THE IMPACT OF REFUGEE SETTLEMENT ON VEGETATION AND LAND USE CHANGES IN IMVEPI, ARUA DISTRICT, NORTH WESTERN UGANDA

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A DISSERTATION SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY AND SOCIAL STUDIES IN PARTIAL FULFILLMENT OF THE REQUIRMENTS FOR THE AWARD OF A MASTER OF ARTS IN GEOGRAPHY DEGREE OF KYAMBOGO UNIVERSITY

AUGUST 2021

ABSTRACT

With increasing refugee influx into Uganda, environmental degradation especially of vegetation cover, with possible irreversible effects is likely in refugee hosting centers. This study aimed at ascertaining the impact of refugee settlement on vegetation and land use changes in Imvepi in Arua District-Uganda. Specifically, the study sought to; to examine the extent and trend of vegetation and land use changes between 2016 and 2019, assess the quantities of fuel-wood harvested by refugees and to analyze the determinants of fuel-wood usage by refugees. Sentinel 2A Imagery data of the study area for four years (2016-2019) were used to map the changes in vegetation and land use, using the Maximum likelihood classification algorithm in QGIS 3.12 software. Following a cross-sectional study design, a sample of 221 households from refugees and hosting community were selected using systematic random and purposive sampling procedures. From these, socio-economic data was collected using questionnaire, interview and focused group discussions. The collected data was analyzed using descriptive statistics, Multiple Response and content analyses. At inferential level, statistical tests were computed using Paired-Samples T-Test and Binomial Statistical Test. Results showed that, woodlands and bushlands declined by 19% and 7%, respectively whilst farmland increased by 27% during the period under study. Refugees collected an average daily head-weight of wet and dry wood of 16 and 12 kg, respectively while average daily, and weekly weight of 2 kg and 1.2 basins of charcoal, respectively. The quantities of dry and wet fuel-wood harvested and used by refugees varied significantly. Family size, culture, poverty, type of food cooked, weak enforcement of environmental policies and methods of cooking significantly determined the quantities of wood and charcoal harvested and used in Imvepi refugee settlement. The study concludes that settling refugees in Imvepi has caused woodland and bushland vegetation degradation. The decision was associated with the need for built-up infrastructure, agricultural land expansion and large-scale fuel-wood consumption. Therefore, programs to revegetate degraded wood and bushlands, restrict refugee numbers at given settlements, promote use of fuel-wood saving techniques, and improve the economic status of refugee households should be emphasized by the UNHCR and the government.

DECLARATION

I **Mweru Aron** declare that this dissertation has never been submitted or presented to any University or institution of higher learning for any degree award.

Signature………………………………   Date…………………………………

17/U/14404/GMAG/PD

APPROVAL

I certify that this dissertation has been compiled under my guidance and supervision and is now ready for submission with my approval.

Signature……………………………… Date…………………………………

DR. BARASA BERNARD

MAIN SUPERVISOR

Signature……………………………… Date…………………………………

DR. TURYABANAWE LOY GUMISIRIZA

SECOND SUPERVISOR

DEDICATION

I dedicate this dissertation to my parents; Fred Masette and Betty Nekesa, my siblings; Flavia, Joan and Edward.

ACKNOWLEDGEMENT

I would like to extend my earnest appreciation to my supervisors, Dr. Barasa Bernard and Dr. Turyabanawe Loy for their intellectual guidance and supervision, throughout the research process. I am also thankful to the entire Department of Geography and Social Studies for all the support and guidance throughout this course and for research funding through the research grants of the University.

I also thank my research assistants; Mr. Nyarwaya Amos and Mr. Muzei John Paul for all the support rendered during field data collection. Appreciation also goes to all persons who participated in questionnaire survey, interview sessions and focus group discussions. I express my deep appreciation to my course mates Alex, Alice, Joel, Joseph, Jackson and Evaristo for the encouragement during the study program.

Am indebted to my workplace colleagues especially Mr. Kinataama John Oscar and Ms. Nakakawa Prossy for the support, which enabled me to be off my duty station, on some days, to concentrate on this study program. I also appreciate the encouragement offered by my friends especially Mr. Twebaze Shafik and Mr. Mbabali Frank.

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ACRONYMS

BST	-	Binomial Statistical Test
DCA	-	Danish Church Aid
ESA	-	European Space Agency
FAO	-	Food and Agriculture Organization of the United Nations
FGD	-	Focus Group Discussion
ICRC	-	International Committee of the Red Cross
IDP	-	Internally Displaced Person
IEA	-	International Energy Agency
MRA	-	Multiple Response Analysis
NDVI	-	Normalized Distance Vegetation Index
NGO	-	Non-Governmental Organizations
OAU	-	Organization of African Unity
OS	-	Operating System
POCs	-	Persons of Concern
SCP	-	Semi-Automatic Classification Plugin
UN	-	United Nations
UNC	-	United Nations Convention
UNDP	-	United Nations Development Program
UNEP	-	United Nations Environmental Program
UNHCR	-	United Nations High Commission for Refugees
USGS	-	United States Geological Society
WFP	-	World Food Program

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The study focused on assessing the impact of refugee settlement on vegetation cover in Imvepi refugee camp in Arua District in West Nile region of Uganda and in this chapter, the background, statement of the problem, objectives, research questions, significance, scope and the conceptual framework of the study are presented.

1.2 Background of the Study

The United Nations High Commission for Refugees (UNHCR) defines a refugee as a person who has been pushed away from his or her home and seeks asylum elsewhere (UNHCR/IUCN, 2005). The term is also used to include displaced persons, either due to war, fear of persecution or because they have been forced to migrate within their home countries (Hyndman and Nylund, 1998). By the end of 2017, 68.5 million individuals had been forcibly displaced worldwide because of persecution, conflict, violence, or human rights violations, registering an increase of about 2.9 million people over the previous year. This included 25 million refugees in the world, 40 million internally displaced people, and 3.1 million asylum seekers (UNHCR, 2018). By the end of 2019, the number of displaced persons had reached 79.5 million people (Maystadt et al., 2020; UNHCR, 2020). This makes the refugee crisis a global challenge as different countries have registered a form of turmoil that has displaced people from their native countries.

In Africa, more than 99 percent of refugees come from South Sudan, Rwanda, Burundi, DRC, Somalia, Eritrea and Sudan (UNHCR, 2016). These are accommodated in a number of refugee settlements, characterized by limited services and opportunities, and depend largely on humanitarian assistance (Maystadt et al., 2020). Since 2013, nearly 1 million men, women and children have fled their homes in desperation, seeking refuge within mosques and churches, as well as in neighboring countries mainly in Cameroon, the Democratic Republic of Congo, Chad and the Republic of the Congo (Kreibaum, 2016; Maystadt et al., 2020).

In Ethiopia by 2017, 883,546 refugees, mainly from neighboring countries were hosted, making it the second largest refugee hosting country in Africa (Othow et al., 2017; Gebre & Andualem, 2018; UNHCR, 2019). Kenya is also a home to “a substantial indigenous Somali Kenyan population” living mainly in the North Eastern region (Lindley, 2007). Located in the horn of the Africa, Somalia is a home to roughly 9 million people, the overwhelming majority of whom are ethnic Somalis (UN Statistics Division, 2010). The country has been plagued with conflict and disorder, which ensued just years after it attained independence. Following the overthrow of President Siyyad Barre in 1991 and the chaos that subsequently ensued, Somalis migrated rapidly from inside the boundaries of Somalia and settled in various nearby locations within East Africa. The largest recipient of Somali refugees in Africa is Kenya, with an influx of thousands more every month for roughly the last twenty years (Meyer et al., 2019). Officially, refugees are confined to designated camps, however, it is common for Somalis to migrate into Nairobi. The Government of Kenya has largely taken a passive approach to refugee assistance and instead, has placed the burden on intergovernmental and non-governmental organizations. Most significantly, the UNHCR has taken the lead to help mitigate the problems posed by refugees in Kenya.

Uganda too is a home to a number of refugees and over one million of them have been hosted in the last two years making it the third-largest refugee hosting country after Turkey and Pakistan globally (Ahimbisibwe, 2019; Komaketch et al., 2019; Schiltz et al., 2019). By 2020, the number of refugees was estimated at 1.4 million mainly coming from South Sudan, Burundi and DRC (UNHCR, 2020). Increased wars, violence and persecution in the Great lakes region and the Horn has seen Uganda emerge as the largest asylum country in the region but also among the largest globally (Meyer et al., 2019). Renewed conflict in South Sudan in 2016 saw an influx of refugees almost doubling the population in all receiving centers in Northern Uganda (Justin and Van Leeuwen, 2016; UNHCR 2019). For this reason, the West Nile Sub region neighboring South Sudan hosts the largest number of refugees and asylum seekers reaching up to approximately 717,779 people (Mogga, 2017; UNHCR, 2019). The trend is projected to worsen, owing to the ongoing political tensions, insecurity, and social instability prevailing in South Sudan (Lyytinen, 2017).

With Uganda’s open policy on refugees, there is no doubt that refugees will continue to flock the country from different directions (Hovil, 2018). Increase in refugee’s results into not only humanitarian crisis but also causes irreversible environmental damages if no apt mitigation measures are not provided for. Increased refugee influx means increased pressure on natural resources especially vegetation at the receiving centers since vegetation becomes the most sought-after resource to provide building materials and fuel-wood for daily cooking and heating energy needs (Kreibaum, 2016; Barbieri et al., 2018). Besides, large expanses of vegetated land are cleared to establish shelter units, support infrastructure and carry out farming (UNHCR, 2017; UNHCR, 2019). Selling of non-wood forest products to generate income is also common among refugees (Young and Goldman, 2015). This means that with refugee settlement comes a number of land use/cover changes. The situation has been made worse here by the fact that refugees are accorded land access and use rights but not ownership (Cullis, 2020). In some areas, the refugees just walk in and start using the land whose productivity varies whilst fuel-wood selling becomes a quick form of livelihood (UNHCR, 2018). All these imply that cases of irresponsible use of environmental resources are likely to emerge. Besides, the limited physical planning in refugee settlements due to lack of technical expertise (UNHCR, 2018) implies that there is limited due diligence to environmental protection in refugee settlements. Thus refugee settlements inevitably result into environmental degradation, reduced ground water recharge and supply, reduced food and nutrition security and increased conflicts over resources with the host community (Milburn 2015; Ratner et al., 2017; Ruiz & Vargas-Silva, 2018). This calls for studies to establish exactly the impact of refugee settlements in specific areas so that the prescribed measures are customized to specific settlements.

1.3 Statement of the Problem

Natural forms of vegetation play an important role in terms of the ecosystem goods and services obtained thereof (Yapp et al., 2010). For refugee settlements that are established adjacent to critical vegetation forms like Imvepi in West Nile, these ecosystems are facing high levels of degradation and threats of extinction. Whereas various studies have been conducted on refugees in different parts of the world (e.g. Miller, 2018; Muller & Yan 2017; Vogelsang, 2017; Riley et al., 2017), the impact of refugee settlement of vegetation cover and the quantities of fuel-wood consumed in refugee settlements is less documented in Northern Uganda (FAO, 2017; UNHCR, 2017; UNHCR, 2019) and yet refugees flocking into the country increases on an annual basis and finding lasting solutions for the refugee crisis has become a major challenge worldwide (Esses et al., 2017). To date, studies quantifying the actual state of land use changes and vegetation degradation related to refugee settlement establishment are rear (Imtiaz 2018; Ali et al., 2019; Musa et al., 2019). Moreover, the refugee conventions in Uganda provide for refugee hosting communities to allow refugees to exercise human rights including access to and ownership of natural resources with likely environmental impacts especially on the visible elements of environmental resources like vegetation and water. Besides, previous studies have made use of relatively coarse resolution data like Landsat and MODIS but less of recently launched Sentinel series sensor data with more spatial features change detection capabilities due to the high spatial resolution. Vegetation cover and land use changes are also continuous that information provided by historical studies may not reflect recent changes (Parveen et al., 2018). Ascertaining information on vegetation and land use changes, wood-fuel consumption and its determinants in refugee settlements is central to the planning processes for possible new refugee settlements and decongestion of existing ones and environmental management. This study therefore sought to quantify the vegetation and land cover changes and establish the quantities and determinants of firewood and charcoal fuel use amongst the refugees in Imvepi refugee settlement in Arua District, Northern Western Uganda.

1.4 Study Objectives and Research Questions

1.4.1 General Objective

The main objective of the study was to ascertain the status of vegetation resources and land use types in Imvepi refugee settlement in Arua district so as to guide proper decision making for vegetation resources management and land use planning under the increasing refugee population in Uganda.

1.4.2 Specific Objectives

The specific objectives of the study were:

i. To examine the extent and trend of vegetation and land use changes between 2016 and 2019 in Imvepi refuge settlement in Arua District.
ii. To assess the quantities of fuel-wood harvested by refugees in Imvepi refugee settlement.
iii. To analyze the determinants of fuel-wood use by refugees in Imvepi refugee settlement.

1.4.3 Research Questions

The following research questions were central to investigating the research problem:

1. **What is the extent and trend of vegetation and land use types between 2016 and 2019?**

    a) What is the transition in vegetation and land use types?
    b) Which vegetation types are the most deforested and degraded?

2. **What are the quantities of fuel-wood harvested by the refugees?**

    a) What is the amount of firewood/charcoal used?
    b) How many times is firewood/charcoal acquired per week?
    c) Which vegetation types have contributed more firewood and charcoal?

3. **What are the determinants of the amount of fuel-wood access and usage in Imvepi refugee settlement?**

    a) Do the refugees use more firewood or charcoal?
    b) What determines the quantities of firewood and charcoal used in Imvepi refugee settlement?

1.5 Significance of the Study

With the influx of refugees into Uganda and other countries all over the world, the findings from this study ought to help to streamline polices related to refugee settlement planning, resource utilization and environmental management in refugee settlements and the hosting communities.

This study highlights the state of vegetation cover in the refugee settlement vis-à-vis land use changes and fuel-wood consumption, which information ought to go a long way in commutating the impact of such a decision especially in areas where vegetation cover is already faced with environmental and anthropogenic stresses, thus calling for meticulous care when implementing decisions related to refugee settlement. Allocation of land to refugees, like it is the case with the refugee settlement in Northern Uganda should be guided by the study findings as it highlights the impacts associated with such a decision to allocate or not.

The study findings indicate the thresholds for refugee numbers for permissible environmental resources access such that if refugee numbers rise above, plans are made for either resettlement of excesses or relocation of the settlement. The study demonstrated that increased refugee numbers is associated with increased fuel-wood requirements and land for agricultural production.

The study findings here provide insights into the need to develop resource conservation technologies in Refugee settlements like use of alternatives to fuel-wood and/ or fuel-wood saving techniques. These are areas of intervention by humanitarian agencies like the UNHCR.

The study involved assessment of vegetation and land use changes brought about settling refugees in Imvepi using Remote Sensing and GIS techniques; demonstrating practical applicability of these techniques in similar studies elsewhere. The information generated from the study is an addition to the existing body of knowledge on refugee settlement and related impact, which other researchers can hinge on to address future research needs.

1.6 Scope of the Study

1.6.1 Geographic Scope

The study was conducted in Imvepi refugee settlement area located in Arua district in Northern western Uganda. The camp is among those designated to host refugees during the insurgence in South Sudan in 2016. Imvepi settlement hosts over 63,116 refugees and the numbers are projected to increase as uncertainties in the social, economic and political situations continues to linger on in South Sudan and DRC (the major centers of displacement) (Watera et al., 2018; OPM, 2019; UNHCR, 2020). The camp was selected for the study due to its proximity to the countries with a history of political turmoil.

1.6.2 Content Scope

The study concentrated on assessing the changes in vegetation and land uses around Imvepi refugee settlement, the quantities of firewood and charcoal used by refugee households, and the determinates of these fuel types access and usage. This was aimed at establishing whether the government decision to settle refugees in Imvepi refugee settlement is associated with significant changes in land resources usage thus degradation or otherwise.

1.6.3 Time Scope

The data used in this study was derived from both primary and secondary sources. Primary/field data was collected over a period of three months that is, between April and July 2019. Secondary data/Sentinel satellite data used was for four years that is, 2016, 2017, 2018 & 2019. This period corresponds to the time of political unrest in South Sudan that saw thousands of people displaced into northern parts of Uganda (Lyytinen, 2017).

1.7 Conceptual framework

In the conceptual framework for this, study (Figure 1.1), refugee settlement and associated needs form the independent variable while vegetation cover and land use changes are the dependent variables.

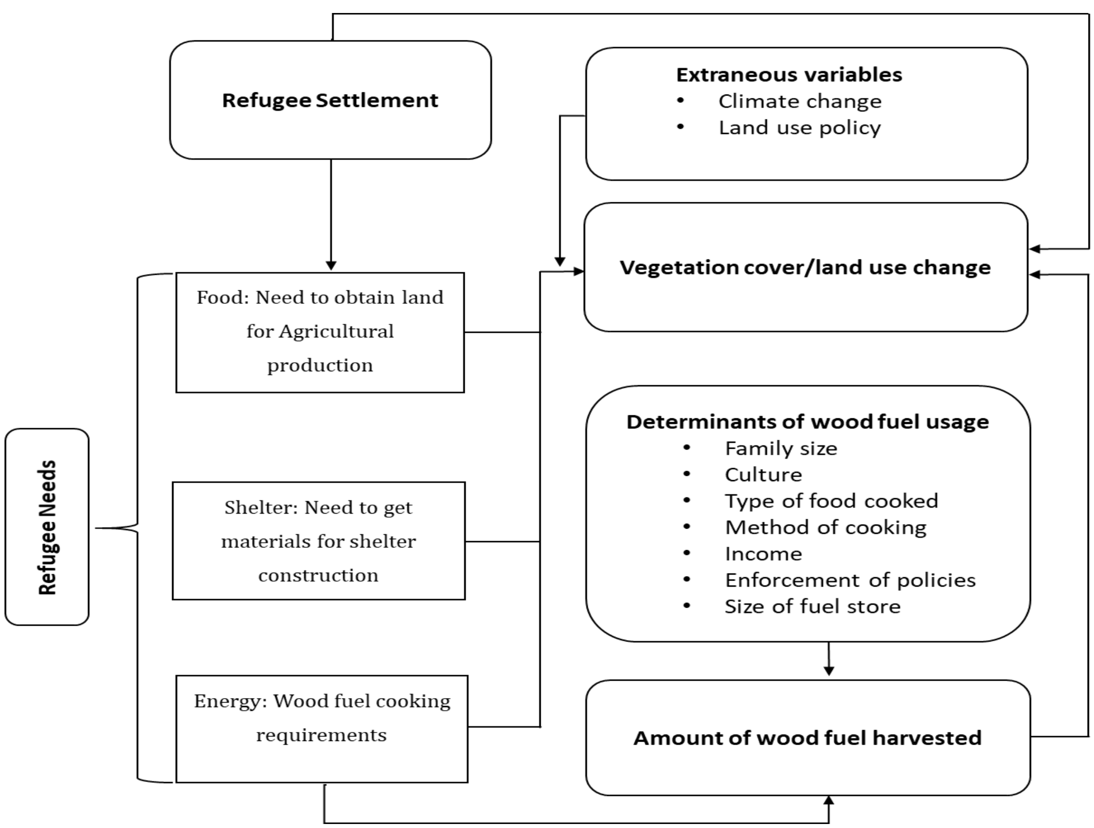

Figure 1.1: Conceptual frameworks for the study (Source: Author's own conception)

It is hypothesized that on arriving into the country refugees need land for agriculture (to produce food), materials for shelter construction and wood for fuel (Kreibaum, 2016). While meeting these needs, several actions are involved which result into vegetation cover and land use changes. In meeting the energy needs, different quantities of wood are harvested and used. This is due to factors (determinants) such as family size, culture, poverty, type of food cooked, and method of cooking, weak enforcement and distance to fuel-wood collection centers, size of fuel-wood store among others. The relationship between refugee settlement and vegetation and land use change is however, interfered with by extraneous variables such as climate change and land use policy.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents the findings by previous scholars on the subject matter of investigation in form of a review. It covers a review of the literature related to the effect of refugee settlement on vegetation cover and land use changes.

2.2 Refugees and refugee settlement

A refugee is a person who has been pushed away from his or her home and seeks asylum elsewhere (UNHCR, 2019). Under the U.N.C, a refugee is defined (in Article 1A) as a person who "owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion is outside the country of his nationality, is unable to or owing to such fear and is unwilling to avail himself of the protection of that country". The term refugee is often used to include displaced persons who may fall outside the legal definition in the convention, either because they have left their home countries because of war and not because of fear of persecution, or because they have been forced to migrate within their home countries (Merkx, 2002; Muller & Yan, 2017; Miller, 2018; UNHCR, 2019). The Convention governing the specific aspects of refugee problems in Africa adopted by the O.A.U in 1969 employs a definition expanded from the Convention including people who left their countries of origin not only because of persecution but also due to acts of external aggression, occupation, domination by foreign powers or serious disturbances of public order.

A refugee settlement is a place built by government or NGOs (such as ICRC) to receive refugees. People may stay in these settlements, receiving emergency food and medical aid, until it is safe to return to their homes or until other people outside the settlements retrieve those (Tastsoglou et al., 2014). In some cases, often after several years, other countries decide it will never be safe to return these people and they are resettled in developed countries away from the border they crossed (UNHCR, 2005). However, more often refugees are not resettled. In the meantime, they are at risk of diseases, child soldier recruitment, and terrorist recruitment, physical and sexual violence.

UNHCR established in December 14, 1950 protects and supports refugees at the request of a government or the United Nations and assists in their return or resettlement (Miller, 2018).

According to the UN refugee Agency, by the end of 2017, 68.5 million individuals were forcefully displaced worldwide because of persecution, conflict, violence or human rights violations, registering an increase of about 2.9 million people over the previous year, and the world's forcibly displaced population remained at a record that is high (UNHCR, 2018). This includes; 25.4 million refugees in the world, 40 million internally displaced people; and, 3.1 million asylum seekers (UNHCR, 2017).

The refugee situation is as a result of uncertainty, instability, insecurity and fear due to violence or civil war (Ratner et al., 2017; Musa et al., 2019). This in turn causes people to flee with a primary purpose of reaching safely in the nearby countries that will host them. As time passes, hope for stability in the home country does not fades. The realization gradually dawns on the refugee that there will be no victorious return and subsequent administrative, economic and psychological pressures in host countries may force the refugees to make a further step and to become an immigrant out of the settlements to major towns and to other countries (Hyndman and Nylund, 1998).

2.2.1 Refugee problem in Uganda

The presence of refugees in Uganda dates back to the early 1940's with the hosting of Polish refugees at Nyabyeya in Masindi district and Koja in Mukono district. These were later resettled in Britain, Australia and Canada. However, Uganda's rigorous involvement with refugees and the refugee problem started in 1955 when Uganda hosted approximately 78,000 Southern Sudan (Kreibaum, 2016, Cullis; 2020). In 1959/1960, influxes of Congolese and Rwandese refugees entered the western part of Uganda (Mulumba, 2000). Since then, Uganda has hosted thousands of refugees from Burundi, Congo, Eritrea, Ethiopia, Kenya, Somalia, Sudan, Sierra Leone, Mozambique, South Africa and Zimbabwe. However, majority of refugees in Uganda have comprised the nationals of the surrounding countries like Rwanda, Congo, Sudan and Kenya (UNHCR, 2020). The numbers from Kenya however have been minimal compared to those from other countries (OPM, 2018).

According to the UNHCR (2018), Uganda is currently hosting the highest number of refugees in the country's history, and is receiving simultaneous emergency influxes from South Sudan, DRC and Burundi. The number of South Sudanese refugees in Uganda has exceeded one million, and the daily arrival rate remains high. Arrivals from DRC have risen since late December 2017 (Table 2.1). Underfunding of the refugee response is threatening humanitarian organization's ability to continue delivering lifesaving and critical assistance.

Table 2.1: Refugee population per country in Africa

Countries of origin	Refugee numbers
South Sudan	1,053, 598
D.R.C	276,570
Burundi	40,497
Somalia	37,193
Others	37,015

Source: UNHCR, 2019

Others include refugees from Eritrea, Ethiopia, Rwanda, Sudan and other countries of origin and the figures are based on data from the Office of the Prime Minister (O.P.M) by March 2018 and are subject to the on-going biometric registration and verification.

2.3 Impact of refugee settlement on vegetation cover and land use

Wherever human populations settle, they live a footprint on the landscape that may be visible or distinct that some remain visible for a considerable period. Studies conducted all over the world show that settlements (whether temporal like under refugee situations or permanent) impact negatively on the landscape aesthetics (UNHCR, 2005; Milburn, 2015; Keshtkar et al., 2017; Ruiz and Vargas-Silva, 2018). The biosphere is the most commonly affected environmental component because it forms the main source of livelihood (ecosystem goods and services) (Tscharntke et al., 2012; Imtiaz, 2018; Borrelli et al., 2019). Vegetation cover is vital to settlements as it forms a source of materials for building and construction, source of supply of energy (fuel-wood) for daily home use and areas formally vegetated become site for both infrastructural development and agricultural production (Ratner et al., 2017; Black, 2018; Swamy et al., 2018). Usually vegetation cover is lost at the expense of developments associated with human inhabitation (Gabre et al., 2018; Parveen et al., 2018). Settlements in new areas or increased settlement density in already settled areas greatly affects vegetation cover. Allnutt et al. (2013) reports that much of Madagascar's forests have been lost to anthropogenic disturbances related to human settlement. The UNHCR report (2018) indicates that in Adjumani, farmers to provide poles needed for construction during the 2017-refugee influx cut approximately 75% of trees. Agricultural activities initiated by human settlements are also noted to bring about changes in ecosystems to which forests, woodlands and grasslands are part (Imtiaz, 2018).

Different techniques can be applied to determine the exact vegetation loss to land conversion and fuel-wood harvesting associated with settlements (Kranz et al., 20015; Keshtkar et al., 2017; Alejandro & Aguilera, 2020). Some techniques rely on ground surveys and opinion estimates while other employ remote sensing techniques. The development of remote sensing and Geographical Information Systems (GIS) technologies have improved on the precision of vegetation and land cover mapping to detect changes resulting from either natural or human acerbated phenomena (Muster et al., 2015; Nedkov, 2017; Parveen et al., 2018). Othow et al. (2017) used Landsat TM image of 1990, ETM+ of 2002 and OLI-TIRS of 2017 to map land use/cover changes and the causes of forest cover change in Gog District, Gambella Regional State, Ethiopia between 2002 and 2017. Their study reported dramatic increase in farmland from (4%) in 2002 to (23%) in 2017 with annual expansion rate (24.86%) per annum, where forest cover declined from (23%) in 2002 to (18.11%) in 2017 with annual decreasing rate (-1.41%) per annum.

The UNHCR (2018) showed that during the 2017 refugee influx into northern Uganda, approximately 75% of the trees were cut to provide poles for construction of settlement units. This implies that vegetation cover was lost for two purposes that is, land clearance for settlement units' establishment and secondly tree destruction to provide building materials hence land use and vegetation cover changes. However, the report did not indicate the overall changes in vegetation and land use in the area in relation to the refugee settlement.

Maystadt et al. (2020) assessed vegetation changes in Africa for the period 2002-2016 using MODIS MCD43A4 and concluded that refugees bear a small increase in vegetation conditions while contributing to increased deforestation. The study noted that vegetation clearance in refugee settlements in Africa is not due to land clearance and massive biomass extraction but due to agricultural expansion into refugee-hosting areas. The study further established that one percent increase in the number of refugees amplifies the transition from dominant forested areas to cropland by 1.4 percentage points. The fact that Maystadt et al. (2020) recognized that refugees contribute to vegetation destruction, points towards negative consequences of refugee settlement. However, the results may vary depending on the specific forms of vegetation and the refugee concentration.

Braun et al. (2016) assessed the impact of refugee settlements on their environment in western Kenya using multi-temporal Earth Resources satellite (ERS) 2 and sentinel 1 data. Six land use /cover classes were derived and the study established a positive relationship between existence of the refugee settlements and vegetation loss. This was however, not connected to fuel-wood consumption that the current study attempted to further investigations into.

Musa et al. (2019), examined impact of internally displaced persons (IDPs) on forest and vegetation cover of Jere of Borno State. The findings revealed that displaced persons destroyed about 12 square kilometers of forest and vegetation cover. The results obtained from various studies employing different remotely sensed data show negative changes in most forms of vegetation although variations are observed in the vegetation cover change rates. This can be accounted for by the differences in the spatial resolutions of the remotely sensed data. Landsat series images that have been applied in most vegetation and land use change studies are of 30 meters spatial resolution (Othow et al., 2017; Parveen et al., 2018). The present study made use of historical satellite data specifically sentinel 2A&B images for the period corresponding to the refugee settlement establishment at Imvepi and increased refugee influx in Uganda (2016-2019).

2.4 Assessing the quantities of fuel-wood harvested and used by refugees

All refugees flocking into Uganda depend on traditional biomass for cooking at an estimated rate of about 3.5 kg per capita per day (UNHCR, 2018). The amount of fuel-wood (fuel or charcoal) used for cooking using inefficient cooking technologies and practices ranges from between 0.7km to 3kg per person per day (Gunning, 2014). The UNHCR conducted rapid fuel-wood assessment for the Bidibidi refugee settlement in northern Uganda using data from field measurements and biomass mapping and established that the total population at the settlement consumes approximately 952 tonnes per day and 347480 tonnes of fuel per year (FAO & UNHCR, 2017). These results were however, based on rapid estimates and in one settlement.

A study by Mislimshoeva et al. (2014) conducted in the Western Pamirs, Tajikistan involving interview data from 170 households from 8 villages report that on average, households consumed 355 kg of firewood, 253 kWh of electricity, 760 kg of dung, and 6 kg of coal per month in the winter of 2011–2012. In a refugee situation like Imvepi, the most likely energy forms exclude electricity and coal, which are energy resources for permanent residents of a semi-rural locality. Traditional biomass becomes the most definite energy resource thus; consumption of energy in Imvepi was assessed for only firewood and charcoal.

Fuel-wood is measured in terms of weight and/ or volume (Owen et al., 2002). One advantage of measurement by volume is that the difference between air-dried wood and wet wood is minimal (Win et al., 2018). Conversely, the weight of wood is highly dependent on moisture content (Barbieri et al., 2018). However, weight may be a more convenient measure if the moisture content is determined and taken into account. The quickest and easiest way to assess the weight of a bundle of wood is to use a scale (Hammad, 2015; Lehne et al., 2016). In the current study, fuel-wood used by refugees in Imvepi was measured in terms of both weight (kgs) and volume (number of basins especially for charcoal). In most practical applications, the energy content of food can be conveniently described by the low heating value (LHV), which is the heat effectively obtained from one unit of fuel (Lehne et al., 2016). Preferably, the LHV should be expressed in joules (or any of its multiples) per original unit, for example gigajoule/tonne (GJ/t) or gigajoule/cubic metre (GJ/m^3). The quantities of fuel-wood usage depend on its moisture content. This can vary considerably depending on the atmospheric ambient conditions mainly temperature, wind and humidity, the time of harvesting and the conditions of storage (Hammad, 2015; Lehne et al., 2016; Barbieri et al., 2018). Therefore, it is important to ascertain the moisture content, if weight is used as a measure for assessing fuel-wood consumption and efficiency during the cooking and heating process. By converting fuel consumption into units of energy, it is possible to compare fuel-wood consumption with consumption of other types of energy (Win et al., 2018). A quantitative estimate of cooking energy demand is required to evaluate the potential for alternative fuel sources and new cooking technologies (Barbieri et al., 2017).

2.5 Determinants of amount of fuel-wood use by refugees

The precise quantity and type of fuel-wood used by households depends on several site-specific factors including the availability and quality of wood, climate, type and quantity of food cooked, stove efficiency and cooking practices (Hammad, 2015). The relatively large-scale biomass consumption is associated with absence of /limited use of wood energy efficient methods and techniques for cooking (Gunning, 2014; Rawat & Kumar, 2015). Availability of energy alternatives helps to reduce fuel-wood consumption although Tahir et al. (2014) asserts that existence of energy alternatives is not a necessary condition to reduce household biomass fuel consumption as economic factors come into play.

The choices of fuel and adoption of improved stoves for cooking in countries where biomass is still the predominant cooking fuel are influenced by; access and availability, collection costs, fuel prices, household income, food tastes, lifestyle, and government policies (Malla & Timilsina, 2014). Rahut et al. (2017) reports that low economic status households in Timor-Leste were dependent on dirty energy like firewood than their counterparts from the high economic class. Social-economic classes are stratified based on levels of income. The low income (poor) are limited to traditional biomass energy as compared to the high income who can opt for clean energy like liquid, gas and electricity alternatives (Rahut et al., 2017). The refugee households in Imvepi rely on fuel-wood that can be accessed freely and/ or at a very low cost given their economic status.

Large-scale fuel-wood usage in the rural areas of Myanmar was also attributed to limited sources of energy (Win et al., 2018; Musa et al., 2019). In the rural communities in Uganda, the commonly available energy alternatives include; firewood and of recent charcoal is being incorporated (Egeru, 2014; Leiterer et al., 2018). Imvepi refugee settlement too is located in northern Uganda, which is dominated by rural livelihoods and lifestyles with possible wood and charcoal fuel as main energy resources for cooking.

Biomass energy consumption also depends on the type of food cooked (Leiterer et al., 2018). Different foods require different heating level (sensible) head to transform them from raw form to cooked state. To cook a kilogram of each of the food items; dry rice, dry beans, raw potatoes and meat is 440 ± 3kJ, 609 ± 4 kJ 212 ± 2 kJ and 626 ± 4 kJ respectively (Rawat & Kumar, 2015). From this list, meat and dry beans are more sensible heat demanding but because beans are the commonest food staff among refugee (given as food aid by USAID); it is likely that more quantities of fuel-wood are consumed. The sensible heat demand therefore determines the time needed to prepare given food items. Mislimshoeva et al. (2014) established a positive relationship between firewood consumption and cooking time.

Mwaura et al. (2014) conducted a study to establish the determinants of households' choice of cooking energy in Uganda and established that the utilization of modern energy sources was only by 4 percent of households. They further observed that household energy choices were determined by consumption expenditure welfare, residing in urban or rural areas, household size, and achievement of education levels beyond primary level and regional location of a household. The study relied on data from the 2005/6 Uganda National Household Survey, which was relatively old. For this reason, some of the factors assessed by Mwaura et al. (2014) were also considered for analysis in the present study using a relatively recently survey data to evaluate any discrepancies and/ or agreements as to what determines energy access and use.

Rahut et al. (2017) too used data from the 2007 Timor-Leste Living Standards Survey to examine the determinants of household energy choices in Timor-Leste. The study reports that the majority of households are dependent on dirty fuels such as fuelwood and kerosene for energy and only a small fraction of households use clean energy such as electricity. In their study it was observed that the use of energy (fuelwood, kerosene and electricity) depended upon household heads' level of education, income status, gender and household location (rural vs urban).

Similarly, Win et al. (2018) sought to understand the factors influencing households' firewood consumption in the Western Pamirs, Tajikistan. Their study relied on interview data from 170 households from eight villages and their observation was that elevation, size of household's private garden, and total hours of heating are positively related to firewood consumption. Level of education and access to reliable electricity supply were shown to have a negative relationship with firewood consumption. Whereas the current study did not consider electricity as a source of energy for cooking, type of food cooked, which determines the hours (referred to under Win et al., 2018 study) was assessed as a determinant of firewood and charcoal access and usage.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents information about the study area, the research design adopted, study population, sample size, sampling techniques, data collection and data analysis methods.

3.2 Description of the Study area

3.2.1 Location

Imvepi Refugee settlement is located in the North Western part of Uganda in Odupi Sub County, Terego County in Arua District. The camp covers part of the Lugbari and Imvepi parishes. The settlement is divided into three zones that is zone I in the East, Zone II in the Central and Zone III in the West (UNOPS and UNHCR, 2017) (Figure 3.1). River Ore, which is the boundary between Arua and Yumbe District, is in the North boarder of the settlement (UNHCR, 2018). River Anyau forms the Southern border of the settlement. The two rivers converge in the East as they enter Albert Nile on its way to Sudan.

3.2.2 Climate

Arua district where the study area is situated experiences a bi-modal rainfall pattern with light rains between April and October (Monaghan et al., 2012). The wettest months are normally August and September, which receive 120mm/month (Kansiime and Mastenbroek, 2016). The average total rainfall is 1250mm. The mean monthly evaporation ranges from 130mm - 180mm. In the dry season (December-March), temperatures remain high throughout (Ministry of Water and Environment, 2019). These climatic conditions impact on the vegetation cover in this area and typically the conditions result into savanna vegetation cover that most suitably support charcoal burning and wood harvesting activities which this study sought to investigate.

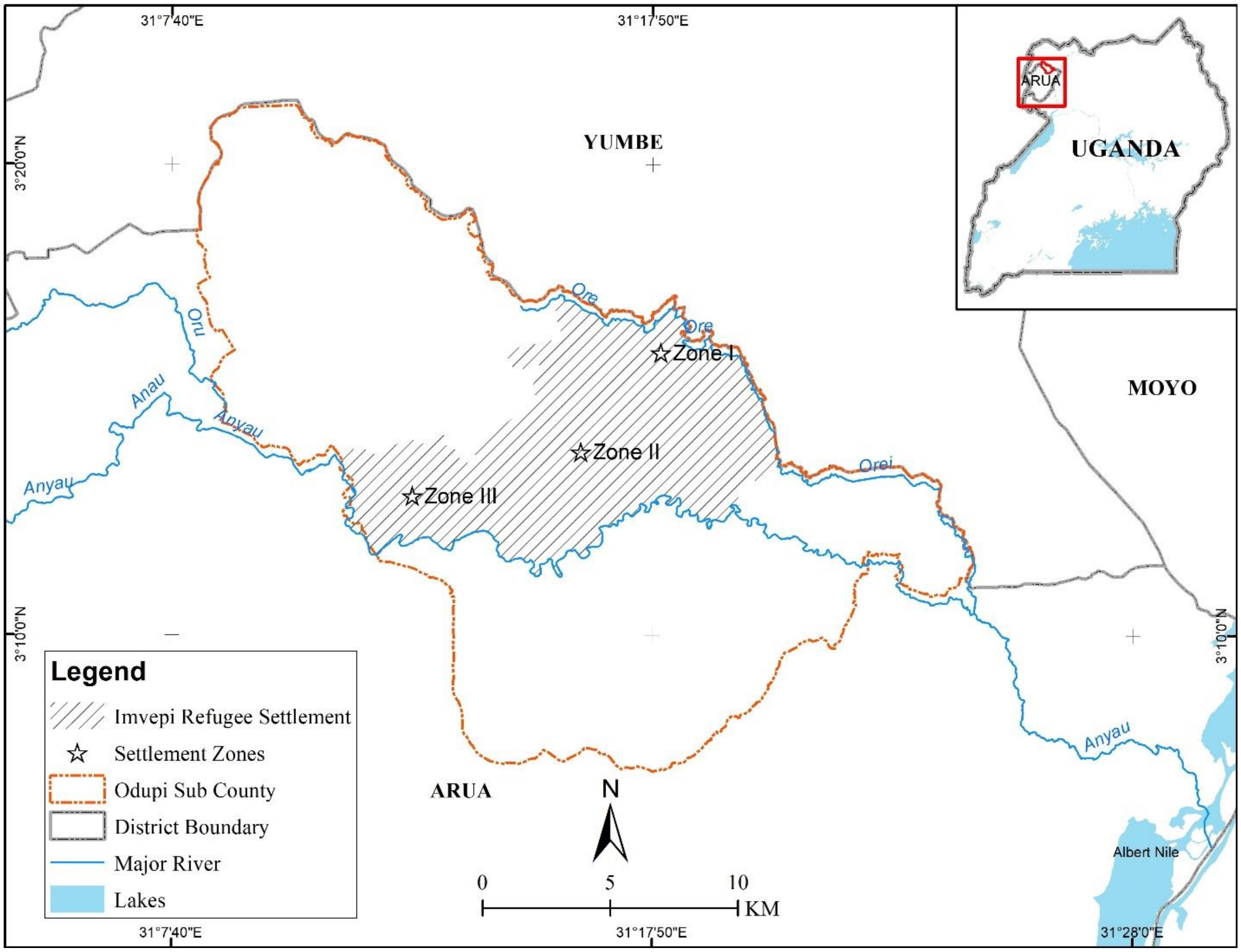

Figure 3.1: Location of the study area (Source: UBOS (2019) shape files & OPM)

3.2.3 Topography

The topography of the study area consists of rolling plains that rise from the floor of the Nile to the Congo-Nile water divide with an altitude ranging from 600 meters above sea level in the former to 1200 meters above sea level in the later (Papru et al., 2018). Imvepi refugee settlement lies under the Madi plateau with an altitude of about 900 meters above sea level and occupies the eastern parts of the district. The plateau is dissected by several broad valleys that end up into River Nile. The other topographic regions include the western highlands and the Rift valley. The western highlands cover the upper plateau with an altitudinal range of 1200 to 1800 metres above sea level. The zone generally covers the central western parts of Arua district with slopes consisting of several facets. The rift valley zone consists of escarpments, which are highest in the South and fade off to the North. They consist of several fault carps arranged, roughly parallel with the Albert

Nile. These scarps separate the Rift valley plains from the Madi plateau. The rift valley lowlands consist of wide seasonal swamps. All major valleys are aggraded and consist of alluvial and swamp deposits (Kansiime and Mastenbroek, 2016). The relief of the study area presents conditions for growth of different vegetation forms ranging from thickets, bushlands, grasslands, woodlands and swamps, which are affected differently by human activities like settlement and agriculture that this study mapped and assessed (Kaiser, 2016).

3.2.4 Drainage

Arua district is not well served with surface water resources. The Nile is the main water body running through the district. River Anyau is also one of the important rivers in the district. It is fed by river Nara and drains to the East (Kansiime and Mastenbroek, 2016). The Albert basin is fed by streams and ground water during the heavy rains but loses its water during the dry season through evaporation and to the surrounding unconsolidated sands, silt and gravel, which recharge the water content of the surrounding countryside through natural processes (Monaghan et al., 2012). Arua is covered by several wetlands with an area coverage of approximately 215 km^2 of the total land area of the district (NEMA, 2009). These are however, facing degradation threats form encroachment for cultivation. With refugee settlements comes increased demand for land for agriculture and possible encroachment on critical drainage systems.

3.2.5 Vegetation

The vegetation in the study area is composed of forests, woodland, grasslands and bushland vegetation. The vegetation of Arua as classified by Langlands (1974) consists of intermediate savannah grassland. This type of vegetation is that found between the moist and the dry savannah. The vegetation type is characterized by open canopy of trees of 10-12 meters high and underlying grasses of 80 centimeters high. The trees are fire resistant and are therefore able to regenerate themselves after being burnt. The common tree species here include; Acacia, *Focus Natalensis*, *contyetum*, *Banasus*, *Aethicpum* (Fanpalm) while the common grasses include; *imperate cylindice*, *Hypemaria Rufa*, *Digitria scalarum*. There are also some herbs like *Bidens Pilosa*, *Ageralum Coinzolds*, *Amarathus* species and *Latana Camara* (Cole and Forrest, 2019). However, man’s activities have tended to interfere with the natural vegetation of the place and this has led to the development of secondary vegetation (Katende et al., 1995). The common tree and grass species here include Jacaranda, Cupressus, Theruvaian, Pienes, Hibiscus, Bougain Vilae and Flamboyant. Kaiser (2016) points out that vegetation is the most degraded environmental component when settlements emerge in an area. Changes in vegetation cover resulting from refugee settlement in Imvepi were the central focus of the current study.

3.2.6 Geology and soils

The study area lies under geologic formation of the Aruan series of Metamorphic and Sedimentary group (Geologic Survey of Finland, 2014). In terms of lithology, the area comprises of sediments, alluvium, and banded gneises of tectonic age, granitoid and undifferentiated gneisses. Arua district is mostly overlain by ferralitic and sand loams. These soils are fine-textured with rather loose structure, making them easily eroded and leached. Most soils are acidic. Specific soil types include; yellow-red sandy, clay loams latosols varying from dark grey to dark, which are slightly acidic and mainly derived from granite, gneissic and sedimentary rocks (Kansiime and Mastenbroek, 2016). They occur on gently undulating hilly topography; brown-yellow clay loams with laterite horizon with a variety of dark brown to dark greyish brown, which are slightly acidic. These occur on flat ridge tops or undulating topography as light - grey- white mottled loamy soils with laterite horizon ground, structure-less loamy sands. They are acidic, allocative and mainly found on the lower and bottom slopes. Soils under different geologic systems possess different agricultural productivity potential thus under refugee settlement situations where agriculture forms the main land use activity, the soil types mentioned above are very crucial.

3.2.7 Land use activities

The biggest percentage of people in Arua is dependent on agriculture, employing over 81% of the population like in many other Ugandan districts engaged. Most parts of Arua are involved in crop cultivation as the fertile soils and suitable climatic condition, favors the activity although 80% of the agriculture is smallholder subsistence farming. Only 0.5% of the Agriculture is commercialized (UBOS, 2016). Both food and cash crops are grown. The major food crops grown include cassava, beans, groundnuts, simsim, millet and maize. Tobacco is the main cash crop and the main source of livelihood. Cotton and coffee are the other cash crops although cotton was abandoned due to marketing challenges. Agriculture has therefore encouraged trade and commerce and these form the main sources of livelihood (UBOS, 2016). When refugees settle in a locality, they adopt land use practices of the new community while abandoning the old practices in their homeland and this may be due to the differences in environmental conditions.

3.2.8 Population and ethnicity

Imvepi refugee settlement hosts over 63,116 refugees comprising mostly people displaced from South Sudan (UNHCR, 2018). Whereas Arua District is occupied by the Lugbara ethnic group who speak Lugubara dialect (UBOS, 2016), Imvepi settlement is occupied by refugee tribes who represent ethnic groups of immigrates' origin (South Sudan). The refugees from DRC are also housed in settlements elsewhere within Arua district and other districts (UNHCR, 2018).

3.3 Data collection and analysis

3.3.1 Secondary data on extent and trend of vegetation and land use changes in Imvepi refugee settlement between 2016 and 2019

3.3.1.1 Satellite data collection

Secondary data for assessment of vegetation and land use changes in the study area was in form of Sentinel-2 images distributed by European Space Agency (ESA) and affiliated institutions like United States Geological Society (USGS). Sentinel data is multispectral and moderate spatial resolution data with RGB and infrared bands captured in 10-meters making it ideal for vegetation and land use change monitoring as compared to Landsat series data. Sentinel images are captured by sensors mounted on Sentinel series 1-2 satellites, launched in 2013 and 2015 respectively. Sentinel data is open access at ESA Copernicus hub and USGS geoportals. For this study, the images for four years that is 2016-2019 (corresponding to the time of increased refugee influx into northern Uganda from South Sudan and taking one image in each year) were acquired from ESA Copernicus, hub via Semi-Automatic Classification Plugin (SCP) in QGIS 10.12. The images downloaded had to be of high quality with less than 5% cloud cover, captured during the dry season (between January and March) as the classification was to be based on the visible bands (RGB & IR-4, 3, 2, & 8). The RGB band combinations offer similar output in terms of reflectance and display of imagery elements prior to interpretation. Image band combinations gainfully add value to image interpretation.

The study made use of Sentinel-2A&B data (20-meter spatial resolution) for 2016, 2017, 2018 and 2019 to assess the impact of refugee settlement on vegetation in terms of extent and trend of vegetation cover and land use changes in the refugee settlement area. The study period 2016 formed the base year because it was then that political turmoil escalated in South Sudan displacing thousands most of whom found their way into Uganda. Since the launch of Sentinel satellites, Sentinel data has become progressively used in mapping and assessment of landscape changes resulting from both anthropogenic and natural factors (Sibanda et al., 2015). Its increased use as compared to Landsat series data stems from its high spatial and temporal resolutions (20 meter and 5 - 8 days respectively) thus improved detection capabilities (Sibanda et al., 2015).

3.3.1.2 Satellite image pre-processing

After securing the images, pre-processing proceeded by atmospheric correction using Dark Object Subtraction (DOSI) model under SCP embedded in Quantum GIS (QGIS) 3.12 software and conversion of bands into surface reflectance. Further, band composites were built to create Normalized Distance Vegetation Index (NDVI) and natural color images for visualization and creation of signature files (training data sets). QGIS software was preferred in this study because it is a free-source software, compatible with windows, Linux, android, mac, OS, which makes it easier for the user to install and use on their personal computers (Matonga et al., 2017).

3.3.1.3 Satellite image processing

The pre-processed Sentinel-2 images were further processed using maximum likelihood supervised classification algorithm in QGIS. The model distinguishes pixel properties for different land uses and cover basing on an input signature data of pixels representing the predefined land use/cover classes (Shoko and Mutanga, 2017). Basing on this data, the algorithm rations the rest of the pixels on the image basing on the signature file data. The high precision of maximum likelihood classification model in land cover/use change detection made it the ultimate choice in the present study (Sibanda et al., 2015; Matonga et al., 2017; Shoko and Mutanga, 2017). The major land cover/use types identified and mapped are shown in Table 3.2. These were decided upon after literature review, field inspection and visual analysis of Google earth images of the study area. The outputs from this process were in form of raster maps.

Table 3.2: Description of land use/ cover classes in the study area

Land cover/use class	**Description**
Bushland	Land comprised of scattered shrubs and thickets
Woodland	Areas associated with woody trees growing to moderate height
Grassland	Includes areas covered with grass and short scattered trees
Burnt vegetation	Areas formally hoisting trees, shrubs, thickets and grass but were cleared by fire.
Bare ground	Areas with exposed earth and without vegetation cover
Built-up	Land consisting of settlements, town clusters, roads and related infrastructure
Farmland	Land under crop farming; covered with crops and or where crops have been harvested
Wetland	Water-logged areas with i.e. swamps, wetlands and open water

Source: Adopted and modified from Li et al. (2016)

3.3.1.4 Satellite image post processing and analysis

Post image classification procedures involved quantification of the spatial extents of the various land use/cover types for the four years (2016 ~ 2019), change detection analysis and classification accuracy assessment. For a change detection assessment, two classified images were compared to determine change in the individual classes and a change detection matrix table was generated showing how much land area (in hectares) had been converted to and from the various land use/cover classes. The classification of 2016 and 2019 images with the highest overall accuracy was used in the change detection process (Rwanga and Ndambuki, 2017; Singh et al., 2018). The classified images were then combined to create a new image indicating the land use/cover transitions over the study period (Global Heat Flow Compilation Group, 2013). One hundred and fifty-nine (159) Ground truthing points collected during the field survey and through Google earth Pro image' inspection, were used to assess the accuracy of the classification algorithm and a confusion/error matrix was generated showing commission and omission errors, user accuracy and producer accuracy, overall accuracy and kappa coefficient (Grizonnet et al., 2017).

3.3.2 Socio-economic data collection

3.3.2.1 Research design

The study relied on both qualitative and quantitative methods to collect relevant information. The quantitative component of the study followed a cross-sectional study design. This design involves studying phenomena in a single point in time to check on prevalence. Since refugees had been settled at the Imvepi settlement for more than four years, their footprint would be visible on the landscape and could therefore be studied during any time of the year and in a single moment and the impact could be projected in the future thus justifying the choice of a cross-sectional survey design. Data obtained from the field and spatial data layers were numeric and or coded whereas responses from the key informants and focused group discussions were qualitative which called for the use of both qualitative and quantitative methods of analysis.

3.3.2.2 Study population

There are two main refugee settlements in Arua district that is, Imvepi and Rhino settlements. Imvepi has a total population of 63,116 people with average household size of six persons (Office of the Prime Minister, 2018; UNHCR, 2019). At an average household size of six persons, Imvepi settlement approximately housed 10,519 households. The study population came from Imvepi refugee settlement, purposely selected due to scanty literature on key aspects of this study. The main study respondents included refugee households, refugee settlement managers, local authorities, NGO workers and local area environmental protection officers.

3.3.2.3 Sample selection

For the quantitative component of this study, refugee were selected through a 2-stage sampling procedure. In the first stage, the number of refugees and refugee household sizes at the settlement were established (UNHCR, 2019). After establishing the study population (number of households) in Imvepi settlement, the sample size was determined using Krejcie and Morgan (1970)' table of sample determination. The table (Krejcie & Morgan, 1970) has worked out sample sizes against the study population after the formula;

$$s = X^2NP(1-P) \div d^2(N-1) + X^2P(1-P)$$

Where;

s = required sample size.

X^2=the table value of chi-square for 1 degree of freedom at the desired confidence

N=the population size

P=the population proportion (assumed to be .50 since this would provide the maximum sample size)

d= the degree of accuracy expressed as a proportion (.05)

There is no requirement for running calculations to determine sample size while using Krejcie and Morgan (1970)'s table. Consequently, from the study population 10,519 households, 370 households were determined to form the sample size of the study. In the second stage, household heads were selected using household lists available from the Office of the Prime Minister through systematic random sampling. Further, respondents for the qualitative data collection were selected using purposive sampling procedures. Three key informants were accessed including the Environmental officer, Forestry officer of Arua District and the Assistant Settlement Commandant and Focal Person for Livelihood and environment in Imvepi refugee settlement (Appendix I). These were selected basing on their knowledge on the refugee problem and status of vegetation cover in the study area. Further, two Focus Group Discussions (FGD) were held with 16 (taking eight members in each FGD) representatives from refugees and the host community. The FGD members were randomly selected using the camp lists. From the sampled household heads, 204 participated in the questionnaire survey, giving a 55% return rate. All the targeted key informants were realized, giving 100% return rate and 14 out of the targeted respondents (16) for the FGD were realized. From all the categories of respondents, a total, 221 respondents participated in the study.

3.3.2.4 Assessing the quantities of fuel-wood harvested and used by the refugees

Data in relation to amount of fuel-wood harvested and used by the refugees in Imvepi refugee settlement was collected using a structured questionnaire, Focused Group Discussions (FGD) and structured informant interviews (Appendices II, III & IV respectively). The amounts of biomass harvested by the refugees were determined by coding the responses obtained into numerical data and consequently subjecting the data to descriptive statistical analyses. The process involved computation of means, standard deviations, range, minimum and maximum for continuous data and frequencies and percentages for categorical data. To establish whether there were significant differences in quantity of wood, fuel harvested in the wet and dry conditions, Paired-Samples T-Test was performed on two pairs of variables. The first pair compared the means for daily wet and daily dry head weights of firewood harvested by refugees while the second pair compared the number of trips of firewood in a week during the dry and wet seasons. The Paired-samples T-Test compares the means of a pair of variables for a single group by computing the differences between values of the two variables for each case and tests whether the mean differs from 0 (Samuels, 2015; Kutner et al., 2005). The significance of the differences in the variables of interest in this study were tested at 0.05 alpha level (95% confidence level). All the statistical analyses were implemented in SPSS computer program version 23.0 and the findings were presented in tables, graphs and analyzed accordingly. The results here were supplemented by findings obtained through FGD and key informant interviews.

3.3.2.5 Analyzing the determinants of fuel-wood use in Imvepi refugee settlement

The study also engaged in the collection of data on the determinants of wood and charcoal fuel access and use among refugees. The data were analyzed both qualitatively and quantitatively. For the quantitative data, multiple response analysis was conducted using SPSS computer program. The results were presented in form of frequencies, percentage of responses and cases. Where structured interview and Focus Group Discussions data was involved, content analysis was conducted and the findings were presented by quoting verbatim or paraphrasing the responses (narrative analysis). Here, the findings were arranged under the respective themes of the study to reinforce findings obtained using other methods. To determine the significance of the factors determining access and use of fuel-wood among refugee settlers, a non-parametric statistical test was conducted that is, the Binomial Statistical Test (BST). The BST procedure compares the observed frequencies of the two categories of a dichotomous variable to the frequencies that are expected under a binomial distribution with a specified probability parameter (Mehta & Patel, 2011). The probability parameter for both groups is 0.5 by default. This statistical test was preferred in this study because responses on the study variables (determinants) took on two values: yes or no (dichotomous outcomes). BST requires that the variables are numeric and dichotomous.

Thus, responses yes were coded as 1 and No as 0. The first value 1 (for yes) defined the first group while the other 0 (for no) defined the second group. BST is a non-parametric test and does not need to meet any assumptions about the shape of the underlying distribution as the data are assumed to a random sample (Mehta & Patel, 2011). This made it ideal for analysis of the determinants of fuel-wood access and use in this study. It was hypothesized that respondents would either select or omit a stated determinant on the structured research tools, which would imply “yes” and “no” respectively. A 90% test proportion was considered for a factor to be significant and tested at 0.05 level of significance meaning that a factor with a p-value less or equal to 0.05 would be considered significant in determining access and use of fuel-wood or otherwise.

3.4 Study limitations and delimitations

In this study, a number of limitations were encountered. Currently the ongoing clashes between the refugees and host communities in the area hampered the data collection process especially during focus group discussions with the refugee households. The meetings were misunderstood by the host communities as a move to either takeover their land to give refugees more power over resources in the area. This was however, overcame by first meeting the leaders of both the refugees and refugee hosting communities to sensitize them about the intentions of the study.

The targeted respondents (refugees mainly) did not wholly disclose the information that were probed from them as they are traumatized or frightened by the events that culminated into them fleeing their home country. This was overcome by collecting data using various methods.

CHAPTER FOUR

RESULTS

4.1 Introduction

Under this chapter, the results from data analyses are presented, interpreted and discussed following the study objectives. First, focus is placed on establishing the extent and trend in vegetation and land use changes in the Imvepi refugee settlement. Secondly, attempts are made to establish the amount of fuel-wood harvested and used and lastly an analysis of fuel-wood access and usage determinants is made.

4.2.1 Extent and trend of vegetation and land use changes in Imvepi refugee settlement between 2016 and 2019

The study involved establishing the extent and trend of vegetation and land use changes experienced in Imvepi Refugee Settlement between 2016 and 2019. In line with the first objective, the spatial coverage of the various vegetation covers and land uses (in hectares (ha)) in the study area for the period spanning from 2016 to 2019 were determined using GIS and remote sensing techniques and the results are presented in Table 4.1. The results show that bushlands covered a land area of 92 ha, 39 ha, 77 ha, and 29 ha in 2016, 2017, 2018 and 2019 respectively. Woodlands covered 253 ha in 2016, 142 ha in 2017, 97 ha in 2018 and 72 ha in 2019, which means that before increase in refugee numbers (in 2016); much land was covered by woodlands as compared to the consequent years. Further, areal extent for grasslands was 97 ha in 2016, 439 ha in 2017, 512 ha in 2018 and 366 ha in 2019, which signifies that much of the land in Imvepi was covered by grass in the year 2018, which also implies that other forms of vegetation had been cleared and thus replaced by grass. Area under burnt vegetation was 166 ha in 2016 as compared to 458 ha, 366 ha and 306 ha in 2017, 2018 and 2019 respectively. Bare ground had 31 hectares in 2016, 321 ha in 2017, 38 ha in 2018 and 14 ha in 2019. Built-up land area consisting of refugee settlement and associated infrastructure covered 262 ha in 2016 compared to 180 ha, 168 ha and 309 ha in 2017, 2018 and 2019 respectively. This shows that built-up environment occupied more land area in 2019 while the lowest spatial coverage was in 2018.

Table 4.1: Imvepi land cover/use spatial extent between for 2016 & 2019

Year	**2016**		**2017**		**2018**		**2019**		**Change between 2016 and 2019**	
Land use/cover types	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**
Bushland	92	8	39	2	77	4	29	1	-63	-7
Woodland	253	23	142	7	97	5	72	4	-181	-19
Grassland	97	9	440	22	512	26	366	18	269	9
Burnt vegetation	166	15	458	23	364	18	306	15	140	0
Bare ground	31	3	321	16	38	2	15	1	-17	-2
Built-up	262	24	180	9	168	9	309	15	47	-9
Wetland	8	1	2	.0	119	1	31	2	23	1
Farmland	189	17	385	20	701.35	36	869	44	680	27

The spatial extent of land uses/covers for the period: 2016 ~ 2019 are shown in Figure 4.1 (Imvepi 2016 ~ Imvepi 2019). The results reveal that in 2016, the various forms of vegetation as indicated by the different shades of green occupied the large portion of Imvepi landscape, whereas land uses occupied a small portion on the western edges. In 2017, bare ground, built-up area, farmlands covered much of the southern parts of Imvepi. This indicates that refugee activities spontaneously increased in Imvepi in 2016 that much of the vegetation forms that existed in 2016 transformed into land use. The land cover/use map for 2018 indicates that in this year, vegetation forms regained in spatial extent but mainly those that have a short gestation period (grasslands and bushlands) only to again loss out in 2019. The land cover/use maps for 2017~2019 indicate further that vegetated areas in Imvepi become dotted with patches of burnt vegetation.

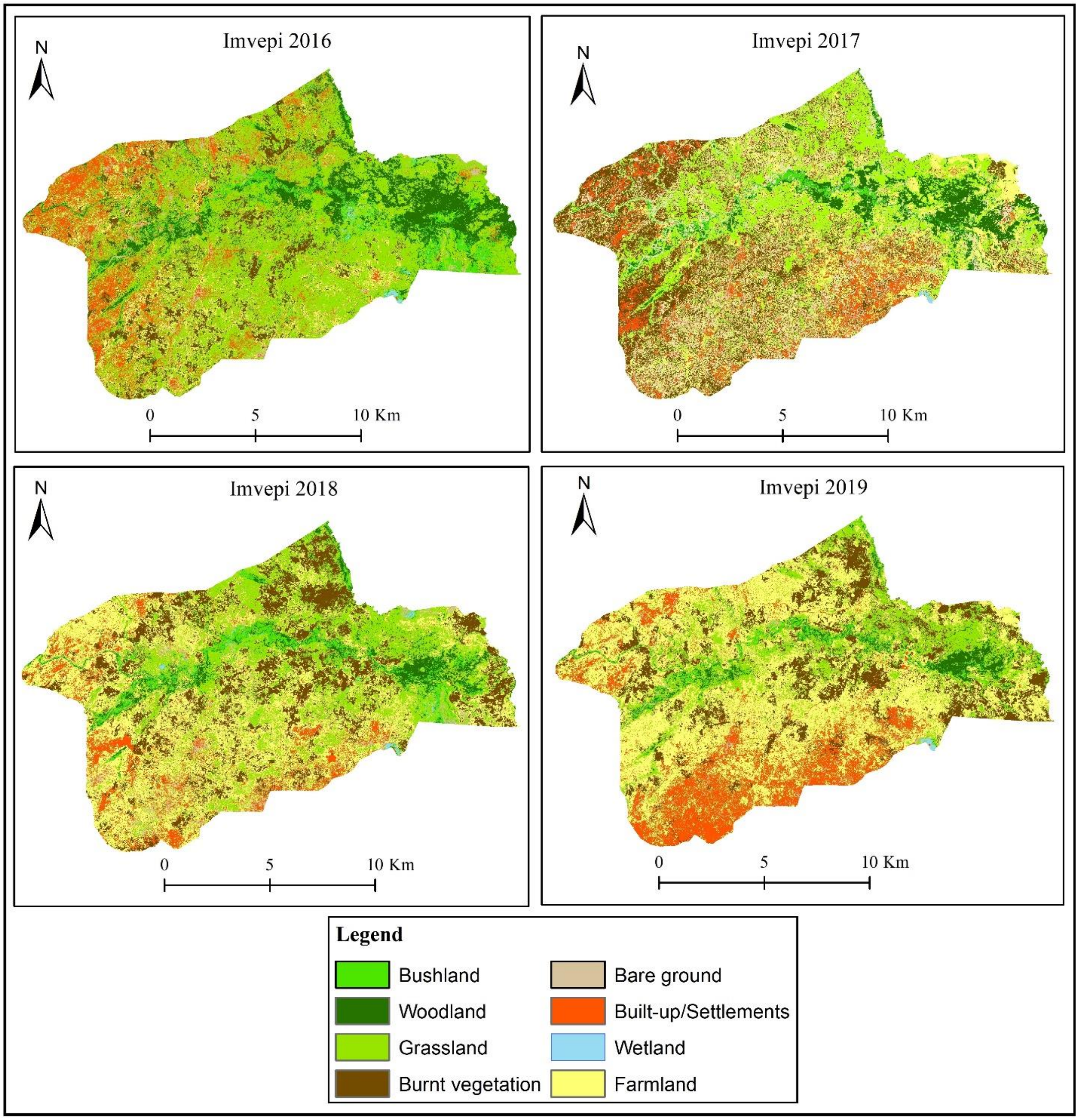

Figure 4.1: Vegetation cover /land use extent in Imvepi between 2016 & 2019

4.2.1.1 Trend of vegetation and land use change analysis between 2016 and 2019

To analyze the vegetation and land use changes in the study area, the spatial extent of the mapped vegetation and land use types for the study period 2016 ~ 2019 were plotted on line graphs (Figure 4.2). The results reveal that area under woodlands decreased significantly ($P<0.005$) from 253ha in 2016 to 142 ha, 97 ha and to 72 ha in 2017, 2018 and 2019 respectively. Area under bushlands too reduced significantly ($P<0.005$) from 92 ha to 39 ha between 2016 and 2017 and from 77 ha to 29 ha between 2018 and 2019. There was however an insignificant increase in bushland from 39 ha to 77 ha between 2017 and 2018. Grasslands saw a significant ($P<0.005$) increase in land area for the period 2016/2017 and 2017/2018 (from 97 in 2016 to 440 ha in 2017 & to 512 ha in 2018) but registered an equally significant decline between 2018 and 2019 to 366 ha).

Area under burnt vegetation registered an increase between 2016 and 2017 (from 166 to 458 ha) however declined to 364 ha and 306 in 2018 and 2019 respectively. The increase of burnt vegetation was significant ($P<0.005$) between 2016 and 2017 while the decline between 2018 and 2019 was not significant ($P>0.05$). This means that the period between 2016 and 2017 witnessed the biggest vegetation lose to burning. Area under bare ground too experienced a significant ($P<0.05$) increase between 2016 and 2017 (from 31 ha to 321 ha) but declined significantly ($P<0.05$) to 38 ha in 2018 and 15 ha in 2019 respectively. The period of increase in bare ground coincides with the time of land clearance possibly for settlement and/ or farm activities by the refugees in Imvepi. Decline in bare ground areal extent between 2017 and 2019 can be explained by increase in coverage of other land use types related to refugee settlement in the area.

Land under built-up environment witnessed a significant ($P<0.05$) decline from 262 ha to 180 ha between 2016 and 2017. The spatial extent for built-up declined insignificantly ($P>0.05$) to 168 ha in 2018 but registered an expansion to 309 ha in 2019 thus a high spatial extent was registered for Built-up environment in 2019 (309 ha) than in 2016 (262 ha). These results imply that built-up environment accounted for minimal destruction to vegetation cover types. However, the results also imply at the time of influx in 2016 (as shown in the literature), the structures (tents) used by refugees were visualized as permanent buildings from space and after some time, the refugees constructed temporal shelters using wattle and grass and thus their settlements become visualized under other cover types.

Wetland as another natural cover experienced swings in spatial extent between 2016 and 2019. Wetland area declined from 8 ha in 2016 to 2 ha in 2017 before registering an increase to 119ha and 31ha in 2018 and 2019 respectively. However, these changes were insignificant ($P>0.05$). Farmland increased significantly ($P<0.05$) from 189 ha in 2016 to 385 ha, 701 ha and to 869 ha in 2017, 2018 and 2019 respectively. This means that farmland registered the biggest increase in spatial extent between 2016 and 2019 in Imvepi refugee settlement. Land use/cover changes assumed a linear trend for the period, 2016/2017 (R^2 0.003) whereas that between 2017/2018 (R^2 0.666) and 2018/2019 (R^2 0.407) took on a curvilinear trend.

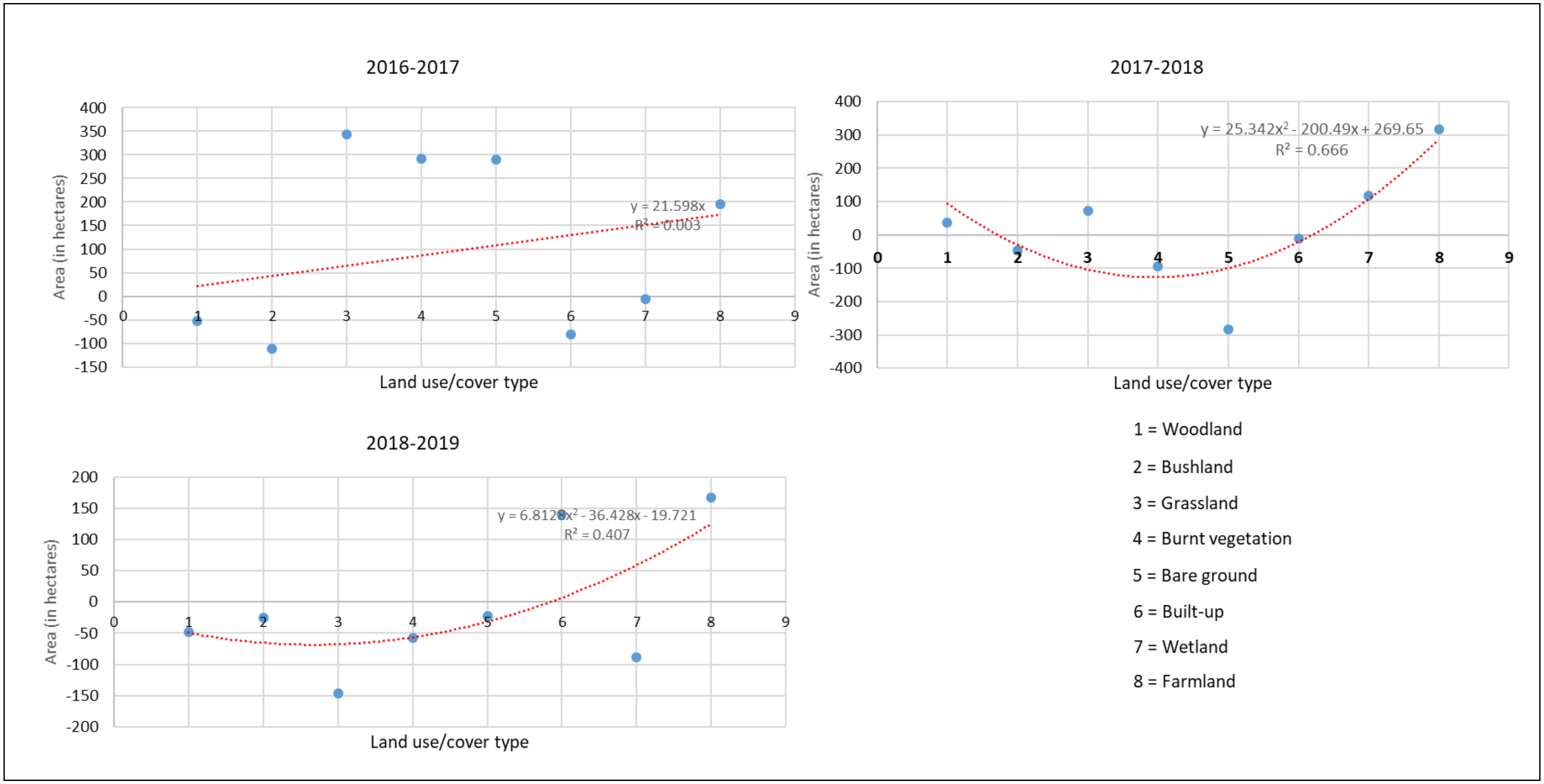

Figure 4.2: Trend of vegetation and land use change analysis between 2016 and 2019

4.2.1.2 Gains and losses in land cover/ use in Imvepi refugee settlement between 2016 and 2019

The gains and losses in vegetation and land use types in the study area over the study period depicted in Table 4.1 are further visualized in Figure 4.3. From the figure, it is noted that the major losses in areal coverage occurred in woodlands, bushlands (-63 ha and -181 ha) among the vegetation cover types in Imvepi refugee settlement over the study period. However, bare surfaces too reduced in spatial coverage as the built-up environment registered a gain in spatial extent, meaning that buildings covered some of the formerly bare surfaces. Farmlands showed the largest gain (of 680 ha) in land area over the study period. This means that losses witnessed under woodland and bushlands were partly contributed by increase in farmland.

Further, Grassland registered a gain in spatial coverage (of 269 ha) over the study period. This shows that, among all the vegetation cover types grasslands were affected positively by the refugee settlement in Imvepi. However, this also implies that where other cover types (woodland and bushland) were lost (Appendix V), the areas were spontaneously colonized by grass, thus replaced by grasslands.

Area under burnt vegetation increased by 139 hectares between 2016 and 2019. This means that some vegetation cover losses were due to burning. The increase in land area under burnt vegetation also signify areas of possible charcoal production in the study area. Similarly, wetlands registered slight positive gains in spatial coverage (by 23 ha) over the study period but this can be explained by differences in dry season conditions despite the fact that images for the different years were for the dry period (January and February).

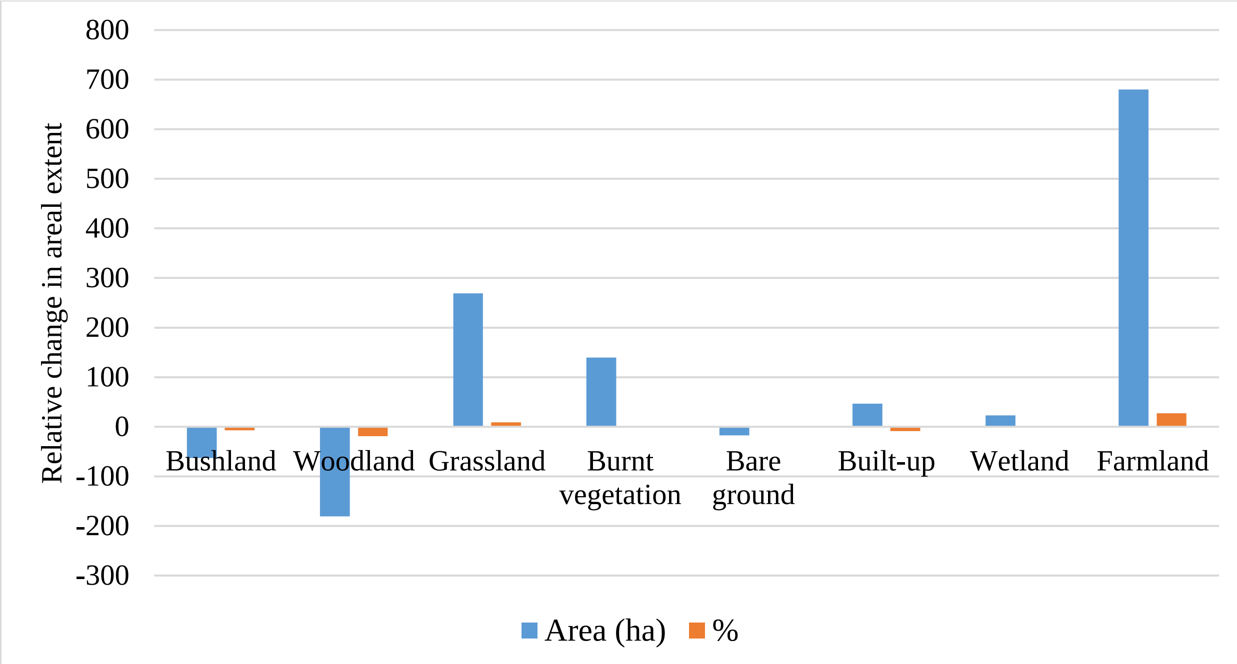

Figure 4.3: Gains and losses in land cover/ use in Imvepi refugee settlement between 2016 and 2019

4.2.1.3 Land use/cover change detection analysis between 2016 and 2019

The change detection analysis of land use and land cover in Imvepi refugee settlement between 2016 and 2019 (Table 4.2 & Figure 4.2) reveal that much of the bare surfaces translated into Built-up area and farmlands. Largest land area under built-up environment transformed to farmlands and grasslands. Largest area of burnt vegetation turned into farmland while much of the Bushland translated into farmland, grassland and burnt vegetation. Much of the farmland transitioned into Built-up environment and burnt vegetation. Grassland transitioned into burnt vegetation, farmland, and Built-up environment. Woodland on the other hand transitioned into grassland, farmland and burnt vegetation. From these results, it is noted that key changes occurred in grasslands, woodlands, and bushland giving in for farmland, built-up environment and burnt vegetation. The later are associated with human actions (refugee settlement in Imvepi). Remarkable translations also occurred between bare ground and farmland, which means areas that had been cleared off vegetation were later used for agricultural activities.

Table 4.2: Change Detection Matrix between 2016 and 2019 and Classification Accuracy

Use/Cover	Bushland	Woodland	Grassland	Burnt vegetation	Bare ground	Built-up	Wetland	Farmland	Sum	Commission Error	User's Accuracy
Bushland	14.4	7.9	23.6	16.91	0.37	1.15	0.84	24.8	4	0.25	0.75
Woodland	8.7	58.4	125.2	31.4	0.04	1.18	0.3	24.3	8	0.25	0.75
Grassland	3.9	4.16	178.1	165.6	3.06	120.8	0.43	210.8	29	0.2758	0.7244
Burnt vegetation	0.03	0.03	6.5	46.4	0.42	38.5	0.009	74.02	24	0.625	0.375
Bare ground	0.5	0.018	2.12	2.3	4.2	9.03	0.01	11.3	4	0.75	0.25
Built-up	0.55	0.54	21.01	25.31	2.94	58.3	0.05	145.5	29	0.3104	0.6897
Wetland	0.15	0.03	0.85	1.81	0.21	0.56	0.215	2.34	3	0	1
Farmland	0.04	0.03	2.4	16.2	1.41	77.4	0.017	86.2	58	0.1552	0.8448
Sum	6	9	28	13	12	24	9	58	159		
Omission Error	0.5	0.3333	0.2142	0.3076	0.9167	0.16667	0.6667	0.1552			
Producer' Accuracy	0.5	0.6667	0.7858	0.6923	0.0833	0.8333	0.3333	0.8448			
Overall Accuracy	0.7044										
Kappa	0.6259										

The land cover/use transitions in the study area between 2016 and 2019 are further visualized in Figure 4.4. Here, it is revealed that built-up and farmland land use types spread mainly to the southern and northern parts of Imvepi while major vegetation cover were confined to the eastern stretch. Within these, patches of burnt vegetation thrived.

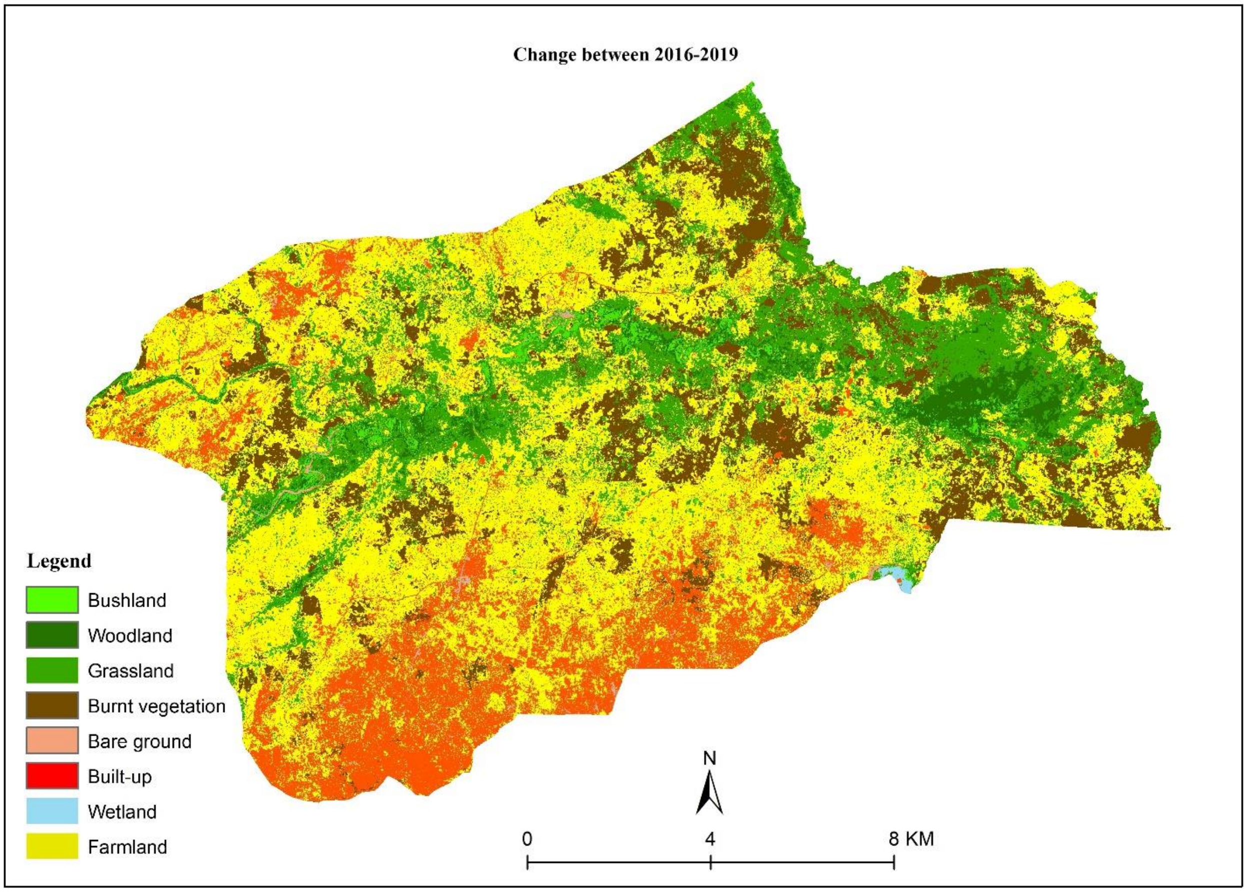

Figure 4.4: Land use/cover transitions in Imvepi Refugee settlement between 2016 and 2019

The results from the classification accuracy assessment (Table 4.2) reveal an overall accuracy of 70% although individual accuracies for classes; burnt vegetation, bare ground and wetland revealed divergences in user and producer accuracy values implying existence of some classification errors. The calculated Kappa statistic of 62% is moderate.

From the results on extent and trend of vegetation and land use changes in Imvepi between 2016 and 2019, the first set of the research questions is answered by stating that; whereas major vegetation cover experienced declines, major land use types (built-up and agricultural) experienced expansion in areal extent over the study period. Further, uses woodlands and bushlands are the most deforested and degraded vegetation types in Imvepi refugee settlement. The major vegetation translated into built-up areas, farmlands, and grasslands.

4.3 Quantity of fuel-wood harvested and used by refugees in Imvepi refugee settlement

4.3.1 Demographic characteristics of the respondents

The results on the demographic characteristics of the respondents (Table 4.3**)** reveals that, 56% of the respondents were female whereas 44% were male meaning that males had seen more persecution in their country of origin thus forced to migrate as compared to their female counterparts. With regard to the country of origin, 84% and the majority of the refugees were from South Sudan and 16% were from DRC.

The respondents were of an average age of 34 years with a standard deviation of 12 years implying that the displacement affected people of varying ages but mostly adults. 72% of the respondents and the majority were married, 13% were single, and 13% were divorced while 3% were windowed. The majority of the refugees being married implies great potential for population increase and the attendant pressures on resources in the refugee settlement.

The households' main sources of livelihood were farming (51%), casual labor (28%), trade and commerce (16%) and formal employment (5%) implying that the majority of the refugee settlers in Imvepi derived their livelihood from the land, which is liable to degradation.

In terms of level of education, 37% of the respondents had attained primary level, 34% had attained secondary level, 11% had attained vocational level, and 8% had attained university level while 10% had never acquired formal education training.

Table 4.3: Demographic characteristics of the respondents (N=204)

Variables	**Description**	**Statistic**
Gender	Male	89(44%)
	Female	115 (56%)
Age	Mean	34
	Std. Deviation	±12
	Minimum	15
	Maximum	77
Marital status	Single	28(13%)
	Married	147(72%)
	Widowed	5(3%)
	Divorced	28(13%)
Country of origin	South Sudan	171 (84%)
	DRC	33(16%)
Education level	Primary	75(37%)
	Secondary	69(34%)
	No formal education	21(10%)
	Vocational	23(11%)
	Tertiary	16(8%)
Sources of income	Subsistence farming	104(51%)
	Formal	10(5%)
	Casual labour	57(28%)
	Business/trading	33(16%)

4.3.2 Quantity of firewood used by refugees in Imvepi settlement

The results on daily wood weight wet, daily wood weight dry, firewood trips per week in wet season, firewood trips per week in dry season, average length of wood (in meters) area summarized in Table 4.4. The results reveal that on average, the daily weight of wet wood used by households in Imvepi refugee settlement was 16 kg with a standard deviation of 10. Minimum and maximum head weight of wet wood was 1 and 45 kg with a range of 44 kg. Average daily head weight of dry wood was 12 kg with a standard deviation of 8. Minimum head weight was 1 kg while maximum head weight was 50 kg. These results imply that there are variations in the quantities of wet and dry wood used by refugee settlers which is accounted for by other factors like family size. The results show that more quantities of wet wood are used as compared to dry wood. However, low dry wood weight can translate into more trees felled as compared wet wood.

In terms of number of trips to pick firewood per week, Table 4.4 indicates that on average 1 trip is made to collect firewood in the wet season. The minimum and maximum number of trips made is 1 and 4 times respectively, with a range of 3 times. In the dry season, 2 trips are made on average, the minimum and maximum is 1 and 5 times respectively per week. This implies high frequency of wood harvesting occurs during the dry season as compared to the wet season.

Furthermore, the average length of the wood picked by the respondents was 2 meters with a standard deviation of 1 meters. Minimum and maximum wood length was 1 and 5 meters respectively. These results imply that firewood in Imvepi refugee settlement comes from mature wood trees that extend beyond 5 meters in length. However, average wood lengths here signify that some of the trees are harvested before they attain a maximum wood height.

Table 4.4: Quantity of firewood used in Imvepi refugee settlement

Variable	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Daily Wood weight wet (kg)	16	18	10	44	1	45
Daily Wood weight dry (kg)	12	10	8	49	1	50
Firewood trips per week in wet season	2	1	1	3	1	4
Firewood trips per week in dry season	2	2	1	5	1	5
Average length of wood (in meters)	2	2	1	5	1	5

To establish whether the differences in wood harvested in wet and dry conditions were significant, the Paired-Samples t-test was conducted and the results are shown in Table 4.5. The results reveal t-test value of 8.261 for the first pair of variables comparing differences in means scores for daily fuel-wood head weight in wet condition and daily wood weight in dry conditions. The t-test value for the second pair of variables comparing the mean number of trips to pick firewood per week in the wet and dry condition was 10. Further, 203 is the degrees of freedom (df) which is one minus the number of observations. The 2-tailed significance value (p-value) indicate that there was a significant difference in the means of the fuel-wood harvested in wet and dry conditions. The significance level for the t-test was above 95%, given a p-value of 0.000.

Table 4.5: Paired-Samples T Test of differences in quantities of fuel-wood harvest in dry and wet conditions

		t	df	Sig. (2-tailed)
Pair 1	Daily fuel-wood head weight wet - Daily fuel-wood head weight dry	8.261	203	.000
Pair 2	No. of trips to pick firewood in dry season - No. of trips to pick firewood in wet season	9.573	203	.000

The implication of the above results is that wet wood is normally harvested in the wet season while dry wood is harvested mainly in the dry season. Similarly, the differences in the mean scores of number of trips to collect fuel-wood per week in the wet and dry seasons were significant at 95% as shown by the p-value (0.000). These results signify that there were significant differences in the quantities of fuel-wood harvested during the wet and that in the dry conditions. That is, more wood was harvested in the dry season as compared to the wet season. This reveals the influence of season on fuel-wood consumption among the refugees in Imvepi settlement.

The results on fuel-wood sources, use, burning quality, persons responsible for collection and type of storage (Table 4.6) indicate that, 73% of the respondents indicated that the wives collect the fuel-wood, 5% indicated the husband and 22% indicated that the children pick the wood. The results here reflect the traditional roles distribution in the household. They show that the responsibility of collecting firewood is largely in the hands of women followed by children. More women that are adults were involved in firewood collection, meaning that more quantities are collected and thus more trees are cleared.

In terms of main use of fuel-wood, 4% of the respondents indicated heating, 90% cited cooking whereas 6% mentioned other uses of firewood like burning of bricks. These results imply that a vast majority of refugees in Imvepi settlement use fuel-wood for cooking than heating and other uses. The results also show that much of the wood harvested in Imvepi is due to the need to provide fuel for home use (cooking).

Table 4.6: Firewood sources, use, burning quality, persons responsible for collection and type of storage (n=204)

	N	**Percent (%)**
Who collects firewood		
Wife	149	73
Husband	10	5
Children	45	22
Total	204	100
Type of fuel-wood storage		
Tent	6	3
Grass thatched house	118	58
Others	80	39
Total	204	100
Perception of fuel-wood burning quality		
Very good	67	33
Good	94	46
Moderate	39	19
Poor	4	2
Total	204	100
Use of fuel-wood		
Heating	8	4
Cooking	183	90
Other	13	6
Total	204	100
Main source of fuel-wood		
Woodlands	97	48
Bush	81	40
Tree plantation	8	4
Gardens	18	9
Total	204	100

Concerning the burning quality of the wood used in Imvepi refugee settlement, 33% of the respondents indicated that it is of very good quality, 46% indicated good quality, 19% indicated moderate quality while 2% indicated the that the quality is poor. These results signify that the overall burning quality of the wood used in Imvepi refugee settlement is good which implies that the wood species are those that easily burn.

Regarding wood storage, 3% of the respondents indicated that wood is stored in tents, 58% indicated grass thatched houses and 39% indicated that the wood is just left in the open place within the homestead. These results imply that firewood in Imvepi refugee settlement is majorly stored in temporally shelters, which implies absence of proper wood storage. Keeping wood especially in a dried state in a grass thatched house means it is highly susceptible to destruction by accidental fire outbreak and thus need for replacement by cutting more trees.

On source of firewood, 48% of the respondents indicated that it comes from woodlands, 40% indicated from the Bush, 4% indicated from tree plantations whereas 9% indicated that the wood is from garden. These results show that much of the fuel-wood comes from woodlands followed by bushland. The least amount of firewood comes from tree plantations, which means that the refugees have not given attention to tree planting but rather rely on naturally existing woodlands for fuel-wood.

During the FGD session in Imvepi refugee camp in Arua with 8 participants of mixed age and gender (Figure 4.5), it was revealed that fire wood is got from the woodlands and bushes around the host community. One of the participants noted however, that the firewood is not got freely but it is exchanged for food staffs like maize, beans or cooking oil with the host community members. This means that the refugees have not been offered full access to the local resources in Imvepi refugee settlement (FGD1- 13:30PM Thursday 28th/02/2019)

Figure 4.5: FGD1= FGD1 with refugees held in Imvepi refugee settlement at 13:30PM on 28th/02/2019, FGD2= FGD2 with hosting community held at 12:40 PM, on 03rd/03/2019

4.3.3 Quantity of charcoal used by refugees in Imvepi refugee settlement

The results on amount of charcoal used by refugees in Imvepi settlement in terms of daily consumption, weekly access, and distance from the collection centers are presented in form of descriptive statistics' summarized in Table 4.7. Results show that the average daily charcoal consumption in Imvepi refugee settlement was 2 kilograms with a standard deviation of 1. The minimum and maximum charcoal access per day in the settlement was 1 and 4 kilograms respectively. The weekly access of charcoal per household was approximately 1 basin. Minimum and maximum number of basins of charcoal used per week in households was 1 and 3, respectively, and a range of two basins between these.

With regard to distance from the charcoal collection center, the mean distance was 2 km with a standard deviation of 1. The minimum and maximum distance recorded for the charcoal collection center was 1 and 6 km respectively. These results imply that charcoal as source of fuel is used in Imvepi refugee settlement, which means trees as raw material are sacrificed to get the final product.

The stretched distance to the charcoal collection centers signifies that charcoal burning takes place away from the camp areas meaning that some nearby woodlands have been depleted already and the trend is spreading beyond the settlement area.

Table 4.7: Quantity of charcoal used in Imvepi refugee settlement

Variable	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Daily charcoal consumption (kg)	2	2	1	4	1	4
Basins of charcoal used per week	1	1	0.4	2	1	3
Distance to charcoal collection center (km)	2	2	1	6	1	6

The study also involved establishing sources of charcoal, its main uses, burning quality and number of times charcoal is bought by refugee in Imvepi settlement and results are summarized in Table 4.8**.** Results show that, in terms of sources of the charcoal used by households, 75% of the respondents used homemade charcoal while 26% indicated that they purchased it from the market. This means that households produce much of the charcoal used in Imvepi refugee settlement while only a few of them just buy from traders. Whereas the results indicate that charcoal trade was in existence in the refugee settlement surroundings, the buyers seem to be coming from outside. These results also signify that majority of the refugee have access to natural resources like woodlands from where they cut down trees for charcoal. The results could also mean that the refugee settlers' resort to seemingly free resources for fuel as their incomes are low to obtain charcoal energy by buying. Results from a FGD session in Imvepi refugee settlement indicated that charcoal is got from both buying and own production. One of the participants pointed out that for the case of charcoal, refugee settlers just buy from the nearby market (Imvepi) in the host community. Another participant noted that the office of the Prime Minister stopped refugees from burning charcoal from the refugee settlement. He further said that they have gone into agreements with the host communities regarding charcoal burning. Another participant stated that the nationals have allowed refugees to cut down trees in their land which they use to burn the charcoal which they share in agreed proportions (FGD1- 13:30PM, Thursday 28th/02/2019) (Figure 4.5).

In terms of main uses of charcoal, 82% of the respondents indicated that it is used for cooking while 18% indicated that it is for heating. These results imply that the biggest quantities of charcoal are used in cooking and since the cooking takes place on a daily basis by all households, it is likely to account for massive deforestation. Heating on the other hand is a season activity required by very few households during the wet season.

When asked to comment on the burning quality of the charcoal used in Imvepi refugee settlement, 31% indicated that it is of very good quality, 56% indicated good quality, 11% indicated moderate quality while 2% indicated the that the quality is poor. These results imply that the quality of charcoal used in Imvepi refugee settlement is generally good and that means that the type of trees from which it is derived are hard wood trees. The 2% who indicated the quality of charcoal as being poor represent cases where the trees used for the burning charcoal could have been of softwood species.

When asked about the frequency of buying charcoal by households, 2% of the respondents indicated daily, 30% indicated weekly, 25% indicated monthly whereas 44% indicated none. These results mean that majority of the residents in Imvepi refugee settlement do not buy the charcoal they use. Since the results on source of charcoal indicated that it is homemade, the majority of the refugees do not therefore buy charcoal because they make their own.

Table 4.8: Sources of charcoal, main use, perception of burning quality and frequency of buying in Imvepi refugee settlement (n=204)

	N	Percent (%)
Source of charcoal		
Home made	152	75
Buying from the market	52	26
Total	**204**	**100**
Use of charcoal		
Heating	36	18
Cooking	168	82
Total	**204**	**100**
Perception of charcoal burning quality		
Very good	64	31
Good	115	56
Moderate	22	11
Poor	3	2
Total	**204**	**100**
Frequency of buying charcoal		
Daily	4	2
Weekly	61	30
Monthly	50	25
Non	89	44
Total	**204**	**100**

From the results on quantity of fuel-wood harvested (section 4.3) the third research question can be answered by stating that, firewood is the most commonly used fuel by refugee households in Imvepi settlement and between 12 kgs and 16 kgs of dry and wet wood head weight are harvested by each household daily. On average, one trip was made to pick firewood in the wet season and two trips in the dry season per week. On the other hand, the refugees on average use two kilograms and one basin of charcoal daily and weekly, respectively. There are significant differences in the quantities of fuel-wood when in wet and dry conditions.

4.4 Determinants of fuel-wood use in Imvepi refugee settlement

4.4.1 Determinants of firewood access and use

Table 4.9 shows a summary of the results on determinants of fuel-wood access and usage by the refugees in Imvepi settlement. The table indicates that 148 respondents stated that the family size determined the amount of firewood they access and use in Imvepi refugee settlement. In relation to other determinants assessed, family size accounted for 26%, which implies that a relatively big-sized household in the settlement is likely to use more firewood as compared to a relatively small-sized one.

Table 4.9 further indicates 58 of the respondents indicated that culture also determined access and use of firewood. This accounted for 10% of the responses on all the determinants assessed. The non-parametric test results showed that family size and culture were significant (at 0.000 and 0.002 respectively) in determining access to and use of firewood by refugees at above 95% confidence level. These results reveal that family size and culture significantly determined the amount of firewood accessed and used in Imvepi refugee settlement.

Similarly, 150 of the respondents indicated that poverty also determines access and use of firewood in Imvepi refugee settlement. The responses for 27% of the responses on all the determinants of firewood access and use. This implies that firewood is used by refugees because it is either freely available or costs less as compared to other energy resources in the refugee community. The results also reflect the low economic status of the refugee settlers in Imvepi. From the BST, poverty as a determent was statistically significant at 95% confidence interval given the p-value (0.000) below the alpha level meaning that the probability of a poor household opting for firewood is higher than for other energy alternatives.

Table 4.9: Determinants of fire wood access and use in Imvepi refugee settlement (n=204)

	N	%	Observed Prop.	Test Prop.	P-Value
Family size	148	26	1	0.9	0.000**
Culture	58	10	1	0.9	0.002**
Poverty	150	27	1	0.9	0.000**
Weak enforcement	58	10	1	0.9	0.002**
Type of food cooked	89	16	1	0.9	0.000**
Method of cooking	9	2	1	0.9	0.387
Availability of labor	26	5	1	0.9	0.065
Size of wood store	8	1	1	0.9	0.430
High income	7	1	1	0.9	0.478
Availability of wood	7	1	1	0.9	0.487

*** Significant at 0.05 level*

Additionally, 58 of the respondents revealed to have cited access and use of firewood in the refugee settlement as being determined by weak enforcement of policies. The responses here is accounted for 10% in relation to all the determinants examined. This reveals that, refugee households in Imvepi refugee settlement use more firewood due to relaxed implementation and enforcement of environmental laws that would argue against deforestation. The BST revealed that the influence of weak enforcement of policies on access and use of fire fuel-wood was significant at above 95% level, given the p-value: 0.002.

Table 4.9 further reveals that type of food cooked is one of the determinants of access and use of firewood by refugee households in Imvepi settlement as represented 16% of all the determinants. The influence of type of food cooked in determining access and use of fire wood was statistically significant given the BST p-value (0.000) below the decision rule. The results signify that refugee households in Imvepi are more likely to vary the amount of firewood used depending on the type of food cooked.

Table 4.9 shows further that method of cooking determined the amount of firewood used in Imvepi refugee settlement households however, the influence was not statistically significant. The responses on this factor as a proportion of all the determinants assessed accounted for 2% and the non-parametric statistical test results indicated a p-value of 0.387, which means as a determinant of firewood access and use, method of cooking meagerly determined the amount of firewood used by the refugees.

Another determinant of firewood access and use assessed and depicted in table 4.9 was availability of labor to collect the firewood. Responses on this determinant represented 5% as a proportion of responses on all the determinants. The BST results revealed that the influence of labor availability on access and use of firewood was significant statistically given the p-value 0.065. The results here signify that refugee households would readily and more likely to use more or less firewood irrespective of availability of labor. However, because refugee households in Imvepi were averagely large (five persons, as shown by the respondents' baseline data), the labor to collect firewood would not be an issue of concern hence use of more quantities of fuel-wood.

Table 4.9 further reveals that size of the wood store, high income, and availability of wood all accounted for 3% (each factor taking a proportion of 1%) of the responses on all the determinants assessed in this study. The three determinants were shown not to be statistically significant at 95% level as shown by the p-values: 0.430, 0.478 and 0.487 for size of the wood store, high income and availability of wood respectively. The results imply that the amount of firewood accessed and used by refugees in Imvepi settlement varied depending on size of wood store, income and availability of wood.

From the study findings on firewood access and usage determinants (Table 4.9), the first part the third research question can be answered by noting that, the amount of firewood accessed and used in Imvepi refugee settlement is determined by a number of factors. However, family size, poverty, culture, type of food cooked and weak enforcement of policies stand out as the most significant.

4.4.2 Determinants of charcoal fuel access and usage

Table 4.10 shows a summary of the results on determinants of charcoal access and use in Imvepi refugee settlement. Results reveal that 155 of the respondents cited family size as one of the determinants of charcoal fuel access and usage, which accounted for 29% of all the determinants. This represents the biggest proportion of responses on all the determinants examined. The non-parametric statistical test results also show that family size was significant in determining amount of charcoal accessed and used by refugee households in Imvepi settlement. This means that the larger the family the more the quantities of charcoal used by the residents in Imvepi refugee settlement. Family size was significant in determining access and use of charcoal at 95% level given the 0.000 p-value within the decision rule (0.05).

Further, 82 respondents noted culture as a determinant of charcoal fuel. Culture accounted for 15% in relation to all the determinants. The BST results indicate that culture significantly determined access to and use of charcoal fuel among Imvepi households given the p-value: 0.000, which is above the decision rule (0.05). The results signify that the use of charcoal is part of the cultural norms governing the livelihoods of most refugees in Imvepi settlement in Arua. Thus charcoal access and use in Imvepi refugee settlement is significantly determined by culture.

Seventy respondents' responses representing a proportion of 13% among all the determinants pointed out that access to and use of charcoal fuel is determined by poverty. The non-parametric statistical results also reveal that the influence of poverty in determining charcoal access and use was significant at 95% level. The test returned a p-value of 0.001, which means that the probability of a poor refugee household accessing and using charcoal fuel was lower than that of a relatively wealthy family in the refugee settlement.

Sixty-two (62) of the respondents also pointed out week enforcement of policies governing charcoal production as one of the determinants of charcoal access in Imvepi refugee settlement. The responses represented 12% out of all the determinants assessed. From the non-parametric BST procedure, a p-value of 0.001 was revealed, which signifies that weak enforcement of policies significantly determines access and use of charcoal fuel. The level of significance was above the alpha level (0.05).

Table 4.10: Determinants of charcoal fuel access in Imvepi refugee settlement (n=204)

	N	Relative %age	Observed Prop.	Test Prop.	P-Value
Family size	155	29	1	0.9	0.000**
Culture	82	15	1	0.9	0.000**
Poverty	70	13	1	0.9	0.001**
Weak enforcement	62	12	1	0.9	0.001**
Type of food cooked	103	19	1	0.9	0.000**
Method of cooking	34	6	1	0.9	0.028**
Availability of labor	7	1	1	0.9	0.478
Size of charcoal store	8	1	1	0.9	0.430
High income	11	2	1	0.9	0.314
Availability of wood	7	1	1	0.9	0.478

** Significant at 0.05 level

Table 4.10 also shows that 103 respondents highlighted the type of food cooked as another determinant of charcoal access and usage among Imvepi refugees' households. The influence of type of food cooked in determining access and use of charcoal was statistically significant at above 95% given the returned BST p-value within the decision rule (0.028). This shows that the type of food cooked by refugees in Imvepi settlement partly accounts for variations in amount of charcoal accessed and used. It means that there are certain foodstuffs cooked by refugee households that can best be prepared using charcoal thus more charcoal accessed and used while others require less charcoal or can be prepared using firewood thus less charcoal used.

Table 4.10 reveals that 7 of the respondents indicated availability of labor as one of the determinants of charcoal access and use in Imvepi refugee settlement. The responses on availability of labor represent a proportion of 1 % of all assessed determinants. The BST results however revealed that the influence of labor availability on access and use of charcoal was statistically insignificant at 95% confidence interval given a p-value of 0.478. The results here signify that refugee household do not require much labor to access and use charcoal.

Similarly, 8 of the respondents highlighted size of the charcoal store to be determining their access to and use of charcoal fuel in Imvepi refugee settlement. In terms of proportion of all the determinants of charcoal analyzed, the responses on size of charcoal store represent 1%. However, the non-parametric results show size of the charcoal store as a significant determinant (at 95% level with a p-value of 0.430 of charcoal fuel access and usage among the refugee households in Arua.

The proportion of respondents citing income as one of the determinants of charcoal fuel access and use in Imvepi refugee settlement represented 2% while the BST results also revealed high income as a significant determinant of charcoal fuel access and use among the refugees. The level of significance was above 95% (p-value of 0.314).

Seven of the respondents representing 1% of the responses on all the determinants indicated availability of charcoal as another determinant of quantities of charcoal accessed and used in Imvepi refugee settlement. Availability of charcoal was statistically significant in determining charcoal access and use at 95% given a p-value 0.478 realized from the non-parametric statistical test results.

From the results in Table 4.10, family size, culture, poverty, weak enforcement, type of food cooked, and method of cooking are noted as the most significant determinants of charcoal fuel access and usage among Imvepi refugee settlers. When the results on the determinants are compared for firewood and charcoal fuel access and usage, it is noted that the same factors that were significant in determining fire wood access and use also significantly determined charcoal access and usage only that under the former, method of cooking was not found to be significant. From these results, the second section of the third research question can be answered by stating that refugees in Imvepi use more use more or less charcoal due to family size, culture, poverty, weak enforcement, type of food cooked, and method of cooking.

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter presents and scrutinizes the major findings of the current study in relation to previous studies, following the trajectory of the study objectives.

5.2 Discussion

5.2.1 Extent and trend of vegetation cover and land use changes in Imvepi Refugee settlement between 2016 and 2019

Woodland and bushland vegetation experienced the biggest losses (by 19% & 7%, respectively) in areal extent over the study period (2016 - 2019) due to refugee settlement in Imvepi. These mainly translated into built-up areas, farmlands, and grasslands. It is evident that woodlands and bushlands are the main target for vegetation resources' exploitation as these are a source of wood for both charcoal burning and firewood. Besides, building poles that refugees resort to for establishment of temporal house structures come from woodlands and bushlands. These changes are attributed to the refugee settlement and the quest to meet their needs. The impact of the community on these vegetation form is this case is discounted from these results due to the fact that refugee settlements are established on public land which may be adjacent to natural resources including forests, wetlands, grasslands and water bodies, among others. For the vegetation cover, these are highly degraded, primarily because of the high demand for wood fuel used for cooking and heating (Hovil, 2007).

These results communicate directly with the findings of by UNHCR (2018), that 75% of the trees are estimated to have been cut in Adjumani during the 2017 refugee influx into Northern Uganda. In the present study, the start of wood and bushland vegetation losses coincide with the period noted to have experienced the biggest influx of refugees in northern Uganda (UNHCR, 2017).

In the current study, it was established that woodland and bushland decreased consistently over the study period which rhymes with the study f1nding by Gebre & Andualem (2018) who investigated the extent, trends and causes of land use and land cover changes over a period of 1987 to 2009 in a resettlement in Gambella – Ethiopia. In Their study, they noted that woodlands decreased on an annual basis over the study period. In the same study area, Othow et al. (2017) used Landsat TM image of 1990, ETM+ of 2002 and OLI-TIRS of 2017 to map land use/cover changes and the causes of forest cover change between 2002 and 2017 and found out that forest cover declined from (23%) in 2002 to (18.11%) in 2017 with annual decreasing rate (1.41%) per annum. Whereas forest cover was not among the vegetation cover classes identified in Imvepi during the current study, the findings by Othow et al. (2017) imply that with refugee settlement comes destruction of some form of vegetation cover.

Similarly Hagenlocher et al. (2012) noted that increasing internally displaced persons camps cause considerable decrease in woody vegetation in the areas surrounding the settlement. Long-term environmental impacts, including deforestation, around refugee settlements in Lukole, Tanzania were also reported by Muster et al. (2015). The development of refugee settlements caused significant degradation of natural vegetation according to these studies, which reflects the situation exhibited in Imvepi refugee settlement. Although in the current study, some of the cover classes like grasslands were noted to have increased, the general view is held that with in every refugee settlement, some form of vegetation degradation is recorded over time.

Grassland cover was the main vegetation type that witnessed gains in spatial extent over the four-year span in Imvepi. It is not just coincidental that woodland and bushland's areal extent decreased while that for grassland decreased over the same time in the study area. Often when vegetation is cleared, a different vegetation form replaces it (Gianvenuti et al., 2019; Maystadt et al., 2020). Thus, the scenario observed in the current study indicated that bushlands and woodlands were replaced by grasslands, which accounts for the overall increase in grassland area. Kuemmerle (2009)'s study in Arges County in Romania, indicated that gain in grassland area was attributed to conversion of cropland, which was related to the rapid changes in socio-economic, demographic and institutional conditions after 1989. This contrasts with the situation observed in Imvepi settlement because here, both farmland and grassland gained in spatial extent over the study period, which means the gains originated for other cover whose spatial extent deteriorated and that is bushland and woodland.

Built-up environment in the current study experienced consistent expansion over the study period as compared to vegetation cover which signifies that part of vegetation cover was cleared to create room the refugee settlement and related infrastructure as shown in by previous studies elsewhere (e.g. Swamy et al., 2018; Celuis, 2020). This is similar to the findings by the UNDP (2018) which showed that during the 2017 refugee influx into northern Uganda, approximately 75% of the trees were cut to provide poles for construction of settlement units. This is the very time Imvepi settlement started experiencing losses in major vegetation forms (wood and bushlands) according to the present study findings. The refugee settlements with time too, increased in size and thus accounting for increase in built-up area as reflected in the Imvepi refugee settlement.

The current study established that farmlands registered the biggest increment in spatial extent between 2016 and 2019 in Imvepi refugee settlement which is agrees with the findings by Othow et al. (2017), who mapped land use/cover changes and the causes of forest cover change between 2002 and 2017 in Ethiopia and indicated farmland in the study area increased from (4%) in 2002 to (23%) in 2017 with annual expansion rate (24.9%). This provides evidence to suggest that after the arrival of refugees in Imvepi, the quest for subsistence pushed people into clearance of vegetation especially woodlands and bushlands which were still virgin and thus more productive agriculturally as compared to grasslands to carry out small-scale farming. Maystadt et al. (2020) in their study argued that vegetation changes in refugee settlements in Africa occurred not because of land clearance and massive biomass extraction but from agricultural land expansion into the hosting community. Similarly, Mark and Kudakwashe (2010) conducted a study in Shurugwi district in Midlands Province of Zimbabwe and established that cropland had increased over the study period at the expense of forests. In the study, it was observed that forest cover was cleared for different farm related activities including opening up of new farm plots to create farming plots, fuel-wood, poles for building both homes and cattle pens, among other activities. The changes in land use/ cover in Zimbabwe stemmed from Land reform and resettlement program in Zimbabwe (Mark and Kudakwashe, 2010) which brought about conditions similar to those created by the refugee settlement in Imvepi. The intensification in farming due to increase in refugee numbers thus accounts for vegetation degradation in Imvepi settlement just like what is already pointed out by Alam and Starr (2009).

In a study by Maystadt et al. (2020) involving the assessment of vegetation changes (2000-2016) attributable to refugees in Africa using MODIS MCD43A4, it was concluded that refugees bear a small increase in vegetation conditions while contributing to increased deforestation. The study noted further that vegetation clearance in refugee settlements in Africa is not due to land clearance and massive biomass extraction but due to agricultural expansion into refugee-hosting areas. A one percent increase in the number of refugees amplifies the transition from dominant forested areas to cropland by 1.4 percentage points (Maystadt et el., 2020). The fact that Maystadt et al. (2020) recognized that refugees contribute to vegetation destruction, mirrors the findings of the present study. Similarly, agricultural activities from settlement expansion were reported to cause changes in forests, woodlands and grasslands (Spröhnle et al., 2016; Owar et al., 2017; Maystadt et al., 2020) which was also true in the Imvepi refugee settlement.

5.2.2 Quantity of fuel-wood used in Imvepi refugee settlement

The current study established that firewood is the commonly used fuel by refugee households in Imvepi, on average between 12 and 16 kilograms of dry and wet wood are used per household daily. On the other hand, on average, two kilograms and one basin of charcoal are used daily and weekly respectively per refugee. Further, on average, one trip is made to pick firewood in the wet season and two trips in the dry season per week. There were significant differences in the quantity of fuel-wood used during the wet and dry seasons. The findings revealed that more wood is harvested and used in the dry season than in the wet season. The relatively large-scale wood energy consumption reflects the absence of /limited use of wood energy efficient methods and techniques for cooking as reported elsewhere (Gunning, 2014; Mushtaq et al., 2014; Mwaura et al., 2014; Rawat & Kumar, 2015). Similarly, there are limited alternatives to biomass consumption in Imvepi that could alleviate the consumption of fuel-wood. Tahir et al. (2014) however, notes that existence of energy alternatives is not a necessary condition to reduce household biomass fuel consumption as economic factors come into play.

The survey in the current study also revealed that the burning quality of the wood and charcoal used by refugee settlers is generally good. This is only possible with trees from woodlands and bushes. The traditional biomass usage for cooking in refugee settlements was estimated by UNDP (2018) to be at 3.5 kg per capita per day. FAO & UNHCR (2017) rapid fuel-wood assessment for the Bidibidi settlement in northern Uganda using data from field measurements and biomass mapping established that the total population at the settlement consumes approximately 952 tonnes per day and 347,480 tonnes of fuel per year. When the current study household firewood and charcoal daily consumption is computed for all the households sampled, similar findings are shown. Here, 2.5 tonnes of fuel-wood and 330 kgs of charcoal are estimated to be consumed daily by the 204 households sampled in Imvepi. This generally indicates large-scale biomass consumption patterns among refugees. The current study findings are also related to Gunning (2014)'s study on biomass consumption. Gunning (2014) reports that between 0.7 and 3 kgs of charcoal are consumed when inefficient cooking technologies and practices are involved. In the present study, it was established that on average 2 kgs of charcoal are used by refugee households in Imvepi, which quantities lie within Gunning' (2014)'s estimates.

The study revealed that the major purpose for the fuel-wood in Imvepi is cooking whereas these energy forms can be used for other purposes like heating and lighting, which is also communicated in other studies (e.g. Lehne et al., 2016). UNDP (2018) report indicates that refugees at Bidibidi refugee settlement in Northern Uganda depended on traditional biomass (firewood and charcoal) for mainly cooking. Firewood is a primary source of energy for rural households used for cooking but also food preservation (Egeru, 2014; Thulstrup and Wani, 2015).

Although some of the charcoal used by refugees in Imvepi is bought from the market, much of it is "self-made" by the refugee households. This has negative consequences on vegetation cover, as there may be no limit on trees cut for this aforementioned purpose (Tscharntke et al., 2012). This is true with most commons (communally managed resources) as every refugee household tries to maximize the utility of the vegetation resources for fuel (Twongyirwe et al., 2018; Soseco et al., 2018).

The study led to an understanding that woodlands and bushlands are the main sources of fuel-wood for the refugee settlers. The assessment of vegetation cover changes in line with the first objective of this study revealed that the spatial extent for woodlands and bushlands drastically reduced between 2016 and 2019 as with the case elsewhere (Muster et al., 2015; Li et al, 2016). This signals that firewood collection and charcoal production are responsible for the losses in these vegetation forms. The scenario in Imvepi presents risks of climate variability and change in an area, which inherently exhibits semi-arid conditions (Salih et al., 2013). Biomass consumption is associated with emission of greenhouse gasses such as carbon dioxide from burning of charcoal and use of firewood (Raleigh et al., 2007; Rawat & Kumar, 2015). Continued forest and woodland vegetation clearance imply reduced carbon uptake in the atmosphere by vegetation, which is released into the atmosphere due to the very human related activities.

5.2.3 Determinants of fuel-wood access and use in Imvepi refugee settlement

Accessibility and use of both fuel-wood and charcoal in Imvepi settlement is mostly determined by family size, culture, poverty, weak enforcement, type of food cooked and method of cooking. Some foodstuffs like beans (given as food aid but also locally produced) take long to get ready and thus consume more energy in terms of firewood and charcoal. The minimum sensible heat required to transform 1 kg of raw food into cooked food are 440 ± 3kJ (1kg of dry rice), 609 ± 4 kJ (1 kg of dry beans) 212 ± 2 kJ (1 kg of raw potatoes) and 626 ± 4 kJ (1 kg of meat) (Rawat & Kumar, 2015; Paparu et al., 2018). Some foods are consequently highly demanding in terms of heat supply more so that much of the cooking in the Imvepi settlement is done in the open where some of the heat is lost by wind blowing it away and cooking takes much more time than under controlled heating conditions. Total hours of heating are positively related with firewood consumption according to Mislimshoeva et al. (2014).

The present study results are synonymous with the findings by Egeru (2014) who reports that expenditure on food per week, household size, expenditure on charcoal, price of fuelwood and household income are key determinants of fuelwood demand in rural areas. It is noted in the present study that poverty limits the refugee households from venturing into other energy sources or energy saving technology alternatives. On average, a refugee household in Imvepi earns fifty thousand Uganda shillings, which is meagerly spent on basics like food. Poverty as a factor here is implied under household income in previous studies (e.g. Egeru, 2014; Thulstrup and Wani, 2015).

The current study established that poverty and income level significantly determine access to and use of fuel-wood in Imvepi refugee settlement. The large fuel-wood consumption among refugees in Imvepi is thus related to the rural set-up and poor economic status in the area makes firewood and charcoal the only energy alternatives available for both refugees and the refugee hosting communities as already reveled by other studies (e.g. World Vision, 2017 and Win et al., 2018). The results also relate to those by Malla & Timilsina (2014) who stated that the choices of fuel and adoption of improved stoves for cooking in countries where biomass is still the predominant cooking fuel are influenced by; access and availability, collection costs, fuel prices, household income, food tastes, lifestyle, and government policies. Rahut et al. (2017) also report that low economic status households in Timor-Leste were dependent on dirty energy like firewood than their counterparts from the high economic class. Social-economic classes are stratified based on levels of income. The low income (poor) are limited to traditional biomass energy as compared to the high income who can opt for clean energy like liquid, gas and electricity alternatives (Rahut et al., 2017). The refugee households in Imvepi rely on fuel-wood that can be accessed freely and/ or at a very low cost given their economic status. Large-scale fuel-wood consumption in the rural areas of Myanmar was also attributed to limited sources of energy (Win et al., 2018).

Over reliance on traditional biomass in Uganda has been previously blamed on poverty (Mwaura et al., 2014). Mwaura et al. (2014) noted that utilization of modern energy sources was only by 4 percent of households in Uganda. Their study pinpointed out consumption expenditure welfare, residence in rural or urban, household size, achievement of education levels beyond primary level and regional location of a household as the main determinants of household energy choices. Some of these factors have also been highlighted in the present study as important in determining biomass consumption. Similarly Musa et al. (2019) noted that the persons conditioned in settlements are deplorable far from the ideal situation and recommended government and humanitarian support for such people to improve on their living condition through socio-economic education, skills, and vocational training that promotes lifelong learning opportunities. These studies all point towards the fact that displaced persons such as refugees are economically hand-capped thus reliance on natural resources like vegetation cover for subsistence which means their economic status influence their natural resource utilization decisions including biomass fuel use (Young and Goldman, 2015).

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The chapter presents conclusions and recommendations in line with the study objectives.

6.2 Conclusion

From the study, it is clear that refugee settlement is associated with enormous pressures on the various components of the environment leading to land use and land cover changes and thus environmental degradation. Refuge settlement is responsible for wood and bushland vegetation deforestation and degradation in Imvepi settlement in Arua. The refugee settlement has created more built-up environment and expansion of farmlands into critical vegetation zones in a bid to meet the refugee households' food demands. It is for such reasons that areal extent for built-up and farmland increased at the expense of vegetation cover in Imvepi between 2016 and 2019.

Further, refugees in Imvepi use large quantities of fuel-wood although these vary significantly depending of the moisture conditions of the wood during the dry and wet seasons. Among the vegetation types, woodland and bushland vegetation provides more to fuel-wood production for the refugees in Imvepi settlement. The huge fuel-wood demands by the refugee in Imvepi is thus, exacerbating the vegetation degradation problem and with time, if no interventions are implemented, these vegetation forms are bound to undergo extinction in the area.

The large quantities of fuel-wood harvested and used by the refugees are mainly due to the large family size, culture, poverty, weak enforcement and type of food cooked hence these determine the rate of vegetation resource utilization and consequent environmental degradation in Imvepi refugee settlement.

It is hoped that the findings from this study on the status of vegetation resources, land use changes and fuel-wood consumption in Imvepi refugee settlement will provide apt guidance to resource managers and land use planners in refugee communities in different parts of Uganda in the course of executing their duties and responsibilities.

6.3 Recommendations

Programs to revegetate the depleted woodlands and bushlands such as agroforestry should be implemented in the refugee communities to address both environmental and livelihood concerns. As refugees are allotted land for settlement and agriculture, it should be mandated that part of it be dedicated to woodlots. It was established in this study that woodlands and grasslands were replaced mainly by farmlands thus a balance between tree plantations and crop farming becomes ideal to squally address these concerns.

The refugee communities should embrace use of fuel-wood saving stoves and alternatives to firewood and charcoal fuel such as use of briquettes. The organizations in charge of refugees like UNHCR should put-up programs for skilling refugees in making briquettes using waste material and general energy conservation skills on arrival at the receiving centers before they are allotted land access in the hosting communities. The government and other stakeholders should also help the refugees to start up income generating projects to elevate their economic status and venture into other environmentally friendly energy options.

The government of Uganda and UNHCR should restrict the number of refugees per center while taking into consideration the refugee household size vis-à-vis spatial extent of the settlement area and the existing population in the host community. Refugee resettlement planning should therefore consider spatially spreading settlements to reduce effects of concentration in a single location. The current excesses of the refugee population should also be relocated to other new centers. In refugee settlements, family planning campaigns should be intensified as a population control measure. More to that, the government should strictly enforce environmental protection laws for example those against deforestation caused by agricultural extension and charcoal and bush burning.

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APPENDICES

APPENDIX I: FIELD LETTER

KYAMBOGO UNIVERSITY

P. O. BOX 1 KYAMBOGO
FACULTY OF ARTS AND SOCIAL SCIENCES
DEPARTMENT OF GEOGRAPHY AND SOCIAL STUDIES

25th February, 2019

TO WHOM IT MAY CONCERN
MWERU ARON
17/U/14404/GMAG/PE

This is to introduce to you the above named student who is pursuing a Master of Arts in Geography degree course at Kyambogo University. He is in his second and final year and he is supposed to conduct a research study in **Assessing the Impact of Refugee Settlement and their land use activities on the Vegetation in imvepi Settlement camp in Arua District**." His research is under the supervision of Dr. Turyabanawe Loy Gumisira and Dr. Barasa Bernard.

Any assistance accorded to him will be highly appreciated.

Thank you

Nabbosa Miilly(Ms)
RESEARCH COORDINATOR

DISTRICT FORESTRY OFFICER
01 MAR 2019
ARUA DISTRICT LOCAL GOVERNMENT
P.O. BOX 1, ARUA

DEPARTMENT OF GEOGRAPHY & SOCIAL STUDIES
KYAMBOGO UNIVERSITY
P.O. BOX 1, KYAMBOGO

noted Proceed
Ottwang
01.3.2019

For:- CHIEF ADMINISTRATIVE OFFICER
01 MAR 2019
ARUA DISTRICT LOCAL GOV'T
P.O. BOX 1, ARUA

OPM- REFUGEE DEPARTMENT
27 FEB 2019
RECEIVED
IMVEPI REFUGEE SETTLEMENT

Settlement Commandant Imvepi Refugee Settlement.

APPENDIX II: SURVEY QUESTIONNAIRE

Dear participant,

This questionnaire is for helping Mr. **MWERU ARON** a student of M.A in Geography at Kyambogo University to obtain information that will assist him to write a dissertation that is a partial requirement for this course. It is **NOT** meant for any other purpose; and therefore, information provided herein will be kept with utmost confidentiality. You are therefore kindly requested to cooperate in answering the questions honestly to provide the required information. The topic of study is "*The impact of refugee settlement on vegetation and Land use changes in Imvepi settlement in Arua district, North Western Uganda"*.

Section I: Socio-economic characteristics	
100. Date of interview: Day__________Month______/2019 101. Start time of interview: ______/______ End time_____/_____	
102. Interview name:	
103. Respondent/Household:	
104. Name of the respondent (optional):	
105. District	
106. Refugee settlement:	
107. Sub-county:	
108. Parish	
109. Village	
110. GPS coordinates and altitude (elevation):	

110a. GPS: Longitude________________________ Latitude_________________________ 110b. Elevation: _______________________(Meters)	
111. Household position (by roles such as father, mother, son, daughter, grandfather etc.)	
112. Gender of respondent	1. Male 2. Female
113. Country of origin	
114. Age (years) of the respondent?	
115. What is your marital status	1. Single 2. Married 3. Separated 4. Divorced 5. Widowed
116. What is your level of education	1. Primary 2. Secondary 3. Vocational 4. University 5. None
117. How many household members stay in your house?	
118. Who collects firewood in this house?	1. Women 2. Husband 3. Children All
119. What is the main use of fuel-wood	1. Heating 2. Cooking 3. Other (specify)………………………………..
120. What is your main source of livelihood?	1. Farming 2. Formal 3. Casual labour 4. Business/trading

	5. Other (specify)…………………………………
121. What is your average monthly income?	
122. What is the size of your plot?	(Acre)

Section 2: Wood analysis

Process of sampling

1. *Weight harvested fuel-wood per day*
2. *After weighing, get a sample of both day or wet wood and store in paper bag for lab analysis (a small piece)*
3. *Ask for distance of collection*

Measures:

201a. 201b.	**Wood** Daily head weights of fuel-wood consumed (wet/green) Daily head weights of fuel-wood consumed (air-dried)?	…………………………………….(Kgs) …………………….………….(Kgs)
202	What is your perception on the burning quality of the fuel-wood?	1. Very good 2. Good 3. Moderate 4. Poor
203	What do you use the fuel-wood for?	1. Heating 2. Cooking 3. Other (specify)………………………
204	Number of trips to pick firewood in a week	During dry season: During the wet season
205	What is the average length of fuel-wood?	

206	What is the source of fuel-wood?	1. Woodlands 2. Bush 3. Tree plantations 4. Wetlands 5. Gardens 6. Other (specify)………………………
Charcoal:		
207	Daily weights of charcoal consumed?	
208	What is the distance of charcoal collection?	
209	What is your perception on the burning quality?	1. Very good 2. Good 3. Moderate 4. Poor
210	What do you use the fuel-wood for?	1. Heating 2. Cooking 3. Other (specify)………………………
216.	What is the type of fuel-wood storage?	1. Permanent house 2. Tent 3. Grass thatched house 4. Other (specify)………………………
217.	What is the name of the tree species? (In local language)	
218.	What is the amount of charcoal consumed by your HH per week?	1. 1-2 Basins 2. 3-5 Basins 3. Over 5 Basins 4. Less than a basin
219.	How many times does HH buy charcoal	1. Daily 2. Weekly 3. Monthly
220.	What is the distance from your HH to the charcoal store	1. Less than Km 2. 1-2 Km 3. More than 3 Km

221.	What is the source of charcoal used in your household?	1. Homemade 2. Buying from the market/shop 3. Borrowing from neighbours 4. Other (specify)………………………

Section 3: Determinants of fuel-wood use

	Process of selecting respondents: *The respondents will be interviewed basing on the family sizes for example 1-3 very small, 6-8 medium, 9-12 large and 13-15 very large*	***Key notes:*** *1=family size, 2=culture, 3=poverty, 4=weak enforcement of laws, 5=type of food cooked, 6=method of cooking, 7=availability of labour, 8=size of house for wood storage, 9=high income, 10=availability of wood, 11=Others (Specify)*				
301	**Influence of household size on fuel-wood demand**					
	Parameters					
	Firewood					
	Charcoal					

Section 4: Constraints and opportunities to fuel-wood access, storage and use

	Constraints: *Order 1=no funds, 2=long distance, 3=limited awareness, 4=wildfires, 5=indiscriminate cutting, 6=strict forest laws, 7=rape, 8=wild animals, 9= conflicts, 10=land use, 11-Threats from the Host community, 12=Others Specify)*	***Opportunities:*** *Orders 1=Availability of forests/Bushes, 2=Provision from NGOs, 3=Other (specify)……………………………………………..*				
401	**What are the constraints to fuel-wood access, storage and use?**					
	Type of fuel-wood					
	Firewood					
	Charcoal					
402	**What are the opportunities to fuel-wood access, storage and use?**					
	Type of fuel-wood					
	Firewood					
	Charcoal					

<table>
<tr><td colspan="7">Section 5: Measures to generate degraded vegetation and increase fuel-wood</td></tr>
<tr><td></td><td>Examples:
1=Establishment of new woodlots (Afforestation), Reforestation, 2=Use of Briquettes, 3=Use of energy saving cook stoves, 4=Availability of solar energy, 5=Environmental awareness and sensitization programs, 7=Agroforestry programs (Planting fruit trees at HH level)</td><td colspan="5">Sources of information: 1=Tv, 2=Radio, 3=Wood of mouth, 4=Community announcer, 5=Newspapers

Who:
1=NGOs, 2=Govt, 3=Community, 4=Individual</td></tr>
<tr><td>501</td><td>What measures have been out in place to regenerate degraded vegetation in order to increase fuel-wood?</td><td colspan="5"></td></tr>
<tr><td></td><td>Measures</td><td>Who</td><td>Where</td><td>When (period)</td><td>Source of information</td><td>Thoughts on how to do it better</td></tr>
<tr><td></td><td>Regenerate degraded vegetation</td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td></td><td>Available measures to increase fuel-wood</td><td></td><td></td><td></td><td></td><td></td></tr>
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APPENDIX III: FOCUS GROUP DISCUSION GUIDE

Day/Date: _____/_____/_____

Time: _________________

Number of participants: _________________

Participants

No.	Name	Sex	Nationality	Telephone No.

Question 1

What are the sources of fuel-wood in this settlement?

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………………………………………………………………………………………………………
………………………………………………………………………………………………………
…………………………………………………………………

Question 2.

What are the challenges/problems to access fuel-wood in this settlement? And who is more affected?

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Question 3.

What strategies/copying measures do you use to access fuel-wood in this settlement?

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………………………………………………………………

Question 4.

What are the strength and opportunities to fuel-wood access in the settlement?

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………………………………………………………………

APPENDIX IV: KEY INFORMANT INTERVIEW GUIDE

Name………………………………………………………….

Position: ……………………………………………………

Contact…………………………………………………...

Email: ………………………………………………………

Question 1.

What are the strength and opportunities to fuel-wood access in the settlement?

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Question 2.

What are the challenges to fuel-wood access in the settlement?

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Question 3.

What are the solutions to the challenges?

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Question 4.

What are the measures to regenerate degraded vegetation and increase fuel-wood?

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Question 5

Which partners (NGOs) are involved in these activities.

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…………………………………………………………………

APPENDIX V: IMVEPI REFUGEE SETTLEMENT AREA PHOTOGRAPHS

Source: Field survey, February 2019