remnant indigenous species still exist in a tiny forest patch (about 1 ha.) on the northern side of the existing power line. The southern side also has some indigenous species but many have been cut down to pave way for cultivation or replanting with eucalypts. A total of 43 species belonging to 17 families were recorded in Namyoya forest reserve. The richest family was Asteraceae with 14% of the total number of species (Appendix P1). Some of the indigenous tree species recorded include *Funtumia elastica, Alchornea cordifolia, Sapium ellipticum* and *Erythrina abyssinica*. The eucalyptus stand on the northern side is in the sapling stage with dbh ranges of 3.8 – 10.6 cm, mean dbh of 6.5 cm and a mean density of 850 stems $ha.^{-1}$

2.24 SIMILARITIES AMONG MABIRA, KIFU AND NAMYOYA FOREST RESERVES

Based on the presence/absence data of species, the similarity among the three forests investigated, based on the species assemblages, was explored using cluster analysis (Figure P5).

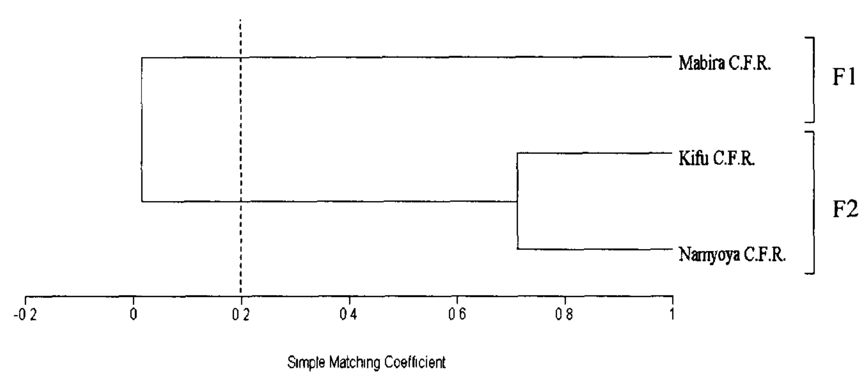

Figure P5: Cluster analysis of the three forest reserves based upon the presence or absence of 315 plant species using a Simple Matching coefficient (SM) cut-off of 0.2.

There was a closer similarity between Namyoya and Kifu forest reserves (0.713) than Mabira. This may be attributed to the relatively high number of species characteristic of disturbed areas that were recorded for Namyoya and Kifu forest reserves. However, it should be noted that the relatively low number of species observed for Kifu and Namyoya forest reserves could also influence the clustering process.

2.25 *GENERAL DISCUSSION AND COMPARATIVE OVERVIEW WITH PREVIOUS STUDY*

The total number of species (315) recorded for the three reserves compares well with those recorded in the previous survey. However, some of the species recorded previously have not been recorded in the present survey. This is more pronounced with Mabira forest. Species such as *Abrus canescens, Basella alba,* and *Strombosia schefleri* were not recorded in the present study. This may be explained by this spatial rarity since the previous survey recorded them only once on a particular transect. Likewise, there are species that were recorded this time that were not recorded in the previous survey. These include *Psilotricum scleranthum, Senecio syringifolius, Stictocardia beraviensis* and *Mukia maderaspatana*, which are mainly herbaceous plants. Their being herbaceous and spatially rare, may partly explain why they were not recorded in the previous survey. Some tree species, mainly *Celtis mildbraedii* and *Celtis wightii* were recorded in higher abundances than previously reported in sites 1 and 2, which are dominated by *Broussonetia papyrifera.* Langdale-Brown *et al.* (1964) reported that species of the genus *Celtis* in Mabira forest could represent a pre-climax forest and therefore sites 1 and 2 will, over the years, tend towards a pre-climax stage. There is a considerable variation in species compositions for Namyoya and Kifu forest reserves. This can be attributed to the conversion of the reserves into plantation forests requiring specific silvicultural practices that obviously influence the species compositions.

Given the logging history and disturbance due to encroachers on Mabira forest, the values of basal area recorded are not surprising. Tropical secondary forests, like Mabira, usually undergo rapid accumulation of biomass during the first 15 years or so and then slow down, often reaching values of basal area comparable to those of mature forest before maturity (Brown & Lugo, 1990).

Tree density, particularly for smaller trees, was the most pronounced difference in the vegetation structure of the three cluster groups in Figure P3. Whereas it was expected that sites 1 and 2 would have a higher stem density, given the prolific regeneration of *Broussonetia papyrifera*, clusters M1 and M2 in Figure P3 exhibited a comparable similarity in stem density. This result agrees with a well-known self-thinning process of aging secondary forests in which a declining tree density, mostly caused by mortality rates of smaller trees (< 10 cm dbh), is compensated by the growth of surviving trees (Oliveira Filho *et al.* 1997). Therefore as forest regeneration proceeds, the average tree size increases while tree density declines. However, one cannot rule out the role of harvesting of trees for timber, poles or fuelwood in influencing the richness and diversity of species as observed in some sites sampled in the forest. In general, tropical secondary forests restore species richness first and then diversity, species composition, and finally vegetation structure, particularly tree density, all within a time span between 50 and 150 years (Saldarriaga & Uhl, 1991).

The high basal area recorded on site 3 can be attributed to the presence of a relatively higher number of tree individuals with very high dbh, representing the biggest trees recorded, compared to Site 8. The biggest trees recorded on this site were mainly of the genera *Albizia* and *Alstonia* with dbh up to 170 cm.

2.26 *SPECIES OF CONSERVATION CONCERN AND ECONOMIC IMPORTANCE*

The Mahogany species namely, *Entandrophrama cylindricum, Entandrophragma angolense* and *Khaya anthotheca* are listed as globally threatened and categorized as Vulnerable (IUCN, 2000). These were recorded in Mabira forest in lower diameter classes but only three individuals were observed and they were beyond the planned wayleave extension. They provide first class timber.

Albizia spp are used as second class timber species (Katende *et al.* 2000). Other species commonly used for timber are *Antiaris toxicaria, Trilepisium madagascriensis* and *Holoptelea grandis.* Several species are used for medicinal and related purposes including *Citropsis articulata, Antiaris toxicaria, Albizia grandebracteata, Alstonia boonei, Bridelia micrantha* and *Croton megalocarpus* (Katende *et al.* 2000). *Dracaena fragrans* is used as an ornamental, hedge and boundary marking. Most of the woody species can be used as poles for local construction, tools, firewood and charcoal burning. Invasive alien plants such as *Broussonetia papyrifera* and *Lantana camara* are a serious threat to plant biodiversity through the formation of very dense populations that affect the population dynamics of the persisting species (Mack *et al.*, 2000). Land use changes such as the replacement of natural ecosystems by agricultural systems, such as Mabira forest encroachment until the early 1990s, alter many ecosystem functions and may promote biological invasions (Hobbs, 2000).

2.27 ALIEN INVASIVE SPECIES: BROUSSONETIA PAPYRIFERA, TITHONIA DIVERSIFOLIA AND LANTANA CAMARA

Sample sites 1 and 2 in Mabira forest were predominantly *Broussonetia papyrifera* whereas the wayleave was dominated by *Lantana camara* and *Tithonia diversifolia* in most areas sampled. The removal of encroachers from Mabira forest in 1992 created large areas of forest land with minimal or no tree cover. This provided suitable conditions for the growth and proliferation of *Broussonetia papyrifera*, a light demander. The continued periodic removal of vegetation in the wayleave has maintained the most prolific and resilient species that are able to withstand the periodic disturbances including *Lantana camara* and *Tithonia diversifolia.* Light is an important plant resource (Blankenship, 2002) that may interact with other plant resources to affect plant performance. Below certain thresholds, however, light limitation alone can prevent seedling survival regardless of other resources (Tilman, 1982). It is therefore probable that the vertical stratification of *Broussonetia papyrifera* may reduce the intensity or duration of light and thus prevent the establishment of other tree species seedlings. Low light has been shown to affect the distribution of other herbaceous species in understorey habitats (Sharma *et al.*, 2005) and this may have important management implications for biological invasions and maintenance of biological diversity.

2.3 WETLAND ECOSYSTEMS – LUBIGI SWAMP

2.31 INTRODUCTION

In Uganda, the rising human population together with increased agricultural production has led to substantial pressure on wetland resources (Mafabi & Taylor, 1993). It is the lowland valley and swamp forest wetlands that have currently come under the strongest pressure. The small valley swamps and seasonal wetlands are closely associated with human activities and it is in these that a heavy toll on resources has occurred (Mafabi & Taylor, 1993). Though these swamps are small in size, individually they are of great significance to the people and to wildlife conservation.

Wetlands are however difficult to classify because they share the characteristics of both permanently wet and generally dry environments. The difficulties are compounded further by the enormous variety of wetland types, and their highly dynamic character, which complicates defining their boundaries with precision (Maltby, 1991). Visser (1960) recognized two types of wetlands in Uganda, the lake edge/Nile shore swamps and the valley swamps. Whereas both may occur in the same region, the lake edge and the Nile shore swamps are more typical of central, northern and eastern Uganda. Carter (1956) also described two kinds of swamps in Uganda, namely the littoral swamps covering the lakes, and the Nile shores and the shallow valleys, which are characteristic of the country between Lake Albert, Victoria and Kyoga. However, Mafabi and Taylor (1993) classified the Uganda wetlands into three categories, namely: swamps, swamp forest and sites with impeded drainage.

Swamps tend to be dominated for large tracts by a single, vigorous species, which in most cases are sedges (Moss, 1980). *Phragmites, Typha* and *Cyperus papyrus* characterise many African swamps (Moss, 1980). Visser (1960) had earlier recognised that 60% of the permanent swamps of Uganda consist of *Cyperus papyrus* which agrees with the more recent view by Moss (1980). Carter (1956) also recognised four succession zones in the swamps of Uganda and observed the presence of members of family Cyperaceae in each zone, with one zone being dominated entirely by *Cyperus papyrus*.

The dominant plant in the Uganda wetlands is *Cyperus papyrus* whose stalks rise, sometimes as a dense forest, some four to five metres above the surface of the rhizomes embedded in a mat of decaying vegetation (Beadle & Lind, 1960). A typical valley wetland adjoining Lake Victoria is fringed with dense forest, an important constituent of which is the wild date palm *(Phoenix reclinata*). The forest does not extend across the lower reaches of the valley, although seedlings are often found there. This, according to Beadle & Lind (1960), may be due to the fluctuations of the water depth as well as to the practice of firing the swamp vegetation in the dry season (see below, and Section 6.4).

Cyperus papyrus is not always the dominant plant in the lower valley wetlands, it is replaced in different parts by the bulrush *(Typha capensis*), *Cladium mariscus* or by *Phragmites mauritianus* (Beadle & Lind, 1960). They further noted that each of these plants seemed to have its own requirements, and the nature of the plant cover could prove to be a valuable indicator of the quality of the mud below with respect to acidity, nutrients, degree of flooding and silting, etc. *Phragmites*, for instance, is common in regions of former volcanic activity where it occurs abundantly in the valleys and around lake edges. *Typha* is found in flooded silted areas and *Cladium mariscus* in less acidic muds.

After *Cyperus papyrus* the commonest wetland plant is *Miscanthus violaceus* (Beadle & Lind, 1960). It often grows around the dry landward edge of the lake-bay wetlands and also forms floating mats. Beadle and Lind (1960) reported that *Miscanthus* seems to favour rather acid conditions and is often found in small lakes surrounded by grasslands on sandy soils and it is sometimes associated with species of *Sphagnum* moss.

Grazing in wetlands especially in the dry season has been a common traditional practice which has survived many generations. This is because these wetlands provide an important source of fresh grazing material in the dry season. Since wetlands have been used to sustain livestock within their proximities in the dry season, they have been subjected to periodic burning in order to encourage the growth of fresh vegetation. Burning has also been applied to these wetlands so as to open up the wetland to access the open water for fishing or to hunt the Sitatunga whose habitat is wetland. Other activities carried out in the wetlands include harvesting of *Cyperus papyrus*, burning, cultivation and grazing (Mafabi & Taylor, 1993).

2.32 METHODS

Transects of up to 200 m were used, following habitat types that characterized each site as much as possible (Figure P6). Line transects and circular plots were used to collect the species richness data. Sampling points were located at 10 m intervals. Using the sampling point, two circular plots of 1 m radius were located equidistant from the sampling point and from each other at a distance of 2 m. This is a modification of the point frequency method (Okland, 1990) and the method used by Wettstein & Schmid (1999). All species found in these plots were recorded and those that could not be identified in the field were collected for identification at the Makerere University herbarium.

To place sites into meaningful groups, cluster analysis was used to produce a dendrogram containing all the six sites using the agglomerative clustering technique provided in the Multivariate Statistical Package (MVSP) of Kovach (1999). A minimum Simple Matching Coefficient (SM) of 0.2 (dotted line in Figure P6) was used for defining clusters.

2.33 RESULTS

Floristics

There were 124 species, belonging to 90 genera and 36 plant families. The most dominant plant family was Fabaceae with 20 species followed by Cyperaceae, Poaceae and Asteraceae with 17, 12 and 12 species respectively (Appendix P2). The most abundant genus was *Cyperus* with six species followed by *Scleria* with five. The tree species constituted 13% (16 species) of the total species while the herbs represented 63% (78 species). The commonest herbaceous species recorded were *Pycreus nitidus, Panicum maximum* and *Cyperus denudatus* whilst the commonest tree species was *Phoenix reclinata,* which was recorded at five of the six sites surveyed. Among the rare but typical wetland species were *Enhydra fluctuans, Eulophia horsfallii, Geniosporum rotundifolium, Lygodium microphyllum, Lysimachia ruhmeriana, Mikania cordata, Nephrolepis biserrata, Polygonum strigosum, Siegesbeckia abyssinica, Stephania abyssinica, Gomphocarpus fruticosus, Ficus verruculosa* and *Tabernamontana odoratissima.* Each of these was found in only one of the six sites.

2.34 SIMILARITY AMONG SITES

Cluster analysis (Kovach, 1999; Okland, 1990) was used to determine the degree of similarity among sites based on the presence or absence of species. Two distinct community types were easily identifiable as shown in Figure P6. Cluster Sw 1 consists of sites with an extensive seasonally flooded area, subjected to grazing. The characteristic species of these sites include open grassland species such as *Loudetia kagerensis, Scleria melanomphala, Sporobolus pyramidalis, Eragrostis racemosa,* and *Indigofera* sp. Other species that represent swamp forest and thickets include *Maesa lanceolata, Rhus* sp., *Alchornea cordifolia, Leersia hexandra, Macaranga sp.,* and *Phoenix reclinata.* Areas with semi-permanent and permanent water are characterised by *Loudetia phragmatoides, Cyperus papyrus, Miscanthus violaceus* and *Kotschya africana* as the dominant species.

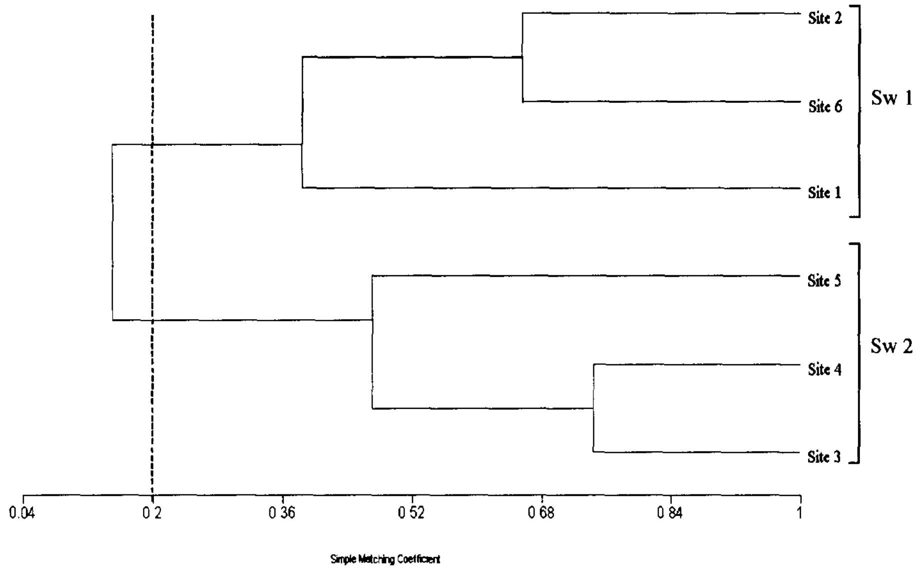

Figure P6: Cluster analysis of the six sample sites in Lubigi swamp based upon the presence or absence of 124 plant species. Site 1 (Kazinga 1), Site 2 (Kazinga 2), Site 3 (Lubanyi 1), Site 4 (Lubanyi 2), Site 5 (Nakawudde) and Site 6 (Nganda-Nansana).

Cluster Sw 2 is characterised by thick *Cyperus papyrus* stand that are less species rich compared to sites in cluster Sw 1. The swamp fringes are characterised by *Acanthus pubescens*, *Phoenix reclinata, Aframomum angustifolium, Urena lobata, Teramnus* sp., *Leersia hexandra, Bridelia micrantha, Mimosa pigra, Alchornea cordifolia* and *Bothriocline bagshwei*. These then give way to the permanent deeper water tolerant species such as *Hyptis lanceolata, Ficus verrruculosa, Cyperus papyrus, Typha domengensis, Eulophia* sp. and *Cyclosorus striatus*.

3.0 INVERTEBRATES: BUTTERFLIES AND DRAGONFLIES

3.1 INTRODUCTION

Approximately 200 species of butterflies and 60 species of dragonflies are known to occur in Mabira forest (Davenport *et al*, 1996; JJ Kisakye, *pers comm.*). The butterfly and dragonfly fauna of Kifu forest, Namyoya forest and Lubigi swamp have not been previously documented.

Little research has been conducted on the impact of transmission lines on terrestrial insects and other arthropods. The impact of clear-cutting the forest along transmission lines is limited since most invertebrate species adapt quickly and migrate to either the clear-cut, mature forest/edge, or interior forest areas.

This study was mainly carried out to document the butterfly and dragonfly species from the different sites covered by this project. The study was intended to

1. document species along the proposed transmission line
2. provide a description of the anticipated environmental effects
3. identify potential impacts on the invertebrate diversity by construction of the transmission line.

3.2 METHODS

The butterfly and dragonfly fauna of Mabira was sampled through the systematic use of sweep nets and baited traps (in the case of butterflies) for a total of 8 man-days. Fermenting banana was used as bait for the traps. For the other sites, only intensive use of sweep nets was employed. Sweep netting was done both along an established 0.5km transect line as well as random sweeping within the entire areas around each sampling site. This approach also known as Rapid Biodiversity Assessment, involved combing through the entire area, and catching every species encountered. A number of standard field guides were used, as well as the extensive collections at the Zoology Museum, Makerere University, for identifying any butterfly specimens that were collected. Preliminary identifications of common and familiar butterfly species were done in the field. Mr. Joseph Kisakye (Department of Zoology) helped with the identification of the dragonfly specimens, using a number of keys.

The sampling locations that were used are detailed in Appendices G1 and G2.

3.3 RESULTS: DRAGONFLIES

20 species (Appendix A1) were recorded, including three belonging to the suborder Zygoptera and 17 species belonging to Anisoptera. Together, these account for only 8.6% of Uganda's species. For the proposes of this report, we refer to all members of the Order Odonata as 'dragonflies'.

A total of 17 species were recorded for Mabira forest, accounting for 29% of the known species for this forest. A few taxonomically difficult species were only identified to generic level, meaning that the total diversity of species recorded is a little higher than indicated here.

Two particular species are worth highlighting: *Orthetrum macrostigma* was only previously known to occur in Bwindi forest (JJ Kisakye, pers.comm.) and the Uganda endemic species, *Chlorocypha trifaria*; both recorded in Mabira forest in site 3. This site also registered the highest species richness, with 8 out of the 17 recorded. In four of the sites dragonflies were recorded.

Namyoya and Kifu forests had very low dragonfly species richness with only three and four species respectively. This may be attributed to the status of the forests that are quite degraded and with few wetlands compared to Mabira.

From Lubigi swamp on the other hand, a total of 9 species were recorded, with sites 1 and 3 registering 5 species each. Site 6 had the highest total number of species with 6, whilst site 4 registered only 2 species.

Species abundance

Based on relative commonness of individuals seen, Table A1 presents a scheme that has been used to categorize the species abundance, which varied both between and within sites.

Table A1.Dragonfly species abundance categorization

Number	Number of individuals observed	Range category
1	1	Rare
2	2-3	Relatively rare
3	4-5	Relatively abundant
4	6-9	Abundant
5	>10	Very abundant

For Mabira forest, 6 out of the 17 species fall into category 1, accounting for 35.3% of total species recorded. Eight species belonged to category 2 (47.1%) and only three species belonged to category 3. None of the species could be said to be very common in Mabira forest, although this picture may not hold for other areas.

3.4 RESULTS: BUTTERFLIES

The total number of spcies recorded were 165 (Mabira), 65 (Kifu FR), 48 (Namyoya FR) and 56 (Lubigi) respectively (Appendix A2). Table A2 summarises the numbers of species recorded in the different families for the dfferent areas. For Mabira this number is less than that recorded during the 1990s biodiversity surveys that registered 199 species in total. However, an unpublished report puts the number higher at 218 species for this forest.

Table A2. Summary of species recorded by this study

Family	**Mabira**				
	This study	Previous records			
Nymphalidae	102	128	41	32	28
Pieridae	23	24	5	2	7
Lycaenidae	17	25	11	4	8
Papilionidae	10	9	4	2	2
Hesperiidae	15	13	6	8	11
Total	**167**	**199**	**67**	**48**	**56**

For Mabira Forest Reserve, there was a slight increase in number of species recorded from three families: Pieridae, Lycaenidae and Papilionidae as compared to those reported in Davenport *et. al.*. (1996). The other families however registered declines in numbers of species, with Nymphalidae having 26 species less.

3.5 DISCUSSION

Five restricted range species (Davenport *et al*, 1996) were recorded during this study, namely *Neptis trigonophora* (179) F and *Acraea rogersi* (179) F that were only recorded in Mabira. The others were recorded in 2 or 3 forests: *Acraea aganice* (174) f, *Celaenorrihinus intermixtus* (169) F and *Celaenorrhinus bettoni* (169) f.

Appendix A3 compares the species of butterflies previously rcorded with my surveys. From the appendix, it can be seen that 34 species of butterflies that were previously recorded from Mabira forest have not been recorded by this study. On the other hand, 50 species not previously known for Mabira have been added to the existing species list. I attribute the additional number of species to the ability of more open and widespread species to colonize areas of disturbances within the forest

Table A3. Summary of butterfly species with their respective ecological types according to Davenport et al (1996)

Ecotype (see text)	Sites			
	Mabira	Kifu	Namyoya	Lubigi
F	92	29	2	5
f	26	18	15	11
O	6	2	4	8
W	27	14	22	18
S	0	0	0	5
M	16	4	5	9

Every species recorded by this study was assigned to one of the ecological categories: F-forest dependent species, f- forest edge/woodland species, S- swamp/wetland species, O- open habitat species, W- widespread, M- migratory species (Table A3). The proportion of the F and f species in a sample is used as an indication of the ecological state of the habitat. For Mabira forest, 71.6% of total species fell in these categories, with 55.8% F- species. Only 29.7% of the butterfly fauna belonged to the O, S and W ecotypes. This picture however shifted dramatically in the much more degraded Namyoya forest where only 4.2% of the butterfly fauna are forest dependent. Over 50% of the species in Namyoya are open habitat dwellers and/or widespread.

Table A4. Butterfly species abundance data.

Number	Number of individuals	Rank category
1	1-3	Rare
2	4-10	Relatively rare
3	10-25	Relatively abundant
4	25- 39	Abundant
5	≥40	Very abundant

For all four sites, only 5 species can be described as rare based on the ranking in Table A4. These were *Papilio nobilis, Mimeresia sp, Charaxes zelica, Neptis ochracea* and *Iolaus pasasilanus*. Most of the other species fell in category 3 or 4 and only a few species were recorded for category 5. In Mabira, most of the species were relatively rare especially within the deeper and denser forest areas at sites 5 - 8. For Kifu and Namyoya forests, the numbers were much lower.

4.0 AMPHIBIANS AND REPTILES

4.1 INTRODUCTION

Both Amphibians and Reptiles are classes of vertebrates, the forest comprising of frogs, toads, caecilians, newts and salamanders. In their evolution amphibians are said to have evolved from fish 350 million years ago (Young, 1981). Reptiles Include turtles and tortoises, lizards, chameleons, skinks including limb-less skinks, geckoes, crocodiles, monitors and all types of serpents commonly known as snakes (Foster, 1994; Goin *et al*, 1962). Reptiles are said to have evolved from amphibians some 270 million years ago.

Ecologically, amphibians are important in many ways; they are mostly predators, acting as primary and secondary carnivores. Their prey consists mostly of insects, some of which are pests of crops or disease vectors. Amphibians are therefore important ecological components of both wetlands and dryland. Among vertebrates they are distinctive in many ways. A thin, moist, highly permeable skin; jellied, unshelled eggs; possession of aquatic and terrestrial life histories; restricted home range; and limited dispersal abilities of many species make amphibian effective biomonitors. For biological assessments, they are especially promising because of their capability of linking wetlands with surrounding landscapes (upland habitats) (U.S. EPA. 2002). They are also interlinked in food chains, often acting as food for other vertebrates, such as pigs, birds, snakes and sometimes man. Because of their ectothermic physiology, the life history and ecology of amphibians often differ markedly from that of birds or mammals (McCollough *et al*, 1992).

Reptiles are also ecologically important. They feed on a number of animals and this predation involves reptiles in ecosystem food webs.

The area where the proposed Bujagali Hydropower line is to pass or to be erected is also inhabitated by the herpetofauna. This study was designed to find out the status of the amphibian and reptilian species and whether the proposed activities would have significant effects on their habitats and the species themselves.

4.2 OBJECTIVES

The overall objective was to study amphibians and reptiles in the areas where the proposed power line for Bujagali Hydropower project will pass. It also involved evaluating the potential impacts. Specifically, the work involved:

- Generating species lists for amphibians and reptiles in and around the proposed area where the power line will pass.
- Identifying the species of conservation concern.
- Determining the impact that the construction of the power line would have on them.

Impacts on the habitats where amphibians and reptiles are found are reflected in changes in numbers and species diversity in a short time. These are some of the factors that have led to amphibians being recognized today as good indicators of habitat change. The geographical ranges of amphibians are smaller than those of other vertebrates (Bibby *et al*, 1992), which suggest that amphibians are more likely to be affected by habitat changes than other vertebrates.

Most reptiles on the other hand are highly mobile and are diversified in habitats. They can be encountered in aquatic habitats, shorelines, rock outcrops, trees and bushes and on any slopes of the terrain. Those more specialized in habitat use such as crocodiles, monitor lizards and water snakes are good indicators for monitoring changes in a habitat due to human activity.

Study Area

The surveys for the amphibians and reptiles were conducted in the locations detailed in Appendices G1 & G2. Additional locations that were particularly important for amphibians were also noted even when they lay outside the eight sample sites in Mabira, but were along the general transmission line area.

4.3 METHODS

Several methods are available for surveying amphibians (reviewed in Heyer *et al*, 1994; Fellers and Freel, 1995; Halliday, 1996; Olson, *et al*, 1997). These include visual encounters, egg surveys, and call surveys, terrestrial cover boards, dip nets, seines, aquatic funnel traps, and terrestrial pitfall traps. The method is dictated by the habitat type. Because of the time limitations, three sampling methods were employed during study, namely opportunistic observations, visual encounter surveys and acoustic Surveys.

Opportunistic Observations/Searches

Opportunistic searches were used to maximize the number of species encountered in the study area. This method involved recording any amphibian or reptilian species encountered anywhere and at any time in the study area, or brought in or reported by local people.

Visual Encounter Surveys

The visual encounter survey (VES) method is commonly used to determine the species richness of an area, to compile a species list and to estimate relative abundances of species within an assemblage. It was used to determine the species richness of the study areas. This involved walking through the sampling areas or habitat for a prescribed time period systematically searching for amphibians.

The VES was done along the transects established by the research team for the purpose of studying other taxa, and also along the streams and ponds, sampling all amphibians and reptiles that were visible. This focused on surface-dwelling amphibians and reptiles.

Local Consultations and Literature Review

Local people can be a valuable source of information. Some are constantly in touch with their environment, encountering amphibians and reptiles of different kinds as they carry out their activities. Talking to the local people yielded one species record of family Testudinidae. The record was confirmed by reviewing literature of studies carried by other researchers.

Data Analysis

The reptiles and amphibians were identified using standard reference books available namely; Schiotz (1972), Schiotz (1972b), De Witte (1937), Drewes (1984), Drewes and Vindum (1994), Loveridge, (1957), Welch (1982), Stewart (1967), and Wager (1965). Kigoolo (1994) and Behangana (1995) were also useful for comparison of species' distribution in Uganda.

Unlike other taxa such as birds or mammals, no standard species list exists, although the Herps Working Group of Nature Uganda is developing one. However, species categorization using the IUCN Red Data Book categories for some species is available and has been used.

4.4 RESULTS

A total of 19 amphibian species and 6 reptilian species were recorded present during the survey as shown in Tables H1 – H4.

4.41 AMPHIBANS

Eight (8) amphibian species were recorded in Mabira Forest reserve; while sixteen (16) were recorded in Lubiji Swamp. Most of the species recorded in Lubiji swamp are wetland specialists. Only two species (*Arthroleptis adolfifriederici* and *Leptopelis christy*) recorded present in Mabira Forest reserve are purely forest specialists.

The commonest species were members of family Hyperoliidae (genera *Afrixalus* and *Hyperolius*) followed by family Ranidae (genera *Ptychadena*, *Phrynobatrachus*, *Afrana* and *Hoplobatrachus*). Family Pipidae (genus *Xenopus*) was also common especially in Lubiji (Kazinga 1, sampling site). More specifically, members of family Hyperoliidae found to be most common include *Afrixalus quadrivitattus*, *Hyperolius cinnamomeoventris*, *Hyperolius viridiflavus bayoni* and *Hyperolius viridiflavus viridiflavus*. Those of family Ranidae included *Ptychadena mascareniensis*, *Phrynobatrachus natalensis*, *Afrana angolensis* and *Hoplobatrachus occipitalis* in that order.

The more individuals of a given species you encounter are indicative of the abundance of that particular species. *Afrixalus quadrivitattus*, *Hyperolius cinnamomeoventris*, *Hyperolius viridiflavus bayoni* and *Hyperolius viridiflavus viridiflavus* are therefore the most abundant amphibian species. These are followed by *Ptychadena mascareniensis*, *Phrynobatrachus natalensis*, *Afrana angolensis* and *Hoplobatrachus occipitalis*.

The said common species of family Hyperoliidae are generally associated with permanent water sources and tend to select habitats with water all year round. These were mainly recorded in Lubiji Swamp sites. Several of these species, however, have the ability to resist temporary and regular drying up of their habitats (Dudley, 1978). Members of the genus *Hyperolius*, commonly known as Reed frogs are most active from dusk to dawn when they are highly active but they are hardly noticed during the day time. They are commonly found perched on swamp wetland vegetation such as water reeds and papyrus.

Tables H1 & H2 present the lists of amphibians recorded in Mabira CFR and Lubigi wetland sites.

Members of genera *Xenopus*, *Afrana* and *Hoplobatrachus* are also associated with permanent water sources. They are commonly found near water, more so for the bullfrog which only gets out of water to feed. *Afrana angolensis* is a riverine species found mainly along rivers and this was encountered along rivers in Mabira Forest Reserve. *Xenopus* is more aquatic than the rest and is found in water most of the time. *Xenopus* and the bull frog were mainly recorded in Lubiji swamp, on swamp edges and along transects in the swamps.

One member of family Arthroleptidae, *Artholeptis adolfifriederici* was recorded for the first time in Mabira Forest Reserve. No threatened species were recorded.

Table H1: Amphibian encountered in Mabira Forest Reserve

Family	Species	Common name	Total number of Individuals
Hyperoliidae	*Leptopelis christy*		10
Pipidae	*Xenopus laevis*	African Clawed Frog, Common Platanna	2
Ranidae	*Phrynobatrachus acridoides*	Eastern puddle frog	1
	Phrynobatrachus natalensis	Natal Dwarf Puddle Frog	9
	Ptychadena anchietae	Anchieta's ridged frog, Plain Grass Frog	1
	Ptychadena mascareniensis	Mascarene ridged Frog	15
	Afrana angolensis	Angola river frog	11
Arthroleptidae	*Arthroleptis adolfifriederici*	?	1
Totals	**8 species**		

Table 2: Amphibian encountered in Lubiji Swamp

Family	Species	Common name	Total number of Individuals
Bufonidae	*Bufo reguralis*	African Common Toad	4
	Bufo maculatus		7
	Afrixalus quadrivitattus	Four-lined Leaf-folding frog	30
	Hyperolius kivuensis	Kivu Reed Frog	10
	Hyperolius cinnamomeoventris	Cinnamon-bellied reed frog	26
	Hyperolius viridiflavus bayoni		29
	Hyperolius vidiflavus viridiflavus		32
	Kassina senegalensis	Senegal Kassina	12
	Leptopelis christy		1
Pipidae	*Xenopus laevis*	African Clawed Frog Common Platanna	10
	Phrynobatrachus natalensis	Natal Dwarf Puddle Frog	4
	Phrynobatrachus graueri		3
	Ptychadena anchietae	Anchieta's ridged frog, Plain Grass Frog	2
	Ptychadena mascareniensis	Mascarene ridged Frog	8
	Ptychadena oxyrhynchus	Sharp-nosed ridged Frog	1
	Hoplobatrachus occipitalis	Crowned bullfrog	11
Totals	**16 species**		

4.42 REPTILES

Five reptile species were recorded in Mabira and Kifu Forest Reserve and five in Lubiji swamp. Of special interest are the Nile Monitor (recorded in Kifu Forest) and the African Rock Python recorded in Kifu Forest and Lubiji swamp (Site 1). The two species are of importance to the people in the area.

Reptiles, like amphibians are cold-blooded vertebrates. They utilize the sun's energy to raise their body temperatures in order to be more active. Therefore, the best sampling time for reptiles are the early hours of the day when they come out of hiding to bask. The commonest reptilian species was Jackson's Lizard, *Lasutus jacksonii* with 16 individuals encountered followed by the Blue-headed Agama *Agama atricolis* for which 5 individuals were encountered. Both these species were encountered within Mabira forest reserve and on culverts along access road in Mabira forest.

One species of family Testudinidae, the soft-shelled turtle, was reported by the local community at Ganda sampling site (Site 6) in Lubiji swamp.

The species recorded in the different study areas are listed in Table H3 for Mabira and Kifu CFRs & Table H4 for Lubigi swamp.

Table H3: Reptilian fauna recorded from Mabira & Kifu Forests

Order Squamata	**Species**	**Common Name**	**Total number of individuals**
Mabira Forest Reserve			
Family Lacertidae	*Lasutus jacksoni*	Jackson's Lizard	14
Family Agamidae	*Agama atricolis*	Blue-headed Agama	4
Suborder Serpentes			
Family Colubridae	*Rhamnophis aethiopissa*	Large-eyed Tree Snake	1
Kifu Forest Reserve			
Order Squamata			
Family Varanidae	*Varanus niloticus*	The Nile Monitor	1
Suborder Serpentes			
Family Pythonidae	*Python sebae*	Rock Python	1
Total	**5 Species**		

Table H4: Reptilian fauna recorded from Lubiji Swamp

Order Squamata	**Species**	**Common Name**	**Total number of individuals**
Family Lacertidae	*Lasutus jacksoni*	Jackson's Lizard	2
Family Agamidae	*Agama atricolis*	Blue-headed Agama	1
Suborder Serpentes			
Family Pythonidae	*Python sebae*	Rock Python	1
	Naja melanoleuca	Water Cobra	1
Order: Testudinidae			
Family Trionychidae	*Trionyx triunguis*	Soft-shelled Turtle	0
Total	**5 Species**		

4.43 SPECIES OF CONSERVATION CONCERN

Certain species in wetlands merit special attention due to their scarcity, restricted ranges or unique habitat requirements. In Uganda, among the amphibians, only frogs and toads have been recorded. However, like in many other developing countries of the world, amphibians of Uganda are less known than reptiles, birds and mammals. The conservation status of amphibians in Uganda is generally unknown because of data deficiency.

As for reptiles, no species of conservation concern were encountered or recorded in the areas to be traversed by the proposed where we conducted our surveys. .

4.5 DISCUSSION

In Uganda, among the amphibians, only frogs and toads have been recorded. However, as in many other developing countries, amphibians are less known than reptiles, birds and mammals. The conservation status of amphibians in Uganda is generally unknown because of data deficiency. No reptiles of conservation concern under the IUCN red list categories was encountered.

The amphibian and reptile species encountered during the limited surveys for this report, are widely distributed in Uganda. The majority, especially those in the wetland are quite abundant. The population to be affected by the construction of the power line is therefore small and will not affect the overall survival of the species. No species of conservation concern were recorded in the areas where the power line will pass.

5 BIRDS

5.1 FOREST BIRDS: INTRODUCTION

The birds of Mabira Forest are well-known, from the work of Carswell (1986), Davenport *et al* (1996), Rossouw and Sacchi (1998) and Naidoo (2003).

5.2 METHODS

Most data were collected along transect lines, as described in section 1.2 and Appendix G1. Birds were recorded opportunistically at any time, but most data derive from two standard methods. The first, *Timed Species Counts (TSCs)*, are described in the literature (Freeman *et al*, 2003) as well as in the previous report (AESNP, 2001) and our 2006 Bujagali report (Pomeroy, *et al* 2006). Essentially, all birds seen or heard (and the latter predominate in forests) are recorded in the order in which they are detected, and scored out of six (for the first ten minutes), with the score decreasing step by step to 1 for the final ten minutes of a one-hour count. In this study, time was limited, counts were relatively few, and so the results are simply given as averages. In Mabira, two counts were done on each of the transect in 2001, whilst in 2006 only one TSC was done at each transect line. *Mist nets* catch birds because they are so fine that, when set against a dark background, as in a forest, they are almost invisible. They are set in lines along the transects, and checked periodically. Birds caught in the nets are identified and released. Since the nets are set vertically, reaching a height of about 2 metres, they predominantly catch the low-flying birds of the forest understorey – which is where many species mainly live. Altogether, the trapping effect at each transect totalled 1440 metre-net-hours.

As with the Bujagali studies, we categorised birds in various ways, as indicated in Table B1. Of particular importance are the forest specialists, FF and to some extent the generalists, F; the former cannot survive without forest. The 'f' species are those that only occasionally visit forest, and typically only forest edge. Collectively we refer to these three categories as 'tree species'.

Table B1. Bird descriptors. No globally-threatened species were observed. The species' preferred habitats and migratory status are also indicated in Table B4 and Appendix B1.

Threat categories	G-EN	globally endangered
	G-VU	globally vulnerable
	R-VU	regionally vulnerable
	R-NT	regionally near threatened
	R-RR	species of regional responsibility
Habitat	E	papyrus endemic
	e	Papyrus near-endemic
	W	waterbird
	w	bird often found ear water
	FF	forest specialist
	F	forest generalist
	f	Forest visitors
	G	species characteristic of grassland
Migrants	P	palearctic migrants
	A	afrotropical migrants, migrating within Africa

Global threat categories (G-) are from IUCN's web site and regional categories (R-)are from Bennun and Njoroge (1969).

5.3 RESULTS AND DISCUSSION

The data from both 2001 and 2006 for all three forests are summarised in Tables B2 - B4, and a more detailed set of the data from 2006 is given in Appendix B1 and B2. The forest is within easy reach of Kampala, and is popular with bird watchers. Birds also featured in the 2001 EIA Report which included information on the smaller forests too. As mentioned in the Introduction (section 1.1.1), the surveys in 2006 were intended, so far as possible, to replicate those of 2001, but some differences were inevitable. To start with, the 2006 studies were in July, whilst those of 2001 were in February, normally a drier month with fewer leaves on the trees and hence better visibility of birds in the trees. A few Palearctic migrants were recorded in 2001, but in July 2006 they will have been breeding in Europe or Asia. During 2001, the main method was Timed Species Counts, complemented by Point Counts. TSCs were also the main method in 2006 but in this case were supplemented by mist-netting, which is an excellent method for hard-to-see understorey birds. Finally, the field work in 2001 was by Isaiah Owiunji and in 2006 by Eric Sande. Both, however, are experienced observers of forest birds.

Table B2. Summary of numbers of 'tree birds' and other species recorded in Mabira Forest in 2001 and 2006. There were 16 counts in 2001, and 8 in 2006.

Category	**2001**	**2006**	**Davenport *et al* (1996)**
FF	57	31	75
F	48	31	63
F	38	12	56
Others	37	7	95
Total	180	81	287

Table B3. Summary of 'tree birds' and other species recorded in Kifu Forest in 2001 and 2006. In 2001, two TSC counts were made, with three in 2006.

Category	**2001**	**2006**
FF	10	7
F	22	17
F	3	11
Others	3	9
Total	38	41

Table B4. Summary of 'tree birds' and other species recorded in Namyoya Forest in 2001 and 2006. Two counts were made in 2001, but only one in 2006.

Category	**2001**	**2006**
FF	10	1
F	22	7
F	3	14
Others	3	12
Total	38	34

There were substantially fewer forest birds recorded in 2006 than 2001. This is partly explicable in terms of the fewer counts in 2006, as well as the different months of field work, and some differences in methods resulting from the seasonal change. However, a drop in forest specialist species from 57 to31, and from 105 to 62 for the combined forest species (FF, F), does suggest that other factors may be involved. We have data from another forest in the area, Ziika, which is much smaller – in fact it is only 14 hectares. Number of species in the two categories combined also dropped, although less steeply, from 23 in 2001 to 17 in 2006 (NBDB, unpublished data). These slightly alarming results should cause us to investigate this further. In neither Mabira nor Ziika does there seem to have been any major change in the habitat during this period. In Mabira in 2001, 72% of the species from the forest as a whole by Davenport *et al* (1996) were noted, compared to only 45% in 2006.

But despite the drop in species numbers, we recorded almost as many species of conservation concern in 2006 as in 2001. For the earlier year, Table 5 listed 32 such species that are known from Mabira, of which only 8 were recorded then. Seven species of conservation concern were recorded in 2006, including two that are globally-listed (Table B5).

Table B5. Globally and regionally threatened species recorded in Mabira Forest in 2006.

Atlas No.	Species	Forest category	Red Data listing
86	BROWN SNAKE-EAGLE *Circaetus cinereus*		R-NT
124	CROWNED EAGLE *Stephanoaetus coronatus*	FF	R-VU
156	NAHAN'S FRANCOLIN *Francolinus nahani*	FF	G-EN, R-VU
290	GREY PARROT *Psittacus erithacus*	FF	R-NT
498	WHITE-HEADED SAW-WING Psalidoprocne *albiceps*	f	R-RR
551	TORO OLIVE GREENBUL *Phyllastrephus hypochloris*	FF	R-VU/RR
559	GREEN-TAILED BRISTLEBILL *Bleda eximia*	FF	G-VU

The two TSCs in the present wayleave area of Mabira forest yielded 39 species (Appendix B2), including a few forest birds flying over.

Neither of the two smaller Forest Reserves (Kifu and Namyoya) contain any significant areas of natural forest (see Sections 2.122 & 2.123); hence the relatively small numbers of forest birds (see Table B2 and B3, and Appendix B2). Although there were again differences in the numbers of counts at each site, the total numbers of species recorded were similar. The drop in numbers of FF species recorded, especially at Kifu, is therefore likely to reflect the continuing loss of forest trees there.

The degredation of Kifu forest is well-illustrated by the decline in forest specialist (FF) species. Dranzoa (1990) recorded 41, compared to ten in 2001 and a mere seven in 2006.

5.4 SWAMP BIRDS

Unlike the forest sites, swamp birds were not sampled in 2001. The six study sites for birds were the same as for other taxa. A single one-hour TSC (section 3.2) was made at each of the six points listed in Appendix G2. The results, given in detail in Appendix B3 and summarised in Table B6, show that these areas contain a number of species of interest, including three species which are largely confined to papyrus swamps – the so-called 'papyrus endemics' (Britton 1978, Byaruhanga *et al*, 2001, Carswell *et al*, 2005, Maclean *et al*, 2006). The best-known of these, the Papyrus Gonolek, is a striking bird of brilliant red and black with a conspicuous yellow crown. Other papyrus birds are less remarkable in their appearance, but because of their restricted distributions, they are considered to be of conservation concern. Two of the four other papyrus endemics, Carruther's Cisticola and White-winged Warbler, were also common. The remaining two – the Papyrus Canary and Papyrus Yellow Warbler - were not recorded, although the first of these might be found with more thorough surveys. The Greater Swamp Warbler, although not entirely confined to papyrus swamps, can be considered a near-endemic; it was seen at two sites.

The data in Table B6 are divided into two categories: those dominated by papyrus and more open sites with large areas that are flouded only seasonally (clusters Sw2 and Sw1 respectively in Figure P6).

The full species list is given in Appendix B3. The majority of the 94 species recorded are not strictly waterbirds, their presence being due either to their being generalists, such as the Common Bulbul, or to the fact that there were many trees in and near to the swamp. The latter explains the quite large number of 'tree birds' (F and f in Table B6). No species of global consideration concern was recorded.

The only species to occur at all six sites was the Grey-capped Warbler, which also had the highest mean score (Appendix B3); next commonest were the Papyrus Gonolek and Winding Cisticola. The average numbers of species per count were high, averaging 32.3 in the more open sites (W3, 4 and 5) and 34.3 at the sites with more vegetation. We used a Jack-knife estimate for total species richness, and obtained a figure of 131, which is also quite high and would probably increase with further sampling. So it is evident that the swamps, despite their closeness to Kampala, and levels of human disturbance, still have notable numbers of birds, of great variety and in good numbers. The 'papyrus endemics' are known to be fairly tolerant of moderate levels of disturbance (Maclean *et al*, 2006). There were few species of conservation concern, but the high diversity is in itself a measure of the importance of these swamps.

The more specialised species – and thus those which are of some conservation concern – were quite numerous in the papyrus-dominated sites, and still common in the more open sites (Table B6, last line).

Table B6. Summary of bird data from the six swamp sites (as listed in Appendix G2). The categories of bird types are listed in Table B4.

		Numbers of species	
		Papyrus sites[a]	Open sites[b]
Red Data species	R-VU	1	0
	R-NT	4	0
	R-RR	6	6
Papyrus endemics[c]	E	3	3
	e	1	1
Water birds	W	18	9
	w	16	15
Tree birds	FF + F	6	8
	f	16	24
Migrant status	P	0	4
	A	4	4
Total species of conservation concern[d]		36	27

Notes: a Sites 1, 2 and 6
b Sites 3, 4 and 5
c See Section 4: P indicates papyrus endemics, and p are other species for which papyrus is a major habitat
d Categories E, W, R-VU, R-NT and R-RR

6.0 MAMMALS

6.1 INTRODUCTION

The results presented in this report have been collected from surveys conducted for the same purpose as those we presented in the AESNP (2001) report. In the present study I aimed at conducting mammal surveys to answer similar questions: -

(i) Documentation of the diversity of mammals in the area along the transmission line
(ii) Reviewing the relative abundance of species documented through trapping
(iii) Reviewing the conservation status of the mammal species recorded and
(iv) Assessing potential and/or real threats to the mammal species recorded along the transmission line.

In addition however the present study.

(v) Assessed any changes in mammalian diversity and abundance between the two studies

6.2 METHODS

These followed closely the approaches used in AESNP (2001) to enable acquisition of a data set that would enable comparisons to be made between the two studies. We still maintain two groups of mammals (large and small), which require different strategies for their inventory.

The presence of larger mammals (Primates, Carnivores and Ungulates) was recorded through:

(i) Direct observation for the diurnal species
(ii) Indirect cues for their presence (such as spoors/paw/foot prints) and fecal pellets
(iii) Recovery of skeletal material of species, and
(iv) Interviews with local people.

The smaller mammals (rodents, insectivores and bats) were surveyed using traps or mist nets set along transect established at the same locations used for the surveys in the 2001 study. The nomenclature of these sampling locations is presented in Appendix G1.

For the terrestrial small mammals (rodents and shrews), traps were used to capture them for subsequent identification. Baited traps were used along each of the transects to sample the diversity and abundance of species present in the different locations.

Unlike the study in 2001, this time round, the bats were surveyed at all the transect points and at an additional two locations along the way leave. Well as the results from the netting for bats contribute to the total species list, they would also contribute to the picture of spatial occurrence of the different species if it were not for the selective sampling of the bat fauna by mist nets.

6.3 RESULTS

6.31 MABIRA FOREST

Table M1 summarizes the trap and net success along the various sample transects in the 8 sites. These values represent the quotient of number of individuals captured and the effort invested to capture them.

Table M1 Trap and netting success recorded at the different sampling locations

Transect	Trap success	Net success
Site 1 (at Pylon 179)	4.8	0
Site 2 (at Pylon 174)	2.4	22.2
Site 3(between Pylon 170 & 169)	22.8	37.0
Site 4 (at Pylon 164)	15.8	0
Site 5 (at Pylon 158)	22.9	16.7
Site 6 (at Pylon 154)	24.4	22.2
Site 7 (at Pylon 149)	22.2	11.1
Site 8 (at Pylon 144)	10.4	27.8

Trap success is a fair measure of relative abundance of the species for the terrestrial small mammals (rodents and shrews) although in some situations it may have species that are 'trap happy' overrepresented in the results, than compared to those that do not ordinarily easily go into traps. Nevertheless, trap success figures can still give a good indication of relative abundance of the small mammals while for bats these figures may be misleading because certain groups of bats (Megachiroptera or the fruit bats), are easier to capture in nets than the Microchiroptera.

For the terrestrial small mammals therefore sites 1 & 2 returned very low values emphasizing the low abundance of individuals in these two areas of the forest which are primarily composed of *B. papyrifera* with a very sparse undergrowth. The rest of the transects on the other hand are located in more or less intact natural forest which provides more diverse niches and presumably resources for the occurrence of higher numbers of individuals of the different species.

A total of 35 species of mammals have been recorded altogether, which represents 3 species less than those recorded in 2001. The difference however lies in the species composition of species recorded.

The present study represents both a decline in numbers of species recorded for order Rodentia (9 instead of 17 species) and slight increases in four orders Insectivora, Chiroptera, Primates and Pholidota (Table M2).

Table M2 Proportionate record of the known mammalian richness in Mabira FR in 2001 and 2006

Order	Known species number	% of known mammalian diversity recorded in 2001 study	% of known mammalian diversity recorded in 2006 study
Insectivora	6	33.3	50.0
Chiroptera	17	29.4	41.2
Primates	6	33.3	50.0
Carnivora	6	83.3	83.3
Artiodactyla	4	100.0	100.0
Pholidota	1	0.0	100.0
Hyracoidea	1	100.0	100.0
Rodentia	26	61.5	34.6
Macroscelidea	1	100.0	100.0

I have recorded just a little over 50% of the known mammal species for Mabira forest but slightly fewer species than were documented for the 2001report.
Appendix M1 presents the species richness of mammals recorded in the different areas of the forest along the transmission line.

In total 35 species of mammals have been recorded for Mabira forest (Table M2) distributed in varying levels of species richness in the different transect locations. Although these results do not suggest that a total species inventory has been achieved, they however suggest some trends. The lowest species richness was recorded along transect 1 (Pylon 179) which, as observed from Section 2.121 was largely dominated by *Broussonetia papyrifera* and a very poor and sparse under storey. Transect 3 that was located in the forest along river Waliga returned the highest species richness of all sample locations in Mabira forest.

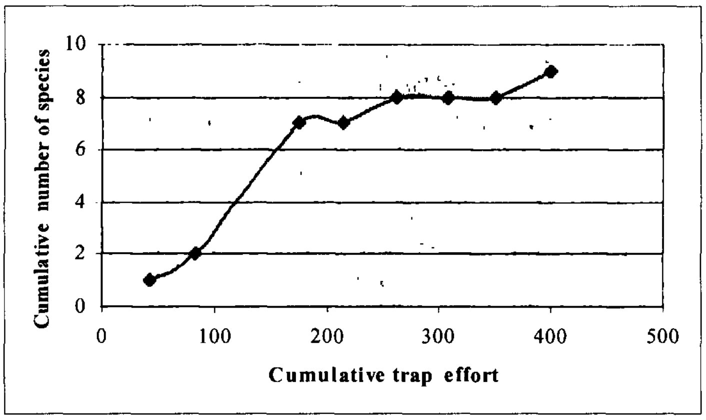

Figure M1. The cumulative number of species of small mammals (rodents & insectivores) recorded overall along the sample transects.

As is evident from Figure M1 a total species list was yet to be achieved since even after a cumulative sampling effort of 399 trap nights the graph has not reached an asymptote. The species recorded for these two taxa represent about 53% of those known to occur in Mabira forest implying that several more could have been recorded.

6.32 KIFU AND NAMYOYA FORESTS

Both these forests are very degraded, however for Kifu Forest Reserve the part to the south of the transmission line is in a secondary growth state with thick undergrowth among *Maesopsis eminii* (Section 2.122). The sections of the forest to the North of the transmission line are currently under plantation forests; the same is the case in Namyoya. The two are however under different management regimes with Kifu still under the direct control and management by the National Forestry Authority (NFA) while Namyoya was leased out to individual holders to grow trees. At the time we conducted the surveys for this report all the plots we visited in Namyoya had *Eucalyptus* growing or in some cases it had been harvested (Plates 12d, e & f).

The plantations are not very significant habitats for forest interior mammals because the complex undergrowth they depend on is lost in plantations (Plate 7). The undergrowth is important because it provides among other things: -

(i) Cover for the mammals

(ii) A source of food both for themselves and the other organisms they feed on.
(iii) Maintains ambient environmental conditions for forest interior species

Table M3. Mammal species recorded from Kifu and Namyoya Central Forest Reserves

Mammal species	Kifu forest	Namyoya forest
Crocidura olivieri (Northern Giant Musk Shrew)	√	
Crocidura turba (Southern Woodland Musk Shrew)	√	
Cercopithecus ascanius (Red tailed Monkey) *	√	√
Cercopithecus aethiops (Vervet Monkeys)	√	√
Cercoccebus albigena (Grey Cheeked Mangabey) *	√	
Potamochoerus porcus (Bushpig)	√	
Sylivicapra grimmia (Common Duiker)	√	
Canis adustus (Side stripped Jackal)	√	
Civettictis citetta (African Civet)	√	
Panthera pardus (Leopard)	√	
Dendrohyrax arboreus (Tree Hyrax) *	√	
Thryonomys gregorianus (Cane Rat)	√	
Arvicanthis niloticus (Nile rat)	√	√
Dasymys incomtus (Shaggy Marsh Rat)		√
Grammomys dolichurus (Common Thicket Rat)	√	
Lemniscomys striatus (Common striped Grass rat)	√	
Lophuromys flavopunctatus (Eastern Brush-furred Mouse)		√
Lophuromys sikapusi (Common Brush furred Mouse)	√	
Mus minutoides (Pygmy Mouse)		√
Mus triton (Grey-bellied Pygmy Mouse)	√	√
Oenomys hypoxanthus (Rusty nosed Rat)		√
Xerus erythropus (Stripped Ground Squirrel)		√
Totals	**17**	**9**

Altogether 22 species are presented in Table M4 for Kifu and Namyoya forests. Although Kifu CFR is badly degraded it still retains a fairly high species richness of mammals. However of these only three species (marked * Table M4), represent the forest interior species.

Namyoya forest on the other hand does not seem to retain much importance for forest interior mammals. The only such mammals that were recorded in this area are the Red tailed Monkeys. Given that the forest is now converted for growing *Eucalyptus* it is not likely that this species will survive in this area for very long. All other mammals recorded for this area are those of wide spread occurrence for which Namyoya is not a significant part of their range and/or for their conservation.

6.34 IMPORTANCE OF THE FOREST ALONG THE TRANSMISSION LINE FOR MAMMALS

The part of the Mabira forest that was surveyed for this report represents only a little over 1% of the total area of the Forest Reserve. The proportion of Mabira Forest's mammal species (50.7%) that have been documented in this small section of forest highlights its importance for mammal conservation within it.

Although some of the species recorded during these surveys (*A. paludinosus, M. longipes* and *D. ferrugineous*) appear in the IUCN records of assessed mammals (IUCN 2006), none of them is currently threatened. The majority of the species recorded are fairly common and widespread mammals except for the following, which are important regionally:

1 *Malacomys longipes* is a forest interior rodent with a niche strongly tied to riverine or other water-logged situations.
2 *Deomys ferrugineus* a strict forest interior species that never occurs in large densities
3 *Scutisorex somereni* a strict forest interior insectivore
4 *Rhynchocyon cirnei* a forest interior elephant shrew
5 *Rhinolophus alcyone* a forest interior microchiropteran
6 *Megaloglossus woermanni* a largely forest interior bat although it does extend its ranges into agro ecosystems typical of the Coffee/Banana systems.
7 *Crocidura selina* a Ugandan endemic shrew previously only known from Mabira Forest although it was subsequently recorded in other forests of Uganda

6.4 LUBIGI WETLANDS

The methods used here followed closely the approaches used in AESNP (2001) to enable acquisition of a primary data set that could be used in the future to assess potential impacts on the wetland ecosystem. Surveys in the wetlands were done for both any large and small mammals still present in the system.

The presence of larger mammals (Primates, Carnivores and Ungulates) was recorded through:
(i) Direct observation for the diurnal species
(ii) Indirect cues for their presence (such as spoors/paw/foot prints) and fecal pellets
(iii) Recovery of skeletal material of species, or
(iv) Interviews with local people.

The smaller mammals (rodents, insectivores and bats) were surveyed using traps.

Table M4 presents the record of mammal species recorded in the various sample sites of Lubigi wetlands.

A total of 16 species were recorded for the swamp, with 8 of these belonging to the single order Rodentia. Wetlands are usually not particularly rich in terrestrial biodiversity, but there is no reason to suppose that we recorded all possible mammals species in the swamp. An extended survey could record several other species. The seasonally flooding parts of the swamp could present suitable foraging and ranging areas for a variety of mammals.

In the swamp, primates are represented by the hardy Vervet monkey (*Cercopithecus aethiops*), which is only one of the very few primates that can still be found in human modified environments.

Owing to the location of Lubigi wetlands in a peri-urban setting and given the dense human population in areas surrounding the wetlands it is unlikely that Lubigi will be a significant ecosystem for much longer for larger mammals. From interviews with local people in Kazinga and Nganda Villages, Sitatunga and Bushbuck continue to be hunted for meat in the Lubigi wetlands. The wetlands are not receiving any active conservation, implying therefore that the surrounding local communities easily access and use resources in them.

Table M4. Mammal records for Lubigi Wetlands

	Sampling Sites along Lubigi Swamp						
	1	2	3	4	5	6	General Swamp records
Insectivora							
Northern Giant Musk Shrew (*Crocidura olivieri*)	√						
Shrew (*Crocidura*)	√						
Primates							
Vervet Monkeys (*Cercopithecus eathiops)*	√			√	√		√
Artiodactyla							
Bush Buck (*Tragelaphus scriptus*)		√					
Sitatunga (*Tragelaphus spekii)*	√	√	√	√	√	√	√
Common Duiker (*Sylivicapra grimmia*)		√					
Carnivora							
Marsh Mongoose (*Atilax palludinosus*)	√		√	√	√		√
Slender Mongoose (*Herpestes sanguineus*)		√		√	√	√	√
Rodentia							
(*Aethomys kaiseri*)	√		√	√	√		
Nile Grass rat (*Arvicanthis niloticus*)	√		√	√			
Shaggy Swamp rat (*Dasymys incomtus)*	√	√	√	√			
Stripped Grass Mouse (*Lemniscomys striatus*)		√	√				
Brush-furred Mouse (*Lophuromys flavopunctatus)*	√	√	√	√	√	√	
Brush furred Mouse (*Lophuromys sikapusi)*	√	√	√	√	√	√	
Lesser cane Rat (*Thryonomys gregorianus*)	√		√		√		
Striped Ground Squirrel (*Xerus erythropus*)	√	√					√

7. 0 SUMMARY OF IMPACTS AND PROPOSED MITIGATION MEASURES

7.1 LIKELY IMPACTS

Table 7.1. Potential impacts in the forested areas

Possible effect / impact if not mitigated	**Mitigation Options**	**Residual Impacts**
1a. Forest cover (72 hectares) lost 1b. Habitat for under storey/forest interior species lost 1c. Forest edge to be extended deeper into forest 1d. Relatively intact forest to be lost between Pylons 148-170 1e. Forest fragmentation especially in Mabira CFR	1a. Provide compensation planted area of at least equivalent size to that to be cleared. 1b. Conduct enrichment planting with native plant species in Mabira and Kifu CFRs 1c. Allow for corridors between forest blocks north and south of transmission line 1d. Invest forest restoration in Kifu forest reserve	1a. Compensation area will not mirror exact forest state and biodiversity level to that lost 1b. Home ranges of forest interior/under storey species will be shrunk 1c. No overall loss of habitat if habitat creation is done early. 1d. Forest along the wayleave to have a richer influx of non forest species of for example butterflies 1e. Larval food plants and nectar plants are frequently found in large concentrations along roadways that similarly contain aggregations of pre- and -post diapause larvae of butterflies.
2. Expansion of extent of the invasive *Broussonetia papyrifera*	2. Conduct regular thinning out *B. papyrifera* or have it harvested by NFA and sold for fuel wood	2. Invasive *B. papyirefera* could expand deeper into the natural forest.
3a. Rare species in direct impact zone lost 3b. Species richness and diversity lowered	3a. For plants carry out enrichment planting with in adjacent forest and the Kalagala offset. 3b. For animals, allow corridors of low vegetation to facilitate interconnectivity between forest sections.	3. No overall loss of biodiversity in Mabira forest if enrichment planting and restoration are done early
4. Increased access into the forest possibly for illicit resource harvesting	4a. Strengthen forest Ranger outposts in areas close to the area of transmission line to provide enhanced policing of activities in the forest 4b. Increase community participation in managing Mabira and provide alternatives to reduce pressure on forest	
5a. Habitat lost or degraded for riverine forest species 5b. Population fragmentation of forest interior understorey birds 5c. Behavioral disruption for mammals due to extended human presence 5d. Loss of breeding sites 5e. Loss of connectivity for understorey birds unwilling to cross the wayleave	5a. Preserve corridors of low vegetation along water courses crossing the wayleave	5a. No severe loss of habitat and biodiversity if corridors established early 5b. Reduced gene flow & consequently long term population viability 5c. Understorey takes decades to develop needing closure of canopy
6. Risk of collision by flying birds with conductors	6. Attach reflectors to the conductors when finally installed	

Tables 7.1 and 7.2 summarise the main impacts, and the measures which might mitigate them to some extent. They are described in more detail in Section 7.3.

Plates 8 a – h and Plate 10 show a variety of impacts already happening on the swamp from actions of the neighbouring communities. Some of these actions such as harvesting papyrus and other grasses (Plate 8h), may be sustainable while mining for sand and clay for block making (Plates 8b and 10) alter the wetland consderably.

Table 7.2. Potential impacts in the wetland sites

Possible effect / impact if not mitigated	Mitigation Options	Residual Impacts
1a. Swamp Vegetation (~2 hectares) lost 1b. Habitat for typical swamp species lost	1a. Construct pylon footings out of or at edge of the swamp as much as is possible 1b. Discuss with Wetland Inspection Division options for better protection of the remaining intact swamp 1c. Increase community awareness and sensitization of the importance of wetlands	1. Swamp lost to infilling
2. Increased prominence of species not characteristic of swamp vegetation around pylons	2. Restrict the in filing to absolute minimum required for pylon footing	2. Swamp lost to infilling but no major loss of plant biodiversity in Lubigi Swamp
3a Species richness and diversity to be reduced 3b. Loss of breeding sites for animals	3a. Limit infilling and access routes into swamp to absolute minimum necessary	
4. Risk of collision by flying birds with conductors	4. Attach reflectors to the conductors when finally installed	

7.2 OVERALL IMPACT ASSESSMENT

For the different taxa we have covered for this assessment, many are widely distributed in Uganda in the right habitats with only a few that we have classified as rare because they were infrequently encountered in the transects or because they are actually known to be rare. The few Red Data species, as listed by IUCN, are unlikely to be seriously affected by the Bujagali Interconnection Project, and no specific mitigation measures are proposed for them. None of the potentially affected area is considered to be Critical Habitat as defined in IFC Performance Standard 6.

Except for the loss of a significant amount of forest and its attendant biodiversity it does not seem that the expansion of the wayleave for constrution of the transmission line will result in major negative impacts on the terrestrial ecology. However, unless some forest vegetation, especially understorey vegetation, connects the north with the south of the forest, the negative effects of forest fragmentation will be increased.

With about 25 pylons installed along the wetland, this will translate into 1 ha of swamp lost and so will be its biodiversity and services. This increases the need for the remaining swamp to be better protected.

7.3 MANAGEMENT OPTIONS AND MITIGATION MEASURES

On the basis of our observations and the biological environment we have described in sections 2 – 6 we suggest the following as options for minimizing and mitigating the losses in biodiversity during and after the construction of the new transmission line and during maintanace activities along the wayleave.

1. Rare species (see Appendix P1) need special attention since they are the main contributors to diversity and conservation strategies should be laid out to protect them.
2. Mabira Forest is maintained in a pre-climax state by the anthropogenic pressure such as extraction of fuelwood, poles and even timber which if increased may retrogress the succession into a degraded community and, if decreased, may substitute *Broussonetia papyrifera* for other species such as *Celtis* spp and *Teclea nobilis*.
3. The southern side of the present powerline is relatively more degraded and more vulnerable to abuse because of the villages nearby, particularly near sites 7 and 8. It would, therefore, be best if the proposed transmission line was located on the southern side of the existing line, if that is possible.
4. There are various ways in which the forest lost to the wayleave could be compensated by improving the quality of other parts of the forest. FOREAIM is a project funded by the EU which is involved in restoration of degraded landscapes through a broad multidisciplinary approach. Using this approach, FOREAIM produces knowledge, practical tools, models and management guidelines for restoration implementation. With the full involvement of all stakeholders, FOREAIM synthesises information on economic, societal, policy and marketing issues to enhance employment opportunities and incomes, thus improving livelihoods for all sectors of the community. In Uganda, it is concentrating its efforts in Mabira and the progress is satisfactory. Given a history of degradation of Mabira forest, FOREAIM objectives are aimed at ensuring the natural regeneration of the forest, by considering the needs and expectations of the communities around. Support for this program, or at least adoption of its principles, would contribute to natural forest regeneration.
5. MAFICO a local Non-Governmental Organisation (NGO), is based at Najjembe, Mabira Forest Reserve. MAFICO aims to sensitise and educate communities on issues relating to the sustainable use of forest resources, ecotourism, agriculture, and income generating activities that support conservation. These would be useful allies for managing pressures on the forest.
6. The forest would benefit from enrichment-planting with high value timber species e.g. *Khaya anthotheca, Entandrophragma angolense*
7. Increased policing will be needed in Mabira since the expanded wayleave might give increased access into the forest.
8. The investor should replant a degraded forest area of equivalent or larger size to that which will be lost from Mabira, with indigenous trees.
9. Corridors of low vegetation should be maintained at the low points (Plates 4a & b) we have identified in the forest and vegetation along these should be left intact whenever the wayleave is cleared. These would enable uderstorey forest birds and other animals to maintain their link between the northern and southern sections of the forest. For this to be effective an "environmental managent program" should be put in place for the Uganda Electricity Transmission Company (UETCL) where the supervisors will be able leave these locations,

and supervise the wayleave maintainance team accordingly.

10. If pylons in the Lubigi wetlands are to be placed at the same inter-pylon distance (about 400m), as is the case in Mabira forest, we envisage a total of about 25 pylons to be installed in the distance of about 10 km along the swamp. Given a footing of 0.04 ha for each pylon this will result into 1 ha of land offtake or wetland filling. As much as possible the pylons should be placed further landward to minimize the amount of swamp to be filled in.
11. The Lubigi swamp should be better protected. We were pleasantly surprised by the richness of the swamp flora and fauna, and the comparatively intact nature of large parts of the swamp. To judge from the EIA (Ministry of Works, Housing and Communications, 2001), the northern bypass to Kampala is likely to do far more damage to the swamp than the footings for the pylons. We propose that our report be drawn to the attention of the Wetlands Inspectorate Division in due course, with the recommendation that they give serious consideration to declaring as large a part as possible as some form of nature reserve. As well as the benefits to biodiversity and the environment generally, there are considerable educational possibilities for a site so close to Kampala.
12. Bird numbers in the three forests showed changes between the two years, but these may have been due to the data having been collected at different seasons and by different people. However, it is notable that there was also a drop in the numbers of forest mammal species, due mainly to there being far fewer rodents. These, like the forest birds, mainly inhabit the undergrowth; however, we observed no major changes in the vegetation. The reasons for the changes must therefore remain unexplained especially as there were no major changes observed in the vegetation. Continued monitoring of forest biodiversity is strongly recommended.
13. Improved management of Mabira Forest would probably more than compensate for the 72 hectares to be lost from widening the way leave. Illegal activities, in particular tree felling and trapping of mammals, appear to be common. But, as Naidoo and Adamowicz (2006) have shown, the potential income from ecotourists in Mabira could probably be increased considerably, for example by the ten-fold increase in fees that, they found, visitors would willingly pay and which, if used to improve forest management, would greatly benefit the conservation of the forest.

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Appendix F1. Figures (Maps)

Figure 1. The Mabira Forest Reserve Environs showing Sites where Detailed Ecolgical Surveys were Conducted

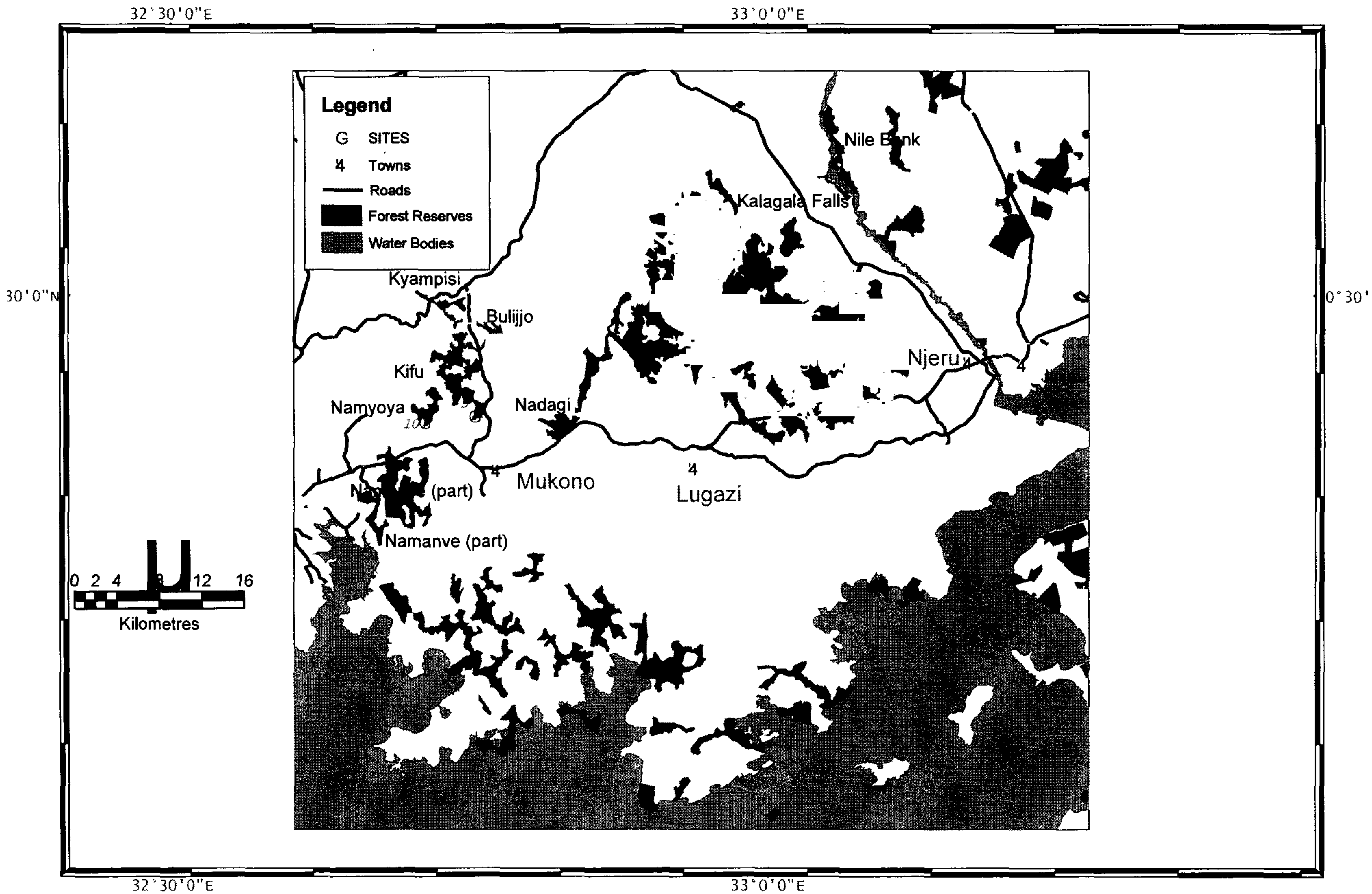


Figure 2. Lubigi Location Plan

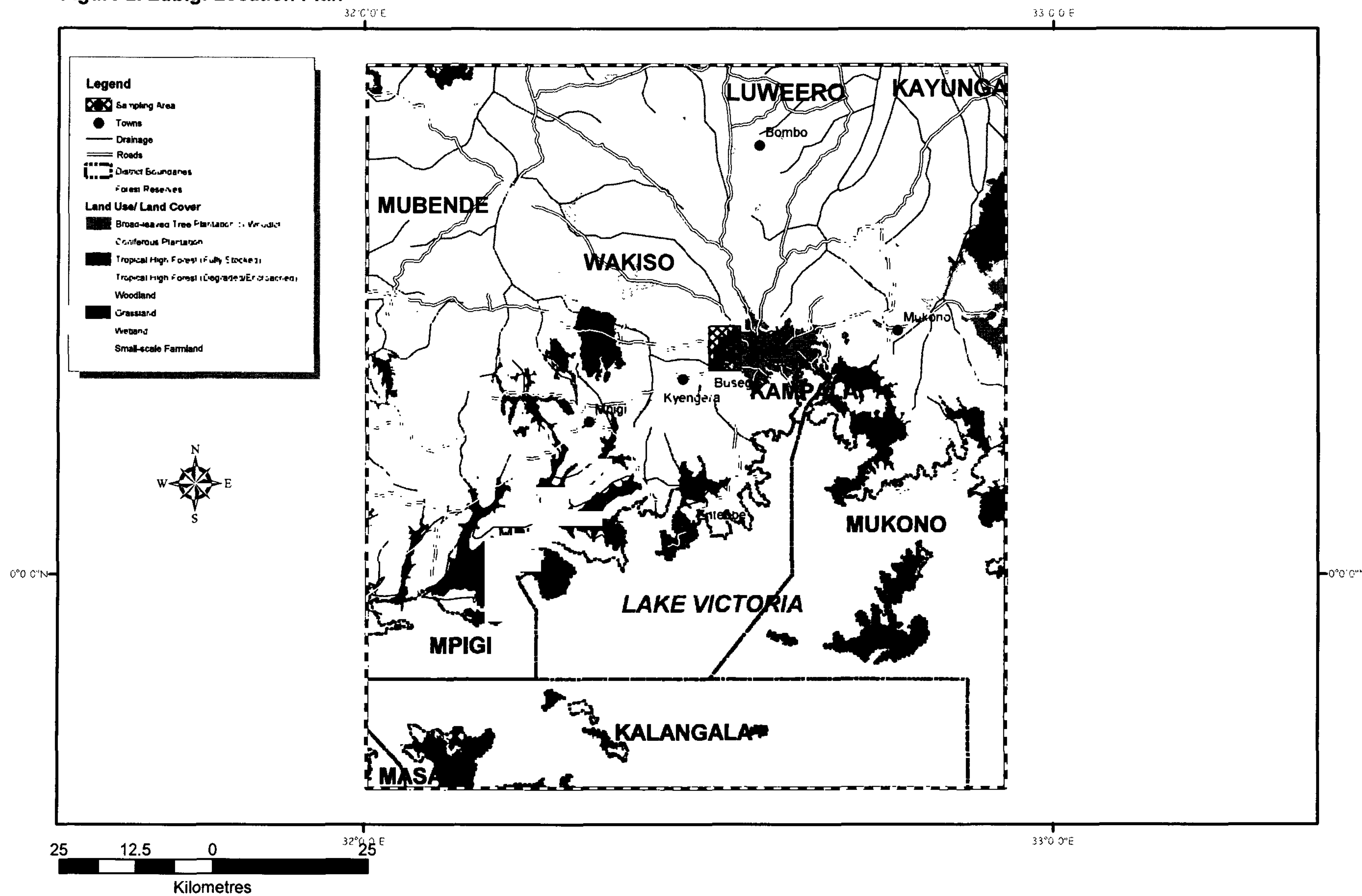


Figure 3: Sampling Site Locations on 1:50,000 Topomap Base (Lands and Surveys Department, 1969)

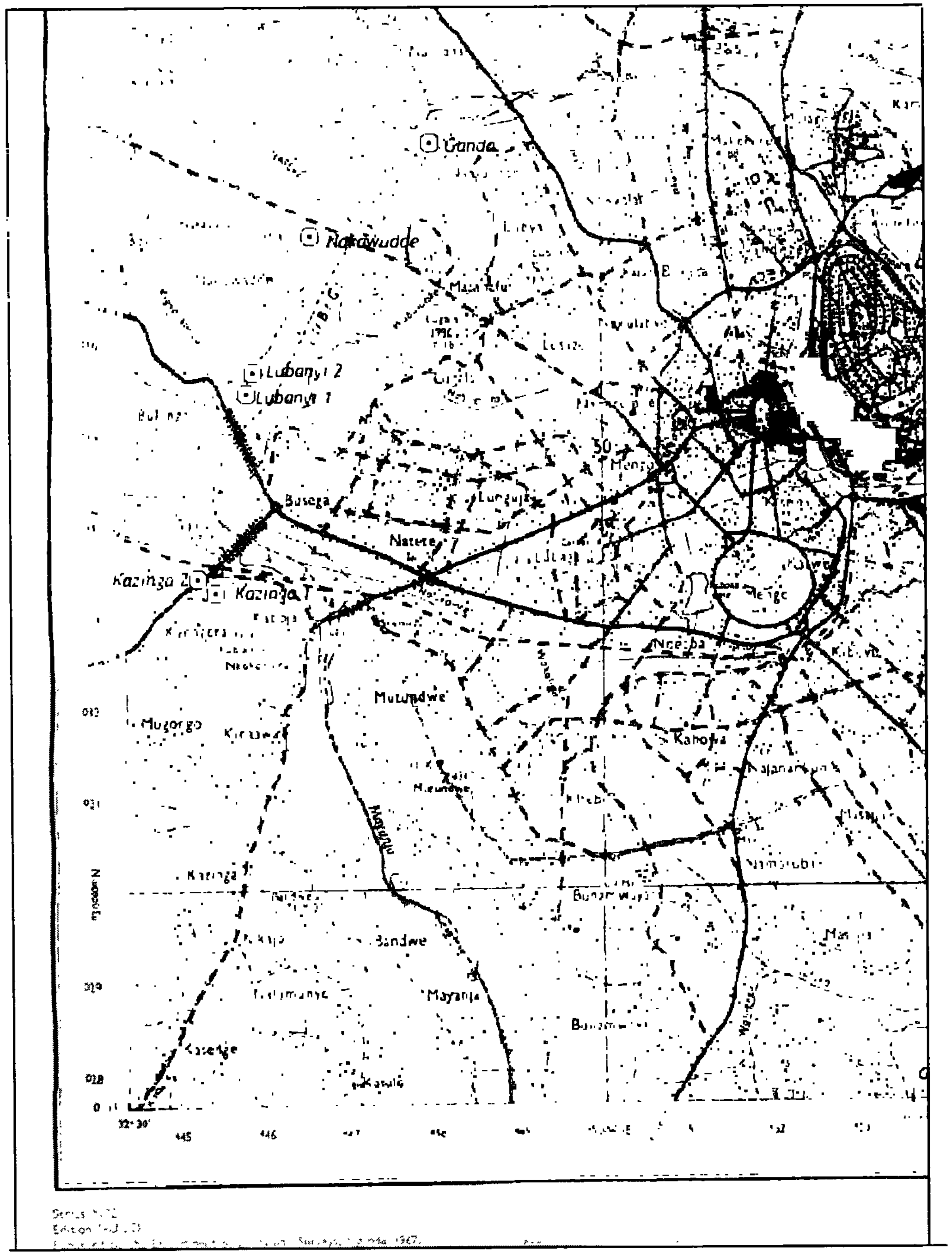


Figure 4: Dominant Plant Formation(s)

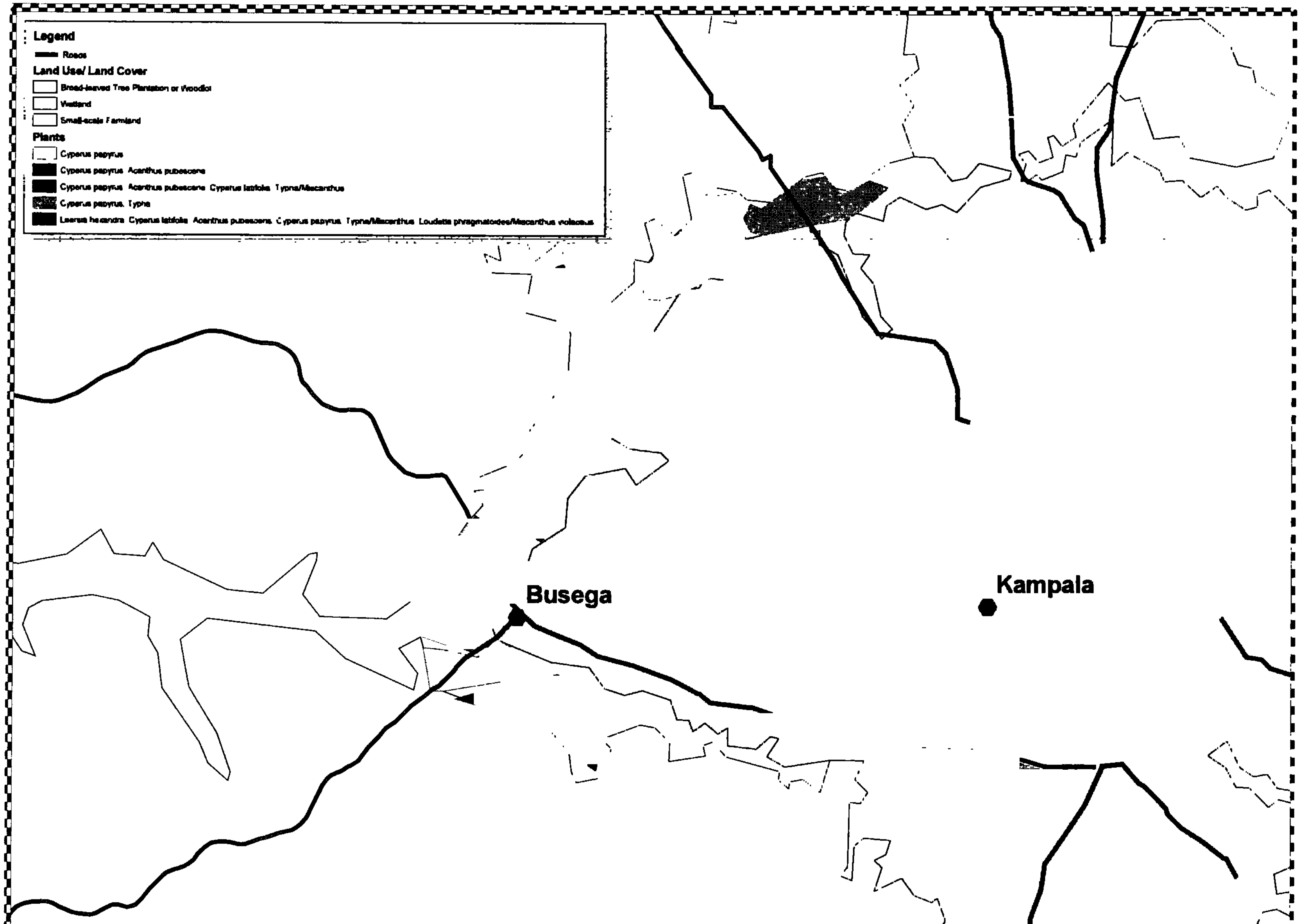
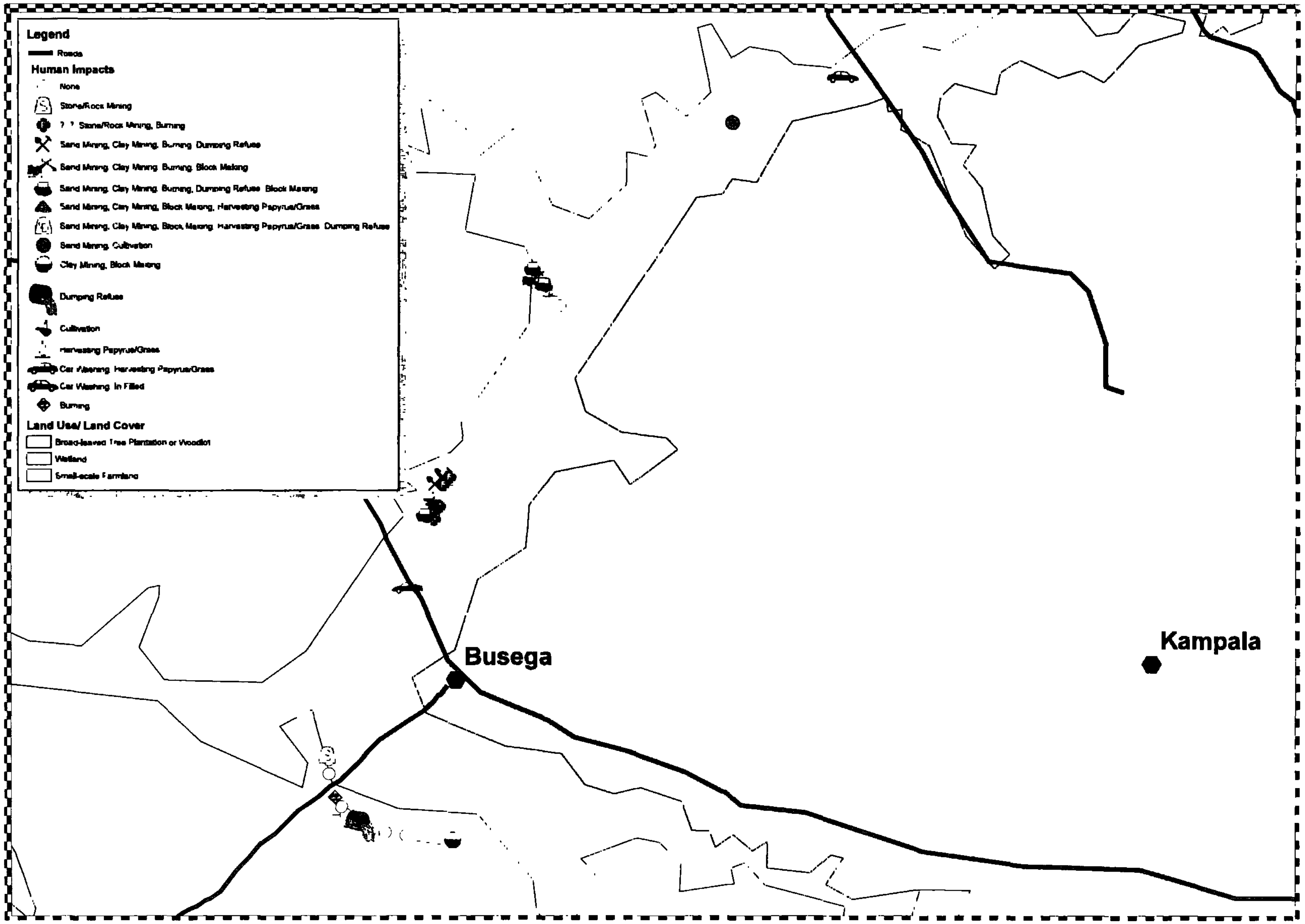


Figure 5: Human Impacts



Appendix G1. GPS locations of landmarks that were noted in Mabira, Kifu and Namyoya Forests

Land Mark	Latitude	Longitude	Altitude (m)
Mabira Forest readings			
Site 1 – Pylon 179	N00°27.1202'	E033°06.1618'	1216.9
Site 2 – Paylon 174	N00°27.0178'	E033°05.3587'	1173.2
Site 3 – Pylon 170/169	N00°26.9230'	E033°04.5116'	1141.4
Site 4 – Pylon 164	N00°26.7980'	E033°03.4528'	1153.2
Site 5 – Pylon 158	N00°26.5470'	E033°01.7723'	1176.8
Site 6 – Pylon 154	N00°26.4410'	E033°00.8432'	1154.9
Site 7 – Pylon 149	N00°26.6517'	E033°02.4092'	1204.4
Site 8 – Pylon 144	N00°26.3183'	E032°59.9755'	1167.4
Cultivation along wayleave	N00°26.2285'	E032°59.3487'	1215.0
Stream with water	N00°26.5123'	E033°01.3877'	1159.5
Stream with water	N00°26.5012'	E033°01.2997'	1147.2
Stream with water	N00°26.4943'	E033°01.2399'	1154.9
Stream with water	N00°26.3682'	E033°00.3463'	1157.5
Stream with water	N00°26.3469'	E033°00.2221'	1158.0
Stream with water	N00°26.3424'	E033°00.1773'	1166.0
Valley point at a steep drop near Pylon 141	N00°26.2701'	E032°59.6397'	1256.6
Temporary Pond	N00°26.6133'	E033°02.0754'	1189.7
Kifu Forest readings			
Pylon 64	N00°23.928'	E032°45.254'	
Auracaria Plantation	N00°23.954'	E032°45.359'	
Namyoya Forest readings			
Pylon 51	N00°23.611'	E032°42.749'	
Harvested *Eucalyptus* plot	N00°23.634'	E032°42.894'	
Wetland	N00°23.637'	E032°42.989'	

Appendix G2. GPS locations of landmarks that were noted along the western border of Lubigi Swamp

Land Mark	Latitude	Longitude	Altitude (m)
	N00°19.2496'	E032°30.8257'	1159.0
	N00°19.2755'	E032°30.8276'	1159.2
	N00°19.2963'	E032°30.8475'	1159.0
	N00°19.3067'	E032°30.8233'	1160.2
	N00°19.3279'	E032°30.8156'	1160.2
	N00°19.3549'	E032°30.8954'	1155.9
	N00°19.3809'	E032°30.8646'	1162.1
	N00°19.4165'	E032°30.8654'	1160.2
	N00°19.4126'	E032°30.8908'	1159.7
	N00°20.1655'	E032°31.2236'	1163.1
	N00°18.1515'	E032°30.4714'	1162.6
	N00°18.3314'	E032°30.4273'	1161.6
	N00°18.3509'	E032°30.4222'	1163.1
	N00°18.0342'	E032°30.8065'	1162.6
	N00°18.0234'	E032°30.9017'	1155.6
Swamp Site 4 (Lubanyi 2)	N00°19.3867'	E032°30.8364'	1161.4
	N00°18.0544'	E032°30.6420'	1163.1
	N00°20.1431'	E032°31.2487'	1165.2
	N00°18.0439'	E032°30.7200'	1162.6
	N00°20.1307'	E032°31.2723'	1164.8
	N00°18.1879'	E032°30.4494'	1162.6
	N00°18.0420'	E032°30.7499'	1158.0
	N00°18.1223'	E032°30.4918'	1160.7
Swamp Site 6 (Ganda)	N00°20.7580'	E032°31.9657'	1170.8
Swamp Site 2 (Kazinga 2)	N00°18.1497'	E032°30.4729'	1162.4
	N00°18.2754'	E032°30.4233'	1163.8
	N00°18.0399'	E032°30.7679'	1163.3
	N00°18.0321'	E032°30.8443'	1159.9
	N00°18.9849'	E032°30.7235'	1160.4
	N00°20.0647'	E032°31.3053'	1168.6
	N00°20.9327'	E032°32.3873'	1168.8
Swamp Site 1 (Kazinga 1)	N00°18.0655'	E032°30.5876'	1160.4
	N00°18.0878'	E032°30.5172'	1161.9
Swamp Site 3 (Lubanyi 1)	N00°19.2612'	E032°30.7911'	1159.7
Swamp Site 5 (Nakawudde)	N00°20.2028'	E032°31.2075'	1165.2
Rubish dump	N00^{0}18.075'	E032^{0}30.545'	
Brick Making	N00^{0}18.082'	E032^{0}30.520'	
Sewage	N00^{0}18.101'	E032^{0}30.417'	
Grass harvesting	N00^{0}18.101'	E032^{0}30.417'	
Potato Garden	N00^{0}18.108'	E032^{0}30.388'	
Old tyres burnt	N00^{0}18.122'	E032^{0}30.348'	
Block making	N00^{0}18.130'	E032^{0}30.301'	

Appendix P 1: Plant species recorded from Mabira, Kifu and Namyoya forest reserves
1 means presence of species at site
H = Herb; C = Climber; T = Tree, S = Shrub
Abundance: D – Dominant, A –Abundant, F – Frequent, O – Occasional, R - Rare

Family	**Species**	**Life form**	**Abundance**	**Mabira F.R. Sites**								**Kifu F.R.**	**Namyoya F.R.**	**Totals**
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Acanthaceae	*Acanthus pubescens*	S	O									1	1	**2**
Acanthaceae	*Asystasia gigantea*	H	O	1							1			**2**
Acanthaceae	*Dicliptera laxata*	H	R	1										**1**
Acanthaceae	*Dyschoriste radicans*	H	O		1	1								**2**
Acanthaceae	*Hypoestes sp.*	H	R									1		**1**
Acanthaceae	*Justicia flava*	H	O		1							1		**2**
Acanthaceae	*Justicia scandens*	H	O	1		1								**2**
Acanthaceae	*Justicia sp.*	H	R						1					**1**
Acanthaceae	*Justicia striata*	H	R							1				**1**
Acanthaceae	*Lankasteria elegans*	H	R		1									**1**
Acanthaceae	*Phaulopsis angolana*	H	R									1		**1**
Acanthaceae	*Pseuderanthemum ludovicianum*	H	F			1	1	1		1	1			**5**
Alangiaceae	*Alangium chinense*	T	O						1	1				**2**
Amaranthaceae	*Achyranthes aspera*	H	A		1	1		1	1	1	1	1		**7**
Amaranthaceae	*Aerva lanata*	H	R			1								**1**
Amaranthaceae	*Amaranthus spinosa*	H	O				1			1				**2**
Amaranthaceae	*Psilotricum scleranthum*	H	R				1							**1**
Anacardiaceae	*Pseudospondias microcarpa*	T	F				1		1	1	1	1		**5**
Annonaceae	*Monodora myrstica*	T	R						1					**1**
Annonaceae	*Uvariopsis congensis*	C	R						1					**1**
Apocynaceae	*Alafia caudata*	C	R				1							**1**
Apocynaceae	*Alafia scandens*	C	O	1			1							**2**
Apocynaceae	*Alstonia boonei*	T	F			1	1	1		1	1			**5**
Apocynaceae	*Funtumia africana*	T	F					1	1		1			**3**
Apocynaceae	*Funtumia elastica*	T	A		1	1		1	1	1	1	1	1	**8**
Apocynaceae	*Motandra guineensis*	C	R			1								**1**
Apocynaceae	*Rauvolfia caffra*	T	R			1								**1**
Apocynaceae	*Tabernamontana holstii*	T	O					1				1		**2**
Araceae	*Culcasia fulcifolia*	H	O		1	1								**2**

Appendix P1 (Continued)

Family	**Species**	**Life form**	**Abundance**	**Mabira F.R. Sites**								**Kifu F.R.**	**Namyoya F.R.**	**Totals**
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Araceae	*Culcasia scandens*	H	F					1	1	1	1	1		**5**
Aristolochiaceae	*Aristolochia elegans*	C	R					1						**1**
Aristolochiaceae	*Aristolochia triactina*	C	R	1										**1**
Asclepiadaceae	*Mondia whytei*	C	R		1									**1**
Asclepiadaceae	*Pentarrhinum abyssinicum*	C	R		1									**1**
Asclepiadaceae	*Secamone africana*	C	R									1		**1**
Asclepiadaceae	*Secamone sp.*	C	R		1									**1**
Aspleniaceae	*Asplenium sp.*	H	R			1								**1**
Asteraceae	*Acmella caulorrhiza*	H	R				1							**1**
Asteraceae	*Ageratum conyzoides*	H	A			1	1			1	1	1	1	**6**
Asteraceae	*Aspilia africana*	H	O	1			1							**2**
Asteraceae	*Bidens pilosa*	H	F		1	1						1	1	**4**
Asteraceae	*Conyza floribunda*	H	A	1	1				1	1	1		1	**6**
Asteraceae	*Crassocephalum montuosum*	H	R										1	**1**
Asteraceae	*Melanthera scandens*	H	O				1					1		**2**
Asteraceae	*Senecio syringifolius*	C	R								1			**1**
Asteraceae	*Synedrella nodiflora*	H	A		1	1	1			1	1	1	1	**7**
Asteraceae	*Tithonia diversifolia*	S	O							1	1			**2**
Asteraceae	*Vernonia amygdalina*	S	O									1	1	**2**
Auraucariaceae	*Araucaria cunninghamii*	T	R									1		**1**
Balanitaceae	*Balanites wilsoniana*	T	O			1	1							**2**
Bignoniaceae	*Kigelia africana*	T	R		1									**1**
Bignoniaceae	*Markhamia lutea*	T	A	1		1	1	1	1	1	1	1		**8**
Bignoniaceae	*Spathodea campanulata*	T	R				1							**1**
Burseraceae	*Canarium schweinfurthii*	T	O				1		1					**2**
Capparidaceae	*Capparis erythrocarpos*	C	R		1									**1**
Capparidaceae	*Capparis tomentosa*	C	R	1										**1**
Capparidaceae	*Maerua duchesnei*	S	O				1				1			**2**
Capparidaceae	*Ritchiea afzeli*	T	O				1		1					**2**
Cecropiaceae	*Myrianthus arboreus*	T	R								1			**1**
Celastraceae	*Pristimera plumbea*	C	R									1		**1**
Celastraceae	*Salacia leptoclada*	C	O				1				1			**2**
Combretaceae	*Combretum paniculatum*	C	R						1					**1**

Appendix P1 (Continued)

Family	Species	Life form	Abundance	Mabira F.R. Sites								Kifu F.R.	Namyoya F.R.	Totals
				1	2	3	4	5	6	7	8	9	10	
Commelinaceae	*Commelina africana*	H	O		1	1								**2**
Commelinaceae	*Commelina benghalensis*	H	R									1		**1**
Commelinaceae	*Commelina latifolia*	H	F					1	1	1	1			**4**
Commelinaceae	*Palisota manii*	H	O			1						1		**2**
Commelinaceae	*Pollia condensata*	H	A		1	1	1		1	1	1			**6**
Connaraceae	*Agelaea pentagyna*	C	R			1								**1**
Connaraceae	*Agelaea ugandensis*	C	F			1			1		1			**3**
Connaraceae	*Cnestis ugandensis*	S	R							1				**1**
Connaraceae	*Connaras longistipitatus*	C	R								1			**1**
Convolvulaceae	*Dichondra repens*	H	R							1				**1**
Convolvulaceae	*Evolvulus nummularius*	H	F			1		1	1	1	1			**5**
Convolvulaceae	*Hewittia sublobata*	C	F	1								1	1	**3**
Convolvulaceae	*Ipomoea acuminata*	C	R			1								**1**
Convolvulaceae	*Ipomoea batatus*	C	R										1	**1**
Convolvulaceae	*Ipomoea grantii*	C	R									1		**1**
Convolvulaceae	*Lepistemon owariense*	C	R									1		**1**
Convolvulaceae	*Stictocardia beraviensis*	C	R									1		**1**
Cucurbitaceae	*Cucumis figarei*	C	R			1								**1**
Cucurbitaceae	*Momordica foetida*	C	F		1	1			1		1	1		**5**
Cucurbitaceae	*Mukia maderaspatana*	C	R					1						**1**
Cyperaceae	*Cyperus cyperoides*	H	R										1	**1**
Cyperaceae	*Cyperus distans*	H	O									1	1	**2**
Cyperaceae	*Fimbristylis dichotoma*	H	R				1							**1**
Cyperaceae	*Kyllinga aurata*	H	O			1						1		**2**
Davalliaceae	*Arthropteris orientalis*	H	O					1			1			**2**
Davalliaceae	*Arthropteris palisoti*	H	R			1								**1**
Dichapetalaceae	*Tapura fischeri*	S	F		1	1				1				**3**
Dilleniaceae	*Tetracera potatoria*	C	F		1	1		1	1					**4**
Dioscoreaceae	*Dioscorea abyssinica*	C	R			1								**1**
Dracaenaceae	*Dracaena fragrans*	S	A	1	1	1	1	1	1	1	1			**8**
Dracaenaceae	*Dracaena laxissima*	C	R				1							**1**
Ebenaceae	*Diospyros abyssinica*	T	F	1				1	1					**3**
Euphorbiaceae	*Acalypha acrogyna*	S	R	1										**1**

Appendix P1 (Continued)

Family	**Species**	**Life form**	**Abundance**	**Mabira F.R. Sites**								**Kifu F.R.**	**Namyoya F.R.**	**Totals**
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Euphorbiaceae	*Acalypha bipartita*	S	A	1	1	1		1	1	1		1		**7**
Euphorbiaceae	*Acalypha neptunica*	S	D	1	1	1	1	1	1	1	1	1		**9**
Euphorbiaceae	*Acalypha ornata*	S	F			1				1		1	1	**4**
Euphorbiaceae	*Alchornea cordifolia*	T	O									1	1	**2**
Euphorbiaceae	*Argomuellera macrophylla*	S	A	1	1	1	1	1	1	1	1			**8**
Euphorbiaceae	*Bridelia micrantha*	T	F	1						1		1		**3**
Euphorbiaceae	*Croton macrostachyus*	T	A			1	1	1	1	1		1		**6**
Euphorbiaceae	*Croton megalocarpus*	T	R					1						**1**
Euphorbiaceae	*Erythrococca sp.*	S	R									1		**1**
Euphorbiaceae	*Erythrococca stolziana*	S	F	1	1	1	1							**4**
Euphorbiaceae	*Euphorbia hirta*	H	R			1								**1**
Euphorbiaceae	*Mallotus oppositifolius*	S	R			1								**1**
Euphorbiaceae	*Manhot esculentus*	S	R										1	**1**
Euphorbiaceae	*Margaritaria discoides*	T	F			1	1	1		1	1			**5**
Euphorbiaceae	*Neobotonia melleri*	T	R							1				**1**
Euphorbiaceae	*Phyllanthus amarus*	H	F	1	1								1	**3**
Euphorbiaceae	*Phyllanthus ovalifolius*	S	R									1		**1**
Euphorbiaceae	*Ricinus communis*	S	O	1	1									**2**
Euphorbiaceae	*Sapium ellipticum*	T	A	1			1	1	1			1	1	**6**
Euphorbiaceae	*Spondianthus preusii*	T	R									1		**1**
Euphorbiaceae	*Tragia brevipes*	C	O			1							1	**2**
Fabaceae	*Acacia pentagona*	C	A			1		1	1	1	1	1		**6**
Fabaceae	*Albizia coriaria*	T	O							1	1			**2**
Fabaceae	*Albizia glaberrima*	T	A	1		1	1	1	1	1	1			**7**
Fabaceae	*Albizia grandibracteata*	T	A	1			1	1	1			1	1	**6**
Fabaceae	*Albizia gummifera*	T	A	1		1	1	1	1	1	1			**7**
Fabaceae	*Albizia zygia*	T	F							1	1	1		**3**
Fabaceae	*Baikiaea insignis*	T	F			1	1		1					**3**
Fabaceae	*Baphiopsis parviflora*	T	R						1					**1**
Fabaceae	*Cassia spectabilis*	T	R										1	**1**
Fabaceae	*Centrosema pubescens*	C	O			1							1	**2**
Fabaceae	*Crotalaria sp.*	S	O					1	1					**2**
Fabaceae	*Dalbergia lactea*	C	O							1		1		**2**

Appendix P1 (Continued)

Family	Species	Life form	Abundance	Mabira F.R. Sites								Kifu F.R.	Namyoya F.R.	Totals
				1	2	3	4	5	6	7	8	9	10	
Fabaceae	*Desmodium adscendens*	H	F	1			1					1	1	**4**
Fabaceae	*Desmodium repandum*	H	A	1	1		1	1	1	1	1	1		**8**
Fabaceae	*Desmodium salicifolium*	H	R			1								**1**
Fabaceae	*Desmodium triflorum*	H	O				1	1						**2**
Fabaceae	*Desmodium velutinum*	S	R	1										**1**
Fabaceae	*Erythrina abyssinica*	T	R			1								**1**
Fabaceae	*Glycine wightii*	H	A	1	1		1	1	1	1		1		**7**
Fabaceae	*Indigofera spicata*	H	A	1	1	1	1	1	1					**6**
Fabaceae	*Mimosa pudica*	H	A			1	1	1	1	1	1			**6**
Fabaceae	*Parkia filicoidea*	T	R									1		**1**
Fabaceae	*Peptadeniastrum africanum*	T	F	1	1			1						**3**
Fabaceae	*Rhynchosia sublobata*	C	R									1		**1**
Fabaceae	*Senna hirsuta*	S	D	1	1		1	1	1	1	1	1	1	**9**
Fabaceae	*Teramnus labialis*	C	A	1		1	1	1	1	1				**6**
Fabaceae	*Vigna unguiculata*	H	R		1									**1**
Flacourtiaceae	*Dovyalis macrocalyx*	S	R				1							**1**
Flacourtiaceae	*Lindackeria lanceolata*	S	R		1									**1**
Guttiferae	*Harungana madagascariensis*	T	O									1	1	**2**
Hernandiaceae	*Illigera pentaphylla*	C	O		1						1			**2**
Labiatae	*Leonotis nepetifolia*	S	R										1	**1**
Labiatae	*Leucas martinicensis*	H	R			1								**1**
Labiatae	*Ocimum gratissimum*	S	A	1	1	1	1		1	1	1			**7**
Labiatae	*Stachys argillicola*	H	F				1	1	1	1	1			**5**
Leeaceae	*Leea guineensis*	S	O			1						1		**2**
Malpighiaceae	*Flabellaria paniculata*	C	R				1							**1**
Malvaceae	*Hibiscus calyphyllus*	H	F	1								1	1	**3**
Malvaceae	*Hibiscus surrantensis*	H	R									1		**1**
Malvaceae	*Pavonia urens*	S	R	1										**1**
Malvaceae	*Sida acuta*	H	A		1		1	1	1	1	1	1	1	**8**
Malvaceae	*Sida rhombifolia*	H	A		1	1	1	1	1	1				**6**
Malvaceae	*Urena lobata*	H	A	1	1	1	1					1	1	**6**
Marantaceae	*Marantochloa leucantha*	H	F			1			1	1		1		**4**
Melastomataceae	*Memecylon jasminoides*	S	R		1									**1**

Appendix P1 (Continued)

Family	Species	Life form	Abundance	Mabira F.R. Sites								Kifu F.R.	Namyoya F.R.	Totals
				1	2	3	4	5	6	7	8	9	10	
Meliaceae	*Entandrophragma angolense*	T	O						1		1			**2**
Meliaceae	*Entandrophrama cylindricum*	T	R						1					**1**
Meliaceae	*Khaya anthotheca*	T	O	1						1				**2**
Meliaceae	*Trichilia dregeana*	T	F					1	1	1				**3**
Meliaceae	*Trichilia fischeri*	T	F				1	1	1					**3**
Meliaceae	*Trichilia preuriana*	T	A			1	1	1	1	1	1			**6**
Meliaceae	*Trichilia rubescens*	T	R						1					**1**
Meliaceae	*Turraea vogellioides*	T	R				1							**1**
Menispermaceae	*Cissampelos mucronata*	C	F					1	1				1	**3**
Menispermaceae	*Tinospora caffra*	C	R					1						**1**
Moraceae	*Antiaris toxicaria*	T	A		1	1		1	1	1	1	1	1	**8**
Moraceae	*Artocarpus heterophyllus*	T	F	1	1								1	**3**
Moraceae	*Broussonetia papyrifera*	T	A	1	1	1	1	1	1	1	1			**8**
Moraceae	*Ficus asperifolia*	T	F	1				1				1		**3**
Moraceae	*Ficus brachylepis*	T	R				1							**1**
Moraceae	*Ficus exasperata*	T	A	1	1		1	1	1	1	1		1	**8**
Moraceae	*Ficus lingua*	T	R							1				**1**
Moraceae	*Ficus mucuso*	T	F				1	1		1				**3**
Moraceae	*Ficus ovata*	T	R			1								**1**
Moraceae	*Ficus polita*	T	F			1	1		1		1			**4**
Moraceae	*Ficus sur*	T	F			1	1				1	1	1	**5**
Moraceae	*Ficus vallis-chaude*	T	R							1				**1**
Moraceae	*Mesozygia lactea*	T	R			1								**1**
Moraceae	*Morus mesozygia*	T	R						1					**1**
Moraceae	*Trilepisium madagascariensis*	T	A	1		1	1	1	1	1	1	1		**8**
Musaceae	*Musa sapientum*	H	R						1					**1**
Myrsinaceae	*Ardisia staudtii*	S	R							1				**1**
Myrsinaceae	*Maesa lanceolata*	T	R									1		**1**
Myrsinaceae	*Maesa welwitschii*	C	R		1									**1**
Myrtaceae	*Eucalyptus grandis*	T	R										1	**1**
Myrtaceae	*Eugenia emens*	S	O					1	1					**2**
Myrtaceae	*Psidium guajava*	T	O	1									1	**2**
Myrtaceae	*Syzygium guineense*	T	R								1			**1**

Appendix P1 (Continued)

Family	Species	Life form	Abundance	Mabira F.R. Sites								Kifu F.R.	Namyoya F.R.	Totals
				1	2	3	4	5	6	7	8	9	10	
Nyctaginaceae	*Pisonia aculeata*	C	R							1				**1**
Ochanaceae	*Ouratea densiflora*	T	R					1						**1**
Oleaceae	*Jasminum eminii*	C	O	1						1				**2**
Oleandraceae	*Schrebera arborea*	T	R								1			**1**
Oxalidaceae	*Oxalis corniculata*	H	R							1				**1**
Passifloraceae	*Adenia aculeata*	C	R					1						**1**
Passifloraceae	*Adenia cissampeloides*	C	O					1		1				**2**
Passifloraceae	*Passiflora edulis*	C	R		1									**1**
Phytolaccaceae	*Phytolacca dodecandra*	C	O		1					1				**2**
Piperaceae	*Piper umbellatum*	C	F	1		1					1	1		**4**
Plumbaginaceae	*Plumbago zeylanica*	H	R			1								**1**
Poaceae	*Acroceras zizanioides*	Gr	R									1		**1**
Poaceae	*Brachiaria decumbens*	Gr	R										1	**1**
Poaceae	*Chloris pycnothrix*	Gr	O	1	1									**2**
Poaceae	*Cynodon aethiopicus*	Gr	O		1	1								**2**
Poaceae	*Cynodon dactylon*	Gr	F	1			1	1	1	1				**5**
Poaceae	*Digitaria abyssinica*	Gr	R										1	**1**
Poaceae	*Eleusine indica*	Gr	O		1		1							**2**
Poaceae	*Eragrostis tunuifolia*	Gr	R		1									**1**
Poaceae	*Isachne buettneri*	Gr	R									1		**1**
Poaceae	*Leptaspis cochleata*	Gr	F			1		1	1					**3**
Poaceae	*Olyra latifolia*	Gr	R							1				**1**
Poaceae	*Oplismenus hirtellus*	Gr	F	1	1							1		**3**
Poaceae	*Panicum maximum*	Gr	F	1	1	1							1	**4**
Poaceae	*Panicum trichocladum*	Gr	F	1								1	1	**3**
Poaceae	*Panicum vaginatum*	Gr	R									1		**1**
Poaceae	*Paspalum conjugatum*	Gr	A	1	1	1	1	1	1	1		1		**8**
Poaceae	*Paspalum scrobiculatum*	Gr	O		1							1		**2**
Poaceae	*Pennisetum polystachion*	Gr	R		1									**1**
Poaceae	*Pennisetum purperium*	Gr	R		1									**1**
Poaceae	*Pseudobromus silvaticus*	Gr	R								1			**1**
Poaceae	*Rottboelia conchinchinensis*	Gr	R										1	**1**
Poaceae	*Setaria megaphylla*	Gr	O	1								1		**2**

Appendix P1 (Continued)

Family	**Species**	**Life form**	**Abundance**	**Mabira F.R. Sites**								**Kifu F.R.**	**Namyoya F.R.**	**Totals**
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Poaceae	*Sporobolus africanus*	Gr	R	1										**1**
Poaceae	*Sporobolus pyramidalis*	Gr	R		1									**1**
Pteridaceae	*Pteris dentata*	H	O							1		1		**2**
Rhamnaceae	*Gouania longispicata*	T	R									1		**1**
Rhamnaceae	*Maesopsis eminii*	T	F	1		1	1					1		**4**
Rhamnaceae	*Scutia myrtina*	S	F			1	1	1				1		**4**
Rhamnaceae	*Ventilago diffusa*	C	R			1								**1**
Rosaceae	*Rubus apetalus*	S	O	1								1		**2**
Rubiaceae	*Canthium lactescens*	T	O		1			1						**2**
Rubiaceae	*Coffea canephora*	S	O						1		1			**2**
Rubiaceae	*Dictyandra arborescens*	S	R						1					**1**
Rubiaceae	*Geophila repens*	H	O		1						1			**2**
Rubiaceae	*Hymenocoleus hirsuta*	H	R				1							**1**
Rubiaceae	*Oxyanthus subpunctatus*	S	R		1									**1**
Rubiaceae	*Psychotria sp.*	S	R									1		**1**
Rubiaceae	*Spermacoce princeae*	H	R									1		**1**
Rubiaceae	*Uncaria africana*	C	R				1							**1**
Rutaceae	*Chaetachme aristata*	S	F			1			1			1		**3**
Rutaceae	*Citropsis articulata*	S	F	1		1		1		1	1			**5**
Rutaceae	*Clausena anisata*	S	O				1					1		**2**
Rutaceae	*Fagaropsis angolensis*	T	O					1	1					**2**
Rutaceae	*Rothmannia urcelliformis*	T	R			1								**1**
Rutaceae	*Rutidea orientalis*	C	R				1							**1**
Rutaceae	*Teclea nobilis*	T	A	1		1	1	1	1	1		1		**7**
Rutaceae	*Toddalia asiatica*	S	F				1		1			1		**3**
Rutaceae	*Zanthoxylum gilletii*	T	F				1		1		1			**3**
Sapindaceae	*Allophylus africana*	S	O	1								1		**2**
Sapindaceae	*Allophylus macrobotrys*	S	R				1							**1**
Sapindaceae	*Aphania senegalensis*	T	F			1	1	1	1	1				**5**
Sapindaceae	*Blighia unijugata*	T	F			1	1	1	1		1			**5**
Sapindaceae	*Cardiospermum grandiflorum*	C	O			1						1		**2**
Sapindaceae	*Cardiospermum halicacabum*	C	F	1		1	1					1		**4**
Sapindaceae	*Deinbollia kilimandscharica*	T	R			1								**1**

Appendix P1 (Continued)

Family	**Species**	**Life form**	**Abundance**	**Mabira F.R. Sites**								**Kifu F.R.**	**Namyoya F.R.**	**Totals**
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Sapindaceae	*Glenniea africana*	T	F			1		1	1					**3**
Sapindaceae	*Lasciodiscus mildbraedii*	T	A		1	1	1	1	1	1	1			**7**
Sapindaceae	*Lychnodiscus cerospermus*	T	F		1	1	1	1			1			**5**
Sapindaceae	*Majidea fosteri*	T	R		1									**1**
Sapindaceae	*Paullinia pinnata*	C	F		1	1		1						**3**
Sapindaceae	*Zahna golungensis*	C	F	1		1	1	1						**4**
Sapotaceae	*Aningeria altissima*	T	F	1		1			1	1	1			**5**
Sapotaceae	*Chrysophyllum albidum*	T	A			1	1	1	1	1	1			**6**
Sapotaceae	*Chrysophyllum muerense*	T	F				1	1	1		1			**4**
Sapotaceae	*Manilkara dawei*	T	F						1	1	1			**3**
Sapotaceae	*Mimusops bagshawei*	T	R			1								**1**
Sapotaceae	*Pachystela brevipes*	T	O					1	1					**2**
Simaroubaceae	*Harrisonia abyssinica*	T	R						1					**1**
Smilacaceae	*Smilax anceps*	C	O			1						1		**2**
Solanaceae	*Capsicum frutescens*	S	O	1									1	**2**
Solanaceae	*Physalis peruviana*	S	F			1	1	1	1					**4**
Solanaceae	*Solanum indicum*	S	R	1										**1**
Solanaceae	*Solanum mauritianum*	S	A			1	1	1	1		1	1		**6**
Solanaceae	*Sorghum arundinaceum*	Gr	R		1									**1**
Sterculiaceae	*Byttneria catalpifolia*	C	R							1				**1**
Sterculiaceae	*Cola gigantea*	T	O			1			1					**2**
Sterculiaceae	*Dombeya dawei*	T	R					1						**1**
Sterculiaceae	*Dombeya mukole*	T	R		1									**1**
Sterculiaceae	*Leptonychia mildbraedii*	T	F			1		1	1	1	1			**5**
Thelypteridaceae	*Christella parasitica*	H	R									1		**1**
Thelypteridaceae	*Thelypteris hamulosa*	H	O					1		1				**2**
Thymelaeaceae	*Peddiea fischeri*	H	R									1		**1**
Tiliaceae	*Grewia bicolor*	T	R	1										**1**
Tiliaceae	*Grewia mildbraedii*	T	F	1	1	1				1				**4**
Tiliaceae	*Triumfetta rhomboidea*	H	R	1										**1**
Ulmaceae	*Celtis africana*	T	A		1	1	1	1	1	1	1	1		**8**
Ulmaceae	*Celtis durandii*	T	A	1	1	1	1	1		1	1			**7**
Ulmaceae	*Celtis mildbraedii*	T	A		1	1	1	1	1	1	1	1		**8**

Appendix P1 (Continued)

Family	**Species**	**Life form**	**Abundance**	**Mabira F.R. Sites**								**Kifu F.R.**	**Namyoya F.R.**	**Totals**
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Ulmaceae	*Celtis phillipensis*	T	F			1	1		1	1	1			**5**
Ulmaceae	*Celtis wightii*	T	F			1		1	1					**3**
Ulmaceae	*Celtis zenkeri*	T	F				1	1	1	1	1			**5**
Ulmaceae	*Holoptelea grandis*	T	F					1	1	1	1			**4**
Ulmaceae	*Trema orientalis*	T	F		1			1		1	1			**4**
Umbelliferae	*Centella asiatica*	H	A	1		1	1	1	1	1	1		1	**8**
Urticaceae	*Boehmeria macrophylla*	S	O							1	1			**2**
Verbenaceae	*Clerodendrum myricoides*	S	R	1										**1**
Verbenaceae	*Clerodendrum silvaticum*	C	R									1		**1**
Verbenaceae	*Lantana camara*	S	A	1	1		1	1	1	1	1		1	**8**
Verbenaceae	*Lantana triphylla*	S	F					1	1		1			**3**
Verbenaceae	*Lippia grandifolia*	S	R			1								**1**
Verbenaceae	*Stachytarpheta jamaicensis*	S	R			1								**1**
Verbenaceae	*Vitex amboniensis*	T	R				1							**1**
Violaceae	*Rinorea ilicifolia*	T	O				1	1						**2**
Vitaceae	*Cissus petiolata*	C	R	1										**1**
Vitaceae	*Cissus rotundifolia*	C	R		1									**1**
Zingiberaceae	*Aframomum angustifolia*	H	R							1				**1**
Zingiberaceae	*Aframomum mildbraedii*	H	R				1							**1**
Zingiberaceae	*Renealmia congolana*	H	O								1	1		**2**
Zingiberaceae	*Renealmia engleri*	H	R							1				**1**
Total				**63**	**66**	**96**	**81**	**76**	**84**	**74**	**65**	**85**	**41**	

Appendix P2: Plant species list for Lubigi swamp

1means presence

H = Herb; C = Climber/Creeper; T = Tree, S = Shrub

Abundance: D – Dominant, A –Abundant, F – Frequent, O – Occasional, R - Rare

Family	Species	Life form	Abundance	Lubigi swamp sites						Totals
				1	2	3	4	5	6	
Acanthaceae	*Acanthus pubescens*	S	A	1	1	1	1	1		5
Acanthaceae	*Dyschoriste radicans*	H	R						1	1
Acanthaceae	*Hypoestes aristata*	H	R		1					1
Acanthaceae	*Justicia heterocarpa*	H	R		1					1
Anacardiaceae	*Pseudospondias microcarpa*	T	R				1			1
Apocynaceae	*Tabernamontana odoratissima*	T	R	1						1
Asclepiadaceae	*Cynanchum polyanthum*	C	O	1				1		2
Asclepiadaceae	*Cynanchum strigosum*	C	R	1						1
Asclepiadaceae	*Dragea sp.*	C	R		1					1
Asclepiadaceae	*Gomphocarpus fruticosus*	S	R	1						1
Asteraceae	*Ageratum conyzoides*	H	F	1	1	1	1			4
Asteraceae	*Bidens pilosa*	H	R						1	1
Asteraceae	*Conyza floribunda*	H	R	1						1
Asteraceae	*Crassocephalum sp.*	H	F	1	1	1		1		4
Asteraceae	*Enhydra fluctuans*	H	R						1	1
Asteraceae	*Melanthera scandens*	H	F		1	1	1	1		4
Asteraceae	*Mikania cordata*	H	R						1	1
Asteraceae	*Siegesbeckia abyssinica*	H	R						1	1
Asteraceae	*Spilanthes mauritiana*	H	R		1					1
Asteraceae	*Vernonia amygdalina*	S	F		1		1	1	1	4
Asteraceae	*Vernonia auriculifera*	H	R					1		1
Asteraceae	*Vernonia lasciopus*	H	R					1		1
Bignoniaceae	*Spathodea campanulata*	T	R	1						1
Commelinaceae	*Aneilema beniniense*	H	R			1				1
Commelinaceae	*Commelina africana*	H	O	1	1					2
Commelinaceae	*Commelina erecta*	H	O					1	1	2
Commelinaceae	*Commelina thomasii*	H	R						1	1
Convolvulaceae	*Ipomoea cairica*	C	D	1	1	1	1	1	1	6
Cyperaceae	*Cyperus cyperoides*	H	R			1				1
Cyperaceae	*Cyperus denudatus*	H	A	1		1	1	1	1	5
Cyperaceae	*Cyperus distans*	H	R	1						1
Cyperaceae	*Cyperus latifolius*	H	A	1	1	1	1		1	5
Cyperaceae	*Cyperus papyrus*	H	A	1	1	1	1		1	5
Cyperaceae	*Cyperus sp.*	H	R		1					1
Cyperaceae	*Fimbristylis dichotoma*	H	F	1		1	1			3
Cyperaceae	*Fimbristylis miliaceae*	H	O				1	1		2
Cyperaceae	*Kyllinga sp.*	H	D	1	1	1	1	1	1	6
Cyperaceae	*Pycreus flavescens*	H	R	1						1
Cyperaceae	*Pycreus nitidus*	H	D	1	1	1	1	1	1	6
Cyperaceae	*Scleria achtenii*	H	A	1	1	1	1	1		5
Cyperaceae	*Scleria bulbifera*	H	R			1				1
Cyperaceae	*Scleria catophylla*	H	O			1	1			2
Cyperaceae	*Scleria melanomphala*	H	A	1	1	1	1	1		5
Cyperaceae	*Scleria nyasensis*	H	O	1	1					2
Davalliaceae	*Nephrolepis biserrata*	H	R	1						1
Euphorbiaceae	*Alchornea cordifolia*	T	O	1		1				2
Euphorbiaceae	*Bridelia micrantha*	T	F		1		1		1	3
Euphorbiaceae	*Euphorbia sp.*	H	O			1			1	2

Appendix P2 (Continued)

Family	Species	Life form	Abundance	Lubigi swamp sites						Totals
				1	2	3	4	5	6	
Euphorbiaceae	*Phyllanthus nummulariifolius*	H	F			1		1	1	3
Euphorbiaceae	*Phyllanthus ovalifolius*	H	R			1				1
Euphorbiaceae	*Ricinus communis*	S	O					1	1	2
Fabaceae	*Aeschynomene indica*	H	F			1	1	1	1	4
Fabaceae	*Aeschynomene schimperi*	S	R		1					1
Fabaceae	*Albizia grandibracteata*	T	F			1	1	1		3
Fabaceae	*Albizia zygia*	T	R	1						1
Fabaceae	*Cassia kirki*	H	O			1		1		2
Fabaceae	*Cassia mimosoides*	H	O	1				1		2
Fabaceae	*Crotalaria cleomifolia*	H	R				1			1
Fabaceae	*Crotalaria ochroleuca*	H	R	1						1
Fabaceae	*Desmodium ramosissimum*	H	R	1						1
Fabaceae	*Desmodium salicifolium*	H	F	1	1	1			1	4
Fabaceae	*Desmodium velutinum*	H	O					1	1	2
Fabaceae	*Eriosema laurentii*	H	O			1	1			2
Fabaceae	*Erythrina abyssinica*	T	F			1	1	1		3
Fabaceae	*Indigofera spicata*	H	O					1	1	2
Fabaceae	*Kotschya africana*	H	O					1	1	2
Fabaceae	*Mimosa pigra*	H	A	1		1	1	1	1	5
Fabaceae	*Vigna luteola*	H	A	1	1		1	1	1	5
Fabaceae	*Vigna parkeri*	H	R	1						1
Fabaceae	*Vigna sp.*	H	R	1						1
Guttiferae	*Harungana madagascariensis*	T	F			1	1	1		3
Labiatae	*Geniosporum rotundifolium*	H	R				1			1
Labiatae	*Hyptis lanceolata*	H	F	1			1		1	3
Labiatae	*Leonotis nepetifolia*	H	F			1	1	1		3
Labiatae	*Ocimum grattisimum*	H	R				1			1
Labiatae	*Plectranthus sp.*	H	O			1	1			2
Malvaceae	*Hibiscus diversifolius*	H	A	1	1		1	1	1	5
Malvaceae	*Sida rhombifolia*	H	O					1	1	2
Malvaceae	*Sida sp.*	H	F		1		1	1		3
Melastomataceae	*Dissotis canescens*	H	R					1		1
Melastomataceae	*Dissotis rotundifolia*	H	R		1					1
Melastomataceae	*Tristemma mauritianum*	H	F	1	1				1	3
Menispermaceae	*Cissampelos mucronata*	C	D	1	1	1	1	1	1	6
Menispermaceae	*Stephania abyssinica*	H	R						1	1
Moraceae	*Antiaris toxicaria*	T	R	1						1
Moraceae	*Ficus ovata*	T	R	1						1
Moraceae	*Ficus vallis-chaude*	T	O	1		1				2
Moraceae	*Ficus verruculosa*	T	R	1						1
Myrsinaceae	*Maesa lanceolata*	S	R	1						1
Myrtaceae	*Eucalyptus grandis*	T	F	1	1				1	3
Myrtaceae	*Syzygium guineense*	T	R			1				1
Onagraceae	*Jussiaea abyssinica*	H	R	1						1
Orchidaceae	*Eulophia horsfallii*	H	R			1				1
Palmae	*Phoenix reclinata*	T	A	1	1	1	1	1		5
Poaceae	*Brachiaria decumbens*	G	R			1				1
Poaceae	*Chloris sp.*	G	O			1			1	2
Poaceae	*Cymbopogon sp.*	G	R			1				1
Poaceae	*Digitaria abyssinica*	G	F			1	1	1	1	4
Poaceae	*Eragrostis mildbraedii*	G	R	1						1

Appendix P2 (Continued)

Family	**Species**	**Life form**	**Abundance**	**Lubigi swamp sites**						**Totals**
				1	**2**	**3**	**4**	**5**	**6**	
Poaceae	*Hyparrhenia sp.*	G	O			1		1		**2**
Poaceae	*Leersia hexandra*	G	D	1	1	1	1	1	1	**6**
Poaceae	*Loudetia kagerensis*	G	R					1		**1**
Poaceae	*Loudetia phragmatoides*	G	R					1		**1**
Poaceae	*Miscanthus violaceus*	G	R					1		**1**
Poaceae	*Panicum maximum*	G	A	1	1	1		1	1	**5**
Poaceae	*Setaria sphacelata*	H	F	1		1	1	1		**4**
Poaceae	*Sporobolus sp.*	G	R						1	**1**
Polygonaceae	*Polygonum salicifolium*	H	F		1		1	1	1	**4**
Polygonaceae	*Polygonum sp.*	H	O	1	1					**2**
Polygonaceae	*Polygonum strigosum*	H	R	1						**1**
Primulaceae	*Lysimachia ruhmeriana*	H	R	1						**1**
Rosaceae	*Rubus apetalus*	S	F	1		1	1			**3**
Sapindaceae	*Paullinia pinnata*	C	R	1						**1**
Schizaeaceae	*Lygodium microphyllum*	H	R		1					**1**
Smilaceae	*Smilax anceps*	C	R			1				**1**
Solanaceae	*Solanum mauritianum*	S	O			1	1			**2**
Thelypteridaceae	*Thelypteris confluens*	H	O					1	1	**2**
Thelypteridaceae	*Thelypteris fadenii*	H	R	1						**1**
Thelypteridaceae	*Thelypteris totta*	H	A	1	1	1	1		1	**5**
Tiliaceae	*Triumfetta macrophylla*	S	A		1	1	1	1	1	**5**
Typhaceae	*Typha domingensis*	H	F	1		1	1		1	**4**
Verbenaceae	*Clerodendrum fuseum*	C	R				1			**1**
Verbenaceae	*Lantana camara*	S	F			1	1	1		**3**
Zingiberaceae	*Aframomum angustifolium*	H	F	1		1	1	1		**4**
Totals				**57**	**37**	**51**	**45**	**47**	**42**	

Appendix A1 Dragonfly species list

Species	Forest sites										Swamp sites						
	Mabira																
	8	7	6	5	4	3	2	1	Kifu	Namyoya	1	2	3	4	5	6	Typical Habitat
Zygoptera																	
Chlorophora trifaria						1											thickly forested streams
Platycypha lacustris		1		1							1						rivers and streams in dense forest
Umma saphirina						1			1	1							thickly forested streams
Anisoptera																	
Gynacantha villosa				1											1	1	forest, thick bush
Orthetrum julia		1		1		1											forest, dense woodland, streams
Orthetrum macrostigma			1										1	1		1	bush fringed swamps and pools
Orthetrum microstigma			1														swamp forest
Orthetrum sp 1			1														
Orthetrum sp 2						1						1		1		1	
Orthetrum sp 3										1		1					
Orthetrum sp 4									1					1		1	
Orthetrum sp 5			1														
Orthetrum trinacria										1		1		1	1	1	pools, lakes, rivers in savannah, bush, woodland
Palpopleura lucia		1							1								reedy sluggish streams and pools in woodland and forest
Palpopleura portia		1							1								reedy or grassy sluggish streams or pools in savannah, woodland, bush
Pseudagrion kersteni						1					1	1	1	1	1	1	abundant in most habitat except dense forest
Pseudagrion melanicterum						1											forest streams, thich bush and litmus
Pseudagrion rufocinctum			1			1											forest
Pseudagrion sp						1						1			1		
Pseudagrion spermatum			1														montane streams or rivers, shade or thick bush
Totals	0	4	6	3	0	8	0	0	4	3	2	5	2	5	4	6	
All forest and swamp sites						20								9			

Appendix A2. Butterfly species list

Species	Forest sites										Swamp sites						
	8	7	6	5	4	3	2	1	Kifu	Namyoya	1	2	3	4	5	6	Ecotype[a]
Nymphalidae																	
Acraea bonasia											1	1					F
Acraea acerata									1			1					W
Acraea aganice	1	1	1														f
Acraea alicia											1	1					W
Acraea althoffi	1								1								F
Acraea aurivillii	1				1	1			1								F
Acraea cerasa									1								f
Acraea egina		1	1	1		1											W
Acraea encedon							1	1	1		1	1					W
Acraea epaea	1																F
Acraea eponina			1	1	1	1	1	1	1					1			W
Acraea humilis	1																F
Acraea jodutta	1				1												F
Acraea johnstoni	1				1			1						1			f
Acraea leucographa							1							1			F
Acraea lycoa		1		1	1	1			1								F
Acraea macaria	1						1										F
Acraea macarista								1						1			F
Acraea natalica		1		1			1										W
Acraea neobule				1						1							W
Acraea orinata					1	1											F
Acraea peneleos						1		1									F
Acraea penelope		1			1	1											F
Acraea poggei									1								F
Acraea psudegina		1	1	1		1	1			1	1	1	1	1	1	1	W
Acraea quirina								1	1								F
Acraea quirinalis	1			1					1								F
Acraea rogersi	1	1	1	1													F
Acraea servona	1																F
Acraea tellus								1									F
Acraea uvui									1				1	1			f
Acraea venrura																	S
Acraea viviana	1			1					1	1							f
Acraea zetes		1							1								W
Amauris albimaculata	1						1			1							F
Amauris echeria							1										f
Amauris niavius		1							1	1							W
Amauris oscarus				1										1			F
Tirumala petiverana						1								1			W/m

Appendix A2 (Continued)

Species	Forest sites										Swamp sites						
	8	7	6	5	4	3	2	1	Kifu	Namyoya	1	2	3	4	5	6	Ecotype[a]
Amauris tartarea	1	1	1			1			1	1	1	1	1	1	1	1	F
Ariandne albifascia	1			1		1	1		1								F
Ariandne enotrea								1	1	1							f
Aterica galene						1			1								F
Bebearia ribensis									1								F
Bicyclus auricrudus	1	1						1	1								F
Bicyclus funebris	1								1								FL
Bicyclus istaris									1				1	1			f
Bicyclus jefferyi		1			1	1			1	1	1	1	1	1	1	1	f
Bicyclus mesogena	1	1															F
Bicyclus mollitia	1	1															F
Bicyclus sambulos	1	1															F
Bicyclus sandace		1		1	1	1	1	1									F
Bicyclus saussurei																	F
Bicyclus sebetus	1				1												FL
Bicyclus safitza										1							W
Bicyclus smithi		1			1			1	1								FL
Bicyclus sophrosyne				1	1		1	1									f
Bicyclus uniformis	1	1			1												FL
Bicyclus vulgaris					1	1		1	1		1						W
Byblia anvatara	1	1		1	1	1	1		1	1	1	1	1	1	1	1	W/m
Byblia ilithyia									1								O
Catuna crithea	1	1			1	1	1										F
Charaxes acuminatus		1															FH
Charaxes cynthia	1				1												F
Charaxes etheocles						1											F
Charaxes fulvescence					1				1								FL
Charaxes pleione						1											f
Charaxes tiridates						1											FL
Charaxes varanes					1	1											W
Charaxes zelica						1											F
Cyrestis camillus						1											F
Danaus chrysippus						1	1		1	1	1						O/m
Euphaedra eleus	1	1			1	1											F
Euphaedra harpalyce					1												F
Euphaedra medon	1				1	1			1								F
Euphaedra preussi	1	1															F
Euphaedra rex	1	1															F
Euphaedra ruspina						1	1										F

Appendix A2 (Continued)

Species	Forest sites										Swamp sites						
	8	7	6	5	4	3	2	1	Kifu	Namyoya	1	2	3	4	5	6	Ecotype[a]
Eurytela dryope									1	1							W
Eurytela hiarbas			1		1	1	1	1	1								f
Gnophodes betsimena		1															F
Gnophodes chelys		1			1		1										F
Harma theobene	1			1		1		1									F
Henotesia peitho		1			1												W
Henotesia perspicua											1						O
Hypolimnas monteironis	1																F
Hypolimnas salmacis	1						1										F
Junonia chorimene								1		1							O
Junonia oenone							1										W
Junonia sophia				1	1	1	1	1	1	1	1	1	1	1	1	1	W
Junonia stygia						1											f
Junonia terea				1				1		1							W
Junonia westermanni	1	1		1	1	1	1		1								F
Libythea labdaca	1			1		1											W/m
Melanitis leda						1											W
Mesoxantha ethosea	1	1		1													FL
Neptidopsis ophione				1				1	1								f
Neptis melicerta			1			1		1									F
Neptis metella				1			1							1			f
Neptis necomedes						1											f
Neptis nemetes					1	1			1								f
Neptis ochracea									1								F
Neptis trigonophora							1										F
Neptis saclava				1		1	1	1	1								W
Neptis serena					1						1						W
Phalanta phalanta	1							1					1				O/m
Pseudacraea deludens							1										FH
Pseudacraea lucretia				1	1	1											f
Pseudoneptis bugandensis	1					1											F
Salamis cacta							1										F
Salamis parhassus				1		1			1								f
Sallya boisduvali						1											f/m

Appendix A2 (Continued)

Species	Forest sites								Swamp sites								
	8	7	6	5	4	3	2	1	Kifu	Namyoya	1	2	3	4	5	6	Ecotype[a]
Sallya garega				1													F/m
Sallya occidentalium						1											F/m
Tirumala petiverana		1															W/m
Venessula milca						1											f
Ypthima albida					1	1			1								f
Ypthima antennata											1			1			O
Ypthima asterope						1	1	1					1				O
Ypthima doleta									1				1			1	W
Ypthimomorpha itonia											1						f
Pieridae																	
Appias epaphia	1							1			1						f/m
Appias sabina							1	1									F
Appias sylvia						1											F
Belenois aurota													1	1			O/m
Belenois calypso	1			1		1											F
Belenois crawshayi							1	1									F
Belenois creona							1			1							O/m
Belenois solilucis						1											f
Belenois theora				1	1	1											f
Belenois thysa				1				1	1								f
Catopsilia florella				1	1												O/m
Dixeia orbona	1			1			1	1									W
Eurema desjardinsi											1			1			W
Eurema hapale											1		1				S
Eurema hecabe	1	1			1			1	1	1							W/m
Eurema senegalensis							1		1								F
Leptosia alcesta					1						1						W
Leptosia hybrida	1	1		1	1		1										F
Leptosia nupta	1			1	1	1			1								F
Leptosia wigginsi	1		1	1	1	1	1	1									F
Mylothris continua					1	1											F
Mylothris hilara						1											F
Mylothris rubricosta											1			1			S
Mylothris schumanni					1												F
Nepheronia argia	1			1	1		1		1								F
Nepheronia pharis							1										F

Appendix A2 (Continued)

Species	Forest sites										Swamp sites						
	8	7	6	5	4	3	2	1	Kifu	Namyoya	1	2	3	4	5	6	Ecotype[a]
Nepheronia thalassina	1			1	1	1											F
Lycaenidae																	
Abisara neavei	1			1	1	1		1	1								F
Anthene indefinita					1	1											O
Anthene larydas						1											F
Anthene princeps					1	1											O
Anthene schoutedeni				1	1				1								F
Cupidopsis jobates											1						W
Eicochrysops hippocrates														1			W
Eicochrysops messapus													1				O
Epitola mpanensis									1								F
Euchrysops malathana											1			1			O
Hypolycaena liara	1																F
Hypolycaena philippus						1			1								W
Iolaus parasilanus						1											F
Larinopoda tera									1								F
Leptotes pirithous						1	1										W/m
Liptena xanthostola				1													F
Megalopalpus zymna				1	1	1			1								F
Mimeresia sp									1								F
Oboronia punctatus						1			1								F
Phlyaria heritsia													1				F
Tetrarhanis ilma					1		1		1								F
Thermoniphas micyclus											1			1			F
Triclema nigeriae									1								f
Tuxentius margaritaceus						1			1								W
Uranothauma falkensteini		1				1											W
Zizeeria knysna							1				1					1	W
Zizina antanossa											1						W
Zizula hylax							1										W
Papilionidae																	
Papilio bromius	1			1	1	1	1		1								f
Papilio cynorta	1				1	1											FL
Papilio dardanus	1		1	1	1	1		1	1								W

Appendix A2 (Continued)

Species	Forest sites										Swamp sites						
	8	7	6	5	4	3	2	1	**Kifu**	**Namyoya**	1	2	3	4	5	6	**Ecotype**[a]
Papilio demodocus				1	1		1	1	1	1							W/m
Papilio echerioides									1								f
Papilio interjecta					1												F
Papilio lormieri	1				1												F
Papilio nireus					1												f
Papilio nobilis				1													F
Papilio phorcas	1	1	1	1	1	1	1	1									F
Papilio rex		1			1												FH
Hesperiidae																	
Acleros ploetzi																	f
Andronymus neander			1														f/m
Ankola fan											1			1		1	F
Borbo fallax						1			1							1	O
Borbo kaka														1			F
Borbo lugens									1		1						f
Borbo micans											1			1			S
Calaenorrhinus proxima	1																F
Celaenorrhinus bettoni					1												f
Celaenorrihinus galenus	1					1		1									F
Celaenorrihinus intermixtus									1								F
Ceratrichia flava						1											F
Coeliades forestan							1	1	1	1							W
Eagris lucetia									1								f
Eretis lugens	1						1		1	1							W
Gegenes hottentota														1			O
Gegenes niso	1					1	1										W
Gorgyra sp											1						f
Lepella lepeletier														1			f
Metisella midas											1			1		1	S
Monza alberti	1															1	F
Pardeleodes incerta				1						1				1			F
Pardeleodes tibullus					1	1	1										F
Sarangesa bouvieri	1																F
Spialia spio	1										1						O

Note a : see Table A3

Atlas No[a]	Species	Status[b]	Spec[c]	RD[d]	T1	T1	T2	T3	T4	T5	T6	T7	T8	Mean TSC	M1	M2	M3	M4	M5	M6	M7	M8	Mean Net	OP
426	SPECKLED TINKERBIRD *Pogoniulus scolopaceus*	RB	F		0	0	6	6	5	6	6	5	5	4.5	0	0	0	0	0	0	0	0	0.0	0
430	YELLOW-THROATED TINKERBIRD *Pogoniulus subsulphureus*	RB	FF		6	5	6	6	5	6	6	3	6	5.4	0	0	0	0	0	0	0	0	0.0	0
431	YELLOW-RUMPED TINKERBIRD *Pogoniulus bilineatus*	RB	F		0	0	0	0	0	0	3	0	0	1.5	0	0	0	0	0	0	0	0	0.0	0
434	YELLOW-SPOTTED BARBET *Buccanodon duchaillui*	RB	FF		6	1	1	4	0	6	3	0	0	2.3	0	0	0	0	0	0	0	0	0.0	0
435	HAIRY-BREASTED BARBET *Tricholaema hirsuta*	RB	F		0	4	4	5	4	5	0	4	1	2.8	0	0	0	0	0	0	0	0	0.0	0
445	YELLOW-BILLED BARBET *Trachyphonus purpuratus*	RB	FF		0	4	2	4	1	2	5	5	6	3.6	0	0	0	0	0	0	0	0	0.0	0
456	LESSER HONEYGUIDE *Indicator minor*	RB	f		0	0	0	0	0	0	0	0	0	0.0	0	1	0	0	0	0	0	0	0.1	0
469	BUFF-SPOTTED WOODPECKER *Campethera nivosa*	R(B)	FF		0	0	0	0	0	0	0	0	0	0.0	0	1	0	0	2	0	0	1	0.5	0
470	BROWN-EARED WOODPECKER *Campethera caroli*	RB	FF		0	0	0	0	0	0	0	0	0	0.0	0	1	0	0	0	0	0	0	0.1	0
498	WHITE-HEADED SAW-WING *Psalidoprocne albiceps*	RB, AfM/NB?	f	R-RR	4	0	0	0	0	0	0	6	1	1.4	0	0	0	0	0	0	0	0	0.0	0
538	LITTLE GREENBUL *Andropadus virens*	RB	F		6	6	6	6	6	5	3	6	6	5.5	6	7	2	4	5	1	1	4	3.8	0
540	CAMEROON SOMBRE GREENBUL *Andropadus curvirostris*	RB	FF		0	0	0	0	0	0	0	0	0	0.0	0	0	0	1	0	0	0	0	0.1	0
541	SLENDER-BILLED GREENBUL *Andropadus gracilirostris*	RB	FF		0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	2	0	0.3	0
542	YELLOW-WHISKERED GREENBUL *Andropadus latirostris*	RB	F		5	0	3	5	5	0	6	5	4	3.4	4	3	1	3	8	3	3	3	3.5	0
543	HONEYGUIDE GREENBUL *Baeopogon indicator*	R(B)	FF		0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		1
551	TORO OLIVE GREENBUL *Phyllastrephus hypochloris*	RB	FF	R-VU/RR	0	0	0	0	0	0	0	0	0	0.0	0	0	1	2	0	0	0	2	0.6	0
556	WHITE-THROATED GREENBUL *Phyllastrephus albigularis*	RB	FF		0	0	0	0	0	0	0	4	0	0.4	1	5	7	9	5	4	4	11	5.7	0
558	RED-TAILED BRISTLEBILL *Bleda syndactyla*	RB	FF		0	3	0	6	2	6	1	0	0	2.2	0	2	6	1	3	3	2	4	2.6	0
559	GREEN-TAILED BRISTLEBILL *Bleda eximia*	RB	FF		0	0	0	0	0	0	2	0	0	0.8	0	0	4	0	2	1	4	3	1.8	0
561	RED-TAILED GREENBUL *Criniger calurus*	RB	FF		0	0	0	0	5	5	5	6	6	3.7	0	1	2	0	0	0	0	0	0.4	0
562	COMMON BULBUL *Pycnonotus barbatus*	RB	f		4	4	4	0	0	0	0	0	0	1.2	0	0	0	0	0	0	0	0	0.0	0
563	WESTERN NICATOR *Nicator chloris*	RB	F		0	0	0	3	6	0	0	0	5	1.8	0	0	0	0	0	0	0	0	0.0	0
566	FOREST ROBIN *Stiphrornis erythrothorax*	RB	FF		0	0	0	0	0	0	0	4	0	0.4	0	6	6	4	3	2	2	5	3.5	0
575	BLUE-SHOULDERED ROBIN-CHAT *Cossypha cyanocampter*	RB	F		0	5	0	0	0	1	2	0	5	1.3	1	0	1	0	1	0	2	0	0.6	0
577	RED-CAPPED ROBIN-CHAT *Cossypha natalensis*	RB	F		0	0	0	0	0	0	0	0	0	0.0	1	2	0	0	0	0	0	0	0.4	0
579	FIRE-CRESTED ALETHE *Alethe diademata*	RB	FF		0	0	0	0	0	0	6	0	0	0.6	0	3	3	4	4	4	3	1	2.7	0
581	BROWN-CHESTED ALETHE *Alethe poliocephala*	RB	FF		0	0	0	0	0	0	0	0	0	0.0	0	1	13	1	2	7	0	2	2.3	0
584	RUFOUS FLYCATCHER-THRUSH *Stizorhina fraseri*	RB	FF	G-VU	0	4	0	6	0	5	6	0	5	3.7	0	0	0	1	1	0	0	1	0.4	0
670	BLACK-THROATED APALIS *Apalis jacksoni*	RB	FF		0	0	0	0	0	0	5	5	5	2.2	0	0	0	0	0	0	0	0	0.0	0
677	GREY-BACKED CAMAROPTERA *Camaroptera brachyura*	RB	f		4	4	0	0	0	2	3	4	1	2.7	1	0	0	0	0	0	0	1	0.3	0
679	OLIVE-GREEN CAMAROPTERA *Camaroptera chloronota*	RB	FF		0	0	0	0	6	0	0	0	0	0.6	0	0	0	1	2	0	1	1	0.6	0
709	GREEN HYLIA *Hylia prasina*	RB	F		0	0	0	0	1	0	0	5	0	1.0	1	0	0	0	1	0	1	0	0.4	0
719	ASHY FLYCATCHER *Muscicapa caerulescens*	RB	F		0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0.0	0
734	DUSKY CRESTED-FLYCATCHER *Trochocercus nigromitrata*	RB	F		0	0	0	0	0	0	0	0	0	0.0	0	0	1	0	0	0	0	0	0.1	0

Atlas No[a]	Species	Status[b]	Spec[c]	RD[d]	T1	T1	T2	T3	T4	T5	T6	T7	T8	Mean TSC	M1	M2	M3	M4	M5	M6	M7	M8	Mean Net	OP
739	AFRICAN PARADISE-FLYCATCHER *Terpsiphone viridis*	RB	f		0	0	0	0	0	2	0	0	0	0.2	0	0	0	0	0	0	0	0	0.0	0
740	RED-BELLIED PARADISE-FLYCATCHER *Terpsiphone rufiventer*	RB	F		0	2	1	0	0	0	6	4	2	1.5	0	1	0	0	0	1	1	0	0.4	0
743	CHESTNUT WATTLE-EYE *Dyphorophyia castanea*	RB	FF		0	2	0	3	6	5	6	2	3	2.7	1	0	0	0	0	0	0	0	0.1	0
744	JAMESON'S WATTLE-EYE *Dyphorophyia jamesoni*	RB	FF		0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	1	1	0.3	0
755	BROWN ILLADOPSIS *Illadopsis fulvescens*	RB	FF		0	0	0	1	0	5	0	0	0	1.2	0	1	4	4	3	0	0	3	1.9	0
757	SCALY-BREASTED ILLADOPSIS *Illadopsis albipectus*	RB	FF		0	3	4	0	0	6	2	0	3	2.4	0	1	1	1	0	1	2	1	0.9	0
784	OLIVE SUNBIRD *Cyanomitra olivacea*	RB	FF		0	5	5	0	6	6	0	4	0	2.6	1	2	3	4	1	3	6	2	2.7	0
794	COLLARED SUNBIRD *Hedydipna collaris*	RB	F		0	0	0	0	0	0	0	4	0	0.4	0	0	0	0	0	0	0	0	0.0	0
796	OLIVE-BELLIED SUNBIRD *Cinnyris chloropygia*	RB	F		0	0	5	0	0	0	0	0	4	1.8	0	0	0	0	0	0	0	0	0.0	0
811	YELLOW WHITE-EYE *Zosterops senegalensis*	RB	f		0	1	0	0	0	0	0	0	0	1.0	0	0	0	0	0	0	0	0	0.0	0
831	BROWN-CROWNED TCHAGRA *Tchagra australis*	RB			0	3	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0.0	0
848	WESTERN BLACK-HEADED ORIOLE *Oriolus brachyrhynchus*	RB	F		0	0	0	5	2	6	6	6	6	4.3	0	0	0	0	0	0	0	0	0.0	0
853	FORK-TAILED DRONGO *Dicrurus adsimilis*	RB	f/F		0	0	0	0	0	2	0	0	0	0.2	0	0	0	0	0	0	0	0	0.0	0
937	GROSBEAK WEAVER *Amblyospiza albifrons*	RB	fW		0	0	0	2	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0.0	0
954	RED-HEADED BLUEBILL *Spermophaga ruficapilla*	RB	F		0	0	0	0	0	0	0	0	0	0.0	0	2	0	2	2	0	0	0	0.6	0
976	ZEBRA WAXBILL *Amandava subflava*	RB			0	0	0	0	0	0	0	0	0	0.0	1	0	2	0	0	0	0	0	0.4	0
	Count Totals[e]			Σ	9	18	16	22	17	26	30	25	27											
				new	9	20	4	11	3	4	8	5	1											
				ΣΣ	9	20	24	35	38	42	50	55	55											

Notes:

a Species numbers and names correspond to the Uganda bird check-list (NBDB, unpubl) and Carswell *et al* (2005) respectively

b RB = resident breeding species; R (B) refers to a species whose breeding is probable in Uganda but has not been confirmed, AfM is an Afrotropical migrant, PM a Palearctic migrant and NB means non-breeding. A query mark (?) indicates uncertainty.

c Specialisations of species are listed in Table B4

d Red Data species (IUCN, 2006; Bennun and Njoroge, 1996)

e Σ is the total number of species; these are accumulated by adding those species which were new in successive counts to give the running total (∑∑).

Appendix B2. Summary of bird count data from the smaller forests, and from the wayleave in Mabira, which is a non-forest site. There were two TSCs in the Mabira wayleave area (T9, 10); three in Kifu (K1, 2,3 and the mean KM) and one at Namyoya (N)

Atlas No[a]	Species	Status[b]	Spec[c]	RD[d]	T9	T10	KI	K2	K3	KM	N
26	BLACK-HEADED HERON *Ardea melanocephala*	RB	w		0	0	0	0	0	0	6
75	BLACK KITE *Milvus migrans*	RB, PM	pA		0	0	0	0	0	0	6
109	LIZARD BUZZARD *Kaupifalco monogrammicus*	RB	F		0	3	0	0	0	0	0
142	HELMETED GUINEAFOWL *Numida meleagris*	RB	G		0	0	0	0	0	0	1
168	WHITE-SPOTTED FLUEFFTAIL *Sarothrura pulchra*	RB	FW		1	4	4	6	0	3.3	0
270	TAMBOURINE DOVE *Turtur tympanistria*	RB	F		6	6	0	4	0	1.3	0
271	BLUE-SPOTTED WOOD-DOVE *Turtur afer*	RB	F		4	0	6	6	6	6.0	5
283	RED-EYED DOVE *Streptopelia semitorquata*	RB	f		0	0	3	0	0	1.0	3
290	GREY PARROT *Psittacus erithacus*	RB	FF	R-NT	5	0	0	0	0	0	5
296	GREAT BLUE TURACO *Corythaeola cristata*	RB	F		0	1	4	4	0	2.7	1
297	BLACK-BILLED TURACO *Tauraco schuetti*	RB	FF		0	5	0	0	0	0	0
302	ROSS'S TURACO *Musophaga rossae*	RB	F		0	0	6	0	0	2.0	0
305	EASTERN GREY PLANTAIN-EATER *Crinifer zonurus*	RB			0	0	6	0	0	2.0	2
309	RED-CHESTED CUCKOO *Cuculus solitarius*	RB, AfM/NB?	AF		0	0	5	5	0	3.3	5
314	DUSKY LONG-TAILED CUCKOO *Cercococcyx mechowi*	RB	FF		0	4	0	0	0	0	0
317	AFRICAN EMERALD CUCKOO *Chrysococcyx cupreus*	RB?	F		2	6	4	2	4	3.3	0
319	KLAAS' CUCKOO *Chrysococcyx klaas*	RB	f		0	5	4	0	0	1.3	4
320	DIEDERIK CUCKOO *Chrysococcyx caprius*	RB, AfM/(B)? PM			0	0	0	0	3	1.0	0
321	YELLOWBILL *Ceuthmochares aereus*	RB	F		0	1	0	0	0	0	0
323	WHITE-BROWED COUCAL *Centropus superciliosus*	RB			6	0	5	0	4	3.0	1
358	AFRICAN PALM SWIFT *Cypsiurus parvus*	RB			1	0	0	0	0	0	0
367	ALPINE SWIFT *Apus melba*	RB	p		4	0	0	0	0	0	0
369	SPECKLED MOUSEBIRD *Colius striatus*	RB			0	0	0	1	4	1.7	4
371	NARINA'S TROGON *Apaloderma narina*	RB	F		1	6	0	0	0	0	0
375	WOODLAND KINGFISHER *Halcyon senegalensis*	PM, RB	A		0	0	5	0	3	2.7	0
378	AFRICAN PYGMY KINGFISHER *Ceyx picta*	RB, AfM/NB	fw		0	0	0	0	0	0	4
390	WHITE-THROATED BEE-EATER *Merops albicollis*	AfM/NB, FB, PM	Af		0	1	0	0	0	0	0
401	BROAD-BILLED ROLLER *Eurystomus glaucurus*	RB, AfM/NB?	Afw		0	0	6	1	6	4.3	0
419	CROWNED HORNBILL *Tockus alboterminatus*	RB	f		0	0	5	0	0	1.7	0
422	BLACK-AND-WHITE CASQUED HORNBILL *Bycanistes subcylindricus*	RB	F		5	6	6	3	6	5.0	6
426	SPECKLED TINKERBIRD *Pogoniulus scolopaceus*	RB	F		0	6	0	2	5	2.3	0
430	YELLOW-THROATED TINKERBIRD *Pogoniulus subsulphureus*	RB	FF		5	6	6	1	6	4.3	0
431	YELLOW-RUMPED TINKERBIRD *Pogoniulus bilineatus*	RB	F		6	6	5	0	4	3.0	6

Atlas No[a]	Species	Status[b]	Spec[c]	RD[d]	T9	T10	KI	K2	K3	KM	N
434	YELLOW-SPOTTED BARBET *Buccanodon duchaillui*	RB	FF		6	0	0	0	6	2.0	0
435	HAIRY-BREASTED BARBET *Tricholaema hirsuta*	RB	F		1	0	0	0	0	0	0
445	YELLOW-BILLED BARBET *Trachyphonus purpuratus*	RB	FF		1	6	3	0	0	1.0	0
456	LESSER HONEYGUIDE *Indicator minor*	RB	f		0	0	0	5	0	1.7	0
498	WHITE-HEADED SAW-WING *Psalidoprocne albiceps*	RB, AfM/NB?	f	R-RR	0	3	0	2	6	2.7	0
505	LESSER STRIPED SWALLOW *Hirundo abyssinica*	RB			0	0	0	0	1	0.3	0
538	LITTLE GREENBUL *Andropadus virens*	RB	F		5	6	6	6	6	6.0	0
542	YELLOW-WHISKERED GREENBUL *Andropadus latirostris*	RB	F		6	0	0	0	0	0	0
558	RED-TAILED BRISTLEBILL *Bleda syndactyla*	RB	FF		4	0	0	0	0	0	0
559	GREEN-TAILED BRISTLEBILL *Bleda eximia*	RB	FF		0	6	0	0	0	0	0
561	RED-TAILED GREENBUL *Criniger calurus*	RB	FF		0	5	0	0	0	0	0
562	COMMON BULBUL *Pycnonotus barbatus*	RB	f		0	0	0	5	4	3.0	5
563	WESTERN NICATOR *Nicator chloris*	RB	F		2	2	0	0	0	0	0
584	RUFOUS FLYCATCHER-THRUSH *Stizorhina fraseri*	RB	FF	G-VU	5	6	0	0	0	0	0
638	RED-FACED CISTICOLA *Cisticola erythrops*	RB	w		0	0	0	0	0	0	3
647	WINDING CISTICOLA *Cisticola galactotes*	RB	w		0	0	0	0	0	0	2
658	TAWNY-FLANKED PRINIA *Prinia subflava*	RB	fw		0	0	0	0	0	0	5
662	WHITE-CHINNED PRINIA *Prinia leucopogon*	RB	F		0	0	1	5	0	2.0	0
670	BLACK-THROATED APALIS *Apalis jacksoni*	RB	FF		2	5	0	0	0	0	0
677	GREY-BACKED CAMAROPTERA *Camaroptera brachyura*	RB	f		4	5	0	5	4	3.0	5
709	GREEN HYLIA *Hylia prasina*	RB	F		4	0	0	3	2	1.7	0
719	ASHY FLYCATCHER *Muscicapa caerulescens*	RB	F		4	0	0	0	0	0	0
742	BLACK-AND-WHITE SHRIKE-FLYCATCHER *Bias musicus*	RB	f		0	0	0	0	1	0.3	0
746	BROWN-THROATED WATTLE-EYE *Platysteira cyanea*	RB	f		0	0	0	6	0	2.0	2
755	BROWN ILLADOPSIS *Illadopsis fulvescens*	RB	FF		6	0	0	0	0	0	0
757	SCALY-BREASTED ILLADOPSIS *Illadopsis albipectus*	RB	FF		6	0	0	0	0	0	0
796	OLIVE-BELLIED SUNBIRD *Cinnyris chloropygia*	RB	F		4	5	0	0	4	1.3	5
809	SUPERB SUNBIRD *Cinnyris superba*	RB	F		0	0	0	4	0	1.3	0
810	COPPER SUNBIRD *Cinnyris cuprea*	RB	fw		0	0	0	0	0	0	3
831	BROWN-CROWNED TCHAGRA *Tchagra australis*	RB			0	0	0	0	0	0	3
848	WESTERN BLACK-HEADED ORIOLE *Oriolus brachyrhynchus*	RB	F		6	6	0	0	0	0	0
871	SPLENDID GLOSSY STARLING *Lamprotornis splendidus*	AfM/NB? RB	F		0	0	2	1	4	2.3	6
872	RÜPPELL'S LONG-TAILED STARLING *Lamprotornis purpuropterus*	RB			0	0	2	0	0	0.7	0
893	BAGLAFECHT WEAVER *Ploceus baglafecht*	RB	f		0	0	0	0	0	0	2
896	BLACK-NECKED WEAVER *Ploceus nigricollis*	RB	f		0	0	0	0	0	0	1

Atlas No[a]	Species	Status[b]	Spec[c]	RD[d]	T9	T10	KI	K2	K3	KM	N
897	SPECTACLED WEAVER *Ploceus ocularis*	RB	f		0	0	0	0	1	0.3	0
907	VIEILLOT'S BLACK WEAVER *Ploceus nigerrimus*	RB	f		0	0	0	0	0	0	4
908	BLACK-HEADED WEAVER *Ploceus cucullatus*	RB			0	0	0	1	0	0.3	0
913	YELLOW-MANTLED WEAVER *Ploceus tricolor*	RB	FF		0	0	0	1	0	0.3	0
932	FAN-TAILED WIDOWBIRD *Euplectes axillaris*	RB	w		0	0	0	0	0	0	1
937	GROSBEAK WEAVER *Amblyospiza albifrons*	RB	fW		0	0	0	0	0	0	3
942	WHITE-BREASTED NEGROFINCH *Nigrita fusconota*	RB	F		0	0	0	0	1	0.3	0
970	BLACK-CROWNED WAXBILL *Estrilda nonnula*	RB	f		0	0	0	0	0	0	3
980	BRONZE MANNIKIN *Lonchura cucullata*	RB			0	0	0	0	4	1.3	5
981	BLACK-AND-WHITE MANNIKIN *Lonchura bicolor*	RB	f		0	0	0	0	0	0	3
995	YELLOW-FRONTED CANARY *Serinus mozambicus*	RB			0	0	0	0	0	0	3

Notes a to d: see Appendix B1

*Appendix B3. **Bird records from Lubigi wetland***

Atlas[a] No.	Species	Status[b]	Spc[c]	RD[d]	TSC scores Site1	Site2	Site 3	Site 4	Site 5	Site 6	Mean
9	PINK-BACKED PELICAN *Pelecanus rufescens*	RB	W		5						0.8
14	COMMON SQUACCO HERON *Ardeola ralloides*	WV?, AfM/NB?, RB	W						4	3	1.2
17	CATTLE EGRET *Bubulcus ibis*	RB	G		5	5			4	2	2.7
21	LITTLE EGRET *Egretta garzetta*	RB	W							4	0.7
23	GREAT [=WHITE] EGRET *Casmerodius alba*	RN?, AfM/NB?	W	R-VU						5	3.8
24	PURPLE HERON *Ardea purpurea*	RB? FB	W	R-NT						1	0.2
25	GREY HERON *Ardea cinerea*	RB? FB, OW?	W	R-NT						4	0.7
26	BLACK-HEADED HERON *Ardea melanocephala*	RB	w							4	0.7
28	HAMERKOP *Scopus umbretta*	RB	w		6	6	3			6	3.5
36	MARABOU STORK *Leptoptilos crumeniferus*	RB, AfM/B	w		4	6	6	3			3.2
39	HADADA *Bostrychia hagedash*	RB	w		5					1	1.0
75	BLACK KITE *Milvus migrans*	RB, PM	pA							2	0.3
80	HOODED VULTURE *Necrosyrtes monachus*	RB	f		5	1	6	3			2.5
90	AFRICAN HARRIER-HAWK *Polyboroides typus*	RB	f						1		0.2
93	AFRICAN MARSH HARRIER *Circus ranivorus*	R(B)	W	R-NT						5	0.8
109	LIZARD BUZZARD *Kaupifalco monogrammicus*	RB	F						6		1.0
117	WAHLBERG'S EAGLE *Aquila wahlbergi*	AfM/NB, RB	Af						1		0.2
132	GREY KESTREL *Falco ardosiaceus*	RB							1		0.2
178	BLACK CRAKE *Amaurornis flavirostris*	RB	W			5				1	1.0
185	GREY CROWNED CRANE *Balearica regulorum*	RB, AfM/NB?	WG	R-NT						1	0.2
221	AFRICAN WATTLED LAPWING [=PLOVER] *Vanellus senegallus*	RB	W		3						0.5
268	AFRICAN GREEN-PIGEON *Treron calva*	RB	F				2				0.3
270	TAMBOURINE DOVE *Turtur tympanistria*	RB	F					2	2	1	0.8
271	BLUE-SPOTTED WOOD-DOVE *Turtur afer*	RB	F		4			2		1	1.2
283	RED-EYED DOVE *Streptopelia semitorquata*	RB	f		6		5		5	2	3.0
289	LAUGHING DOVE *Streptopelia senegalensis*	RB			5		1		2		1.3
293	RED-HEADED LOVEBIRD *Agapornis pullaria*	AfM/NB? RB	F				1	6			1.2
305	EASTERN GREY PLANTAIN-EATER *Crinifer zonurus*	RB							6	6	2.0
317	AFRICAN EMERALD CUCKOO *Chrysococcyx cupreus*	RB?	F						5		0.8
319	KLAAS' CUCKOO *Chrysococcyx klaas*	RB	f			1					0.2
320	DIEDERIK [=DIDRIC] CUCKOO *Chrysococcyx caprius*	RB, AfM/(B)? PM							3		0.5

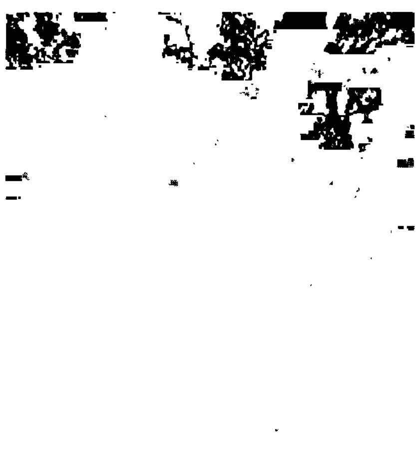
Atlas[a] No.	Species	Status[b]	Spc[c]	RD[d]	TSC scores						
					Site1	Site2	Site 3	Site 4	Site 5	Site 6	Mean
326	BLUE-HEADED COUCAL *Centropus monachus*	RB	W		1		2			1	0.7
358	AFRICAN PALM SWIFT *Cypsiurus parvus*	RB						1			0.2
369	SPECKLED MOUSEBIRD *Colius striatus*	RB			6			4	6		2.7
375	WOODLAND KINGFISHER *Halcyon senegalensis*	PM, RB								1	0.2
385	LITTLE BEE-EATER *Merops pusillus*	RB	G						6		1.0
386	BLUE-BREASTED BEE-EATER *Merops variegatus*	RB	W						2		0.3
390	WHITE-THROATED BEE-EATER *Merops albicollis*	AfM/NB, FB, PM	Af		6		6	5			2.8
392	BLUE-CHEEKED BEE-EATER *Merops persicus*	WV, PM	P					5			0.8
401	BROAD-BILLED ROLLER *Eurystomus glaucurus*	RB, AfM/NB?	Afw		5	4	3	6	6		4.0
419	CROWNED HORNBILL *Tockus alboterminatus*	RB	f						5		0.8
433	YELLOW-FRONTED TINKERBIRD *Pogoniulus chrysoconus*	RB	f				1				0.2
443	DOUBLE-TOOTHED BARBET *Lybius bidentatus*	RB	f		5				6		1.8
465	NUBIAN WOODPECKER *Campethera nubica*	RB					5			1	1.0
498	WHITE-HEADED SAW-WING [=ROUGHWING] *Psalidoprocne albiceps*	RB, AfM/NB?	f	R-RR				1		2	0.5
512	ANGOLA SWALLOW *Hirundo angolensis*	RB, AfM/B?	w			3					0.5
520	AFRICAN PIED WAGTAIL *Motacilla aguimp*	RB	w							2	0.3
529	YELLOW-THROATED LONGCLAW *Macronyx croceus*	RB	G		6		1	6			2.2
538	LITTLE GREENBUL *Andropadus virens*	RB	F				6	4	2		2.0
547	YELLOW-THROATED GREENBUL [=LEAFLOVE] *Chlorocichla flavicollis*	RB	f				6				1.0
562	COMMON BULBUL *Pycnonotus barbatus*	RB	f		5	6	6		6	2	4.2
576	WHITE-BROWED ROBIN-CHAT *Cossypha heuglini*	RB	f				6				1.0
615	WHITE-WINGED WARBLER *Bradypterus carpalis*	R(B)	E, W		5		9		1	5	2.8
621	AFRICAN MOUSTACHED WARBLER *Melocichla mentalis*	RB							4		0.7
630	GREATER SWAMP WARBLER *Acrocephalus rufescens*	RB	e,W		6	6	2		4	5	0.8
631	LESSER SWAMP WARBLER *Acrocephalus gracilirostris*	RB	w							1	0.2
638	RED-FACED CISTICOLA *Cisticola erythrops*	RB	w		5				6		1.8
647	WINDING CISTICOLA *Cisticola galactotes*	RB	w		6	6	6		5	6	4.8
648	CARRUTHERS'S CISTICOLA *Cisticola carruthersi*	RB	E, W	R-RR	5		4	6		6	3.5
658	TAWNY-FLANKED PRINIA *Prinia subflava*	RB	fw				5				0.8
662	WHITE-CHINNED PRINIA *Prinia leucopogon*	RB	F		5		6				1.8
677	GREY-BACKED CAMAROPTERA *Camaroptera brachyura*	RB	f						6	1	1.2
701	GREY-CAPPED WARBLER *Eminia lepida*	RB	fw	R-RR	3	5	6	6	1	6	4.5
720	SWAMP FLYCATCHER *Muscicapa aquatica*	RB	W		1					2	0.5

Atlas[a] No.	Species	Status[b]	Spc[c]	RD[d]	TSC scores						
					Site1	Site2	Site 3	Site 4	Site 5	Site 6	Mean
746	BROWN-THROATED WATTLE-EYE *Platysteira cyanea*	RB	f				5				0.8
764	BLACK-LORED BABBLER *Turdoides sharpei*	RB		R-RR	6						1.0
781	GREEN-HEADED SUNBIRD *Cyanomitra verticalis*	RB	F		3					4	1.2
784	OLIVE SUNBIRD *Cyanomitra olivacea*	RB	FF		2	3		6			1.8
787	SCARLET-CHESTED SUNBIRD *Chalcomitra senegalensis*	RB	f				6	5		5	2.7
802	MARICO [=MARIQUA] SUNBIRD *Cinnyris mariquensis*	RB			2			5			1.2
803	RED-CHESTED SUNBIRD *Cinnyris erythrocerca*	RB	W	R-RR	5				6	6	2.8
810	COPPER SUNBIRD *Cinnyris cuprea*	RB	fw			6		6			2.0
815	GREY-BACKED FISCAL *Lanius excubitoroides*	RB	Afw			6					1.0
828	SULPHUR-BREASTED BUSH-SHRIKE *Malaconotus sulfureopectus*	RB? AfM/B?	f						4		0.7
830	MARSH TCHAGRA *Tchagra minutus*	RB	w						2		0.3
842	PAPYRUS GONOLEK *Laniarius mufumbiri*	R(B)	E, w		6	6	2		6	6	4.3
843	BLACK-HEADED GONOLEK *Laniarius erythrogaster*	RB	f				6		5		1.8
855	PIED CROW *Corvus albus*	RB			4	2				2	1.3
872	RÜPPELL'S LONG-TAILED [=GLOSSY] STARLING *Lamprotornis purpuropterus*	RB			1	4	1	6			2.0
881	GREY-HEADED SPARROW *Passer griseus*	RB				3				2	0.8
894	SLENDER-BILLED WEAVER *Ploceus pelzelni*	RB	fW		4	5			5	3	2.8
897	SPECTACLED WEAVER *Ploceus ocularis*	RB	f				6				1.0
908	BLACK-HEADED WEAVER *Ploceus cucullatus*	RB								3	0.5
910	YELLOW-BACKED WEAVER *Ploceus melanocephalus*	RB	W						4	1	0.8
911	GOLDEN-BACKED WEAVER *Ploceus jacksoni*	RB	w	R-RR			6				1.0
915	COMPACT WEAVER *Ploceus superciliosus*	RB	fw				5		1		1.0
932	FAN-TAILED WIDOWBIRD *Euplectes axillaris*	RB	w				6	6	6	2	3.3
943	WHITE-COLLARED OLIVEBACK *Nesocharis ansorgei*	R(B)	fw	R-RR					1		0.2
959	RED-BILLED FIREFINCH *Lagonosticta senegala*	RB					2				0.3
969	COMMON WAXBILL *Estrilda astrild*	RB	wG		5	6	5	4			3.3
980	BRONZE MANNIKIN *Lonchura cucullata*	RB			2	6	6		1	6	3.5
981	BLACK-AND-WHITE MANNIKIN *Lonchura bicolour*	RB	f		1		5	4			1.7
995	YELLOW-FRONTED CANARY *Serinus mozambicus*	RB				1				1	0.3
		Σ			37	23	37	23	38	43	

Notes: a to d are as for Appendix B1.

Appendix M1. Mammal species recorded along the various transects and locations surveyed in Mabira Forest.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	General Wayleave
Insectivora									
Uganda forest Musk Shrew *(Crocidura selina)*		√		√					
Northern Giant Musk Shrew *(Crocidura olivieri)*								√	
Hero Shrew *(Scutisorex somereni)*					√	√	√	√	
Chiroptera									
Straw colored Fruit Bat *(Eidolon helvum)*	√	√						√	
Little epauletted Fruit Bat *(Epomophorus labiatus)*		√						√	√
Africaan Long-tongued Fruit Bat *(Megaloglossus woermanni)*									√
Bocage's Fruit Bat (*Rousettus angolensis)*			√		√		√	√	
Noack's Leaf-nosed Bat (*Hipposideros rubber)*						√			
Halcyon Horseshoe Bat (*Rhinolophus alcyone)*		√	√			√		√	
Banana Bat (*Pipistrellus nanus)*									√
Primates									
Red tailed Monkey (*Cercopithecus ascanius)*	√	√	√	√	√	√	√	√	
Galago (*Galago senegalensis)*		√							
Grey Cheeked Mangabey *(Cercocebus abigena)*							√		
Carnivora									
Marsh Mongoose (*Atilax paludinosus)*									√
Forest Genet (*Genetta victoriae)*					√				
Dwarf Mongoose (*Hologale parvula)*						√			√
Slender Mongoose (Herpestes ichneumon)							√		
Side Striped Jackal (*Canis adustus*)									√
Serval Cat (*Felis serval*)									√
Pholidota									
Tree Pangolin (*Manis tricupsis)*				√					
Hyracoidea									
Tree Hyrax (*Dendrohyrax aboreaus)*	√	√	√	√	√	√	√	√	
Artiodactyla									
Blue Duiker (*Cephalophus monticola)*			√	√					
Bushpig (*Potamochoerus porcus)*			√						
Red Forest Duiker (*Cephalophus harveyi)*			√						
Bushbuck (*Tragelaphus scriptus)*			√						
Rodentia									
Congo forest Rat (*Deomys ferugeneous)*					√				
Stella Wood Mouse (*Hylomyscus stella)*	√		√	√		√	√		
Eastern B rush-furred Mouse (*Lophuromys flavopunctatus)*			√					√	
Common Brush furred Mouse (*Lophuromys sikapusi)*			√						
Peter's Stripped Mouse (*Hybomys univitattus)*			√		√				
Long footed rat (*Malacomys longipes)*			√						
Jackson's Soft-furred Rat (*Praomys jacksoni)*			√		√	√	√	√	
Stripped Ground Squirrel (Xerus erythropus)					√				
Brush tailed Porcupine (*Atherurus africanus*)			√						
Macroscelidea									
Giant Elephant Shrew (*Rhynchocyon cirnei)*		√							
Totals	4	8	15	6	9	8	8	10	7



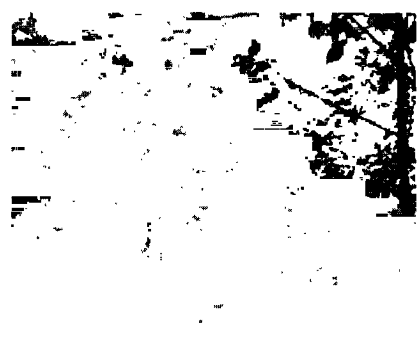
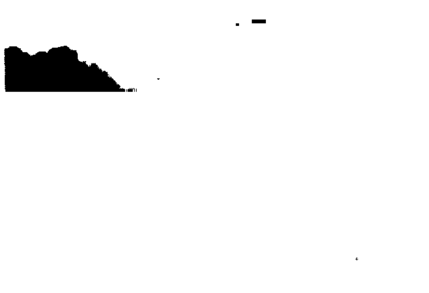
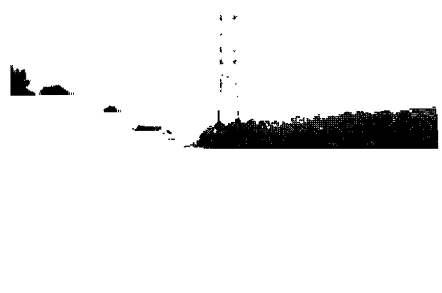


Plate 1: Some of the bigger diameter trees that are found in the sites 5, 6,7 and 8 (Cluster M1 of Figure P3) of Mabira forest. *Dracaena fragrans*, a common forest floor shrub is in the foreground.

Plate 2: A *Broussonetia papyrifera* dominated stand. This species is characteristic of study Sites 1 and 2 in Mabira forest.

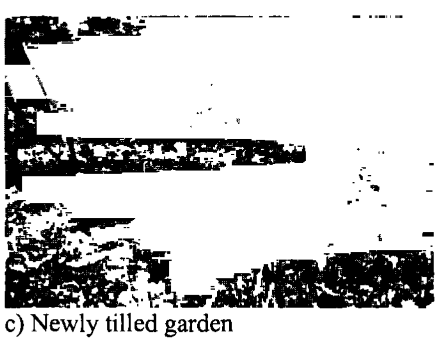


a)

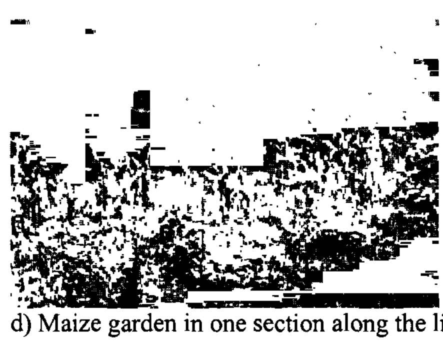


b)

Garden of Cassava either side of the transmission line in Mabira (a & b)



c) Newly tilled garden



d) Maize garden in one section along the line

Plate 3(a- d): Various scenes of cultivation along the transmission line in Mabira forest towards Wasswa Village

a) b)

Plate 4: Transmission line rising over the canopy (a & b) at the low points in the forest

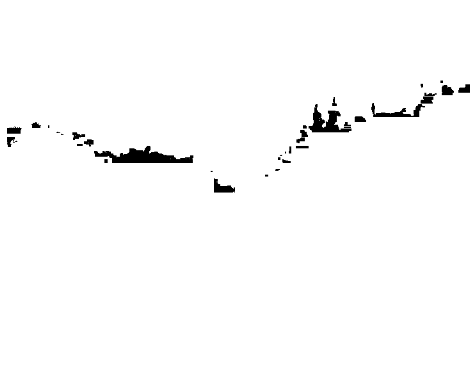


Plate 5: Dense growth of vegetation along wayleave in Kifu

Plate 6: Regeneration in Kifu Forest within *Maesopsis eminii*

Plate 7: A plantation of *Auracaria cunninghamii* on the immediate northern side of the existing power line in Kifu forest reserve.

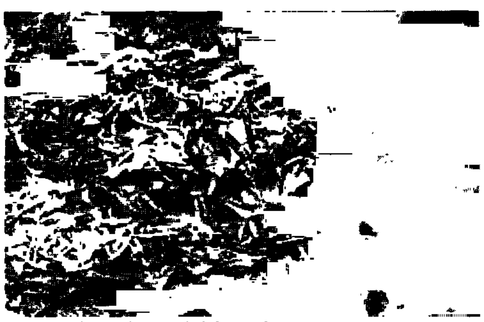
Plate 8: A variety of ongoing/existent human impacts that we recorded in Lubigi Wetlands (a – h)


a. Cultivation


b. Hollows left after mining sand or clay

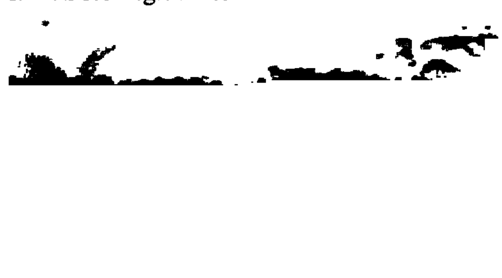

c. An area Quarried for rocks


d. Biodegradable Refuse dumping


e. Non bio-degradable refuse


f. Non bio degradable after its burnt


g. A variety of domestic refuse


h. Papyrus harvesting

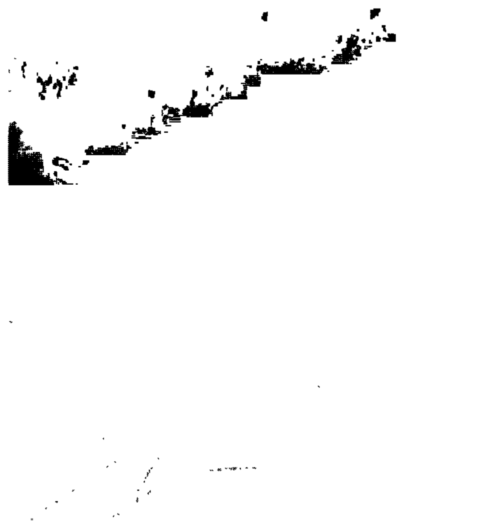


Plate 9: A transect located through a thick *papyrus* stand at Site 1

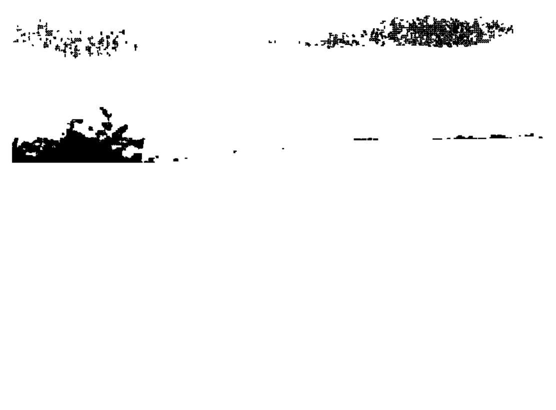
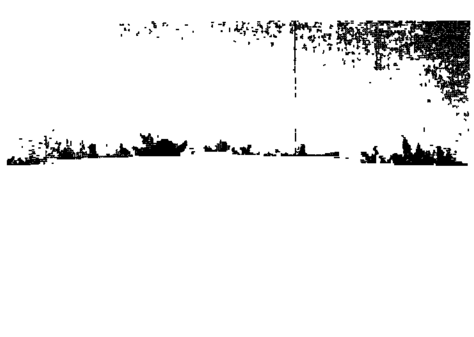


Plate 10: Another human impact Block *Cyperus* Making in Lubigi

Plate 11: Different vegetation communities that characterise the Lubigi Swamp

a. *Phoenix reclinata* and *Alchornea cordifolia* dominated swamp fringes

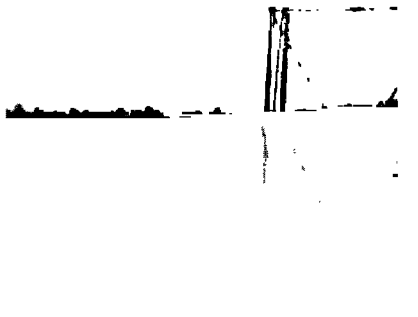
b. *Cyperus* and *Scleria* dominated seasonally flooded grassland



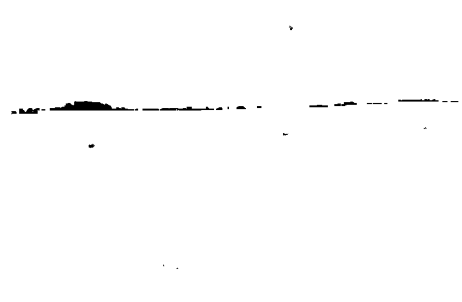
c. *Aeschynomene indica* dominated swamp fringe

d. Papyrus & Phoenix co-dominated Swamp fringes

Plate 12: Situational photos taken in Namyoya/ Mwola Forest

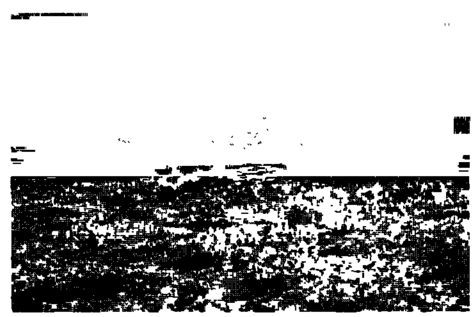


a) Pylon 51 facing towards the tea plantations

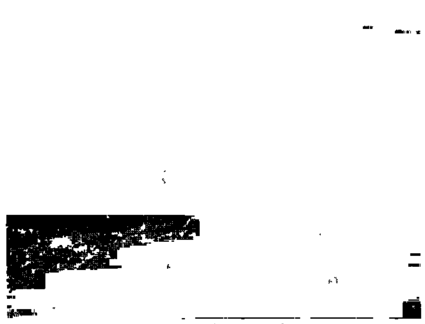


b) *Eucalyptus* plantations in the fore ground

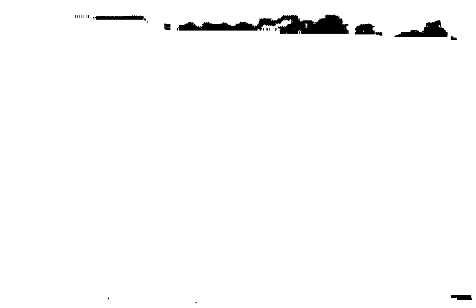
c) Maize growing in the *Eucalyptus*



d) Field of harvested *Eucalyptus*



e) Field of harvested *Eucalyptus*



f) Field of harvested *Eucalyptus*

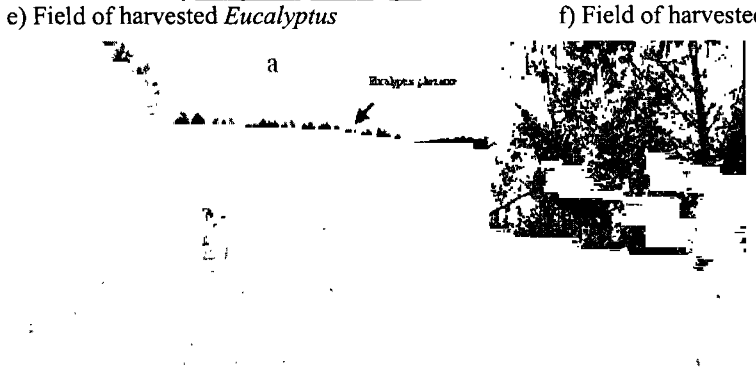
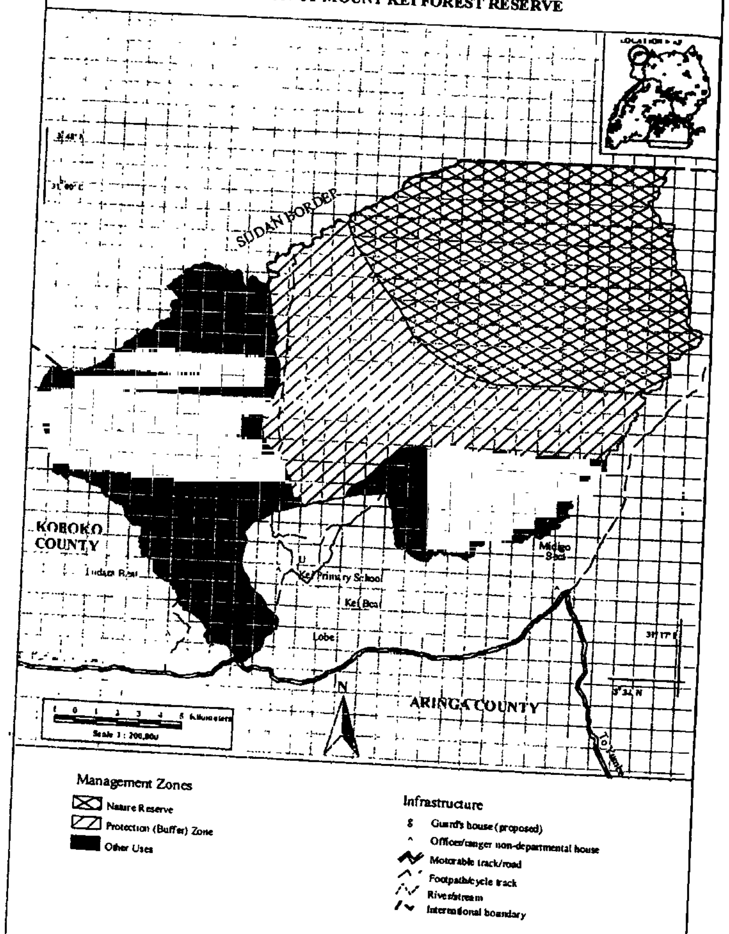


Plate 13: The *Eucalyptus* plantation on the immediate northern side of the existing power line in Namyoya forest reserve: (a) the plantation landscape view (b) the *Eucalyptus* stand

BURNSIDE

Appendix B.4
Excerpts from NFA's Forest Nature Conservation Plan, March 1999

Fig A15.1 ZONATION OF MOUNT KEI FOREST RESERVE



APPENDIX 16 MABIRA FOREST PROFILE
(Category CORE conservation forest)

1 Basis for selection

The forest was selected for Nature Reserve establishment in recognition of its biodiversity importance, especially because

- the site contributes more than 1% of the national protected area system complement
- the site supports at least one unique species of tree of conservation importance
- the site supports vegetation type D1 (Langdale - Brown et al 1964) otherwise not represented in protected area system of Uganda

2 Physical description

Area and demarcation Area 306 km^2 (311 km^2, with Namananga Namawanyi), with a total boundary length 343.4 km, all adjoining community lands. The boundary is largely artificial maintained as a cut-line with corner cairns and directional trenches

Establishment First established under the Buganda Agreement (1900) and later formally gazetted in 1932

Location On the Kampala-Jinja highway at about 54 km from Kampala and 26 km from Jinja, 20 km north of the Lake Victoria shoreline in central Uganda, between 0°24'-0°35' N and 32° 52'-33° 07' E. The reserve occupies part of counties of Ntenjeru Nakifuma Buikwe and Mukono, all in Mukono District. Covered by Uganda Department of Lands and Surveys map sheets 61/4, 62/3, 71/2 and 72/1 at 1:50,000

Physical features The reserve occupies gently undulating terrain with numerous flat-topped hills with altitudes of 1070-1340 m a s l, with less than 10% exceeding 5° slope. The area is drained by two main rivers the Musamya and Sezibwa which flow northwards into Lake Kyoga

3 Vegetation and forest condition

The majority of the area (292km^2 95%) is occupied by Tropical High Forest communities, classified as type D1 (*Celtis-Chrysophyllum* medium altitude moist semi-deciduous forest) and the remainder (5%) by *Piptadeniastrum-Albizia-Celtis* medium altitude moist evergreen forest (Langdale Brown et al 1964). Human activities have greatly influenced the forest condition making some areas characteristic sub-climaxes. Sub-types of vegetation present are young or colonising mixed forest, dominated by *Maesopsis eminii* (25%), young mixed *Celtis holoptelea* (60%) and mixed forest of wet valley bottoms dominated by *Baikeae insignis*

A detailed forest type map is available at Forest Department headquarters based on the 1950s aerial photography and also reproduced in Howard (1991)

The forest is largely disturbed by human activity (overall condition score 2) mainly because it is located between the two largest urban centres in Uganda, and the area is largely accessible. There has been extensive pitsawing activity and agricultural encroachment (1973-1987). Hunting is widespread

Forest integrity scores Settlement = 2 Hunting = 2 Livestock = 1 Timber = 4 Fire = 0 Community = 3 Mining = 1

4 Economic importance

Community use values The forest is situated in one of the most densely populated parts of the country (235 people per km^2 in 1991). Pressure on the peripheral areas of the forest for firewood, building poles and non-timber forest products is correspondingly high. The forest is largely accessible because of the presence of village enclaves and roads leading to them. The "community-use" value of the reserve is 20 and it is thus potentially very important economically to the communities around, and for the two nearest towns; Jinja and Kampala.

Timber production: The forest is an important source of pitsawn timber, providing a registered annual off take of about 4,284m^3 of sawn timber over the period 1994-96 (Table 16.1), as well as large volumes of illegally cut timber. A timber inventory by Forest Department (in 1992) provided an estimate of 60m^3 per ha. standing volumes of merchantable timber exceeding 50 cm dbh. Records showing the number of registered pitsawyers do not exist. However, timber volumes over the period 1964-1996 are indicated in Table 16.1.

Table 16.1 Timber production in Mabira: 1964-1996

Period	Sawmill	Volume (m^3)
1964-1974	Sick Sawmill & Ginners Ltd.	15,694
1973-1980	Kiira Sawmill & Plywood Factory	16,321
1981-1989	Kiira Sawmill & Plywood Factory	19,041
1990- 1993	Kiira Sawmill & Plywood Factory	-
1994-1996 (July)	Nile Plywood (U) Ltd	2,907
1994- 1996 (July)	Jinja Construction and Joinery Ltd.	1,377
	Total	**55,340**

Nadagi compartment (479 ha) has been put aside for the establishment of eucalyptus plantations with temporary permits being issued to potential farmers, and there is potential for expansion of this programme.

Other economic values: The reserve has been locally important as a source of building poles, firewood and medicinal compounds. It has also been important for the production of charcoal. It is located between two of the major urban centres in Uganda, and has potential for ecotourism development based on such attractions as the luxurious flora and fauna, and the scenic rivers Musamya and Sezibwa (on which falls are located). The reserve is important for biodiversity (see below) and thus offers scope for the development of a research and education role.

5 Biodiversity values

Of the 65 forest reserves investigated for biodiversity, Mabira does not score among the highest in terms of overall biodiversity, ranking 24th (score =13.1), but ranks 19th in terms of the rarity value of species represented. The forest supports 9 species found in no other Ugandan forest (including 6 butterflies, 1 moth, 1 bird and 1 tree) and one species endemic to Uganda (Table 16.4). It presents the only block of medium altitude moist semi-deciduous forest type D1 (Langdale-Brown et al., 1964) in the protected area system, a vegetation type that does not occur in any of the country's National Parks or Wildlife Reserves.

6 Present management

The reserve is managed from Lwankima Forest Station, by a Forest Officer. The Mukono District forest office plays a supervisory role. Table 16.2 shows the staffing position for Mabira Forest Reserve. There are three Forest Officers, stationed at Lwankima, Maliata and Najjembe. The one at Najjembe works specifically on tourism development. In addition, a total of 3 Assistant Forest Officers, 8 Forest Rangers and 9 Forest Guards assist in the management of this important forest, and are based at various forest stations as indicated in Table 16.2.

The department has six staff houses at Lwankima Forest Station, the local headquarters of the reserve, and has endeavoured to offer ample housing at all the 12 forest stations on this reserve as indicated in Table 16.3.

Table 16.2 Existing and proposed staff deployment at Mabira forest

	Existing (proposed) number of staff by category					
Station	**FO**	**AFO**	**F.R**	**F.G**	**PM**	**Total**
Lwankima	1 (0)	1 (0)	1* (1)	1* (2)	4 (0)	8 (3)
Maligita	1 (0)	0 (0)	0 (1)	1 (0)	2 (0)	4 (1)
Namawanyi	0 (0)	0 (0)	0 (0)	1 (0)	1 (1)	2 (1)
Naluvule	0 (0)	0 (0)	0 (0)	0 (1)	1 (0)	1 (1)
Kyabana	0 (0)	0 (0)	1 (0)	1* (0)	1 (0)	3 (0)
Buwoola	0 (0)	0 (0)	1 (2)	1 (0)	1 (0)	3 (2)
Najjembe	1 (0)	0 (0)	1* (0)	1 (0)	0 (1)	3 (1)
Wanende	0 (0)	0 (0)	1* (0)	0 (1)	4 (0)	5 (1)
Nandagi	0 (0)	1 (0)	1* (0)	0 (1)	0 (1)	2 (2)
Nagojje	0 (0)	1 (0)	1* (0)	1 (0)	2 (0)	5 (0)
Namulaba	0 (0)	0 (0)	1 (0)	1 (0)	1 (1)	3 (1)
Nazigo	0 (0)	0 (0)	0 (0	1 (0)	0 (2)	1 (2)
Total	**3 (0)**	**3 (0)**	**3 + 5* (4)**	**7 + 2* (5)**	**17 (6)**	**40(15)**

Note: FO - Forest Officer FG - Forest Guard AFO - Assistant Forest Officer PM - Patrol Man
FR - Forest Ranger, * denotes temporary employment on EU Project, not Government employee.

Table 16.3 shows the status of housing in Mabira Forest Reserve and the proposed requirements in order to offer accommodation to all staff.

Table 16.3 Existing (proposed) staff housing

Station	FD old houses.	FD detached	FD semi	Uniport	Total
Lwankima	6(0)	0(0)	0(1)	2(0)	8(1)
Najjembe	1(0)	1(0)	1(1)	0(0)	3(1)
Wanende	0(0)	1(0)	2(0)	0(0)	3(0)
Buwoola	0(0)	0(0)	1(0)	0(0)	1(0)
Kyabaana	0(0)	1(0)	1(0)	0(0)	2(0)
Maligita	1(0)	1(0)	1(1)	4(0)	7(1)
Naluvule	0(0)	0(0)	1(0)	0(0)	1(0)
Namawanyi	0(0)	0(0)	1(0)	0(0)	1(0)
Nandagi	0(0)	0(0)	1(1)	2(0)	3(1)
Nazigo	1(0)	0(0)	0(0)	0(0)	1(0)
Namulaba	0(0)	1(1)	2(0)	0(0)	3(1)
Nagojje	5(0)	0(0)	0(0)	0(0)	5(0)
	14(0)	**5(1)**	**11(4)**	**8(0)**	**38(5)**

There are no bicycles or motorcycles to facilitate the management of the forest, inspite of the availability of a road network in the forest reserve. The latest (Interim) Management Plan covered the period (1994-1995) and prescribed for the conservation of the forest biodiversity, the protection of the area's important water catchment role and the maximum yield of hardwood timber. Although a Nature Reserve was proposed, actual demarcation did not take place and discussions were still going on for further changes to the zones. A detailed management plan to cover the period 1997-2007 is now under preparation.

In recent years (since 1990), with the support of the EU-financed Natural Forest Management and Conservation Project, some parts of the boundary have been redemarcated and few sections planted with live markers (see Fig. A16.1). An ecotourism project has also been established and further tourism development is expected.

7 Proposed zonation

Figure A16.1 shows the proposed zonation of the reserve, with one Nature Reserve (approximately 73 km²) one protection zone (approximately 30 km²), recreation zone (approximately 40 km²) and the rest of the reserve (Approximately 170 km²) as production zones.

The proposed Nature Reserve

It will cover the central portion of the forest reserve which is relatively intact. This has been selected to protect a viable area of semi-deciduous forest type D1 (Langdale Brown et. al., 1964), which is important because this is the only protected area in the country in which this forest type is represented.

The proposed protection zone

This will cover the area adjacent to the Nature Reserve with the aim of enhancing the long term viability of the latter. The proposed recreation zone is expected to centre around Najjembe (to the South) and around Musamya river (to the north, near the boundary). The zone encompasses the river and mashes called Musamya, which are a valuable habitat for a number of species of plants and animals, and are some of the most scenic areas of the forest.

The proposed production zones

These cover the majority of the reserve, including the areas that have already been heavily exploited by pitsawyers, the more accessible peripheral areas of the reserve; and most of the south-central parts of the reserve which adjoin a number of enclaves and are more suitable for timber production.

8 Proposed management programme

Staffing: The present staff is inadequate, and redeployment may also be necessary. Most areas lack forest workers; only patrolmen and Forest Guards occur, resulting in inadequate control, and not much labour work on the ground such as planting and boundary maintenance. The Forest Officer at Maligita does not have a Ranger to assist him in his duties. Furthermore, the Forest Guards at the various stations do not have properly motivated and facilitated patrolmen under them. Each guard would need at least four workers and two patrolmen to assist him/her.

Transport will be required as follows: 1-4 wheel drive vehicle for the FO and 3 motorcycles; 1 for Maligita to facilitate operation on the Eastern axis and another for Nagojje for the western part of the reserve, and finally, one for Lwankima forest station. Each Forest Ranger and FG should be facilitated with bicycles. The FO tourism needs to be facilitated with a 4-wheel drive vehicle to enable community outreach programmes, and the running of the visitor's centre. The Forest Officers in charge should be facilitated with transport to carry out effective patrols of the reserve as well as with a radio communication system.

Infrastructure: Four houses will be required for staff, at Lwankima (1 duplex), Najjembe (1 duplex), Namulaba (1 replacement), Maligita (1 duplex) and Nandagi (1 duplex). Details are indicated in Table 16.3.

Demarcation: Over 250 km of reopened external boundary lacks maintenance. Only a few short scattered sections have any remaining live markers. It is urgent that all these boundaries are attended to in this densely populated area. All internal management zone boundaries should be demarcated by ring-painting trees in the standard way. Red paint will be used to indicate Nature Reserve; yellow for 'buffer' zones. Sign boards will be erected wherever prominent footpaths cross (external and internal) boundaries.

Patrol and protection: Twelve patrol teams each comprising one Forest Guard and two patrolmen will be constituted with responsibility for safeguarding ranges as per the twelve forest stations. Men will be rotated between patrol teams and teams will be moved periodically between ranges. Patrol routes and checkpoints

will be established throughout the reserve. An incentive scheme will be instituted to reward success in curbing illegal activities.

Public access and community needs: One Forest Officer and two Forest Rangers (based at Najjembe and Maligita) will assume responsibility for community outreach programmes including the development of tourism activities, Joint Forest Management programmes within the reserve and community tree-planting programmes outside the boundary. A programme of village meetings should be instituted and developed to explain and discuss management of the reserve, and in particular the management zones as they are established. The staff will be facilitated as indicated under infrastructure.

Table 16.4: Summary Table of biodiversity values for Mabira Forest Reserve

Criteria	Trees & Shrubs	Birds	Mammals	Butterflies	Moths	Overall
Total No of species known	312	287	23	199	97	
No. of restricted range species (< 5 forests)	9	37	-	27	7	
Species unique for forest (list)	*Caesalpinia volkensii*	Tit Hylia	None	*Epitola catuna* *Pseudathyma plutonica* *Neptis trigonophora* *Sallya natalensis* *Acraea rogersi* *Caenides dacena*	*Orthogonioptilum* sp. C.	9 spp
Uganda endemics (list)	None	none	*Crocidura selina*			4 spp
Albertine Rift endemics (list)	*Grewia pubescens*	none	None	none	None	1 spp
Species diversity (score and rank)	6.5 (26=)	6.5 (24=)	5.4 (4.0)	6.9 (25=)	5.8 (30=)	6.4(22=)
Species rarity value (Score & rank)	7.2 (29=)	6.6 (14=)	5.4 (22=)	5.6 (15=)	6.8 (+5=)	6.7(19=)

Overall biodiversity score 13

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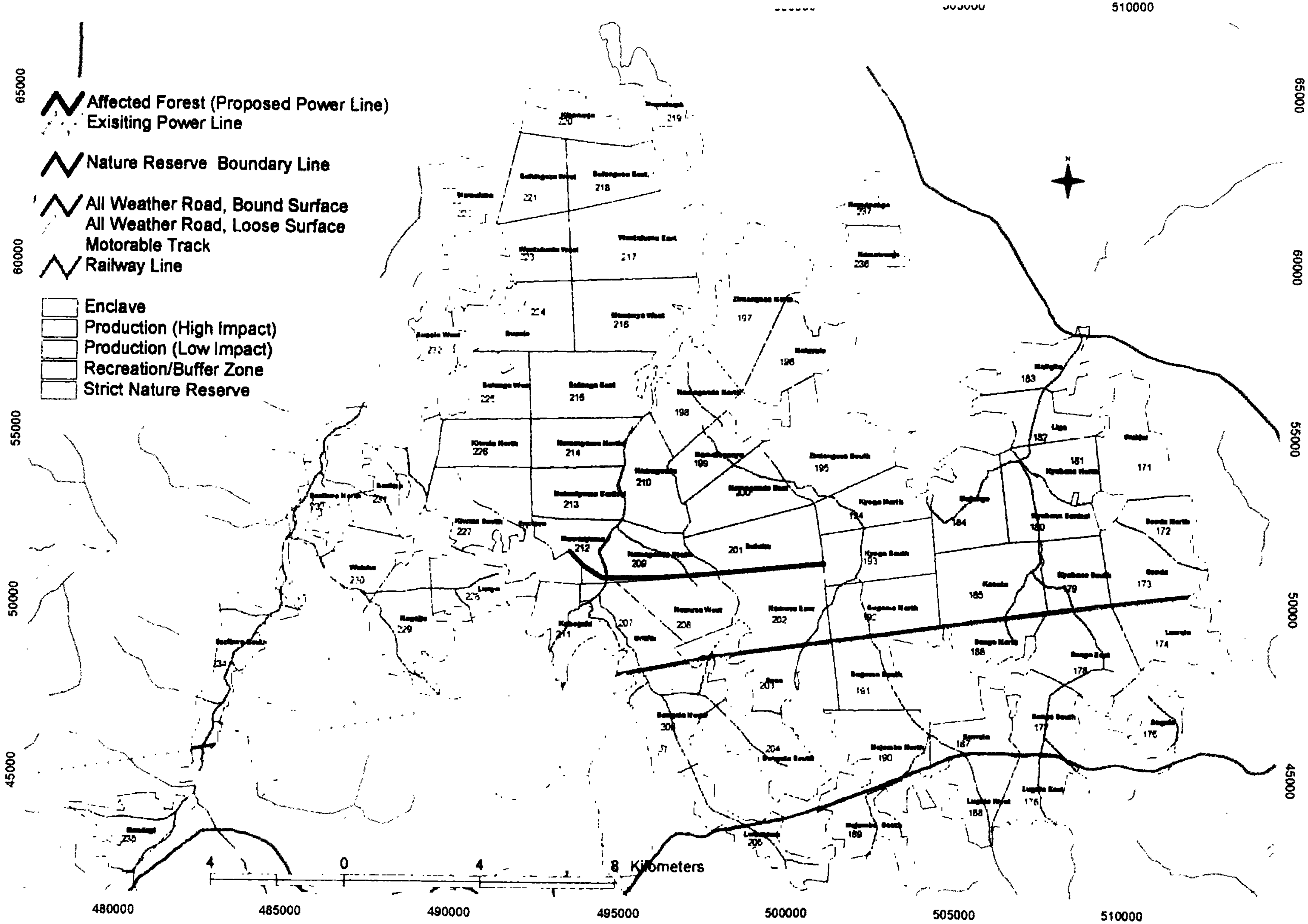
Appendix B.5
Map of Forest Reserves and the Proposed Wayleave



Affected Forest (Proposed Power Line)
Exisiting Power Line
Nature Reserve Boundary Line
All Weather Road, Bound Surface
All Weather Road, Loose Surface
Motorable Track
Railway Line
Enclave
Production (High Impact)
Production (Low Impact)
Recreation/Buffer Zone
Strict Nature Reserve
4 0 4 8 Kilometers
480000
485000
490000
495000
500000
505000
510000
65000
60000
55000
50000
45000

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Appendix B.6
Archaeological Assessment Report

Phase 1: Archaeological Assessment for the Proposed Bujagali Interconnection Project at Kawanda Sub- Station, Uganda.

By *D. Kiyaga- Mulindwa and E R Kamuhangire*
November 2006

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Introduction

An Impact Assessment of development project is a requirement of the National Environment Management Authority (NEMA) in Uganda (Ug. Govt 1995). It is also a requirement of other development funding agencies such as the African Development Bank (AfDB) and World Bank (WB 1994). This exercise is one aspect in the overall fulfillment of Impact Assessment requirement for the proposed Bujagali Interconnection project.

The main objective of this exercise was to determine if there was any possible adverse impact of project- related activities to the Archaeological resource in the direct impact zone. This survey was restricted to the area of Kawanda, in Wakiso District, which is the proposed location of the sub-station. The following is our observations and assessment in line with the main objective of the study during and after the archaeological impact assessment survey.

Study team

1. Professor D. Kiyaga Mulindwa, Professor of History, Kyambogo University, Uganda. Archaeologist, Museologist with specific Research interest in African Cultural History and several publications in these areas, especially the African Iron Age.

2. Dr. Ephraim R Kamuhangire, Commissioner Museums and Monuments of Uganda. A Historian with specific interest in Ethno- Archaeology .

3. Nelson A. Abiti, Photographer and Conservator, with specific interest in visual history and heritage management.

Methods

Methods of recognizing sites with evidence of heritage resources are varied. The general idea is to be able to recognize surface indicators of what could lie in sub surface levels to warrant further investigation through opening up test excavations. In the case of Kawanda no mapping was available and it was decided to use the Garmin GPS 76 to give the coordinates for the required relevant points. These will be down loaded to produce a map for the subsequent final version of this report.

The foot survey entailed walking the entire area since this was relatively small site. Surface or reconnaissance survey was carried out to locate archaeological features and to recover surface pottery sherds as indicator of where human activity might have taken place. This was done by walking narrow transects of 3 metres each by the three members of the team and each noting any of these indicators in his transect. Where these were noted, the location was immediately recorded and entered into the GPS.

The foot survey sought out features and artifacts, particularly potsherds. Both the physical extent and concentration of the pottery scatter are obvious indicators of the physical extend of the site as well as the concentration of human activity in that particular area.

Specific locations that seem to point to the concentration of human activity such as pottery scatter or heaps / mounds of soils or patches of ash, normally call for further investigation, such as test excavation to check on what could be lying in the sub-terrain levels . Excavation produced artifacts *in situ* and are also instrumental in displaying stratigraphic accumulation of cultural deposits which could give the chronological sequence of the occupation of that site.

A few test excavations were tried out at the proposed Kawanda sub-station for exactly the same objective as notified above.

Results.

We were directed to the proposed Kawanda – sub station by the company lawyer. As of now the site is free of occupants or any obvious permanent encumbrances.

The site situated on a hillock and estimated at about a hectare in size and is covered by rush undergrowth. To the east of the site is a patch of sweet potatoes and at the crest is another patch of sweet potatoes and some maize garden. The site is crossed by a village road, from north-west to south east.

The hill is generally covered by black top soil immersed in lateritic gravels. The site is in the middle of heavily settled area and we have a reason to believe that the settlement here has been of some antiquity since burial ground and related court of Sekabaka Sunna II (1856) at Wamala is a few kilometers west of this site. The soil composition is not the best for crop agriculture in this area and this may account for the sparse agricultural activity we noted. Furthermore, to the east of the site, we encountered recent trench which was sunk about 1.0 metres deep and equally long which exposed a bare rock. The top soil on this hillock seems to be thin in most places and underlain by bedrock, very close to the surface. This would have made settlement in earlier times which involve construction of post, mud, and wattle houses at the top of this hill, less attractive if there were easier spots lower down the slopes for such activity.

The survey revealed three house foundations one at (N00°24.577' E032°32.604') the other at (N00°24.655' E032°32.618') and the third at (N 00°24.558' E 32°.32.666'). These are foundations of recent houses which were broken down during evictions. A foot survey was conducted with transects running south to north and each measuring 3 metres apart. These were walked looking out for features and artifacts. About 20 potsherds were recovered from this foot survey. These sherds were mainly from pots with roulleted decorative motifs, especially on the neck of the pot. Such decorative motifs are quite common in the Great Lakes area and in Buganda in particular and are datable from recent- to- modern. These potsherds cannot be regarded as unique archaeological finds. Four shovel test pits were sunk to test the sub- surface level for possible artifacts of antiquity at the Kawanda sub- station site and nothing was recorded.

Discussion

Kawanda sub- station is well located as it is free of any obvious encumbrances other than the few quick growing crops. Archaeologically the stratigraphy of the site has shown very light and sparse cultural deposits. From all indications even such deposits are obviously of modern times, so the area shows no historical or archaeological resource that would be threatened by the project activities. The potsherds recovered fall within what is referred to as rouletted ware. This pottery type is widely used by settled agricultural communities in this area of the interlacustrine region; it spreads up to the western province of Kenya and even the areas of northern Tanzania, south of Lake Victoria. However, in the chronological sequence, which has helped us so far to date various community migrations and settlements in this area, this pottery style is very recent. At Kawanda, what was recovered is mainly string or knotted strip roulettes, some of which are still being made and used to this day.

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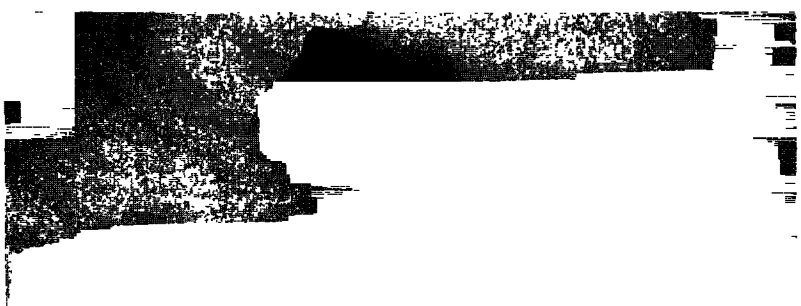
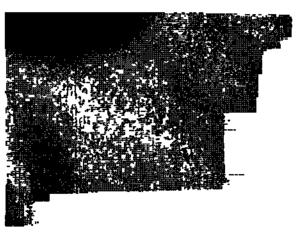
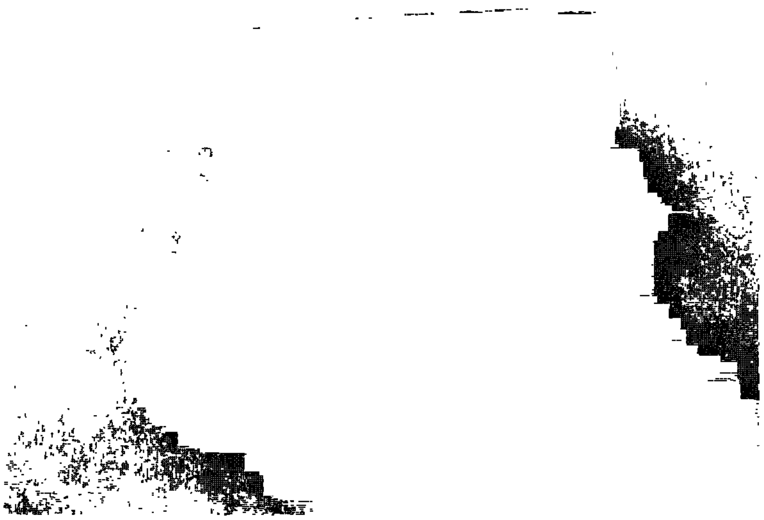
Appendices.

Photos A





Kawanda Potsherds (Roulleted decoration)



Kawanda Potsherds (Roulleted decoration)

Kawanda foot survey

Quarry trench- Kawanda

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Appendix C
Alternative Transmission System Routes Considered by AESNP

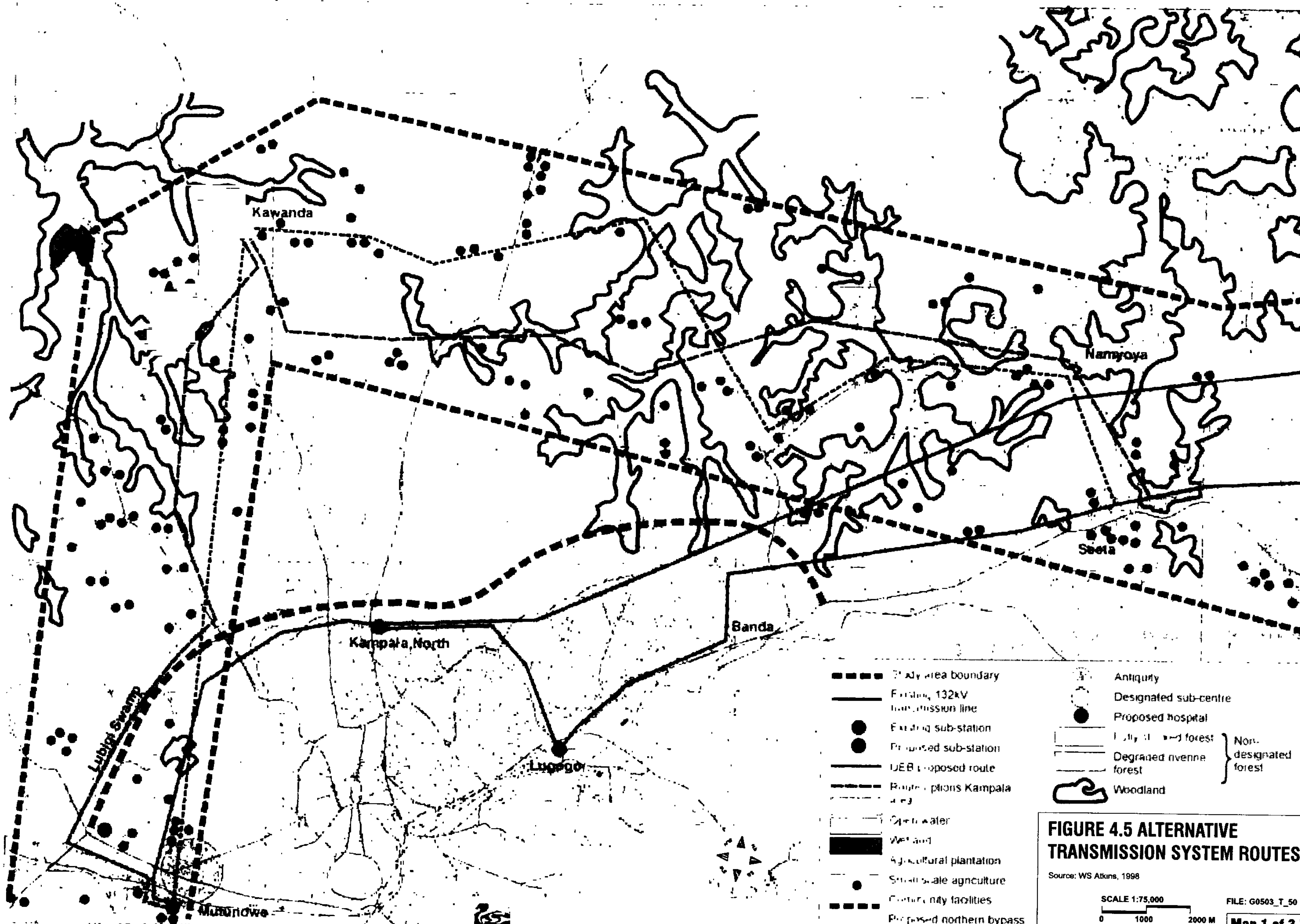

FIGURE 4.5 ALTERNATIVE TRANSMISSION SYSTEM ROUTES

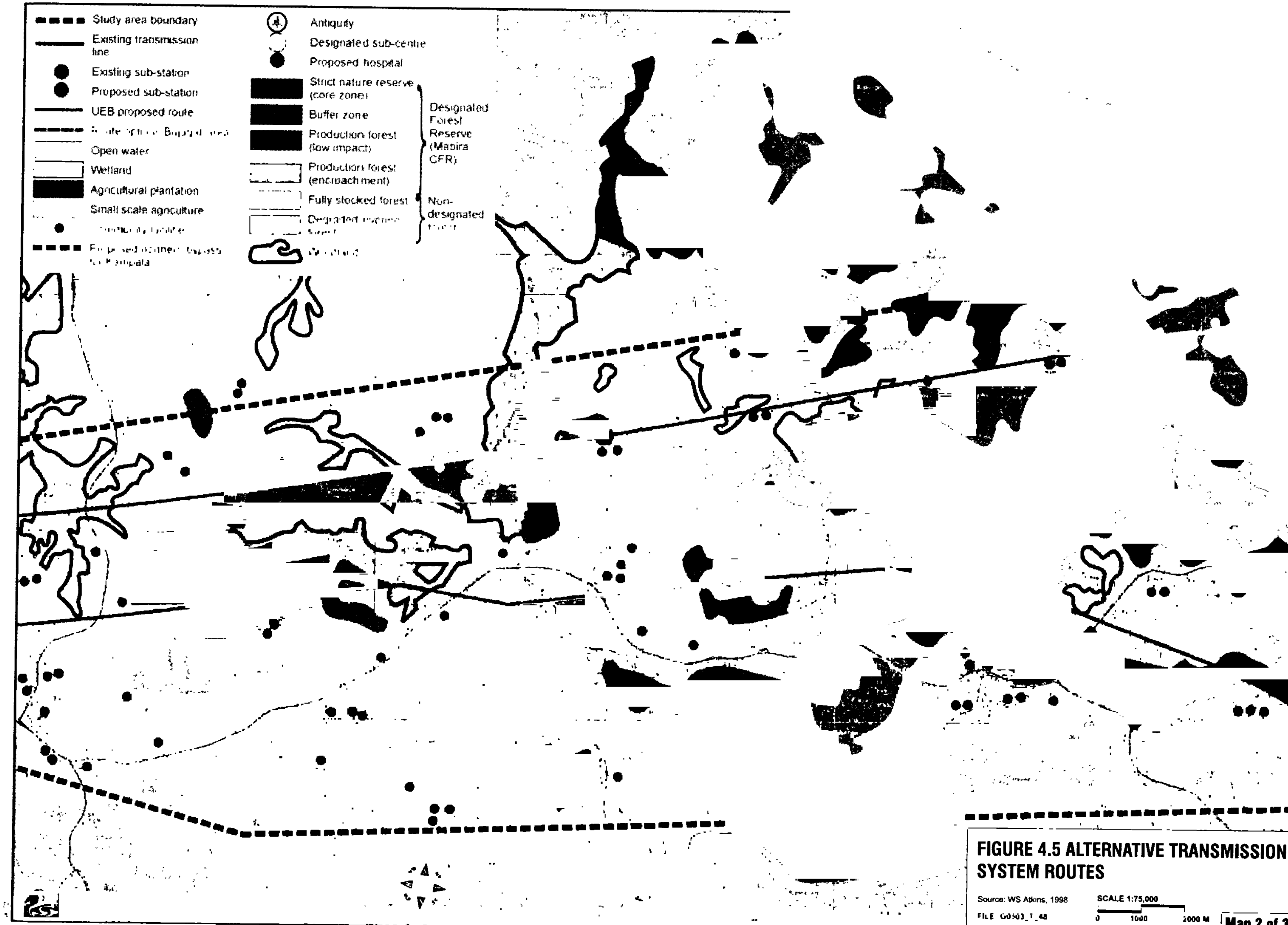

FIGURE 4.5 ALTERNATIVE TRANSMISSION SYSTEM ROUTES

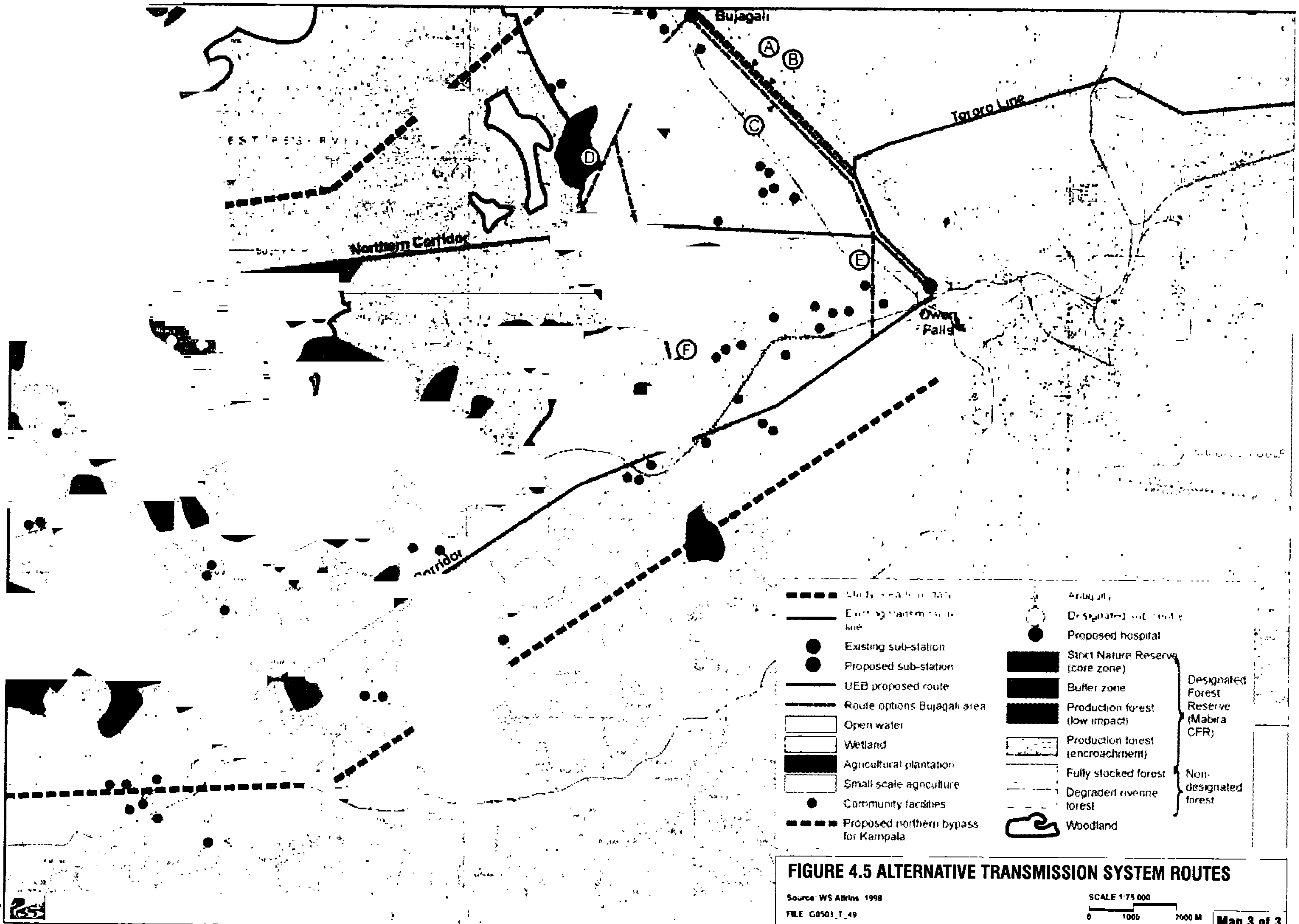

FIGURE 4.5 ALTERNATIVE TRANSMISSION SYSTEM ROUTES

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Appendix D
Forest Economic Assessment Report

Bujagali Hydro-Electric Power Project

Economic Assessment of Resource Values Affected by the 220 KV Powerline Wayleave Traversing Mabira, Kifu and Namyoya Central Forest Reserves

November 2006

Yakobo Moyini, PhD
Principal Associate
YOMA Consultants

REPORT

Acronyms and Abbreviations

AAC	Annual Allowable Cut
AR	Average Annual Net Benefit
CFM	Collaborative Forest Management
CFR	Central Forest Reserve
CVM	Contingent Valuation Method
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
FD	Forest Department
FGD	Focus Group Discussion
FORRI	Forestry Resources Research Institute
GFF	Greater Forest Functions
Ha	Hectare
MAFICO	Mabira Forest Integrated Community Organisation
MPA	Management Plan Area
MUIENR	Makerere University Institute of Environment and Natural Resources
MW	Mega Watt
NARS	National Agricultural Research Systems
NFA	National Forestry Authority
NPV	Net Present Value
NTFP	Non-Timber Forest Product
SNR	Strict Nature Reserve
TCM	Travel Cost Method
TEV	Total Economic Value
THF	Tropical High Forest
ToR	Terms of Reference
TPV	Total Present Value
USD	United States Dollar
USHS	Uganda Shillings
WTP	Willingness to Pay

Executive Summary

In order to evacuate electricity from the proposed power plant at Dumbbell Island on the River Nile and carry it to Kampala and other parts of Uganda, a 220 KV transmission line is to be installed. The proposed routing of the line passes through Mabira, Kifu and Namyoya CFRs. The powerline Wayleave traversing the three forests is 40 metres wide on the northern side of the existing 132 KV line.

Both the *National Environment Act* and the *National Forestry and Tree Planting Act* require that for certain major developments such as the installation of the powerline through the three forests, an environmental impact assessment (or environmental impact study) should be carried out. The same requirement holds in respect of the World Bank environmental and social safeguard policies. This report constitutes part of the environmental impact assessment process. In particular, the study is concerned with assessing the economic impact of the development in terms of resources lost and benefits foregone. The estimates were derived from both primary and secondary data and follow the principle of total economic value of forests.

The results of the study suggest a timber stock (50 cm + dbh) worth UShs 307.6 million will be lost in Mabira CFR. The present value of timber benefit streams obtained from long-run sustainable yield in Mabira CFR and timber values foregone in the plantations of Kifu and Namyoya CFRs were estimated at UShs 157.1 million. Furthermore, the present value of other annual benefit streams from forest products, biodiversity, domestic water, carbon storage and ecotourism was estimated at UShs 37.2 million. The present value of annual ground rent payments was calculated to be UShs 13.6 million. Other values which include immature tree plantings and incremental management costs had a present value of UShs 18.4 million. Hence the total values lost or foregone was estimated at UShs 533.9 million.

Of the total amount of values lost or foregone, the NFA can realise UShs 307.6 million from the disposal of the standing crop in Mabira CFR through its auction process. The Developer on the other hand, should compensate the NFA for lost forest benefits and added management responsibilities to the tune of UShs 226.3 million. The table below shows a summary of economic values lost or foregone.

Summary Impact Area Economic Values Lost or Foregone (UShs '000s)*

Value Sources	*Amount*
A. NATURAL FOREST GROWING STOCK	307,557
B. PRESENT VALUE OF BENEFITS STREAMS	
1. Timber	157,127
2. Poles + Firewood	4,788
3. Non-Timber Forest Products	5,399
4. Biodiversity	1,555
5. Domestic Water	4,334
6. Carbon Storage	18,243
7. Ecotourism	2,888
8. Landtake	13,635
SubTotal B	207,969
C. OTHERS	
1. Immature Tree Plantings	1,826
2. Management Costs	16,552
SubTotal C	18,378
D. TOTAL (B+C)	226,347
E. TOTAL (A+B+C)	**533,904**

* - *corrected to nearest 1000*

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Appendix A3. Comparison of butterfly species recorded from Mabira forest.

Species	Previous record only	This study but not previously
Nymphalidae		
A. homilis		x
A. neobule		x
A. pharsalus	x	
A. quirina		x
A. zetes		x
A.leucographa		x
A.viviana		x
Acraea cabira	x	
Acraea encedon		x
Amauris echeria		x
Amauris oscarus		x
Antanartia delius	x	
Ariadne pagenstecheri	x	
Bebearia cocalia	x	
Bicyclus càmpinus	x	
Bicyclus sebetus	x	
Charaxes ameliae	x	
Charaxes bipunctatus	x	
Charaxes brutus	x	
Charaxes candiope	x	
Charaxes etesipe	x	
Charaxes eupale	x	
Charaxes lucretius	x	
Charaxes numenes	x	
Charaxes porthos	x	
Charaxes protoclea	x	
Charaxes pythodoris	x	
Charaxes subornatus	x	
Charaxes virilis	x	
Charaxes zelica		x
Charaxes zingha	x	
Cymothoe caenis	x	
Cymothoe herminia	x	
Cymothoe hobarti	x	
Euphaedra ruspina		x

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1.0 Introduction

1.1 Background

Bujagali Energy Ltd. (BEL), a project-specific company owned by World Power Holdings, LLC of Luxembourg and IPS (Kenya) Limited proposes to build, own and operate a 250 MW hydro electric power plant at Dumbbell Island on the River Nile. To evacuate electricity from the generating station Uganda Electricity Transmission Company Limited (UETCL) proposes to construct a transmission line from the power generation house to Kampala. The aligned route passes through mostly private land. However, the line also passes through three central forest reserves (CFRs) – Mabira CFR, Kifu CFR and Namyoya CFR (*Figure 1*). The powerline Wayleave through the three forests is 40 metres (m) wide along the northern side of the existing 132 kV transmission line.

The National Environment Act Cap 153 and the National Forestry and Tree Planting Act require that for certain developments such as the installation of the powerline in forest areas, an environmental impact assessment (EIA) should be carried out. The same holds with respect to the World Bank's environmental and social safeguard policies. Furthermore, these policy and legal instruments call for the fair compensation of any resources that will be lost as a result of the development. This, therefore, calls for an economic assessment of the value of forest resources which will be lost as a result of the 40m wide Wayleave. Economic valuation is a tool that can provide decisionmakers with useful information with which to decide between alternatives or in favour of preferred combinations of possible interventions. In this case, economic valuation was used to arrive at a fair and objective estimation of the value of resources which will be lost or foregone as a result of the Wayleave so as to guide negotiations on the appropriate level of compensation. The value of forests depends not only on the market prices of its direct uses but is also based on other indirect uses of the forest resources that cannot be traded on some kind of market.

1.2 Project description

The project will involve the clearance of a 40m wide area along the entire length traversing Mabira, Kifu and Namyoya CFRs, on the northern side of the existing 132 kV line.

Table 1 shows the Mabira CFR compartments through which the proposed line passes. The data excludes community enclaves. In Mabira CFR, the line passes through 8.26 km of production (Encroachment) zone[1], 3.72 km of production/low impact zone[2], and 5.63 km of recreation buffer zone.

[1] The production (encroachment) zone comprises compartments that had previously (in the 1970s) been encroached. The name does not mean encroachment is allowed in this zone.

[2] Although designated production/low impact management zone, the 0.7 km of the line passing through Compartment 234 is in a severely encroached area with no timber. However, the area contains a young crop of *Terminalia sp.* less than 1 year old.

Within Kifu CFR, the line passes through a 0.9 km stretch of forest plantation planted with *Araucaria cunninghamii* and owned by NFA. Similarly, the line passes through 1.9 km of *Eucalyptus grandis* plantations owned by private tree farmers licenced by the NFA in Namyoya CFR. Consequently, the total length of Wayleave through the CFRs (excluding community enclaves) is 20.5 km going through natural and plantation forests.

Table 2 shows the total area of impact in the three CFRs is about 81.8 ha made up of 70.4 ha in Mabira CFR, 3.7 ha in Kifu CFR and 7.7 ha in Namuyoya CFR.

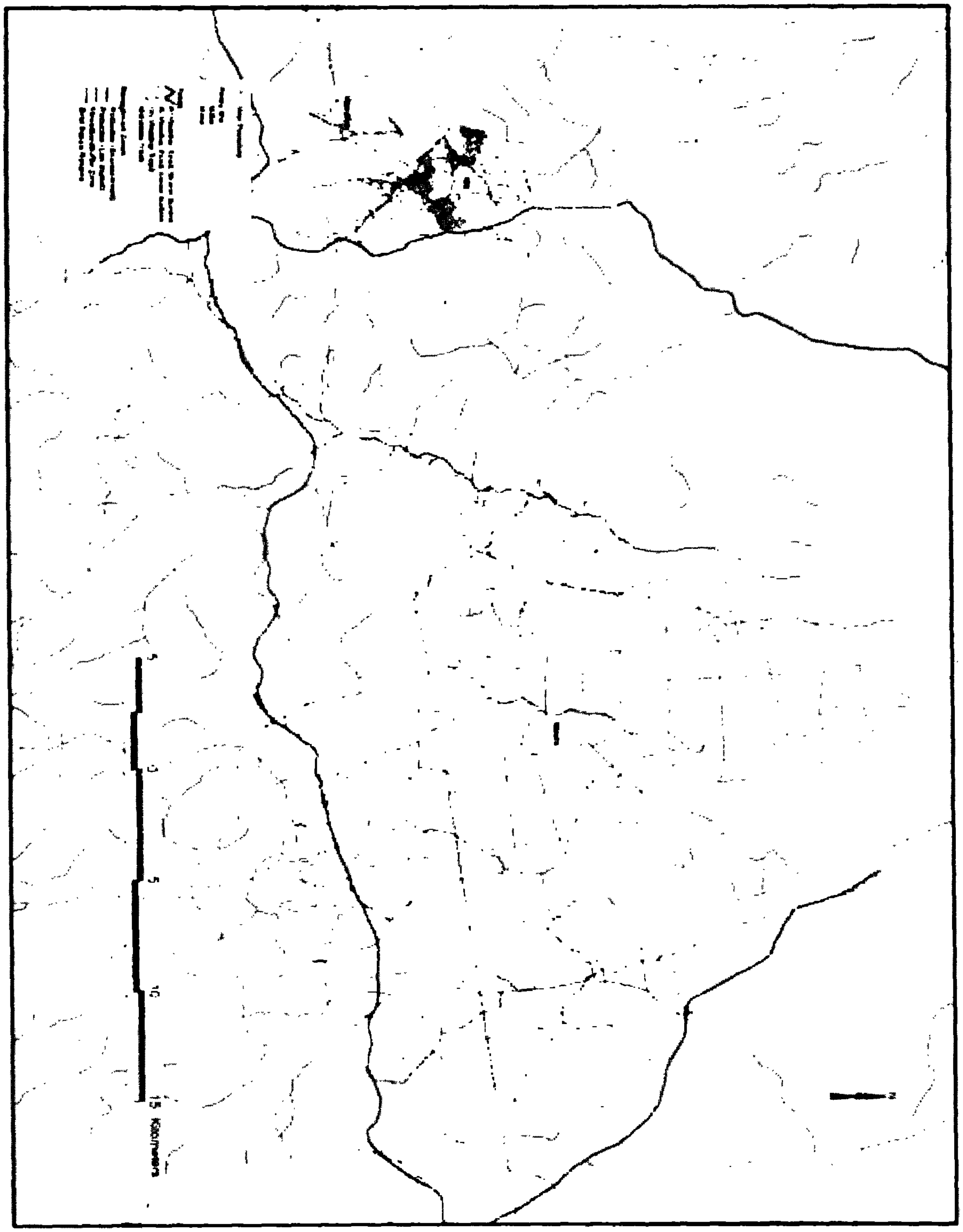
Table 1. Project Impact Area in Mabira CFR Alone

Compartment	Management Zone	Area (ha)
173	Production (Encroachment)	10.02
179	Production (Encroachment)	7.78
185	Production (Encroachment)	12.44
192	Production (Low Impact)	13.02
202	Recreation/Buffer Zone	6.27
203	Recreation/Buffer Zone	5.16
206	Recreation/Buffer Zone	1.68
207	Recreation/Buffer Zone	8.23
211	Recreation/Buffer Zone	1.16
229	Production (Low Impact)	1.87
234	Production (Encroachment)	2.81
Totals		**70.44**

Table 2. Combined Total Project Impact Areas in Mabira CFR, Kifu CFR and Namyoya CFR

CFR	Impact Area (ha)	Description
Mabira	33.05	Production (Encroachment)
	14.89	Production/Low Impact
	22.50	Recreation/Buffer Management Zone Includes crop of *Araucaria cunninghamii* less than 1 year old
Kifu	3.70	*Araucaria cunninghamii* owned by the NFA
Namyoya	7.70	Two *Eucalyptus grandis* plantations privately owned and grown under licence/permit from the NFA
TOTAL PROJECT IMPACT AREA	81.84	

Figure 1. New Power Line Through Mabira, Kifu and Namyoya CFRs



1.3 Scope of the assignment

The Terms of Reference (ToR) of the study required a comprehensive Economic Assessment of the environmental and natural resources impacts of the establishment of the 220 kV Electric Transmission Wayleave through the central forest reserves.

The conceptual, spatial and temporal scope of the study were as follows:

- the conceptual scope of the study involved the estimation of total economic value (TEV) of the forest areas affected. In this context, due to the small area of forestland withdrawn the bequest and existence values will not be significantly affected by the Wayleave. Hence, only direct use and indirect use and option values were considered. Direct use values are those deriving from timber, poles, firewood, non-timber forest products (NTFPs), water and ecotourism. The indirect use value considered consisted only of carbon sequestration values since the area affected will be too small to make any significant impact on watershed values of the three CFRs. The option value considered concerned the loss of biodiversity.

- the temporal aspect of the study related to considering annualised stream of net resource benefits capitalised at an appropriate discount rate to arrive at net present values (NPVs); and

- the spatial scope of the study was limited to a 40m width along the entire length of the sections of CFRs the line is proposed to traverse. The spatial scope was indexed to the appropriate forest zones, considered on compartment by compartment basis in Mabira CFR, and ownership of planted crops in Kifu and Namyoya CFRs.

1.4 Report structure

This economic assessment report of forest values is divided into five chapters including this introduction as Chapter 1.0. Characteristics of the three CFRs is presented in Chapter 2.0 and relate primarily to general area physical characteristics, climate, flora, fauna and forest enclaves for Mabira; and descriptions of the plantations in Kifu and Namyoya. Chapter 3.0 was devoted to impact analysis beginning with defining the systems boundaries and then to a closer examination of the three CFRs. Chapter 4.0 was dedicated to economic valuation covering the theory and practice of forest valuation, methodologies employed and estimates of economic values of significant impacts. Chapter 5.0 looked at several mitigation options, and is followed by References and Annexes.

2.0 Area Characteristics

While the proposed transmission line passes through both public and private lands, this report covers the former. In particular, the report is devoted to the three CFRs – Mabira, Kifu and Namyoya. Hence any enclaves of community areas such as those in Mabira were not covered since they are not within the boundaries of the CFR and valuation follows different legal approaches.

2.2 Mabira Central Forest Reserve[3]

Mabira Forest reserve was established in 1900 (under the Buganda Agreement). It lies in the counties of Buikwe and Nakifuma in the administrative district of Mukono. It occupies an area of 306 km^2 with an altitudinal range of 1070-1340 m above sea level and is situated between latitude 0^0 22′ and 0^0 35′ and between longitude 32^0 56′ and 33^0 02′E. The Forest Reserve is, therefore, the largest natural high forest in the Lake Victoria crescent.

Mabira Forest Reserve is located in a heavily settled agricultural area close to large urban centres including Kampala, Lugazi, Mukono and Jinja. This makes it a very important refugium and eco-tourist destination. The location of the forest also makes it a very important source of forest products whose demand has increasingly grown in the towns mentioned earlier. The management of Mabira forest therefore, currently caters for production, conservation and recreational functions of the forest ecosystem.

Whereas the forest suffered considerable destruction through illegal removal of forest produce and agricultural encroachment which activities threatened the integrity of the forest, these have now been controlled and the forest has near regained its original integrity.

Vegetation

The vegetation in Mabira Forest is dominated by Celtis-Chrysophyllum medium altitude moist semi-deciduous Tropical High Forest communities of type D1 (95% equivalent to 292 km^2). The remaining 5 % of the forest area is made up of medium altitude moist evergreen forest communities of Piptadeniastrum-Albizia-Celtis tree species (Langdale-Brown, 1964).

Mabira Forest is a dominantly sub-climax forest which is just recovering from a long period of exploitation and encroachment. The forest is, therefore, made up of young colonising mixed forest trees dominated by *Maesopsis eminii* (25%), young mixed *Celtis-Holoptelea spp.* (60%), and mixed wet valley bottom species dominated by *Baikiaea spp.* (15%).

The forest also suffered selective felling (creaming) of high value trees (ie. Class 1A and B) in the last twenty or so years and today, only retains a small percentage of such trees (including *Milicia excelsa, Holoptelea grandis* and *Olea welwitschii*) in the growing stock (0.06%). Most trees in the forest are Class III fee group tree species making up as much as

[3] Description of Mabira CFR is adapted from Muramira (2000)

52.4% of all trees of all fee groups. The remaining 47.5% of the growing stock is comprised of Class II fee group tree species including *Celtis species, Albizia species, Alstonia boonei* and *Funtumia africana*. The forest is notably dominated by Paper Mulberry (*Broussonetia papyriferra)* particularly in the previously heavily encroached areas (25.1%). Whereas *Broussonetia papyriferra* is an exotic tree specie with clearly invasive characteristics, the specie is not considered a threat to natural regeneration. In fact, the tree species has been noticed to help the natural regeneration of indigenous tree species including *Antiaris africana, Prunus africana, Lovoa trichilioides* and *Celtis species*, which require shade and forest cover for their successful regeneration. *Broussonetia papyriferra* has also quickly taken up areas which would otherwise be invaded by pioneer grasses like *Imperata cylindricum* which discourage regeneration and growth of indigenous forest cover. The species is also a very important source of firewood (Davenport *et al*, 1996).

Birds

The birds of Mabira Forest have been subjected to a considerable amount of survey work including regular surveys, summarized by Carswell (1986). Birds are arguably therefore, the best known faunal group in Mabira forest.

The bird species list for Mabira Forest now stands at 287 species of which 109 were recorded during the 1992-1994 Forest Department Biodiversity Inventory (Davenport *et al*, 1996). These include three species listed as threatened by the Red Data Books (Collar *et al*, 1994) i.e. the blue swallow (*Hirundo atrocaerulea*), the papyrus Gonolek (*Laniarius mufumbiri*) and Nahan's Francolin (*Francolini nahani*).

Mammals

A number of recordings of the mammalian diversity of the Mabira Forest Reserve have been done in the last thirty years. The most comprehensive published study of the mammals of the forest however, is that by the Forest Department of 1996 (Davenport *et al* 1996). The Davenport report documented 17 new species of small mammals found in the forest. Other recordings include those by the Tropical Forest Diversity Project (1987-88 on woody vegetation, birds and mammals); Kingdon (1971) on mangabeys and red tailed monkeys; and Delany (1975) for rodents.

The Davenport report indicates a high incidence of small forest dependent mammal species including *Deomys ferrugineus* and *Scutisorex somereni*. The two mammals are closed forest-dependent specialists and are often regarded as the most sensitive indicators of forest disturbance. The Uganda endemic shrew *Crocidura selina*, only previously recorded in Mabira Forest and reported in 1990 is again recorded in the Davenport report (Davenport *et al*. 1996).

Butterflies and Moths

Mabira Forest Reserve is considered rich in terms of the diversity of its butterfly fauna (Davenport *et al*. 1996). The forest supports a variety of forest dependent butterflies, as well as a number of uncommon and restricted-range species. Despite a recent history of intensive human disturbance, the butterfly fauna of Mabira Forest has shown marked resilience.

Mabira forest reserve is a home to two sub-species which are endemic to Uganda including *Tanuetheira timon orientius* (for which Ugandan forests are the eastern limit of the species' range) and *Acraea lycoentebbia* (Davenport *et al.* 1996).

The moth fauna is typical of large forests situated on the lake crescent. Mabira Forest Reserve supports a few rainforest species from West and Central Africa. A total of 52 hawk moth and 45 silk moth species characteristic of closed canopy forests and forest edges live in the forest. Several lowland species have also been recorded. Compared with other major forests in Southern and Western Uganda, Mabira Forest is a high-ranking site for silk moths, but less so for hawk moths. This is because the Eastern range of most West African hawk moth species does not extend to this region.

Objectives of Management

The location, unique species richness and productivity of Mabira Forest Reserve, impart to it special qualities demanding a multiple objective management approach. The objectives of management of the forest therefore, are:

- to conserve and enhance forest biodiversity and ecological conditions;
- to produce timber and non-timber products on a sustainable yield basis using the most efficient methods (i.e. without compromising the capability of the forest to provide environmental services);
- to integrate the communities within the forest enclaves and parishes surrounding the forest reserve into the management of the forest;
- to provide recreational facilities for the people of Ugandan citizen, visitors and tourists; and
- to carry out research aimed at obtaining information on various aspects of forest ecosystem dynamics for the improvement of the management of Mabira Forest in particular, and other forests in general.

To achieve the above management objectives, Mabira forest reserve is divided into five working circles namely:

- the conservation working circle consisting of 13 compartments including compartments 198-202, 207-210 and 213-216 as the Strict Nature Reserve;
- the production working circle consisting of 45 compartments which include compartments 171-188, 192-197, 217-237 and 71 ha of Kalagala Falls forest reserve;

- the community participation working circle to pilot Collaborative Forest Management (CFM) within selected forest enclaves and parishes surrounding the forest reserve;
- the recreation working circle consisting of 9 compartments which include compartments 189-191, 203-206, 211-212 and 33 ha of Kalagala Falls forest reserve totaling 4,097 ha; and
- the research working circle.

2.3 Kifu Central Forest Reserve[4]

Kifu CFR covers an area of 1419 ha (Statutory Instrument No. 63, 1998). It was gazetted in 1932. The CFR is located in close proximity to Mukono Town Council; just off the Mukono-Kayunga Highway (32 km from Kampala City and about 6 km from Mukono Town).

Originally Kifu CFR was a well-stocked Natural High Forest. It held Greater Forest Functions (GFF) in addition to water catchment. The CFR is drained by several rivers and streams (Kifu, Kasota, Lwajali and Ssezibwa) which flow into Lake Victoria. The population around Kifu CFR, rapidly urbanising, exerted pressure on the reserve as a result of ever greater demand for fuelwood and other livelihood activities. This pressure led to the degradation of the reserve and reduced the flow of most of the forest use values. Currently, the NFA is implementing the following management objectives:

- to restore the forest through planting of mixed broad leaved species;
- to demonstrate fast growing tree species with high yield;
- to promote *ex situ* conservation by way of maintaining superior seed tree species; and
- to implement technologies and forest management practices for poverty reduction and reduce pressure on the forest reserve.

The foregoing objectives are being met through the creation of three land use categories as follows.

- Research – 425 ha has been licensed to the Forestry Resources Research Institute (FORRI) under the National Agricultural Research Systems (NARS) programme
- Private plantation establishment (694 ha)
- NFA management practices (300 ha), of which about 79 ha has been planted (*Table 3*).

Wayleave construction in Kifu CFR passes through the land use category of NFA Management Practices, and covers 3.713 ha. Of this area only 2.4 ha has been planted. The crop of *Araucaria cunninghamii* is now 5 years old. The remainder is severely degraded natural forest area. *A. cunninghamii* is grown on 25-year economic rotation in Uganda.

[4] The description which follows was obtained from NFA records.

Table 3. Demonstration, Restoration and Seed Species by NFA in Kifu CFR

Tree species	Area planted (ha)	Planting date	Age (yrs)	Remarks
Araucaria cunninghamii	26.5	May 2001 Oct 2002 April 2003	5 4 3	Fast growing timber species with high Yield
Araucaria haustenii	2	Oct 2002	4	
Araucaria agathis	2	Oct 2002	4	
Araucaria cunninghamii and *Araucaria haustenii*	6	1974	32yrs	Superior seed tree species /Seed/Mother stand for seedling production
	3	1971-72	34yrs	
Araucaria cunninghamii and *Araucaria haustenii*	10 4	1974 1971-72	32yrs 34yrs	Under trial
Maesopsis emnii	15	May 2001	5	Natural forest restoration / Broad leaved
Cedrella ordorata	1	May 2002	4	Quality Timber species, High demand
Eucalyptus Citrodora	3.7	May 2004	2	Technology for poverty reduction (Essential oils / Medicinal)
Eucalyptus paniculata	1 2	May 2004 May 2005	2 1	Charcoal production trials
Eucalyptus cleosiana	1	May 2005	1	Poles and Charcoal production trials
Eucalyptus grandis	2	Dec 2004	2	Pole production
Grafted Pine	0.25	Nov 2002	4	Hybrid seed production

Total area planted = 79.45 ha

Source: NFA Records

2.4 Namyoya Central Forest Reserve

Similar to Kifu, the Namyoya CFR was originally a natural forest but now entirely converted to plantation forestry. The entire CFR is allocated to private tree farmers initially on 5-year lease permits by the Forest Department (FD). These permits are now being converted to 25-year licences which allows a private tree farmer to harvest at least three crops of Eucalyptus suitable as electric poles (on 8-year economic rotation basis).

3.0 Impact Analysis

3.1 Systems boundaries

The systems boundaries have been defined in terms of valuation area, magnitude of development impacts, management costs, and other considerations.

Valuation area

The valuation area is only 40 m wide on the northern side of the existing 132 kV line along sections of the forest through which the transmission line passes. Defined thus, the valuation area consists of both natural and plantation forests, the first assessed according to the different zones specified in the Forest Management Plan 1997-2007 for Mabira CFR; and the latter based on age and species of plantings for Kifu CFR and Namyoya CFR. For Mabira CFR recognition was given to the fact that not all compartments are homogenous and benefit streams were therefore estimated on compartment by compartment basis. Detailed maps of the three CFRs showing the areas to be impacted by the Wayleave construction are presented in *Annex 1.*

Magnitudes of development impacts

Only significant impacts were considered in the impact analysis. What this meant was that by and large, the hydrological functions of the forests will be largely left unaffected since much smaller areas relative to the total area of the reserve will be impacted. Similarly, the construction and subsequent maintenance of the Wayleave will have virtually no noticeable impact on options, bequest and existence values except for considerations of loss of biodiversity (under option values).

Management costs

Monitoring of mitigation measures will entail additional management effort by the NFA. Furthermore, the NFA is about to begin preparing a new Forest Management Plan (FMP) for Mabira CFR and, as such, the impacts of the proposed transmission line will also have to be addressed during the process.

Plantations

Only established plantation tree crops were considered for estimates of future values foregone based on the length of the license issued to the tree farmer. For the Kifu CFR plantation crop, the NFA is equated to a private tree farmer and applicable licence periods used as a basis for calculating benefits foregone. For eucalyptus planting, a crop of more than 1 year is considered established. For other species, a crop of 5 years is considered established. For plantings less than the age of establishment, investments lost in ground clearing, planting, beating up and weeding were considered.

Other considerations

Some 5.1 ha of land in community enclaves in Mabira CFR, owned by individuals, will be affected. These areas need to be compensated for to allow the Developer to enjoy un-encumbered access. However, the compensation was excluded from the economic assessment in Mabira CFR, since a different methodology would be required and the areas are not part of the reserve as further explained below.

3.2 Triangulation and ground truthing

A significant amount of the information used in the analytical part of this report was obtained from secondary sources. However, a conscious effort was made to triangulate and 'ground truth' the information with on the ground work. This was achieved using key informant interviews, focus group discussions, participant observations, and a semi-structured household survey using questionnaires.

In general, it was clear that Mabira CFR, the main area of concern because of its natural forest cover, provides a number of livelihood opportunities for the communities in the enclaves and the surrounding areas. From key informant interviews and participant observation, the restoration of the degraded parts of Mabira and maintaining the ecotourism attributes of the CFR features prominently as stakeholder interests. During the Focus Group Discussions (FGDs) hunting, firewood and the harvesting of medicinal plants for home consumption and limited intra-community sales were highlighted as significant non-timber uses. Households also emphasized the important role Mabira CFR plays in ensuring clean supplies of water.

On the other hand, communities were either ambivalent or welcomed the development. Those in favour of the development requested that suitable young and energetic members be considered for employment in project work. With respect to compensatory investments, the communities would like the Developer to commit resources towards putting up classroom blocks and providing classroom furniture. The communities also requested that the Developer should ensure community roads used during the construction of the Wayleave be left in a sound condition. Finally, the communities requested that electricity be made available in their enclaves and surrounding areas.

Details of Key Informant Interviews are presented in *Annex 2;* Focus Group Discussions in *Annex 3;* and Household Survey in *Annex 4.*

4.0 Economic Valuation

4.1 Theory

Forests in general are complex ecosystems and generate a range of goods and services. For purposes of determining the magnitudes of net benefits lost due to conversion of a forest to other development options, the total economic value (TEV) approach was chosen as the most comprehensive. The TEV is made up of use and non-use values. The use values in turn consist of direct and indirect use values; while the non-use values consist of options, bequest and existence values. This classification was characterised by Monasinghe (1992). *Figure 2*, shows adaptation of the classification by Lette & de Boo (2002).

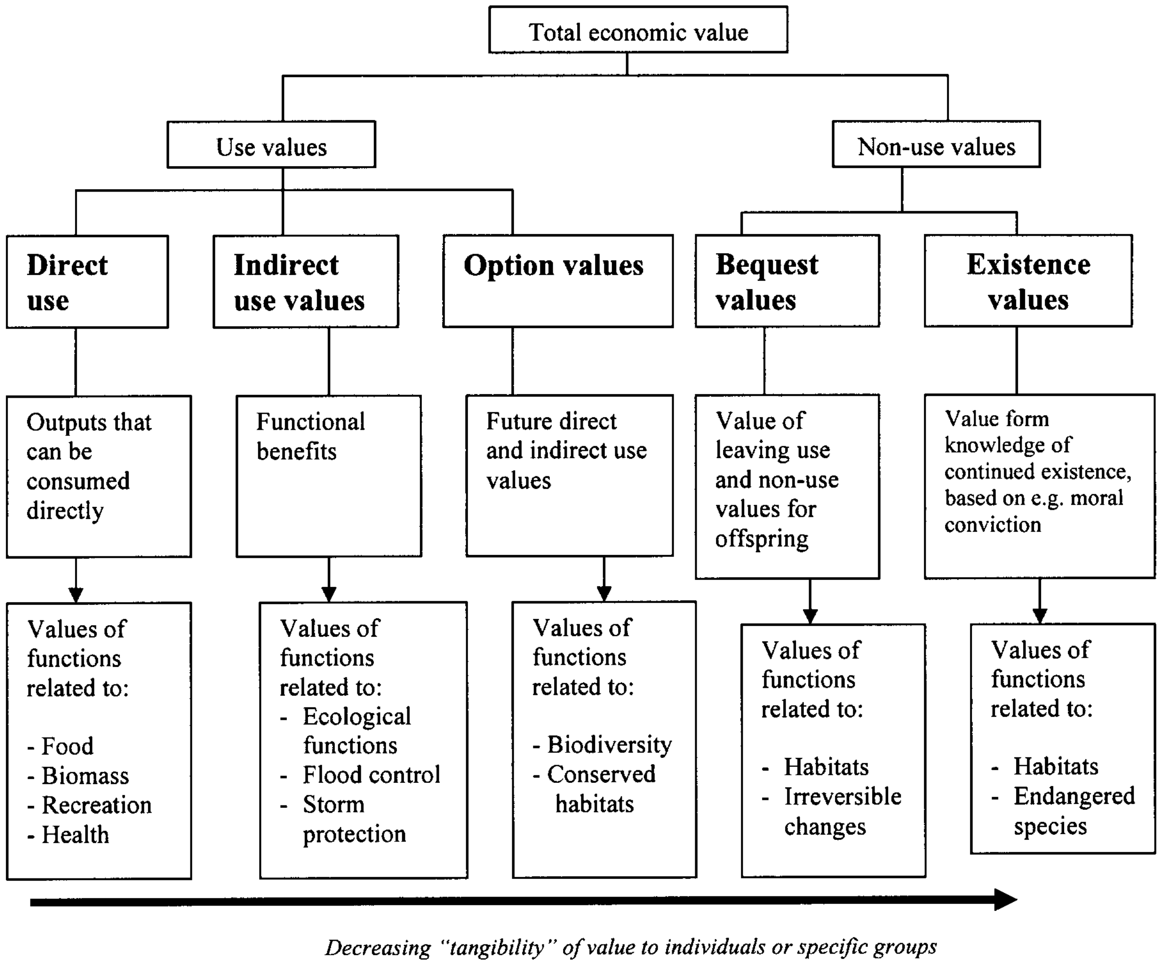
Economic valuation is a tool for decisionmaking intended to compare the advantages and disadvantages of alternative development options or alternatives. The value of forests depends not only on the market prices of its direct uses but is also based on other indirect uses of the forest resources that cannot be traded on some kind of market (Lette & de Boo 2002). Valuation of the goods and services provided by forests is needed because these areas are under great pressure and are in fact disappearing. Extensive areas of Mabira CFR were severely encroached not too long ago (Karani *et al* 1997). The natural forest cover of Kifu CFR and Namyoya CFR have been completely destroyed and the areas have now reverted to plantation forests. The lack of knowledge and awareness of the total value of the goods and services provided by the forest resources will obscure the ecological and social impact of the conversion of forests into other uses. Proper valuation of all goods and services provided by a forest can help us understand the extent to which those who benefit from the forest or its conversion also bear the associated management costs or opportunities foregone (Lette & de Boo 2002). As part of an expanding response to declining global biodiversity (Daily & Walker 2000), interdisciplinary research teams of economists and ecologists have conducted valuation exercises designed to estimate the costs (Ando *et al* 1998; Montgomery *et al* 1999; Balmford *et al* 2003) and benefits (Pimentel *et al* 1997; Costanza *et al* 1997; Balmford *et al* 2002) of forest use alterations.

Despite the importance of the valuation of forests and nature, under-valuation was and still is the order of the day, as a result of market and policy failures (Lette & de Boo 2002). Market failure has been identified as one of the major causes of under-valuation (Lette & de Boo 2002). For example, when determining the economic value of a forest, decisionmakers usually only take into account the easily quantifiable – financial – costs and benefits related to goods and services traded on the market, whereas there are numerous functions of forests for which markets malfunction, are distorted or simply do not exist (Lette & de Boo 2002). Markets only exist for some of the production functions of forests, such as timber, fuelwood, and non-timber products. However, even if markets exist, market prices for these goods may not reflect their real value, since markets can be distorted, for example by subsidies which represent policy failures (Lette & de Boo 2002). The authors suggest that the market price of a particular good may not reflect all the costs involved in producing that good because there may be benefits or costs enjoyed or borne by others not directly involved in the production of the good, what economists call externalities (Lette & de Boo 2002).

With respect to the valuation of a forest using the total economic value approach, the following terms are defined as follows.

- *direct use values* – benefits that accrue directly to the users of forests, whether extractive (e.g. timber and NTFPs) or non-extractive (e.g. ecotourism);
- *indirect use values* – benefits that accrue indirectly to users of forests, primarily ecological or environmental services;
- *option value* – the amount that individuals would be willing to pay to conserve a forest for future use (e.g. biodiversity values);
- *bequest value* – the value attached to the knowledge that others might benefit from a forest area in the future; and
- *existence value* – the value placed by non-users on the knowledge that something exists, i.e. its intrinsic value.

Figure 2. The Total Economic Value of Forests



Source: Lette & de Boo (2002); Munasinghe (1992)

Various valuation tools have been developed to estimate the monetary value of non-marketed goods and services (Lette & de Boo 2002). Munasinghe's classification of major value categories has proved to be a useful analytical tool to link value categories and their underlying environmental goods and services with specific valuation tools (Munasinghe 1992; Lette & de Boo 2002) as shown in *Table 4.*

While the direct use value of goods and services traded on the market can be easily translated into monetary terms by taking their market prices, there are a lot of other goods and services often conceived as having direct use values. These functions can be better valued by means of other valuation tools (e.g. Related Goods Approach, Hedonic Pricing or Travel Cost Method). The regulation functions of forests from which indirect use value is perceived can also be valued by various valuation tools (e.g. Replacement Cost Technique, Production Function Approach). To capture option, bequest and existence values, Contingent Valuation

Method (CVM) is used to estimate the monetary value of environmental amenities. Lette & de Boo (2002) have cautioned on the use of valuation tools as follows:

> *"It must be emphasised that none of these valuation tools provides comprehensive answers. All of them value only part of the goods and services provided by forests and nature. They all have limitations and should be chosen and used with care. Using several valuation tools for a single object case, could contribute to a more complete valuation"*

Table 4. Example of links between value category, functions and valuation tools

	USE VALUES		NON-USE VALUES		
USE	**1. Direct use value**	**2. Indirect use value**	**3. Option value**	**4. Bequest value**	**5. Existence value**
FUNCTIONS	Wood products (timber, fuel) Non-wood products (food, medicine, genetic material) Educational, recreational and cultural uses Human habitat	Watershed protection Nutrient cycling Air pollution reduction Micro-climatic regulation Carbon storage	Possible future uses of the goods and services mentioned in 1&2 (Use Values) by actual stakeholders	Possible future uses of the goods and services mentioned in 1&2 (use Values) by the offspring of actual stakeholders	Biodiversity Culture, heritage Benefits to stakeholders of only knowing of the existence of goods or services without using them
	Tool to be used:	Tool to be used:	Tool to be used:	Tool to be used:	Tool to be used:
VALUATION TOOLS	Market Analysis Related Goods Approaches Travel Cost Method Contingent Valuation Method Hedonic Pricing	Restoration Cost Preventive Expenditure Production Function Approach Replacement Costs	Contingent Valuation Method	Contingent Valuation Method	Contingent Valuation Method

Source: Lette & de Boo (2002)

The foregoing tools have been successfully applied in the valuation of several tropical high forests and other ecosystems. Naidoo & Adamowicz (2005) quantified the costs and benefits of avian biodiversity in Mabira CFR through a combination of economic surveys of tourists, spatial land-use analyses, and species-area relationship. The results showed that revising entrance fees and redistributing ecotourism revenues would protect 114 of the 143 forest bird species under current market conditions. This total would increase if entrance fees were optimised to capture the tourists' willingness to pay for forest visits and the chance of seeing increased numbers of bird species.

Beukering & Cesar (2001) calculated the total economic value of the Leuser ecosystem in the Philippines under conservation and deforestation scenarios using extended Cost-Benefit Analysis and found that the conservation scenario far outweighed the deforestation scenario and they concluded that the ecosystem would be in the interests of the local population, local and national governments, and the international community. Hadker *et al* (1997) used the Contingent Valuation Method to estimate willingness-to-pay on the part of residents of Bombay (Mumbai) for the maintenance of Borivli National Park, located within the City's limits. The study arrived at a willingness-to-pay of 7.5 rupees per month per household, which amounted to a total present value of 1033 million rupees (or USD 31.6 million). The authors suggested that this figure could be used to influence policy decisions, given that the Protected Area at the time ran on a budget of 17 million rupees (USD 520 000).

Menkhaus & Lober (1995) used the Travel Cost Method (TCM) to determine the value that tourists from the US placed on Costa Rican rainforests as ecotourism destinations using the Monteverde Cloud Reserve as a sampling site. Consumer surplus was estimated to be approximately USD 1150, representing the average annual per person valuation of the ecotourism value of PAs in Costa Rica. The ecotourist value of the Monteverde Cloud Forest Reserve was obtained by multiplying the total number of visitors by the average consumer surplus. This resulted in a total annual US ecotourism value of USD 4.5 million for the Monteverde Reserve.

Janssen & Padilla (1999) used a combination of Cost-Benefit Analysis and Multi-Criteria Analysis to assess the opportunity cost of preservation and analyse tradeoffs to be made in deciding whether to preserve or convert a mangrove forest in the Philippines. The result showed that the aquaculture alternatives performed better than the forestry alternatives and preservation in terms of economic efficiency.

Kramer *et al* (1995) used a combination of valuation tools (Contingent Valuation combined with Opportunity Cost Analysis and Recreation Demand Analysis) to investigate changes in environmental values resulting from the creation of Mantadia National Park in Madagascar. Kramer *et al* (1993) used Contingent Valuation Method to determine the value of tropical rainforest protection as a global environmental good. Using two approaches the authors determined the average willingness-to-pay of US citizens at USD 24 to31 and extending to all US households, total willingness-to-pay was estimated at USD 2180 to 2820 million per year.

Sikoyo (1995), used the Contingent Valuation Method to determine community direct use benefits from Bwindi Impenetrable Forest National Park in Uganda; while Moyini & Uwimbabazi (2001) used the Travel Cost Method and the Contingent Valuation Method to determine the Mountain gorilla tourism value of Bwindi Impenetrable Forest National Park. The results showed a consumer surplus of USD 100.

Muramira (2000) estimated the value of the overall impact of Wayleave construction through Mabira at USD 340,202 and suggested that this money be set aside to address the environmental impacts of the development. The author used inventory and market analysis, secondary information on resource usage and willingness-to-pay studies in comparable areas and project data.

4.2 Analytical framework

The analytical approach adopted in this report consists of the following.

1. Resource values were estimated from the perspective of net benefit streams, annualised, and then their present values obtained by capitalising the average annual benefits stream using the Government of Uganda's social opportunity cost of capital of 12%.

   That is, the present value of product or service (i) equals average annual net benefits (economic rent) capitalised by the social opportunity cost of capital, or:

   $$PVi = ARi/r$$

   where
   PVi - present value of product i
   ARi – average annual net benefit from product i
   r – social opportunity cost of capital (discount rate)

   Subsequently, the total present value of the Wayleave impact area is given by the equation $TPV = \sum_{i=1}^{n} (ARi/r)$

   where
   TPV-stands for total present value.
   n – number of products

   The approach is a good measure of the opportunity cost (or forest benefits foregone) as a result of the Wayleave construction in Mabira CFR.

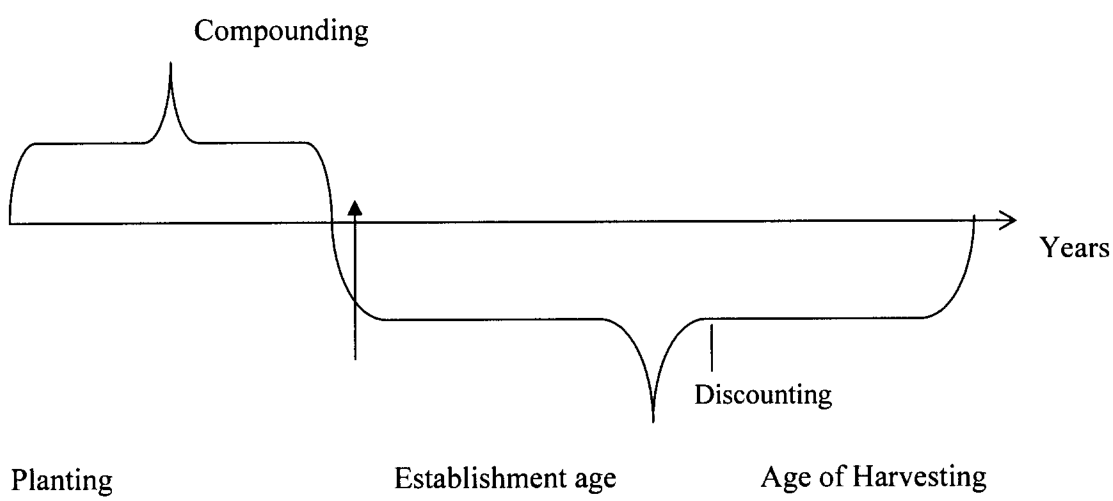
2. For Mabira CFR, the volume of the standing timber is the capital stock from which benefits are derived, and not the stream of benefits themselves. The Developer compensates the NFA for forest benefits foregone. Therefore, the capital stock remains the property of the NFA and represents an encumbrance to the construction of the Wayleave. One option is for the NFA to issue a salvage operation licence for a third party to remove this encumbrance, preferably at a net benefit to the Authority.

3. In calculating the streams of benefits arising from timber, poles and firewood, stumpage values and not market prices were used.

4. The powerline from Bujagali while passing through Mabira CFR also traverses Kifu CFR and Namyoya CFR, areas which are now under plantation, rather than natural,

forests compared to Mabira CFR. The plantations are production-oriented, supplying timber, poles and firewood. Where the tree crop is below the age which is considered established, the present value of costs incurred was the eligible item for compensation. On the other hand, benefits streams were calculated for tree crops above establishment stage using the appropriate stumpage values.

For the forest plantations of Kifu and Namyoya CFRs, the capitalisation of annual benefits would not be appropriate. For one, the yield of benefits are not annual. Rather, they are periodic. For purposes of this valuation 25 years for *Eucalyptus sp* and 50 years for *Araucaria sp* were used since the permits granted though renewable do not immediately satisfy long-run continuity conditions and the areas planted have not been compartmentalised to yield even annual returns. Hence, plantation expenses incurred up to establishment age should be compounded while those to be incurred from the present to full rotation age discounted as shown below. The same applies to benefits.



In other words, the present value of net benefits accruing between now and subsequent harvests is given by the following formulae:

$PVc = C / \ 1/(1+r)^t$ for costs; and

$PVb = B/ \ 1/(1+r)^t$ for benefits

or $PVnb = (B-C) / 1/(1+r)^t$

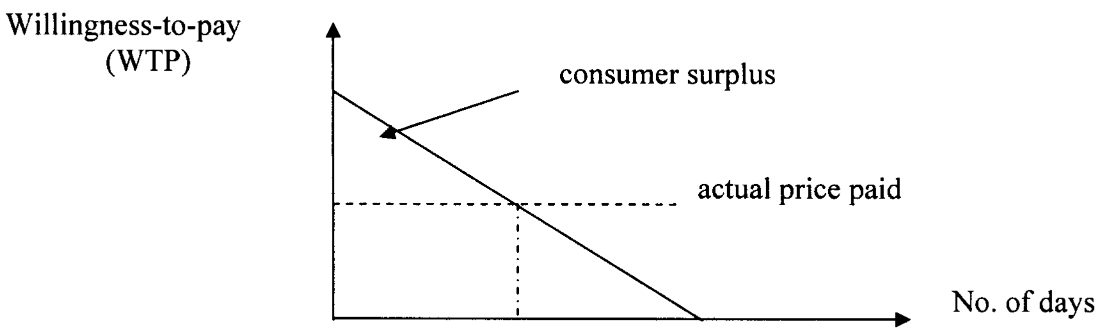
where:
PVc – present value of cost
PVb – present value of benefit
C – cost
B – benefit
PVnb – present value of net benefits (benefits less costs)
r – social opportunity cost of capital
t – time

On the other hand, for expenses incurred earlier – such as planting, beating up and weeding before a crop is considered established – the value of those investments were amortised as follows:

$$PVc = C\,(1+r)^t$$

5. The basis for calculating the value of forests for ecotourism is the consumer surplus, representing the price tourists are willing-to-pay, up and above what they actually pay for the ecotourism experience (*Figure 3*). Ecotourism is an important activity in Mabira CFR but not Kifu and Namyoya central forest reserves.

Figure 3. Graphic Illustration of Willingness to Pay



6. *Non-timber forest products* are harvested in Mabira CFR and not the other two reserves. This study used the extensive research of Bush *et al* (2004) on community livelihoods in representative forests in Uganda. The results of their research was used in this study, augmented by the Consultants' household survey and Focus Group Discussions (FGDs), among others.

7. *Carbon sequestration* values were derived from Bush *et al* (2004) where average values of tonnes of carbon per unit area per year have been estimated multiplied by the appropriate domestic market price prevailing then for carbon.

8. *Hydrological functions* were omitted from calculations for compensation for the reason that the area of forest removed for the Wayleave construction is too small to affect the hydrological functions of the forest. However, water conservation values, based on supply of water for forest communities were estimated as part of the livelihoods contribution.

9. *Bequest and Existence Values* were also removed from the calculations on the basis that the area required for the Wayleave construction is too small to significantly affect the bequest and existence values of Mabira CFR.

10. Biodiversity values were estimated using secondary data from research in comparable areas. Being forest plantation areas, Kifu CFR and Namyoya CFR were assumed to have minimal biodiversity richness and hence values were estimated only for Mabira CFR.

11. Small parts of Buwoola and Namusa community enclaves extend into Mabira CFR and will be impacted by the development. This *land is owned by individuals* who should be compensated so that the Developer has quiet enjoyment of its use rights in Mabira. However, the valuation of the lands is outside the scope of this study as explained earlier.

12. *Landtake*. The Developer is expected to obtain a use right for the Wayleave construction from the NFA. The use right is issued free of charge. However, an annual ground rent will be levied on forest land withdrawals for the Wayleave Construction. The NFA charges a ground rent of UShs 20,000 per hectare per annum. The present value of this annual payment was estimated.

4.3 Data gathering methods

The study used six approaches to gathering data, as shown below.

Secondary data through review of literature, project documents and records of the NFA. Data on forest characteristics, value of the forest for community livelihoods, carbon sequestration and biodiversity values were derived.

Consultations and meetings were held with the management and field staff of the NFA, and with representatives of community organisations to obtain site-specific information.

Stock assessment. The Makerere University Institute of Environment and Natural Resources (MUIENR) carried out detailed biodiversity assessment in Mabira CFR as part of a biodiversity inventory survey. The data related to timber stocking was to be used to calculate the volume of timber which would be removed as a result of the Wayleave construction. However, to the extent that the NFA is best suited to carry out timber inventory for its auction process and preparation of management plans, the accuracy of the volume of standing timber crop is less important compared to estimates of annual allowance cut (AAC). Hence timber inventory data from the Forest Management Plan were used. Plantation data for Kifu and Namyoya were obtained from the inventory work of the NFA.

Key informant interviews were conducted with individuals who were informed about the three CFRs. They were: Steven Khauka currently Manager of the Tree Seed Centre and formerly in charge of planning at the NFA; executive committee members of Mabira Forest Integrated Conservation Organisation (MAFICO); and the staff of the Mabira Ecotourism Centre. Their views are presented in *Annex 2.*

Focus Group Discussions (FGDs) were held with three communities within the enclaves and surrounding Mabira CFR. Meetings were held at Buwoola, Ssese and Sanga. The purpose of these meetings was to elicit the views of the communities with respect to the importance they attach to, and the livelihoods values they derive from, Mabira CFR (see *Annex 3* for details).

Household survey was conducted using a structured questionnaire based on the format of the Bush *et al* (2004) study to determine community livelihoods derived from Mabira CFR. It was assumed the benefits to communities surrounding Kifu CFR and Namyoya CFR were negligible and therefore these were excluded from the calculations of total livelihoods. Results of the household survey are presented in *Annex 4.*

4.4 Mabira CFR

Timber

Table 5 shows that the impact area for the line passing through Mabira CFR holds a standing volume of 2,808.1 m^3 for trees of 50 cm diameter at breast height (dbh) and above.

Table 6 shows the exploitable timber yield. The data indicate a long-run sustainable yield (LRSY) of $1m^3$/ha/year for the species desired for timber made up of 21% Class I, 31% of Class II timber and 48% of Class III timber.

The LRSY timber yield in the Wayleave impact area was, therefore, estimated at $67.6m^3$/year (*Table 7*).

To convert the sustainable volume removals into monetary terms, the stumpage values (or reserve prices the NFA uses for its timber auctioning business) were obtained from the Authority. The stumpage value for each timber utilisation class was simply the average for all the species in that class. *Table 8* shows stumpage values for different species in Mabira CFR. Average stumpage values (at 100% management costs, per cubic metre) for the different utilisation classes were estimated as: UShs 172,770 for Class I; Ushs 102,511 for Class II and Ushs 86,385 for Class III[5].

[5] Historically bidders have paid prices slightly above the reserve prices.

Table 5. Estimates of Standing Timber Crop in Area of Impact[/a]

Compartment No.	Impact Area (ha)	Volume/ha[/b] (m^3/ha)	Total Volume (m^3)	Management Zone
173	10.02	8.1	81.2	Production /Encroachment
179	7.78	30.2	235.0	Production /Encroachment
185	12.44	8.1	100.8	Production /Encroachment
192	13.02	60.3	785.1	Production /Low impact
202	6.27	59.3	371.8	Recreation / Buffer Zone
203	5.16	61.8	318.9	Recreation / Buffer Zone
206	1.68	56.4	94.8	Recreation / Buffer Zone
207	8.23	79.1	651.0	Recreation / Buffer Zone
211	1.16	60.7	70.4	Recreation / Buffer Zone
229	**1.87**	53.0	**99.1**	Production /Low Impact
Totals	**67.63**		**2,808.1**	

/a – Compartment 234 excluded because there were no large trees in the area of impact
/b – Appendix 7, Mabira CFR Forest Management Plan 1997 – 2007

Source: Karani *et al* (1997)

Table 6. Mabira Forest Exploitable Timber Yield Trees above 50cm dbh (based on 60 year felling cycle for whole forest - 30,305 ha)

A. By Species	Utilisation Class	m^3/ha	m^3/yr	m^3/ha/yr
Holoptelea	I	5.3	2,676	0.088
Albizia	I	7.2	3,636	0.120
Alstonia	II	3.4	1,717	0.057
Antiaris	II	4.6	2,323	0.077
Celtis	II	18.3	9,243	0.305
Chrysophyllum	II	2.4	1,212	0.040
Trilepsium	III	1.9	959	0.031
Cola gigantea	III	1.2	606	0.020
Ficus	III	2.7	1,363	0.045
Other species	III	13	6,866	0.217
		60.0	30,305	1.000
B. By Utilisation Class				
		12.5	6,312	0.208
Class I		28.7	14,495	0.479
Class II		18.8	9,794	0.313
Class III		60	30,601	1.000

Source: Karani *et al* (1997), Table 9.

Table 7. Exploitable Natural Forest Timber Yield in the Impact Area

Compartment	Impact Area (ha)	Annual timber yield (m^3/year) Class I	Class II	Class III	Total Volume/ Year (m^3)
173	10.02	2.1	3.1	4.8	10.0
179	7.78	1.6	2.4	3.7	7.7
185	12.44	2.6	3.9	6.0	12.5
192	13.02	2.7	4.1	6.2	13.0
202	6.27	1.3	2.0	3.0	6.3
203	5.16	1.1	1.6	2.5	5.2
206	1.68	0.3	0.5	0.8	1.6
207	8.23	1.7	2.6	3.9	8.2
211	1.16	0.2	0.4	0.6	1.2
229	1.87	0.4	0.6	0.9	1.9
Totals		**14.0**	**21.2**	**32.4**	**67.6**

/a - based on the following: 0.208m^3/ha/year for Class I, 0.313 m^3/ha/year for Class II and 0.479 m^3/ha/year for Class III. Derived from Karani *et al* (1997)

To convert the sustainable volume removals into monetary terms, the stumpage values (reserve prices the NFA uses for its timber auctioning business) were obtained from the Authority. The stumpage value for each timber utilisation class was arrived at by obtaining the average for all species in that class. *Table 8* shows stumpage values for different species in Mabira CFR. Average stumpage values per cubic metre (at 100% management costs) for the different utilisation classes where subsequently estimated at: Ushs 172,770 for Class I; Ushs 102,511 for Class II; and Ushs 86,386 for Class III[6].

Using the foregoing stumpage values multiplied by the volumes in each class presented in *Table 8,* one arrives at an annual stream of timber values of:

Class	**Amount (Ushs)/year**
I	2,418,780
II	2,173,233
III	2,798,906
Total	**7,390,919**

Capitalising this annual timber benefits flow by 12% per year (social opportunity cost of capital) gives a present value of Ushs 61,590,992, representing the timber (sawlogs/peer logs) production opportunity cost.

[6] Historically, purchases of standing timber have paid in excess of the NFA's reserve prices. Hence, these values should be considered conservative.

The value of the standing crop was estimated using data presented in *Table 5* and assuming the total volume represents 21% Class I, 31% Class II, and 48% Class III. That is:

$V_{sc} = P_1\,(2808.1 * S_{pi}) + P_2\,(2808.1 * S_{pii}) + P_3\,(2808.1 * S_{piii})$

where

V_{sc} – volume of standing crop in the impact area
S_{pi}, S_{pii} and S_{piii} represent stumpage values for Class I, Class II and Class III, respectively
P_1, P_2, and P_3 represent the proportion of the different utilisation classes, where $P_1 = 0.21$, $P_2 = 0.48$, and $P_3 = 0.31$.

Therefore:

$V_{sc} = 0.21\,(2808.1*172{,}770) + 0.31\,(2808.1*102{,}511) + 0.48\,(2808.1*86{,}385)$

$= 101{,}882{,}642 + 89{,}236{,}953 + 116{,}437{,}305$
$= 307{,}556{,}900$

Hence the value of the standing timber crop in Mabira CFR area of impact was established to be Ushs 307,556,900 for trees having dbh of 50 cm and above.

Table 8. Stumpage Values for Mabira

Species	Stumpage Values (Ushs /m³)		
	Base	**75%***	**100%***
Muvule	126,667	151,553	201,565
Nkoba	90,476	108,252	143,975
Aningeria / chysophyllum	104,953	125,572	167,011
Albizia	72,381	86,602	115,181
Maesopsis	65,143	77,942	103,663
Nkuzanyana	54,289	64,951	86,385
Antiaris	25,333	30,311	40,314

* refers to management cost levels
Source: NFA databank

Poles and Firewood

The Management Plan for Mabira CFR 1997-2007 did not encourage the harvesting of poles from the forest. The Plan had this to say in Prescription No. 30.

> " *Though a limited quantity of poles is permitted for domestic use, there are attempts to collect and sell poles due to socioeconomic pressures. There is absolute need to watch out for any large quantities collected by people neighbouring the reserves, as a small business. The FD (now the*

> *NFA) staff will investigate any suspected cases and take appropriate steps to stamp out the practice*".
> Karani, *et al* (1997).

Similarly, for fuelwood or woodfuel (representing firewood and charcoal), the Management Plan 1997-2007 Prescription 31 said thus.

> " Fuelwood cutting (sic) and charcoal production are destructive to a standing crop, as licence holders are indiscriminate i.e. cutting young trees of marketable species. *Fuelwood cutting (sic) and charcoal production shall not be allowed in the MPA (Management Plan Area)*". Karani *et al* (1997).

From the foregoing, harvesting of both poles and firewood in commercial quantities is prohibited. However, harvesting the products in limited quantities for own use is permissible. Hence the approach to estimating the combined stream of values from firewood and poles was the one Bush *et al* (2004) used based on household livelihoods.

Bush *et al* (2004) estimated the total livelihood value of timber (largely poles and firewood) and non-timber products from a typical protected tropical high forest in Uganda at UShs 18,074 per ha per year, of which 47% was timber and 53% non-timber forest products. Hence the combined annual stream of poles and firewood values was estimated at UShs 8,495/ha. Since the impact area in Mabira CFR is estimated at 67.63 ha, this gives a benefit stream of UShs 574,517/year. Capitalising this annual benefit stream by 12% gives a net present value for poles and firewood of UShs 4,693,492. Bush *et al* (2004) cautioned as follows.

> " It is important to note at this point that the values calculated *do not* imply that the level of economic value derived is sustainable. (They estimated economic value based on the current levels of use). However, it is reasonable to assume that protected THF [Tropical High Forest] values are closer to sustainable harvest rates considering the management efforts of the NFA".

In summary, the values of poles and firewood were arrived at as follows.

Poles + Firewood livelihood value	UShs 8,495/ha/year
Size of Impact Area	67.63 ha
Total annual benefit stream	UShs 574,517/year
Present Value of Poles + Firewood benefits	UShs 4,787,642

Non-timber forest products

Prescription 32 of the Mabira Forest Management Plan 1997-2007 had this to say about handicrafts materials.

> "*Demand for handicraft products, including easy chairs, stools, mats and baskets is rising. Although limited quantities, for domestic use, are permitted free of charge under the FORESTS ACT, a system shall be devised to monitor, record and control harvesting. Any collection/harvesting for commercial purposes shall be fully charged at appropriate rates of such forest product*". Karani *et al* (1997).

For other non-timber forest products, Prescription 33 of the Mabira Forest Management Plan 1997-2007 stated as follows:

> "*Domestic collection of medicinal herbs, edible plants and other food materials does not pose any immediate danger to the resource or the standing forest crop. Such collection may promote protection and conservation of the respective forest resource in the MPA by neighbouring communities. However, levels of harvesting shall be controlled and in case of commercial interests, corresponding fees shall be charged. In case of any destruction to standing forest crop, e.g. debarking and uprooting, the FD (now NFA) officers shall take steps to immediately stop such actions*". Karani *et al* (1997).

To estimate the benefits stream from non-timber forest products, the Bush *et al* (2004) study was used. The results of the research showed that typical tropical high forest protected areas (PAs) on average generate UShs 9,579/ha/year, an amount much lower than Afromontane forest PAs, private THFs and savanna woodland/bushland. Nonetheless, the value for tropical high forest PA is thought to be the closest to the Mabira situation. Using the approach similar to the one for poles and firewood, the present value of the benefits stream from non-timber forest products was estimated at UShs 5,292,398 as shown below.

NTFPs livelihood value	UShs 9,579/ha/year
Size of impact area	67.63 ha
Annual benefit stream	UShs 647,828/year
Present Value of NTFPs	UShs 5,398,565

Biodiversity

Mabira CFR is rich in biodiversity. Although the area of impact of the Wayleave construction is small and, therefore, unlikely to affect overall biodiversity richness, it is possible even in a small area some may be lost.

Biodiversity richness of a forest represents an option value; and it is perhaps one of the least tangible benefits of Uganda's forests (Bush *et al* 2004). The value of biodiversity lies partly in the development of plant-based pharmaceuticals (Bush *et al* 2004; Emerton & Muramira 1999; Mendelsohn & Balik 1997; Howard 1995; Pearce & Moran 1994; Ruitenbeek 1989). In addition to undiscovered plant-based pharmaceuticals, Howard (1995) reported that there is potential in wild coffee genetic material. According to Bush *et al* (2004), Uganda's farmed coffee is being hit by a *Fusarium* wilt against which no known cultural or chemical practices appear to succeed and wild coffee is known to be resistant to it (Bush *et al* 2004).

Various estimates have been made of the value of forest biodiversity. Ruitenbeek (1989) estimated the biodiversity of Korup Park in Cameroon at £0.1/ha/annum. Pearce & Moran (1994) provided a range of values for tropical forest, ranging from US$0.1/ha to US $ 21/ha.

Mendelsohn & Balik (1997) produced a value for undiscovered plant-based drugs in tropical forest with average plant endemism of US$3/ha. Howard (1995) suggested that Uganda's forests are not as species rich as Korup Park and the country would be less competitive in say supply of *Prunus africana*. Bush *et al* (2004), suggest an average value for biodiversity at US$1.50/ha/year. Using this estimate the biodiversity opportunities foregone in the impact area would be UShs 186,659/year (using an exchange rate of 1 US$ = UShs 1840). This annual benefit stream translates into a present value of UShs 1,555,490.

Domestic water conservation

During Focus Group Discussions with communities surrounding Mabira CFR and living in the forest enclaves (*Annex 3*), they revealed that to them the most important use of the forest was for water collection. All the surrounding communities and those living in the forest enclaves, said they get their water from the forest. This view tallies with the observation of Bush *et al* (2004), where the forests surveyed across Uganda represented important sources of water for local communities.

Bush *et al* (2004) estimated the mean value of water provision for both humans and livestock per household at UShs 18,415 per annum, and ranges from UShs 12,078 per annum for Budongo CFR to UShs 30,928 per annum for Ruwenzori Mountains National Park. In this report, the value for Budongo CFR which is relatively similar to Mabira CFR was used in estimating community water benefits.

Muramira (2000) estimated the number of households in the enclaves and within the proximity of Mabira at 15,631. Assuming population growth rate of 3.4% per annum (UBOS 2002), by 2006, this population would have increased to about 19,103 households. Therefore multiplying the mean value of water provision of UShs 12,078 per annum by the number of households gives a total value of UShs 230,726,034 per annum. However, the impact area is 67.63 ha out of the total size of about 30,000 ha. Therefore, the value of water provision in impact area which will be lost is equivalent to UShs 520,133 per annum. Holding this value constant over the project period, the net present value of domestic water provision translates into a conservative estimate of UShs 4,334,445[7].

[7] The estimate is conservative because the population in the enclaves and the surrounding areas will increase over the years. However, it is possible with increased development, alternative water sources are likely to be developed.

Carbon storage

The removal of tree cover as a result of the Wayleave construction will result in loss of some of the carbon storage capacity of Mabira CFR. According to Bush *et al* (2004), at the global level, the forestry sub-sector is an important carbon sink, helping to reduce accumulation of greenhouse gases and hence global warming which will lead to adverse changes in climate. Emerton & Muramira (1999) and Bush *et al* (2004) give the following carbon storage values for different vegetation types: primary closed forest UShs 54,660/ha/year; degraded forest UShs 32,538/ha/year; and woodland, bushland and grassland UShs 2,603/ha/year. The Wayleave construction is expected to leave the cleared impact area under grassland instead of bare ground. Furthermore, the Production (Encroachment) and the Recreation/Buffer Zone would have carbon sink values equivalent to a degraded forest. The Production (Low Impact) zone on the other hand should have carbon sink values somewhere between the primary and degraded forests. Subsequently, the value of carbon sink/ha/year for the Production/Encroachment and Recreation/Buffer Zone was estimated at UShs 32,358/ha/year less grassland value of UShs 2,603/ha/year giving a net value of UShs 29,935/ha/year. Using a similar approach, the carbon sink value for the Production/Low Impact Zone would be UShs 40,996/ha/year, using the average value for a primary closed forest and a degraded forest and deducting grassland values.

Multiplying the carbon sink values by the size of the applicable impact area, *Table 9* shows the annual values lost. The Wayleave construction is expected to result in a loss of carbon sink values equivalent to UShs 2,189,202/year. Capitalised at the social opportunity cost of capital, the annual stream gives a present value of UShs 18,243,350.

Table 9. Carbon Sink Values

Management Zone in Mabira	Impact Area (ha)	Value of Carbon sequestrated/ha/yr*	Total Value/year (U Shs)
Production (Encroachment)	30.24	29,935	905,234
Production (Low Impact)	14.89	40,996	610,430
Recreation / Buffer Zone	22.5	29,935	673,538
	67.63		**2,189,2002**

*adapted from Bush *et al* (2004) and Emerton & Muramira (1999)

Landtake

The total impact area in Mabira CFR was estimated at 70.44 ha (including Compartment 234). An annual ground rent of UShs 20,000/ha/year is charged by the NFA. Therefore the annual benefit stream from landtake was estimated at UShs 1,408,800; and the present value of this annualised series was Ushs 11,740,000.

Ecotourism

According to Muramira (2000), Uganda's tropical high forests have some of the richest biodiversity of plant and animal life in the world. The biodiversity inventory for Mabira CFR revealed that the forest has average biodiversity attributes (Davenport *et al* 1996). However, the ecotourism value of Mabira lies in the fact that it is the only THF protected area within the Lake Victoria shore crescent. Furthermore, Mabira CFR is close to the urban centres of Kampala (50km) and Jinja (21km). There is increasing interest in ecotourism in Mabira CFR as shown in *Table 10*. Finally, in addition to the Ecotourism Centre operated by the NFA, new developments are either nearing completion (for example the facility of Ecolodges) or are in the early stages of development (for example the plans of MAFICO).

Table 10. Visitor statistics

Year	Foreigners/ Foreign Residents	Locals	Total
2005/06	1,989	2,854	4,843
1999	1,312	2,880	4,172
1998	1,450	1,125	2,575
1997	1,304	1,094	2,398
1996	1,097	515	1,612

Source : data for 2005/06 fiscal year from the NFA
: data for remaining years, Muramira (2000)

The basis to estimating the annual value of ecotourism is the consumer surplus, the difference between the price tourists are willing to pay and the price they actually paid. Naidoo & Adamowicz (2005) found that an entrance of US$47 would maximise tourism value i.e. the amount foreign and foreign residents of Uganda are currently charged US$5 to visit Mabira CFR (Naidoo & Adamowicz 2005). This dramatic under-valuation of the willingness to pay of tourist visitors is consistent with results from other tropical areas and suggests much room for improvement in entrance fee policy (Naidoo & Adamowicz 2005).

From the above, the consumer surplus for foreigners and foreign residents is US$42 per tourist. In the absence of data on the local tourists' willingness-to-pay and considering their low income levels, this study assumes a zero consumer surplus pertaining to local tourists. For foreigners and foreign residents US$ 42 or UShs 77,280 (at exchange rate of UShs 1840 to the US$) – was used. Furthermore, using the 2005/06 data for foreigners and foreign residents of 1,989 tourists, the annual value of ecotourism for the whole Mabira CFR was estimated at UShs 153,709,920/year. Mabira CFR is about 30,000 ha in size and it would be incorrect to allocate all the annual value lost due to the impact area of 67.63 ha. Hence, the proportionate share of ecotourism benefits lost was estimated as a fraction of the value for Mabira as a whole (that is, UShs 153,709,920/year x 67.63/30,000) giving a value of UShs 346,513.

Subsequently, the present value of the ecotourism benefits foregone as a result of the Wayleave construction translates into UShs 2,887,612.

Recently planted crop

In Compartment 234, there was a crop of *Terminalia sp* less than I year old and hence below the age of establishment. Nonetheless, the private tree farmer ought to be compensated for expenses incurred assuming that the money will be realised in the third year. Total expenses were estimated at UShs 1,300,000 (based on NFA experience). When this amount was compounded by 3 years, the present value equaled to UShs 1,826,370.

4.5 Kifu CFR

Timber

On a plot of 10m x 20m or 0.02 ha, 15 standing trees of average dbh of 6.5 cm-12.4 cm and height of 2-3 m were counted in Kifu CFR. This gives a stocking rate of 750 trees/ha. The latest yield recording for *Araucaria sp.* was 1,400 m^3/ha. The stumpage value was UShs 86,000/m^3. The area impacted by the Wayleave construction in the part of Kifu forest was 3.713 ha. However only about 600 m by 40 m is planted, indicating an area of 2.4 ha. A crop of *Araucaria* matures in 25 years (economic rotation age). Licence for growing *Araucaria* is 50 years, renewable, meaning 2 rotations are realisable. Therefore, the total Present Value for the *Araucaria* crop is given by UShs 288,960,000 each received in the 25th and 50th years based on present stumpage values. When the two receipts were discounted at the appropriate social opportunity cost of capital, the present value of future benefits foregone was equal to UShs 17,990,650, or put in another way UShs 7,496,104/ha.

Landtake

In addition to this foregone benefit payable to the crop owner, the Developer is also required to pay UShs 20000 /ha/year of ground rent to the NFA. Therefore, payment of ground rent for the impact area of 3.713 ha was estimated at UShs 74,260/year, giving a present value of UShs 618,833.

4.6 Namyoya CFR

Timber

On a plot of 10m x 20m or 0.02 ha, 16 standing trees of *Eucalyptus grandis* of average dbh of 3.8 to 10.6 cm were counted in Namyoya CFR. This gives a stocking rate of 800 trees/ha. It is assumed that all 800 trees would be suitable for electric poles. The stumpage value for electric poles is UShs 20,000/tree. The area impacted by the Wayleave construction in Namyoya CFR was 7.658 ha. Production of electricity poles from E. grandis takes 8 years and the tree growers noe have 25-year licences, renewable which gives them an opportunity to raise three crops during the licence period. Therefore, the total Present Value for the Eucalyptus crops is given by UShs 122,528,000 each received in the 8th, 16th and 24th years based on present stumpage values. When the three harvest payments were discounted at the appropriate social opportunity cost of capital, the total present value of future benefits foregone was equal to UShs 77,545,521 or put in another way, UShs 10,126,080/ha of area impacted.

Landtake

In addition to this foregone benefit payable to the crop owner, the Developer is also required to pay UShs 20000/ha/year of ground rent to the NFA. Therefore, payment of ground rent for the impact area of 7.658 ha was estimated at UShs 153,160/year, giving a present value of UShs 1,276,333.

4.7 Management costs

The NFA will need to commit staff and equipment to monitor the implementation of the mitigation measures proposed in the project EIS. Second, there is a need to revise the management plan for Mabira CFR but not Kifu and Namyoya reserves. Third, the NFA will need to allocate other lands for the private tree farmers whose land is to be affected by the construction of the Wayleave. The attendant costs will be one time expenditures and even if they cover a period of 18 months (e.g. monitoring), the cost figures were treated as present values.

Muramira (2000) estimated the cost of monitoring to be UShs 6,526,080. This cost is probably on the lower side since the remuneration of the staff of the NFA has gone up and so has the cost of fuel. Therefore, a doubling of this cost at UShs 13,052,160 would be more reasonable.

Revision of the management plan for Mabira CFR was estimated at UShs 2,000,000. Finally the cost of demarcating new areas to be allocated to tree farmers in Kifu and Namyoya CFR is expected to cost a nominal amount of UShs 1,500,000.

Subsequently, total management costs were estimated at UShs 16,552,160 as follows.

Monitoring of EIS	UShs 13,052,160
Revision of management plan	UShs 2,000,000
Planting area allocation	UShs 1,500,000
	UShs 16,552,160

It is worth noting that the NFA will incur additional costs in removing the timber stock in the area of impact. However, it is expected that the Authority will meet this cost from proceeds it gets from issuing salvage felling licenses to third parties.

4.8 Summary of economic values

This section provides a summary of the economic value lost or foregone as a result of the construction of the Wayleave for the new 220 KV transmission line north of the existing 132 KV line. *Table 11* shows a summary of the overall economic impact.

The data show a growing stock (50 cm dbh +) in Mabira CFR worth UShs 307,556,900 will have to be cleared to make way for the transmission line. Furthermore, the present value of use and non-use values foregone including land and compensation for recently planted crop of *Terminalia sp.* and a small compensation for private land, would amount to UShs 112,364,466.

In Kifu CFR the value of timber benefits foregone and annual payments of ground rent would amount to a present value of UShs 18,609,483. Similarly, in Namyoya CFR, foregone timber values and annual ground rent payments would give a present value of UShs 78,821,854.

The NFA would incur incremental management costs arising from monitoring of the EIS; preparation of a new management plan for Mabira CFR; administering the allocation of new areas to the private tree farmers who are expected to lose their planting area as a result of the Wayleave construction. These added management costs were estimated at UShs 16,552,160.

Finally, the present value of the growing stock for Mabira, the benefit streams foregone in all the three CFRs together with associated incremental management costs were estimated to total UShs 533,903,863.

Table 11. Summary of Economic Values (Ushs)

Source of Economic Value	Mabira CFR	Kifu CFR	Namyoya CFR	TOTAL VALUE
A. GROWING STOCK	**307,556,900**	**0**	**0**	**307,556,900**
B. PRESENT VALUES OF BENEFITS STREAMS				
1. Timber	61,590,992	17,990,650	77,545,521	157,127,163
2. Poles + Firewood	4,787,642	0	0	4,787,642
3. Non-Timber Forest Products	5,398,565	0	0	5,398,565
4. Biodiversity	1,555,490	0	0	1,555,490
5. Domestic Water	4,334,445	0	0	4,334,445
6. Carbon Storage/Sequestration	18,243,350	0	0	18,243,350
7. Ecotourism	2,887,612	0	0	2,887,612
8. Landtake	11,740,000	618,833	1,276,333	13,635,166
9. Immature plantings	1,826,370	0	0	1,826,370
Sub Total B	**112,364,466**	**18,609,483**	**78,821,854**	**209,795,803**
C.TOTAL GROWING STOCK AND BENEFITS STREAM(A+B)	**419,921,366**	**18,609,483**	**78,821,854**	**517,352,703**
D. ADD MANAGEMENT COSTS				**16,552,160**
E. GRAND TOTAL ECONOMIC VALUES				**533,904,863**

5.0 Mitigation Plan

5.1 Stakeholder Roles

For the construction of the Wayleave through Mabira, Kifu and Namyoya Central Forest Reserves, four distinct stakeholders were identified – the NFA, the Developer, Private Tree Farmers (PTF) and the Communities in the forest enclaves and surrounding areas. Each stakeholder has specific roles as described below.

The NFA

- Disposes the growing stock in the impact area in Mabira CFR, to allow the Developer easy access and incurs the cost of removal of growing stock and receives all benefits realized therefrom.
- Acquires and disposes timber crop of the private tree farmers in Namyoya CFR.
- Disposes owned timber in Kifu CFR within the impact area.
- Allocates new planting area for affected tree farmers in Namyoya and Mabira CFRs
- Provides the local communities of Mabira CFR with compensatory benefits for lost values with respect to firewood and poles, NTFPs, and domestic water.
- Provides the global community with compensatory benefits for lost biodiversity and carbon sequestration values.
- Invests in natural forest rehabilitation from proceeds of the disposal of the standing timber crop.
- Prepares new Forest Management Plan for Mabira CFR taking into account the impacts of the Wayleave construction

The Developer

- Pays the NFA for lost investments in plantation crop to compensate affected tree farmers and the Authority's own crop.
- Pays the NFA for loss of future benefits streams.
- Pays the NFA ground rent annually or makes a one time payment of UShs 13,635,166 representing the present value of annual payments.
- Meets the NFA's incremental management costs.
- *Does not* compensate the NFA for timber value of the growing stock since the Authority will supervise and realise benefits from the disposal of the timber in the impact area of Mabira.

Private Tree Farmers

- Receive payments for lost future crops
- The NFA allocates proportionate compensatory area for planting within suitable CFRs.

Communities

- Receive 'compensatory benefits' for lost livelihood values
- Get preferential treatment for employment (if suitably qualified) during the construction and maintenance of the Wayleave and any forestry-related activities.

5.2 Financial implications

The roles of the different stakeholders imply varying levels of financial commitments or benefits as described below.

The NFA

A. Receives

1. Compensation for benefits stream from the developer: UShs 209,795,803
2. Incremental management costs from the Developer: UShs 16,552,160
3. Auctions growing stock in the impact area in Mabira: UShs 307,556,900.

Total receipts: UShs 533,904,863

B. Pays out

1. Private tree farmers for lost timber values UShs: 79,371,891
2. Management costs: UShs 16,552,160
3. Pays itself for lost *Araucaria* crop UShs 17,990,650
4. Invests in forest rehabilitation and other forest management priorities, and compensatory investments in community social infrustructure: UShs 419,990,162

The Developer

A. Receipts None

B. Payouts

Benefit streams Foregone paid to the NFA: UShs 209,795,803
Incremental management costs paid to the NFA: UShs 16,552,160
Total payout: UShs 226,347,963

5.3 Summary

- The NFA will have to organise the disposal of the Mabira CFR standing timber crop in the impact area through its auction process.

- The NFA on its own or in collaboration with the affected Private Tree Farmers arranges to dispose of the immature plantation trees from the impact area in Kifu and Namyoya CFRs.

- The Developer pays the NFA cash amount equal to UShs 226,347,963 or US$ 123,015 (using exchange rate of UShs 1,840 to the dollar).

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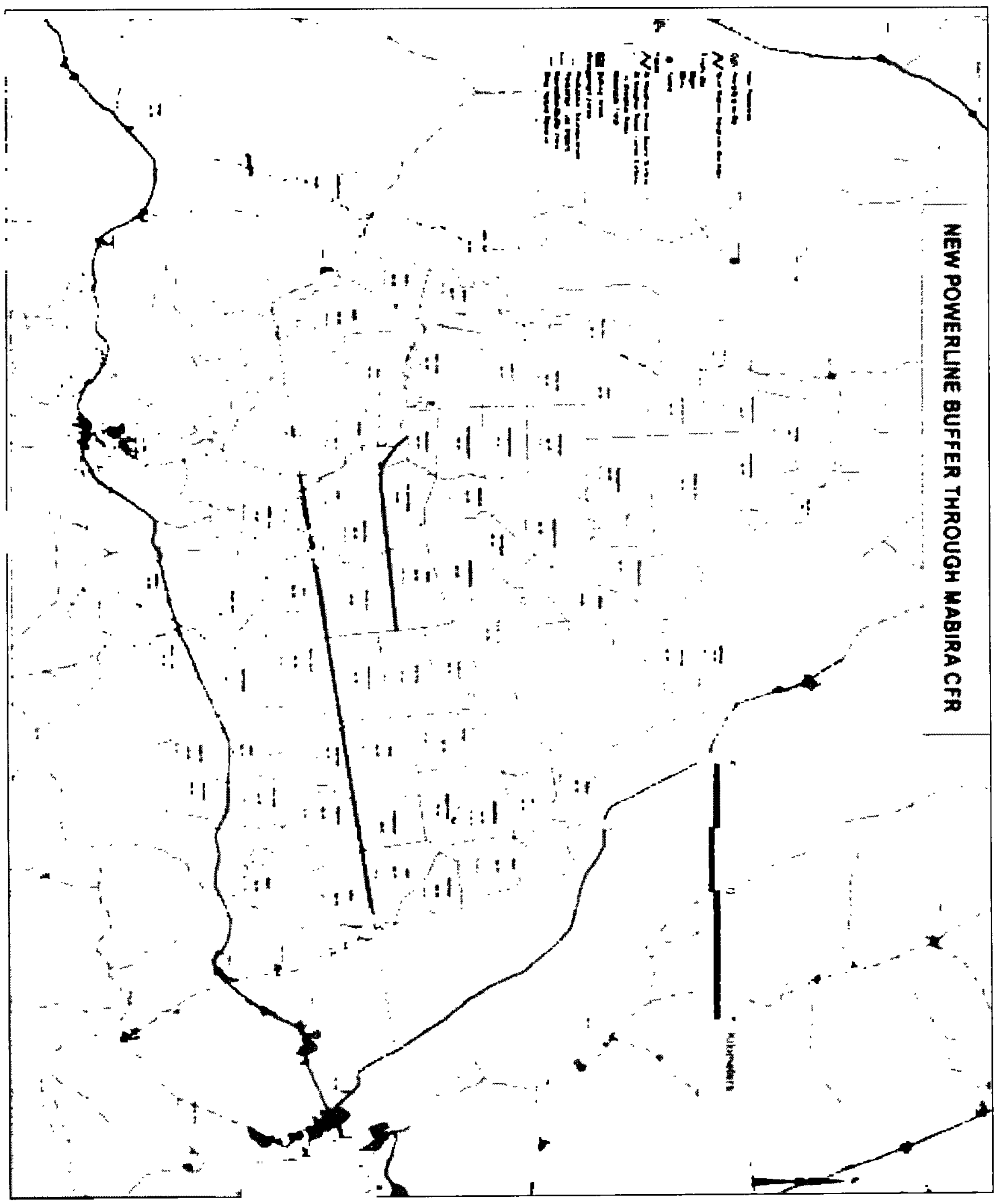
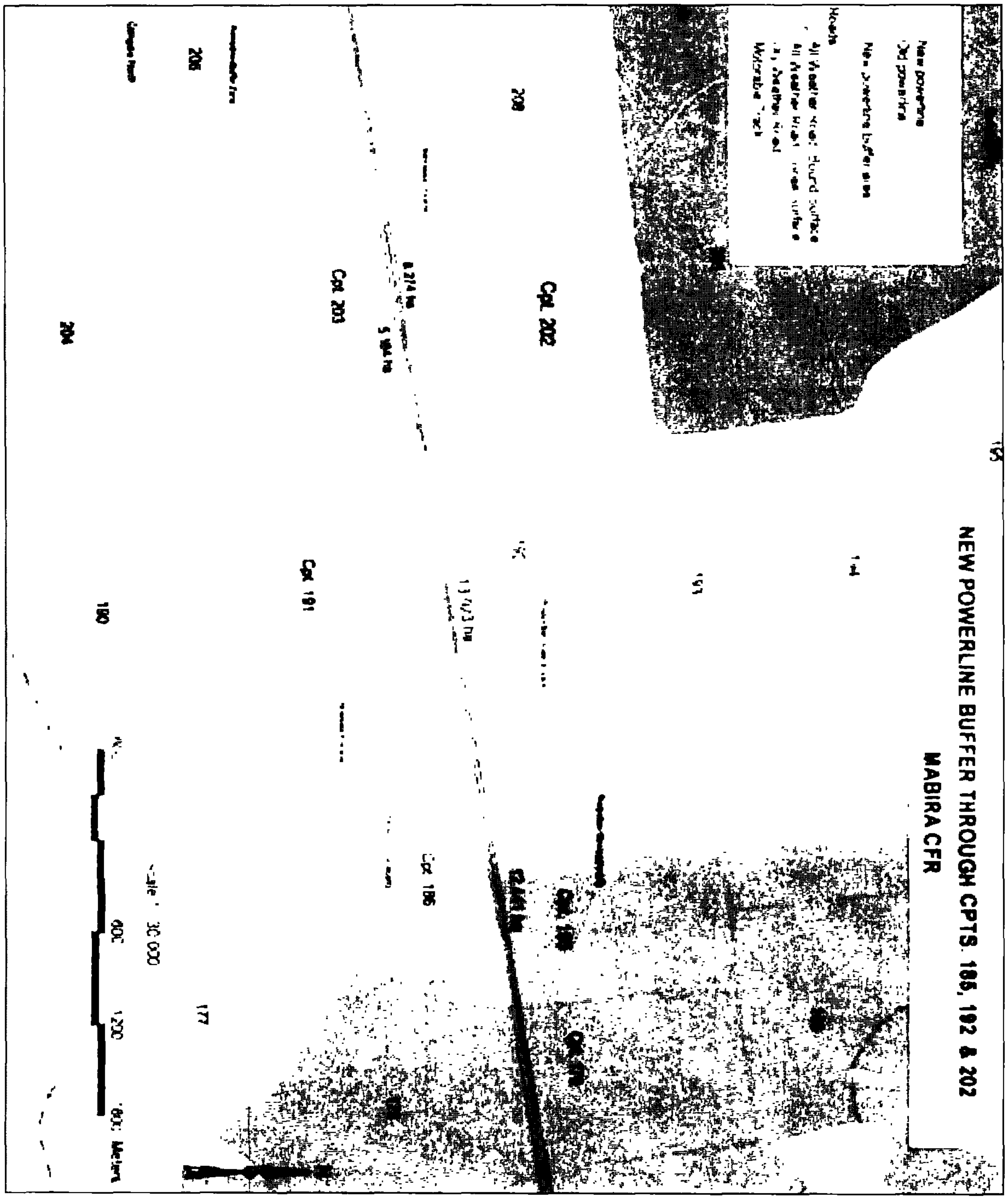
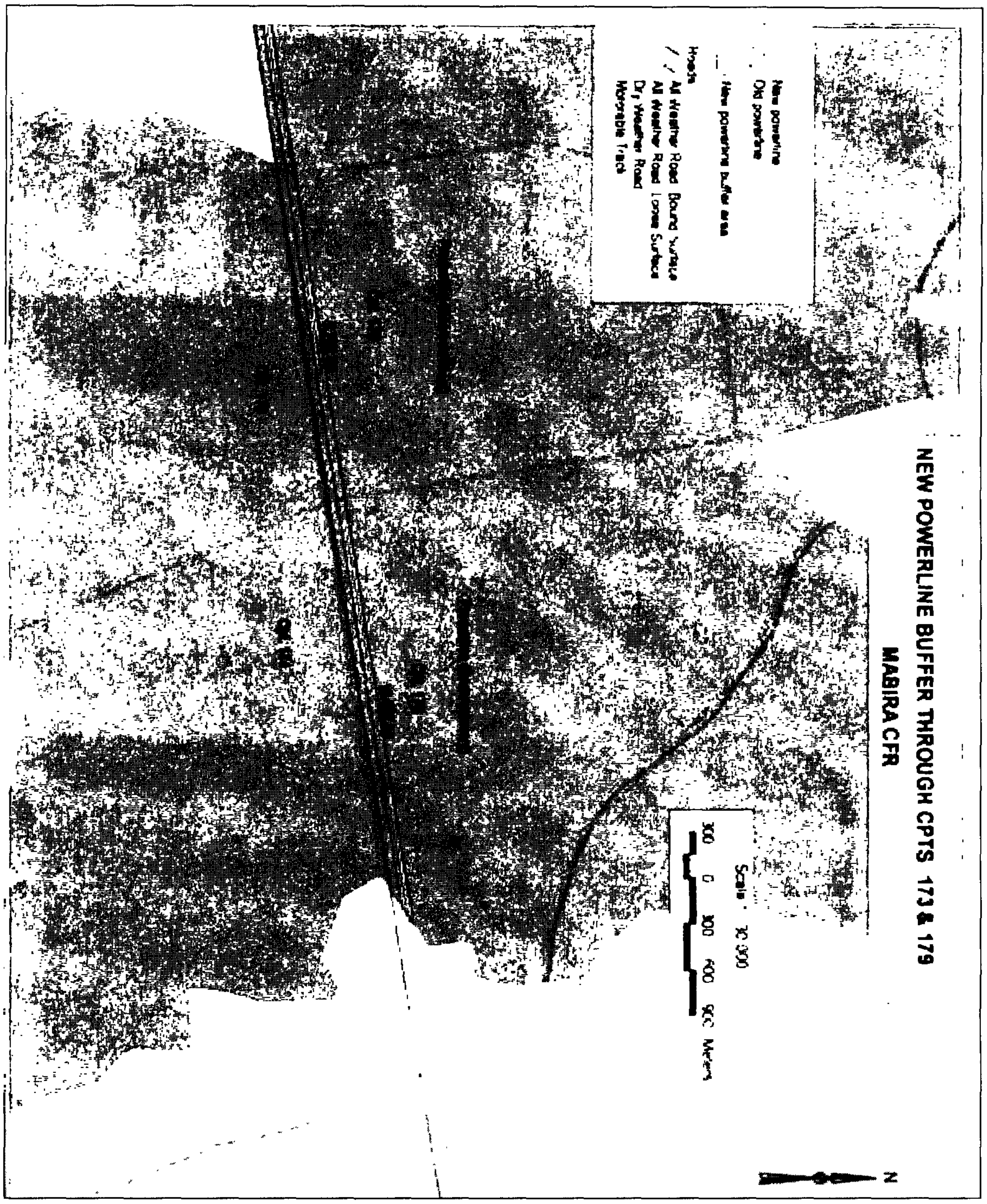
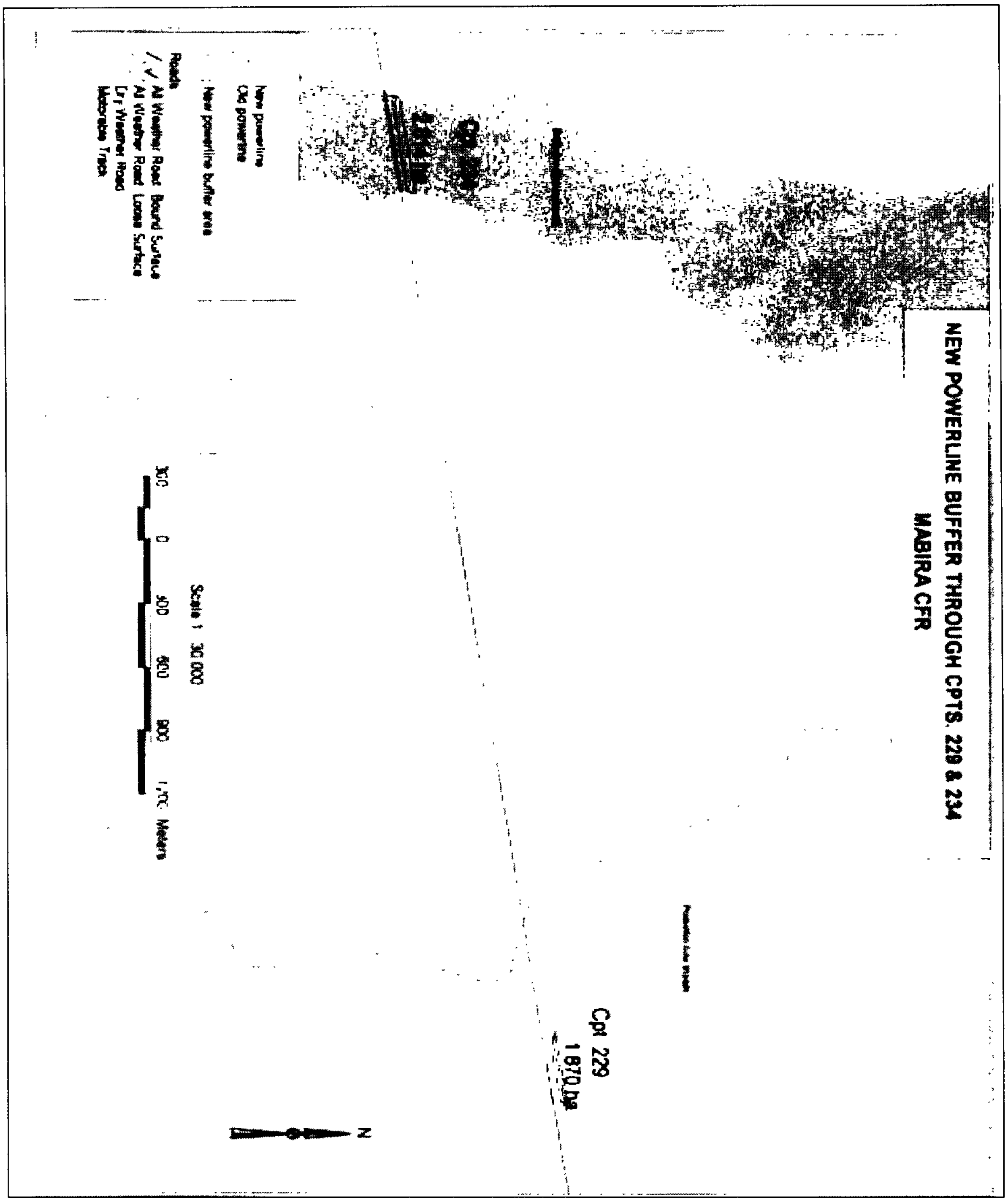
Annexes

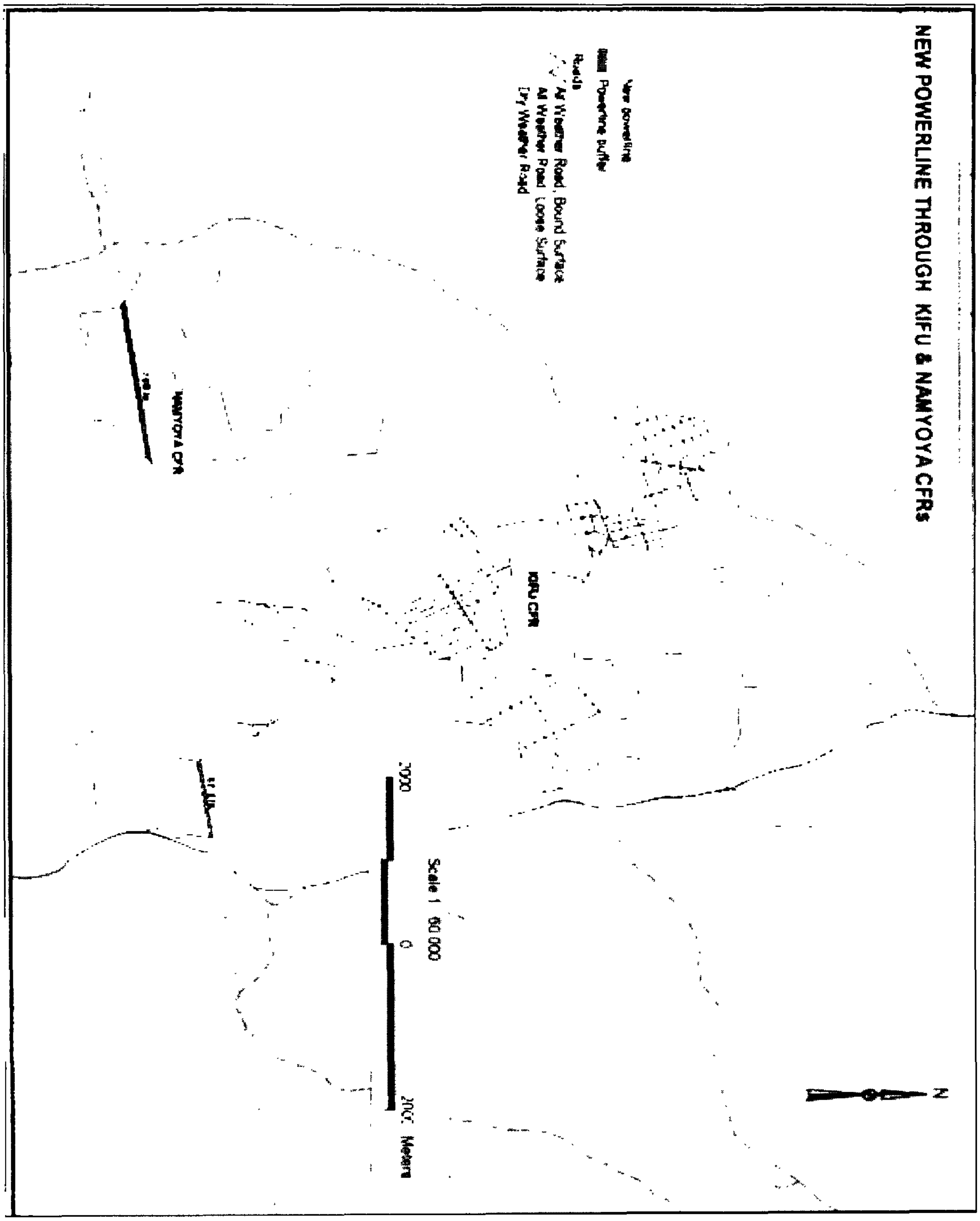
Annex 1
Maps of Impact Areas in Mabira, Kifu and Namyoya CFRs




NEW POWERLINE BUFFER THROUGH CPTS. 185, 192 & 202
MABIRA CFR
Cpt. 202
Cpt. 203
Cpt. 191
Cpt 186
208
206
204
180
177
Metres


NEW POWERLINE BUFFER THROUGH CPTS 173 & 179
MABIRA CFR
New powerline
Old powerline
New powerline buffer area
Roads
All Weather Road Bound Surface
All Weather Road Loose Surface
Dry Weather Road
Motorable Track
Scale
300 0 300 600 900 Meters
N


NEW POWERLINE BUFFER THROUGH CPTS. 229 & 234
MABIRA CFR
New powerline
Old powerline
New powerline buffer area
Roads
All Weather Road Bound Surface
All Weather Road Loose Surface
Dry Weather Road
Motorable Track
Scale 1: 30,000
300
0
300
600
900
Meters
Cpt 229
1,870 ha
N


NEW POWERLINE THROUGH KIFU & NAMYOYA CFRs
Powerline buffer
Roads
All Weather Road, Bound Surface
All Weather Road, Loose Surface
Dry Weather Road
NAMYOYA CFR
KIFU CFR
Scale 1 : 60 000
0
Meters
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Annex 2

Key Informant Interviews

The following people and groups were consulted in regards to the importance of Mabira CFR and the likely impacts of the Wayleave for the proposed transmission line. They were: Steven Khauka – formerly in planning at the NFA, and now, the Manager of Namanve Tree Seed Centre; the Executive Committee Members of Mabira Forest Integrated Community Organisation (MAFICO); and the staff of Mabira Ecotourism Centre.

1) Steven Khauka

Steven Khauka mentioned enrichment planting as the best option in managing degraded forests. It involves planting of selected tree species in the degraded areas. This helps faster and easy regeneration of the forests in areas where the required species are planted. The option also helps in the introduction of new tree species in the planted areas as opposed to natural regeneration. Despite being the best option however, the method requires high investment levels in terms of care and maintenance, which is not catered for in most cases. Maintenance costs involved include opening of canopy to create space for the newly planted trees and clearing of climbers, as they are easily attracted to opened spaces thereby hindering the growth of the planted trees. Enrichment planting using different tree species gives rise to mixed tree species in the forest, which caters for different values attached to the forests.

Steven felt that natural regeneration as a method of managing degraded forests is not feasible. This is because the method needs a long time for regeneration to take place and in cases where the parent trees are missing, which is a major phenomenon in degraded forests, quality regeneration may never be seen due to lack of seeds.

In terms of restoring degraded forests, the best method to be followed as per Steven's concern would be to identify the highly degraded forests. After this, carry out enrichment planting using mixed species for quick regeneration. The method is not new in Ugandan forest management as it was a method used to restore part of Mabira forest before recalls Steven. This can be recognised in places around the Ecotourism Centre and the Picnic site where almost trees of the same size and age can be identified.

The high existence of Paper Mulberry in some parts of Mabira Forest can be handled effectively through enrichment planting. Paper Mulberry can be cut and sold for firewood. This will help in creating space for the planting of new valuable trees. However, the method is expensive in terms of care and maintenance. This is due to the high regeneration rate of Paper Mulberry, which needs constant cutting of the re-growth if enrichment planting is to yield better results.

Steven also emphasized that with respect to restoring the integrity of Mabira CFR, the National Forestry Authority is better equipped to handle the value of a forest than any other organisation. That is for the 40 metres to be cut in Mabira Forest to create a pathway for the Bujagali powerline in a way of compensation for the lost forested areas. There is need to channel part of the money in restoring degraded forest's integrity not by the powerline developer but by the National Forestry Authority.

2) Mabira Forest Integrated Community Organisation (MAFICO)

Committee members contacted

Kabali Juliet	Chairperson
Kiyimba Rajab	Administrative Secretary
Kungujje Robert	General Secretary
Tigawalana Sebastian	Publicity Secretary
Luyombya Moses	Secretary for Resource Conservation and tourism

The organisation started as a Community Based Organisation (CBO) in 1998 under the name of Mabira Tourism Advisory Committee. It was at the time of massive eviction of people from Mabira Forest and also at a time when Mabira Ecotourism Centre was being established. The main idea for the establishment of the organisation was to intervene on part of the communities affected by the action. At that time the organisation covered seven parishes of Najjembe Sub- County. Later, the organization's name changed to Mabira Forest Tourism Committee.

In 2000-2003 the idea of a Non-Governmental Organisation called MAFICO was born. That is between 2000-2002, the organisation was in place but not registered until 2003 when it started existing formally after registration.

Presently MAFICO covers Najjembe and Nagojje Sub-Counties performing a number of activities. These include: environmental education in schools; encouraging good forest activities like bee-keeping; community woodlot planting; provision of seedlings; and capacity building for Community Based Organisations like organising workshops and proposal writing among others.

The CBOs being assisted by MAFICO are under collaborative forest management organisations. The two are COFSDA, in Najjembe Sub-County covering Koko, and Buvunga villages and NACOBA in five villages of Nagojje Sub-County. These CBOs have enjoyed the benefits of working with MAFICO for example MAFICO helps NACOBA in proposal writing concerning bee-keeping. So far the proposal was accepted for funding by the National Forestry Authority in Compartment 222. The agreement between NACOBA and the NFA was signed on 22nd April, 2006. Under this agreement the NFA is to buy the beehives for the organisation. The NFA also promised to link the organisation to Uganda Bee-Keeping Association

MAFICO is looking forward to establishing a community ecotourism centre in Mabira Forest. The centre is to be set in Nagojje Sub-County. The planned site is about 2-3 km sq km from which several activities are to be carried out. There will be three accommodation bandas, a campsite, and a visitor's centre. The project is to be funded by the United Nations Development Programme Small Grants Programme.

The planned site for the MAFICO ecotourism centre is located in compartment 207 which is a buffer zone; 30m north of the existing power line the buffer zone borders a strict nature reserve. This means that the proposed 40m of the new power line go into the planned site for the ecotourism centre reducing the space required to put up the centre which means the centre has to be pushed inward into the strict nature reserve. However it is important to note that no activity is allowed in the strict nature reserve and so it is impossible to push the planned site inward. The ecotourism centre may not be located in the proposed area. This may result in finding an alternative site for the centre away from the strict nature reserve where ecotourism is not allowed. It is possible MAFICO may abandon the whole project altogether because of the development.

It is important to note that the integrity or pristine nature of a forest makes ecotourism more meaningful and attractive. Recreation centres amidst forests have proved to control forest degradation by human beings since the recreation centres become no-go areas for timber and log cutters as well as charcoal burners. Setting up the recreation centre by MAFICO would mean a conservation opportunity for this part of the forest.

The opportunity cost of foregoing the location of the ecotourism centre in the proposed area is not for MAFICO alone but also for the communities. This is because a proposed percentage of revenue accruing from the centre was to go to the communities. Therefore the community will also be affected

3) *Mabira Ecotourism Centre*

The Mabira Ecotourism Centre is a tourism facility that offers walks ranging from 30 minutes to 3-4 hours, mountain biking, picnics, residences in camps, or bandas. All that comes with the forest setting with spectacular birds, butterflies, and monkeys. From July 2004-June 2005 the centre received Ushs 11,58,800 from entry permits, Ushs 343,100 from camping, Ushs 4,641,500 from Banda accommodation and Ushs 495,000 making a total of Ushs 16,638,400 as the revenue collected for the year. Twenty percent of the money goes to the communities (Ushs 3,327,680). In the past this money was given directly to the communities but in the new policy this money will be used to support bigger community developments like building schools, repairing and improving road criteria. It is important to note that the pristineness of a forest may determine its tourist value. Hence cutting down the forest causes tourism damage and this would affect the activities of the tourism centre especially reducing the revenue realised by the tourism centre, while in turn may affect the communities' gain of 20%.

Annex 3
Focus Group Discussions

Community members in the enclaves of Mabira CFR and the surrounding areas were consulted. Focus Group Discussions (FGDs) were held with communities in Buwoola, Ssanga and Ssesse.

All the communities consulted accepted using Mabira Forest for a variety of purposes. They derive a range of products which include firewood, medicinal plants, wild meat, among others. The communities also looked at the forest mainly as a source of the direct use values such as firewood and medicinal plants with hardly any mention of the other values of the forest, including indirect uses, option values bequest and existence values.

The communities also were not much concerned of any impacts from the proposed power line in the forest. This was showed by the urge and eagerness waiting to be accepted as part of the team to cut down the 40m in the forest. The communities also wanted to be given these trees as firewood, building poles, timber, among others.

The communities also demanded for the employment opportunities at the new power site. They proposed that when the time comes the LCs be contacted to recruit some of the community members in their villages.

The members present also wanted to know the reason for being consulted since previously during the construction of the powerline nothing transpired from the answers given to the people who visited the communities. They complained that since power was not going to the communities they had no reason to be consulted.

The communities also urged the National Forestry Authority officials to channel part of the compensation to community development. This could be in the form of assistance with the main area emphasised in the three communities being education. That is, build more school blocks for the government-funded schools in the area and the provision of timber materials for construction of desks as people kept on emphasizing what a shame it was for schools next to the forest being faced with a shortage of desks.

Communities also showed the urge to be provided with seedlings of valuable tree species that are either not in the forest any more or exotic species like pine, Cypress, etc to community members to plant on their farms.

The specific community reactions were as presented below.

1. *Buwoola Community*

Buwoola Parish is located in Najjembe Sub-County, Buikwe County, Mukono District. Buwoola is an enclave in Mabira Forest and consists of Nkaga, Ssanga and Bakata villages among others. The people of Buwoola depend on the forest for things like medicine, water, and firewood, among others. The focus group discussion with the people of Buwoola highlighted what they get from the forest as follows.

Medicine is got from the forest. The medicines got include *Vernonia amygdalina* (mululuza), *Momordica foetida* (bombo), *Albizia zygia* (ennongo), *Syzgium cordatum* (kanzinzilo), *Albizia coriaria* (mugavu), W*arburgia ugandensis* (mukuzanume), among others. The medicine is mostly used for personal consumption and some people sell to their fellow community members for money.

Another resource they get from the forest is firewood. The community said they are not allowed to sell firewood or charcoal and it is illegal. However, they admitted to getting firewood for home consumption from the forest. Others establish wood lots on their own land where they get firewood.

Hunting is another activity carried out by the people of Buwoola Several animals hunted include the kob, antelope, the wild pig and porcupine. Hunting is mostly done on Thursdays and Saturdays

Had there been a vote about the construction of a new powerline, the majority of the people in Buwoola would have said no. However, they suggested if the powerline was built they should get bigger and better schools built for their use. Society benefits like a health centre were also suggested.

The communities also suggested that once the powerline started the jobs be given to the able youth and men of the village. They asked for repair of their roads. They complained that in the construction of the existing powerline, their roads were used and damaged but not repaired. They wanted to have better roads by the end of the construction of another powerline.

The people of Buwoola also suggested that power should be extended to the community. They complained that although cutting of the forest affected them they had no gains from the construction. One of the community members claimed that a piece of his land was in the 40 metre zone where the old power line passes and he wanted compensation.

2. *Sanga Community*

Ssanga Village an enclave in Mabira Forest is located in Buwoola Parish Najjembe Sub-County, Buikwe County. Ssanga Village is not at the border of the powerline; however, this community says any damage to the forest affects them because they depend on the whole forest.

Members of Ssanga get firewood from the forest. Although they did not agree to selling charcoal or firewood, one community member told us that a bundle of firewood goes for 250/= to 300/= as a bag of charcoal goes for 3000/=. The community also collects water from the forest.

The medicines got from the forests by the Ssanga community include *Alstonia boone* (Mubajjangalabi), *Albzia coriaria* (Mugavu), *Entada abyssinica* (Omwoloola), *Carrisa edulis* (Omuyoza), *Markharmia lutea* (Musambya), *Prunus africana* (Ntaseesa), and *Spathodea campanulata* (Kifabakazzi), among others.

Hunting is another activity carried out by the people of Ssanga. Hunting is done mainly on Tuesdays, Thursdays and Saturdays. However members sometimes go into the forest to hunt as individuals. The meat is sold to community members and some is taken to Najjembe market. The hunted animals include Antelope, Porcupine, Guinea fowl and wild pigs.

The people of Ssanga requested that trees cut at the site of the new powerline be given to them so that they would get charcoal and firewood to sell as a way of benefiting from the damage done to the forest. The members present especially the women requested that their sons be given jobs during the construction of the new powerline. They claimed that in the past jobs that would be done by community members were done by foreigners; they asked that this time they did no want foreigners to do the jobs which the community could do.

3. *Ssese Community*

Just like the people of Ssanga, the people of Ssesse are not directly close to the powerline. However, they agreed to using the whole forest and throughout the year. The most important resources got from the forest were: water, firewood, timber, charcoal and fish from river Miasma and micro climate benefits.
The medicine got from the forest include *Alstonia boone* (Mubajjangalabi), *Albzia coriaria* (Mugavu), *Entada abyssinica* (Omwoloola), *Carrisa edulis* (Omuyoza), *Markharmia lutea* (Musambya), *Prunus africana* (Ntaseesa), and *Spathodea campanulata* (Kifabakazzi), Vernonia amygalina (mululuza), albizia zyia (enongo) *momordica foetida* (bombo,), *Rhus vulgaris* (kakwansokwanso). *A*part from the forest these community members have some of these trees in their woodlots in their homes. Some community members sell these medicines and even treat community members for money.

Hunting is also done by the communities. The animals hunted include the antelope, porcupine, guinea fowl, wild pig and the kob. Hunting is usually done on Saturdays and Thursdays though some community members go into the forest on other days to hunt. Mudfish is also got from River Musamya

Firewood and charcoal are collected from the forest. Though illegally, the communities sell firewood charcoal and timber, which are taken to Lugazi and Kawoolo. A bag of charcoal goes for about 2500-3000 Ush and a bundle of firewood goes for 250-500 Ush.

The communities asked for the wood cut down at the site of the new powerline so they would get firewood and charcoal to earn an income. They also said foreigners should not be brought from elsewhere to do work that can be done by community members that instead community members should be asked to do the work. In the construction of the old powerline the community roads were used and damaged by heavy trucks yet they were not repaired. They asked for improvement of their roads once the powerline was constructed. Some members claimed that the powerline went through their land so they could not use the land, they wanted compensation. They requested that their bridge be repaired since it was in a very bad condition.

The community also asked for seeds for certain economic tree species that did not exist in the forest or those that did not exist anymore. Such trees include Albizia and Cypress.

4. *Names of Focus Group Discussion Participants**

a. Buwoola Participants

1) Nabatanzi Mary
2) Ngabirano Moses
3) Tusiime Gertrude
4) Okuta Charles
5) Kiziti Isaac
6) Bwanga Wilson
7) Mutebi Desire
8) Alice Nabagala
9) Wejjo Keluiris
10) Namayanja Efrancis
11) Alex Kinene
12) Akamanda Byekwaso
13) Musana Swaib Kinya David
14) Musoke Paul
15) Luyembya Grace
16) Leo Twinnomuhangi
17) Kiiza Kiviri
18) Byaruhanga Karugo Nuru
19) Sundar Viseti
20) Naggayi Sophia
21) Kibirige Catherine
22) Aisa Nasuuna
23) Kabuye Samuel
24) Nanyonjo Ritah
25) Babigunira Aziz
26) Wandera Masiga
27) Hussein Kabanda
28) Kayaga Betty
29) Naggiba Harriet
30) Nakayima Kiviri
31) Sande Moses
32) Matovu Tom
33) Ngabirano John
34) Namuyanja Christine

b. Sanga Participants

1) Nabatanzi Mary
2) Tusiime Gertrude
3) Mbabazi Patience
4) Natukunda Catherine
5) Moini Edward
6) Etyono Denis
7) Katusiime Cuthbert
8) Balidawa Simon
9) Kanku
10) Okoyu
11) Deo
12) Tadeo
13) Demaga
14) Zikulabe
15) Walusimbi Franco
16) Aguda Franco
17) Mubiru Paul
18) Lutakome
19) Sem Musisi
20) m. babalanda
21) amos mewda
22) h.kato
23) Bernard kibanda
24) Robat badaga
25) Lubwama R
26) Kyalimpa
27) Sande
28) Kako
29) Sebilagala
30) Katongole
31) Tegewagala M
32) Aku
33) Gwavunamuyanja Christine
34) Bilabwa
35) Namulondo
36) M.Namatovu
37) Maama Sabasi
38) Wampamba
39) Nankumba
40) Diya
41) Roko

c. Ssesse Participants

1) Nabatanzi Mary
2) Natukunda Catherine
3) Mbabazi Patience
4) Katusiime Gertrude
5) Moini Edward
6) Ssentamu Emmanuel
7) A.Tanga
8) Muwonge Rogers
9) Musa Mukwaya
10) Seidi
11) Galabuzi Jimmy
12) Mayambala
13) Nsubuga Steven
14) Kiggwe Steven Miburo Siraj
15) Kikomeko Omea
16) Bogere Edward
17) Mwanzi Ronald
18) Kyogulanyi Angelo
19) Kuiwanuka George
20) Bazilakye Steven
21) Mukasa David
22) Consta Nce Munyakazi
23) Yowasi Obulu
24) Mbaliire Robert
25) Baguma Henry
26) Kakooza George
27) Sulaiman Tibesigwa
28) Yiga Miche
29) Mukasa Nkugwa
30) Wajja Mutebi
31) Liiba Alaniya
32) Kayitana Pascal
33) Mujjesera Vincent
34) Falidah Namubiru
35) Kikomeko Abdul
36) Mwodi Martin kagere

** Includes Consultants from YOMA*

Annex 4

Survey of Community Livelihoods from Mabira Forest

1.0 Introduction

The main objective or purpose of the survey was to find out the benefits and the costs the communities in the forest area and the NFA derive from the forest so that they are compensated as the 220 KV powerline which is going to run 40 metres north and parallel to the old powerline is going to traverse through the forest, and therefore some parts of the forest will be destroyed or cut in order to create a Wayleave for the new 220KV powerline.

Problem statement

Following a lot of load shedding over the years in Uganda the Government of the Republic of Uganda is under pressure from the public to do something in order to reduce on power outage. Therefore, the Government through a private developer is considering extending a new powerline 40metres parallel to the old one. The 220 KV new powerline is going to pass through Mabira Forest where some parts of the forest has to be cleared to create a Wayleave. Therefore, communities in and around Mabira Forest and the National Forestry Authority (NFA) need to be compensated for this loss of the part of the forest as this will present some opportunity costs to them as well as reduced forest benefits.

Coverage of the survey

The survey mainly covered villages of Ssese, Ssanga, Nkaaga, Bakata all found in Buwola Parish, in Najjembe Sub-County, Mukono District. The reason for targeting these villages in Najjembe Sub-County was because of their close location to the new 220 KV powerline proposed area of passage.

Methodology

A questionnaire with 34 open-ended and close-ended questions was distributed to forty two (42) respondents selected at random from the villages of Nkaaga, Bakata, Ssanga, and Ssese to find out their views about the benefits, costs and the likely compensation they expected due to the loss of the part of the forest as a result of the 220 KV powerline.

2. Findings

Distribution of respondents by sex

	Number of respondent by sex	Percentage	Valid percentage
Male Female Missing	21 8 29	50.0 19.0 69.0	72.4 27.6
Total	**42**	**100.00**	**100.00**

Source; primary data

42 respondents were interviewed of which 21 were male and 8 were female respondents, whilst 29 did not state their gender.
Therefore, the valid percentage of respondents by sex is as follows; 72.4% are males and 27.6% are female as a percentage of the total valid responses.

Collection of medicinal plants from the forest

	Number of respondents	percentage	Valid percentage
Collect medicinal plants	32	76.2	82.1
Do not collect medicinal plants	7	16.7	17.9
Missing	3	7.1	
Total	**42**	**100.0**	**100.0**

Source; primary data

Of the 42 respondents, 82.1% and 17.9% collect medicinal plants from the forest and do not collect medicinal plants from the forest (Mabira forest) as a valid percentage, respectively.

Woodlot ownership

	Number of respondents	Percentage	Valid percentage
Wood lot	11	26.2	35.5
No wood lot	20	47.6	64.5
Missing	11	26.2	
Total	**42**	**100.00**	**100.00**

Source: Primary data.

Of the 42 respondents interviewed for ownership of woodlot, 35.5% own woodlots and 64.5% do not own woodlots as a valid percentage of valid responses.

This implies that most of the respondents do not own woodlots (64.5%) and therefore rely heavily on the forest (Mabira Forest) for firewood and other forest resources.

Use of the forest

	Number of Respondents	**percentage**	**Valid percentage**
Use the forest	37	88.1	90.2
Do not use the forest	4	9.5	9.8
Invalid	1	2.4	
Total	**42**	**100.0**	**100**

Source: primary data

90.2% of the respondents use the forest while only 9.8% do not use the forest. This is as a valid percentage of respondents. Therefore, communities (90.2%) depend on the forest for a variety of uses and benefits compared to only very few 9.8% who do not use the Forest as a valid percentage of respondents. Therefore, any development that is going to destroy the forest particularly as a whole is going to make them (communities) (90.2%) forego a lot of benefits and uses that they derive from the forest.

Reason	**No of respondents**	**Percentage**	**Valid percentage**
Own consumption	32	76.2	76.2
For sale	10	23.8	23.8
Total	**42**	**100.00**	**100.00**

Source: primary data.

32 (76.2%) of the respondents agree that they collect medicinal plants from the forest (Mabira forest) for own consumption while 10 (23.8%) agree that they collect the medicinal plants from Mabira forest for sale.

Therefore, it means majority of the respondents (76.2%) collect medicinal plants for their own consumption than for sale from the forest.

Willingness to Pay (WTP) and Willingness to Accept Compensation (WTA)

Statistic	**WTA(Shs)**	**WTP** (Shs)
Mean	5,010,265	175,788
Median	1,100,000	103,000
Sums of WTA and WTP	**170,349,000**	**5,801,000**

Source: primary data

Respondents were asked to vote for forest Department Management scheme that would prohibit the use of the forest for three months. Then asked how much they would accept to compensate their loss in livehood in order to vote for the new regulation.

The sum of their willingness to accept compensation (WTA) is Shs 170,349,000. Mean Shs 5,010,265, and Median Shs 1,100,000 of willingness to accept compensation.

Mean willingness to accept compensation is Shs 5,010,265. It means on average the community members are willing to accept compensation of Shs 5,010,265. However, the mean is relevant if the valuation is for cost- benefit analysis.
Median Willingness to pay (WTP) is shillings US 1,100,000. The median is relevant for public choice since it corresponds to that amount which will receive a majority approval. Therefore, for the purpose of compensation, Median willingness to accept compensation (WTA) is best hence consideration of compensation of Shs 1,100,000 is quite relevant than the mean WTA.

The Respondents (42) were asked how much they are willing to pay (WTP) towards locally run Management Scheme that was designed to maintain and improve their forest resources so that they had secure access to and better quantity and quality of forest products. The sum of the willingness to pay is Shs 5,801,000. This means on average Respondents are willing to pay Shs.175,788 for locally-run Management Scheme. The median willingness to pay (WTP) is just Shs. 103,000.

Household Income/Consumption (Non-Forest Based)

Crop Name	**Total annual income** (Shs)	**Percentage**
Coffee	16,643,300	5.85
Staple food	27,367,700	9.63
Vegetables	9,160,660	3.22
Beans	83,100,300	29.24
Tea	000000	0.00
Cocoa	000000	0.00
Mairungi[8]	147,887,000	32.04
Total	**284,158,960**	**100**

Source: primary data.

Of the respondents' Annual Income sources, Mairungi is the main annual source of income with value of Shs 17,887,000 (52.04%) followed by Beans (Shs 83,100,300) and coffee (16,643,300). This statistic is quite shocking in that 32% of household income is from al illegal crop. There is, therefore, need to assist the communities to identify alternative income generating opportunities. On the other hand, Mairungi is legally grown in Kenyan communities. The harmonization of the East African laws may need to address this issue and make Mairungi growing legal.

[8] Mairungi or Khat is a narcotic in the Laws of Uganda and, therefore, illegal

Forest as Source of Water

Water source	Number of Respondents	Percentage	Valid percentage
Forest water	30	71.4	75.0
Non forest water	10	23.8	25.0
Missing	2	4.80	
Total	**42**	**100.0**	**100.0**

Source: primary data

When asked about water source whether forest or not, 75% of the Respondents as percentage of valid Respondents agreed to obtaining their water from forest whilst 25% of valid Respondent percentage claimed that they do not get water from the forest.
Therefore majority (75%) of the Respondents get their water from forest (Mabira).

Respondents' Distribution by Sources of Water

Water Source Name	Number Of Respondents	Percentage	Valid percentage
Borehole	6.0	14.3	14.3
Spring Protected	16.0	38.1	38.1
Spring unprotected	18.0	42.9	42.9
Pond or clan	2.0	4.8	4.8
Total	**42**	**100**	**100**

Source: Primary Data

Livestock Assets

Animal Name	Number of Household heads with animals	Total Number of Animals by Type
Goats	21	96
Sheep	6	31
Pigs	15	44
Chicken	33	733
Rabbits	1	2
Cows	10	83
Total		**989**

Source: Primary data

Total number of livestock is 989 including birds.33 of the respondents have Chicken and 21 of the respondents have Goats.

Head of household education level distribution

Education Level	Number of house holds heads	Percentage	Valid percentage
No formal Education	2	4.8	5.4
Primary Education	17	40.5	45.9
Secondary Education	14	33.3	37.8
College/University	4	9.5	10.8
Missing	5	11.9	
Total	**42**	**100.0**	**100.00**

Source: Primary data

Most of the household heads are educated up to the level of primary and secondary education with valid percentages of 45.9% and 37.8% respectively.

Head of households distribution by occupation

Occupation	Number of household Heads	Percentage	Valid percentage
Farming	32	762	82.1
Own Business	5	11.9	12.8
Salaried employee	1	2.4	2.6
Infant/old	1	2.4	2.6
Missing	3	7.1	
Total	**42**	**100.00**	**100.0**

Source; Primary Data

Most of the household heads of the respondents are engaged in farming (82.1) valid percentages while only 12.8% as valid percentage are involved in own Business. Forest and farming are many times antagonistic

Crop-raiding animals from the forest

Respondents were asked if they had problems with crop raiding animals from the forest. The table is the summary of their responses

Responses	Number of Respondents	Valid percentages
Problems	38	90.5
No problems	4	9.5
Total	**42**	**100.00**

Source; primary data

90.5% of the Respondents have problems with crop raiding animals as this negatively reduces their crop out put and quality. While 9.5% of the Respondents ascertain that they do not have problem with crop raiding animals.

The most problematic species from the forest (Mabira forest)

Specie Name	Number of Respondents	Valid percentage	Percentage
Monkeys	33	86.8	78.6
Wild pigs	5	13.2	11.9
Missing	4		9.5
Total	**42**	**100**	**100**

Source: primary data.

The most problematic species identified by the respondents from Mabira Forest are Monkeys and Wild pigs. 86.8% of the Respondents pointed at Monkeys as problematic and 13.2% of the Respondents also pointed at Wild pigs as being problematic. Therefore, the most Problematic species are the Monkeys.

Use of the Various Sources of Fuel

Use of Wood as Fuel

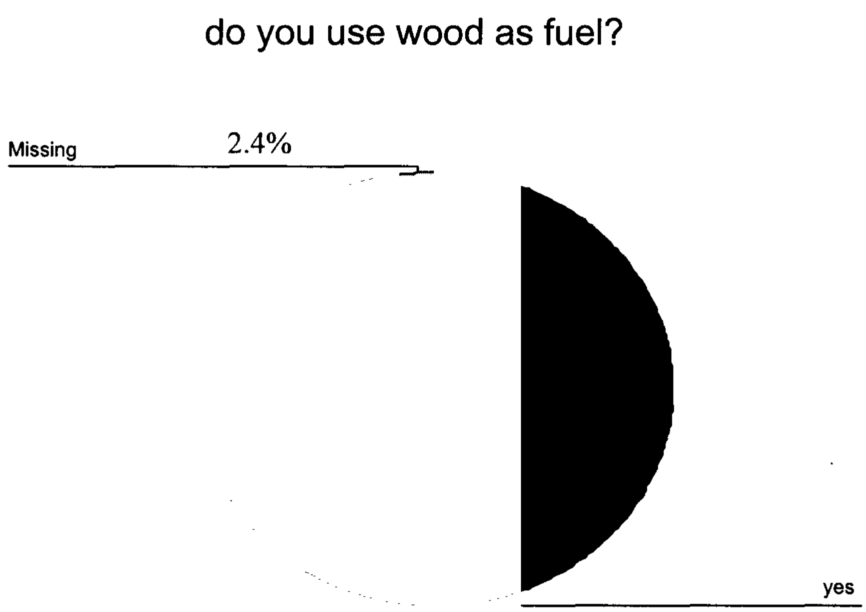
Do you use wood as fuel?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	41	97.6	100.0	100.0
Missing	System	1	2.4		
Total		42	100.0		

Source: Primary data

Respondents were asked if they use Wood as fuel, 97.6% accept that they use Wood as Fuel, whilst 2.4% of the respondents did not provide any responses. The valid percentage of the respondents who accept using wood as fuel is 100%.

The Pie chart below represents the responses of the forty two Respondents on whether they use Wood as fuel. Wood appears to be the main source of energy for the communities of Mabira Forest. This may threaten the sustainability of the Forest especially if the wood is mainly obtained from the forest and harvested in inappropriate ways.



Use of Charcoal as Fuel

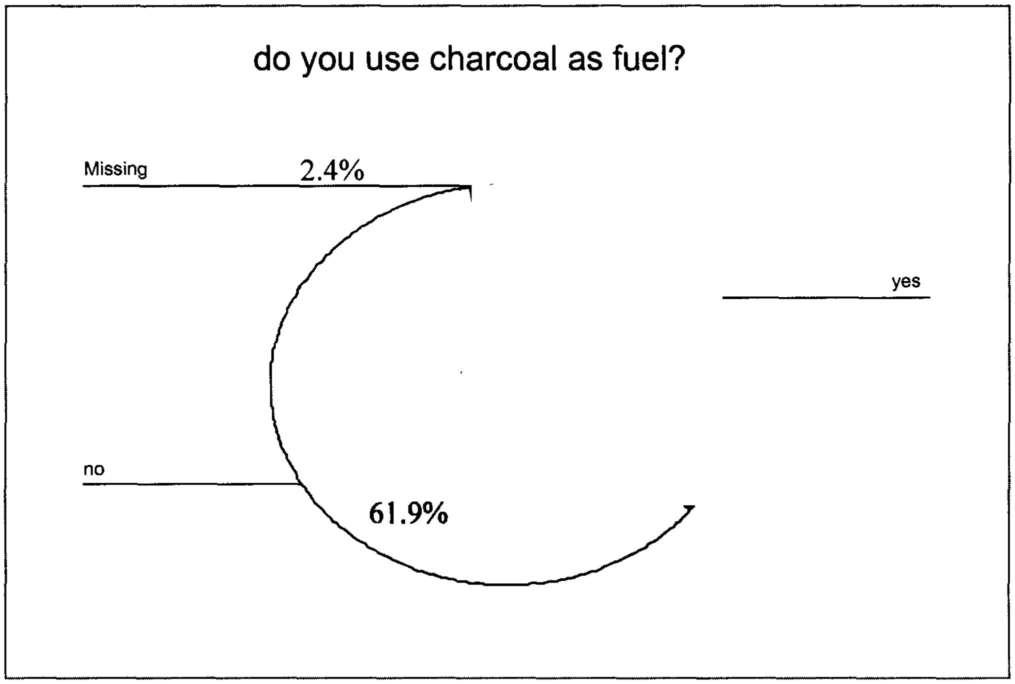
do you use charcoal as fuel?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	15	35.7	36.6	36.6
	no	26	61.9	63.4	100.0
	Total	41	97.6	100.0	
Missing	System	1	2.4		
Total		42	100.0		

Source: Primary data

For Charcoal use as fuel, 35.7% of the Respondents use Charcoal as fuel whilst 61.9% do not use Charcoal as fuel and 2.4% of the responses are Invalid. Of the valid responses 36.6% and 63.4% use Charcoal and do not use charcoal as fuel, respectively.

The pie chart below represents the responses of the forty two respondents on whether they use Charcoal as fuel.



3.4.3 Use of Paraffin as Fuel

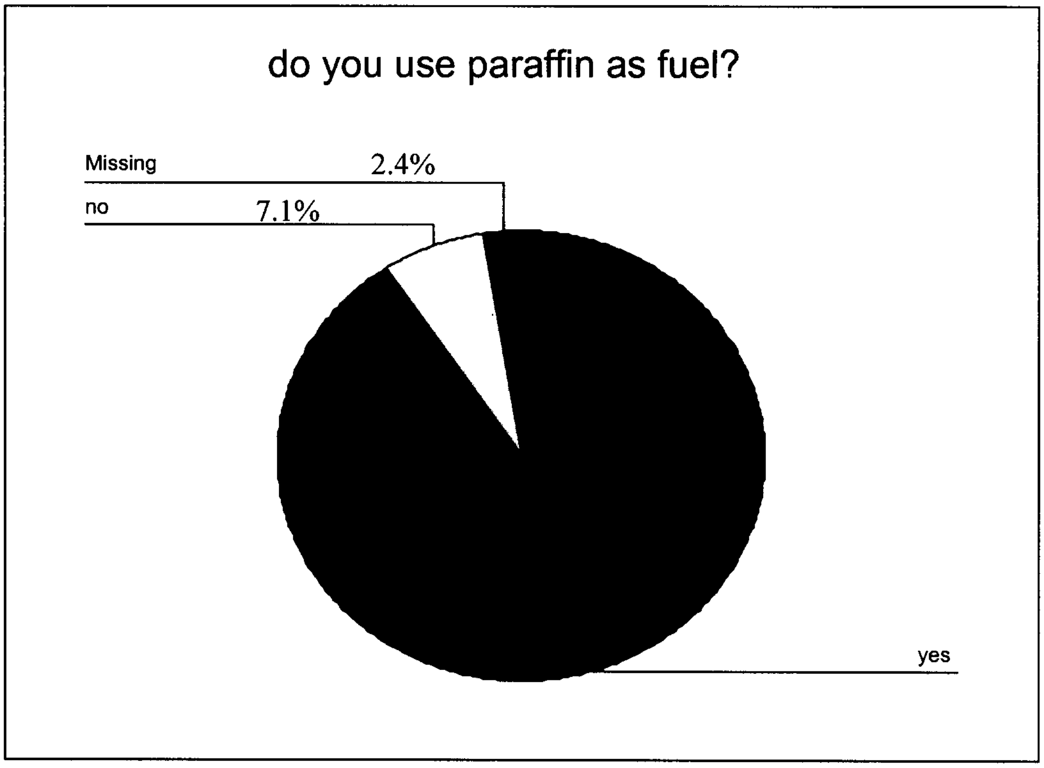
do you use paraffin as fuel?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	38	90.5	92.7	92.7
	no	3	7.1	7.3	100.0
	Total	41	97.6	100.0	
Missing	System	1	2.4		
Total		42	100.0		

Source; Primary data

90.5% of the Respondents said they use Paraffin as Fuel and 7.1% do not. The valid Percentage of the Respondents who use and do not use Paraffin as fuel are 92.7% and 7.3%, respectively. Paraffin is mainly used for lighting.

Below is the Pie chart representing the responses of the Respondents on whether they use Paraffin as fuel or not.



Use of Gas as fuel

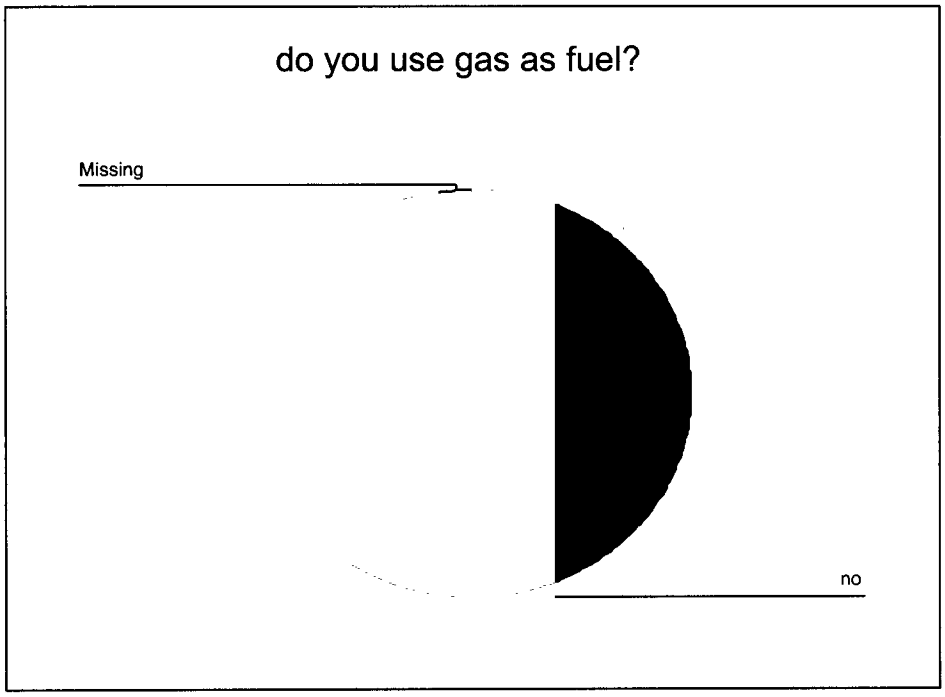
do you use gas as fuel?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	41	97.6	100.0	100.0
Missing	System	1	2.4		
Total		42	100.0		

Source; Primary data

97.6% of the Respondents do not use Gas as fuel while 2.4% account for missing responses. Therefore, 100% of the Respondents do not use Gas as Fuel as a valid percentage.

The below Pie chart represent the responses of the respondents for the use of Gas as fuel including the missing percentage.



Use of Electricity as Fuel

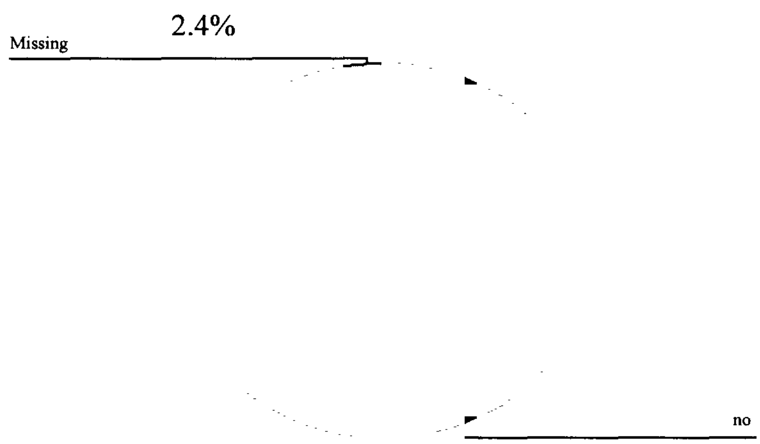
do you use electricity as fuel?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	41	97.6	100.0	100.0
Missing	System	1	2.4		
Total		42	100.0		

Source; Primary data

97.6% of the Respondents do not use Electricity as fuel while 2.4% are missing responses. Therefore, the valid percentage of the respondents who do not use Electricity as fuel is 100%.It implies all the respondents do not use Electricity as fuel or Energy.

do you use electricity as fuel?



Reasons for Growing Crops in the Woodlot

Growing of Crops for Home Use Purpose

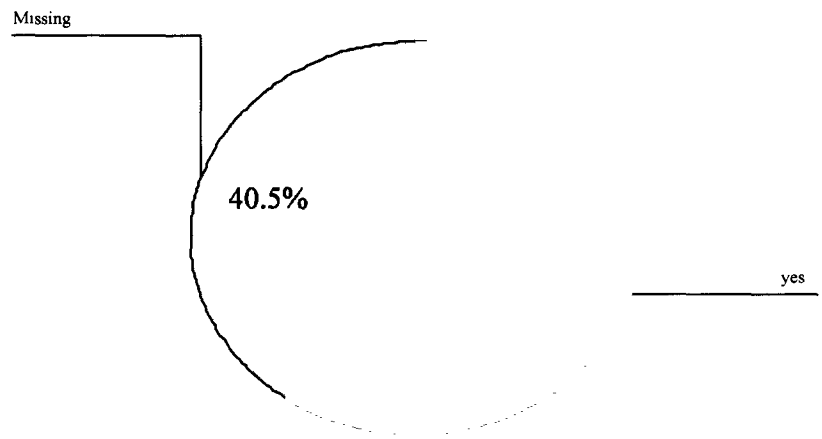
Do you grow the crop for Home use?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	25	59.5	100.0	100.0
Missing	System	17	40.5		
Total		42	100.0		

Source: Primary data

Forty two respondents were asked if they grow crops in their woodlot for Home use purposes, 59.5% agree that the crops they grow in their woodlots are mainly for home use whilst 40.5% did not respond. Therefore the valid percentage of respondents who said they grow crops for home use is 100%.This means 100% of the respondents grow crops for home use purposes.

Do you grow the crop for Home use?



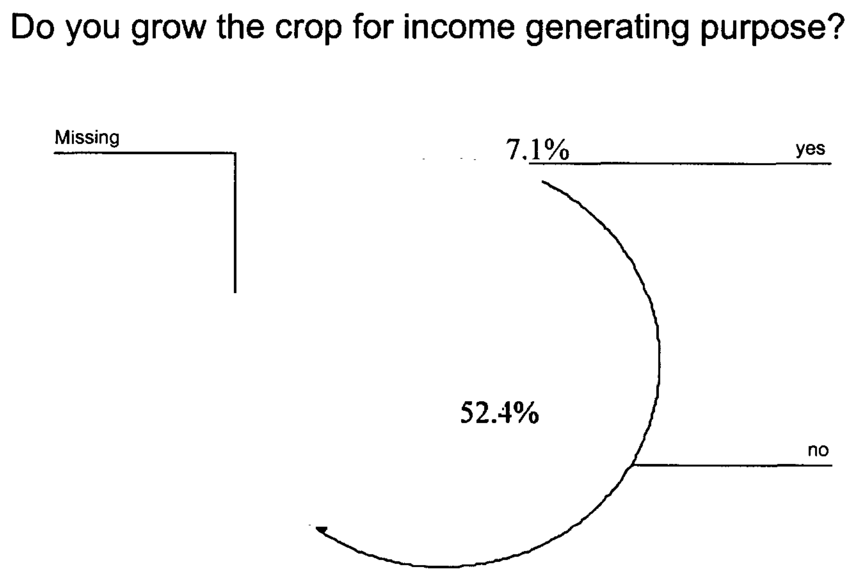
Growing of Crops for Income Generating Purposes

Do you grow the crop for income generating purpose?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	3	7.1	12.0	12.0
	no	22	52.4	88.0	100.0
	Total	25	59.5	100.0	
Missing	System	17	40.5		
Total		42	100.0		

Source: Primary data

Twelve percent (12%) of the Respondents said they Grow Crops in Their Woodlot for Income generating purposes and eighty eight percent(88%) of the Respondents when asked whether they grow the Crops in their Woodlot for Income generating purpose said no.



Uses of the Various Sources of Fuel

Uses of Wood

uses of wood

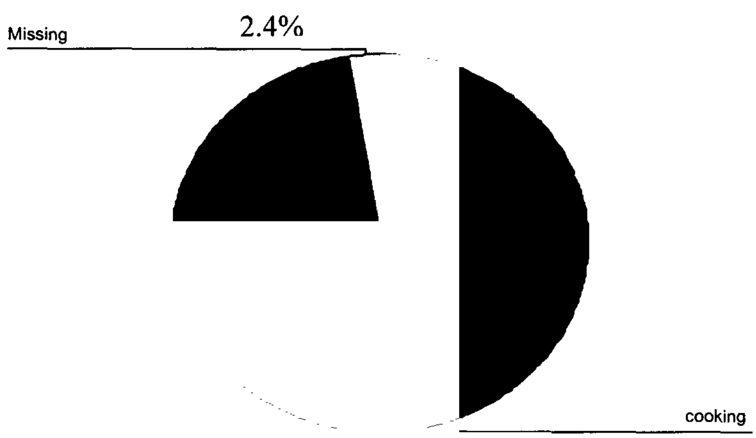
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	cooking	41	97.6	100.0	100.0
Missing	System	1	2.4		
Total		42	100.0		

Source: Primary data

Three uses of sources of fuel like Paraffin, Electricity, Wood, Charcoal, and Gas were provided. The uses provided included: heating, lighting and cooking.

97.6% Of the Respondents use wood for Cooking while 2.4% are missing. This implies that 100% Of the Respondents use wood for Cooking. Therefore, all the Respondents use Wood for cooking.

uses of wood



Uses of Charcoal

uses of charcoal

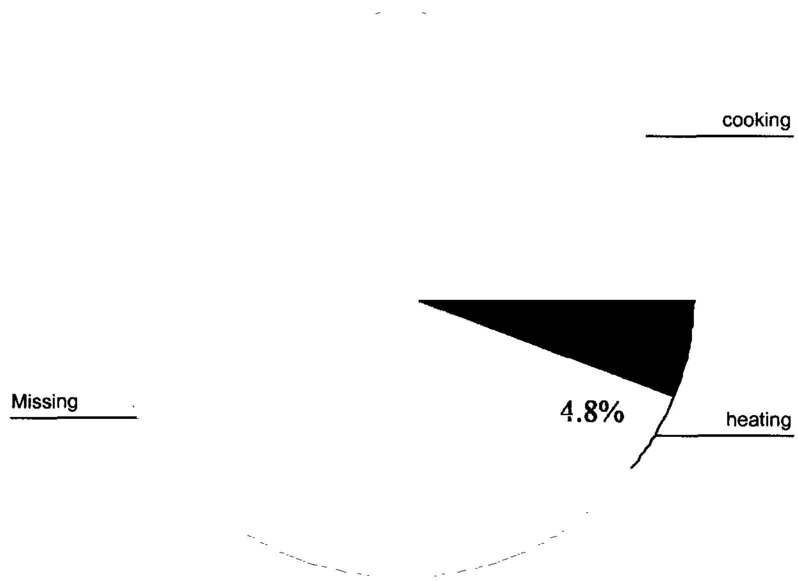
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	cooking	13	31.0	86.7	86.7
	heating	2	4.8	13.3	100.0
	Total	15	35.7	100.0	
Missing	System	27	64.3		
Total		42	100.0		

Source; Primary data

For uses of Charcoal, 31.0% use Charcoal for cooking, 4.8% use charcoal for heating and 64.3% are missing responses. Therefore, the valid percentage of respondents who use charcoal for cooking and heating is 86.7% and 13.3%, respectively. The implication is that majority of the Communities in Mabira forest use Charcoal for Cooking than for heating.

The Pie chart below represents the various uses of Charcoal for the respondents.

uses of charcoal



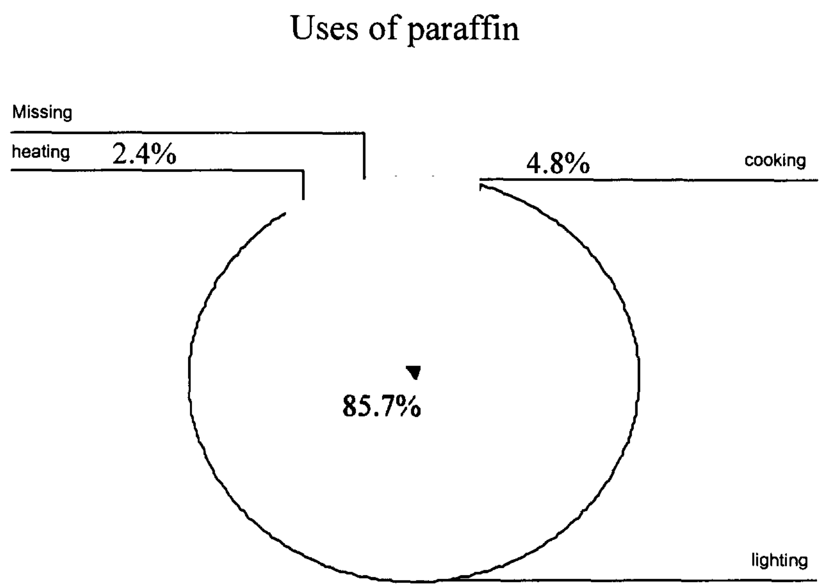
Uses of Paraffin

usesof paraffin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	cooking	2	4.8	5.1	5.1
	lighting	36	85.7	92.3	97.4
	heating	1	2.4	2.6	100.0
	Total	39	92.9	100.0	
Missing	System	3	7.1		
Total		42	100.0		

Source: Primary data

For the uses of Paraffin, 5.1% of the Respondents use Paraffin for Cooking, 92.3% use Paraffin for lighting and 2.6% of the Respondents use Paraffin for heating. Therefore, Paraffin is mainly used for lighting as Electricity is not accessible to many of the Communities in and around Mabira Forest.



3. Conclusion

- The local communities derive a lot of livelihoods from Mabira Forest. **90.2%** of the Respondents agree that they use the forest for a variety of uses

Some of the benefits from the forest that the communities derive among others include;

- Spring water both protected and unprotected. **81%**of the Respondents agree that they use spring water. And **75%** of the Respondents accept that they get their water from the Forest compared to only **25%** that claim they do not get their water from the Forest.

- Medicinal plants from the Forest. **82.1%** of the Respondents derive Medicinal plants from the Forest. However, 76.2**%** of the Respondents use the Medicinal plants for their own consumption and **23.8%** sell the Medicinal plants they derive from Mabira Forest. Therefore, it means that Medicinal plants are mainly collected for own consumption rather than for sale by the communities in and around Mabira Forest.

- Mairungi is the highest source of annual income. Mairungi earned an annual income of Shs.**147,887,000.**

Bujagali Hydro-Electric Power Project

Economic Assessment of Resource Values Affected by the 220 KV Powerline Wayleave Traversing Mabira, Kifu and Namyoya Central Forest Reserves

October, 2006

Yakobo Moyini, PhD
Principal Associate
YOMA Consultants

FINAL DRAFT REPORT

Acronyms and Abbreviations

AR	Average Annual Net Benefit
CFM	Collaborative Forest Management
CFR	Central Forest Reserve
CVM	Contingent Valuation Method
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
FD	Forest Department
FGD	Focus Group Discussion
FORRI	Forestry Resources Research Institute
Ha	Hectare
MAFICO	Mabira Forest Integrated Community Organisation
MPA	Management Plan Area
MUIENR	Makerere University Institute of Environment and Natural Resources
MW	Mega Watt
NARS	National Agricultural Research Systems
NFA	National Forestry Authority
NPV	Net Present Value
NTFP	Non-Timber Forest Product
SNR	Strict Nature Reserve
TCM	Travel Cost Method
TEV	Total Economic Value
THF	Tropical High Forest
ToR	Terms of Reference
TPV	Total Present Value
USD	United States Dollar
USHS	Uganda Shillings
WTP	Willingness to Pay

Executive Summary

Inorder to evacuate electricity from the proposed power plant at Dumbbell Island on the River Nile and carry it to Kampala and other parts of Uganda, a 220 KV transmission line is to be installed. The proposed routing of the line passes through Mabira, Kifu and Namyoya CFRs. The powerline Wayleave traversing the three forests is 40 metres wide on the northern side of the existing 132 KV line.

Both the *National Environment Act* and the *National Forestry and Tree Planting Act* require that for certain major developments such as the installation of the powerline through the three forests, an environmental impact assessment (or environmental impact study) should be carried out. The same requirement holds in respect of the World Bank environmental and social safeguard policies. This report constitutes part of the environmental impact assessment process. In particular, the study is concerned with assessing the economic impact of the development in terms of resources lost and benefits foregone. The estimates were derived from both primary and secondary data and follow the principle of total economic value of forests.

The results of the study suggest a timber stock (50 cm + dbh) worth UShs 249.2 million will be lost in Mabira CFR. The present value of timber benefit streams obtained from long-run sustainable yield in Mabira CFR and timber values foregone in the plantations of Kifu and Namyoya CFRs were estimated at UShs 157.3 million. Furthermore, the present value of other annual benefit streams from forest products, biodiversity, domestic water, carbon storage and ecotourism – was estimated at UShs 35.9 million. The present value of annual ground rent payments was calculated to be UShs 13.4 million. Other values which include immature tree plantings and incremental management costs had a present value of UShs 18.4 million. Hence the total values lost or foregone was estimated at UShs 474.2 million.

Of the total amount of values lost or foregone, the NFA realises UShs 249.2 million from the disposal of the standing crop in Mabira CFR through its auction process. The Developer on the other hand, should compensate the NFA for lost forest benefits and added management responsibilities to the tune of UShs 225.0 million. The table below shows a summary of economic values lost or foregone.

Impact Area Economic Values (UShs '000s)*

Value Sources	*Amount*
A. NATURAL FOREST GROWING STOCK	249,220
B. PRESENT VALUE OF BENEFITS STREAMS	
1. Timber	157,314
2. Poles + Firewood	4,693
3. Non-Timber Forest Products	5,292
4. Biodiversity	1,525
5. Domestic Water	4,249
6. Carbon Storage	17,341
7. Ecotourism	2,831
8. Landtake	13,412
SubTotal B	206,657
C. OTHERS	
1. Immature tree plantings	1,826
2. Management Costs	16,552
SubTotal C	18,378
D. TOTAL (B+C)	225,035
E. TOTAL (A+B+C)	**474,225**

** - corrected to nearest 1000*

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1.0 INTRODUCTION

1.1 Background

Bujagali Energy Ltd. (BEL), a project-specific company owned by World Power Holdings, LLC of Luxembourg and IPS (Kenya) Limited proposes to build, own and operate a 250 MW hydro electric power plant at Dumbbell Island on the River Nile. To evacuate electricity from the generating station Uganda Electricity Transmission Company Limited (UETCL) proposes to construct a transmission line from the power generation house to Kampala. The aligned route passes through mostly private land. However, the line also passes through three central forest reserves (CFRs) – Mabira CFR, Kifu CFR and Namyoya CFR (*Figure 1*). The powerline Wayleave through the three forests is 40 metres (m) wide along the northern side of the existing 132 kV transmission line.

The National Environment Act Cap 153 and the National Forestry and Tree Planting Act require that for certain developments such as the installation of the powerline in forest areas, an environmental impact assessment (EIA) should be carried out. The same holds with respect to the World Bank's environmental and social safeguard policies. Furthermore, these policy and legal instruments call for the fair compensation of any resources that will be lost as a result of the development. This, therefore, calls for an economic assessment of the value of forest resources which will be lost as a result of the 40m wide Wayleave. Economic valuation is a tool that can provide decisionmakers with useful information with which to decide between alternatives or in favour of preferred combinations of possible interventions. In this case, economic valuation was used to arrive at a fair and objective estimation of the value of resources which will be lost or foregone as a result of the Wayleave so as to guide negotiations on the appropriate level of compensation. The value of forests depends not only on the market prices of its direct uses but is also based on other indirect uses of the forest resources that cannot be traded on some kind of market.

1.2 Project description

The project will involve the clearance of a 40m wide area along the entire length traversing Mabira, Kifu and Namyoya CFRs, on the northern side of the existing 132 kV line.

Table 1 shows the Mabira CFR compartments through which the proposed line passes. Within Mabira CFR, there are community enclaves. The line passes through Buwoola and Namusa enclaves, covering a length of 1.3 kilometres (km). Of the total length of 18.6 km, the remaining 17.3 km passes through 8.3 km of the production/encroachment management zone, 6.8 km of the recreation/buffer zone and 3.2 km of production/low impact zone[1].

Within Kifu CFR, the line passes through a 0.9 km stretch of forest plantation planted with *Araucaria cunninghamii* and owned by NFA. Similarly, the line passes through 1.9 km of *Eucalyptus grandis* plantation in Namyoya CFR.

[1] Although designated production/low impact management zone, the 0.7 km of the line passing through Compartment 234 is in a severely encroached area with no timber but containing a young crop of *Terminalia sp.*

Consequently, the total length of Wayleave through the CFRs is 21.4 km of which 1.3 km traverses through community enclaves leaving a net distance of 20.1 km going through natural and plantation forests.

Table 2 shows the total area of impact in the three CFRs is about 85.5 ha made up of 74.4 ha in Mabira CFR, 3.7 ha in Kifu CFR and 7.7 ha in Namuyoya CFR.

Figure 1. Map of Forest Reserves and the Proposed Wayleave

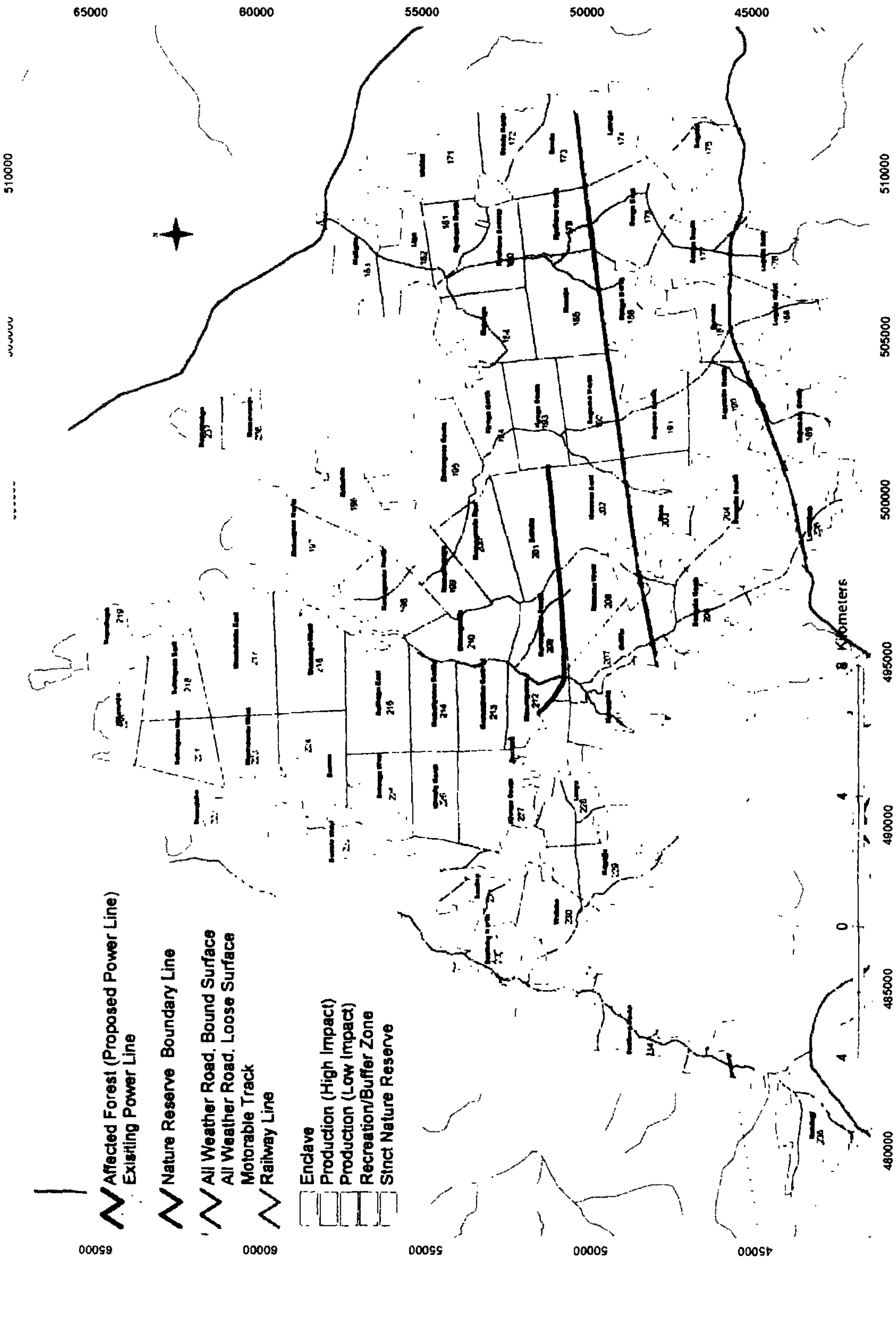


Table 1. Project area in Mabira CFR

Management Zone	Compartments	Impact Area	
		(ha)	% total
Production (Encroachment)	173,179,185	30.250	40.7%
Production (Low Impact)	192,229	8.715	11.7%
Production (Low Impact)/Plantation	234	2.814	3.8%
Recreation/Buffer Zone	191,203,206,211	27.341	36.8%
Community Enclaves	n/a	5.132	7.0%
Totals		**74.252**	**100.0%**

n/a – not applicable

Table 2. Project impact area in Mabira, Kifu and Namyoya CFRs

CFR	Size of area affected (ha)	Description
Mabira	5.2	Community enclave area
	33.2	Production/Encroachment Management Zone
	27.2	Recreation/Buffer Management Zone
	8.8	Production/Low Impact Management Zone (includes *Terminalia sp* crop of less than 1 year old)
	74.4	Total, Mabira
Kifu	3.7	*Araucaria cunninghamii* plantation owned by the NFA
Namyoya	7.7	*Eucalyptus grandis* plantations, privately owned and grown under licence/permit from the NFA
Total	85.5	

1.3 Scope of the assignment

The Terms of Reference (ToR) of the study required a comprehensive Environmental Economic Assessment of the environmental and natural resources impacts of the installation of the 220 kV Electric Transmission Wayleave through the central forest reserves.

The conceptual, spatial and temporal scope of the study were:

- the conceptual scope of the study involved the estimation of total economic value (TEV) of the forest areas affected. In this context, due to the small area of forestland withdrawn the bequest and existence values will not be significantly affected by the Wayleave. Hence, only direct use and indirect use and option values were considered. Direct use values are those deriving from timber, poles, firewood, non-timber forest products (NTFPs), water and ecotourism. The indirect use value considered consisted of carbon sequestration values since the area affected will be too small to make any significant impact on watershed values of the three CFRs. The option value considered concerning the loss of biodiversity.

- the temporal aspect of the study related to considering annualised stream of net resource benefits capitalised at an appropriate discount rate to arrive at net present values (NPVs); and

- the spatial scope of the study was limited to a 40m width along the entire length of the sections of CFRs the line is proposed to traverse. The spatial scope was indexed to the appropriate forest zones, considered on compartment by compartment basis in Mabira CFR, and ownership of planted crops in Kifu and Namyoya CFRs.

1.4 Report structure

This economic assessment report of forest values is divided into five chapters including this introduction as Chapter 1.0. Characteristics of the three CFRs is presented in Chapter 2.0 and relates primarily to general area physical characteristics, climate, flora, fauna and forest enclaves for Mabira; and descriptions of the plantations in Kifu and Namyoya. Chapter 3.0 was devoted to impact analysis beginning with defining the systems boundaries and then to a closer examination of the three CFRs. Chapter 4.0 was dedicated to economic valuation covering the theory and practice of forest valuation, methodologies employed and estimates of economic values of significant impacts. Chapter 5.0 looked at several mitigation options, and is followed by References and Annexes.

2.0 Area Characteristics

While the proposed transmission line passes through both public and private lands, this report covers the former. In particular, the report is devoted to the three CFRs – Mabira, Kifu and Namyoya. Hence any enclaves of community areas such as those in Mabira were not covered since they are not within the boundaries of the CFR and valuation follows different legal approaches.

2.2 Mabira Central Forest Reserve[2]

Mabira Forest reserve was established in 1900 (under the Buganda Agreement). It lies in the counties of Buikwe and Nakifuma in the administrative district of Mukono. It occupies an area of 306 km^2 with an altitudinal range of 1070-1340 m above sea level and is situated between latitude 0^0 22′ and 0^0 35′ and between longitude 32^0 56′ and 33^0 02′E. The Forest Reserve is, therefore, the largest natural high forest in the Lake Victoria crescent.

Mabira Forest Reserve is located in a heavily settled agricultural area close to large urban centres including Kampala, Lugazi, Mukono and Jinja. This makes it a very important refugium and eco-tourist destination. The location of the forest also makes it a very important source of forest products whose demand has increasingly grown in the towns mentioned earlier. The management of Mabira forest therefore, currently caters for production, conservation and recreational functions of the forest ecosystem.

Whereas the forest suffered considerable destruction through illegal removal of forest produce and agricultural encroachment which activities threatened the integrity of the forest, these have now been controlled and the forest has near regained its original integrity.

Vegetation

The vegetation in Mabira Forest is dominated by Celtis-Chrysophyllum medium altitude moist semi-deciduous Tropical High Forest communities of type D1 (95% equivalent to 292 km^2). The remaining 5 % of the forest area is made up of medium altitude moist evergreen forest communities of Piptadeniastrum-Albizia-Celtis tree species (Langdale-Brown, 1964).

Mabira Forest is a dominantly sub-climax forest which is just recovering from a long period of exploitation and encroachment. The forest is, therefore, made up of young colonising mixed forest trees dominated by *Maesopsis eminii* (25%), young mixed *Celtis-Holoptelea spp.* (60%), and mixed wet valley bottom species dominated by *Baikiaea spp.* (15%).

The forest also suffered selective felling (creaming) of high value trees (ie. Class 1A and B) in the last twenty or so years and today, only retains a small percentage of such trees (including *Milicia excelsa, Holoptelea grandis* and *Olea welwitschii*) in the growing stock (0.06%). Most trees in the forest are Class III fee group tree species making up as much as

[2] Description of Mabira CFR is adapted from Muramira (2000)

52.4% of all trees of all fee groups. The remaining 47.5% of the growing stock is comprised of Class II fee group tree species including *Celtis species, Albizia species, Alstonia boonei* and *Funtumia africana.* The forest is notably dominated by Paper Mulberry (*Broussonetia papyriferra)* particularly in the previously heavily encroached areas (25.1%). Whereas *Broussonetia papyriferra* is an exotic tree specie with clearly invasive characteristics, the specie is not considered a threat to natural regeneration. In fact, the tree species has been noticed to help the natural regeneration of indigenous tree species including *Antiaris africana, Prunus africana, Lovoa trichilioides* and *Celtis species*, which require shade and forest cover for their successful regeneration. *Broussonetia papyriferra* has also quickly taken up areas which would otherwise be invaded by pioneer grasses like *Imperata cylindricum* which discourage regeneration and growth of indigenous forest cover. The species is also a very important source of firewood (Davenport *et al*, 1996).

Birds

The birds of Mabira Forest have been subjected to a considerable amount of survey work including regular surveys, summarized by Carswell (1986). Birds are arguably therefore, the best known faunal group in Mabira forest.

The bird species list for Mabira Forest now stands at 287 species of which 109 were recorded during the 1992-1994 Forest Department Biodiversity Inventory (Davenport *et al*, 1996). These include three species listed as threatened by the Red Data Books (Collar *et al*, 1994) i.e. the blue swallow (*Hirundo atrocaerulea*), the papyrus Gonolek (*Laniarius mufumbiri*) and Nahan's Francolin (*Francolini nahani*).

Mammals

A number of recordings of the mammalian diversity of the Mabira Forest Reserve have been done in the last thirty years. The most comprehensive published study of the mammals of the forest however, is that by the Forest Department of 1996 (Davenport *et al* 1996). The Davenport report documented 17 new species of small mammals found in the forest. Other recordings include those by the Tropical Forest Diversity Project (1987-88 on woody vegetation, birds and mammals); Kingdon (1971) on mangabeys and red tailed monkeys; and Delany (1975) for rodents.

The Davenport report indicates a high incidence of small forest dependent mammal species including *Deomys ferrugineus* and *Scutisorex somereni*. The two mammals are closed forest-dependent specialists and are often regarded as the most sensitive indicators of forest disturbance. The Uganda endemic shrew *Crocidura selina*, only previously recorded in Mabira Forest and reported in 1990 is again recorded in the Davenport report (Davenport *et al*. 1996).

Butterflies and Moths

Mabira Forest Reserve is considered rich in terms of the diversity of its butterfly fauna (Davenport *et al.* 1996). The forest supports a variety of forest dependent butterflies, as well as a number of uncommon and restricted-range species. Despite a recent history of intensive human disturbance, the butterfly fauna of Mabira Forest has shown marked resilience.

Mabira forest reserve is a home to two sub-species which are endemic to Uganda including *Tanuetheira timon orientius* (for which Ugandan forests are the eastern limit of the species' range) and *Acraea lycoentebbia* (Davenport *et al.* 1996).

The moth fauna is typical of large forests situated on the lake crescent. Mabira Forest Reserve supports a few rainforest species from West and Central Africa. A total of 52 hawk moth and 45 silk moth species characteristic of closed canopy forests and forest edges live in the forest. Several lowland species have also been recorded. Compared with other major forests in Southern and Western Uganda, Mabira Forest is a high-ranking site for silk moths, but less so for hawk moths. This is because the Eastern range of most West African hawk moth species does not extend to this region.

Objectives of Management

The location, unique species richness and productivity of Mabira Forest Reserve, impart to it special qualities demanding a multiple objective management approach. The objectives of management of the forest therefore, are:

- to conserve and enhance forest biodiversity and ecological conditions;
- to produce timber and non-timber products on a sustainable yield basis using the most efficient methods (i.e. without compromising the capability of the forest to provide environmental services);
- to integrate the communities within the forest enclaves and parishes surrounding the forest reserve into the management of the forest;
- to provide recreational facilities for the people of Ugandan citizen, visitors and tourists; and
- to carry out research aimed at obtaining information on various aspects of forest ecosystem dynamics for the improvement of the management of Mabira Forest in particular, and other forests in general.

To achieve the above management objectives, Mabira forest reserve is divided into five working circles namely:

- the conservation working circle consisting of 13 compartments including compartments 198-202, 207-210 and 213-216 as the Strict Nature Reserve;
- the production working circle consisting of 45 compartments which include compartments 171-188, 192-197, 217-237 and 71 ha of Kalagala Falls forest reserve;

- the community participation working circle to pilot Collaborative Forest Management (CFM) within selected forest enclaves and parishes surrounding the forest reserve;

- the recreation working circle consisting of 9 compartments which include compartments 189-191, 203-206, 211-212 and 33 ha of Kalagala Falls forest reserve totaling 4,097 ha; and

- the research working circle.

2.3 Kifu Central Forest Reserve[3]

Kifu CFR covers an area of 1419 ha (Statutory Instrument No. 63, 1998). It was gazetted in 1932. The CFR is located in close proximity to Mukono Town Council; just off the Mukono-Kayunga Highway (32 km from Kampala City and about 6 km from Mukono Town).

Originally Kifu CFR was a well-stocked Natural High Forest. It held Greater Forest Functions (GFF) in addition to water catchment. The CFR is drained by several rivers and streams (Kifu, Kasota, Lwajali and Ssezibwa) which flow into Lake Victoria. The population around Kifu CFR, rapidly urbanising, exerted pressure on the reserve as a result of ever greater demand for fuelwood and other livelihood activities. This pressure led to the degradation of the reserve and reduced the flow of most of the forest use values. Currently, the NFA is implementing the following management objectives:

- to restore the forest through planting of mixed broad leaved species;
- to demonstrate fast growing tree species with high yield;
- to promote *ex situ* conservation by way of maintaining superior seed tree species; and
- to implement technologies and forest management practices for poverty reduction and reduce pressure on the forest reserve.

The foregoing objectives are being met through the creation of three land use categories as follows.

- Research – 425 ha has been licensed to the Forestry Resources Research Institute (FORRI) under the National Agricultural Research Systems (NARS) programme
- Private plantation establishment (694 ha)
- NFA management practices (300 ha), of which about 79 ha has been planted (*Table 3*).

Wayleave construction in Kifu CFR passes through the land use category of NFA Management Practices, and covers 3.713 ha. Of this area only 2.4 ha has been planted. The crop of *Araucaria cunninghamii* is now 5 years old. The remainder is severely degraded natural forest area. *A. cunninghamii* is grown on 25-year economic rotation in Uganda.

[3] The description which follows was obtained from NFA records.

Table 3. Demonstration, Restoration and Seed Species by NFA

Tree species	Area planted (ha)	Planting date	Age (yrs)	Remarks
Araucaria cunninghamii	26.5	May 2001 Oct 2002 April 2003	5 4 3	Fast growing timber species with high Yield
Araucaria haustenii	2	Oct 2002	4	
Araucaria agathis	2	Oct 2002	4	
Araucaria cunninghamii and *Araucaria haustenii*	6	1974	32yrs	Superior seed tree species /Seed/Mother stand for seedling production
	3	1971-72	34yrs	
Araucaria cunninghamii and *Araucaria haustenii*	10 4	1974 1971-72	32yrs 34yrs	Under trial
Maesopsis emnii	15	May 2001	5	Natural forest restoration / Broad leaved
Cedrella ordorata	1	May 2002	4	Quality Timber species, High demand
Eucalyptus Citrodora	3.7	May 2004	2	Technology for poverty reduction (Essential oils / Medicinal)
Eucalyptus paniculata	1 2	May 2004 May 2005	2 1	Charcoal production trials
Eucalyptus cleosiana	1	May 2005	1	Poles and Charcoal production trials
Eucalyptus grandis	2	Dec 2004	2	Pole production
Grafted Pine	0.25	Nov 2002	4	Hybrid seed production

Total area planted = 79.45 ha

Source: NFA Records

2.4 Namyoya Central Forest Reserve

Similar to Kifu, the Namyoya CFR was originally a natural forest but now entirely converted to plantation forestry. The entire CFR is allocated to private tree farmers initially on 5-year lease permits by the Forest Department (FD). These permits are now being converted to 25-year licences which allows a private tree farmer to harvest at least three crops of Eucalyptus suitable as electric poles (on 8-year economic rotation basis).

3.0 Impact Analysis

3.1 Systems boundaries

The systems boundaries have been defined in terms of valuation area, magnitude of development impacts, management costs, and other considerations.

Valuation area

The valuation area is only 40 m wide on the northern side of the existing 132 kV line along sections of the forest through which the transmission line passes. Defined thus, the valuation area consists of both natural and plantation forests, the first assessed according to the different zones specified in the Forest Management Plan 1997-2007 for Mabira CFR; and the latter based on age and species of plantings for Kifu CFR and Namyoya CFR. For Mabira CFR recognition was given to the fact that not all compartments are homogenous and benefit streams were therefore estimated on compartment by compartment basis. Detailed maps of the three CFRs showing the areas to be impacted by the Wayleave construction are presented in *Annex 1.*

Magnitudes of development impacts

Only significant impacts were considered in the impact analysis. What this meant was that by and large, the hydrological functions of the forests will be largely left unaffected since much smaller areas relative to the total area of the reserve will be impacted. Similarly, the construction and subsequent maintenance of the Wayleave will have virtually no noticeable impact on options, bequest and existence values except for considerations of loss of biodiversity (under option values).

Management costs

Monitoring of mitigation measures will entail additional management effort by the NFA. Furthermore, the NFA is about to begin preparing a new Forest Management Plan (FMP) for Mabira CFR and, as such, the impacts of the proposed transmission line will also have to be addressed during the process.

Plantations

Only established plantation tree crops were considered for estimates of future values foregone based on the length of the license issued to the tree farmer. For the Kifu CFR plantation crop, the NFA is equated to a private tree farmer and applicable licence periods used as a basis for calculating benefits foregone. For eucalyptus planting, a crop of more than 1 year is considered established. For other species, a crop of 5 years is considered established. For plantings less than the age of establishment, investments lost in ground clearing, planting, beating up and weeding were considered.

Other considerations

Some 5.1 ha of land in community enclaves in Mabira CFR, owned by individuals, will be affected. These areas need to be compensated for to allow the Developer to enjoy un-encumbered access. However, the compensation was excluded from the economic assessment in Mabira CFR, since a different methodology would be required and the areas are not part of the reserve as further explained below.

3.2 Effective area impacted

Table 4 shows the area of impact in the three CFRs including community enclaves in Mabira CFR. A total of 69.1 ha of Mabira CFR consisting of different management categories will be impacted. However Compartment 234 is so severely degraded and devoid of any big trees that it cannot be considered a natural forest area. There is a wetland along the tributary of the Ssezibwa River, otherwise the area is scrub land except for about 0.2 ha of private planting of a *Terminalia sp.* crop of less than 1 year old. Hence in estimates of total natural forest area impacted, the zone in Compartment 234 should be removed altogether, leaving natural forest area impacted at 66.3 ha.

Two Community Enclaves – Buwoola and Namusa – within Mabira CFR will be impacted. An area of 5.1 ha is the impact zone. Although these enclaves are within the boundaries of Mabira CFR, they are not part of the reserve. The enclaves are settlements with subsistence agriculture practiced by the households. The land in question is owned by individuals. The value for the 5.1 ha of Community Enclave land is, therefore, outside the consideration of the forest area economic assessment of this assignment. Hence, this area is removed from further consideration.

The area the project will impact in Kifu CFR consists of 3.7 ha of *Araucaria cunninghamii* plantation. Similarly, 7.7 ha of privately-owned *Eucalyptus grandis* plantations in Namuyoya CFR will be affected by the development.

Subsequently, the effective area of impact for forest area by the project is made up of:

♦ natural forest in Mabira CFR	66.3 ha
♦ plantation area in Mabira CFR	0.2 ha
♦ plantation area in Kifu CFR	3.7 ha
♦ plantation area in Namuyoya CFR	7.7 ha
	77.9 ha

Table 4. Area of Impact

CFR/Other	Compartment No.	Effective Area Impacted (ha)	Management zone
MABIRA CFR	173	10.0	Production/Encroachment
	179	7.8	Production/Encroachment
	185	12.4	Production/Encroachment
	192	6.8	Production/Low Impact
	191	6.5	Recreation/Buffer Zone
	203	10.3	Recreation/Buffer Zone
	206	9.4	Recreation/Buffer Zone
	211	1.2	Recreation/Buffer Zone
	229	1.9	Production/Low Impact
	234	2.8	Production/Encroachment
TOTAL MABIRA		69.1	-
COMMUNITY ENCLAVES IN MABIRA CFR	Buwoola	0.2	-
	Namusa	4.9	
TOTAL ENCLAVES		5.1	-
KIFU CFR	-	3.7	
NAMUYOYA CFR	-	7.7	
TOTAL IMAPCT AREA	-	85.6	

3.3 Triangulation and ground truthing

A significant amount of the information used in the analytical part of this report was obtained from secondary sources. However, a conscious effort was made to triangulate and 'ground truth' the information with on the ground work. This was achieved using key informant interviews, focus group discussions, participant observations, and a semi-structured household survey using questionnaires.

In general, it was clear that Mabira CFR, the main area of concern because of its natural forest cover, provides a number of livelihood opportunities for the communities in the enclaves and the surrounding areas. From key informant interviews and participant observation, the restoration of the degraded parts of Mabira and maintaining the ecotourism attributes of the CFR features prominently as stakeholder interests. During the Focus Group Discussions (FGDs) hunting, firewood and the harvesting of medicinal plants for home consumption and limited intra-community sales were highlighted as significant non-timber uses. Households also emphasized the important role Mabira CFR plays in ensuring clean supplies of water.

On the other hand, communities were either ambivalent or welcomed the development. Those in favour of the development requested that suitable young and energetic members be considered for employment in project work. With respect to compensatory investments, the communities would like the Developer to commit resources towards putting up classroom blocks and providing classroom furniture. The communities also requested that the Developer should ensure community roads used during the construction of the Wayleave be left in a sound condition. Finally, the communities requested that electricity be made available in their enclaves and surrounding areas.

Details of Key Informant Interviews are presented in *Annex 2;* Focus Group Discussions in *Annex 3;* and Household Survey in *Annex 4.*

4.0 Economic Valuation

4.1 Theory

Forests in general are complex ecosystems and generate a range of goods and services. For purposes of determining the magnitudes of net benefits lost due to conversion of a forest to other development options, the total economic value (TEV) approach was chosen as the most comprehensive. The TEV is made up of use and non-use values. The use values in turn consist of direct and indirect use values; while the non-use values consist of options, bequest and existence values. This classification was characterised by Monasinghe (1992). *Figure 2*, shows adaptation of the classification by Lette & de Boo (2002).

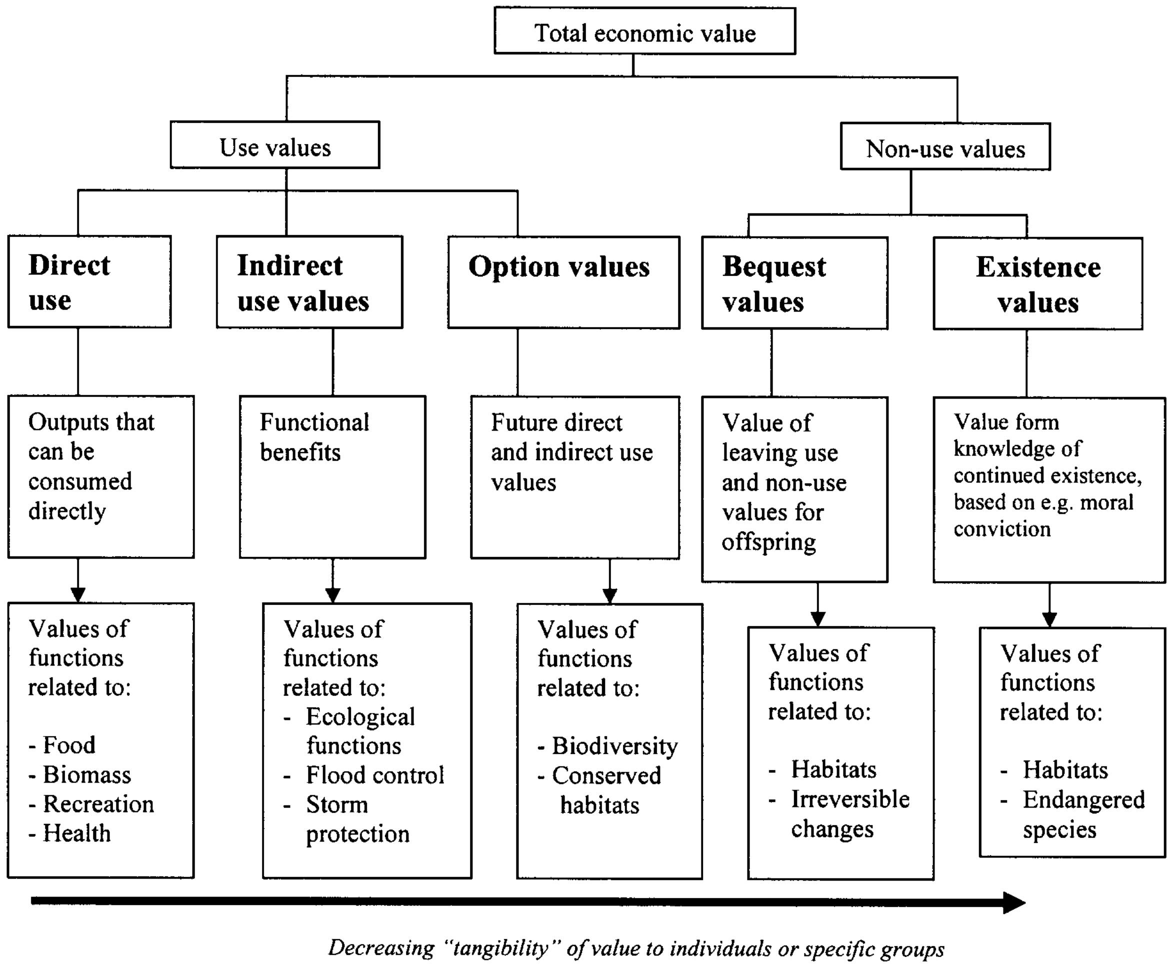
Economic valuation is a tool for decisionmaking intended to compare the advantages and disadvantages of alternative development options or alternatives. The value of forests depends not only on the market prices of its direct uses but is also based on other indirect uses of the forest resources that cannot be traded on some kind of market (Lette & de Boo 2002). Valuation of the goods and services provided by forests is needed because these areas are under great pressure and are in fact disappearing. Extensive areas of Mabira CFR were severely encroached not too long ago (Karani *et al* 1997). The natural forest cover of Kifu CFR and Namyoya CFR have been completely destroyed and the areas have now reverted to plantation forests. The lack of knowledge and awareness of the total value of the goods and services provided by the forest resources will obscure the ecological and social impact of the conversion of forests into other uses. Proper valuation of all goods and services provided by a forest can help us understand the extent to which those who benefit from the forest or its conversion also bear the associated management costs or opportunities foregone (Lette & de Boo 2002). As part of an expanding response to declining global biodiversity (Daily & Walker 2000), interdisciplinary research teams of economists and ecologists have conducted valuation exercises designed to estimate the costs (Ando *et al* 1998; Montgomery *et al* 1999; Balmford *et al* 2003) and benefits (Pimentel *et al* 1997; Costanza *et al* 1997; Balmford *et al* 2002) of forest use alterations.

Despite the importance of the valuation of forests and nature, under-valuation was and still is the order of the day, as a result of market and policy failures (Lette & de Boo 2002). Market failure has been identified as one of the major causes of under-valuation (Lette & de Boo 2002). For example, when determining the economic value of a forest, decisionmakers usually only take into account the easily quantifiable – financial – costs and benefits related to goods and services traded on the market, whereas there are numerous functions of forests for which markets malfunction, are distorted or simply do not exist (Lette & de Boo 2002). Markets only exist for some of the production functions of forests, such as timber, fuelwood, and non-timber products. However, even if markets exist, market prices for these goods may not reflect their real value, since markets can be distorted, for example by subsidies which represent policy failures (Lette & de Boo 2002). The authors suggest that the market price of a particular good may not reflect all the costs involved in producing that good because there may be benefits or costs enjoyed or borne by others not directly involved in the production of the good, what economists call externalities (Lette & de Boo 2002).

With respect to the valuation of a forest using the total economic value approach, the following terms are defined as follows.

- *direct use values* – benefits that accrue directly to the users of forests, whether extractive (e.g. timber and NTFPs) or non-extractive (e.g. ecotourism);
- *indirect use values* – benefits that accrue indirectly to users of forests, primarily ecological or environmental services;
- *option value* – the amount that individuals would be willing to pay to conserve a forest for future use (e.g. biodiversity values);
- *bequest value* – the value attached to the knowledge that others might benefit from a forest area in the future; and
- *existence value* – the value placed by non-users on the knowledge that something exists, i.e. its intrinsic value.

Figure 2. The Total Economic Value of Forests



Source: Lette & de Boo (2002); Munasinghe (1992)

Various valuation tools have been developed to estimate the monetary value of non-marketed goods and services (Lette & de Boo 2002). Munasinghe's classification of major value categories has proved to be a useful analytical tool to link value categories and their underlying environmental goods and services with specific valuation tools (Munasinghe 1992; Lette & de Boo 2002) as shown in *Table 5.*

While the direct use value of goods and services traded on the market can be easily translated into monetary terms by taking their market prices, there are a lot of other goods and services often conceived as having direct use values. These functions can be better valued by means of other valuation tools (e.g. Related Goods Approach, Hedonic Pricing or Travel Cost Method). The regulation functions of forests from which indirect use value is perceived can also be valued by various valuation tools (e.g. Replacement Cost Technique, Production Function Approach). To capture option, bequest and existence values, Contingent Valuation

Method (CVM) is used to estimate the monetary value of environmental amenities. Lette & de Boo (2002) have cautioned on the use of valuation tools as follows:

> *"It must be emphasised that none of these valuation tools provides comprehensive answers. All of them value only part of the goods and services provided by forests and nature. They all have limitations and should be chosen and used with care. Using several valuation tools for a single object case, could contribute to a more complete valuation"*

Table 5. Example of links between value category, functions and valuation tools

	USE VALUES		NON-USE VALUES		
USE	**1. Direct use value**	**2. Indirect use value**	**3. Option value**	**4. Bequest value**	**5. Existence value**
FUNCTIONS	Wood products (timber, fuel) Non-wood products (food, medicine, genetic material) Educational, recreational and cultural uses Human habitat	Watershed protection Nutrient cycling Air pollution reduction Micro-climatic regulation Carbon storage	Possible future uses of the goods and services mentioned in 1&2 (Use Values) by actual stakeholders	Possible future uses of the goods and services mentioned in 1&2 (use Values) by the offspring of actual stakeholders	Biodiversity Culture, heritage Benefits to stakeholders of only knowing of the existence of goods or services without using them
	Tool to be used:	Tool to be used:	Tool to be used:	Tool to be used:	Tool to be used:
VALUATION TOOLS	Market Analysis Related Goods Approaches Travel Cost Method Contingent Valuation Method Hedonic Pricing	Restoration Cost Preventive Expenditure Production Function Approach Replacement Costs	Contingent Valuation Method	Contingent Valuation Method	Contingent Valuation Method

Source: Lette & de Boo (2002)

The foregoing tools have been successfully applied in the valuation of several tropical high forests and other ecosystems. Naidoo & Adamowicz (2005) quantified the costs and benefits of avian biodiversity in Mabira CFR through a combination of economic surveys of tourists, spatial land-use analyses, and species-area relationship. The results showed that revising entrance fees and redistributing ecotourism revenues would protect 114 of the 143 forest bird species under current market conditions. This total would increase if entrance fees were optimised to capture the tourists' willingness to pay for forest visits and the chance of seeing increased numbers of bird species.

Beukering & Cesar (2001) calculated the total economic value of the Leuser ecosystem in the Philippines under conservation and deforestation scenarios using extended Cost-Benefit Analysis and found that the conservation scenario far outweighed the deforestation scenario and they concluded that the ecosystem would be in the interests of the local population, local and national governments, and the international community. Hadker *et al* (1997) used the Contingent Valuation Method to estimate willingness-to-pay on the part of residents of Bombay (Mumbai) for the maintenance of Borivli National Park, located within the City's limits. The study arrived at a willingness-to-pay of 7.5 rupees per month per household, which amounted to a total present value of 1033 million rupees (or USD 31.6 million). The authors suggested that this figure could be used to influence policy decisions, given that the Protected Area at the time ran on a budget of 17 million rupees (USD 520 000).

Menkhaus & Lober (1995) used the Travel Cost Method (TCM) to determine the value that tourists from the US placed on Costa Rican rainforests as ecotourism destinations using the Monteverde Cloud Reserve as a sampling site. Consumer surplus was estimated to be approximately USD 1150, representing the average annual per person valuation of the ecotourism value of PAs in Costa Rica. The ecotourist value of the Monteverde Cloud Forest Reserve was obtained by multiplying the total number of visitors by the average consumer surplus. This resulted in a total annual US ecotourism value of USD 4.5 million for the Monteverde Reserve.

Janssen & Padilla (1999) used a combination of Cost-Benefit Analysis and Multi-Criteria Analysis to assess the opportunity cost of preservation and analyse tradeoffs to be made in deciding whether to preserve or convert a mangrove forest in the Philippines. The result showed that the aquaculture alternatives performed better than the forestry alternatives and preservation in terms of economic efficiency.

Kramer *et al* (1995) used a combination of valuation tools (Contingent Valuation combined with Opportunity Cost Analysis and Recreation Demand Analysis) to investigate changes in environmental values resulting from the creation of Mantadia National Park in Madagascar. Kramer *et al* (1993) used Contingent Valuation Method to determine the value of tropical rainforest protection as a global environmental good. Using two approaches the authors determined the average willingness-to-pay of US citizens at USD 24 to31 and extending to all US households, total willingness-to-pay was estimated at USD 2180 to 2820 million per year.

Sikoyo (1995), used the Contingent Valuation Method to determine community direct use benefits from Bwindi Impenetrable Forest National Park in Uganda; while Moyini & Uwimbabazi (2001) used the Travel Cost Method and the Contingent Valuation Method to determine the Mountain gorilla tourism value of Bwindi Impenetrable Forest National Park. The results showed a consumer surplus of USD 100.

Muramira (2000) estimated the value of the overall impact of Wayleave construction through Mabira at USD 340,202 and suggested that this money be set aside to address the environmental impacts of the development. The author used inventory and market analysis, secondary information on resource usage and willingness-to-pay studies in comparable areas and project data.

4.2 Analytical framework

The analytical approach adopted in this report consists of the following.

1. Resource values were estimated from the perspective of net benefit streams, annualised, and then their present values obtained by capitalising the average annual benefits stream using the Government of Uganda's social opportunity cost of capital of 12%.

   That is, the present value of product or service (i) equals average annual net benefits (economic rent) capitalised by the social opportunity cost of capital, or:

   $$PVi = ARi/r$$

   where
   PVi - present value of product i
   ARi – average annual net benefit from product i
   r – social opportunity cost of capital (discount rate)

   Subsequently, the total present value of the Wayleave impact area is given by the equation $TPV = \sum_{i=1}^{n} (ARi/r)$

   where
   TPV-stands for total present value.
   n – number of products

   The approach is a good measure of the opportunity cost (or forest benefits foregone) as a result of the Wayleave construction in Mabira CFR.

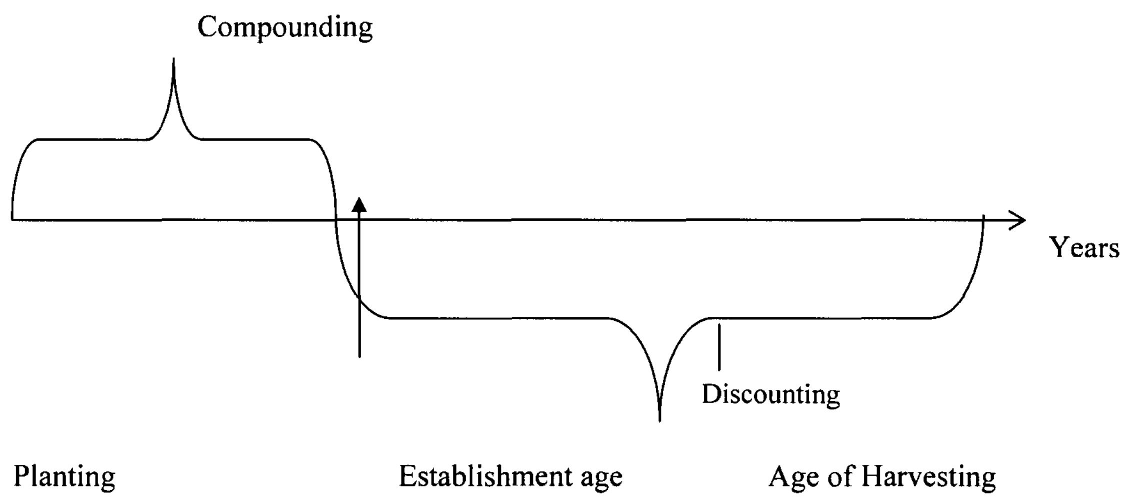
2. For Mabira CFR, the volume of the standing timber is the capital stock from which benefits are derived, and not the stream of benefits themselves. The Developer compensates the NFA for forest benefits foregone. Therefore, the capital stock remains the property of the NFA and represents an encumbrance to the construction of the Wayleave. One option is for the NFA to issue a salvage operation licence for a third party to remove this encumbrance, preferably at a net benefit to the Authority.

3. In calculating the streams of benefits arising from timber, poles and firewood, stumpage values and not market prices were used.

4. The powerline from Bujagali while passing through Mabira CFR also traverses Kifu CFR and Namyoya CFR, areas which are now under plantation, rather than natural,

forests compared to Mabira CFR. The plantations are production-oriented, supplying timber, poles and firewood. Where the tree crop is below the age which is considered established, the present value of costs incurred was the eligible item for compensation. On the other hand, benefits streams were calculated for tree crops above establishment stage using the appropriate stumpage values.

For the forest plantations of Kifu and Namyoya CFRs, the capitalisation of annual benefits would not be appropriate. For one, the yield of benefits are not annual. Rather, they are periodic. For purposes of this valuation 25 years for *Eucalyptus sp* and 50 years for *Araucaria sp* were used since the permits granted though renewable do not immediately satisfy long-run continuity conditions and the areas planted have not been compartmentalised to yield even annual returns. Hence, plantation expenses incurred up to establishment age should be compounded while those to be incurred from the present to full rotation age discounted as shown below. The same applies to benefits.



In other words, the present value of net benefits accruing between now and subsequent harvests is given by the following formulae:

$PVc = C / \ 1/(1+r)^t$ for costs; and

$PVb = B / \ 1/(1+r)^t$ for benefits

or $PVnb = (B-C) / \ 1/(1+r)^t$

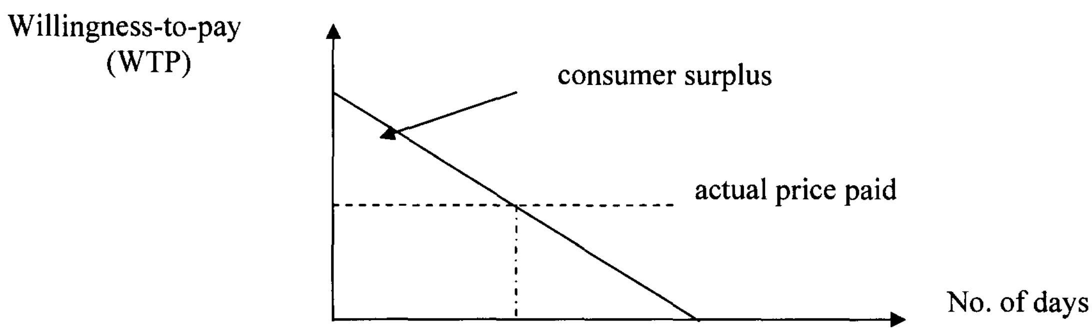
where:
PVc – present value of cost
PVb – present value of benefit
C – cost
B – benefit
PVnb – present value of net benefits (benefits less costs)
r – social opportunity cost of capital
t – time

On the other hand, for expenses incurred earlier – such as planting, beating up and weeding before a crop is considered established – the value of those investments were amortised as follows:

$$PVc = C\,(1+r)^t$$

5. The basis for calculating the value of forests for ecotourism is the consumer surplus, representing the price tourists are willing-to-pay, up and above what they actually pay for the ecotourism experience (*Figure 3*). Ecotourism is an important activity in Mabira CFR but not Kifu and Namyoya central forest reserves.

Figure 3. Graphic Illustration of Willingness to Pay



6. *Non-timber forest products* are harvested in Mabira CFR and not the other two reserves. This study used the extensive research of Bush *et al* (2004) on community livelihoods in representative forests in Uganda. The results of their research was used in this study, augmented by the Consultants' household survey and Focus Group Discussions (FGDs), among others.

7. *Carbon sequestration* values were derived from Bush *et al* (2004) where average values of tonnes of carbon per unit area per year have been estimated multiplied by the appropriate domestic market price prevailing then for carbon.

8. *Hydrological functions* were omitted from calculations for compensation for the reason that the area of forest removed for the Wayleave construction is too small to affect the hydrological functions of the forest. However, water conservation values, based on supply of water for forest communities were estimated as part of the livelihoods contribution.

9. *Bequest and Existence Values* were also removed from the calculations on the basis that the area required for the Wayleave construction is too small to significantly affect the bequest and existence values of Mabira CFR.

10. Biodiversity values were estimated using secondary data from research in comparable areas. Being forest plantation areas, Kifu CFR and Namyoya CFR were assumed to have minimal biodiversity richness and hence values were estimated only for Mabira CFR.

11. Small parts of Buwoola and Namusa community enclaves extend into Mabira CFR and will be impacted by the development. This *land is owned by individuals* who should be compensated so that the Developer has quiet enjoyment of its use rights in Mabira. However, the valuation of the lands is outside the scope of this study as explained earlier.

12. *Landtake*. The Developer is expected to obtain a use right for the Wayleave construction from the NFA. The use right is issued free of charge. However, an annual ground rent will be levied on forest land withdrawals for the Wayleave Construction. The NFA charges a ground rent of UShs 20,000 per hectare per annum. The present value of this annual payment was estimated.

4.3 Data gathering methods

The study used six approaches to gathering data, as shown below.

Secondary data through review of literature, project documents and records of the NFA. Data on forest characteristics, value of the forest for community livelihoods, carbon sequestration and biodiversity values were derived.

Consultations and meetings were held with the management and field staff of the NFA, and with representatives of community organisations to obtain site-specific information.

Stock assessment. The Makerere University Institute of Environment and Natural Resources (MUIENR) carried out detailed biodiversity assessment in Mabira CFR as part of a biodiversity inventory survey. The data related to timber stocking was to be used to calculate the volume of timber which would be removed as a result of the Wayleave construction. However, to the extent that the NFA is best suited to carry out timber inventory for its auction process and preparation of management plans, the accuracy of the volume of standing timber crop is less important compared to estimates of annual allowance cut (AAC). Hence timber inventory data from the Forest Management Plan were used. Plantation data for Kifu and Namyoya were obtained from the inventory work of the NFA.

Key informant interviews were conducted with individuals who were informed about the three CFRs. They were: Steven Khauka currently Manager of the Tree Seed Centre and formerly in charge of planning at the NFA; executive committee members of Mabira Forest Integrated Conservation Organisation (MAFICO); and the staff of the Mabira Ecotourism Centre. Their views are presented in *Annex 2*.

Focus Group Discussions (FGDs) were held with three communities within the enclaves and surrounding Mabira CFR. Meetings were held at Buwoola, Ssese and Sanga. The purpose of these meetings was to elicit the views of the communities with respect to the importance they attach to, and the livelihoods values they derive from, Mabira forest (see *Annex 3* for details).

Household survey was conducted using a structured questionnaire based on the format of the Bush *et al* (2004) study to determine community livelihoods derived from Mabira CFR. It was assumed the benefits to communities surrounding Kifu CFR and Namyoya CFR were negligible and therefore these were excluded from the calculations of total livelihoods. Results of the household survey are presented in *Annex 4.*

4.4 Mabira CFR

Timber

Table 6 shows that the impact area for the line passing through Mabira CFR holds a standing volume of 2,219.9 m^3 for trees of 50 cm diameter at breast height (dbh) and above.

Table 7 shows the exploitable timber yield. The data indicate a long-run sustainable yield (LRSY) of $1m^3$/ha/year for the species desired for timber made up of 21% Class I, 31% of Class III and 48% of Class II timber.

The LRSY timber yield in the Wayleave impact area was, therefore, estimated at $66.1m^3$/year (*Table 8*).

To convert the sustainable volume removals into monetary terms, the stumpage values (or reserve prices the NFA uses for its timber auctioning business) were obtained from the Authority. The stumpage value for each timber utilisation class was simply the average for all the species in that class. *Table 9* shows stumpage values for different species in Mabira CFR. Average stumpage values (at 100% management costs, per cubic metre) for the different utilisation classes were estimated as: UShs 172,770 for Class I; Ushs 102,511 for Class II and Ushs 86,385 for Class III[4].

[4] Historically bidders have paid prices slightly above the reserve prices.

Table 6. Standing Crop (50cm db+) in Area of Impact[/a]

Compartment	Impact Area (ha)	Volume/ha[/b] (m^3/ha)	Total Volume (m^3)	Management Zone
173	10.0	8.1	81.0	Production /Encroachment
179	7.8	30.2	235.6	Production /Encroachment
185	12.4	8.1	100.4	Production /Encroachment
192	6.8	60.3	410.0	Production /Low impact
191	6.5	8.1	52.7	Recreation / Buffer Zone
203	10.3	61.8	636.5	Recreation / Buffer Zone
206	9.4	56.4	530.2	Recreation / Buffer Zone
211	1.2	60.7	72.8	Recreation / Buffer Zone
229	1.9	53.0	100.7	Production /Low Impact
	66.3	-	**2,219.9**	-

/a – Compartment 234 excluded because there were no large trees in the area of impact
/b – Appendix 7 Mabira FMP 1997 - 2007

Source: Karani *et al* (1997)

Table 7. Mabira Forest Exploitable Timber Yield Trees above 50cm dbh (based on 60 year felling cycle for whole forest - 30,305 ha)

A. By Species	Utilisation Class	m^3/ha	m^3/yr	m^3/ha/yr
Holoptelea	I	5.3	2,676	0.088
Albizia	I	7.2	3,636	0.120
Alstonia	II	3.4	1,717	0.057
Antiaris	II	4.6	2,323	0.077
Celtis	II	18.3	9,243	0.305
Chrysophyllum	II	2.4	1,212	0.040
Trilepsium	III	1.9	959	0.031
Cola gigantea	III	1.2	606	0.020
Ficus	III	2.7	1,363	0.045
Other species	III	13	6,866	0.217
		60.0	30,305	1.000
B. By Utilisation Class				
		12.5	6,312	0.208
Class I		28.7	14,495	0.479
Class II		18.8	9,794	0.313
Class III		60	30,601	1.000

Source: Karani *et al* (1997), Table 9.

Table 8. Exploitable Natural Forest Timber Yield in Impact Area

Compartment	Impact Area	Annual timber yield (m^3/year)			
	(ha)	Class I	Class II	Class III	TOTAL
173	10.0	2.1	4.8	3.1	10.0
179	7.8	1.6	3.7	2.4	7.7
185	12.4	2.6	5.9	3.9	12.4
192	6.8	1.4	3.3	2.1	6.8
191	6.5	1.4	3.1	2.0	6.5
203	10.3	2.1	4.9	3.2	10.2
206	9.4	2.0	4.5	2.9	9.4
211	1.2	0.2	0.6	0.4	1.2
229	1.9	**0.4**	**0.9**	**0.6**	**1.9**
	66.3	**13.8**	**31.7**	**20.6**	**66.1**

* - based on the following: 0.208m^3/ha/year for Class I, 0.479 m^3/ha/year for Class II and 0.313 m^3/ha/year for Class III. Derived from Karani *et al* (1997) Table 9.

To convert the sustainable volume removals into monetary terms, the stumpage values (reserve prices the NFA uses for its timber auctioning business) were obtained from the Authority. The stumpage value for each timber utilisation class was arrived at by obtaining the average for all species in that class. *Table 9* shows stumpage values for different species in Mabira CFR. Average stumpage values per cubic metre (at 100% management costs) for the different utilisation classes where subsequently estimated at: Ushs 172,770 for Class I; Ushs 102,511 for Class II; and Ushs 86,386 for Class III[5].

Using the foregoing stumpage values multiplied by the volumes in each class presented in *Table 8,* one arrives at an annual stream of timber values of:

Class	**Amount (Ushs)/year**
I	2,384,226
II	3,249,599
III	1,779,531
Total	**7,413,356**

Capitalising this annual timber benefits flow by 12% per year (social opportunity cost of capital) gives a present value of Ushs 61,777,967, representing the timber (sawlogs/peer logs) production opportunity cost.

The value of the standing crop was estimated using data presented in *Table 6* and assuming the total volume represents 21% Class I, 48% Class II, and 31% Class III. That is:

[5] Historically, purchases of standing timber have paid in excess of the NFA's reserve prices. Hence, these values should be considered conservative.

$V_{sc} = P_1 (2219.9^* S_{pi}) + P_2 (2219.9^* S_{pii}) + P_3 (2219.9^* S_{piii})$

where

V_{sc} – volume of standing crop in the impact area
S_{pi}, S_{pii} and S_{piii} represent stumpage values for Class I, Class II and Class III, respectively
P_1, P_2, and P_3 represent the proportion of the different utilisation classes, where $P_1 = 0.21$, $P_2 = 0.48$, and $P_3 = 0.31$.

Therefore:

$V_{sc} = 0.21 (2219.9^*172{,}770) + 0.48 (2219.9^*102{,}511) + 0.31 (2219.9^*86{,}385)$

$= 80{,}541{,}746 + 109{,}230{,}801 + 59{,}447{,}479$
$= 249{,}220{,}026$

Hence the value of the standing timber crop in Mabira CFR area of impact was established to be Ushs 249,220,026 for trees having dbh of 50 cm and above.

Table 9. Stumpage Values for Mabira

Species	Stumpage Values (Ushs /m^3)		
	Base	75%*	100%*
Muvule	126,667	151,553	201,565
Nkoba	90,476	108,252	143,975
Aningeria / chysophyllum	104,953	125,572	167,011
Albizia	72,381	86,602	115,181
Maesopsis	65,143	77,942	103,663
Nkuzanyana	54,289	64,951	86,385
Antiaris	25,333	30,311	40,314

* refers to management cost levels
Source: NFA databank

Poles and Firewood

The Management Plan for Mabira CFR 1997-2007 did not encourage the harvesting of poles from the forest. The Plan had this to say in Prescription No. 30.

> " *Though a limited quantity of poles is permitted for domestic use, there are attempts to collect and sell poles due to socioeconomic pressures. There is absolute need to watch out for any large quantities collected by people neighbouring the reserves, as a small business. The FD (now the NFA) staff will investigate any suspected cases and take appropriate steps to stamp out the practice*".
> Karani, *et al* (1997).

Similarly, for fuelwood or woodfuel (representing firewood and charcoal), the Management Plan 1997-2007 Prescription 31 said thus.

> " Fuelwood cutting (sic) and charcoal production are destructive to a standing crop, as licence holders are indiscriminate i.e. cutting young trees of marketable species. *Fuelwood cutting (sic) and charcoal production shall not be allowed in the MPA (Management Plan Area)*". Karani *et al* (1997).

From the foregoing, harvesting of both poles and firewood in commercial quantities is prohibited. However, harvesting the products in limited quantities for own use is permissible. Hence the approach to estimating the combined stream of values from firewood and poles was the one Bush *et al* (2004) used based on household livelihoods.

Bush *et al* (2004) estimated the total livelihood value of timber (largely poles and firewood) and non-timber products from a typical protected tropical high forest in Uganda at UShs 18,074 per ha per year, of which 47% was timber and 53% non-timber forest products. Hence the combined annual stream of poles and firewood values was estimated at UShs 8,495/ha. Since the impact area in Mabira CFR is estimated at 66.3 ha, this gives a benefit stream of UShs 563,219/year. Capitalising this annual benefit stream by 12% gives a net present value for poles and firewood of UShs 4,693,492. Bush *et al* (2004) cautioned as follows.

> " It is important to note at this point that the values calculated *do not* imply that the level of economic value derived is sustainable. (They estimated economic value based on the current levels of use). However, it is reasonable to assume that protected THF [Tropical High Forest] values are closer to sustainable harvest rates considering the management efforts of the NFA".

In summary, the values of poles and firewood were arrived at as follows.

Poles + Firewood livelihood value	UShs 8,495/ha/year
Size of Impact Area	66.3 ha
Total annual benefit stream	UShs 563,219/year
Present Value of Poles + Firewood benefits	UShs 4,693,492

Non-timber forest products

Prescription 32 of the Mabira Forest Management Plan 1997-2007 had this to say about handicrafts materials.

> "*Demand for handicraft products, including easy chairs, stools, mats and baskets is rising. Although limited quantities, for domestic use, are permitted free of charge under the FORESTS ACT, a system shall be devised to monitor, record and control harvesting. Any*

> *collection/harvesting for commercial purposes shall be fully charged at appropriate rates of such forest product*". Karani *et al* (1997).

For other non-timber forest products, Prescription 33 of the Mabira Forest Management Plan 1997-2007 stated as follows:

> "*Domestic collection of medicinal herbs, edible plants and other food materials does not pose any immediate danger to the resource or the standing forest crop. Such collection may promote protection and conservation of the respective forest resource in the MPA by neighbouring communities. However, levels of harvesting shall be controlled and in case of commercial interests, corresponding fees shall be charged. In case of any destruction to standing forest crop, e.g. debarking and uprooting, the FD (now NFA) officers shall take steps to immediately stop such actions*". Karani *et al* (1997).

To estimate the benefits stream from non-timber forest products, the Bush *et al* (2004) study was used. The results of the research showed that typical tropical high forest protected areas (PAs) on average generate UShs 9,579/ha/year, an amount much lower than Afromontane forest PAs, private THFs and savanna woodland/bushland. Nonetheless, the value for tropical high forest PA is thought to be the closest to the Mabira situation. Using the approach similar to the one for poles and firewood, the present value of the benefits stream from non-timber forest products was estimated at UShs 5,292,398 as shown below.

NTFPs livelihood value	UShs 9,579/ha/year
Size of impact area	66.3 ha
Annual benefit stream	UShs 635,088/year
Present Value of NTFPs	UShs 5,292,398

Biodiversity

Mabira CFR is rich in biodiversity. Although the area of impact of the Wayleave construction is small and, therefore, unlikely to affect overall biodiversity richness, it is possible even in a small area some may be lost.

Biodiversity richness of a forest represents an option value; and it is perhaps one of the least tangible benefits of Uganda's forests (Bush *et al* 2004). The value of biodiversity lies partly in the development of plant-based pharmaceuticals (Bush *et al* 2004; Emerton & Muramira 1999; Mendelsohn & Balik 1997; Howard 1995; Pearce & Moran 1994; Ruitenbeek 1989). In addition to undiscovered plant-based pharmaceuticals, Howard (1995) reported that there is potential in wild coffee genetic material. According to Bush *et al* (2004), Uganda's farmed coffee is being hit by a *Fusarium* wilt against which no known cultural or chemical practices appear to succeed and wild coffee is known to be resistant to it (Bush *et al* 2004).

Various estimates have been made of the value of forest biodiversity. Ruitenbeek (1989) estimated the biodiversity of Korup Park in Cameroon at £0.1/ha/annum. Pearce & Moran (1994) provided a range of values for tropical forest, ranging from US$0.1/ha to US $ 21/ha.

Mendelsohn & Balik (1997) produced a value for undiscovered plant-based drugs in tropical forest with average plant endemism of US$3/ha. Howard (1995) suggested that Uganda's forests are not as species rich as Korup Park and the country would be less competitive in say supply of *Prunus africana*. Bush *et al* (2004), suggest an average value for biodiversity at US$1.50/ha/year. Using this estimate the biodiversity opportunities foregone in the impact area would be UShs 182,988/year (using an exchange rate of 1 US$ = UShs 1840). This annual benefit stream translates into a present value of UShs 1,524,900.

Domestic water conservation

During Focus Group Discussions with communities surrounding Mabira CFR and living in the forest enclaves (*Annex 3*), they revealed that to them the most important use of the forest was for water collection. All the surrounding communities and those living in the forest enclaves, said they get their water from the forest. This view tallies with the observation of Bush *et al* (2004), where the forests surveyed across Uganda represented important sources of water for local communities.

Bush *et al* (2004) estimated the mean value of water provision for both humans and livestock per household at UShs 18,415 per annum, and ranges from UShs 12,078 per annum for Budongo CFR to UShs 30,928 per annum for Ruwenzori Mountains National Park. In this report, the value for Budongo CFR which is relatively similar to Mabira CFR was used in estimating community water benefits.

Muramira (2000) estimated the number of households in the enclaves and within the proximity of Mabira at 15,631. Assuming population growth rate of 3.4% per annum (UBOS 2002), by 2006, this population would have increased to about 19,103 households. Therefore multiplying the mean value of water provision of UShs 12,078 per annum by the number of households gives a total value of UShs 230,726,034 per annum. However, the impact area is 66.3 ha out of the total size of about 30,000 ha. Therefore, the value of water provision in impact area which will be lost is equivalent to UShs 509,905 per annum. Holding this value constant over the project period, the net present value of domestic water provision translates into a conservative estimate of UShs 4,249,204[6].

Carbon storage

The removal of tree cover as a result of the Wayleave construction will result in loss of some of the carbon storage capacity of Mabira CFR. According to Bush *et al* (2004), at the global level, the forestry sub-sector is an important carbon sink, helping to reduce accumulation of greenhouse gases and hence global warming which will lead to adverse changes in climate.

[4]The estimate is conservative because the population in the enclaves and the surrounding areas will increase over the years. However, it is possible with increased development, alternative water sources are likely to be developed.

Emerton & Muramira (1999) and Bush *et al* (2004) give the following carbon storage values for different vegetation types: primary closed forest UShs 54,660/ha/year; degraded forest UShs 32,538/ha/year; and woodland, bushland and grassland UShs 2,603/ha/year. The Wayleave construction is expected to leave the cleared impact area under grassland instead of bare ground. Furthermore, the Production (Encroachment) and the Recreation/Buffer Zone would have carbon sink values equivalent to a degraded forest. The Production (Low Impact) zone on the other hand should have carbon sink values somewhere between the primary and degraded forests. Subsequently, the value of carbon sink/ha/year for the Production/Encroachment and Recreation/Buffer Zone was estimated at UShs 32,358/ha/year less grassland value of UShs 2,603/ha/year giving a net value of UShs 29,935/ha/year. Using a similar approach, the carbon sink value for the Production/Low Impact Zone would be UShs 40,996/ha/year, using the average value for a primary closed forest and a degraded forest and deducting grassland values.

Multiplying the carbon sink values by the size of the applicable impact area, *Table 10* shows the annual values lost. The Wayleave construction is expected to result in a loss of carbon sink values equivalent to UShs 2,080,921/year. Capitalised at the social opportunity cost of capital, the annual stream gives a present value of UShs 17,341,008.

Table 10. Carbon Sink Values

Management Zone in Mabira	Impact Area (ha)	Value of Carbon sequestrated/ha/yr*	Total Value/year (U Shs)
Production (Encroachment)	30.2	29,935	904,037
Production (Low Impact)	8.7	40,996	356,665
Recreation / Buffer Zone	27.4	29,935	820,219
	66.3		**2,080,921**

*adapted from Bush *et al* (2004) and Emerton & Muramira (1999)

Landtake

The total impact area in Mabira CFR was estimated at 69.1 ha (including Compartment 234). An annual ground rent of UShs 20,000/ha/year is charged by the NFA. Therefore the annual benefit stream from landtake was estimated at UShs 1,382,000; and the present value of this annualised series was Ushs 11,516,667.

Ecotourism

According to Muramira (2000), Uganda's tropical high forests have some of the richest biodiversity of plant and animal life in the world. The biodiversity inventory for Mabira CFR revealed that the forest has average biodiversity attributes (Davenport *et al* 1996). However, the ecotourism value of Mabira lies in the fact that it is the only THF protected area within the Lake Victoria shore crescent. Furthermore, Mabira CFR is close to the urban centres of Kampala (50km) and Jinja (21km). There is increasing interest in ecotourism in Mabira CFR as shown in *Table 11*. Finally, in addition to the Ecotourism Centre operated by the NFA, new developments are either nearing completion (for example the facility of Ecolodges) or are in the early stages of development (for example the plans of MAFICO).

Table 11. Visitor statistics

Year	Foreigners/ Foreign Residents	Locals	Total
2005/06	1,989	2,854	4,843
1999	1,312	2,880	4,172
1998	1,450	1,125	2,575
1997	1,304	1,094	2,398
1996	1,097	515	1,612

Source : data for 2005/06 fiscal year from the NFA
: data for remaining years, Muramira (2000)

The basis to estimating the annual value of ecotourism is the consumer surplus, the difference between the price tourists are willing to pay and the price they actually paid. Naidoo & Adamowicz (2005) found that an entrance of US$47 would maximise tourism value i.e. the amount foreign and foreign residents of Uganda are currently charged US$5 to visit Mabira CFR (Naidoo & Adamowicz 2005). This dramatic under-valuation of the willingness to pay of tourist visitors is consistent with results from other tropical areas and suggests much room for improvement in entrance fee policy (Naidoo & Adamowicz 2005).

From the above, the consumer surplus for foreigners and foreign residents is US$42 per tourist. In the absence of data on the local tourists' willingness-to-pay and considering their low income levels, this study assumes a zero consumer surplus pertaining to local tourists. For foreigners and foreign residents US$ 42 or UShs 77,280 (at exchange rate of UShs 1840 to the US$) – was used. Furthermore, using the 2005/06 data for foreigners and foreign residents of 1,989 tourists, the annual value of ecotourism for the whole Mabira CFR was estimated at UShs 153,709,920/year. Mabira CFR is about 30,000 ha in size and it would be incorrect to allocate all the annual value lost due to the impact area of 66.3 ha. Hence, the proportionate share of ecotourism benefits lost was estimated as a fraction of the value for Mabira as a whole (that is, UShs 153,709,920/year x 66.3/30,000) giving a value of UShs 339,699.

Subsequently, the present value of the ecotourism benefits foregone as a result of the Wayleave construction translates into UShs 2,830,824.

Recently planted crop

In Compartment 234, there was a crop of *Terminalia sp* less than I year old and hence below the age of establishment. Nonetheless, the private tree farmer ought to be compensated for expenses incurred assuming that the money will be realised in the third year. Total expenses were estimated at UShs 1,300,000 (based on NFA experience). When this amount was compounded by 3 years, the present value equaled to UShs 1,826,370.

4.5 Kifu CFR

Timber

On a plot of 10m x 20m or 0.02 ha, 15 standing trees of average dbh of 6.5 cm-12.4 cm and height of 2-3 m were counted in Kifu CFR. This gives a stocking rate of 750 trees/ha. The latest yield recording for *Araucaria sp.* was 1,400 m^3/ha. The stumpage value was UShs 86,000/m^3. The area impacted by the Wayleave construction in the part of Kifu forest was 3.713 ha. However only about 600 m by 40 m is planted, indicating an area of 2.4 ha. A crop of *Araucaria* matures in 25 years (economic rotation age). Licence for growing *Araucaria* is 50 years, renewable, meaning 2 rotations are realisable. Therefore, the total Present Value for the *Araucaria* crop is given by UShs 288,960,000 each received in the 25th and 50th years based on present stumpage values. When the two receipts were discounted at the appropriate social opportunity cost of capital, the present value of future benefits foregone was equal to UShs 17,990,650, or put in another way UShs 7,496,104/ha.

Landtake

In addition to this foregone benefit payable to the crop owner, the Developer is also required to pay UShs 20000 /ha/year of ground rent to the NFA. Therefore, payment of ground rent for the impact area of 3.713 ha was estimated at UShs 74,260/year, giving a present value of UShs 618,833.

4.6 Namyoya CFR

Timber

On a plot of 10m x 20m or 0.02 ha, 16 standing trees of *Eucalyptus grandis* of average dbh of 3.8 to 10.6 cm were counted in Namyoya CFR. This gives a stocking rate of 800 trees/ha. It is assumed that all 800 trees would be suitable for electric poles. The stumpage value for electric poles is UShs 20,000/tree. The area impacted by the Wayleave construction in Namyoya CFR was 7.658 ha. Production of electricity poles from E. grandis takes 8 years and the tree growers noe have 25-year licences, renewable which gives them an opportunity to raise three crops during the licence period. Therefore, the total Present Value for the Eucalyptus crops is given by UShs 122,528,000 each received in the 8th, 16th and 24th years based on present stumpage values. When the three harvest payments were discounted at the appropriate social opportunity cost of capital, the total present value of future benefits foregone was equal to UShs 77,545,521 or put in another way, UShs 10,126,080/ha of area impacted.

Landtake

In addition to this foregone benefit payable to the crop owner, the Developer is also required to pay UShs 20000/ha/year of ground rent to the NFA. Therefore, payment of ground rent for the impact area of 7.658 ha was estimated at UShs 153,160/year, giving a present value of UShs 1,276,333.

4.7 Management costs

The NFA will need to commit staff and equipment to monitor the implementation of the mitigation measures proposed in the project EIS. Second, there is a need to revise the management plan for Mabira CFR but not Kifu and Namyoya reserves. Third, the NFA will need to allocate other lands for the private tree farmers whose land is to be affected by the construction of the Wayleave. The attendant costs will be one time expenditures and even if they cover a period of 18 months (e.g. monitoring), the cost figures were treated as present values.

Muramira (2000) estimated the cost of monitoring to be UShs 6,526,080. This cost is probably on the lower side since the remuneration of the staff of the NFA has gone up and so has the cost of fuel. Therefore, a doubling of this cost at UShs 13,052,160 would be more reasonable.

Revision of the management plan for Mabira CFR was estimated at UShs 2,000,000. Finally the cost of demarcating new areas to be allocated to tree farmers in Kifu and Namyoya CFR is expected to cost a nominal amount of UShs 1,500,000.

Subsequently, total management costs were estimated at UShs 16,552,160 as follows.

Monitoring of EIS	UShs 13,052,160
Revision of management plan	UShs 2,000,000
Planting area allocation	UShs 1,500,000
	UShs 16,552,160

It is worth noting that the NFA will incur additional costs in removing the timber stock in the area of impact. However, it is expected that the Authority will meet this cost from proceeds it gets from issuing salvage felling licenses to third parties.

4.8 Summary of economic values

This section provides a summary of the economic value lost or foregone as a result of the construction of the Wayleave for the new 220 KV transmission line north of the existing 132 KV line. *Table 12* shows a summary of the overall economic impact.

The data show a growing stock (50 cm dbh +) in Mabira CFR worth UShs 249,220,026 will have to be cleared to make way for the transmission line. Furthermore, the present value of use and non-use values foregone including land and compensation for recently planted crop of *Terminalia sp.* and a small compensation for private land, would amount to UShs 111,052,830.

In Kifu CFR the value of timber benefits foregone and annual payments of ground rent would amount to a present value of UShs 18,609,483. Similarly, in Namyoya CFR, foregone timber values and annual ground rent payments would give a present value of UShs 78,821,854.

The NFA would incur incremental management costs arising from monitoring of the EIS; preparation of a new management plan for Mabira CFR; administering the allocation of new areas to the private tree farmers who are expected to lose their planting area as a result of the Wayleave construction. These added management costs were estimated at UShs 16,552,160.

Finally, the present value of the growing stock for Mabira, the benefit streams foregone in all the three CFRs together with associated incremental management costs were estimated to total UShs 474,256,353.

Table 12. Summary of Economic Values

Economic Value Sources	Mabira CFR	Kifu CFR	Namyoya CFR	TOTAL
A. GROWING STOCK	**249,220,026**	**0**	**0**	**249,220,026**
B. BENEFITS STREAM (Present Values)				
1. Timber	61,777,967	17,990,650	77,545,521	157,314,138
2. Poles + Firewood	4,693,492	0	0	4,693,492
3. Non-Timber Forest Products	5,292,398	0	0	5,292,398
4. Biodiversity	1,524,900	0	0	1,524,900
5. Domestic Water	4,249,204	0	0	4,249,204
6. Carbon Storage/Sequestration	17,341,008	0	0	17,341,008
7. Ecotourism	2,830,824	0	0	2,830,824
8. Landtake	11,516,667	618,833	1,276,333	13,411,833
9. Immature plantings	1,826,370	0	0	1,826,370
Sub total Beneifts Streams	**111,052,830**	**18,609,483**	**78,821,854**	**208,484,167**
C.TOTAL GROWING STOCK AND BENEFITS STREAM(A+B)	**360,272,856**	**18,609,483**	**78,821,854**	**457,704,193**
D. ADD MANAGEMENT COSTS				**16,552.160**
E. GRAND TOTAL ECONOMIC VALUES				***474,256,353***

5.0 Mitigation Plan

5.1 Stakeholder Roles

For the construction of the Wayleave through Mabira, Kifu and Namyoya Central Forest Reserves, four distinct stakeholders were identified – the NFA, the Developer, Private Tree Farmers (PTF) and the Communities in the forest enclaves and surrounding areas. Each stakeholder has specific roles as described below.

The NFA

- Disposes the growing stock in the impact area in Mabira CFR, to allow the Developer easy access and incurs the cost of removal of growing stock and receives all benefits realized therefrom.
- Acquires and disposes timber crop of the private tree farmers in Namyoya CFR.
- Disposes owned timber in Kifu CFR within the impact area.
- Allocates new planting area for affected tree farmers in Namuyoya and Mabira CFRs
- Provides the local communities of Mabira CFR with compensatory benefits for lost values with respect to firewood and poles, NTFPs, and domestic water.
- Provides the global community with compensatory benefits for lost biodiversity and carbon sequestration values.
- Invests in natural forest rehabilitation from proceeds of the disposal of the standing timber crop.
- Prepares new Forest Management Plan for Mabira CFR taking into account the impacts of the Wayleave construction

The Developer

- Pays the NFA for lost investments in plantation crop to compensate affected tree farmers and the Authority's own crop.
- Pays the NFA for loss of benefit streams.
- Pays the NFA ground rent annually or makes a one time payment of UShs 13,411,833 representing the present value of annual payments.
- Meets the NFA's incremental management costs.
- *Does not* compensate the NFA for timber value of the growing stock since the Authority will supervise and realise benefits from the sale of the timber in the impact area of Mabira.

Private Tree Farmers

- Receive payment for lost future crop
- The NFA allocates proportionate area for planting within suitable CFRs.

Communities

- Receive 'compensatory benefits' for lost livelihood values
- Get preferential treatment for employment (if suitably qualified) during the construction and maintenance of the Wayleave and any forestry-related activities.

5.2 Financial implications

The roles of the different stakeholders imply varying levels of financial commitments or benefits as described below.

The NFA

A. Receives

1. Compensation for benefits stream from the developer: UShs 208,484,167
2. Incremental management costs from the Developer: UShs 16,552,160
3. Auctions growing stock in the impact area in Mabira: UShs 249,220,026.

Total receipts: UShs 474,256,353

B. Pays out

1. Private tree farmers for lost timber values UShs: 79,371,891
2. Management costs: UShs 16,552,160
3. Pays itself for lost *Araucaria* crop UShs 17,990,650
4. Invests in forest rehabilitation and other forest management priorities, and compensatory investments in community social infrustructure: UShs 360,341,652

The Developer

A. Receipts None

B. Payouts

Benefit streams Foregone paid to the NFA: UShs 208,484,167
Incremental management costs paid to the NFA: UShs 16,552,160
Total payout: UShs 225,036,327

5.3 Summary

- The NFA will have to organise the harvesting of the Mabira CFR standing timber crop in the impact area through its auction process.

- The NFA on its own or in collaboration with the affected Private Tree Farmers arranges to dispose of the immature plantation trees from the impact area in Kifu and Namyoya CFRs.

- The Developer pays the NFA cash amount equal to UShs 225,036,327 or US$ 122,302 (using exchange rate of UShs 1,840 to the dollar).

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Annexes

Annex 1
Maps of Impact Areas in Mabira, Kifu and Namyoya CFRs

Annex 2

Key Informant Interviews

The following people and groups were consulted in regards to the importance of Mabira CFR and the likely impacts of the Wayleave for the proposed transmission line. They were: Steven Khauka – formerly in planning at the NFA, and now, the Manager of Namanve Tree Seed Centre; the Executive Committee Members of Mabira Forest Integrated Community Organisation (MAFICO); and the staff of Mabira Ecotourism Centre.

1) Steven Khauka

Steven Khauka mentioned enrichment planting as the best option in managing degraded forests. It involves planting of selected tree species in the degraded areas. This helps faster and easy regeneration of the forests in areas where the required species are planted. The option also helps in the introduction of new tree species in the planted areas as opposed to natural regeneration. Despite being the best option however, the method requires high investment levels in terms of care and maintenance, which is not catered for in most cases. Maintenance costs involved include opening of canopy to create space for the newly planted trees and clearing of climbers, as they are easily attracted to opened spaces thereby hindering the growth of the planted trees. Enrichment planting using different tree species gives rise to mixed tree species in the forest, which caters for different values attached to the forests.

Steven felt that natural regeneration as a method of managing degraded forests is not feasible. This is because the method needs a long time for regeneration to take place and in cases where the parent trees are missing, which is a major phenomenon in degraded forests, quality regeneration may never be seen due to lack of seeds.

In terms of restoring degraded forests, the best method to be followed as per Steven's concern would be to identify the highly degraded forests. After this, carry out enrichment planting using mixed species for quick regeneration. The method is not new in Ugandan forest management as it was a method used to restore part of Mabira forest before recalls Steven. This can be recognised in places around the Ecotourism Centre and the Picnic site where almost trees of the same size and age can be identified.

The high existence of Paper Mulberry in some parts of Mabira Forest can be handled effectively through enrichment planting. Paper Mulberry can be cut and sold for firewood. This will help in creating space for the planting of new valuable trees. However, the method is expensive in terms of care and maintenance. This is due to the high regeneration rate of Paper Mulberry, which needs constant cutting of the re-growth if enrichment planting is to yield better results.

Steven also emphasized that with respect to restoring the integrity of Mabira CFR, the National Forestry Authority is better equipped to handle the value of a forest than any other organisation. That is for the 40 metres to be cut in Mabira Forest to create a pathway for the Bujagali powerline in a way of compensation for the lost forested areas. There is need to channel part of the money in restoring degraded forest's integrity not by the powerline developer but by the National Forestry Authority.

2) Mabira Forest Integrated Community Organisation (MAFICO)

Committee members contacted

Kabali Juliet	Chairperson
Kiyimba Rajab	Administrative Secretary
Kungujje Robert	General Secretary
Tigawalana Sebastian	Publicity Secretary
Luyombya Moses	Secretary for Resource Conservation and tourism

The organisation started as a Community Based Organisation (CBO) in 1998 under the name of Mabira Tourism Advisory Committee. It was at the time of massive eviction of people from Mabira Forest and also at a time when Mabira Ecotourism Centre was being established. The main idea for the establishment of the organisation was to intervene on part of the communities affected by the action. At that time the organisation covered seven parishes of Najjembe Sub- County. Later, the organization's name changed to Mabira Forest Tourism Committee.

In 2000-2003 the idea of a Non-Governmental Organisation called MAFICO was born. That is between 2000-2002, the organisation was in place but not registered until 2003 when it started existing formally after registration.

Presently MAFICO covers Najjembe and Nagojje Sub-Counties performing a number of activities. These include: environmental education in schools; encouraging good forest activities like bee-keeping; community woodlot planting; provision of seedlings; and capacity building for Community Based Organisations like organising workshops and proposal writing among others.

The CBOs being assisted by MAFICO are under collaborative forest management organisations. The two are COFSDA, in Najjembe Sub-County covering Koko, and Buvunga villages and NACOBA in five villages of Nagojje Sub-County. These CBOs have enjoyed the benefits of working with MAFICO for example MAFICO helps NACOBA in proposal writing concerning bee-keeping. So far the proposal was accepted for funding by the National Forestry Authority in Compartment 222. The agreement between NACOBA and the NFA was signed on 22nd April, 2006. Under this agreement the NFA is to buy the beehives for the organisation. The NFA also promised to link the organisation to Uganda Bee-Keeping Association

MAFICO is looking forward to establishing a community ecotourism centre in Mabira Forest. The centre is to be set in Nagojje Sub-County. The planned site is about 2-3 km sq km from which several activities are to be carried out. There will be three accommodation bandas, a campsite, and a visitor's centre. The project is to be funded by the United Nations Development Programme Small Grants Programme.

The planned site for the MAFICO ecotourism centre is located in compartment 207 which is a buffer zone; 30m north of the existing power line the buffer zone borders a strict nature reserve. This means that the proposed 40m of the new power line go into the planned site for the ecotourism centre reducing the space required to put up the centre which means the centre has to be pushed inward into the strict nature reserve. However it is important to note that no activity is allowed in the strict nature reserve and so it is impossible to push the planned site inward. The ecotourism centre may not be located in the proposed area. This may result in finding an alternative site for the centre away from the strict nature reserve where ecotourism is not allowed. It is possible MAFICO may abandon the whole project altogether because of the development.

It is important to note that the integrity or pristine nature of a forest makes ecotourism more meaningful and attractive. Recreation centres amidst forests have proved to control forest degradation by human beings since the recreation centres become no-go areas for timber and log cutters as well as charcoal burners. Setting up the recreation centre by MAFICO would mean a conservation opportunity for this part of the forest.

The opportunity cost of foregoing the location of the ecotourism centre in the proposed area is not for MAFICO alone but also for the communities. This is because a proposed percentage of revenue accruing from the centre was to go to the communities. Therefore the community will also be affected

3) *Mabira Ecotourism Centre*

The Mabira Ecotourism Centre is a tourism facility that offers walks ranging from 30 minutes to 3-4 hours, mountain biking, picnics, residences in camps, or bandas. All that comes with the forest setting with spectacular birds, butterflies, and monkeys. From July 2004-June 2005 the centre received Ushs 11,58,800 from entry permits, Ushs 343,100 from camping, Ushs 4,641,500 from Banda accommodation and Ushs 495,000 making a total of Ushs 16,638,400 as the revenue collected for the year. Twenty percent of the money goes to the communities (Ushs 3,327,680). In the past this money was given directly to the communities but in the new policy this money will be used to support bigger community developments like building schools, repairing and improving road criteria. It is important to note that the pristineness of a forest may determine its tourist value. Hence cutting down the forest causes tourism damage and this would affect the activities of the tourism centre especially reducing the revenue realised by the tourism centre, while in turn may affect the communities' gain of 20%.

Annex 3
Focus Group Discussions

Community members in the enclaves of Mabira CFR and the surrounding areas were consulted. Focus Group Discussions (FGDs) were held with communities in Buwoola, Ssanga and Ssesse.

All the communities consulted accepted using Mabira Forest for a variety of purposes. They derive a range of products which include firewood, medicinal plants, wild meat, among others. The communities also looked at the forest mainly as a source of the direct use values such as firewood and medicinal plants with hardly any mention of the other values of the forest, including indirect uses, option values bequest and existence values.

The communities also were not much concerned of any impacts from the proposed power line in the forest. This was showed by the urge and eagerness waiting to be accepted as part of the team to cut down the 40m in the forest. The communities also wanted to be given these trees as firewood, building poles, timber, among others.

The communities also demanded for the employment opportunities at the new power site. They proposed that when the time comes the LCs be contacted to recruit some of the community members in their villages.

The members present also wanted to know the reason for being consulted since previously during the construction of the powerline nothing transpired from the answers given to the people who visited the communities. They complained that since power was not going to the communities they had no reason to be consulted.

The communities also urged the National Forestry Authority officials to channel part of the compensation to community development. This could be in the form of assistance with the main area emphasised in the three communities being education. That is, build more school blocks for the government-funded schools in the area and the provision of timber materials for construction of desks as people kept on emphasizing what a shame it was for schools next to the forest being faced with a shortage of desks.

Communities also showed the urge to be provided with seedlings of valuable tree species that are either not in the forest any more or exotic species like pine, Cypress, etc to community members to plant on their farms.

The specific community reactions were as presented below.

1. *Buwoola Community*

Buwoola Parish is located in Najjembe Sub-County, Buikwe County, Mukono District. Buwoola is an enclave in Mabira Forest and consists of Nkaga, Ssanga and Bakata villages among others. The people of Buwoola depend on the forest for things like medicine, water, and firewood, among others. The focus group discussion with the people of Buwoola highlighted what they get from the forest as follows.

Medicine is got from the forest. The medicines got include *Vernonia amygdalina* (mululuza), *Momordica foetida* (bombo), *Albizia zygia* (ennongo), *Syzgium cordatum* (kanzinzilo), *Albizia coriaria* (mugavu), W*arburgia ugandensis* (mukuzanume), among others. The medicine is mostly used for personal consumption and some people sell to their fellow community members for money.

Another resource they get from the forest is firewood. The community said they are not allowed to sell firewood or charcoal and it is illegal. However, they admitted to getting firewood for home consumption from the forest. Others establish wood lots on their own land where they get firewood.

Hunting is another activity carried out by the people of Buwoola Several animals hunted include the kob, antelope, the wild pig and porcupine. Hunting is mostly done on Thursdays and Saturdays

Had there been a vote about the construction of a new powerline, the majority of the people in Buwoola would have said no. However, they suggested if the powerline was built they should get bigger and better schools built for their use. Society benefits like a health centre were also suggested.

The communities also suggested that once the powerline started the jobs be given to the able youth and men of the village. They asked for repair of their roads. They complained that in the construction of the existing powerline, their roads were used and damaged but not repaired. They wanted to have better roads by the end of the construction of another powerline.

The people of Buwoola also suggested that power should be extended to the community. They complained that although cutting of the forest affected them they had no gains from the construction. One of the community members claimed that a piece of his land was in the 40 metre zone where the old power line passes and he wanted compensation.

2. *Sanga Community*

Ssanga Village an enclave in Mabira Forest is located in Buwoola Parish Najjembe Sub-County, Buikwe County. Ssanga Village is not at the border of the powerline; however, this community says any damage to the forest affects them because they depend on the whole forest.

Members of Ssanga get firewood from the forest. Although they did not agree to selling charcoal or firewood, one community member told us that a bundle of firewood goes for 250/= to 300/= as a bag of charcoal goes for 3000/=. The community also collects water from the forest.

The medicines got from the forests by the Ssanga community include *Alstonia boone* (Mubajjangalabi), *Albzia coriaria* (Mugavu), *Entada abyssinica* (Omwoloola), *Carrisa edulis* (Omuyoza), *Markharmia lutea* (Musambya), *Prunus africana* (Ntaseesa), and *Spathodea campanulata* (Kifabakazzi), among others.

Hunting is another activity carried out by the people of Ssanga. Hunting is done mainly on Tuesdays, Thursdays and Saturdays. However members sometimes go into the forest to hunt as individuals. The meat is sold to community members and some is taken to Najjembe market. The hunted animals include Antelope, Porcupine, Guinea fowl and wild pigs.

The people of Ssanga requested that trees cut at the site of the new powerline be given to them so that they would get charcoal and firewood to sell as a way of benefiting from the damage done to the forest. The members present especially the women requested that their sons be given jobs during the construction of the new powerline. They claimed that in the past jobs that would be done by community members were done by foreigners; they asked that this time they did no want foreigners to do the jobs which the community could do.

3. *Ssese Community*

Just like the people of Ssanga, the people of Ssesse are not directly close to the powerline. However, they agreed to using the whole forest and throughout the year. The most important resources got from the forest were: water, firewood, timber, charcoal and fish from river Miasma and micro climate benefits.
The medicine got from the forest include *Alstonia boone* (Mubajjangalabi), *Albzia coriaria* (Mugavu), *Entada abyssinica* (Omwoloola), *Carrisa edulis* (Omuyoza), *Markharmia lutea* (Musambya), *Prunus africana* (Ntaseesa), and *Spathodea campanulata* (Kifabakazzi), Vernonia amygalina (mululuza), albizia zyia (enongo) *momordica foetida* (bombo,), *Rhus vulgaris* (kakwansokwanso). *A*part from the forest these community members have some of these trees in their woodlots in their homes. Some community members sell these medicines and even treat community members for money.

Hunting is also done by the communities. The animals hunted include the antelope, porcupine, guinea fowl, wild pig and the kob. Hunting is usually done on Saturdays and Thursdays though some community members go into the forest on other days to hunt. Mudfish is also got from River Musamya

Firewood and charcoal are collected from the forest. Though illegally, the communities sell firewood charcoal and timber, which are taken to Lugazi and Kawoolo. A bag of charcoal goes for about 2500-3000 Ush and a bundle of firewood goes for 250-500 Ush.

The communities asked for the wood cut down at the site of the new powerline so they would get firewood and charcoal to earn an income. They also said foreigners should not be brought from elsewhere to do work that can be done by community members that instead community members should be asked to do the work. In the construction of the old powerline the community roads were used and damaged by heavy trucks yet they were not repaired. They asked for improvement of their roads once the powerline was constructed. Some members claimed that the powerline went through their land so they could not use the land, they wanted compensation. They requested that their bridge be repaired since it was in a very bad condition.

The community also asked for seeds for certain economic tree species that did not exist in the forest or those that did not exist anymore. Such trees include Albizia and Cypress.

4. *Names of Focus Group Discussion Participants**

a. Buwoola Participants

1) Nabatanzi Mary
2) Ngabirano Moses
3) Tusiime Gertrude
4) Okuta Charles
5) Kiziti Isaac
6) Bwanga Wilson
7) Mutebi Desire
8) Alice Nabagala
9) Wejjo Keluiris
10) Namayanja Efrancis
11) Alex Kinene
12) Akamanda Byekwaso
13) Musana Swaib Kinya David
14) Musoke Paul
15) Luyembya Grace
16) Leo Twinnomuhangi
17) Kiiza Kiviri
18) Byaruhanga Karugo Nuru
19) Sundar Viseti
20) Naggayi Sophia
21) Kibirige Catherine
22) Aisa Nasuuna
23) Kabuye Samuel
24) Nanyonjo Ritah
25) Babigunira Aziz
26) Wandera Masiga
27) Hussein Kabanda
28) Kayaga Betty
29) Naggiba Harriet
30) Nakayima Kiviri
31) Sande Moses
32) Matovu Tom
33) Ngabirano John
34) Namuyanja Christine

b. Sanga Participants

1) Nabatanzi Mary
2) Tusiime Gertrude
3) Mbabazi Patience
4) Natukunda Catherine
5) Moini Edward
6) Etyono Denis
7) Katusiime Cuthbert
8) Balidawa Simon
9) Kanku
10) Okoyu
11) Deo
12) Tadeo
13) Demaga
14) Zikulabe
15) Walusimbi Franco
16) Aguda Franco
17) Mubiru Paul
18) Lutakome
19) Sem Musisi
20) m. babalanda
21) amos mewda
22) h.kato
23) Bernard kibanda
24) Robat badaga
25) Lubwama R
26) Kyalimpa
27) Sande
28) Kako
29) Sebilagala
30) Katongole
31) Tegewagala M
32) Aku
33) Gwavunamuyanja Christine
34) Bilabwa
35) Namulondo
36) M.Namatovu
37) Maama Sabasi
38) Wampamba
39) Nankumba
40) Diya
41) Roko

c. Ssesse Participants

1) Nabatanzi Mary
2) Natukunda Catherine
3) Mbabazi Patience
4) Katusiime Gertrude
5) Moini Edward
6) Ssentamu Emmanuel
7) A.Tanga
8) Muwonge Rogers
9) Musa Mukwaya
10) Seidi
11) Galabuzi Jimmy
12) Mayambala
13) Nsubuga Steven
14) Kiggwe Steven Miburo Siraj
15) Kikomeko Omea
16) Bogere Edward
17) Mwanzi Ronald
18) Kyogulanyi Angelo
19) Kuiwanuka George
20) Bazilakye Steven
21) Mukasa David
22) Consta Nce Munyakazi
23) Yowasi Obulu
24) Mbaliire Robert
25) Baguma Henry
26) Kakooza George
27) Sulaiman Tibesigwa
28) Yiga Miche
29) Mukasa Nkugwa
30) Wajja Mutebi
31) Liiba Alaniya
32) Kayitana Pascal
33) Mujjesera Vincent
34) Falidah Namubiru
35) Kikomeko Abdul
36) Mwodi Martin kagere

** Includes Consultants from YOMA*

Annex 4

Survey of Community Livelihoods from Mabira Forest

1.0 Introduction

The main objective or purpose of the survey was to find out the benefits and the costs the communities in the forest area and the NFA derive from the forest so that they are compensated as the 220 KV powerline which is going to run 40 metres north and parallel to the old powerline is going to traverse through the forest, and therefore some parts of the forest will be destroyed or cut in order to create a Wayleave for the new 220KV powerline.

Problem statement

Following a lot of load shedding over the years in Uganda the Government of the Republic of Uganda is under pressure from the public to do something in order to reduce on power outage. Therefore, the Government through a private developer is considering extending a new powerline 40metres parallel to the old one. The 220 KV new powerline is going to pass through Mabira Forest where some parts of the forest has to be cleared to create a Wayleave. Therefore, communities in and around Mabira Forest and the National Forestry Authority (NFA) need to be compensated for this loss of the part of the forest as this will present some opportunity costs to them as well as reduced forest benefits.

Coverage of the survey

The survey mainly covered villages of Ssese, Ssanga, Nkaaga, Bakata all found in Buwola Parish, in Najjembe Sub-County, Mukono District. The reason for targeting these villages in Najjembe Sub-County was because of their close location to the new 220 KV powerline proposed area of passage.

Methodology

A questionnaire with 34 open-ended and close-ended questions was distributed to forty two (42) respondents selected at random from the villages of Nkaaga, Bakata, Ssanga, and Ssese to find out their views about the benefits, costs and the likely compensation they expected due to the loss of the part of the forest as a result of the 220 KV powerline.

2. Findings

Distribution of respondents by sex

	Number of respondent by sex	Percentage	Valid percentage
Male	21	50.0	72.4
Female	8	19.0	27.6
Missing	29	69.0	
Total	**42**	**100.00**	**100.00**

Source; primary data

42 respondents were interviewed of which 21 were male and 8 were female respondents, whilst 29 did not state their gender.
Therefore, the valid percentage of respondents by sex is as follows; 72.4% are males and 27.6% are female as a percentage of the total valid responses.

Collection of medicinal plants from the forest

	Number of respondents	percentage	Valid percentage
Collect medicinal plants	32	76.2	82.1
Do not collect medicinal plants	7	16.7	17.9
Missing	3	7.1	
Total	**42**	**100.0**	**100.0**

Source; primary data

Of the 42 respondents, 82.1% and 17.9% collect medicinal plants from the forest and do not collect medicinal plants from the forest (Mabira forest) as a valid percentage, respectively.

Woodlot ownership

	Number of respondents	Percentage	Valid percentage
Wood lot	11	26.2	35.5
No wood lot	20	47.6	64.5
Missing	11	26.2	
Total	**42**	**100.00**	**100.00**

Source: Primary data.

Of the 42 respondents interviewed for ownership of woodlot, 35.5% own woodlots and 64.5% do not own woodlots as a valid percentage of valid responses.

This implies that most of the respondents do not own woodlots (64.5%) and therefore rely heavily on the forest (Mabira Forest) for firewood and other forest resources.

Use of the forest

	Number of Respondents	percentage	Valid percentage
Use the forest	37	88.1	90.2
Do not use the forest	4	9.5	9.8
Invalid	1	2.4	
Total	**42**	**100.0**	**100**

Source: primary data

90.2% of the respondents use the forest while only 9.8% do not use the forest. This is as a valid percentage of respondents. Therefore, communities (90.2%) depend on the forest for a variety of uses and benefits compared to only very few 9.8% who do not use the Forest as a valid percentage of respondents. Therefore, any development that is going to destroy the forest particularly as a whole is going to make them (communities) (90.2%) forego a lot of benefits and uses that they derive from the forest.

Reason	No of respondents	Percentage	Valid percentage
Own consumption	32	76.2	76.2
For sale	10	23.8	23.8
Total	**42**	**100.00**	**100.00**

Source: primary data.

32 (76.2%) of the respondents agree that they collect medicinal plants from the forest (Mabira forest) for own consumption while 10 (23.8%) agree that they collect the medicinal plants from Mabira forest for sale.

Therefore, it means majority of the respondents (76.2%) collect medicinal plants for their own consumption than for sale from the forest.

Willingness to Pay (WTP) and Willingness to Accept Compensation (WTA)

Statistic	WTA(Shs)	WTP (Shs)
Mean	5,010,265	175,788
Median	1,100,000	103,000
Sums of WTA and WTP	**170,349,000**	**5,801,000**

Source: primary data

Respondents were asked to vote for forest Department Management scheme that would prohibit the use of the forest for three months. Then asked how much they would accept to compensate their loss in livehood in order to vote for the new regulation.

The sum of their willingness to accept compensation (WTA) is Shs 170,349,000. Mean Shs 5,010,265, and Median Shs 1,100,000 of willingness to accept compensation.

Mean willingness to accept compensation is Shs 5,010,265. It means on average the community members are willing to accept compensation of Shs 5,010,265. However, the mean is relevant if the valuation is for cost- benefit analysis.
Median Willingness to pay (WTP) is shillings US 1,100,000. The median is relevant for public choice since it corresponds to that amount which will receive a majority approval. Therefore, for the purpose of compensation, Median willingness to accept compensation (WTA) is best hence consideration of compensation of Shs 1,100,000 is quite relevant than the mean WTA.

The Respondents (42) were asked how much they are willing to pay (WTP) towards locally run Management Scheme that was designed to maintain and improve their forest resources so that they had secure access to and better quantity and quality of forest products. The sum of the willingness to pay is Shs 5,801,000. This means on average Respondents are willing to pay Shs.175,788 for locally-run Management Scheme. The median willingness to pay (WTP) is just Shs. 103,000.

Household Income/Consumption (Non-Forest Based)

Crop Name	Total annual income (Shs)	Percentage
Coffee	16,643,300	5.85
Staple food	27,367,700	9.63
Vegetables	9,160,660	3.22
Beans	83,100,300	29.24
Tea	000000	0.00
Cocoa	000000	0.00
Mairungi[7]	147,887,000	32.04
Total	**284,158,960**	**100**

Source: primary data.

Of the respondents' Annual Income sources, Mairungi is the main annual source of income with value of Shs 17,887,000 (52.04%) followed by Beans (Shs 83,100,300) and coffee (16,643,300). This statistic is quite shocking in that 32% of household income is from al illegal crop. There is, therefore, need to assist the communities to identify alternative income generating opportunities. On the other hand, Mairungi is legally grown in Kenyan communities. The harmonization of the East African laws may need to address this issue and make Mairungi growing legal.

[7] Mairungi or Khat is a narcotic in the Laws of Uganda and, therefore, illegal

Forest as Source of Water

Water source	Number of Respondents	Percentage	Valid percentage
Forest water	30	71.4	75.0
Non forest water	10	23.8	25.0
Missing	2	4.80	
Total	**42**	**100.0**	**100.0**

Source: primary data

When asked about water source whether forest or not, 75% of the Respondents as percentage of valid Respondents agreed to obtaining their water from forest whilst 25% of valid Respondent percentage claimed that they do not get water from the forest.
Therefore majority (75%) of the Respondents get their water from forest (Mabira).

Respondents' Distribution by Sources of Water

Water Source Name	Number Of Respondents	Percentage	Valid percentage
Borehole	6.0	14.3	14.3
Spring Protected	16.0	38.1	38.1
Spring unprotected	18.0	42.9	42.9
Pond or clan	2.0	4.8	4.8
Total	**42**	**100**	**100**

Source: Primary Data

Livestock Assets

Animal Name	Number of Household heads with animals	Total Number of Animals by Type
Goats	21	96
Sheep	6	31
Pigs	15	44
Chicken	33	733
Rabbits	1	2
Cows	10	83
Total		**989**

Source: Primary data

Total number of livestock is 989 including birds.33 of the respondents have Chicken and 21 of the respondents have Goats.

Head of household education level distribution

Education Level	Number of house holds heads	Percentage	Valid percentage
No formal Education	2	4.8	5.4
Primary Education	17	40.5	45.9
Secondary Education	14	33.3	37.8
College/University	4	9.5	10.8
Missing	5	11.9	
Total	**42**	**100.0**	**100.00**

Source: Primary data

Most of the household heads are educated up to the level of primary and secondary education with valid percentages of 45.9% and 37.8% respectively.

Head of households distribution by occupation

Occupation	Number of household Heads	Percentage	Valid percentage
Farming	32	762	82.1
Own Business	5	11.9	12.8
Salaried employee	1	2.4	2.6
Infant/old	1	2.4	2.6
Missing	3	7.1	
Total	**42**	**100.00**	**100.0**

Source; Primary Data

Most of the household heads of the respondents are engaged in farming (82.1) valid percentages while only 12.8% as valid percentage are involved in own Business. Forest and farming are many times antagonistic

Crop-raiding animals from the forest

Respondents were asked if they had problems with crop raiding animals from the forest. The table is the summary of their responses

Responses	Number of Respondents	Valid percentages
Problems	38	90.5
No problems	4	9.5
Total	**42**	**100.00**

Source; primary data

90.5% of the Respondents have problems with crop raiding animals as this negatively reduces their crop out put and quality. While 9.5% of the Respondents ascertain that they do not have problem with crop raiding animals.

The most problematic species from the forest (Mabira forest)

Specie Name	Number of Respondents	Valid percentage	Percentage
Monkeys	33	86.8	78.6
Wild pigs	5	13.2	11.9
Missing	4		9.5
Total	**42**	**100**	**100**

Source: primary data.

The most problematic species identified by the respondents from Mabira Forest are Monkeys and Wild pigs. 86.8% of the Respondents pointed at Monkeys as problematic and 13.2% of the Respondents also pointed at Wild pigs as being problematic. Therefore, the most Problematic species are the Monkeys.

Use of the Various Sources of Fuel

Use of Wood as Fuel

Do you use wood as fuel?

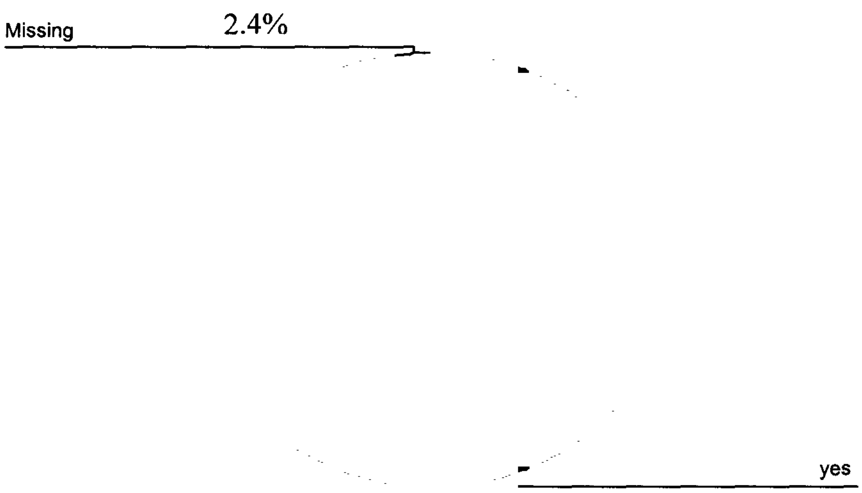
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	41	97.6	100.0	100.0
Missing	System	1	2.4		
Total		42	100.0		

Source: Primary data

Respondents were asked if they use Wood as fuel, 97.6% accept that they use Wood as Fuel, whilst 2.4% of the respondents did not provide any responses. The valid percentage of the respondents who accept using wood as fuel is 100%.

The Pie chart below represents the responses of the forty two Respondents on whether they use Wood as fuel. Wood appears to be the main source of energy for the communities of Mabira Forest. This may threaten the sustainability of the Forest especially if the wood is mainly obtained from the forest and harvested in inappropriate ways.

do you use wood as fuel?



Use of Charcoal as Fuel

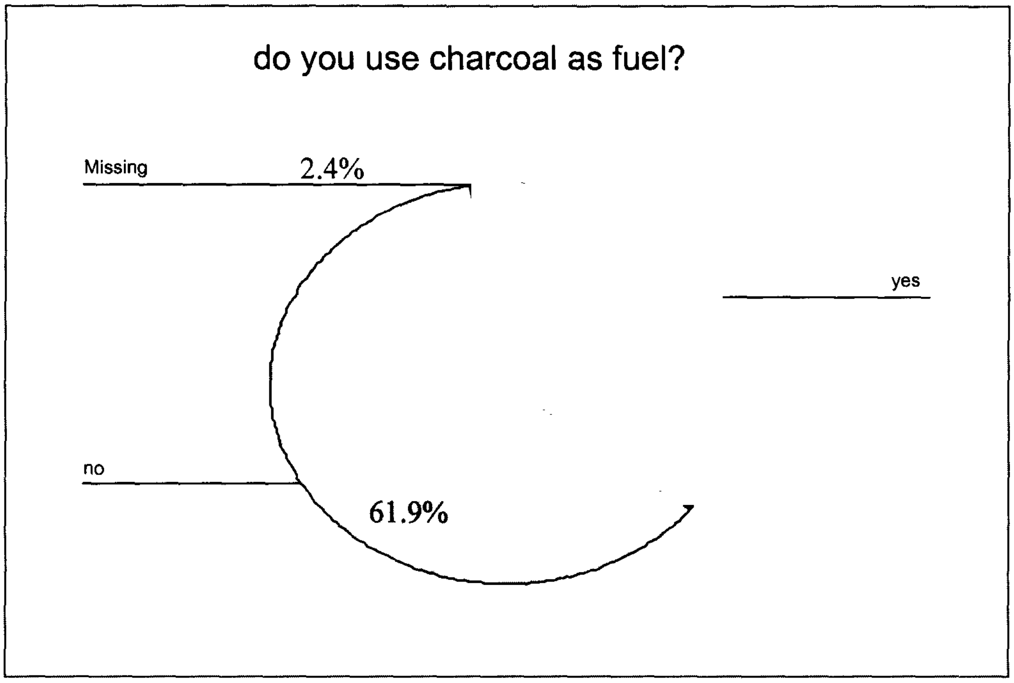
do you use charcoal as fuel?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	15	35.7	36.6	36.6
	no	26	61.9	63.4	100.0
	Total	41	97.6	100.0	
Missing	System	1	2.4		
Total		42	100.0		

Source: Primary data

For Charcoal use as fuel, 35.7% of the Respondents use Charcoal as fuel whilst 61.9% do not use Charcoal as fuel and 2.4% of the responses are Invalid. Of the valid responses 36.6% and 63.4% use Charcoal and do not use charcoal as fuel, respectively.

The pie chart below represents the responses of the forty two respondents on whether they use Charcoal as fuel.



3.4.3 Use of Paraffin as Fuel

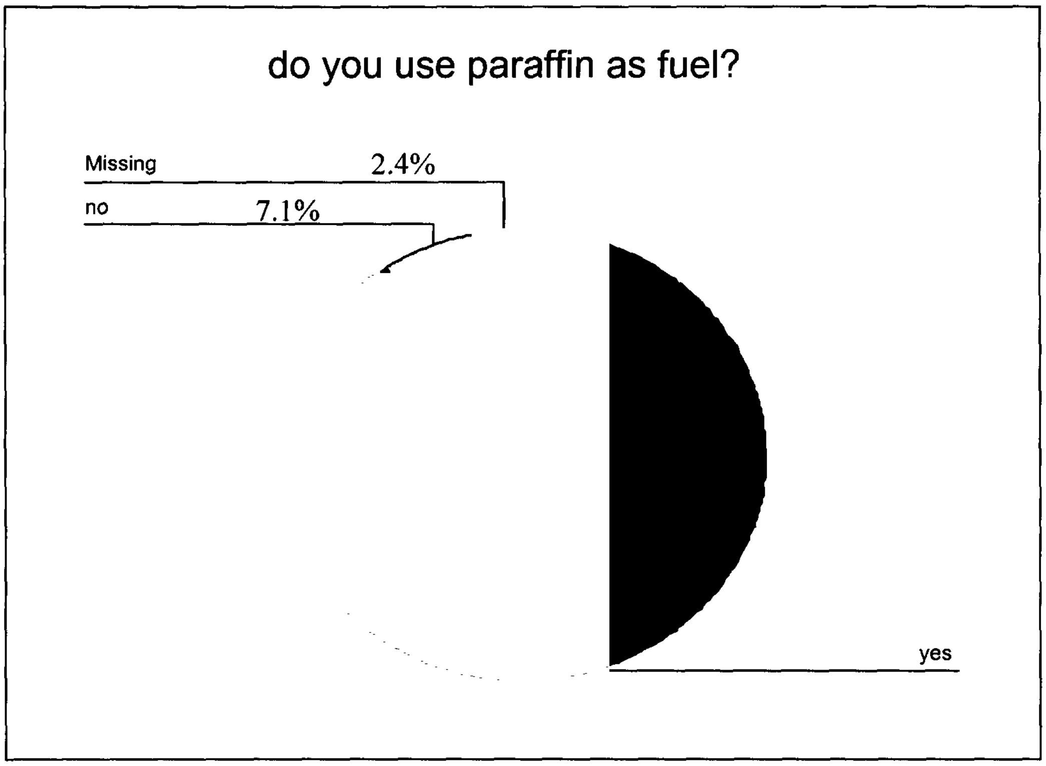
do you use paraffin as fuel?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	38	90.5	92.7	92.7
	no	3	7.1	7.3	100.0
	Total	41	97.6	100.0	
Missing	System	1	2.4		
Total		42	100.0		

Source; Primary data

90.5% of the Respondents said they use Paraffin as Fuel and 7.1% do not. The valid Percentage of the Respondents who use and do not use Paraffin as fuel are 92.7% and 7.3%, respectively. Paraffin is mainly used for lighting.

Below is the Pie chart representing the responses of the Respondents on whether they use Paraffin as fuel or not.



Use of Gas as fuel

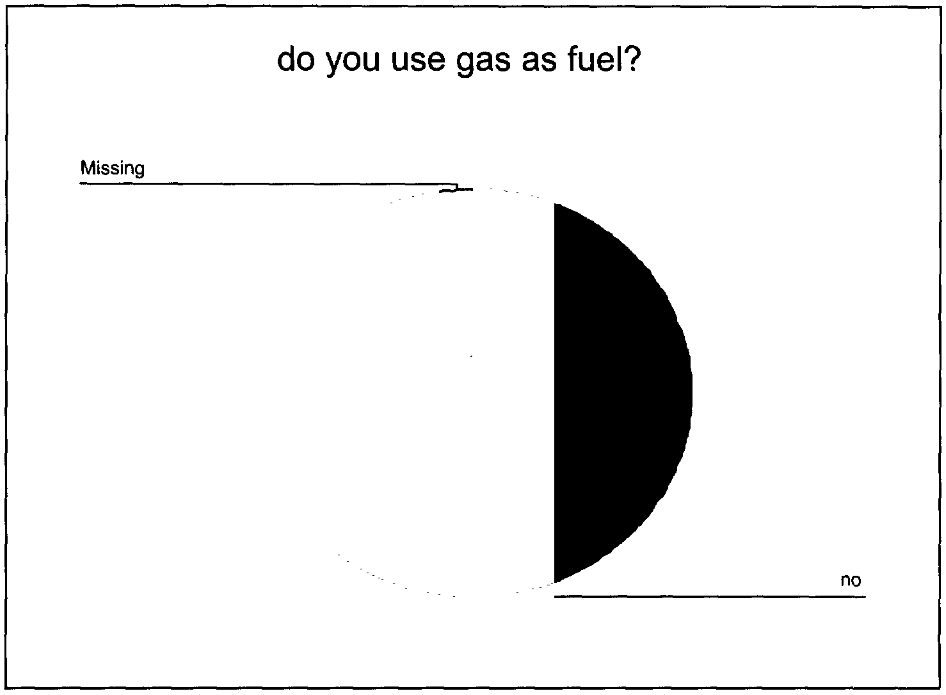
do you use gas as fuel?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	41	97.6	100.0	100.0
Missing	System	1	2.4		
Total		42	100.0		

Source; Primary data

97.6% of the Respondents do not use Gas as fuel while 2.4% account for missing responses. Therefore, 100% of the Respondents do not use Gas as Fuel as a valid percentage.

The below Pie chart represent the responses of the respondents for the use of Gas as fuel including the missing percentage.



Use of Electricity as Fuel

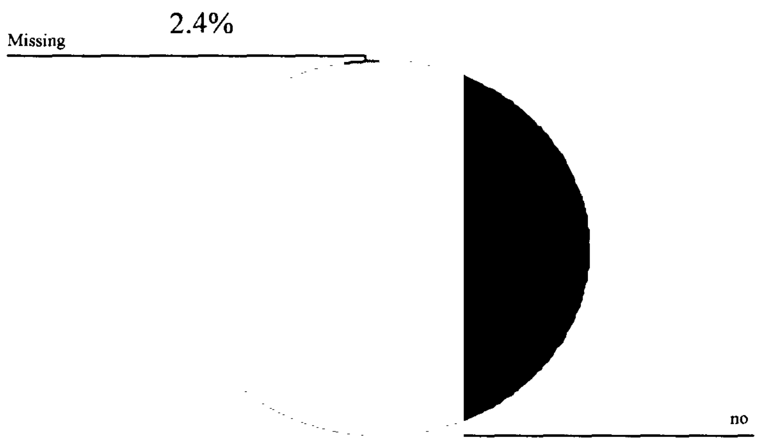
do you use electricity as fuel?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	41	97.6	100.0	100.0
Missing	System	1	2.4		
Total		42	100.0		

Source; Primary data

97.6% of the Respondents do not use Electricity as fuel while 2.4% are missing responses. Therefore, the valid percentage of the respondents who do not use Electricity as fuel is 100%.It implies all the respondents do not use Electricity as fuel or Energy.

do you use electricity as fuel?



Reasons for Growing Crops in the Woodlot

Growing of Crops for Home Use Purpose

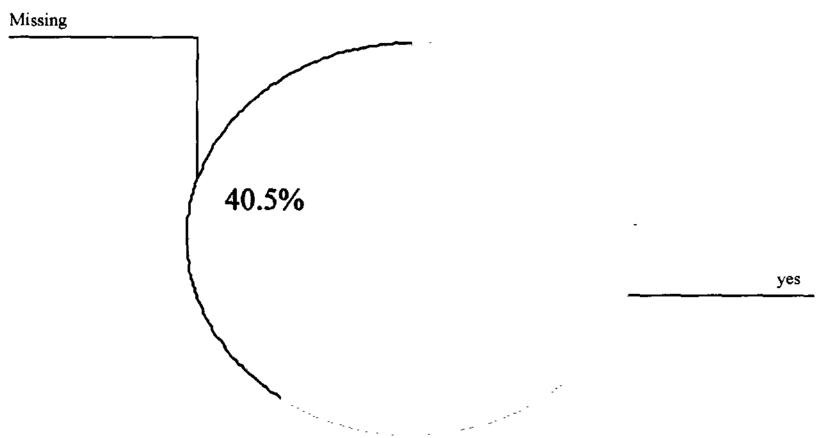
Do you grow the crop for Home use?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	25	59.5	100.0	100.0
Missing	System	17	40.5		
Total		42	100.0		

Source: Primary data

Forty two respondents were asked if they grow crops in their woodlot for Home use purposes, 59.5% agree that the crops they grow in their woodlots are mainly for home use whilst 40.5% did not respond. Therefore the valid percentage of respondents who said they grow crops for home use is 100%.This means 100% of the respondents grow crops for home use purposes.

Do you grow the crop for Home use?



Growing of Crops for Income Generating Purposes

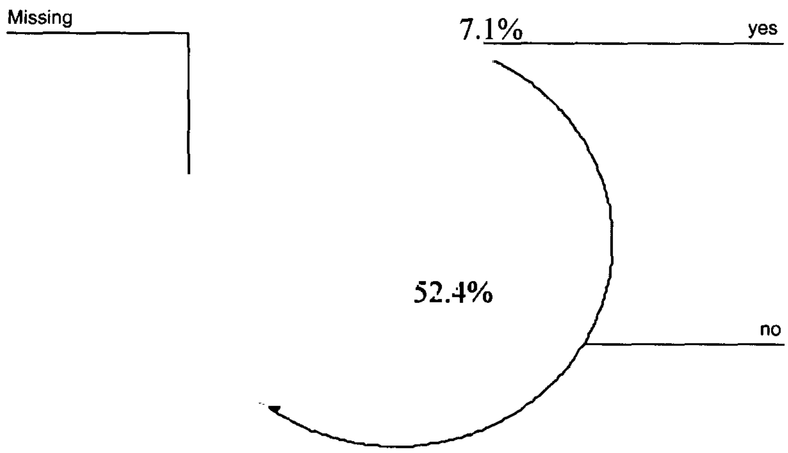
Do you grow the crop for income generating purpose?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	3	7.1	12.0	12.0
	no	22	52.4	88.0	100.0
	Total	25	59.5	100.0	
Missing	System	17	40.5		
Total		42	100.0		

Source: Primary data

Twelve percent (12%) of the Respondents said they Grow Crops in Their Woodlot for Income generating purposes and eighty eight percent(88%) of the Respondents when asked whether they grow the Crops in their Woodlot for Income generating purpose said no.

Do you grow the crop for income generating purpose?



Uses of the Various Sources of Fuel

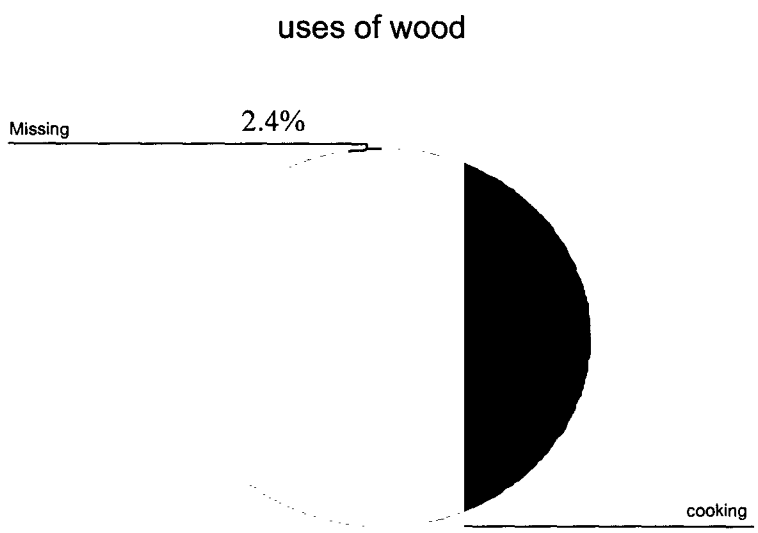
Uses of Wood

uses of wood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	cooking	41	97.6	100.0	100.0
Missing	System	1	2.4		
Total		42	100.0		

Source: Primary data

Three uses of sources of fuel like Paraffin, Electricity, Wood, Charcoal, and Gas were provided. The uses provided included: heating, lighting and cooking.
97.6% 0f the Respondents use wood for Cooking while 2.4% are missing. This implies that 100% 0f the Respondents use wood for Cooking. Therefore, all the Respondents use Wood for cooking.



Uses of Charcoal

uses of charcoal

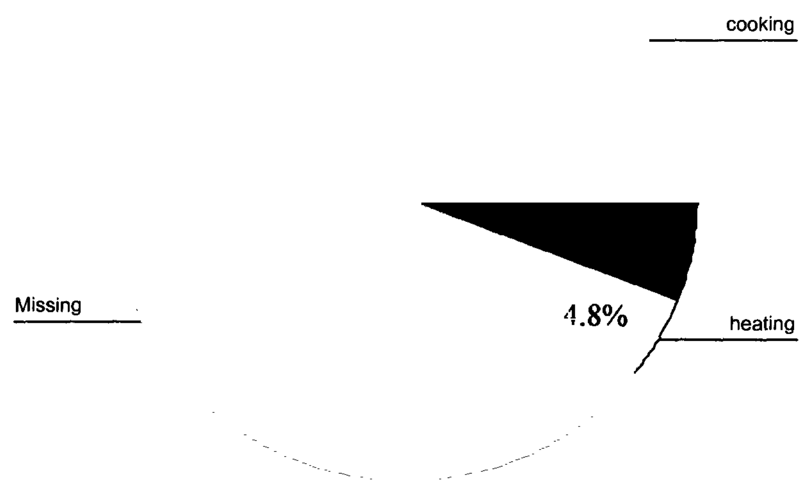
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	cooking	13	31.0	86.7	86.7
	heating	2	4.8	13.3	100.0
	Total	15	35.7	100.0	
Missing	System	27	64.3		
Total		42	100.0		

Source; Primary data

For uses of Charcoal, 31.0% use Charcoal for cooking, 4.8% use charcoal for heating and 64.3% are missing responses. Therefore, the valid percentage of respondents who use charcoal for cooking and heating is 86.7% and 13.3%, respectively. The implication is that majority of the Communities in Mabira forest use Charcoal for Cooking than for heating.

The Pie chart below represents the various uses of Charcoal for the respondents.

uses of charcoal



Uses of Paraffin

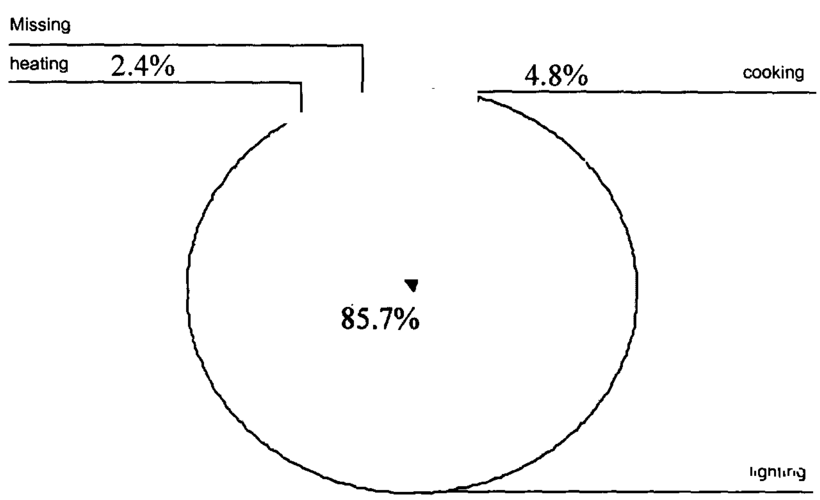
usesof paraffin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	cooking	2	4.8	5.1	5.1
	lighting	36	85.7	92.3	97.4
	heating	1	2.4	2.6	100.0
	Total	39	92.9	100.0	
Missing	System	3	7.1		
Total		42	100.0		

Source: Primary data

For the uses of Paraffin, 5.1% of the Respondents use Paraffin for Cooking, 92.3% use Paraffin for lighting and 2.6% of the Respondents use Paraffin for heating. Therefore, Paraffin is mainly used for lighting as Electricity is not accessible to many of the Communities in and around Mabira Forest.

Uses of paraffin



3. Conclusion

- The local communities derive a lot of livelihoods from Mabira Forest. **90.2%** of the Respondents agree that they use the forest for a variety of uses

Some of the benefits from the forest that the communities derive among others include;

- Spring water both protected and unprotected. **81%**of the Respondents agree that they use spring water. And **75%** of the Respondents accept that they get their water from the Forest compared to only **25%** that claim they do not get their water from the Forest.

- Medicinal plants from the Forest. **82.1%** of the Respondents derive Medicinal plants from the Forest. However, 76.2**%** of the Respondents use the Medicinal plants for their own consumption and **23.8%** sell the Medicinal plants they derive from Mabira Forest. Therefore, it means that Medicinal plants are mainly collected for own consumption rather than for sale by the communities in and around Mabira Forest.

- Mairungi is the highest source of annual income. Mairungi earned an annual income of Shs.**147,887,000.**