THE EFFECT OF REFUGEE POPULATION INFLUX ON PLANT DIVERSITY OF BUGOMA FOREST, UGANDA

BY

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DECLARATION

Declaration by candidate:

I Bihunirwa Medius, declare that this thesis is my original work and has never beenpresented for the award of a degree in any university.

Signature ..... Date 2/9/2022

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Declaration by Supervisors

I/we confirm that the work in this thesis was done by the candidate under my/oursupervision.

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LIST OF ACRONYMS

DRC	-	Democratic Republic of Congo
FAO	-	Food and Agriculture Organisation
IDH	-	Intermediate Disturbance Hypothesis
KY-7	-	Kyangwali block Compartment 7
KYA	-	Kyangwali Block t
MU- 11	-	Muhangaizima block comprtment 11
MU-10	-	Mahangaizima block compartment 10
MU-12	-	Muhangaizima block compartment 12
MUH	-	Mahangaizima block
NFA	-	National Forestry authority
OPM	-	Office of the Prime of the Prime minister
QGIS	-	Quantum Geographical Information Systems
SCP	-	Semi-Automatic Classification Plugins
SPP	-	Species
UNHCR	-	United Nations High
Commission for refugeesUSGS	-	United States
Geographical Society		
WFP	-	World Food Programme
IUCN	-	International Union for Conservation of Nature
WCS	-	Wild life Conservation Society

ABSTRACT

Refugee population is one of the causes of land and environmental degradation in refugee hosting countries. However, the relationship between forest plant diversity and refugee population influx is not well documented. This study assessed the effect of refugee population influx in Kyangwali Refugee settlement on plant diversity of Bugoma Forest in Uganda. Sentinel 2 imagery data for the study area for 2016, 2018, 2020 were used for vegetation cover and land use change analysis using QGIS 3.12 and 296 households were randomly surveyed for socio economic data. A total of 1,091 plant counts were recorded in 18 plots for computation of plant species diversity and richness. Simpsons diversity for tree species ranged between 0.4562 to 0.9583 for Kyangwali block accessed by refugees and 0.7873 to 0.9979 for Muhangaizima block accessed by host community . A higher Shannon weiner index of 2.4836 was recorded in Muhangaizima block compared to 2.0106 for Kyangwali block. Grasslands experienced the biggest vegetation cover loss (11.09%) followed by woodland (2.73%) and the tropical high forest (0.85%) while subsistence farming and built up land uses increased by 11.8% and 2.09% respectively for the study period 2016 to 2020 that coincides with the biggest refugee population influx in Kyangwali refugee settlement. Whereas refugees and host community accessed forest resources mainly fire wood, charcoal and building materials from Bugoma forest for cooking energy, livelihood and building construction, the dependence on Bugoma forest as a source of these resources was higher for refugee households than the host community. Pearson's correlation coefficient revealed a positive relationship between the plant diversity and quantity of firewood used by the refugee households ($r=0.047$, $p=0.004$, $n=296$) and frequency of collecting forest resources ($r=0.011$, $p=0.002$, $n=296$). Therefore, the refugee population influx in Kyangwali refugee settlement to a large extent contributed to decrease in plant diversity of Bugoma forest. However, other underlying factors affecting plant diversity in Bugoma forest require further studies.

CHAPTER ONE: INTRODUCTION

1.0 Background to the study

Globally, sixty-eight million five hundred people are displaced due to political instability, conflict, oppression and human rights violations and 36% are refugees mainly hosted by developing countries (UNHCR, 2018). The refugees are highly dependent on natural resources like forests in the hosting countries as the main source of fuel wood for cooking, building materials and livelihood (FAO, 2018). The increasing number of refugees concentrated in refugee settlements and camps in many developing countries pose a threat to the environment and ecosystems since bigger refugee populations are assumed to trigger land degradation, habitat loss, biodiversity loss, and water resource contamination (Martin et al., 2016). An estimated 80% of the 68.5 million displaced people worldwide rely on biomass fuels mostly wood fuel for cooking and heating (FAO, 2018).

Uganda is currently hosting 1,252,664 refugees (OPM, 2019) making it the largest hosting country in Africa and second in the world (UNHCR, 2018). The refugee population in Uganda are settled in 13 refugee settlements located in the Northern and Western parts of the country. Instability, war violence, ethnic Conflicts, persecution and human rights violations in South Sudan, Democratic Republic of Congo (DRC) and Burundi are the main triggers of refugee population influx in Uganda (Herbert et al., 2018).

Uganda already faces pressure on its forest resources due to deforestation. Net loss of Uganda's forests from 2000 to 2015 was 1.8 million hectares with an annual loss of 4%- the highest in the world. In the year 2000, forest covered 19.4% of the land area in Uganda and this had reduced to 10.4% by 2015 (FAO, 2015). Wood fuels being the primary source of energy for cooking for both the refugee and host communities in Uganda, extraction of wood for cooking and building materials by refugees is likely to escalate forest degradation in Uganda and the associated biodiversity decline (FAO, 2018).

Kyangwali refugee settlement is one of the 13 refugee settlements in Uganda whose refugee population more than doubled from 36,713 in December 2017 to 87,906 by December 2018 (UNHCR, 2018). The new refugee influx led to opening up of new areas to settle the refugees in Maratatu, Kavule, Mombasa among others that are in close proximity to Bugoma Forest reserve.

The close proximity of the refugee settlements and camps to the forest reserves is a key contributing factor to environmental degradation (UNHCR, 2008). This drastic refugee population increase in Kyangwali refugee settlement was expected to adversely affect the plant diversity of Bugoma forest yet studies conducted in Uganda on effect of refugees focused only on land and natural resources degradation and limited attention was given to plant diversity. According to FAO (2018), the South Sudanese refugee influx intensified the rate of degradation and forest cover loss within and around the refugee settlements in West Nile in Uganda and Maystadt et al. (2020) who investigated vegetation changes attributable to refugees in Africa found out that a one percent increase in the number of refugees magnifies the conversion from dominant vegetation cover to cropland by 1.4%. The drastic refugee population growth in Kyangwali refugee settlement was hypothesized to have far reaching implications on the forest plant diversity compared to the host community. Therefore, the study established the relationship between the socio-economic dimensions of the refugee population and plant diversity of Bugoma forest as a starting point for identification of interventions for sustainable energy access and forest management.

1.1 Problem statement

Kyangwali refugee settlement with a population of 128,037 by June 2021 is in close proximity to Bugoma forest, a protected tropical forest rich in diversity with varied endemic plant species. Expansion of the settlement area, due to the increasing numbers of refugees is hypothesized to have implications on the plant diversity there in. Limited information is documented on the effects of the refugee population on the plant diversity in this forest despite the fact that building materials,

fuel are obtained directly from it. This study therefore sought to establish the relationship between the socio-economic dimensions of the refugee population and the plant diversity in Bugoma forest.

1.2 Objectives of the study

1.2.1 General Objective of the study

To assess the effect of refugee population influx in Kyangwali Refugee settlement and the host community on plant diversity of Bugoma forest.

1.2.2 Specific Objectives of the study

1. To determine the changes in the plant diversity in un disturbed, mildly and highly disturbed sites in Bugoma forest
2. To map the vegetation, cover and land use changes before and after the 2017/2018population influx in Kyangwali Refugee settlement
3. To assess the socio–economic factors of the refugee population and host community contributing to plant diversity changes in Bugoma forest reserve.

1.3 Research Questions

1. What are the changes in the plant species, evenness and richness at un disturbed, mildly and highly disturbed sites in Bugoma forest
2. How has vegetation cover and land uses changed before and after the 2017/2018 refugee population influx in Kyangwali refugee settlement?
3. To what extent have the socio-economic factors of refugee population and host community contributed to the plant diversity changes in Bugoma Forest reserve?

1.4 Significance of the study

The findings of the study will enrich environment and energy sector, planning and programmingby the humanitarian agencies. Whereas forest resources play an important role in biodiversity conservation in Uganda, the refugee influx in Uganda is predicted to increase due to the continued persecution, conflict, violence and Human rights violation in the neighboring countries like South Sudan, Democratic Republic of Congo, Somalia, Burundi among others.

For National Forestry Authority and other Government agencies; the study will inform sustainable forestry biodiversity conservation management practices in refugee settlements and the neighboring forests.

For the academia, the study will contribute to the wealth of knowledge that can be used to develop models and innovation on forest biodiversity conservation and sustainable energy access in refugee settlements.

1.5 Scope of the studyGeographical scope

The study was conducted in Kyangwali refugee settlement and Bugoma Forest reserve located in Kikube District. Kikube is a new District that has been curved out of Hoima District in the Albertine Region of Western Uganda. The study focused on the refugee population and host community socio – economic and livelihood dimensions' effect on the plant diversity of Bugoma forest reserve and the vegetation cover and landuse changes in relation to the refugee population influx of 2017/2018.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Bugoma Forest Reserve is one of the biodiversity hotspots with a diversity of floral and faunal species. Of the 257 tree and shrub species, 7 species are endemic to the Albertine Rift, over 12 species are globally threatened and 14 tree species are listed under IUCN's Red List (Uganda parks, 2016). This Reserve is a central Conservation Forest which is the 12th top places of importance out of the 65 forests studied for biodiversity and the 17th among forests with exceptional species (Uganda parks, 2016).

Therefore, the drastic refugee population growth in Kyangwali refugee settlement is claimed to have far reaching implications on the plant diversity of Bugoma Forest Reserve yet plants are the basis for vegetation types and habitat structure as well as providing the major production base for food chains for wildlife and human beings (Wildlife Conservation Society, 2016).

2.1 Theoretical Review

The study relied mainly on 2 theories namely; Kunz's Kinetic Model of refugee theory (1973, 1981), the Intermediate Disturbance Hypothesis (IDH).

2.1.2 Kunz's Kinetic Model of Refugee Theory (1973, 1981)

Refugee population movement; according to Kunz (1973, 1981), the flight and settlement patterns of most refugees conform to two kinetic types i.e., anticipatory refugee movement and acuterefugee movement. **Anticipatory refugees** sense danger early, thus allowing an orderly departure before the crises occurs. They are usually accompanied by their entire family along with their properties prepared for a new life. Anticipatory refugees leave as soon as they find a country willing to host them. While **Acute refugee movements,** are responses to an overwhelming pushthat forces people to leave their homes instantly. They are not prepared for the journey and concentrate basically on

surviving the disaster zone (Kunz, 1981). Therefore, this study targeted refugees who are as a result of acute refugee movement whose dependence on natural resources like forests in the host country for survival is hypothesized to contribute to forest plant diversity changes.

Species diversity and ecological disturbance; The intermediate disturbance hypothesis (IDH) suggests that local species diversity is maximized when ecological disturbance is neither too rarenor too frequent. This hypothesis proposes that species richness should be maximized under intermediate levels of disturbance since low levels of disturbance leads to dominance of superior species and exclude other species. At high disturbance levels, only the resistant species survive.

At high levels of disturbance, due to frequent forest fires or human impacts like deforestation, all species are at risk of going extinct. IDH is a no equilibrium model used to describe the relationship between disturbance and species diversity. Although IDH has been critiqued by some scholars, itis extensively acknowledged concept for explaining patterns of species diversity for the past 40 years (Huston, 2014). The universality of the intermediate disturbance hypothesis (IDH) has been the subject of many theoretical and empirical studies to varying degrees of support (Fox 2012). Some authors have proposed that this relationship is strongly related to site productivity (Huston,2014).

Therefore, this study focused on 3 differently disturbed sites in Bugoma forest reserve to assess species diversity. However, there is limited literature to demonstrate the relationship between acute refuge movements with the existing ecological disturbance theories.

2.2 Empirical review

2.2.1 Changes in the forest plant species, numbers and abundance

Forests cover about one third of the global land and are one of the most diverse terrestrial ecosystems. According to Aerts (2013), forest contain over 80% of terrestrial biodiversity but forests ecosystem value continues to decline due to rapid deforestation and fragmentation causing loss of biodiversity.

About 12 million hectares of forests are lost annually, and most of it is lost by the tropical rainforest (FAO, 2015). Forests are habitats for biodiversity and are also important for the provision of a wide range of ecosystem services for the well-being of humankind (Biodivers conserv, 2017). Forest plant species richness influence forest biodiversity since they are key in the food chain for wild animals and human beings (Biodivers conserv, 2017). However, plant species in forest ecosystems have faced various environmental changes due to natural and anthropogenic disturbances. FAO (2018) states that pressures from anthropogenic activities have led to forest loss and degradation resulting into biodiversity decline (FAO, 2015).

Globally, Uganda is prominent for its rich biodiversity but some of this richness is being lost (Pomeroy et al., 2017). Bugoma Forest Reserve is one of the biodiversity hotspots in Uganda with a diversity of floral and faunal species. Over 257 tree and shrub species are inhabitants of Bugoma including 7 species that are endemic to Albertine Rift, over 12 species that are globally threatened and 14 tree species listed on the IUCN's Red List (Uganda parks, 2016).

The refugee influx in Uganda is stated to have had a range of environmental impacts and ecological related challenges that include; deforestation and land degradation (FAO, 2018). The increased need for wood fuel to meet the cooking energy needs, building materials, habitat conversion for agricultural production, land clearing for refugee settlements constitute the main threats to forest resources in the refugee populated areas (Babu et al., 1995). Given the role of biodiversity in the provision of ecosystem services, the widespread degradation of forests is likely to have far-reaching effects, such as vulnerability to natural or human –induced disturbances (Biodivers conserv, 2017). Since vegetation is a key indicator of environment in a specific habitat at particular time frames, it is imperative for it to be properly studied at species and ecosystem levels in relation to its surroundings (Khan et al., 2012). Thus, the need to assess the Bugoma forest plant diversity -

refugee population influx relationship.

2.2.2 Forest cover changes

Mohammed (2018) claims that to accommodate the mass number of refugees, forestland is cleared to build refugee settlements, this threatens habitats, biodiversity, and entire ecosystems and functions. According to FAO (2018), the South Sudanese refugee influx intensified the rate of degradation and forest cover loss within and around the refugee settlements in West Nile in Uganda. The Land cover change analysis done by FAO on the refugee settlements in West Nile in Uganda revealed an increase in tree cover loss. Total tree cover loss between 2010 and 2013 was about 1,919 ha while from 2014 to 2018 there was 34,112 ha of loss and 29,604 ha of degradation.

The lasting need of wood by refugees for cooking energy, building shelter and latrines lead to rapid deforestation around the refugee camps/settlement (Leitererer et al., 2018).

Literature predictthat changes in forest cover affect the capacity of forest biomass to store carbon, disturbing local climate by modulating the diurnal temperature variation, and thus escalating global climate change (Mohammed 2018).

Recent approaches to ecological system management link land-cover, species' habitats, and ecosystem stability and ecosystem services in a bid to understand how natural and anthropogenic-induced changes in land cover might affect ecological, social, and economic well-being (Ingraham& Foster, 2008). Therefore, it is important to map the Bugoma forest cover and loss before and after the 2017/2018 refugee population influx in Kyangwali refugee settlement so as to estimate forest cover changes.

2.2.3 The socio-economic dimensions of refugee population and forest cover changes

There are sixty-eight million five hundred thousand (68.5 million) individuals forcibly displaced worldwide as a result of persecution, conflict, violence and Human rights violation by end of 2017 (UNHCR, 2018). Of these, 25.4 million are refugees, 40.0 million internally displaced persons and 3.1 million asylum seekers. Developing regions host 85% of the world refugees under UNHCR's mandate (UNCHR, 2018).

Mass population displacements put additional stress on the ecosystems especially in the case of refugees and internally displaced persons (leitererer et al., 2018). An estimated 80 % percent of the refugees are forest dependent, relying at least in part on forest products for energy, shelter, fodder, nutrition and cash income (FAO, 2018). Further literature revealed that 97% of households across the refugee and host communities in West Nile in Uganda use firewood for cooking (FAO, 2018). Average daily consumption of firewood by refugees is 1.6 kg per person (FAO 2018). High levels of environmental degradation often stem from the dependency of highly concentrated populations upon natural resources including water, agricultural land, pastures, and forests (Tscharntke et al., 2012).

Disruption of forest structure by natural and anthropogenic disturbance alters species richness and other ecosystem properties (Kumur et al., 2005). While some species are adaptable to some disturbances including ability to thrive in human- modified landscapes, others are on the decline (WCS, 2016). Most forest biota respond negatively to forest degradation and to fragmentation (Biodivers Conserv, 2017). Increasing fragmentation and loss of primary forest fundamentally alters both the species and functional composition of forested landscape (Barnes et al., 2017).

Existing literature reveals a decline in forest species globally. Uganda already faces one of the

highest forest cover loss in the world estimated at 4%, therefore, refugee influx fuels the existing pressure on the forests in the quest to meet increased demand for wood fuel posing a high risk of degradation (FAO, 2018).Therefore, is need to identify the impacts of refugee population influx on forest plant diversity and to highlight potential mitigation measures so that the range of ecosystem functions and services directly supported by biodiversity are maintained (Biodivers Conserv, 2017).

2.3 Summary of literature and research gaps

The review of literature indicates that massive movement of refugees exert pressure on the natural resources in the surrounding environment in refugee populated areas in the different host countries world over. Forest ecosystems are one of the key affected natural resources by refugee population influx in host countries in the developing countries since over 80% of the refugees hosted in these countries are dependent on forests for livelihood in form of fuel wood for cooking, building material for shelter, food, income among others. However, there is limited narrative to assess relationship between plant diversity of Bugoma forest and the socio economic dimensions of refugee population in the area. Therefore, the study was designed to establish the Bugoma forest plant diversity relationship with socio-economic dimensions of refugee population in Kyangwali refugee settlement in Uganda.

2.4 Conceptual frame work

Ecological disturbances perform an important role in the structure and composition of plant species in terrestrial ecosystems (Johnson & Miyanishi, 2010). Plant species diversity, number, richness, cover and abundance in a forest ecosystem is influenced by disturbances. Ecological disturbance is caused by natural or anthropogenic factors. This study focused on anthropogenic (human- induced) disturbance. Plant species are a factor, they respond differently to disturbance regimes in their

habitat depending on intensity and frequency. Plant species can respond to much greater changes in its habitat and can experience significant changes in diversity (Safford & Mallek, 2011).

The relationship between plant species diversity, disturbance intensity and frequency is clear andbe represented by a unimodal curve (Huston, 2014) where diversity is maximized at intermediatelevels of disturbance. In this study, the pattern of plant diversity in 3 differently disturbed sites i.e. undisturbed, mildly and highly disturbed sites were assessed. Results of 2 sites (highly disturbed and mildly disturbed) that represent post disturbance was compared to 1 site (not disturbed)- pre Disturbance as described below:-

Highly disturbed (HD); about 150 metres from the refugee settlement, approximately 300 hectares of the forest was highly disturbed, tree spp of diameter 30cm?? below had been cut for fire wood, building materials, charcoal and timber. Conversion of part of the forest for agriculture was vivid in some parts. Maize growing and vegetable gardens were observed. Only scattered trees remain standing (hard to cut with an axe).

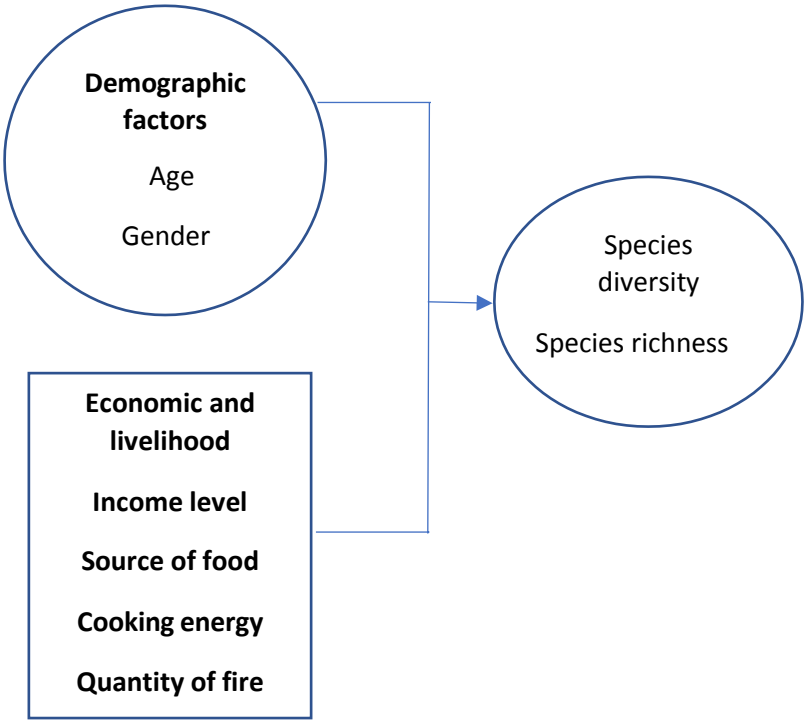
Mildly disturbed (MD); about 300 metres from the settlement, an estimated 200 hectares of the forest are mildly disturbed. Selected spp easy to cut for fire are cut down by refugees, no charcoal burning and no agriculture done due to control by NFA & UNHCR, more trees exist as compared to HD site

Not Disturbed (ND); about 4kms from the refugee settlement; most species of trees, shrubs and herbs still exist, some mild illegal cutting of trees for timber existed.

Conceptual framework

Independent Variables **Dependent**

Variable DisturbanceRefugee population/Host community



Forest plant diversity

From the figure above, Refugee population is the independent variable that was measured by the socio- economic and livelihood factors, energy access, building materials and frequency of collection of forest resources. On the other hand, forest plant diversity is the dependent variable that was measured by species richness, species evenness, and frequency. Therefore, the independent variable refugee population affects the dependent variable forest plant diversity. Whereas diversity can be measured at 4 different levels namely; genetic, species, ecosystem and ecological, this research focused only on species diversity and how it is affected by refugee population influx.

CHAPTER THREE: MATERIALS AND METHODS

3.0 Introduction

This section of the research report describes the methodological aspects related to the context of this research. This section highlights the research approach, sampling procedure and recruitment, interview methods, data analysis and ethical considerations.

3.1 Study Area

The study was conducted in Bugoma Forest and Kyangwali refugee settlement and its host community located in Kikuube, a new District curved out of Hoima District in the Albertine Region of Uganda.

Bugoma Forest is a protected tropical forest that is situated in Southwest of Hoima and North Eastof Kyenjojo and East of Lake Albert. It was gazetted in 1930s and came under the mandate of NFA in 2003. Its surface area is 41,144 hectares and is divided into 6 blocks as indicated in the table below and the blocks are subdivided into compartments

Table 3.1 showing the blocks of Bugoma Forest

	Block	**Area(Ha)**
Bugoma Forest	Nkwaki North	97,780.38
	Nkwaki South	8,587.54
	Rwempunu	5,051.58
	Isangwe	2,882.28
	Kyangwali	6,241.87
	Muhangaizima	8,418.65
	Total	**41,144.000**

Source: Bugoma Forest Management Plan 2013-2023

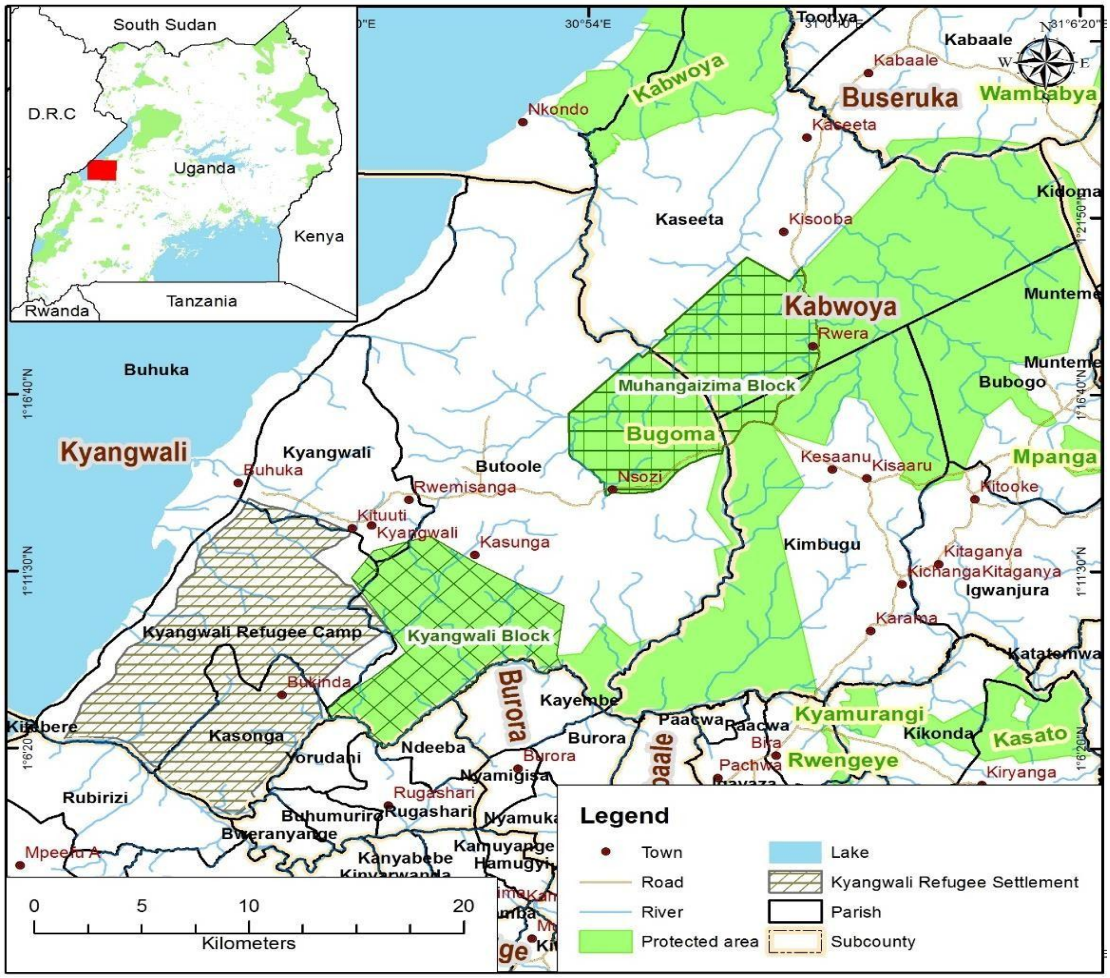
The forest belt is situated between 500 and 1,650 metres above sea level and between 990 and 1,300 m elevation. There are 23 species of mammal, 225 species of birds, and 260 species of trees in the reserve (Musisi, Frederic (September 19, 2013). The forest plant diversity is under threat due to the

refugee population influx in Kyangwali Refugee settlement who are highly dependent on Bugoma forest for fuel wood as their primary source of cooking energy and other livelihoods. Kyangwali refugee settlement is one of the 13 refugee settlements in Uganda. It was established in the 1960s to accommodate Rwandan refugees. After many Rwandese repatriated voluntarily in 1994, the settlement has hosted mostly Congolese refugees. Kyangwali refugee settlement population more than doubled from 36,713 in December 2017 to 87,906 by December 2018 with 32,134 households in the settlement.

The main study site was Kyangwali block due to its closest proximity to Kyangwali refugee settlement that is mainly encroached by the refugees. About 500 hectares of Kyangwali block have been encroached or disturbed (i.e. 300 highly disturbed and 200 ha mildly disturbed) out of a block area of 6,241.87 ha.

The control for study was Muhangaizima block and the host community households in its close proximity. Parts of Muhangaizima block were mainly encroached by Non Refugee households (Ugandan) households; the internal migrants commonly known as Bafuruki and the native Banyoro.

Figure 3.1 showing the map of the study area.



3.2 Research Design

The research design employed mixed research design that include; vegetation assessment using the quadrat method for computation of the plant diversity indices, richness and evenness, the satellite imagery for detection of vegetation cover and land use changes and the household survey for socio-economic data.

3.3Target population

The study targeted the refugees in Kyangwali refugee settlement and its host community nationals. The population of the settlement was 109,207 as of July 2019 (OPM, 2019). About 90% of the

refugees in Kyangwali refugee settlement are Congolese from the Democratic Republic of Congo (DRC) while others are from South SudaTtthese refugees are as a result of acute refugee movement and come to Uganda without property and their dependence on Bugoma forest resource for cooking energy access and livelihood was hypothesized to affect plant diversity.

The nationals living in the host community are mainly Banyoro who are subsistence farmers. The area is also inhabited by internal migrants commonly known as Bafuruki. Some of the nationals that had encroached on Kyangwali refugee settlement land were evicted. It is never a surprise to find Ugandans in a form of an internally displaced camp in Bukinda at times.

3.4 Sampling Design and Sample size

The important issue is how to sample and recruit the participants for interviews. The Convention on Biological Diversity (CBD 1992) compels countries to identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques.

The research techniques in this study was cognizant of this and sampling design adopted by the study was mainly random sampling for the forest plant diversity and household survey.

A total of 296 households (191) from Kyangwali refugee settlement and 105 from the host community) were randomly selected that participated in the house hold survey. The 296households were derived from the target population of 1,280 households from target zones and villages at 5% confidence interval using the sample size calculate accessed from

https://www.surveysystem.com/sscalc.htm

3.5 Data collection and Analysis

3.5.1 Primary data on Forest plant diversity in Bugoma Forest

Primary data for assessment of forest plant diversity was collected using the quadrat method. A total of 18 quadrats were placed along a six 10km transects in Kyangwali and Muhangaizima blocks respectively. The study area was divided into 3 sub plots and 3 quadrats randomly placed along the transect in Kyangwali block's KY-7 Compartment. The distance from one quadrat to another was 50m. Quadrats of 10m by 10 m for trees, 4m by 4m for shrubs and 1m by 1m for forest floor herbs were used. All tree, shrub, forest floor herbs species that fell in the quadrat were counted. The same procedure was used on the control Muhangaizima block in compartments MU-10, MU-11, MU-12. Bugoma forest is divided into 6 blocks that are subdivided into compartments. local and English names for plant species not easily identifiable in the field were recorded and their taxa identified by taxonomists from Tooro Botanical gardens. The important quantitative analysis such as species diversity, frequency, species evenness and species richness for trees, shrubs and herbs species were computed. The diversity indices were calculated using Simpson's diversity index and Shannon Weiner for species richness and evenness while Sorenson's and Jaccard's similarity coefficients were used for computing the similarity indices

Photo 1: preparation of the quadrats in Bugoma Forest

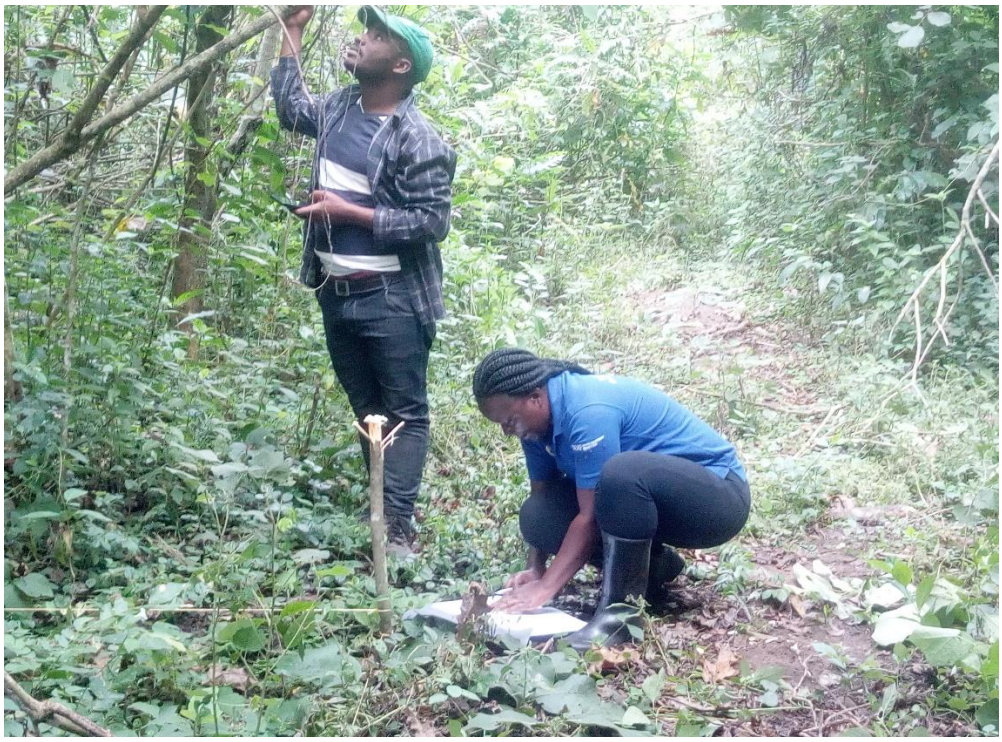


Photo 2: counting and recording number of each species in the quadrat

Diversity indices

Simpson's diversity index(D)

$$\mathbf{D=} \frac{\Sigma n_i (n_i - 1)}{N (N - 1)}$$

Where ni is the number of individuals of each species and N is the total number of individuals of all species.

Shanonn weiner

$$H' = \Sigma^{s}_{i=1} \, pi \ln pi$$

where H' is the species diversity index, s is the number of species, and pi is the proportion of individuals of each species belonging to the ith species of the total number of individuals

Similarity indices

Sorensen's similarity coefficient for Coefficient

$$SC = \frac{\mathbf{2c}}{\mathbf{S1+S2}}$$

Where C is the number of species the two communities have in common, S1 is the total numberof species found in community 1, and S2 is the total number of species found in community 2

Jaccards

$$J = \frac{s_c}{s_a + s_b + s_c}$$

where, s_a and s_b are the numbers of species unique to samples a and b, respectively, and s_c is the number of species common to the two samples. This generated data for research objective 1.

3.5.2. Satellite Image Acquisition

Secondary data for vegetation change detection was generated from the United States Geographical Society (USGS) portal Earth explorer where Sentinel 2 images from 2016 to 2020 were downloaded. Sentinel data is multispectral and moderate spatial data with RGB and infrared bands captured in 20 metres, thus it is ideal for vegetation and landuse change assessment and monitoring. For this study, sentinel images for 3 years ie 2016, 2018, 2020 corresponding to the refugee population influx in Kyangwali refugee settlement From the Democratic Republic Congo were acquired from USGS Copernicus hub via Semi-Automatic Classification Plugins (SCP) in QGIS 3.16 that allows for the classification of remote sensing images, providing tools for the download, the preprocessing and post processing of images. The Images downloaded were of high quality with less than 10% cloud cover captured during the months of March 2016, January 2018 and February 2020. QGIS was preferred in this study since it is an open source software compatible with windows and is easier to install and is user friendly on the personal computer (Matonga et al., 2017).

Table 3.2. Sentinel image acquisition

Year	Image	Satellite	Date of Acquisition	Cloud cover
2016	S2A_OPER_MSI_L1C_TL_SGS__20160314T083159_20160314T135640_A003793_T36NTG_N02_01_01	Sentinel 2	14-Mar-16	8.54
2018	L1C_T36NTG_A004394_20180108T082301	Sentinel 2	08-Jan-18	0.13
2020	L1C_T36NTG_A024242_20200212T082004	Sentinel 2	12-Feb-20	1.05

3.5.2.2 Satellite Image Pre-Processing

The downloaded images are geometrically corrected by projecting them using WGS 1984 UTM Zone 36 N coordinate system which is the planet coordinate system for Uganda. The geometrically corrected images were atmospherically corrected using Dark Object Subtraction (DOSI) atmospheric correction in QGIS 3.16 using the Semi - Automatic Classification Plugin and conversion of bands into surface reflectance. The images were later masked to the study area (Kikube District) using the current administrative dataset of Hoima district. A composite image was created by selection and combination of bands. For this study, visible bands 432 that represent Red Green Blue were used to form composite to create Normalized Disturbance Vegetation Index(NDVI) and natural colours images for better visualization and creation of training data sets. The RGB band combinations offer outputs comparable in terms of reflectance and Imagery elements before interpretation. Imagery composites with natural colours ease image interpretation.

This study used Sentinel -2 (20 metre spatial resolution) for 2016, 2018, 2020 to assess the effect of refugee population in Kyangwali refugee settlement on forest vegetation cover and landuse changes. The year 2016 formed the baseline year since the biggest refugee population influx in Kyangwali refugee settlement started in 2017/2018 due to the ethnic classes between Hema and the Lendu from Ituri and North Kivu Provinces of the Democratic Republic of Congo.

3.6.2.3. Satellite Image Processing

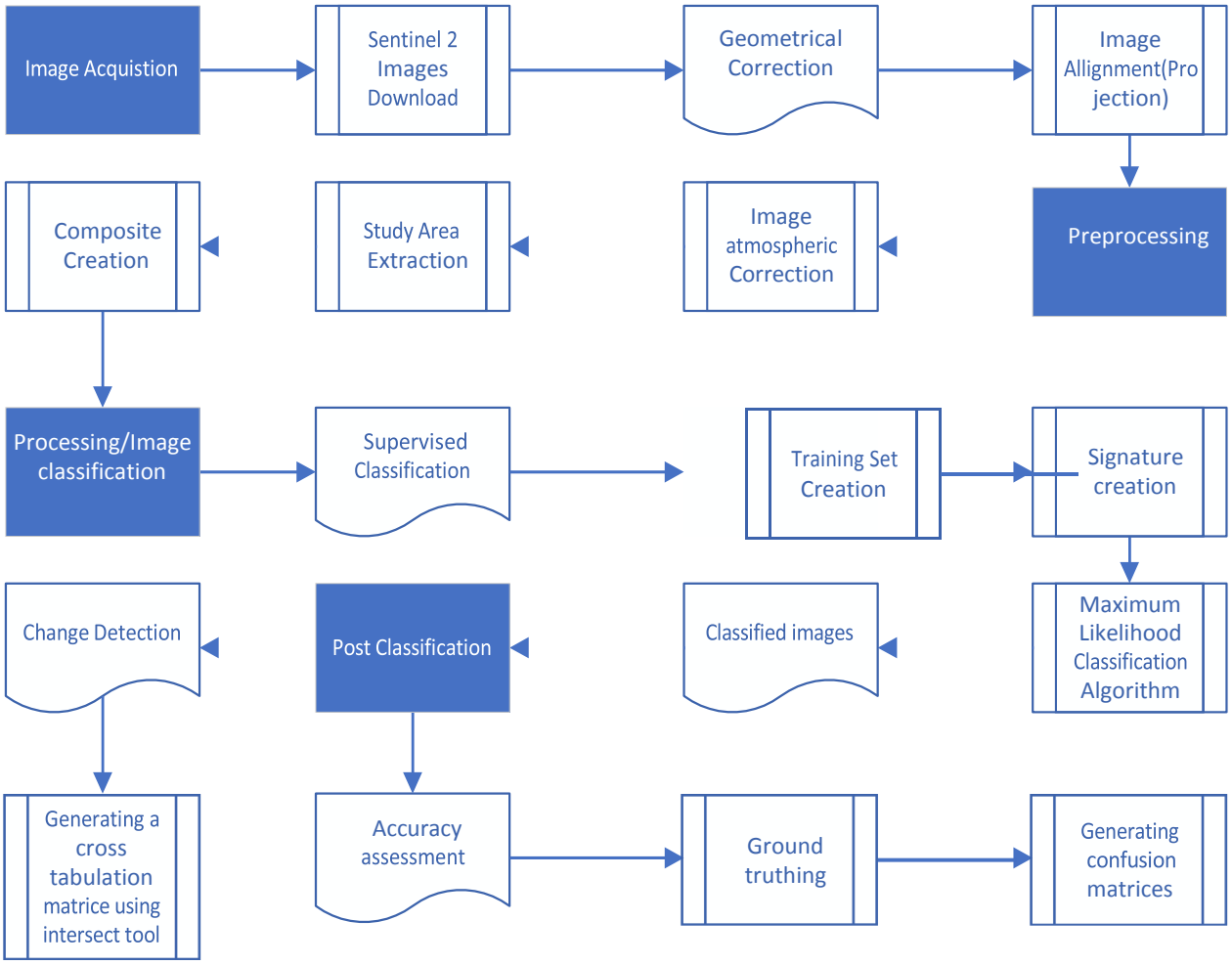
The Pre-Processed Sentinel images were processed using supervised classification algorithm in QGIS. This was chosen over other classification algorithms for image classification. This involved creating training set (pixels that identify and distinguish each landuse/cover class) that was transformed into a signature file by the software and use to perform supervised classification using

maximum likelihood algorithm. This mode with high precision was preferred since it differentiates pixel traits of different vegetation cover and land uses based on the signature
file data that are key change detection (Sibanda et al., 2015). The main vegetation cover and land uses were identified as shown in table 4.4

3.5.2.4 Post Classification

This included accuracy assessment and change detection. Ground truthing points collected in the field were used to assess the accuracy of classification algorithm and a confusion/ error matrix was generated showing the user accuracy, producer accuracy and kappa. In change detection twoimages were compared to assess change in the individual classes and a cross tabulation table wasgenerated showing the changes in the landuse/cover classes. This generated data for the researchobjective 2.

Figure 3.3 Land cover /land use image acquisition and processing flowchart



3.5.3 Household survey

A questionnaire was designed and coded in Kobo collect and was uploaded on mobile phones powered by Android that collected data at household level on socio-economic and livelihood dimensions, cooking energy access and other forest resources access by refugees and host community.

Majority (67.6%) were female respondents. This was key in analysis, the fact that women and girls mainly involved in cooking and collection of fire wood and other forest resources while menare key in building materials. The survey data on source of cooking energy and frequency of collection of firewood and other forest resources was key in assessing their relationship with plant diversity in

Bugoma forest.

Data was downloaded from Kobo tool box to excel where data cleaning was done. Then the cleaned data was exported to SPSS version 22 where data analysis was done. The researcher employed both descriptive and inference statistics for the sample to truly represent the population under study. For the continuous variables like age, the mean, median and interquartile range (IQR) were generated. The researcher generated frequency tables, percentages and charts for categorical variables.

The relationship between variables in the study was measured using bivariate analysis (Pearson's Correlation Coefficient) that provided significance levels for statistical conclusions. This generated data for research objective 3.

3.7. Ethical Considerations.

In this study, the Researcher was given introductory letters from the university and a permit from OPM that were served to respondents before the interviews were conducted. The Researcher sought verbal consent as an ethical research practice in social research stipulating the participant's involvement without any duress and can withdraw from the study anytime a participant wishes so. The respondents were 18 years and above. The Researcher built rapport with participants before asking questions. The participants were treated with integrity and the principle of confidentiality was affirmed. All the information was anonymized, and records kept in a secure computer. Only the researcher responsible for analysis had access to the questionnaire and computer file. All therecords will be kept for a maximum of five years before destroyed. The researcher provided feedback to key stakeholders on the research process and findings

CHAPTER FOUR: PRESENTATION OF RESEARCH FINDINGS

4.0 Introduction

This chapter presents the results and interpretation from the research following the research objectives. In the first instance, it establishes the plant species diversity and similarity indices, evenness and richness at differently disturbed sites i.e. un disturbed, mildly and highly disturbed Forest. Secondly, it establishes the vegetation cover and land use changes in and around Bugoma forest following the refugee population influx of 2017/2018 in Kyangwali refuge settlement and thirdly it assessed the extent to which the socio-economic, and energy access factors of refugee population contributed to the plant diversity changes in Bugoma Forest reserve.

4.1 Changes in plant species diversity, evenness and richness at differently disturbed sites in Bugoma forest

4.1.1 Plant diversity indices of plant communities in Kyangwali and Muhangaizima blocks of Bugoma Forest

The diversity indices for tree species in all the 6 transects are shown in Tables 4.1 Simpson's diversity index (D) for tree species ranged from 0.4562 to 0.9976. Transect H had the highest D of 0.9976 for tree species followed by Transects A, M, K and U with 0.9559, 0.9086, 0.8989 and 0.7751 respectively. Transect Y had the least D of 0.4562. In terms of Species richness, a total of 88 tree species were recorded in the 6 transects. Transect M was richer in tree species followed by transects U, A, M &A while Transect H had the least species richness. Thus, Muhangaizima Block with transects M, U, H was richer in tree species as compared to Kyangwali Block with transects K, Y, A.Shannon Weiner index (H') was higher for Transects M, A, K, U with values 2.6776, 2.6535, 2.1646 and 2.1196 respectively while transects Y and H had the lowest H' values 1.2298

and 1.1537. Mahangaizima block with transects M, U, H when combined gave a higher H' of 2.4836 as compared to 2.0106 for Kyangwali block with Transects K, Y, A. Tree species evenness (E) was higher for transects K, A, M, H and U with values 0.9401, 0.9366, 0.8540,0.8322 and 0.7333 while transect Y of Kyangwali block registered the least tree species E of 0.4436 as illustrated in table 4.1 below.

Table 4.1: Tree species diversity indices, species richness, evenness and similarity indices

Simpson's D; Shannon-Weiner, H'; species richness, S; **Evenness, E;** Sorensen's (SC) and Jaccard's (J)

Similarity Coefficient

	Transects	**Inhabitants**	**Disturbance level**	**N**	**Σn(n - 1)**	**D**	H'	**S**	**E**	Similarity	
										SC	J
Study site (Kyangwali block)	K	Refugees	HD	31	94	0.899	2.165	10	0.940	0.136	7.3%
	Y	Refugees	MD	139	10432	0.456	1.230	16	0.444		
	A	Refugee	MD	27	30	0.958	2.654	17	0.937		
Control (Muhangaizima)	M	Host community	LD	87	634	0.915	2.678	23	0.854		
	U	Host community	MD	73	1118	0.787	2.120	18	0.733		
	H	Host community	HD	7	12	0.998	1.154	4	0.832		

Source: Primary data.

Key: HD-Highly Disturbed**, MD**-Moderately Disturbed**, LD**-Least Disturbed

Transects Y and U recorded the highest Simpson diversity index for shrubs of values 0,6184 and 0.5557 followed by transect A with 0.3816 while the lowest Simpson's index was recorded for Transects K, H, M, with values 0.1539, 0.1527 and 0.1928 respectively.

Shannon weiner index was higher for transects H, M, K, with values 2.0892, 1.8708, 1.8809 followed by transect Y respectively. Transects U and A recorded the lowest Shannon weiner indexof

0.6312 and 0.8484. Higher species evenness values were recorded in transects U, Y, H with 0.9106, 0.8603 and 08124 followed by transect H with 0.7912. Transects Y&A of Kyangwali block recorded the lowest species evenness values of 0.5258 and 0.4735 as show in Table 4.2 below.

Table 4.2. Shrub Species diversity indices ,richness evenness and Similarity indices

	Transects	Inhabitants	Disturbance levels	N	Σn(n -1)	Simpson'sD	Shannon Weiner	Species Richness S	Evenness E	Similarity	
Study site (Kyangwali block)	K	Refugee	MD	43	278	0.1539	1.8809	9	0.8603		
	Y	Refugees	LD	78	3714	0.6184	1.4239	15	0.5258	0.214	%
	A	Refugees	HD	78	668	0.3816	0.8484	6	0.4735		
Control (Muhangaizima)	M	Host ɔmmunity	MD	42	332	0.1928	1.8708	10	0.8124		
	U	Host ɔmmunity	LD	89	4352	0.5557	0.6312	2	0.9106		
	H	Host ɔmmunity	HD	86	1116	0.1527	2.0892	14	0.7916		

Source: Primary data

Key: HD-Highly Disturbed**, MD**-Moderately Disturbed**, LD-**Least Disturbed

The highest Simpson diversity index for forest floor herbs was recorded for transects A of Kyangwali with 1.000 followed by transects H, Y, K with values 0.81737, 0.6140 and 0.39007. The lowest Simpson's diversity index was recorded in Transect U of Muhangaizima Block with 0 value followed by Transect M with 0.0095. Whereas Transect A of Kyangwali Block had the highest Simpson's diversity index, it had the lowest Shannon Weiner index and had only one typesof species that translated into 0.00 evenness, the most common species in this once mature part ofBugoma Forest observed during data collection was *Bidens pilosa*. Transect U of MahangaizimaBlock had the highest Shannon Weiner (1.9044), and had the most species richness of 15 and highest 0.8271 species evenness. Transect U of Muhangaizima had no forest floor herbs at all. This part of the forest has had a closed canopy that did not favour growth of forest floor herbs asobserved during the data collection as showed in table 4.3 below.

Table 4.3 Forest floor herb species diversity indices ,richness evenness and Similarity indices

	Transects	Accessed by	Disturbance levels	N	Σn(n - 1)	Simpson's D	Shannon Weiner	Species richness	Evenness E	Similarity indices	
										SC	J
Study site (Kyangwaliblock)	K	Refugees	LD	48	880	0.39007	1.2931	7	0.5885	0.067	3.4 %
	Y	Refugees	MD	19	132	0.6140	1.0597	4	0.3913		
	A	Refugees	HD	33	1056	1.000	0.000	1	0.00		
Control (Muhangaizima)	M	Host communiy	HD	105	2666	0.0095	1.9044	15	0.8271		
	U	Host community	LD	0	0	0	N/A	0	0		
	H	Host community	MD	140	15906	0.81737	0.3508	3	0.1329		

Source: Primary data

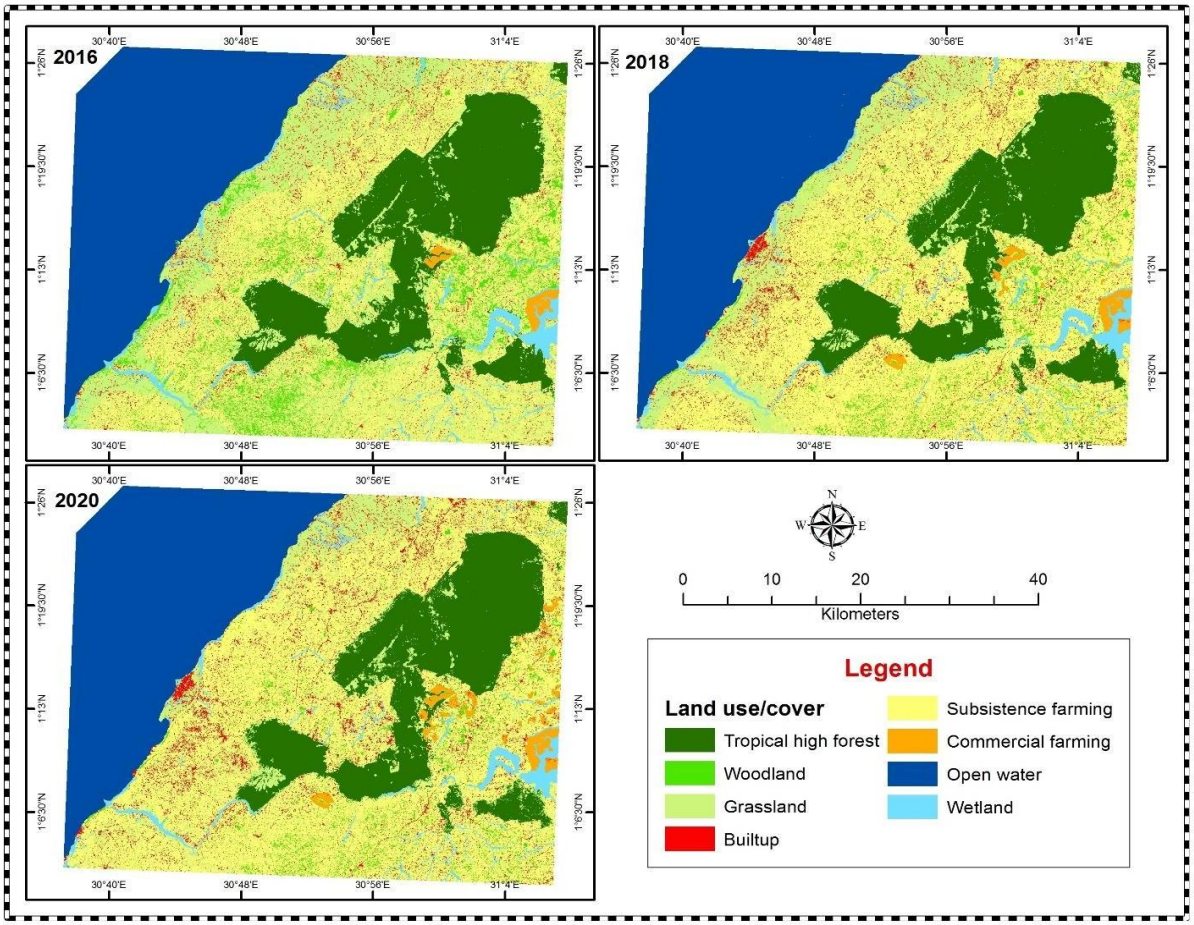
Key: HD-Highly Disturbed**, MD-**Moderately Disturbed**, LD-**Least Disturbed

Sorenson's coefficient for tree species was (0.136), shrubs (0.213) and forest floor herbs(0.067) Kyangwali and Muhangaizima blocks do not have much overlap or similarity in terms trees and shrub species though with an overlap with forest floor herb species Jaccard's similarity coefficient was 7.3% for tree species, 3.4% for shrubs and 3.4% for forest floor herbs indicate that the Kyangwali and Muhangaizima blocks are distinct in terms of plant species

4.2 How vegetation cover and land uses in the study area changed from 2016 to 2020

To analyze the vegetation and land use changes in the study area, the spatial data for vegetation and land use in hectares (ha) for the study area from 2016 to 2020 were analyzed using GIS and remote sensing and results presented in tables 4.4 below.

Figure 4.1: Satellite images for the year 2016, 2018 and 2020



The results revealed that the area under tropical high forest covered 42,221.9 ha, 40,298.6ha, 40,136.9ha in 2016, 2018 and 2020 respectively. Wood land covered 13159.2ha in 2016, 8550.6ha in 2018 and 6500.2ha in 2020 implying that tropical high forest and wood land registered a decrease in cover from 2016 to 2020. Furthermore, grassland covered 63,813.6ha in 2016, 34,025.4ha in 2018 and 36739 ha in 2020. Subsistence farming covered 51,075.1ha in 2016,

84,087.7ha in 2018 and 79,993 ha in 2020 while commercial farming covered 1,250ha in 2016, and 3,299.9ha in 2020 as shown in Table 4.4. The area under commercial farming more than doubled in 2020 implying that other forms of vegetation cover could have been cleared to pave way for commercial farming to cater for the rapid growth in the refugee population and for sugar cane production to meet the demands for sugar factories in the study area.

Built up area consisting of Kyangwali refugee settlement and other infrastructural development covered 6,245.5ha in 2016, 8,967.4ha in 2018 and 11,341.6ha in 2020. This shows that built area occupied more land area in 2018 and 2020 as compared to 2016.

Table 4.4 : The statistics of vegetation cover and landuse

	2016		**2018**		**2020**	
Land use/cover	**Area (ha)**	**Area (%)**	**Area (ha)**	**Area (%)**	**Area (ha)**	**Area (%)**
Tropical High Forest	42,221.9	17.3	40,298.6	16.5	40,136.9	16.4
Woodland	13,159.2	5.4	8,550.6	3.5	6,500.2	2.7
Grassland	63,813.6	26.1	34,025.4	13.9	36,739.0	15.1
Built-up	6,245.5	2.6	8,967.4	3.7	11,341.6	4.6
Subsistence farming	51,075.1	20.9	84,087.7	34.4	79,993.0	32.8
Commercial farming	1,250.1	0.5	2,023.8	0.8	3,299.9	1.4
Open water	60,578.3	24.8	60,613.9	24.8	60,600.8	24.8
Wetland	5,827.4	2.4	5,603.5	2.3	5,559.5	2.3
Total	**244,171.0**	**100**	**244,171.0**	**100**	**244,171.0**	**100**

The spatial analysis results of vegetation cover and landuse for the period of 2016-2020 reveal that vegetation cover namely; tropical high forest, woodland and grassland occupied the largest portion of the study area landscape in 2016 while land uses occupied a small portion as illustrated

in table 4.4 above. In 2018, subsistence farming and built up land uses covered a large portion of the of the south western parts of the study area where Kyangwali Refugee settlement is located implying that the refugee population activities extemporaneously increased that led to the transformation of the vegetation that existed in 2016 to land uses. On the other hand, commercial farming land use increased in cover in the Eastern parts of the study area that could be attributed to sugarcane production. The land cover vegetation map for 2018 show a gain in the grassland cover mainly the annual grasses that showed a loss in 2020.

Table 4.5: The Change in vegetation cover and land use

	2016 to2018		**2018 to 2020**		**2016 to 2020**	
Land use/cover	**Area (ha)**	**Area (%)**	**Area (ha)**	**Area (%)**	**Area (ha)**	**Area (%)**
Tropical High Forest	-1923.28	-0.79	-161.71	-0.07	-2085.00	-0.85
Woodland	-4608.60	-1.89	-2050.41	-0.84	-6659.00	-2.73
Grassland	-29788.15	-12.20	2713.58	1.11	-27074.57	-11.09
Built-up	2721.95	1.11	2374.20	0.97	5096.15	2.09
Subsistence farming	33012.64	13.52	-4094.71	-1.68	28917.93	11.84
Commercial farming	773.71	0.32	1276.08	0.52	2049.80	0.84
Open water	35.57	0.01	-13.03	-0.01	22.54	0.01
Wetland	-223.84	-0.09	-44.01	-0.02	-267.85	-0.11

Overall, the tropical high forest consisting of Bugoma forest registered a loss in cover from 2016 to 2018 and 2018-2020 respectively. An estimated 2,085ha of tropical high forests were lost from 2016 to 2020. Woodland and grasslands lost in the same period were 6,659ha and 27,074ha respectively while subsistence farming, built up and commercial farming registered gain in cover in the same period (see table 4.5 above). The loss in the vegetation cover is spontaneous with the gain in land uses.

Table 4.6 Change detection from 2016 to 2020

		2016								
	Land use/cover	Tropical high forest(ha)	Woodland(ha)	Grassland(ha)	Builtup (ha)	Subsistence farming(ha)	Commercial farming(ha)	Open water(ha)	Wetland(ha)	Total
2020	Tropical high forest	38757.09	146.57	1007.20	0	224.91	0	1.14	0	40136.91
	Woodland	83.94	2570.64	1777.00	0	2052.74	0	0.51	15.35	6500.17
	Grassland	2444.44	1471.43	22361.42	0	10372.14	0	36.79	52.77	36738.99
	Built up	57.97	248.54	2864.05	6245.49	1880.78	0	14.15	30.66	11341.64
	Subsistence farming	855.83	8335.86	35011.73	0	35685.50	0	5.02	99.06	79993.00
	Commercial farming	21.64	336.92	748.13	0	856.97	1250.12	0.01	86.13	3299.92
	Open water	0.99	49.21	44.03	0	2.04	0	60499.26	5.32	60600.84
	Wetland	0	0	0	0	0	0	21.42	5538.07	5559.49
	Total	42221.90	13159.17	63813.56	6245.49	51075.07	1250.12	60578.30	5827.35	244170.96

4.3 Socio–economic and livelihood factors of the refugee and host community contributing to plant diversity changes in Bugoma forest reserve

4.3.1 Demographic characteristics of the respondents

Of the 296 respondents interviewed, 64.5% (n=191) were from Kyangwali refugee settlement and 32.4% (n=105) from the host community of Kyangwali sub-county in Kikuube District. Majority of the surveyed respondents (67.6%) were female with a higher proportion from the refugee settlement than the host community. About 66.9% of the surveyed households were male headed. In addition, majority of the respondents 63.4% (n=121) from Kyangwali refugee settlement had stayed for 2-3 years, followed by 19.9% (n=38) who stayed for more than 4 years and 16.8% for less than a year. The sample was further characterized by respondents with an average age of 32 years and average household size of 6 members. Thus the sample was well

represented in terms of key demographic characteristics as shown in table 4.7 below. This information was useful in testing the correlation between the refugee influx and plant diversity of Bugoma forest.

Table 4.7: Demographic characteristics of the respondents

	Refugee settlement n=191		Host community n=105		Total n=296	
	Freq.	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**
Sex of household head						
Male headed	109	55.1	89	44.9	198	66.9
Female headed	82	83.7	16	16.3	98	33.1
Gender of respondents						
Male	67	69.8	29	30.2	96	32.4
Female	124	62.0	76	38.0	200	67.6
Level of education						
No formal education	89	79.5	23	20.5	112	37.8
Primary	72	54.5	60	45.5	132	44.6
Secondary	27	61.4	17	38.6	44	14.9
Tertiary	3	37.5	5	62.5	8	2.7
Household head marital status						
Divorced	20	95.2	1	4.8	21	7.1
Married	135	59.2	93	40.8	228	77.0
Single	15	65.2	8	34.8	23	7.8
Widowed	21	87.5	3	12.5	24	8.1
Household land size						
Less than 50x50 ft	191	100	0	0	191	64.5
0-1 acres	0	0	57	100	57	19.3
2-3 acres	0	0	32	100	32	10.8
4-5 acres	0	0	9	100	9	3.0
Above 5 acres	0	0	7	100	7	2.4
Household size						
Minimum	**Maximum**		**Mean**		**Std. Deviation**	
1	20		6		2.841	
Age of the respondents						
Minimum	**Maximum**		**Mean**		**Std. Deviation**	
18	80		32		10.858	

4.3.2 Household Economic/livelihood information

4.3.2.1 Household main sources of income

Hired labour is the main source of income for the refugee households as reported by majority (59.7%) of the surveyed refugee households while agriculture was the main source of income for the host community households as reported by 39.1% of the surveyed host community households (Table 4.8). In addition to hired labour, (24.1%) of the refugee respondents were involved in micro business and other non-agriculture activities for income generation as shown in table 4 below. This could be attributed to the small plots of land allocated to the refugee households that limits meaningful involvement of the refugee households in agriculture production for income generation. Kyangwali refugee allocated a plot of 50m by 50m per refugee household before the refugee influx of 2018/2019 and this has since reduced to about 30m by 30m.

Table 4.8 Household's main source of income for refugees and Host community.

Household's source of income	Refugee settlement		Host community (nationals)		Total	
	N	%	n	%	n	%
Hire of labour	114	59.7	2	1.9	116	39.2
Agriculture	30	15.7	78	74.3	108	36.5
Business	16	8.4	17	16.2	33	11.1
Formal employment	1	0.5	5	4.8	6	2.0
Others	30	15.7	3	2.9	33	11.1

Majority of the respondents **(**52.0% (n=154) fell under the low income level category as they reported average annual household income of less than 200,000 Ugandan Shillings per season

(Table 4.9).

A higher proportion (73.3%) of these were from the Kyangwali refugee settlement as compared to 52% of the host community. There is probably relationship between this income level and dependency on resources from Bugoma forest. Low-income earners are often highly dependent on provisioning ecosystem services. In terms of receipt of cash supplements, Majority (51.3%) of the refugee respondents reported receipt of cash for food from the World Food Programme (WFP).

Table 4.9 Household income levels disaggregated by refugees and host community.

Household's level of income per annum.	Refugee settlement		Host community		Total	
	N	%	N	%	n	%
Less than 200,000	140	73.3	14	13.3	154	52.0
200,000-500,000	40	20.9	41	39.0	81	27.4
500,001-1,000,000	9	4.7	31	29.5	40	13.5
Above 1,000,000	2	1.0	19	18.1	21	7.1

Source: Primary data

4.3.2.2 Forest resources used to supplement household income

Firewood and charcoal were the main dominant resources collected from Bugoma Forest to supplement household income for both refugees and host community. Majority (69.1%) of the refugees reported that they collected firewood from Bugoma forest to supplement their income as compared to (49.1%) of the host community. In addition, 27.7% respondents from Kyangwali Refugee settlement burnt charcoal for income compared to 18.2% from the host community. Collection of mushrooms, herbal medicine and building materials ranked least for both refugees and host community as shown in table 4.10 below.

Table 4.10 Forest resources that refugee and host community households use to supplement their income.

Forest resources used to supplement household income	Refugee settlement		Host community		Total	
	n	%	N	%	n	%
Firewood	132	69.1	1	1.0	133	44.9
Charcoal	53	27.7	1	1.0	54	18.2
Mushroom	1	0.5	2	1.9	3	1.0
Herbal medicine	2	1.0	0	0.0	2	0.7
Wood for building materials	1	0.5	0	0.0	1	0.3
None of the above	2	1.0	101	96.2	103	34.8

Source: Primary data

4.3.2.3 Frequency of collecting forest resources

The study further investigated the frequency of collecting forest resources. Majority (60.1%) of the 193 respondents that reported forest resources supplement their household income, collected forest resources once a week. A bigger proportion 60.8% were from Kyangwali refugee settlement as compared to 1% from the host community. This frequency is influenced by the internal regulations set by OPM, UNHCR and NFA to regulate the rate of degradation. Refugee households are only allowed to collect firewood from Bugoma Forest on one designated day per week. However, amidst this regulation 38.6% of the respondents from Kyangwali refugee settlement collected forest resources twice a week as compared to 3% from the host community as shown in table 4.11 below.

Along the transect walk in Kyangwali Block of Bugoma forest with NFA team and the security personnel during data collection. The researchers encountered encroachers with charcoal on a non-designated day for collecting forest resources by refugees. These encroachers ran way and abandoned the charcoal.

This study further investigated the association between the frequencies of collecting forest resources to supplement household income and location of the household (Table 4.12), it was revealed that there was a statistically significant association between the frequencies of collecting forest resources to supplement household income and location of the household (χ^2 = 121.904[a], P (0.000) < 0.05).

Most refugees collect forest resources once a week as opposed to the host community who mainly collect the forest resources twice a week as illustrated in table 4.12 below

Table 4.12 Frequency of collecting forest resources disaggregated by location.

Frequency of collecting forest resources	Host community		Refugee settlement		Total	
	N	%	n	%	n	%
Once a week	1	25	115	60.8	116	60.1
Twice a week	3	75	73	38.6	76	39.4
Twice a month	0	0	1	0.5	1	0.5

Source: Primary data

A Pearson correlation analysis was conducted to investigate the relationship between frequency of collecting forest resources and plant diversity. Results in table 4.13 below revealed that correlation coefficient was 0.011 which implied that there was a weak positive correlation between frequency of collecting forest resources and plant diversity in Bugoma forest. The correlation is significant at 5% level of significance since the p-value (0.002) <0.05 implying that a unit increase in the number of times of collecting forest resources would on average lead to 0.011 increases in plant diversity depletion.

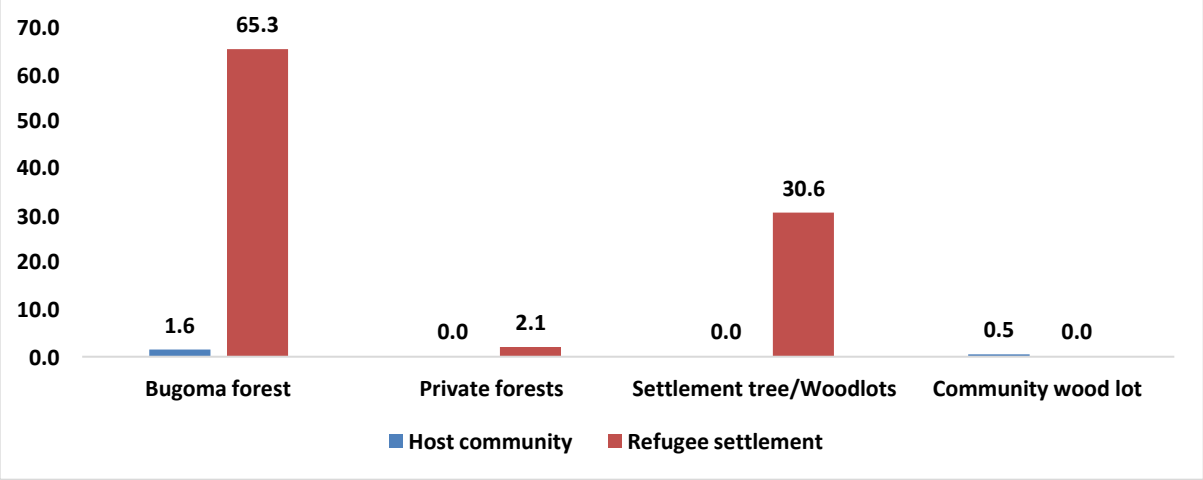
Table 4.13 showing the relationship between frequency of collecting forest resources and plant diversity.

		Plant diversity
Frequency of collecting forest resources	Pearson Correlation	0.011**
	Sig. (2-tailed)	0.002
	N	296

4.3.2.2. Source of the forest resource

This study investigated the source of the forest resources for respondents that used forest resources to supplement their income. The findings revealed that majority (66.8%) reported that Bugoma forest was the source of forest resources that supplemented their household income as compared to 30.6% that collected forest resources from settlement trees/woodlots, 2.1% from private forests and 0.5% from community woodlots. Further analysis showed that majority of the refugees (65.3%)depended on Bugoma forest as the main source of forest resources that supplemented their income as compared to1.6% from the host community.

Figure 4.2 Source of the forest resource disaggregated by refugees and host community



Source: Primary data

4.3.2.4 Awareness of anthropogenic activities carried out in Bugoma forest

This study further established the awareness levels of anthropogenic activities done in Bugoma forest by the respondents. The results revealed cutting trees for firewood, building materials and charcoal burning as the main anthropogenic activities done in Bugoma forest as reported by both refugees and host community 69.6% (n=206) 64.5% (n=191), 59.1% (n=175) in Table 4.14. These were followed by timber and crop production as reported by 26.4% (n=78) and 23.3% (n=69) of the respondents respectively. Animal rearing and herbal medicine collection ranked the least as shown in table 4.14 below-

Table 4.14 Knowledge of Human activities carried out in Bugoma forest.

Human activities done in Bugoma forest	Host Community		Refugee settlement		Total	
	N	%	n	%	N	%
Tree cutting for fire wood	86	81.9	120	62.8	206	69.6
Tree cutting for building materials	72	68.6	119	62.3	191	64.5
Charcoal burning	82	78.1	93	48.7	175	59.1
Timber production	52	49.5	26	13.6	78	26.4
Crop production	19	18.1	50	26.2	69	23.3
Animal rearing	23	21.9	20	10.5	43	14.5
Herbal medicine collection	27	25.7	11	5.8	38	12.8
Collection of materials for hand craft	25	23.8	1	0.5	26	8.8
Fruits collection	4	3.8	0	0.0	4	1.4
Others	17	16.2	28	14.7	45	15.2

Source: Primary data

4.3.3 Food security

4.3.3.1 Frequency of cooking beans.

During the study, respondents were asked how often they cooked beans in their household. And the findings revealed that majority 55.5% (n=106) refugees cooked beans every day as compared to 19% (n=20) host community, followed by Further analysis revealed that about 32.4% of the refugee households cooked beans more than 3 times in a week and only 6.3% of the refugee household's cook beans once a week as compared to 43.9% and 7.6% of the host community respectively as illustrated in table 4.15 below

Table 4.15. Frequency of cooking beans.

Frequency of cooking beans.	Host community, n=105		Refugee settlement, n=191		Total, n=296	
	n	%	N	%	n	%
Once a week	8	7.6	12	6.3	20	6.8
2 times a week	9	8.6	11	5.8	20	6.8
3 times a week	22	21.0	31	16.2	53	17.9
4 times a week	26	24.8	13	6.8	39	13.2
5 times a week	17	16.2	14	7.3	31	10.5
6 times a week	3	2.9	4	2.1	7	2.4
7 times a week	20	19.0	106	55.5	126	42.6
Total	**105**	**100**	**191**	**100**	**296**	**100**

Source: Primary data

4.3.3.2 Mode of cooking dry beans in households.

Different households have different ways of cooking beans especially dry beans. During the study, respondents were asked how they cooked beans in the household and the results revealed that . that majority 92.1% (n=176) households in the refugee settlement and 94.3% (n=99) host community do not Soak dry beans before cooking. Only 7.9% of the households in the refugee

settlement and 5.7% host community reported that they soaked dry beans before cooking implying implies that majority of the households use more fuel while cooking dry beans cooking see table

Table 4.16 showing the mode of cooking dry beans in households.

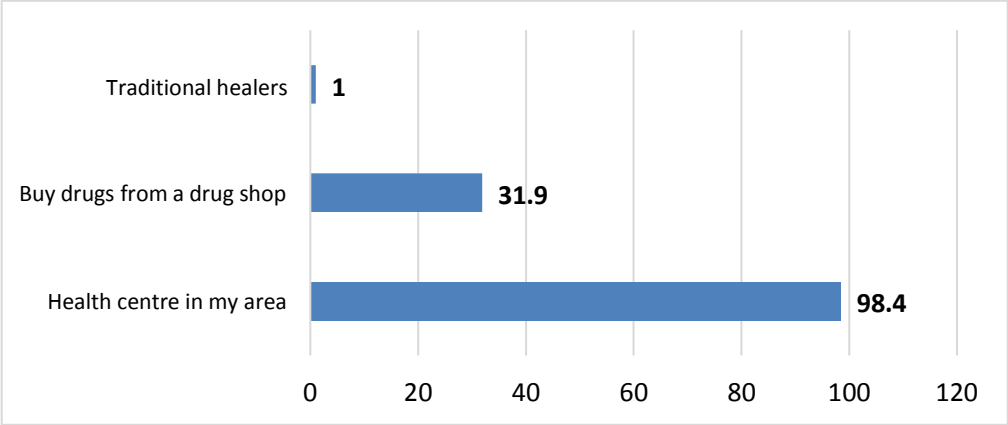
Mode of cooking dry beans in households	Host community		Refugee settlement		Total	
	n	%	n	%	n	%
Soak before cooking	6	5.7	15	7.9	21	7.1
Do not soak before cooking	99	94.3	176	92.1	275	92.9
Total	**105**	**100**	**191**	**100**	**296**	**100**

4.3.4 Health information

4.3.4.1 Access to health services

The respondents were asked where they accessed health services from. The analysis in the figure 4.3 below revealed that majority 98.4% (n=188) of the respondents reported that they accessed health services from the nearest health centers in their communities. This was followedby 31.9% (n=61) of the respondents who reported that they accessed health services from drug shops. The study further revealed that only 1% (n=2) of the respondents reported that they accessed health services from traditional healers.

Figure4.3 showing access to health services in Kyangwali refugee settlement



Source: Primary data

4.3.4.2 Use herbal medicine in households

The study investigated whether respondents use herbal medicine apart from accessing health services from health centers and drug shops. The figure below revealed that 55.4% refugees and 44.6% host community use herbal medicine in their households. The researcher further investigated the commonly used herbal medicine and it was reported that mubirizi is one of the commonest herbal medicine used in Kyangwali refugee settlement. Other herbs used for treatment in Kyangwali included chopu, moringa, Ndabarasanya, Kalira, Neem trees, Njuju among others.

Table 4.17. Use of herbal medicines

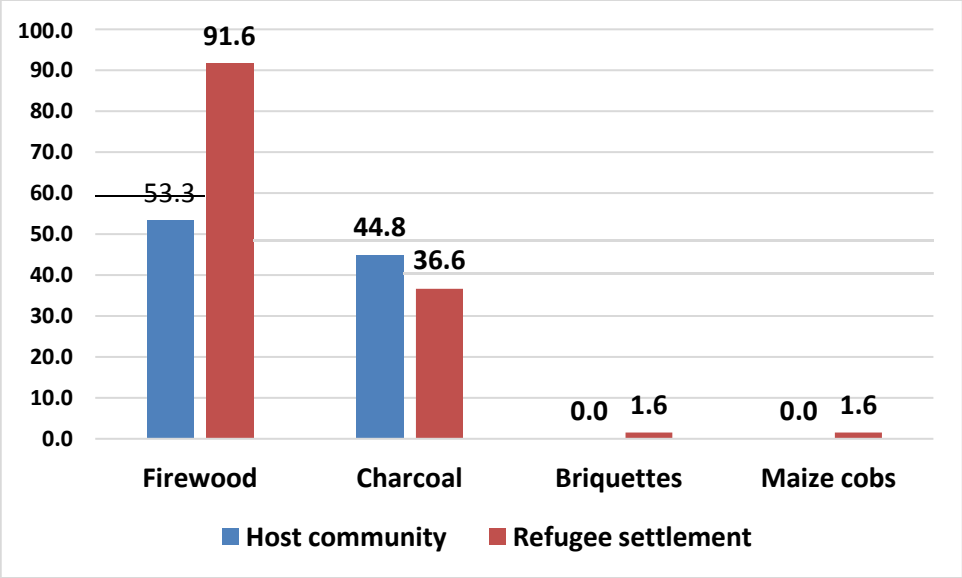
Use herbal medicine in your household	Host community		Refugee settlement		Total	
	N	%	n	%	n	%
Yes	41	44.6	51	55.4	92	31.1
No	64	31.4	140	68.6	204	68.9
Total	105	75.9	191	124.1	296	100

Source: Primary data

4.3.4.3 Cooking technology and fuel wood consumption

The study findings revealed firewood as the primary source of energy for cooking by households in both Kyangwali refuge settlement and its host community as reported by 91.6% households in the refugee settlement and 53.3% host community. This followed by charcoal 36.6% and 44.8 % refugee households and host community respectively. Briquettes and maize cobs were only used in the refugee settlement accounted by only 1% of the respondents as showed in figure 4.5 below. The use of briquettes by refugee households is attributed to concentration of interventions in Kyangwali refugee settlement than the host community by UN agencies, International organizations and theirimplementing partners.

Figure 4.4: Respondents by type cooking energy used



Source : primary data

Photo 3: Fuel wood collected from Bugoma forest by refugees in Kyangwali refugees settlement

This study also assessed 4 restaurants, 2 in Kasonga in Kyangwali refugee settlement and 2 in Bukinda and Kyangwali trading centres in the host community. Charcoal was the main source of

cooking energy for restaurants both in the refugee settlement and the host community. However, there was progress noted on adoption of other clean energy by restaurants in Kyangwali Refugee settlement as compared to the host community. One restaurant out of the two assessed in Kyangwali refugee settlement was using gas cooker alongside charcoal.

The charcoal consumption by restaurants in addition to households in the host community and refugee settlement is probably a key trigger for continued charcoal burning in Bugoma forest amidst strict regulations and enforcement by OPM settlement, NFA and police. During the forest assessment the researcher observed many charcoal kilns in both Kyangwali and Muhangaizima blocks of Bugoma forest although Kyangwali block ranked highest. In Kyangwali block (Ky-7 compartment, around coordinates 256009E, 125582N) the researcher observed and counted 10 charcoal kilns.

Photo 4: Charcoal kiln set in Kyangwali block (KY-7)

A charcoal kiln dismantled by the police officer

In terms of cooking stove used at household level, majority (80.1%) of the respondents in Kyangwali refugee settlement used mud stoves as compared 54.7% in the host community. This was followed by 40.9% (n=121) of the respondents who reported that they use the traditional three cooking stones and other reported cooking technologies used in households for cooking

were metallic stoves 6.1% (n=18), ceramic stoves 4.1% (n=12) and clay stoves 0.3% as shown in Table 4.18 below.

Table 4.18 showing the cooking technology used in households.

Cooking technology/ cooking stove currently Used	Host community		Refugee settlement		Total	
	N	%	N	%	n	%
Three cooking stones	56	53.3	65	34.0	121	40.9
Mud stoves	57	54.3	153	80.1	210	70.9
Metallic stoves	12	11.4	6	3.1	18	6.1
Ceramic stoves	6	5.7	6	3.1	12	4.1
Clay stoves	0	0.0	1	0.5	1	0.3

Photo 5: showing the type of stoves and fuel wood used by refugee households inKyangwali refugee settlement

4.3.4.4 Quantity of firewood used by the household per day and its source

In terms of firewood consumption, majority (50.9% (n=108) refugees reported use of 5-6 Kgs per day of firewood at household level on a daily basis, followed by 40.7% (n=94) of the household that use about 3-4 Kgs on a daily basis as compared to 33.9% a nd 35.7% host community

respectively as shown in the table 4.19 below.

Table 4.19 Quantity of firewood used by each household per day.

Quantity of fire wood used	Host community		Refugee settlement		Total	
	N	%	N	%	n	%
1-2 Kgs	6	10.7	2	1.1	8	3.5
3-4 Kgs	20	35.7	74	42.3	94	40.7
5-6 Kgs	19	33.9	89	50.9	108	46.8
7-8 Kgs	7	12.5	8	4.6	15	6.5
9-10 Kgs	3	5.4	0	0.0	3	1.3
11 Kgs	1	1.8	2	1.1	3	1.3

Source: Primary data

A Pearson correlation analysis was conducted to investigate the relationship between quantity of fire wood used by the household per day and plant diversity. Results in table 4.20 below revealed that the correlation coefficient was 0.047 which implied that there was a weak positive correlation between quantity of fire wood used by the house hold per day and plant diversity in Bugoma forest. The correlation is significant at 5% level of significance since the p-value (0.004) <0.05. This implies that a unit increase in the quantity of fire wood used by the house hold per day wouldon average lead to 0.047 increases in plant diversity depletion.

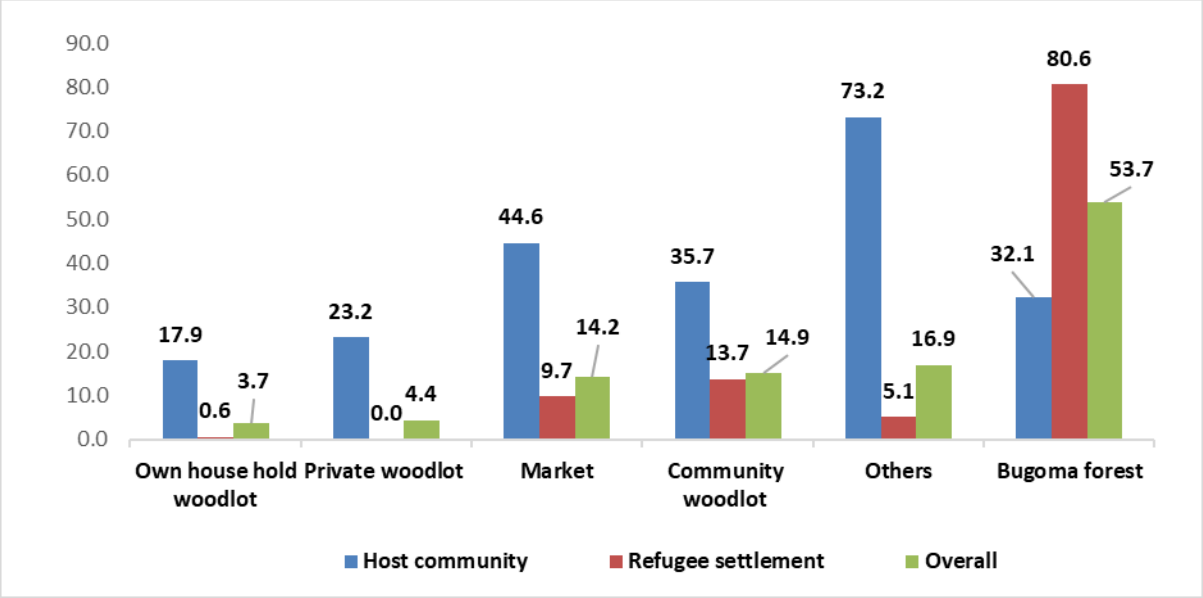
Table 4.20 showing the relationship between quantity of fire wood used by the household per day and plant diversity

		Plant diversity
Quantity of firewood used.	Pearson Correlation	.047**
	Sig. (2-tailed)	.004
	N	296

4.3.4.5 Source of fire wood

Bugoma forest was the main source of firewood for the households as reported by 53.7% of the respondents. About 16.9% of the respondents reported that they collect firewood from other sources like cleared land. The respondents also reported that community woodlots and markets are sources of firewood as reported by 14.9% and 14.2% respectively as shown in figure 4.5 below.

Figure 4.5 Sources of fire wood



Source: Primary data

4.3.4.6 Quantity of charcoal used by the household per day.

The study investigated how much charcoal each household uses on a daily basis and findings revealed that 42.9% , and 22.9% of the refugee households used 3-4 Kgs and 5-6kgs of charcoal daily as compared to 25.5% and and 42.6% host community respectively as illustrated in table 4.21 below.

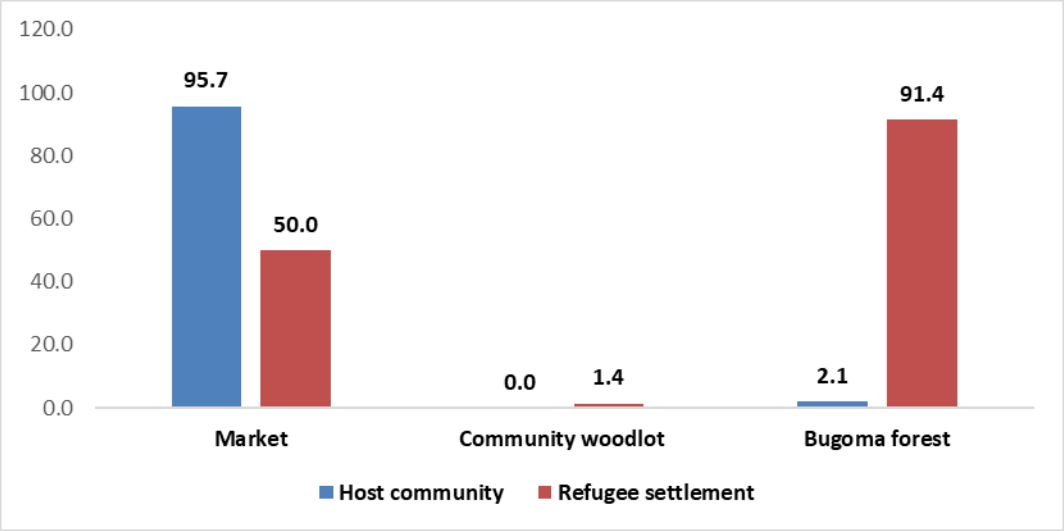
Table 4.21 Quantity of charcoal used by the household per day

Quantity of charcoal used	Host community		Refugee settlement		Total	
	n	%	N	%	n	%
1-2 Kgs	13	27.7	24	34.3	37	31.6
3-4 kgs	12	25.5	30	42.9	42	35.9
5-6 kgs	20	42.6	16	22.9	36	30.8
7-8 Kgs	1	2.1	0	0.0	1	0.9
9-10 Kgs	1	2.1	0	0.0	1	0.9

Source: Primary data

Further analysis of source of charcoal revealed that the market was the main source of charcoal for the host community followed by Bugoma Forest (25.6%) while 91.4% of the households that used charcoal in Kyangwali Refugee settlement revealed that Bugoma forest was their main source of charcoal. Community woodlots and others sources were reported least. The high demand for charcoal is probably related to charcoal burning activities that continue to happen in Bugoma forest amidst the tight regulations and enforcement by OPM, NFAand police.

Figure 4.5 Sources of charcoal



4.3.4.7. Most preferred trees for firewood and charcoal

The study also assed the most preferred tree/ shrub species for firewood and charcoal at household level. *Cynometra alexandria* was the most preferred species as revealed by 60% of the respondents followed by *Combretum molle*, *Maesopsis eminii*, *Eucalyptus grandis*, *Strombosia scheffleri*, *Albizia coriaria* respectively as illustrated in table 4.20 below

Table 4.20. Most preferred trees for firewood and charcoal

Species name	Frequency	Percent
Cynometra Alexandria	153	60.0
Combretum molle	17	6.7
Maesopsis eminii	15	5.9
Eucalyptus grandis	9	3.5
Strombosia scheffleri	9	3.5
Albizia coriaria	7	2.7
Accacia sieberiana	5	2.0
Senna spectabilis	5	2.0
Vernonia amygydalina	4	1.6
Milicia excels	4	1.6
Bridelia micrantha	3	1.2
Markhamia lutea	3	1.2
Mellitia dura	3	1.2
Blighia unijugata	2	0.8
Ficus natalensis	2	0.8
khaya anthotheca	2	0.8
Terminalia brownie	2	0.8
Vepris nobilis	2	0.8
Acanthus pubescence	1	0.4
Albizia gumiffera	1	0.4
Celtis Africana	1	0.4
Diospyros abyssinica	1	0.4
Erythrina abyssinica	1	0.4
Margaritaria discoidea	1	0.4
Persea Americana	1	0.4
Pinus caribea	1	0.4
Total	255	100.0

Source: Primary data

Also describe the source of the charcoal for each of the category of the inhabitants i.e. refugees and host community as you have done for other. On the other hand, strict enforcement on charcoal in Kyangwali refugee settlement including impounding charcoal in the markets, trucks and bodabodas has resulted into other charcoal traders in the neighboring trading centres like Bukinda in the host community to stock charcoal targeting the refugee community and others in

the host community. The two restaurant owners interviewed in Kyangwali refugee settlement reported Bukinda as their sourceof charcoal.

CHAPTER FIVE: DISCUSSIONS

5.0 Introduction

This chapter presents and interprets the main findings of this study in relation to the previous studies as per the research objectives. Previous studies that tried to assess the refugee population effect on land and forest resources in refugee hosting areas in Uganda focused on degradation using land cover and landuse changes linked to socio -economic factors. This study in comparison to previous studies combined species diversity indices and land cover changes linked to socio – economic to establish the relationship between plant diversity in Bugoma Forest and Refugee population influx in Kyangwali refugee settlement for the period 2016 to 2020

5.1 Discussions

5.1.1 Plant Species diversity, richness and evenness.

This study revealed that generally, tree and shrub species diversity indices showed a lower trend in Kyangwali block of Bugoma forest accessed by refugees than the control Muhangaizima block accessed by the host community (the nationals) as shown in table 4.1. In addition, Kyangwali block was less rich in tree and shrub species and had the least tree evenness. Annual herbaceous species richness increased in Kyangwali block at moderately disturbed areas. This can be attributed to the Intermediate Disturbance Hypothesis (IDH). The common species recorded in this once mature part of Bugoma Forest was *Biden pilosa*. Kyangwali Block had the highest Simpson's diversity index for forest floor herbs and this could be attributed to annual herbs' survival strategies that are adaptive to moderately disturbed ecosystems. Table 4.3 showed that the Shannon Weiner species richness and evenness for herbs declined in Kyangwali block.

On the other hand, Muhangaizima Block had the highest Shannon weiner index, the most species

richness and the highest species evenness. In terms of similarity, Sorenson's and Jaccard's similarity coefficients revealed that Kyangwali and Muhangaizima blocks were distinct in terms of tree species composition. Similar results were reported by Kumur et al., (2005) that disruption of forest structure by natural and anthropogenic disturbance alters species richness and other ecosystem properties, while some species are adaptable to some disturbances, others are on the decline (WCS, 2016) and that most forest biota respond negatively to forest degradation and fragmentation (Biodivers Conserv, 2017). Increasing fragmentation and loss of primary forest fundamentally alters both the species and functional composition of forested landscape (Barnes et al., 2017).

5.1.2 Vegetation cover and land use changes in Bugoma Forest and Kyangwali refugee settlement from 2016 to 2020

Grassland experienced the biggest loss (11.09%) followed by woodland (2.73%) and the tropical high forest (0.85%) respectively for the study period 2016 to 2020 due to refugee population influx in Kyangwali refugee settlement. These majorly transformed into subsistence farming whose land area increased by 11.84% and built-up area by 2.09% as shown in table 4.5. This is synonymous with the biggest refugee population influx in Kyangwali refugee settlement that is similar with findings of Barasa et al., (2020) which revealed an increase in areas under subsistence-farming and built up area in refugee hosting areas of West Nile Region of Uganda.

Grasslands and forests are the main target for subsistence farming to cater for food production to meet the food demand for increased refugee population. Maystadt et al. (2020) who investigated vegetation changes attributable to refugees in Africa reported similar results that a one percent increase in the number of refugees magnifies the conversion from dominant vegetation cover to

cropland by 1.4%. Similarly the results of this study are further supported by Faruk and Monoruzaman (2020) study findings on environmental change detection in Rohingya refugee camp area in Bangladesh which revealed that agricultural land increased by 34%.

This study established that woodland and tropical high forest cover decreased throughout the study period (2016-2020) as shown in table 4.5 that rhymes with the findings of world Bank (2020) which revealed that refugee pressure had accelerated land cover changes in bushland and woodland. In addition Reik et al. (2018) findings revealed that decrease of vegetation cover was mainly caused by deforestation for provision of building materials and fuelwood for cooking energy in refugee hosting areas in South Sudan. It is evident that woodlands and forests are the main source of poles for construction of temporary houses for the refugees and for fuel wood for cooking energy. These results correspond with findings of FAO (2020) that observed tree cover loss majorly occurring in the eastern parts of the Kyangwali refugee settlement near the Bugoma Central Forest Reserve. The lasting need of wood by refugees for cooking energy, building shelter and latrines trigger clearing of forest and woodlands that result into rapid deforestation around the refugee settlements (Leitererer et al., 2018, Mohammed 2018).

The losses in grassland, woodland and tropical high forest cover occur simultaneously with the period that Kyangwali Refugee settlement had the biggest refugee population influx that saw its population more than doubled (UNHCR, 2018). However other factors like commercial farming that equally registered an increment in its area of coverage by 0.84% in the study period 2016-2020 need further investigation.

5.1.3 Relationship between species diversity and Socio-economic / livelihood for refugees and host community

This study investigated the relationship between plant diversity and refugee population socio- economic. The findings revealed a positive relationship between the quantity of fire wood used by the refugee/host community?? households and frequency of collecting forest resources with plant diversity where a unit increase in quantity of fire wood used and frequency of collection subsequently leads to decrease in plant diversity by 0.047 and 0.011 respectively for a sample of 296 households that consisted 191 from Kyangwal refugee settlement and 105 from the host community as shown in tables 4.13 and 4.20.

An estimated 91.6% of the refugee households from Kyangwali refugee settlement used firewood as their main cooking energy and 80.6% reported Bugoma forest as their main source of firewood as compared to 53.3% and 32.1% host community. While for charcoal usage big percentage of the refugees that used charcoal revealed Bugoma forest as the main source of charcoal as compared to the host community implying that the refugees dependence on Bugoma forest as source cooking energy was higher than the host community. In terms daily firewood consumption, showed that majority (46.8% (n=108) of the refugee respondents reported that they used 5-6 Kgs of firewood per day at household level followed by 40.7% (n=94) that used 3-4kgs which is similar to FAO(2018) findings which revealed that refugees in Kyangwali refugee settlement demand 230,976kg of fuelwood per day Correspondingly, previous studies have reported similar findings that 80 % of the refugees are forest dependent, relying partly on forest products for energy, shelter, fodder, nutrition and cash income (FAO, 2018) and that increased need for wood fuel to meet the cooking energy needs, building materials constitute the main threats to forest resources in the refugee populated areas (leitererer et al., 2018, Babu et al.,

1995). Whereas both refugees and host community accessed resources from Bugoma forest there were variation in level of dependence. T he nature of dependence is inevitably not uniform (Kumar et al., 2014) in emergencies and development context. The low-income earner refugees more highly dependent on natural resources like forest in the hosting countries as the main source of fuel wood for cooking, building materials and livelihood (FAO, 2018) than the natives.

This relationship can be further explained by Kunz's Kinetic Model of Refugee Theory – the Acute refugee movement where refugees focus on survival aspects immediately, they arrive since they move unprepared. The finding of this study revealed that the refugees that had recently arrived in Kyangwali refugee settlement (0- 1 years) had more frequency of collecting of firewood and other resources from Bugoma forest for survival as compared to their counterparts that had stayed little longer.

However, the relationship was weak implying that there are other factors other than refugee/host community social economic/livelihoods at play that affect plant species diversity in Bugoma forest. Therefore, there is need for further studies to explore other factors affecting plant diversity in Bugoma forest

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The refugee influx in in Kyangwali refuge settlement contributed to increase in population has exerted pressure on forest resources and the plant diversity in Bugoma forest. Tree and shrub species diversity, richness and evenness were lower in Kyangwali block accessed by refugees than Muhangaizima block accessed by host community.

Grasslands, woodlands and topical high forest vegetation cover experienced losses while subsistence farming and built up land uses increased for the study period 2016 to 2020 that coincides with the biggest refugee population influx in Kyangwali refugee settlement.

The refugees and host community accessed forest resources mainly fire wood, charcoal and building materials from Bugoma forest for cooking energy, livelihood and building construction. However, the dependence was higher for refugee households than the host community and positive relationship between the quantity of fire wood used by the refugee and host community households and frequency of collecting forest resources with plant diversity was documented.

Therefore, this study concludes that the refugee population influx in Kyangwali refugee settlement to a large extent contributed to decrease in plant diversity of Bugoma forest. However, other underlying factors affecting plant diversity in Bugoma forest like commercial farming, oil and gas developments require further studies.

6.2 Recommendations

Restoration of degraded parts of Bugoma forests. There is urgent need for accelerating the restoration interventions for the degraded hotspots of Bugoma forest. The restoration efforts should focus on planting different endemic and indigenous tree and shrub species that have been threatened to increase plant diversity and enhance Bugoma forest ecosystems health. In addition collaborative and Community Based Natural management strategies involving NFA, OPM, UNCHR, refugees and host communities should be employed to enhance collaborative restoration for sustainability

***Alternative non-biomass communal renewable cooking energy technologies*;**

Communal cooking technologies like the ongoing pilot of solar powered community kitchens promoted by CARE International in Kyangwali refugee settlement should provide examples that can be scaled by UN agencies and other environment and Energy sector partners backed with evidence generation to inform scalability by the private sector. The communal alternative energy be promoted alongside other house hold level cooking energy innovations since Uganda operates a settlement approach where refugees live as households and some may want to maintain their independent household cooking practices.

Awareness raising; of refugees and host communities on other energy saving practices like soaking of dry beans before cooking and covering of food during cooking at household be integrated in the activities of organizations promoting energy technologies in the refugee settlement and host community.

Community wood lots and agro forestry practices with fast maturing tree species be promoted in different zones of Kyangwali refugee settlement and at household levels to provide for the energy needs of the refugees to mitigate overdependence on the natural forests in their proximity.

***Compliance to international guidelines on settling refugees*;** The UNHCR and OPM need to comply with international guidelines on settling refugees in locations within at least one-day walking distance from gazzetted natural resources and protected areas.

The study also **recommends further studies** on other factors affecting plant diversity in Bugoma forest in the following areas

1) The effect of oil and gas developments on plant diversity of Bugoma forest since the area of study is located in the oil producing area in Uganda

2) the effect of sugar cane production plantation on plant diversity of Bugoma forest

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APPENDICES

Appendix 1: Table showing Accuracy Assessment

Land use/cover	Tropical high forest	Woodland	Grassland	Builtup	Subsistence farming	Commercial farming	Open water	Wetland	Classification Overlall	Producer accuracy
Tropical high forest	13	1	0	0	0	0	0	0	14	93%
Woodland	1	19	0	0	0	0	0	0	20	95.00%
Grassland	1	0	18	1	1	0	0	0	21	86%
Builtup	0	0	0	16	1	0	0	1	18	88.89%
Subsistence farming	0	0	1	1	25	1	0	0	28	89.29%
Commercial farming	0	0	1	1	2	14	0	0	18	77.78%
Open water	0	0	0	0	0	0	15	1	16	93.75%
Wetland	1	0	0	1	1	0	1	16	20	80.00%
Truth Overlall	16	20	20	20	30	15	16	18	155	155
User accuracy	81.25%	95.00%	90.00%	80.00%	83.33%	93.33%	93.75%	88.89%	136	
Overall accuracy	87.74%									
Kappa	0.859									

Appendix II: showing Change detection 2016 to 2018

2018	2016									
	Land use/cover	Tropical high forest	Woodland	Grassland	Builtup	Subsistence farming	Commercial farming	Open water	Wetland	Total
	Tropical high forest	39563.11	78.57	617.09	0.00	38.69	0.00	1.16	0	40298.62
	Woodland	161.98	3603.88	2268.13	0.00	2498.32	0.00	2.78	15.49	8550.58
	Grassland	1887.85	1289.42	24768.98	0.00	5972.34	0.00	18.66	88.15	34025.41
	Builtup	16.08	102.89	1530.43	6245.49	1045.87	0.00	6.29	20.39	8967.44
	Subsistence farming	577.30	7922.49	34239.25	0.00	41310.17	0.00	7.67	30.82	84087.71
	Commercial farming	15.58	114.32	348.10	0.00	209.57	1250.12	0.01	86.13	2023.84
	Open water	0.00	47.60	41.58	0.00	0.10	0.00	60520.30	4.30	60613.87
	Wetland	0.00	0.00	0.00	0.00	0.00	0.00	21.42	5582.08	5603.50
	Total	42221.90	13159.17	63813.56	6245.49	51075.07	1250.12	60578.30	5827.35	244170.96

Appendix III: showing Change detection 2018 to 2020

		2018								
	Land use/cover	Tropical high forest	Woodland	Grassland	Builtup	Subsistence farming	Commercial farming	Open water	Wetland	Total
2020	Tropical high forest	38219.27	146.75	1507.09	0.00	263.79	0.00	0.00	0.00	40136.91
	Woodland	30.30	6236.59	77.41	0.00	155.87	0.00	0.00	0.00	6500.17
	Grassland	1826.38	377.19	16306.33	0.00	18181.21	0.00	39.36	8.52	36738.99
	Builtup	2.37	28.06	770.78	8967.44	1558.03	0.00	14.87	0.10	11341.64
	Subsistence farming	216.52	1665.83	15207.55	0.00	62856.86	0.00	10.85	35.39	79993.00
	Commercial farming	2.74	85.19	128.20	0.00	1059.95	2023.90	0.00	0.00	3299.99
	Open water	1.03	10.98	28.05	0.00	11.99	0.00	60548.80	0.00	60600.84
	Wetland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5559.49	5559.49
	Total	40298.62	8550.58	34025.41	8967.44	84087.71	2023.90	60613.87	5603.50	244171.03

Appendix IV: Showing plant species in Kyangwali Block of Bugoma forest along transect K in KY-7Compartment

KY -7 Compartment (Once part of a mature forest) big trees cut and characterized by high forest floor grasses not common in a mature forest - Highly disturbed (HD)								
Kyangwali Block	**KY-7 Compartment**	**Common names**	**255842E, 126182 N**	**255942E , 126060N**	**256003E, 125791N**			
Family name	**Species**	**Runyoro-Rutooro/English**	**No. of individuals in each quadrat**			**Total(n)**	**n-1**	**n(n-1)**
	Trees		**QI**	**QII**	**QIII**			
Cannabaceae	*Celtis durandii Engl.*	Mujunju, stinkwood	1	1	0	2	1	2
Phyllanthaceae	*Margaritaria discoidea (Baill.) G.L.Webster*	Ebebeng	1	0	1	2	1	2
Rutaceae	*Vepris nobilis (Delile) Mziray*	Omuzo,Teclea	5	0	0	5	4	20
Sapindaceae	*Blighia unijugata Baker*	Omwataibaale-triangle top tree	2	2	0	4	3	12
Moraceae	*Ficus SPP*		3	0	0	3	2	6
Rutaceae	*Vepris nobilis (Delile) Mziray*	Omuzo,Teclea	0	2	1	3	2	6
Meliaceae	*Lovoa SPP*		0	1	0	1	0	0
Ulmaceae	*Trema orientalis Linn. Blume*	Trema, Mutete	0	2	0	2	1	2
Malvaceae	*Dombeya kirkii Mast.*	Mukole,Forest dombeya	0	0	2	2	1	2
Fabaceae	*Albizia zygia (DC.) J.F. Macbr.(Coppicing)*	Omurongo	0	0	7	7	6	42

Shrubs								
Asteraceae	*Vernonia amygdalina Delile*	Ekibirizi, Bitterleaf	2	0	0	2	1	2
Solanaceae	*Lycopersicon esculentum*	Katunkumo (Enyanya)	4	1	0	5	4	20
Dracaenaceae	*Draceana fragrans*	Dragon tree,Muramura	12	0	0	12	11	132

Dracaenaceae	*Dracean steudneri*	Steudners dragontree-Mugorogoro	3	0	0	3	2	6
Asteraceae	*Sh KY7-1- Ageratum conyzoides*	Nyikaranyenka,Munywani-wenkanda	1	0	0	1	0	0
Unknown	*Sh KY7-2*		2	0	5	7	6	42
Unknown	*Unknown Spp*	Kyoganyanje	0	0	5	5	4	20
Musaceae	*Ensete ventricosa*	Ekitembe	0	0	8	8	7	56

Forest floor herbs								
Asteraceae	*Biden pilosa*	Enyabarasana	12	12	5	29	28	812
Unknown	*Gr KY 7-1*		2	0	0	2	1	2
Asteraceae	*Ageratum conyzoides*	Nyikaranyenka,Munywani-wenkanda	1	6	0	7	6	42
Amaranthaceae	*Amaranthus hybridus*	Omubwiga	1	3	0	4	3	12
Poaceae	*Eleusine coracana*		0	4	0	4	3	12
Unknown	*Gr KY 7-3*		0	0	1	1	0	0
Commelinaceae	*Commelina tuberosa*	Ekiteza	0	0	1	1	0	0

Appendix V: Showing plant species in Kyangwali Block of Bugoma forest along transect Y in KY-7compartment

Kyangwali Block KY-7 Compartment		**Common names**	**256119E, 125349N**	**256085E, 125338N**	**256076E, 125288N**			
Family name	**species name**	**Runyoro-Rutooro-English**	**Number of individuals in each quadrat**					
		Trees	QI	**QII**	**QIII**	**Total(n)**	**n-1**	**n(n-1)**
unknown	*Unknown Spp*	Mereau D	3	0	0	3	2	6
Meliaceae	*Trichilia prieureana A Juss*	English monkey apple	2	8	0	10	9	90
Fabaceae	*Cynometra alexandri C.H.Wright*	Uganda iron wood /Nyakabimbi	1	0	0	1	0	0
Sapindaceae	*Blighia unijugata Baker*	Omwataibaale-triangle top tree	0	1	0	1	0	0
Phyllanthaceae	*Margaritaria discoidea (Baill.) G.L.Webster*	Ebebeng	0	1	0	1	0	0
Rutaceae	*Vepris nobilis (Delile) Mziray*	Omuzo,Teclea	29	1	72	102	101	10302
Ulmaceae	*Trema orientalis Linn. Blume*	Trema, Mutete	0	2	0	2	1	2
unknown	*Unknown Spp*	Omutanzi	0	1	0	1	0	0
Cannabaceae	*Celtis durandii Engl.*	Mujunju, stinkwood	1	2	0	3	2	6

Apocynaceae	*Tabernaemontana holstii K.Schum.*	Testacle tree ,Ekinyamagosi	2			2	1	2
Rutaceae	*Citropsis articulata (Willd. ex Spreng.) Swingle & M.Kellerm.*	African cherry orange ,Katimboro	1	0	4	5	4	20
Sapotaceae	*Chrysophyllum perpulchrum*	Monkey star apple	0	0	1	1	0	0
Ulmaceae	*Celtis wightii Planch*	Celtis	0	0	1	1	0	0
Euphorbiaceae	*Alchornea cordifolia (Schumach. & Thonn.) Müll.Arg.*	Alconia	0	0	2	2	1	2
Violaceae	*Rinorea SPP*	Rinorea SPP	0	0	1	1	0	0
Euphorbiaceae	*Alchornea cordifolia (Schumach. & Thonn.) Müll.Arg.*	Alconia	0	0	2	2	1	2
Rubiaceae	*Coffea canephora*	Coffea	0	0	1	1	0	0

Shrubs								
unknown	*Unknown Spp*	Sh- KY7 -2	42	7	12	61	60	3660
unknown	*Unknown Spp*	Nyakasekura	3	0		3	2	6
Rutaceae	*Vepris nobilis (Delile) Mziray*	Omuzo,Teclea	1	0	3	4	3	12
Phytolaccaceae	*Phytolacca dodecandra*	Omuhoko	3	0		3	2	6
unknown	*Unknown Spp*	Okishekaseche	0	1		1	0	0
unknown	*Unknown Spp*	Climbing Shrub	0	0	6	6	5	30

Forest floor herds

Fabaceae	*Desmodium spp*	Gr. KY7-3-Desmodium	1	32	0	33	32	1056
		Total				**N=250**		**Σn(n - 1) =15202**

Appendix VI: Showing plant species in Kyangwali Block of Bugoma forest along transect A in KY-7compartment

Kyangwali Block	**KY-7 Compartment**	**Common names**	**256 037 E, 125765 N**	**256961 E, 124996N**	**256014 E, 125849N**			
Family name	species name	**Runyoro-Rutooro-English**	Number of individuals in each quadrat					
		Trees	QI	QII	QIII	Total(n)	n-1	n(n-1)
Combretaceae	*Combretum molle R.Br. ex G.Don*	Velvet leaved combretum - Omurama	2	0	0	2	1	2
Fabaceae	*Senna spectabilis (DC.) Irwin & Barneby*	American Cassia	0	0	1	1	0	0
Phyllanthaceae	*Bridelia micrantha (Hochst.) Baill.*	Omubaragaza	3	0	0	3	2	6
Euphorbiaceae	*Croton megalocarpus Hutch.*	Croton-munyabakaikuru	3	0	0	3	2	6
Moraceae	*Ficus Spp*	Fig	1	0	0	1	0	0
Apocynaceae	*Funtumia africana (Benth.) Stapf*	Bastard wild rubber,Omujwamata	1	0	0	1	0	0
Rutaceae	*Vepris nobilis (Delile) Mziray*	Omuzo,Teclea	1	0	0	1	0	0
Combretaceae	*Combretum Collinum*	Variable bush-willow		3	0	3	2	6
Fabaceae	*Tetrapleura tetraptera (Schumach. & Thonn.) Taub.*	Omunyege	2	0	0	2	1	2
Fabaceae	*Accacia Spp*	Omweramaino -	0	1	0	1	0	0
Bignoniaceae	*Spathodea campanulata P. Beauv.*	Tulip tree / Omunyara	0	1	0	1	0	0
Zygophyllaceae	*Balanites wilsoniana Dawe & Sprague*	Momulyenjojo	0	1	0	1	0	0
Moraceae	*Ficus mucuso Welw. ex Ficalho*	Omukunyu	0	2	0	2	1	2
Fabaceae	*Albizia zygia (DC.) J.F. Macbr.*	Murongo	0	0	3	3	2	6

unknown	*Unknown Spp*	Tr KY7-2	0	0	1	1	0	0
unknown	*Unknown Spp*	Orubwera	0	0	1	1	0	0

Shrubs								
Acanthathaceae	*Acanthus pubescens*	Amatoojo	6	5	8	19	18	342
Lamiaceae	*Hoslundia opposite*	Orutotoimya	3	0	0	3	2	6
unknown	*Unknown Spp*	Entonwa	1	0	0	1	0	0
unknown	*Unknown Spp*	Sh KY 7-4	1	0	0	1	0	0
unknown	*Unknown Spp*	Omuchundezi	0	1	0	1	0	0
Malvaceae	*Triumfetta rhomboidea*	Oruhugura/Empugura	0	4	0	4	3	12
Musaceae	*Ensete ventricosa*	Ekitembe	0	4	0	4	3	12
	Unknown Spp	Sh Ky 7-5	0	1	0	1	0	0
Asparagaceae	*Asparagus racemosus*	Akakwatango	0	0	2	2	1	2
Apocynaceae	*Tabernaemontana staffiana K.Schum.*	Akanyamagosi	0	0	12	12	11	132

Forest floor herbs								
Poaceae	*Imperata cylindrical*	Esoojo	2	0	0	2	1	2
Poaceae	*Unknown Spp*	Gr KY 7-4	11	0	0	11	10	110
Poaceae	*Unknown Spp*	Gr KY 7-5	5	0	0	5	4	20
Poaceae	*Unknown Spp*	Ekitumba Kyomurusozi	0	1	0	1	0	0
		Total				N=94		Σn(n - 1) =668

Appendix VII: Showing plant species in Muhangaizima Block of Bugoma forest along transect M in MU-10compartment

Muhangaizima Block (MU-10)		**Common names**	**269636N, 138443E**	**269621N, 138455E**				
Family name	**species name**	**Runyoro-Rutoro/English**	**No. of individuals**			**Total(n)**	**n-1**	**n(n-1)**
		Trees	**QI**	**QII**	**QIII**			
Fabaceae	*Erythrina abyssinica DC.*	Red-hot poker tree, Omuko	2	2	0	0	-1	0
Phyllanthaceae	*Bridelia micrantha (Hochst.) Baill.*	Omubaragaza	3	0	13	16	15	240
unknown	*Unknown Spp*	Thyminaria Glyssina	1	0	0	1	0	0
Moraceae	*Ficus Spp*	Ficus spp	2	1	0	3	2	6
Combretaceae	*Combretum Collinum*	Variable bush-willow	3	6	5	14	13	182
Fabaceae	*Accacia Spp*	muyege	2	0	4	6	5	30
Apocynaceae	*Funtumia elastica (Preuss) Stapf*	African wild rubber	4	0	1	5	4	20
Fabaceae	*Albizia gummifera (J.F.Gmel.) C.A.Sm.*	Peacock flower tree,Murongo	1	0	1	2	1	2
Euphorbiaceae	*Sapium ellipticum (Hochst.) Pax*	Omusasa	1	0	0	1	0	0
unknown	*Unknown Spp*	Omugufu (local name)	1	0	0	1	0	0
Sapotaceae	*Aningeria altissima (A.Chev.) Aubrév. & Pellegr.*	Aningre	2	4	3	9	8	72
Oleaceae	*Olea welwitschii (Knobl.) Gilg & G.Schellenb*	Mubengeya (local name)	2	0	0	2	1	2
Fabaceae	*Senna spectabilis (DC.) Irwin & Barneby.*	American Cassia	1	1	0	2	1	2
Sapindaceae	*Blighia unijugata Baker*	Omwataibaale-triangle top tree	1	1	0	2	1	2
Fabaceae	*Albizia gummifera (J.F.Gmel.) C.A.Sm.*	Peacock flower tree-Murongo	0	1	0	1	0	0
Meliaceae	*Trichilia dregeana Sond.*	Cape mahogany,Sekoba	0	1	0	1	0	0
Moraceae	*Antiaris toxicaria (J.F. Gmel.) Lesch*	false mvule,Kirundu	0	1	1	2	1	2
		Omusorongo	0	1	0	1	0	0
Rosaceae	*Hagenia abyssinica (Bruce) J.F.Gmel.*	African red wood	0	3	0	3	2	6

		T1 (Not named)	0	0	8	8	7	56
Bignoniaceae	*Markhamia lutea (Benth.) K.Schum.*	Markamia , Musambya	0	0	1	1	0	0
Meliaceae	*Trichilia dregeana Sond.*	Cape mahogany,Sekoba	0	0	1	1	0	0
Sapindaceae	*Blighia unijugata Baker*	Omwataibaale-triangle top tree	0	0	1	1	0	0

Shrubs								
Asteraceae	*Vernonia amygdalina Delile*	Ekibirizi, Bitterleaf	1	1		2	1	2
Acanthathaceae	*Acanthus pubescens*	Amatoojo	4	8	4	16	15	240
		Sh a(not named)	1	0	0	1	0	0
Apocynaceae	*Mondia whitei*	Murondwa	2	0	1	3	2	6
Fabaceae	*Tetrapleura tetraptera (Schumach. & Thonn.) Taub.*	Omunyege	0	1	0	1	0	0
Melianthaceae	***Bersama abyssinica** Fresen*	omuhungurra	0	8	0	8	7	56

Passifloraceae	*Adenia schweinfurthii*	Ekihuru ckyiiju	0	0	2	2	1	2
unknown	*Unknown Spp*	Amasomi	0	0	5	5	4	20
unknown	*Unknown Spp*	Oruliga	0	0	1	1	0	0
unknown	*Unknown Spp*	Kibonde	0	0	3	3	2	6

Forest floor herbs								
unknown	*Unknown Spp*	G I (not named)	4	0	0	4	3	12
unknown	*Unknown Spp*	Akayisabaisaba(local name)	1	0	0	1	0	0
unknown	*Unknown Spp*	Amasomi (local name)	2	12	0	14	13	182
unknown	*Unknown Spp*	Orukibikibi (local name)	1	0	0	1	0	0
Apiaceae	*Centella asiatica (L.) Urb*	Embutami (local name)	7	28	13	48	47	2256
Commelinaceae	*Commelina tuberosa*	Ekiteza-wondering jew	3	0	0	3	2	6
unknown	*Unknown Spp*	Kakinga (local name)	2	0	0	2	1	2
unknown	*Unknown Spp*	Oruliga (local name)	1	0	0	1	0	0
unknown	*Unknown Spp*	Eryangabi (local name)	1	5	0	6	5	30
Asteraceae	*Blumea perotteniana*	Omurubata	0	3	0	3	2	6
unknown	*Unknown Spp*	G2(Not named)	0	2	0	2	1	2
unknown	*Unknown Spp*	G3	0	2	0	2	1	2
Malvaceae	*Triumfetta rhomboidea*	Oruhugura/Empugura	0	0	4	4	3	12
unknown	*Unknown Spp*	Obunyangabi	0	0	13	13	12	156
unknown	*Unknown Spp*	Omunyungwente	0	0	1	1	0	0
		Total				**N=234**		**Σn(n - 1) =3620**

Appendix VIII: Showing plant species in Muhangaizima Block of Bugoma forest along transect U in MU-11 compartment

Muhangaizima Block -MU 11 Compartment Mature Forest		**Common names**	**269268E, 138882N**		**269301E, 138972N**			
Family name	**species name**	**Runyoro-Rutooro-English**	**Number of individuals in each quadrat**					
		Trees	QI	QII	QIII	Total(n)	n-1	n(n-1)
unknown	*Unknown Spp*	Moollesi Lactea	1	1	0	0	1	2
Cannabaceae	*Celtis durandii Engl.*	Mujunju, stinkwood	1	0	2	3	2	6
Rhamnaceae	*Lasiodiscus mildbraedii Engl.*	Nyamaigya	2	0	0	2	1	2
Ulmaceae	*Celtis wightii Planch*	Celtis	1	0	0	1	0	0
Euphorbiaceae	*Alchornea cordifolia (Schumach. & Thonn.) Müll.Arg.*	Alconia	4	2	2	8	7	56
Rubiaceae	*Coffea canephora*	Coffea	1	0	0	1	0	0
Sapotaceae	*Chrysophyllum perpulchrum*	Monkey star apple	5	0	0	5	4	20
Meliaceae	*Trichilia dregeana Sond.*	Cape mahogany	0	1	0	1	0	0
Rutaceae	*Fagaropsis angolensis (Engl.) H.M.Gardner*	Muyinja	0	1	0	1	0	0
Sapotaceae	*Chrysophyllum albidum G.Don*	White star apple	0	2	0	2	1	2
Fabaceae	*Albizia zygia (DC.) J.F. Macbr.*	Murongo	0	1	0	1	0	0
Fabaceae	*Senna spectabilis (DC.) Irwin & Barneby.*	American Cassia	0	1	0	1	0	0

Apocynaceae	*Funtumia elastica (Preuss) Stapf*	African wild rubber	0	0	3	3	2	6
Phyllanthaceae	*Margaritaria discoidea (Baill.) G.L.Webster*	Ebebeng	0	0	1	1	0	0
Meliaceae	*Khaya anthotheca (Welw.) C.DC.*	Red mahogany	0	0	6	6	5	30
Bignoniaceae	*Markhamia lutea (Benth.) K.Schum.*	Markamia , Musambya	0	0	2	2	1	2
Moraceae	*Antiaris toxicaria (J.F. Gmel.) Lesch*	false mvule,Kirundu	0	0	1	1	0	0
Meliaceae	*Trichilia dregeana Sond.*	Cape mahogany,Sekoba	0	0	32	32	31	992

Shrubs								
unknown	*Unknown Spp*	Sh- MU 11-1 (embazibahigi)	10	19	0	29	28	812
unknown	*Unknown Spp*	Sh- MU 11-2 (Not named)	19	20	21	60	59	3540

Grasses								
		No grasses found in this mauture part of the forest. The floor is littered with dry tree leaves and the canopy is thick and closed	0	0	0	0	-1	0
		Total				N=160		Σn(n - 1) =5470

Appendix IX: Showing plant species in Muhangaizima Block of Bugoma forest along transect H in MU-12 compartment

Muhangaizima MU-12 Compartment		**Common names**	**265851, 140387**		**265786, 140320**		**265774, 140295**	
Family name	**species name**	**Runyoro-Rutooro-English**	**Number of individuals in each quadrat**					
		Tree SPP	**QI**	**QII**	**QIII**	**Total(n)**	**n-1**	**n(n-1)**
Anarcadiaceae	*Lannea welwitschii (Hiern) Engl.*	Lannea	1	0	0	1	0	0
Sterculiaceae	*Cola gigantea A.Chev.*	Cola-Mujugangoma	1	1	2	4	3	12
Phyllanthaceae	*Margaritaria discoidea (Baill.) G.L.Webster*	Ebebeng	1	0	0	1	0	0
Rutaceae	*Fagaropsis angolensis (Engl.) H.M.Gardner*	Mumara	1	0	0	1	0	0

Shrubs								
Asteraceae	*Vernonia amygdalina Delile*	Ekibirizi, Bitterleaf	4	7	3	14	13	182
		Sh Mu 12-1 (Not named)	1	0	0	1	0	0
Myrsinaceae	*Maesa lanceolata Forssk.*	Maesa, Omuhangabagenzi	2	0	0	2	1	2
Solanaceae	*Capsicum frutescens*	Red peper(red chilli)	2	0	0	2	1	2
unknown	*Unknown Spp*	Sh Mu 12-2(Ekyoganyanje)	2	0	0	2	1	2
unknown	*Unknown Spp*	Sh MU 12-3 (not named)	4	0	0	4	3	12
unknown	*Unknown Spp*	Sh MU 12- 4	4	0	0	4	3	12
unknown	*Unknown Spp*	Sh MU 12-5	0	2	0	2	1	2
unknown	*Unknown Spp*	Sh MU 12-6	0	1	0	1	0	0
unknown	*Unknown Spp*	Sh MU 12-7	0	10	6	16	15	240
Verbenaceae	*Lantana camara*	Lantana	0	1	0	1	0	0

unknown	*Unknown Spp*	Sh Mu 12-8	0	13	0	13	12	156	
unknown	*Unknown Spp*	Sh MU 12-9	0	1	0	1	0	0	
Zingiberaceae	*Aframomum angustifolium*	Amatehe-wild cardamom	0	0	23	23	22	506	
Asteraceae	Biden pilosa	Enyabarasana	43	0	83	126	125	15750	
Solonaceae	Solanum nigrum	black night shade-Enswiiga	1	0	0	1	0	0	
		Gr- MU 12-1	0	13	0	13	12	156	
		Total				**N=233**		**Σn(n - 1) =17034**	

Appendix X: Sorensen's coefficient and Jaccards's similarity indices computation for tree, shrub and forest herb species

Sorensen's similarity coefficient for Kyangwali and Muhangaizima

$$\text{BlockSorensen's Coefficient (SC)} = \frac{2c}{S1+S2}$$

Where C is the number of species the two communities have in common, S1 is the total numberof species found in community 1, and S2 is the total number of species found in community 2

Community 1 (S1) is Kyangwali block – 43Community 2(S2) is Muhangaizima Block

$$= \frac{2*6}{43+5}$$

$$= \frac{12}{88}$$

$$= \mathbf{0.1364}$$

$$J = \frac{6}{37 + 39 + 6}$$

$$= 0.0732*100$$

$$=7.3\%$$

Appendix X: Form for tallying and recording the number of individuals of each speciesin the quadrats

Study site……

Name of Species	Tally	Total, n	% cover	Number of quadrants
Tree				
A				
B				
C				
D				
Shrub				
H				
I				
J				
K				
Forest floor Herbs				
O				
P				
Q				
R				

Appendix XI: Household Questionnaire for Socio-economic data collection

THE EFFECT OF REFUGEE POPULATION INFLUX ON PLANT DIVERSITY OF BUGOMA FOREST, UGANDA

House hold Questionnaire for Pre testing

Dear respondent, am Bihunirwa Medius a student at Kyambogo University pursuing a Masters of Science in Conservation and Natural Resource Management. I'm conducting a study on the effect of refugee population influx on plant diversity of Bugoma Forest. You have been identified as a key stakeholder and thus requested to participate in this study as a household respondent. Feel free to answer diligently as your responses will be used purely for academic purposes and your responses shall be kept anonymous

Date …….

Location of the Household Refugee settlement …… Host community ……

Zone…….Village..... (for refugees)

Sub-county……. Parish……Village..... (For nationals)

Household Soccio - demographic information

Instruction: Please tick (□) the most appropriate answer and where applicable write answers in the space provided.

6.3 House hold head sex 1)Male. 2) Female

2 House hold size …….. Household land acreage ……

3. Household head marital status 1) Single 2) Married 3) Divorced 4) Widowed

4. Respondent sex 1) Male…… 2)Female Respondent's age----------

Respondent telephone contact……..

5. Respondents education Level:1) Non formal Education 2) Primary 3) Secondary 4) Certificate 6) Diploma6) Bachelor's Degree 7) Others please specify; ……

6. Respondent's relationship with the house hold head Spouse…… Child…… others please specify …….

7. Years of stay in the refugee settlement 1) 0- 1 year 2) 2-3 years 3) 4-5 years 6+ years (for refugee only)

8. Country of Origin 1) Democratic Repulic of Congo 2) Rwanda 3) Burundi 4) South Sudan 5) others…..... (for Refugees only)

9. Are you a member of community group 1) yes 2) No

10. If yes, which of the following community groups do you belong to?

1) Farming group 2) Village Savings and Loan Association(VSLA) 3) produce marketing cooperative 4) SACCO 5) church group 6) Drama group
7) others specify……...

Household Economic/livelihood and health information

11. Household main sources of income 1) Agriculture 2) hire of labour 3) formal employment 4) Business 5) Others please specify; ……. ……

12. Household income level 1) Less than shs 200,000 2) shs 200,000 – 500,000 3) shs 500,000-1,000,000 4) 1,000,000 and above

13 Do you or any member of your household have savings with the following

1) VSLA 2) SACCO 3) Bank 4) Micro finance Institution 5) friend or neighbor 6) personal saving box at home 7) others specify…..8) Non

14 Have you or any member of your household accessed a loan from the following in the last 3 months?

2) VSLA 2) SACCO 3) Bank 4) Micro finance Institution 5) friend or neighbor 6) money lender 7) others specify .....8) Non

15. Do you or any member of your household receive cash on monthly basis from the following
1) World Food Programme 2) UNHCR 3) Cash from any implementing partner in the

refugee settlement 4) Government 5) family member 6) a friend 7) others please specify……

16 (a). Which forest resources do you use to supplement your household income?

1)fire wood 2) Charcoal 3) fruits 4) mushrooms 5) honey 6) herbal medicine 7) materials for craft making 8) timber or wood for building materials 9. Non

16 (b) How often get the above material /products from the forest. 1). Once a week 2). Twice a week 3) Once a month 4). Twice a month 5). others please specify……

16 (c). What are the sources of the forest resources above? 1) Government/Bugoma forest 2) Private forests 3). Settlement tree/ woodlots 4) own woodlot 5) Others please specify; …….

17 Which human activities are done in Bugoma forest by people

1) Crop production 2) Animal rearing 3) Charcoal burning 4) Tree cutting for fire wood 5) Tree cutting for building materials 6) Timber production 7) Herbal medicine collection 8) fruits collection 9) collection of materials for hand craft 1 0) others please specify……..

18. Which of the following assets does your household own 1) radio 2) bicycle 3) car 4) goats 5) chicken 6) cows 7) others please specify…… 8) Non

19. Numbers of meals consumed in the household per day? 1) one meal 2) 2 meals 3) 3 meals

4)Others please specify; …….

20 a). How many times do you cook beans in your household?
Once a week

2 times a week3 times a week4 times a week

5 times a week6 times a week7 times a weekNone

20 b). Do you soak dry beans before cooking them in your household?

Yes No

21. Do you cover your food when cooking it?

Yes No

20. What are the main sources of food for your household 1) own garden 2) World Food Program

3) Market 4) hire of labour for food 5) Others please specify; …….

21. Does your household receive food Assistance on a monthly basis from World Food Programme

1) yes 2) No. (For refugee households only)

22 (a). Which forest resources do you use to supplement your household food

1) Fruits 2) Mush rooms 3) Honey 4) Vegetables 5) others please specify…….

23 (b) List the most preferred plants for foods and fruits that you collect from the forest

……

24. Where do your household members access health services whenever they are sick

1) health centre in my area 2. Buy drugs from a drug shop 3) Traditional healer

4) Use spiritual healing(Prayers) 5) Others please specify; …….

25 (a). Do you at times use herbal medicine in your house hold 1) Yes 2) No.

26 (b). If Yes, list the local names of the most preferred herbs that you usually use in your household

……
……

House hold energy access and consumption

27. Numbers of meals cooked in the household per day 1) one meal 2) 2 meals 3) 3 meals 4)Others please specify; …….

28. Cooking technology/ cooking stove currently used by the house hold 1) three cooking stones 2) Mud stoves 3) Metallic stoves 4) Ceramic stoves 5. Others Please specify;…….

29. Household main source of energy for cooking 1) Fire wood 2) charcoal 3) briquettes 4)

Paraffin 5) Biogas 6) Electricity 7) Others please specify;…….

30(a) Quantity of fire wood used by the house hold per day1)1-2 kgs 2) 3-4kgs 3)5-6kgs 4) 7-8kgs 5) 9-10kgs 6) 11qks and above 7) None……

30(b) Quantity of fire wood used by the house hold per week……

30(c) Where does household access fire wood for cooking 1) Government Forest (Bugoma forest) 2) Own house hold woodlot 4) Community woodlot 4) Private woodlot 5) market

6) Others please specify;……

31 (a) Quantity of charcoal used by the house hold per day day1)1-2 kgs 2) 3-4kgs 3) 5-6kgs 4) 7-8kgs 5) 9-10kgs 6) 11qks and above 7) None…….

31 (b) Quantity of charcoal used by the house hold per week……..

31 (c) Where does your household access charcoal for cooking 1) Government Forest /Bugoma 2) Own house hold woodlot 4) Community woodlot 4) Private woodlot 5) market

6) Others please specify; ……

32(a) list the local names of the most preferred trees for fire wood or charcoal

……..

Household access to alternative energy sources

33 (a) Have you accessed information on improved cook stoves? 1) Yes) No.

33 (b)If yes, Name the source of your information about the improved cook stoves

……

34. What do you think can be done to improve the adoption of improved or alternatives cook stoves by your household and other households in your village?

……

……

This is the end of the questionnaire. Thank you for your valuable time.

FAO/UNHCR. 2016. Assessing wood fuel supply and demand in displacement settings,guided the development of this questionnaire

Appendix XII: Questionnaire for InstitutionsQuestionnaire for Institutions

Dear respondent,

My name is Bihunirwa Medius and Iam a student at Kyambogo University pursuing a Masters of Science in Conservation and Natural Resource Management. Iam conducting a study on the effect of Refugee population influx on Bugoma Forest plant diversity. Your institution has been identified as a respondent and thus requested to participate in this study. Feel free to answer diligently as your responses will be used purely for academic purposes and your responses shall be kept anonymous

Background Information

1. Location of institution 1) Refugee settlement 2) Host community

2. Type of institution1) Reception Centre 2) Primary school 3) Secondary School 4)Technical School

5) Health Centre 6) Restaurant 7) Others please specify

3. Designation of the respondent……

4. Telephone contact of the Respondent…….

5(a) Institution size.....(no of students at school, No. of refugees, No. of clients, No. of patients.....)

(b) Number served with meals on average per day ……

(c) No of people served with meals per day during peak of emergency influx ……. (for reception centre and other institutions in refugee settlement)

Energy access and consumption

6. Numbers of meals cooked in the institution per day 1) one meal 2) 2 meals 3) 3 meals

7. Others please specify; …….

8. Cooking technology/ cooking stove currently used by the institution1) three cooking stones 2) Mud stoves 3) Metallic stoves 4) Improved institutional stoves

5. Others Please specify; …….

9. Institution main source of cooking energy 1) Fire wood 2) charcoal 3) briquettes 4) Paraffin

5) Biogas 6) Electricity 7) Others please specify;…….

10(a) Quantity of fire wood used by the institution per week…….

(b) Quantity of fire wood used by the institution per Month ……

(c)Where main source of fire wood used by the institution for cooking 1) Government Forest 2) Own institution woodlot 4) Community woodlot 4) Private woodlot 5) market

6) Others please specify;……

11(a)Quantity of charcoal used by the institution per day……..

(b) Quantity of charcoal used by the institution per week……..

(c) Where does institution access charcoal for cooking 1) Government Forest 2) Own house hold woodlot 4) Community woodlot 4) Private woodlot 5) market

6) Others please specify; ……

12(a) list the local names/ scientific names of the trees most preferred for fired wood or charcoal by your cooks .....(This question is to be responded too most preferably by the institution cooks)

Institution access to alternative energy sources

13 (a) Have you accessed information on improved Institutional cook stoves? 1) Yes) No.

(b)If yes, Name the source of your information about the improved cook stoves

…….

14(a)What was the quantity of wood fuel used by your institution per month while using the tradition 3 cooking stones……? (For only those using improved stoves)

(b)What is the quantity of wood fuel used by your institution per month after adopting an improved institutional cook stoves? ..... (For only those using improved stoves)

15.What do you think can be done to improve the adoption of improved or alternatives

institutional stoves by your institution or other institutions in your village?

……

……

……

……

This is the end of the questionnaire. Thank you for your valuable time.