



**SUSTAINABILITY: AVAILABILITY, DISTRIBUTION  
AND CONSUMPTION OF FIREWOOD NEAR  
KIDEPO VALLEY NATIONAL PARK**

Household surveys and forest inventory

2016, August

Albers, Peggy



# **SUSTAINABILITY: AVAILABILITY, DISTRIBUTION AND CONSUMPTION OF FIREWOOD NEAR KIDEPO VALLEY NATIONAL PARK**

Household surveys and forest inventory

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## Preface

A final project; the thesis, is obligatory to finish the course BSc Tropical Forestry and Nature Management at Van Hall-Larenstein University of Applied Sciences. The research for the thesis is conducted in Uganda and will help contribute to the improvement of the livelihoods of the communities living in northern Uganda, near Kidepo Valley National Park (NP). This report presents the motivation for this research, the method of conducting, and the findings of this study.

In Uganda, I worked together with a Community Wildlife Research and Education Centre called Ajokis located in Karenga. The thesis project is about firewood; mainly Social research is conducted, to analyse the current firewood availability, distribution and consumption and if the harvest is done sustainably.

I want to thank Ajokis for assisting me with my research, providing me with a translator and transport. I want to express my appreciation toward John Lobo who assisted me during my whole research, being my translator, guide and expert of the region. I also want to show my gratitude towards Lily Vercruysse for assisting me in the process of doing research and report writing. I want to thank Jos Wintermans, Richard Kraaijvanger and Dagmar Rieseboos for the help they gave me during my report writing.

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Peggy Albers  
30 August 2016

## Abstract

Near Kidepo Valley National Park (NP) there is much deforestation happening. Almost all the people depend on wood, for most, it is the only source of energy, building material and income. Also, the population size is increasing, and every year previously forested land is converted into agricultural fields. Through this, the accessibility to the forested areas is increasing, and it is easier to get to the untouched parts. There is a lack of knowledge, capacity and motivation of the communities to manage and protect the wood supply. These problems and causes together lead to the biggest problem in the area; the unsustainable harvest of wood.

This research has the following objective: "By documenting the availability, the consumption and the distribution of the firewood species used by the communities living near Kidepo Valley NP, a household survey on firewood use will be conducted in the area. Also, the current location of woodlots will be inventoried. With this, comparable, defensible and useful data is collected that can be used to assess if the firewood consumption is sustainable and to find options to improve the current situation." Obtaining this information provides a better knowledge of possible solutions and problems, and options for improving the livelihoods of the communities can be identified. The used methods are; observation, key informant interviews, focus group meetings, household surveys, a forest inventory, a potential biomass productivity, and sustainability evaluation. To reach the objective the research question "Is the firewood consumption of the local communities living near Kidepo Valley National Park sustainable?" was posed and answered.

The mean annual wood biomass yield increment for *Eucalyptus tereticornis* is 4.945,14 kg/ha and for *Acacia albida* 3.220,77 kg/ha. The total area has a mean annual wood biomass yield increment of 39.561,12 kg for *Eucalyptus tereticornis* and *Acacia albida* 25.766,16 kg. In the dry season, most collect daily and walk up to five hours and five kilometres from their compound to the woodlots from which they collect. On average one bundle of firewood sustains a household for 2,3 days and weighs 27,2 kg. The mean annual consumption per household is 4.316,5 kg and per capita 501,9 kg. The entire community of the study area needs 7.528.500 kg of firewood yearly.

This research was able to conclude that the harvest is not done sustainably. The total yield is estimated at 39.561,12 kg for *Eucalyptus tereticornis* and at 25.766,16 kg for *Acacia albida*, which are both much lower than the total use of 7.528.500 kg. The community members do not want to walk far, which leads to overharvesting in the areas closer to the compounds, but leaves options for improvement.

Within a larger area, there is a possibility to sustainably harvest. Another option is to set up plots closer to the compounds with permanently managed firewood. Working in groups together has shown to reduce the firewood consumption. There is the possibility of utilising the resources within the NP.

## Abbreviations

<b>AWF</b>	African Wildlife Foundation
<b>Ba</b>	The annual total net biomass production
<b>bc</b>	Daily gross photosynthesis rate of standard vegetation canopies on very clear days
<b>Bm</b>	The mean annual total biomass increment
<b>bo</b>	Daily gross photosynthesis rate of standard vegetation canopies on overcast days
<b>Bw</b>	The constraint-free mean annual wood biomass yield increment
<b>CDDF</b>	Community driven development fund
<b>Ct</b>	The maintenance respiration
<b>Dbh</b>	Diameter at breast height
<b>GIS</b>	Geographical Information System
<b>Hi</b>	Harvest index
<b>LAI</b>	Leaf Area Index
<b>LEC</b>	Local Environment Committee
<b>LGMSD</b>	Local Government management service delivery
<b>LGP</b>	Length of Growing Period
<b>NGO</b>	Non-Governmental Organisation
<b>NP</b>	National Park
<b>NUSAF</b>	North Uganda Social Action Fund
<b>OXFAM</b>	Oxford Committee for Famine Relief
<b>Pm</b>	The rates of maximum photosynthesis
<b>PRA</b>	Participatory Rural Appraisal
<b>UBOS</b>	Uganda Bureau of Statistics
<b>UWA</b>	Uganda Wildlife Authority

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# 1. Introduction

This chapter functions as an introduction to this report and the research; the problem is described, after which the objective and research questions are given, to finish this chapter with the outline of this report.

For many people living on this planet firewood (firewood and charcoal) is the only available and affordable source of energy, primarily in non-industrialized areas where the demand for firewood by far exceeds the demand for commercial timber. In many countries firewood accounts for up to 90% of the total fuel used. Almost all the rural households use firewood for cooking, food processing and heating, but industries also rely on firewood; restaurants, brick burning and brewing. (FAO, 1985) In many cities firewood is still the predominant source of energy, this leads to a concentration of the demand for firewood and acute firewood scarcity. Urban firewood shortage affects many people; a study conducted by the Food and Agriculture Organisation of the United Nations (FAO) revealed that already eighteen African countries, including Uganda, are affected. (FAO, 1985)

The rural communities living near Kidepo Valley National Park (NP) and its corridor rely on wood as a source of energy. The corridor is an area that exists to protect the animals and their migration routes; it borders the NP and connects multiple parks with each other. The corridor is not yet indicated, and no one exactly knows where the boundaries of the corridor are. As mentioned before, firewood is mostly for domestic use but also for small-scale industries such as brick making and restaurants. The households collect firewood bundles, as is shown in Figure 1, these are head loads of cut or collected wood and vary in size depending on how strong the person who is collecting is (A. Egeru, Kateregga, & Majaliwa, 2014). If the available firewood ceased to exist, the households living here would be subjected to livelihood insecurity. In the past, it was a dangerous place, with much civil unrest, see Chapter 3.5 History. Nowadays it is quiet, but there has not been much progress in the development of the area.



*Figure 1, woman collecting firewood*

## 1.1 Problem

The biggest problem in the area is the unsustainable harvest of wood. Appendix 1 shows the problem tree with the problems and causes in the area related to this study. The problem and causes are identified through what was seen and heard during the first weeks of the research. Also, literature was consulted to gain a more refined understanding of the problem. Below the underlying causes and problems are listed:

- For many people firewood is the only source of energy, there is a lack of affordable and available alternative fuel sources. (A. Egeru et al., 2014)
- For most community members the only affordable option for building material is biomaterial. To build the houses wooden poles are needed and to protect their land and homestead wooden fences are created (see Figure 2).
- There are few possibilities to get an income, people rely on wood to obtain an income, by making bricks and charcoal, both use a lot of firewood.
- The knowledge, capacity and motivation of the communities are lacking, they have limited knowledge on how to manage an area and protect or increase the wood supply.
- Further, their understanding of the laws and regulation concerning firewood collection is not sufficient, and often they do not understand the necessity of protecting the forest.

- The lack of knowledge is related to the inadequate schooling most people got because there was unrest and war when they grew up.
- The laws and regulations that are in place are limited and widely unknown, and the control and punishments are limited.
- The government does help, but can support more. They have good plans to improve the livelihood of their citizens but often are lacking real improvement.
- There are little options to obtain income and food can be scarce, for this reason, the communities practice burning. They will set a large piece of land on fire, to be able to catch an edible rat which is a local delicacy. When the fire is distinguished the landscape will be clear of vegetation and the holes of the animal can be found. Unfortunately, while burning the area all the dead wood will be burned as well, this leads to less available firewood and together with the problem of “more wood is needed” causes the problem of cutting live trees.
- Currently, many people live in the area, and their size is increasing. The current population of Uganda is estimated at almost 42 million, and although Uganda’s population growth rate of 3,2%, is projected to drop to 2,4% by the year 2040, the total population will increase to 61 million in 2040. (Uganda R. o., 2015) This population growth means there are too many people harvesting firewood without regulating or controlling or other management options to increase the available wood.
- In the study area it is tradition to have more than one wife and how many children you have corresponds with your status, the more children, the higher your social status, thus there are many large families (see Figure 2), which means even more people will have need of the wood sources. Although, this is changing a little, in recent years the household sizes are not as big as before.
- The growing population bring another problem; the conversion of forest, shrub and bush land into agriculture. Many forested areas will be converted, and there will be a loss in the available firewood supply.
- The accessibility to the forested areas is also increasing, because the roads are improving and because people move to more remote areas to practice agriculture. The consequence is even the more remote areas are no longer safe from deforestation.
- The communities are not allowed to collect firewood from inside the NP without supervision because it is not safe, this means there is a limited supply of firewood, and many people are collecting and cutting close to the villages.



*Figure 2, a woman at her homestead with some of her grandchildren*

There will be numerous stakeholders that could have an impact or could be affected by this research. In Appendix 2 – Stakeholder analysis, these stakeholders and their interests, how they are affected, and their capacity and motivation to bring about change are shown, also, possible actions to address problems are addressed.

## 1.2 Objective

The objective of this research is: “By documenting the availability, the consumption and the distribution of the firewood species used by the communities living near Kidepo Valley NP, a household survey on firewood use will be conducted in the area. Also, the current location of woodlots will be inventoried. With this, comparable, defensible and useful data is collected that can be used to assess if the firewood consumption is sustainable and to find options to improve the current situation.”

Achieving the objective mentioned above will determine if the harvest of wood is done sustainably. With the outcome of this research, possible solutions will be discovered. These recommendations will be presented to Ajokis, UWA and the local government to come up with a plan to provide the communities with a way to sustainably harvest their firewood. So that the unsustainable harvest of wood is stopped, and there will be firewood available in the future, while simultaneously providing the community with a better livelihood.

## 1.3 Research questions

The main research question is; “Is the firewood consumption of the local communities living near Kidepo Valley National Park sustainable?”

There are three sub-questions:

1. “What is the availability of the firewood species used by the local communities near Kidepo Valley NP?”
2. “What is the distribution of the firewood species used by the local communities near Kidepo Valley NP?”
3. “What is the consumption of the firewood species used by the local communities near Kidepo Valley NP?”

By finding the availability, distribution and consumption of firewood, the main research question can be answered. The answers to the sub-questions can be compared to each other, and it can be concluded if the harvest of firewood is sustainable or not. Also, the coming chapters are sorted according to these three questions.

## 1.4 Preconditions and pre-limitation

During the research the following preconditions and pre-limitations are met:

- The study takes place within a period of 16 weeks, consisting out of 10 weeks of field work and six weeks of data analysis and report writing.
- The field work takes place in Uganda, near Kidepo Valley NP and its corridor, within the communities that live in that area, so not the whole district Kaabong. The data analysis and report writing take place in the Netherlands.
- A car, a scale, a GPS, pen and paper and a translator and guide are needed to be able to conduct the field work.
- A minimum of 30 household survey interviews is required.
- During the research, a computer is necessary with GIS and Excel, for data analysis.
- There are a culture and a language barrier between the researchers and the communities, so a translator is needed. Also, care should be taken with the translation.
- The research area is remote, has limited electricity and internet.
- The role of women and men is important, men are more respected and mostly more educated, this can lead to women answering different when men are there. This risk was taken into account, and it was tried to interview women without men present.

## 1.5 Organisation

The organisation where this research took place is an NGO called Ajokis Community Wildlife Research and Education Centre, located at Buffalo Base in Karenga in northern Uganda. The education centre is currently being re-established, after years of local unrest and war. Ajokis focuses on the conservation of Kidepo Valley NP and its surroundings, by working together with the local communities on different projects. There is not much known about the surroundings yet, together with students and volunteers Ajokis wants to perform research to gain more knowledge about the area. For this thesis, the focus will be on the topic of deforestation and the possibilities with reforestation.

## 1.6 Report outline

In the current chapter, the research is introduced, the problems and causes thereof are mapped out. The process of setting an objective and research question is elaborated. The second chapter gives the site description, with information about the location, topography, soils, climate, vegetation, inhabitants, history and the organisation. Followed by the methodology in Chapter 3, in which the used methods are elaborated. The method is followed by Chapter 4: the results sorted per research question. Chapter 5 shows the conclusions that can be drawn from the research. In Chapter 6 the results are discussed. The final chapter consists of recommendations, here recommendations and possible solutions for the biggest problem are given.

This report is written primarily for the Community Wildlife Research and Education Centre Ajokis, the sub-county Karenga and the Ugandan Wildlife Authority (UWA) so that this report can help improve the livelihoods of the communities.

## 2. Site description

This chapter serves to inform about the study area. First, the location will be shown, then the topography and climate. Hereafter the inhabitants and their history will be explained, to end with the organisation where the research took place.

### 2.1 Location

The research took place near Kidepo Valley NP in Northern Uganda, in the communities that live next to the park and its corridor. On the map in Appendix 3, the location of the research area is shown, the map shows the NP and the main town in the area; Karenga.

Kidepo Valley NP is a 1.442 square kilometre park founded by the British colonial government in 1958 to protect the wildlife. According to the Kidepo Valley NP website (Uganda K. N., 2015): “the park is one of Uganda’s prime most remote but spectacular national parks, which harbours scenery unsurpassed in any other park in East Africa.”

Uganda is divided first into four administrative regions; Western, Central, Eastern and Northern. Each administrative region has many districts, in total 112 as of August 2014. (UBOS, 2014) The districts are divided into counties, which are divided into sub-counties and the sub-counties in its turn into parishes, within these parishes many villages are located. (UBOS, 2014) This division keeps shifting; for instance, new districts are created by splitting up larger districts. On 6 September 2015, Redpepper posted an article online (Our Reporter, 2015); it reads “Parliament Creates 23 New Districts”. The article stated that the creation of 23 new districts has finally been approved. For the research area this is positive because as of July 1, 2019, Karenga will become a district. (Our Reporter, 2015) According to the parish chief of Karenga, this brings many advantages to Karenga, such as more finance.

The study area is located about 700 km from Uganda’s capital; Kampala. The study area is located in the district Kaabong, in the sub-counties Kamion, Karenga and Kawalokol and within numerous parishes and villages. An overview of the visited sub-counties, parishes and villages are shown in Appendix 4 – Visited villages. There is no electricity or tar road reaching this area, but the community members in the area said the president promised it is coming. Although, the electricity will be too expensive for most. The road will bring positive results to the area. The tar road will reach into South-Sudan and will make the area more easy to reach. Some of the small businesses in the area already have small solar panels to charge their phone batteries, to listen to the radio and light their shops at night, and will benefit from the electricity. The improved accessibility will also improve the trade market, and tourism will increase, both leads to the improvement of their well-being.

### 2.2 Topography

In this chapter the topography of the study area is briefly explained, it refers to the relief and has an important influence on the local climate, vegetation and movement of water. The study area is located at an altitude of 914 to 2750 meter above sea level. This altitude varies significantly due to river valleys, plains, hills, rocky outcrops and mountain ranges that run through the study area. The valley floor lies between 910 and 1200 meters above sea level. Mount Morungole at 2750 meters is the highest point of the study area; this mountain is part of the Morungole Range, which runs along the southern boundary of the Kidepo Valley NP. (Authority, 2012) There are multiple mountains and hills in the area; this means there are many slopes, steep cliffs and differences in drainage, but mostly a gradual transition and decline into the valleys.



The NP is located in the lowest part of the area, at the valley and plains. The corridor is mostly located on the plains. The villages are located at the foot of hills and mountain ranges, as is shown in Figure 3, but this is changing; the communities are increasingly living in the lower parts too. Except for the Ik, who live high in the mountains of the Morungole Range (see Chapter 2.6).



Figure 3, Parish Karenga

## 2.3 Soils

According to the UWA (Authority, 2012), the lower parts of the study area predominantly consists out of clay soils. In the more northern part, predominantly black chalky clay and sandy clay loam soils and the south, south-west freer-draining red clays and loams are found. The soil map in Figure 4 was extracted from ISRIC, through the Soil Grids website. (World Reference Base Group, 2014) The map shows most communities and their agricultural fields are located on Cambisols, Vertisols and Luvisols. Cambisols are young soils that are likely to develop into Luvisols, because of their limited age; these soils are only moderately developed. Cambisols are intensively used as agricultural land and are quite fertile. Luvisols are slightly acid soils with a clay-enriched subsoil and a high nutrient-holding capacity. Most often these soils have a good water-holding capacity. The characteristics mentioned above mean these soils are fertile and suitable to practice agriculture. Vertisols are clay-rich soils; the clay minerals can hold much water. These Vertisols cause very fertile soils, but with a difficult clay-rich top soil. (Driessen, 2001) The soils mentioned above are the most important soils in the study area because they are the most common ones and are dominant in the area.

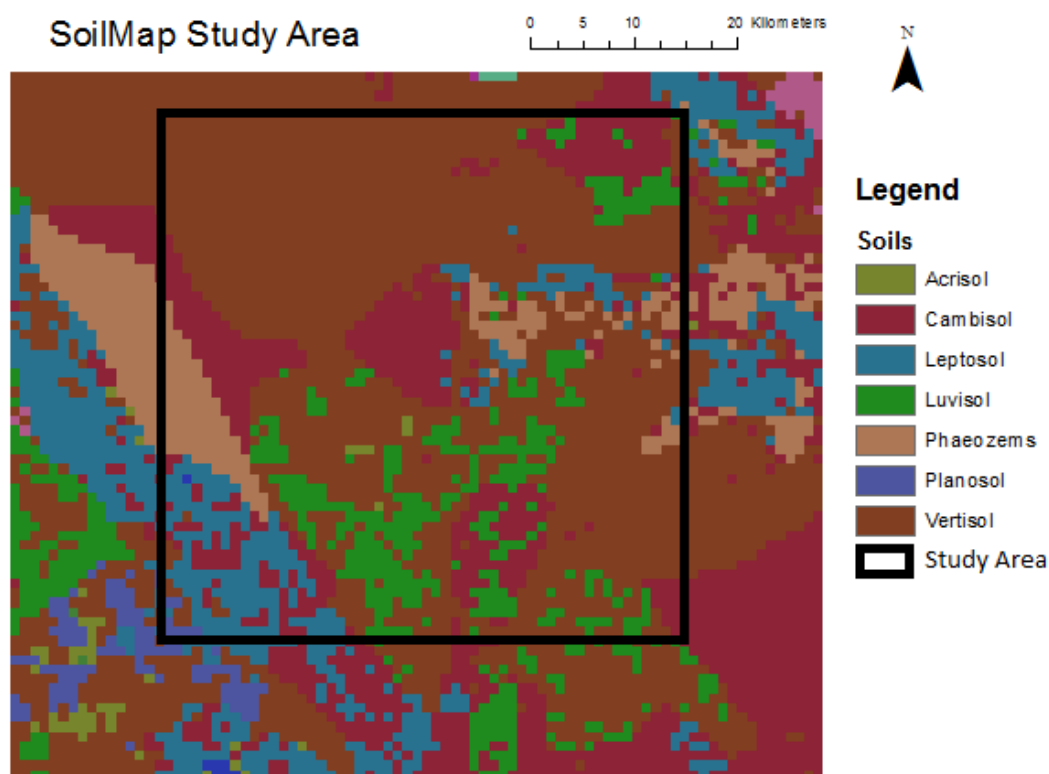


Figure 4, Soil map



## 2.4 Climate

The climate zone of the study area is classified as Equatorial Savannah with a dry winter. The climate in the study area changes from Arid to Semi-Arid. The study area knows two seasons, a wet season and a dry season. The wet season is from April to October and followed by the dry spell for the rest of the year. However, the area can be subjected to droughts and more often the wet season is divided into one short wet season, a short drought and followed again by a short wet season to finish the year with another dry season. According to the ISRIC soils of Africa book (Jones, A., 2013); the mean annual temperature is between 20-25°C. However, during the dry season, there are very hot north-easterly monsoon winds which lead to extreme temperatures (40°C), drought and little green vegetation. The mean annual precipitation in the study area is between 750 and 1000 mm as shown in Figure 5. Towards the west the annual precipitation increases, but that is no longer located within the study area and lies beyond the scope of this research. The study area becomes even arider towards the east. In the Kidepo Valley NP, the average annual rain is 800 mm (Authority, 2012).

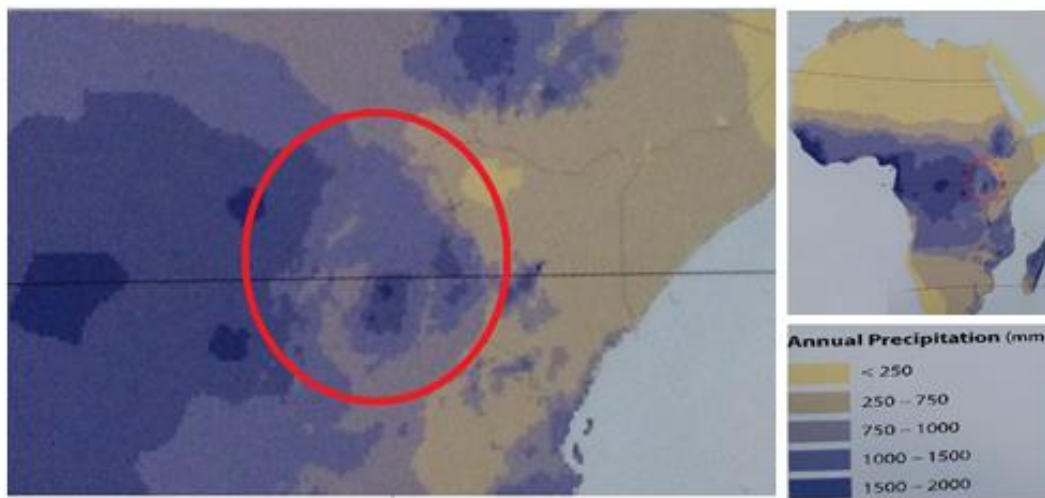


Figure 5, Mean Annual Precipitation in Uganda

In Kidepo Valley NP the surface water only flows during the wet season and disappears in the dry season. However, in the Narus Valley, the surface water flow alternates to subterranean flow and emerges at a few permanent water points throughout the year. (Authority, 2012) In the communities, the only source of water is through water pumps, which are located at several points throughout the area.

## 2.5 Vegetation

The vegetation is formed by climate and soil fertility, in this case, the vegetation type is open tree savannah, except for the mountains and hills, where the vegetation is a mosaic of forest and savannah woodland. The open tree savannah is dominated by grass with numerous widely spaced trees. The grass and grass-like plants form a continuous cover, and 5 to 30% are covered by trees or shrubs. As mentioned in the previous chapter, the study area has a division of wet and dry seasons. During the dry season, the grasses are dormant, and the blades are all dead and dried out, also the trees experience water stress. The grasses and dead foliage are very flammable, and fires are common, either natural or manmade. Because of the frequency of the fires, the tree density stays low. (Knapp, Alan K., 2001)

Savannahs are a zone of high biodiversity for both flora and fauna. The savannahs cover over 65% of Africa; they primarily consist out of grasses scattered with thorny acacia, eucalyptus and baobab trees. According to a study done in the area by D. Aleper (2008), the study area is dominated by *Acacia sieberiana*, especially in young regenerating stages (up to 85% of the woody vegetation). *Acacia sieberiana* is a species widely used by the local community for firewood, charcoal, tools and building material. This report also states other common tree species in the area; *Balanites aegyptica* (Desert Date), *Acacia gerrardii*, *Kigelia pinnata* (sausage tree) and *Combretum*.

## 2.6 Inhabitants

The people that live in the area are from three tribes; mainly the Karamajong and a small part are the Dodoth and Ik, but most of the study area is located in the Karamajong region. The Karamajong used to be cattle herders and raiders but nowadays they are farmers in combination with herding cattle. Likewise, the Dodoth live from both agriculture and cattle herding. The Ik, on the other hand, live on the top of the Mount Morungole. It is a small tribe; they used to live in the lowlands but were forced out with the creation of Kidepo Valley NP. The Ik practice agriculture on the steep slopes of the mountain, the tribe, is isolated and hard to reach. (Jones, A., etc., 2013) The Dodoth live farther away from the NP, and its corridor and they do not collect firewood from there. Therefore they were not included in this research.

The population density is estimated by Jones (2013) at around 10 to 25 people per square kilometre. In reality, the population lives in small villages and for the most part, the area is uninhabited. In the boundary area of the NP and inside the corridor no one lives because that is not allowed and it is dangerous, as there are many buffalo and elephants there. In Uganda, the population is measured every four years; the local governments do this. In the case of this study, the local government is the district Kaabong; the last counting was in 2015. An overview of the outcome of this counting hang inside the sub-county office of Kawalakol, the relevant numbers are shown in Table 1.

Table 1, Population counting

Kaabong District - Local Government			
Sub-county	Men	Women	Total
Kamion	3.132	3.093	6.225
Karenga	7.448	7.527	14.975
Kawalakol	6.949	7.220	14.169

The overview that hung in the office shows the different sub-counties and the number of their inhabitants, in the district Kaabong. As mentioned before the research took place in a part of this District, in the sub-counties: Kawalakol, Karenga and Kamion. The population of the study area is the sum of these sub-counties, but for the sub-counties

Kawalakol and Kamion, this population size is misleading. In the sub-counties, Kamion only the Ik themselves were subjected to the research and in the sub-counties, Kawalakol only two villages neighboured the NP, so only these two were subjected to the research. The same goes for Karenga sub-county, only the villages that border the NP and corridor are subjected to the research. Taking this knowledge into account, a calculated guess about the population size of the research area is made; Kamion almost no one lives in the study area, Karenga about half and Kawalakol also about half, so about 15.000 people live in the area. A more exact number of the population could not be determined because it was not possible to obtain that data. None of the county offices and government officials could give an exact number of the citizens per village or parish.

## 2.7 History

The history of Uganda especially the north is full of violence. In 1962 Uganda became independent from Britain, this conversion went relatively peaceful, but that peace did not last very long. Uganda has many different religions and ethnic groups, which makes the risk of unrest and conflict very high.

There were multiple different leaders all of them not very good for their country, the unrest in Northern Uganda was almost constant from the 1970s until 2008. Especially the Lord Resistance Army (LRA) Uganda is worth mentioning; it came and devastated the area with widespread abduction, kidnapping, death and mutilation, since the 1990s. Originally, the Karamajong were warriors and cattle raiders. Their weapons were spears and bow and arrows, they raided each other and also other tribes and stole their cattle. The LRA caused that most of these cattle raiders came in possession of guns, which led to extreme violence in the area. Also, it caused the government to neglect the area until in 2008 the government had a program to disarm the cattle raiders. Unfortunately, this was an extremely aggressive program, although it did help. Since that year peace talks were held and that led to a somewhat more peaceful time and relatively stability in the north, except for the LRA. Joined effort, from Uganda, DR Congo, South-Sudan and the US, caused the LRA to back down, and they appealed for a ceasefire in 2009. Sadly, the leader remained elusive, and the safety in the north was still not secure. (Peace Direct, 2014)

Nowadays, all is relatively quiet in Uganda, but until now there is still much unrest in South-Sudan, which brings problems to the study area. Museveni has been the president of Uganda since 1986. Officially he has repeatedly been elected, but there was a lot of corruption and fraud with these elections. He even changed the law; he had the presidential limits abolished so that he could be elected for his third term. According to the BBC (BBC, 2016), Museveni is credited with restoring relative stability and economic prosperity to Uganda after years of civil war and repression, but there is also a lot of criticism against him. It is expected that peace will last in Uganda, but certain it is not.

During this year's elections in February, Museveni won again and currently he is doing his fourth term. The situation around the elections was not quiet, especially in the capital Kampala there was much unrest, supporters of the opposition took to the streets to demonstrate. The police took action with tear gas and rubber bullets. In the study area, the elections went smoothly as is shown in Figure 6. Museveni's win was being celebrated by many, and the supporters of the opposition were quiet.



Figure 6, Election day in the study area

Because of the wars and unrest in the past, there is almost no research done in northern Uganda. Also, its remote location causes the government and non-governmental organisations (NGOs), to until now have little attention for the area.

### 3. Methodology

This chapter elaborates on the methods used during this research. To begin with, a short overview of the methods, their expected results and what those results will contribute to, shown in Table 2. The used methods will be further elaborated in the following chapters, first the interviews, where after the forest inventory and then the potential biomass productivity and sustainability evaluation will be explained.

Table 2, Overview of the methodology

Method	Result	Contributes to
<i>Interviews</i> (Chapter 3.1)	Observations Key informant interview answers Household survey answers	Answering the sub-questions of availability, distribution and consumption
<i>Forest inventory</i> (Chapter 3.2) - <i>GIS</i> - <i>Transects</i>	Classified map  Data on location, density and human disturbance of woodlots	Locate woodlots  Ground truthing the GIS classified map and offers management options
<i>Potential biomass productivity and sustainability evaluation</i> (Chapter 3.3)	Yield of two species Consumption of community	Evaluate sustainability of consumption
<i>Cross-checking</i> (Chapter 5 – Discussion)	Most reliable data is selected	Ensure the viability of the results

#### 3.1 Interviews

The primary method used during this research is Participatory Rural Appraisal (PRA). PRA consists of the preparation of the household surveys, key informant interviews and household surveys, which all use semi-structured interviews.

##### 3.1.1 Preparation of the household surveys and key informant interviews

Preparing the household surveys consists of; observing, defining the interview questions, defining communities and people to be interviewed, interview key informants, testing questions and revising them, and a focus group meeting. These activities take place during the first two weeks of the field work, 22 February until 6 March.

##### Observations

The social research starts with observations, to get a first impression of the situation. Observation is an important tool for collecting information, information about the health of the communities, of the food products and in this case of the firewood. (SRM, 2014) Observations are done at the market and in the communities, at their compounds but also on the streets. Observations are written down in the field and later summarised in Word.

##### Defining communities and respondents

The second step is determining which communities and people to interview. Identifying the communities is done by selecting communities that live close to the park. Preferably this is done with a map, if there is no map, the guide will help select the communities that border the NP and its corridor. Within the communities, the respondents are randomly selected, by walking through the community and choosing some households.

### **Formulating interview questions**

After selecting the communities, the interview questions are worded. The literature of previous research is consulted, and the observations are taken into account, to formulate interview questions for the household surveys. Also, the key informants are interviewed, further to obtain knowledge on the subject of firewood and of the overall issues in the area.

### **Key informant interviews**

According to M. N. Marshall (1996): "All key informants are regarded as extraordinary by those around them and usually, but not invariably, occupy a position of responsibility and influence." The 'perfect' key informant interviewee would have the following characteristics, listed by R.G. Burgess (2003):

- *Role in the community:* They have access to the information that is sought for this research.
- *Knowledge:* They have the knowledge to understand the meaning of the information.
- *Willingness:* They should be willing, to be honest, and help with their knowledge.
- *Communicability:* They should be able to communicate their knowledge.
- *Impartiality:* They should be objective and unbiased, any relevant biases should be known to the interviewer.

The key informant interviews are more like a conversation; background information, information about the user groups and detailed information about specific subjects are collected. The key informants and interviewee sit at a table or somewhere on the property, to be able to talk without being disturbed. The key informant will lead the conversation; the interviewer only sometimes directs the conversation, if the subject is not relevant for the research. For instance, if the key informant keeps talking about the diseases in the area, but the researcher wants to know about firewood and related problems, he will ask about firewood. Everything the key informant says is noted and later analysed.

In Appendix 5 – Key informant interview, the interview questions that served as assistance during the interviews is shown. This information is qualitative, and it will be summarised in Word, and the most important issues will be taken into account for this research. The key informants are; the parish chiefs, the community members, restaurants, schools, the Karenga cultural group, Pastor David and the Rangers of UWA.

### **Defining interview questions for the household surveys**

With the qualitative information collected from the key informant interviews, the research objective and questions are redefined if necessary, and the household interview questions are improved if needed, to more fit the important issues discovered from the key informant interviews.

### **Focus group meeting**

With this set of improved interview questions, a focus group meeting is held with the Karenga cultural group, to test the initial findings. The resources and use patterns found during the interviews are discussed in this group. During this meeting, the interview questions are tested, and if needed revised and improved, this meeting was held in their office.

### **Data analysis**

According to De Hoyos and Barnes (2012) the process of analysing qualitative data, in this instance the obtained data from the observations, key informant interviews and focus group meeting consists of:

1. Data collection and management
2. Organising and preparing the data
3. Coding and describing the data
4. Categorising or grouping the data
5. Interpreting the data



Data collection and management is explained above, as well as the organising and preparing of the data. Step 3 Coding and describing the data; all the collected data is coded, the related topics are coded with the same code so that in step 4 they can be easily grouped or categorised. (De Hoyos & Barnes, 2012) These coded groups or categories correspond with the research questions and related topics.

By doing this analyses before the household surveys are conducted, new questions can arise, the focus of the surveys can change.(De Hoyos & Barnes, 2012)

According to De Hoyos and Barnes (2012), the following is important for maintaining the quality of the qualitative data:

- Cross-check codes
- Checking outliners
- Check explanations
- Look for contradictions
- Gain feedback from participants

During the cross-checking, it is checked that if an answer deviates too much from the other answers, it will be left out of the data analysis. While analysing the data, the explanations of the informants are checked, as well as if there are contradictions in what they say. If that is the case, the answer will not be reliable, and thus left out of this research. During the focus group meeting, feedback was gained from participants, so that the interview questions could be improved if they deemed it necessary.

### 3.1.2 Household surveys

For the household surveys, the tested and revised interview questions defined during the preparation and key informant interviews are used. During week 3-8 as many interviews as possible are held (7 March – 17 April), most through household surveys. The household surveys are semi-structured interviews to acquire detailed information on firewood. A semi-structured interview is a formal interview, in which the researcher follows a set of questions, but where there is also room to stray from these questions. (SRM, 2014)

The used research strategy is household surveys; there are numerous interviews held in person, with individuals and with families. The interviews were held at their homes, the individual and the interviewer sat with each other so that they had some privacy and could talk freely. Other times the whole household was present, and they answered the questions together. The researcher asked the questions and noted the answers. The questions asked during these interviews are given in Appendix 6 – Household survey. By acquiring answers to these questions, the research questions can be answered. (SRM, 2014)

To know how much firewood people use, the interviews used in the household surveys contain questions about that topic. To be able to say how this influences the woodlots, the bundles they collect are weighed, for the used method see Chapter 3.3.2.

The data obtained during the household surveys is analysed the same as explained above in Chapter 3.1.1, according to the methods described by De Hoyos and Barnes (2012). The answers to the household survey interviews are sorted in coded groups or categories in Excel. The output data is further analysed; by first putting the data in tables, and then calculate the Standard Deviation. All data that did not fit within the Standard Deviation is left out because it is not significant. The results from the household surveys are later cross-checked with the coded data from the observations and key informant interviews (see Chapter 5 – Discussion), to further prove the validity of the data.

### 3.1.3 Limitations

There are several limitations expected during this part of the research. The first limitation being the language and culture, with research that is related to human interactions there will always be a

barrier, because of the difference in culture and language, there are many risks. (Temple & Edwards, 2002) The gap in language can lead to misinterpretations and the differences in culture can lead to the respondents giving misleading answers and information. Also, the interpreter has an influence on the situation as well. To keep these risks at a minimum, an interpreter who is a trusted member of the community will be hired; with knowledge on the topic, a degree from the University, experience with translating and who originates from the research area was used. Also, the risk of misinterpretation is minimised by not using the direct translation but by talking in context, using more words and no direct translations. (Temple & Edwards, 2002)

Other problems with qualitative data according to De Hoyos and Barnes (2012) with which the researcher need to take care are:

- Reliance on first impressions
- Tendency to ignore conflicting information
- Emphasis on data that confirms
- Ignoring the unusual or information hard to gain
- Over or underreaction to new data
- Co-occurrence interpreted as correlation
- Too many data to handle

## 3.2 Forest inventory

This part of the research is to determine the distribution of the shrub and tree species. Also, the number of dead stumps is measured, to assess the human disturbance in the area. An overview of where the woodlots are located is obtained. The location of the woodlots is measured using two different methods; GIS and Transects. The forest inventory does not include measurements of wood volumes because the location and density of the woodlots are sufficient information to identify management options.

### 3.2.1 GIS

Image classification is used in GIS to identify forested areas, to identify the location of possible firewood and the location of deforested areas, this is done in week 11 (2-8 May). This data is shown on a map of the area that shows the woodlots and the open areas. The image classification is done with satellite images procured from USGS Global visualisation Viewer, analysing is done with GIS. The images are loaded into GIS, and a maximum likelihood classification is performed. (ESRI, 2010) The output is a map that shows the different land uses and thereby the location of the woodlots.

### 3.2.2 Transects

During week 9 and 10 (18 – 28 April), the transects are measured. The transect points are measured to assist with the Image classification in GIS. Two roads cross through the corridor; these roads function as the location of the transect points. These transects are used to determine where the woodlots are located. The exact information that is collected is shown in the Data Form in Appendix 7. The location of the plots along the transect lines will be on both sides of the transect, every 1 or 2 km, 50 meters from the road at a 90 degrees angle, measuring first on the left side and then on the right side.

A transect is a more or less straight line, determined in advance by the researchers, at this instance the roads that cross through the corridor. The transect is chosen at this location because this area is accessible to collectors, would it not be along a road it would be more difficult and even dangerous. The transects start at the beginning of the corridor and go on for about 10 km. This distance is chosen because the community members have revealed in the household surveys that they will not walk

further than that (see Chapter 4.1,3). The goal of measuring along a transect is to get a good overview of the current situation of the woodlot. (de Vletter, 2014)

By law it is not allowed to cut inside the corridor and with this transect/plot measuring it is determined if the law is respected and will reveal possible management options. Also, the data obtained through measuring the transects will function as a way of ground truthing the with GIS produced a classified map, by cross-checking the transects data with the classified map. (Hall, 2014)

### 3.2.3 Limitations

The method forest inventory is divided into transects and image classification with GIS. When measuring a transect or working with an image, it is always a recording from a specific time and date, while the processes that are recorded are changing, this means that the conclusions that are drawn from this apply only for a short period.

Also, it is questionable if the woodlots are correctly classified with GIS. This classification can be difficult that is why the outcome of the image classification is cross-checked with the measured transect, and if they correspond, this result is most likely correct.

Because the corridor is not yet indicated and no maps could be found, the exact location could not be determined beforehand. Another difficulty was that there were no maps or other geographical information of the area available. Information and maps about the area are obtained through local government.

This study is unable to encompass the entire district of Kaabong; it is only aimed at the communities that live near Kidepo Valley NP. Also, the study was only focused on the households. Some different user groups were included in the interviews, but there was too little data to conclude anything significant from that.

## 3.3 Potential biomass productivity and sustainability evaluation

To evaluate the sustainability of the firewood consumption by the communities living near Kidepo Valley NP the mean annual wood biomass yield increment is calculated (3.3.1), the consumption by the communities is also calculated (3.3.2) and these two will be compared(3.3.3).

### 3.3.1 Mean annual wood biomass yield increment

The available amount of firewood is measured, through calculating the mean annual wood biomass yield increment. The mean annual wood biomass yield increment differs per species, only two species are chosen for this research; the *Acacia albida* and the *Eucalyptus tereticornis*, these species are chosen because they are commonly used firewood species in East Africa countries (Najma Dharani, 2011). The *Eucalyptus tereticornis* grows relatively fast, and the *Acacia albida* average and is representative of most of the species that grow in the area. These two were chosen to lessen the misleading information, and one represents the most common species, and one a fast growing species. Also, the *Acacia albida* is a species that can be used for intercropping and has good fodder and edible pods (Vandenbeldt, 1992). These species are representative of many of the other used species, especially the acacia, as there are many acacia species in the area, with similar characteristics. The acacia species are also the most preferred firewood species. The *Eucalyptus tereticornis* was chosen because it is a fast growing tree so good for firewood and the government in the area supplies free seedlings for the local communities (Najma Dharani, 2011).

A report by the FAO (Kassam, 1991) was used to calculate the mean annual wood biomass yield increment. Of the report only Chapter 6 - Fuelwood productivity is used. For the calculations multiple tables are needed, this chapter contains the needed tables. In Appendix 8 the calculations can be found, the references to tables within the text are towards that report. Chapter 6 – Fuelwood productivity (Kassam, 1991) contains a formula that needs to be filled in. The latitude, temperature,



Length of the Growing Period (LGP), cloudiness, month of growing period, rainfall and Leaf Area Index (LAI) of the area and species needs to be known. This information is found within the document and within the book *Soils of Africa* by Jones (2013). The described steps are used to calculate the mean annual wood biomass yield increment.

A mistake that can happen with this calculated mean annual wood biomass yield increment is with the input data. The input data that was used is not necessarily correct for each year. There can be years with more rain or droughts. Also, the soil fertility is not taken into account. The soil fertility and moisture can both have an influence on the mean annual wood biomass yield increment. Taking this into account the concluded yield can serve as a guideline, not as a set number.

### 3.3.2 Consumption

The firewood bundles will be weighed with a simple scale that is usually used to measure the weight of suitcases. After the household survey, one or two of their firewood bundles are weighed. An average of these weighted bundles will function as the guide amount, for further calculations.

The amount of bundles a household uses is found from the household surveys; the number of days one household use one bundle. An average of all households will function as the guide amount of days one household use one bundle. By dividing “the number of days in a month or year” through “the number of days one bundle is used” times “the average weight of a bundle”, the use in a month or year in kg can be found.

The mean annual consumption per capita can be found by dividing “the mean annual household consumption” through “the average household size”.

“The use per capita” times “the whole population in the area” gives “the use of the total area”. “The mean annual wood biomass yield increment” times “the total area from which the firewood is collected” gives “the total yield or growth in the area”.

The area in which the harvest is done and the population size will be estimated after the household surveys are conducted. From the household surveys, the distance people walk to collect firewood is concluded. Also, the areas where they do not collect are determined, by projecting the distance and area with GIS by putting two buffers around the villages; one to eliminate the village and one to select a 5-kilometre radius the total area in which firewood is collected is found. The whole population in the area is estimated in Chapter 2.6.

### 3.3.3 Evaluating the sustainability

By comparing the total mean annual wood biomass yield increment of the area where the communities collect firewood to the total use, it can be estimated if the harvest of firewood is done sustainably. If the yield is higher than the use, the communities can harvest their firewood need sustainable, if it is lower the firewood is harvested unsustainable.

For management options, it can be calculated how much hectares of a particular firewood species would be needed by one household to harvest their need of firewood sustainably. The number of hectares for one household can be found by dividing “the mean annual wood biomass yield increment on one hectare” through “the mean annual consumption per household”.

## 4. Results

This chapter contains the data that is collected during the research period. The chapter is divided per used method. First, the interview results are shown, where after the results of the forest inventory, to finish with the potential biomass productivity and sustainability evaluation.

### 4.1 Interviews

This chapter shows the results from the method interviews. First, the observations are given, then the results of the key informant interviews, where after the results of the household surveys.

#### 4.1.1 Observations

A summary of the observations made during the first weeks of the research is given, made through observing the community, to get a first impression of the situation. The observations are to get a first impression of the situation. In this chapter only the firewood related observations are noted, the observations made about other topics can be found in Appendix 9 – Observations. These other subjects are; management, income, well-being of the communities and overall issues. Below the results:

- Only women and children collect firewood. Sparsely men walk with wood, but this is mostly long poles for building houses.
- From time to time men and women carry bags of charcoal, at the market it is sold daily.

#### 4.1.2 Key informant interviews

A summary of the firewood related information discovered from the key informant interviews is given. With these interviews, an overview of the current situation in the area is found. An overview of the interview questions is provided in Appendix 5 – Key informant interviews and an overview of the answers is shown in Appendix 10 – Key informant answers. Three parish chiefs were interviewed for the research, the leaders of the different parishes; the parish chiefs of Karenga, Loyoro and Opotopot and Lokori. Pastor David is the pastor of the Catholic Church and knows a lot about the people and the area. The Karenga cultural group is a group that is voluntary and has many projects in the area to improve the livelihoods of the people. The Rangers from the NP are there to protect the park and its boundary areas and the people that live there. This information is qualitative not quantitative, and therefore a summary of the for this research relevant information is given.

##### *a) Parish chiefs*

Below a summary of the important findings from the interviews with the parish chiefs:

- Only the Sheanut tree (*Vitellaria paradoxa*) is not allowed to cut.
- There are not yet many alternatives to the use of firewood available, but this will improve with education, more solar powered cooking will be used, and soon there will be electricity (although this will not be affordable for most).
- The parish chiefs and community member do not worry about the availability of firewood in the future.
- Some people use grass or sorghum stock for cooking when there is little firewood available.
- Most people collect too much firewood in the dry season to make a fence from it, this fence they will use in the wet season when the collection is difficult. The dry season is the building season and the wet season is the planting season.
- The law protects shrines, it is not allowed to collect nor cut here and on the hills and mountains there is no cutting allowed, but the collection of dead wood is allowed.
- There are no rules for where you can collect.
- Almost everyone, three-quarter of the people uses firewood.
- Charcoal is too expensive for most but is produced to make money.

- Firewood and wood for fences are collected abundantly.
- Communities are trained to use a stove and in other more efficient way to use of firewood.
- Both cutting and collection are allowed for firewood and building materials.

*b) Pastor David*

Pastor David mentioned the following about the availability, distribution and consumption of firewood in the area:

- There is no real preference; every species is used.
- Here in the area, there are no alternative ways of cooking available, but possible alternatives are; to use paraffin burners, but they are expensive or to cook on solar power, but not everything can be cooked on solar power. Electricity will not be used for cooking.
- The communities are not aware of the problems; they do not think of the future. The wood will finish as the distance to collect firewood keeps increasing over time.
- When there is little firewood available, the communities use sorghum and grass to cook.
- During the wet season, the collection is difficult because of the growth of plants, mainly grasses and bushes. During the dry season, the community members collect every day so that they have a surplus, from this surplus they make a fence, in the wet season they can use the wood from the fence.
- The collection is done daily and can take up to 6 hours, and people can walk as much as 8 km.
- Sub-county Karenga decided that there it is not allowed to collect dead or living wood(cut) on slopes and mountains. Other than that there are no rules about who collects where.
- Almost all people use firewood for cooking; some use charcoal but charcoal is too expensive for most; usually, people make charcoal to sell.
- The firewood is collected by the women and their children.
- They collect dead and living wood; they also cut trees.
- No specific characteristics are required, they take everything.
- Cooking is done mostly once in the evening, only a few cook three times a day.
- People cook mostly on an open fire, using three stones to put the pan on, only a few families have a stove.
- People do not preserve wood, they just let it burn, even to heat the house sometimes.

*c) Karenga cultural group*

The Karenga cultural group only discussed the availability, distribution and consumption of firewood, in Appendix 11 a picture of the topics they wrote down can be found, below the findings are shown:

- Any species is collected, except for some species that are toxic to cattle.
- They are worried about the future because already they have to walk farther than before to collect firewood.
- Firewood is used daily; the collection is about 5 km (two-way).
- The collection is done from everywhere, except not in Shrines.
- Charcoal is not used by many; it is too expensive for most.
- Both men and women collect firewood, but mostly women, men only sell it.
- Many families use a stove.
- People only collect dead wood; they do not cut.
- Most families use one bundle a day sometimes two days; it depends on the household size and size of the bundle. The size of the bundle depends on how much you can carry.

d) *Rangers from UWA*

Below the results of the interviews with the Rangers from UWA are given:

- The communities are allowed to collect resources from inside the park and its corridor, but only if they arrange it with UWA. A ranger will escort them to protect them and to tell them where to take the resource from, but this is rarely done, the Rangers do not know why. The Rangers do inform the communities about this option.
- Illegal cutting and gathering of wood take place inside the park and corridor – evidence of this illegal cutting was seen by the rangers. While Morene says she does not see much evidence.
- Cutting is illegal by law.
- Most of the rangers use charcoal for cooking. The different outposts of UWA use charcoal, firewood and sometimes even gas and they buy it from the local communities.

### 4.1.3 Household surveys

During the household surveys, 43 interviews were held, with women and men from the communities that live near the NP. An overview of the socio-demographic characteristics of the respondents is shown in Table 3. Mostly women are interviewed because men say they do not know anything about firewood because that is the job of the women. The data from the interviews was analysed, all answers that deviated too much were left out. In this chapter, the results of the household surveys are elaborated.

Table 3, Socio-demographic characteristics of the respondents

Variable	% Response (N=43)	Parish	
Sex		Opotopot	7
Female	74	Lokori	7
Male	26	Loyoro	26
		Karenga	42
Age		Morungole	9
<30	35	Naseperwai	9
30-40	44		
>40	21	Family size (mother and kids) *	
		1 - 4	28
Marital status		5 - 8	53
Married	88	>8	5
Single	12	Other: non-responses	14
Education level		Household size (People that live there and is cooked for) **	
None	44	1-4	9
Primary	33	5-8	35
Secondary	21	9-11	30
University	2	11-15	14
		Other; restaurants	12
Occupation			
Peasantry farming	81		
Other; restaurant, brewing, hospital, student, teacher	19		

\*The average family size is 5,4

\*\*Average household size is 8,6

Table 4; The most preferred species are the Acacia species with 52% responses and the Terminalia with 48%. The species that is the least preferred is the Fig species with 30%. The second is the Tamarind with 26%. The Sheanut tree with 18% and both the Lucky bean tree, and Mango have 13%.

Table 5; It is apparent from the results that alternatives to the use of firewood are not used (97%). They are not available or too expensive. The community member did know of some (3%); gas, electricity, solar power and paraffin.

Table 6; When asked what the community members do when there is a shortage of firewood, most (67%) say they go hungry. 33% say they will use an alternative. The alternatives here are asking friends and neighbours for help; this help can be support in firewood or food but also work. They can work for them for one day and earn money so that they can buy firewood. Other alternatives are to use sorghum stock or small sticks, but they do not give much heat, so cooking takes longer. Some split logs, one says he uses a paraffin stove, and one says she would trade in firewood and charcoal.

Most (88%) of the community members do worry about the availability of firewood in the future. They say people will settle inside corridor, and the trees will finish there too because they will need to clear the area for farming. Also, burning is a real problem, and many people cut trees to make fences and burn bricks. 12% of the respondents say they do not worry; they say the trees will regrow.

Most (84%) of the households say they already notice a difference in the availability of the firewood. They say most of the preferred species are finished close by and they have to move farther away to get them. Only 16% of the respondents say they do not notice a difference.

Table 4, Firewood species

Code	Answer	N	%
<i>Preferred</i>			
A1	Acacia's	33	52
A2	Terminalia	31	48
<i>Not preferred</i>			
A1	Tamarind	26	26
A2	Fig species	30	30
A3	Lucky bean tree	13	13
A4	Sheanut tree	18	18
A5	Mango	13	13

Table 5, Alternatives

Code	Answer	N	%
A1	No	37	97
A2	Not here	1	3

Table 6, Availability: Coping with shortage

Code	Answer	N	%
<i>Coping with shortage</i>			
A1	Go hungry	20	67
A2	Alternatives to firewood collection	10	33
<i>Worry for the future</i>			
A1	Don't worry	5	12
A2	Yes worry	38	88
<i>Notice a difference</i>			
A1	No, there is no difference	6	16
A2	Yes, there is a difference	31	84

Table 7; 60% of the respondents will collect more in the dry season and make a fence or stockpile. 40% say it is easy to collect in the dry season. Most (58%) say that the collection in the wet season is more difficult because the vegetation is too abundant. 42% say they will use their fence or stockpile.

Table 8; according to 47% of the respondents, it is prohibited to collect (dead or alive) firewood from hills, slopes and mountains. 30% say it is not allowed in and around the compound but outside everywhere. Only 23% say it is not allowed to go in or near the NP and the corridor. Most (67%) say they go to their gardens to collect firewood, just 33% say the go in or towards the corridor, plain or bush.

Table 9; Most respondents (72%) spend 4 to 5 hours and (70%) 8 up to 10 km on a two-way trip of firewood collection, and 62% goes every day. 28 % will only spend 1 up to 3 hours collecting firewood. 30 % of the respondent walks 2 up to 4 km, and 38% goes 3 times a week.

Table 10; Most of the respondents (76%) say women and daughters older than 10 are responsible for the collection of the firewood. Sometimes (24%) only one woman is responsible for the firewood collection per family. If a woman does not have any children; or her daughters are not old enough yet. It also sparsely happens that they work in groups.

Table 7, Wet season & Dry season

Code	Answer	N	%
<i>Dry</i>			
A1	Make a fence or stockpile	29	60
A2	Easy to collect	19	40
<i>Wet</i>			
A1	Difficult to collect	38	58
A2	Use fence or stockpile	28	42

Table 8, Location collection

Code	Answer	N	%
<i>Location: Not allowed</i>			
A1	In and around compound, outside everywhere	13	30
A2	On hills, slopes and mountains	20	47
A3	In and near the NP and the corridor	10	23
<i>Location: Allowed</i>			
A1	In or towards the corridor, plain or bush	5	33
A2	In the gardens	10	67

Table 9, Time, Distance and Frequency

Code	Answer	N	%
<i>Time (hours) spend on collecting firewood for a two-way trip</i>			
A1	1 - 3	9	28
A2	4 - 5	23	72
<i>Distance (km) walked for two-way trip</i>			
A1	2 - 4	10	30
A2	8 - 10	23	70
<i>Frequency of firewood collection (number of trips in a week)</i>			
A1	7	16	62
A2	3	10	38

Table 10, Who is responsible for the collection

Code	Answer	N	%
A1	Me and my daughters (10+)	25	76
A2	By herself	8	24

Table 11; 91% of the respondents use firewood, only 9 % use charcoal. Cooking is mostly (91%) done on an open fire with three stones around it, only 9% use a stove. 50% sometimes buys firewood, when they have money to spare or when the collection of firewood is too difficult in the wet season. The other 50% never buys firewood or charcoal; they simply do not have the money for that. 79% of the respondents say they collect dead and also cut live wood to use as firewood. The other 21 % says they collect only dead wood.

Table 12; 55% of the respondents prefer firewood that gives little to no smoke. Another 45% prefers firewood that burns well and retains fire for long.

Table 13; most 54% make a fire 3 times a day, although this differs not much with the other 46% who light a fire 2 times a day. 88% only make a fire for cooking, and 12% makes a fire for cooking and brewing. 90% of the respondents put their fire out when they are finished cooking, and only 10% let it burn.

Table 14; most (65%) of the respondents use one bundle of firewood every 2 days, the other 35% use one every 3 days.

Table 11, Use, Buy and Collect type of fuel

Code	Answer	N	%
<i>Type fuel: Use</i>			
A1	Firewood	39	91
A2	Charcoal	4	9
<i>Type of fire</i>			
A1	Open fire with 3 stones	39	91
A2	Stove	4	9
<i>Type fuel: Bought</i>			
A1	Yes, Firewood	19	50
A2	No	19	50
<i>Type fuel: Collect</i>			
A1	Both	26	79
A2	Dead	7	21

Table 12, Preferred quality

Code	Answer	N	%
A1	Burns well, Retains fire for long	23	45
A2	Little/No smoke	28	55

Table 13, Frequency and Reason of fire

Code	Answer	N	%
<i>Frequency (times a day a fire is made)</i>			
A1	2	16	46
A2	3	19	54
<i>Reason</i>			
A1	Cooking	35	88
A2	Cooking and Brewing	5	12
<i>Preserve</i>			
A1	Make it out	38	90
A2	Let it burn	4	10

Table 14, Consumption of firewood bundles

Code	Answer	N	%
A1	Bundle 2 days	17	65
A2	Bundle 3 days	9	35



## 4.2 Forest inventory

The forest inventory consists of GIS image classification and transect measurements. First, the image classification results are given, whereafter the results of the transects.

### 4.2.1 Image classification map – GIS

The map in Figure 11 and Appendix 13 shows the location of the woodlots; these are divided into dense and open. The map has seven different land uses;

#### 1. Mountain/hills & 2. Hills

Mountain/hill and hills are almost the same; these areas have good growing vegetation, consisting mostly out of shrubs and trees and some areas with grass.

#### 3. Grassland/agricultural fields

The grassland/agriculture fields are areas where people live and cultivate crops, but also areas that consist out of only grass, such as the plains inside the NP.

#### 4. Riverbed

The riverbed is an open area with grass, and only a few trees because part of the year this area is wet.

#### 5. Bare soil

The bare soil is areas with no vegetation.

#### 6. Open woodlots & 7. Dense woodlots

The woodlots are divided into two, but they look very similar, they are both open woodlots with grass between the trees. The woodlots classified as dense are in reality not dense, but denser than the open woodlots are.

The map shows that close to the villages and inside the NP there are only grassland and agriculture fields. A little farther away there are dense woodlots; farther away still, there is a more open forest.

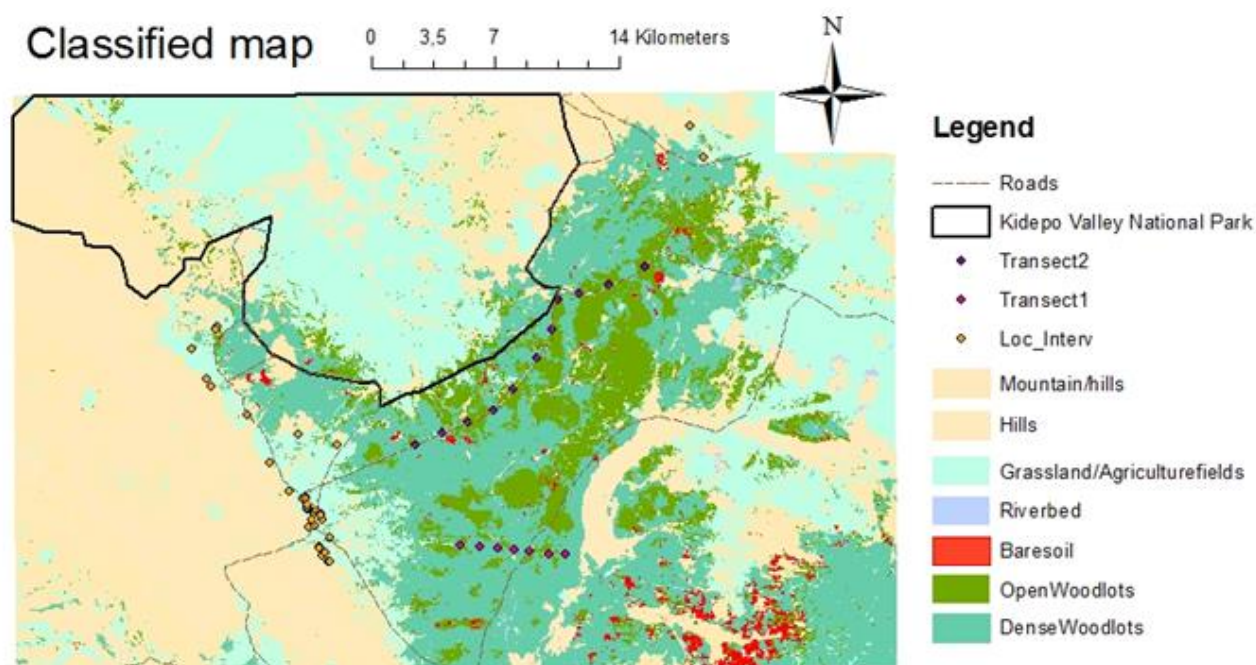


Figure 7, GIS Classified map of the study area



## 4.2.2 Transects

The main point of the transects is to ground truth with the GIS image classification identified land uses. Also, signs of human disturbances are noted during the transect measurements. In a large part of the study area, burning happens often, some recently (late burning), others up to six months ago (early burning). Most of these are lit, some happen naturally. Appendix 14 contains two maps and two tables. The maps show the location of the transect points and the tables show what is measured; the transect point and plot number, the height, density, number of trees, number of stumps and other signs of human disturbances. The transect points are displayed consecutive from left to right, beginning at one.

In Table 17 and Figure 11 in Appendix 14, the results for transect 1 can be found. For transect 1, 14 plots are measured along a transect at seven points, between each point, there is 1 kilometre. At each point, two plots are measured, one on each side of the road, 50 metres away from the road so that the road has no influence on the vegetation. Here the results are listed:

- Only at the first two transect points signs of logging are found in the plots.
- The density did not change much along the transect, only at point 6 the density and number of trees were higher.
- Point 3 north, 4 both north and south and 7 south show early burning and point 5 shows natural burning.
- Point 1 both north and south, 2 only south and 7 only north show signs of trees being cut for their leaves.
- Only point 1 and 2 show signs of logging.

In Appendix 14 Table 18 and Figure 12 show the results for transect 2. For transect 2, 22 plots are measured along a transect at eleven points, with each time 2 kilometre between the points. At each transect points also two plots are measured the same way. At this transect the difference is not very noticeable either, below the results are listed:

- Point 2, 6 and 7 have a higher density and number of trees.
- Point 5, 8 and 11 also have a somewhat higher density and a higher number of trees.
- Only at the first transect point signs of logging are found in the plot. All around the south side of this point, big trees are logged, for brick burning.
- Point 2 shows signs of logging next to the road.
- Early burning is practised at point 1 south, 2 north, 6 south, 7 east and west, 10 north and 11 south and late burning is practised at point 1 north, 2 south, 3 south, 4 south, 5 and 8 both south and north, 9, 10 and 11 south.

This information is not very detailed because that was not necessary as this information is only to help with the GIS analysis and shows possibilities for management of woodlots. In the next chapter, the GIS analysis is elaborated.

## 4.3 Potential biomass productivity and sustainability evaluation

In this chapter the potential biomass productivity and the consumption of firewood will be calculated, and with that information, a sustainability evaluation is made.

### 4.3.1 Mean annual wood biomass yield increment

The calculations for the mean annual wood biomass yield increment is calculated for species 1 (Sp1) the *Acacia albida* and for species 2 (Sp2) the *Eucalyptus tereticornis*; the calculations are shown in Appendix 8 – Mean annual wood biomass yield increment. From these calculations it was discovered that the mean annual wood biomass yield increment on one hectare is:

- Sp1: *Acacia albida*: 3.220,77 kg
- Sp2: *Eucalyptus tereticornis*: 4.945,14 kg

The research area is large, but the communities do not walk farther than 5 km from their compounds to collect firewood, they do not go to the mountains and hills and do not collect close to and inside the compounds (see Chapter 4.1). Also, most of the land close to the compounds is agricultural fields with limited trees. This led to a calculated estimated area of about 8.000 hectares. That means the mean annual wood biomass yield increment for the total area is:

- *Sp 1: Acacia albida:*  $8.000 * 3.220,77 = 25.766,16$  kilograms
- *Sp2: Eucalyptus tereticornis:*  $8.000 * 4.945,14 = 39.561,12$  kilograms

### 4.3.2 Consumption

Table 15 shows the weight of all the measured firewood bundles, the average weight of the firewood bundles is 27,2 kg.

Table 15, Weight of firewood bundles

Firewood bundles weight (kg)			
1	29	16	34
2	15	17	30
3	23	18	32
4	22	19	33
5	18	20	26
6	25	21	25
7	18	22	22
8	30	23	29
9	26	24	30
10	21	25	24
11	27	26	40
12	16	27	29
13	23	28	50
14	22	29	45
15	25	Average 27,2	

In Chapter 4.1.3 Table 14, the number of bundles one household uses is shown. An average of this number functions as the amount to further calculate the consumption of the community. The number of days times the number of respondents is summed up and divided through the total respondents:

$$(17 * 2 + 9 * 3) / 26 = 2,3 \text{ days}$$

Every 2,3 days a household needs 27,2 kg of wood In a month that is:  $31 / 2,3 * 27,2 = 367$  kg. The **mean annual consumption per household** is:  $365 / 2,3 * 27,2 = 4.316,5$  kg

It was discovered, a household is not necessarily a family, often the interviewees cooked for more people than only their family. Therefore the average of the household was calculated (see Chapter 4.1.3, Table 3) and used to calculate the **mean annual consumption per capita**:  $4.316,5 / 8,6 = 501,9$  kg

The population is approximately 15.000 (see Chapter 2.6). The **mean annual consumption of the whole community** within the study area is:  $15.000 * 501,9 = 7.528.500$  kg

### 4.3.3 Evaluation the sustainability

If the yield is compared with the use, see Figure 8, it seems that there is by far too little firewood available for the communities to be able to harvest their yearly needed firewood sustainably within the area where they currently collect.

<b><u>Total Yield Study area</u></b>	<b>&lt;</b>	<b><u>Total Consumption study area</u></b>
Sp1: 25.766,16 kg		7.528.500 kg
Sp2: 39.561,12 kg		

Figure 8, Total yield and consumption compared

For management options, it was calculated how much hectares of a particular firewood species would be needed by one household to harvest their need of firewood sustainably. These calculations were done for the earlier used two species:

- *Sp1: Acacia albida:*
  - 3.220,77 kg of wood is growing annually on 1 hectare.
  - One household living in the research area uses 4.316,5 kg of wood each year.
  - One household has a need of  $4.316,5 / 3.220,77 = 1,3$  hectares to be able to collect firewood sustainably.
- *Sp2: Eucalyptus tereticornis:*
  - 4.945,14 kg of wood is growing annually on 1 hectare.
  - One household living in the research area uses 4316,5 kg of wood each year.
  - One household has a need of  $4.316,5 / 4.945,14 = 0,87$  hectares to be able to collect firewood sustainably.

## 5. Discussion

This chapter serves to cross-check the different information sources, to be able to determine if the information from the different informants correspond. Also, the results are compared to previous research. The discussion will be sorted by research question; first, the availability, then the distribution, where after the consumption, to finish with the sustainability.

### 5.1 Availability

The first sub-question was: "What is the availability of the firewood species used by the local communities near Kidepo Valley NP?" The availability of firewood consists of the firewood species, alternatives, availability, the difference between the dry and the wet season, and the mean annual wood biomass yield increment.

#### *a) Firewood species*

The household surveys name specific species that are preferred and not preferred, but the key informant interviews showed that people do not have a preference and collect everything. The household surveys showed that the communities prefer *Acacia* species as a source of their firewood. In a study conducted by Egeru (2013), the same was concluded for the district Soroti, which is located south of the study area.

The parish chiefs specifically named the Sheanut tree as a species that is not preferred, which corresponds with the household surveys, where 18% of the respondents mentioned this. However, more of the interviewees from the household survey mentioned the Fig tree (30%) and the Tamarind (26%). Also, Karenga cultural group mentioned there is no collection of species toxic for cattle. An example of a species toxic to livestock is the Sheanut tree.

#### *b) Alternatives*

In the topic of alternatives, the household surveys and key informant interviews conclude the same; there is no alternative fuel available instead of firewood. The key informants say the alternatives are too expensive. Ramos (2012) says, alternatives are there but too costly to use, which is in line with what the key informants of current research say. A different research (Egeru, 2013) also states that the alternatives are too expensive. Oxford Committee for Famine Relief (OXFAM) (Magrath, 2008), states one alternative could be to use paraffin for cooking, but also mentioned the price of paraffin had shot up. The community referred to the use of a paraffin stove during the current study, but they also said it was too expensive.

#### *c) Availability*

Most of the respondents of the household surveys say when there is no wood there is no food. Although the community members do not know of any alternatives, they do say there are some alternative options when there is no wood. Most common is the use of sorghum stock; this is what the community members said and corresponds with what the key informants say. In the report of Egeru (2014), it was concluded that about 60% of the households complimented firewood with crop residues of cassava stems, maize stalks and cobs and sorghum stalks.

Most respondents of the key informants and household surveys are worried about the availability of firewood in the future; they already notice that they have to travel further to collect firewood. Pastor David agrees although he says the communities do not worry because they do not think far in the future. The parish chiefs say they are not worried at all, and their community is not either; "There is always enough firewood and building material available." That means although the communities themselves worry the parish chiefs and pastor think the communities do not.

#### *d) Wet and dry season*

Every respondent says that collection in the wet season is more difficult because of the vegetation, for that reason, more firewood is collected in the dry season to make a fence or stockpile that can be used in the wet season. Ramos (2012) also mentioned the collection in the dry season was preferred because of the abundant vegetation in the wet season.

e) *Mean annual biomass yield increment*

From the calculations made in Appendix 8 and Chapter 4.3.1 it was discovered that the mean annual wood biomass yield increment of Sp1 *Acacia albida* is 3.220,77 kg per hectare and of Sp2 *Eucalyptus tereticornis* 4.945,14 kg per hectare. The mean annual wood biomass yield increment for the total area is:

- Sp1 *Acacia albida*: 25.766,16 kg
- Sp2 *Eucalyptus tereticornis*: 39.561,12 kg

## 5.2 Distribution

The second sub-question was: "What is the distribution of the firewood species used by the local communities near Kidepo Valley NP?" To answer this questions the location of the collection of firewood, the collection time, distance and frequency and the location of the woodlots are determined.

a) *Location collection*

About the location, there were many different answers. All respondents said no collection or cutting on the hills, slopes or mountains; this is a rule from the sub-county. The key informants mentioned that firewood collection from shrines is forbidden too, but other than that there are no rules, the collection is everywhere. Although the household surveys also show no collection in and around the compound and in an near the NP and its corridor, apart from that everywhere.

Some of the household interview respondents mention specifically going to the corridor to collect. This corresponds with what the Rangers say; it is allowed to collect but only under the supervision of a ranger, and this is barely done. However, there are many signs of cutting and gathering inside the NP and corridor, although one of the Rangers did not see any signs of cutting or gathering in the corridor.

b) *Collection time, distance and frequency*

Most respondents of the household surveys collect daily and walk for 4 to 5 hours and 8 up to 10 km to collect firewood. This time and distance corresponds with what Pastor David says; they collect daily, and it can take up to 6 hours, with people walking as much as 8 km. The Karenga cultural group also says the collection is daily, but they say it is up to 5 km. According to a firewood research conducted in central Uganda (Agea, 2010) women in the African Sahel walk up to 10 km or 3 hours per day to collect firewood, and women in Niger walk for about 4 hours per day. In their study, in central Uganda, it was concluded they spend 4 to 6 hours and walk for 8 up to 12 km collecting firewood. That leads to thinking the collection time and distance differ between the community members and location but most collect 4 to 5 hours and 8 to 10 km and daily. These factors (collection time, distance and frequency) account only for the dry season; current research took place during the dry season and it was discovered, the collection of firewood in the wet season is limited.

c) *Location of the woodlots*

The classified land uses are compared with what was found during the measuring of the transects to determine if the classification done with GIS is correct.

For transect 1, two points are classified incorrectly, the other five points are correct. Point one is difficult to see, the point is located on a spot on the map that has both dense and open areas, it is hard to conclude if this point was classified correct. Point two is classified as dense; this differs from the results of the transect; there it was identified as having only a density of less than 5%. Point three is on the border between dense and open; there are even some spots of bare soil around the point. This point was identified during the transects with a density of less than 5%. So this point is likely identified correctly. Point four is located at a riverbed, this area is open and has not many trees, both the classified map and the transects concluded that. Point five is classified as open, also in the transects, it only has a density as 5%, so this is classified correctly.

Point six is also classified as open, although the transects measured a density of 20%. This means this piece is not classified correctly. Point seven is classified as dense, during the transects, it was discovered that the density was 10%. Based on the comparison made above; this classification is likely to be correct.

For the second transect, all transect point corresponds with the land use classified with GIS. Point one is classified as dense; there were slightly more trees present at this point during the transect, so this classification is correct. Point two is also classified as dense, during the transects, the same was discovered, so this is correctly classified. Point three is located on the edge but clearly in the open area, because there were no trees found in the plots. Point four is classified as open, in an area between dense woodlots. The transects identified a density of less than 5%; this classification is correct. Point five has a density of less than 5% according to the transect, during the classification it was discovered to be located in an open grassland area. This classification is likely to be correct. Point six is located on the edge of dense and open, but the transects determined the density was low, so this will be classified as open. Point seven and eight both find themselves on the edge as well, so the same conclusion can be drawn; they are both dense, due to the transect measurements. Point nine is located in a river bed, where trees and shrubs are not as abundant as in the rest of the area, so a low density. Point ten is also correctly classified as open, during the transects a density of less than five was measured. At point eleven there is a small area with a more dense woodlot, this is also identified during the transects.

The classified map also shows that the rules of no cutting on the mountains are obeyed because these areas have many trees and shrubs. That leads to thinking the community members do obey the rules for the restricted areas, and this seems promising for future management option.

It is logical that the woodlots closer to town are denser, as they will be logged more often and due to the coppicing characteristics of the trees and shrubs the growth will be abundant, thus denser than farther away.

#### *d) Limitations*

A limitation during the measurements of the transects was met; after the measurements had been taken with transect 1, the community member went to that area to practice agriculture. They chopped down many trees (at the first two transect points shown on the map in Appendix 14) to make huts and cleared the fields for planting crops. This only proves that the rules are not clear. The communities know they are not allowed to collect or cut in that area, but because the corridor is not yet indicated they are making use of that.

The species within the plots were identified. Unfortunately, during the transect measurements, the guide who identified the species quit and another guide had to be hired, this caused a change in some of the identified species' names and from then on only the local name could be determined for most. Therefore the data from the different guides could not be used together and also without the scientific or English name, this information is not useful and therefore not included in the report. For this reason, only the number of trees and density serve as a means to cross-check with the GIS image classified map on density. Moreover, no indication of specific species and their occurrence could be made.

### **5.3 Consumption**

The third sub-questions was: "What is the consumption of the firewood species used by the local communities near Kidepo Valley NP?" This sub-question consist of the type of fuel and fire, who collects, the quality of the firewood, the frequency, reason of a fire and if firewood is preserved, and the consumption of firewood.

*a) Type of fuel and fire*

All the respondents agree that almost everyone uses only firewood, as charcoal is too expensive for most. The observations show the same result. The observations and respondents all show charcoal is mostly made to sell and used by the richer people, as was also concluded by Shackleton (1998). Egeru (2013) states that 98,8% of the households in central Uganda use firewood for cooking. During the same research, it was discovered that like in the current research almost all community members cook on three stones and an open fireplace, with only a few exceptions. According to Dewees (Dewees, 1989), the influence on the consumption of firewood of wood-conserving stoves is limited, the stoves are inefficiently used and deteriorate, but can improve the daily lives. On the contrary, according to Egeru (A. S. Egeru, 2013) stoves will help reduce the amount of firewood needed to cook. The stoves attain a high efficiency by a complete combustion of fuel and a maximum heat transfer of the heat of the combustion from the flame to the cooking pot. In the current research area the use of stoves might improve on the amount of firewood they need for cooking, but next, to cooking, wood is needed for many more activities, so the impact of the stove will be minimal. In all sources on firewood use, it is said that women and girls are the ones who are responsible for the collection of firewood. During the present research, it was discovered that the community members sometimes buy firewood, which corresponds with the conclusion in the report of Agea (Agea et al., 2010).

All respondents agree that firewood is sometimes bought, but charcoal is too expensive. Although most of the interviewees of the household surveys never buy firewood. Agea (2010) states; 92% said they occasionally buy firewood.

The household surveys showed most people collect and cut both dead and alive wood. The key informants say it is by law forbidden to cut, but the law enforcement and implementation are too weak, and there is no real punishment.

*b) Who collects*

From the observations made it was discovered mostly women and children collect firewood, the responses from the key informants and household surveys are in line with this; the women and girls or daughters collect the firewood. Also, the household survey results show women and their daughter are responsible for the firewood collection. Ramos (2012) states that indeed using the method of collecting firewood in head bundles is only conducted by women, although if firewood is collected with a wagon or car, it is a men's job.

*c) Quality*

The most important quality of the firewood is; the fire has no or little smoke. Secondly, the fire has to burn well and long. Agea (2010) states the respondents during his research prefer the same quality. None of the key informants during current research mentioned a preference towards any quality; they say all the species and qualities are taken.

*d) Frequency, reason of fire and preserve firewood*

From the household survey can be concluded that most people make a fire three times a day with a close second of two times a day. Most of the fires are made for cooking. Pastor David on the contrary said; cooking is done mostly once a day in the evening. Also, many people brewed their alcohol but did not dare to tell during the interviews; this is of no further influence on the outcome of the research because the use is calculated per bundles they use and these bundles are used for the brewing too. Pastor David said; People do not preserve wood, they just let it burn, even to make the house warm sometimes, while the household surveys concluded that most people make the fire out when they have finished cooking.

*e) Consumption firewood*

Only the household surveys gave results on the consumption. Most use a bundle of firewood every two days, second came a bundle every three days. The average weight of a firewood bundle was calculated, at 27,2 kg. In a research by Buyinza (2008), one household used 65 kg of firewood is a week, thus  $65 / 7 = 9,3$  kg per day. The households use one bundle of firewood every 2,3 days. Thus in one day they use  $27,2 / 2,3 = 11,8$  kg. that is 2 kg more than in Buyinza's (2008) research.



The mean annual consumption of the whole community within the study area is calculated at 7.528.500 kg. The total consumption was calculated by first obtaining the mean annual consumption per household (4.316,5 kg), and the mean annual consumption per capita (501,9 kg). The mean annual consumption per capita will be compared to other research to assess if its correct. For the consumption of firewood, numerous studies have been done. A study was done in Uganda (Kalumian & Kisakye, 2001) reports a mean annual consumption of 485 kg per capita in Nakasongola and Masindi districts, which is lower than in the current research. Another research by Egeru (A. S. Egeru, 2013) states; in eastern Uganda, the mean annual consumption is 542,32 kg per capita, which is slightly higher. The next two studies also have a higher consumption; in a different research also in Uganda (Buyinza & Teera, 2008) the annual consumption per capita was 629 kg. A study done by Shackleton (1998) in South Africa concluded a mean annual consumption of 687 kg. As all the consumptions differ, and the current study's consumption is one of the lowest but not the lowest, it is safe to say the consumption is correct.

As mentioned in Chapter 4.3.2 a household size does not correspond to the family size, often the household was larger. This difference has some explanations;

- Most men have multiple wives; sometimes they live apart, but sometimes they live together.
- As the oldest son, you have to take care of your parents. Therefore a household does sometimes include parents.
- Also, sometimes more families work together to cook.
- From the household surveys, it was discovered that the community members sometimes work for food.

#### *f) Limitations*

At first, the aim was to ask the interviewees how much their bundles of firewood weighed. Unfortunately, the scale broke and could not be replaced until later. For this reason, the method for weighing changed. Two days were spent in week 9 (19-20 April), walking through the communities to weigh as many bundles as possible. This meant the family size of the weighed bundles were no longer known, so now all measurements were summed up, and an average was calculated, both for the weighed of the bundles, the number of used bundles and for the family size. (For these calculations see Chapter 4.3.3g) For that reason, it was impossible to make a good comparison between the amount of firewood used and the number of people that is cooked for on that fire. It was tried to find a correlation between the number of bundles used and the household size (number of individuals that is cooked for), but this did not show a correlation. Also, the bundles each weigh differently, depending on who collects and how strong that person is, thus with only this information nothing significant could be concluded.

## **5.4 Evaluation sustainability**

The main research question is; "Is the firewood consumption of the local communities living near Kidepo Valley National Park sustainable?"

#### *a) Sustainability*

The yield of *Sp1: Acacia albida*: 3.220,77 kg and *Sp2: Eucalyptus tereticornis*: 4.945,14 kg are much less than what the communities within the study area consume; 7.528.500 kg. Therefore, it seems that there is by far too little firewood available for the communities to be able to harvest their yearly needed firewood sustainably. Although it was discovered during the interviews that the communities do not use the total available area, they will not walk farther than 5 km, and collect as close to their compounds as possible. The same can also be concluded from the forest inventory; the with GIS classified map matches with what was found during the transects. Thus the classified map serves as a good indication of the present land use. The classified map in Appendix 13 shows; the more dense woodlots are indeed about five km from the villages. If the community members used the full area for the harvesting of firewood, there would be a bigger change of harvesting sustainable, but as they now use only a part of the area, the harvest is done unsustainable.



For Sp1 *Acacia albida* one household in the study area would need 1,3 hectares to harvest their need sustainably, and for Sp2 *Eucalyptus tereticornis* only 0,87 hectares is required. These outcomes seem promising; there still is enough land that is currently not used and could be used for firewood management.

#### *b) Limitations*

During this research, it is assumed that managing an area for the firewood collection, with only taking into account the mean annual wood biomass yield increment, is possible. According to Abbot (1999), then the minimum rotation length of a plot of firewood managed on a coppice rotation could be as short as 5 years. As mentioned before, the mean annual wood biomass yield increment serves as a guideline; this is not a set number. It is also possible to establish firewood management based on the annual harvestable deadwood yield. During this research, there was no possibility to estimate or calculate the annual harvestable deadwood yield. Shackleton (1998) states: the deadwood production is relatively constant from year to year, and he concluded; the annual production of Deadwood is strongly related to the standing biomass. Therefore, it appears that an annual rate of deadwood production of 1.5-2.0% of the standing biomass seems realistic. For this research area that means first the standing biomass needs to be calculated, but when this number is known, management options will be discovered. Currently, the management options are based on the mean annual biomass yield increment.

## 6. Conclusion & Recommendations

In this chapter, the research question is answered, and recommendations are given. The main research question is:

- ***“Is the firewood consumption of the local communities living near Kidepo Valley National Park sustainable?”***

To answer the main research question; No, the firewood consumption of the local communities living near Kidepo Valley National Park is not sustainable. There is not enough wood in the area where the collection currently takes place, but there is enough space where if correctly managed, firewood collection can be sustainable. The future of the communities living near the NP looks promising, if they work together and better manage and make use of the area.

It can be concluded from the results of this study, that there are many options for improving the current situation. The communities are worried, they know their wood supply in the future is in danger of disappearing, and are willing to change. They use their wood supply sparsely, but there is still room for improvement. See below for the recommended options for improvement on the current situation.

### 6.1 Communities

There are several recommendations primarily aimed at the communities; they are elaborated below. The communities will need to be assisted in following these recommendations; there is need of knowledge (e.g. education) and aid either financial or in the form of products (e.g. stoves, seedlings).

- **Stove use**

The first option is to promote the use of a stove. During the research, it was discovered almost no one uses a stove. Although as explained before the impact will be limited, it will improve the livelihood of the women who do the cooking.

- **Woodlot management**

What builds forward on this is the management of planted permanent firewood plots close to the compound. The women would not have to walk for long distances and spend much time on the firewood collection. The community members prefer to walk only up to 5 km. Also, the woodlots will be easier to manage closer to home. The animals can be kept out, and the seedlings will be more protected from the wildfires. Also, the firewood trees can be used to let the cattle graze between and the leaves can be used as fodder. A species with good coppicing quality and preferably good fodder is to be planted on the plot. Also, an *Acacia* species would be best, because that is the species that is most preferred as firewood. Even fruit trees could be planted on these plots.

The management of permanent plots would also be positive in the wet season. Permanent plots near their homes mean the collection in the wet season is easier and thus possible, which means they will not have to collect more in the dry season, and that leaves time for other activities.

If looked at the classified map in Appendix 13, areas with dense woodlots still are numerous. A possibility will be to use these areas, make plots and rotate them for the harvesting of firewood. As mentioned before Abbot (1999), recommends a minimum rotation length of 5 years, for a coppice rotation. So this is a good option to harvest sustainably and by that maintain the wood supply for many more years to come. For this, to work, it means cooperation within the communities and strict rules that need to be obeyed.

### ➤ Agroforestry

Another option is to promote the practice of agroforestry. According to Jama and Zeila (2005), the policy framework for the institutionalisation of the concept of agroforestry in Uganda is already in place. The Government's Plan for the Modernization of Agriculture (2000), the Forest Policy (2001) and the National Forest Plan (2002) all are supportive of the promotion and adoption of agroforestry as a strategy for poverty alleviation. (Jama & Zeila, 2005)

Agroforestry means food crops or pasture lands are intercropped with trees; it is aimed at increasing the sustainability of the land. It is a means to protect the natural resources and improve the livelihoods of the communities. There are numerous examples where this system has improved the livelihoods and environment. (Kassam, Fischer, & Antoine, 1991) In the study area it will have several impacts:

- The land will be used to full capacity while still being sustainable and fertile in the future.
- The yield and income will improve.
- The trees will hold onto the moisture.
- Firewood could be collected from the gardens which mean it will be less labour intensive and less dangerous.

### ➤ Group work

Different research (Agea et al., 2010) shows that working in groups to collect firewood and cook has a positive effect on the amount of firewood that is needed. For this reason, it is recommended that group work will be promoted in the area, share the work and food so that they all benefit. Group work is currently not done often; some respondents did work together, but most did not.

### ➤ National Park

An additional source of resources is the NP. As mentioned before, the communities are allowed to collect resources from inside the park and its corridor. As this is rarely done now, they should make this option more clear to the communities, so that they can benefit more from it.

### ➤ Trust

A final recommendation is to improve the trust and respect between the different people in the community. During this research it seemed that the Rangers, pastor and Chiefs have a down-looking view on the community members, they perceive them to be dumber as they are. This lack in trust needs to change, there should be trust and respect towards both sides, for them to be able to work together and improve their future.

## 6.2 Further research

This research did identify some problems in the area, which could not be researched at that time or other additional research that is recommended:

- The first would be the influence of the brick burning. To burn bricks much wood is needed, preferably freshly cut and big, but unfortunately, it is one of the only options for getting some income.
- The same principle goes for the creation of charcoal, another option to get some income. For the creation of charcoal also freshly cut big trees are needed. A solution to stop both these unsustainable businesses should be identified.
- Burning is a problem as well (see Chapter 1.1). It destroys the vegetation and thereby their source of firewood. Also, tree planting activities can only start when the burning is under control. Otherwise, the planted trees are at risk of being destroyed by the fires.

Research about alternative sources of income that are not bad for the environment should be done, or activities to promote and create alternative sources of income should be held. By creating other options to get an income, the need for brick burning and charcoal making should become less. Good options in this are to continue and improve on the activities on chilli planting and beekeeping, as is currently done by NUSAF in cooperation with UWA. However, there needs to be more attention on the marketing part of these projects; the community has not yet a way to sell their products. If there are alternative ways to get an income the burning will most likely lessen as well. Because when there is enough money there is no need to hunt.

Also, additional research is recommended within the identified woodlots. A more detailed forest inventory can take place, to assess the present wood volume, this will help to make a sustainable management plan for these woodlots.

There is still room for further research on the topic of firewood collection but especially the management of it, and thereby gives a starting point for future research.

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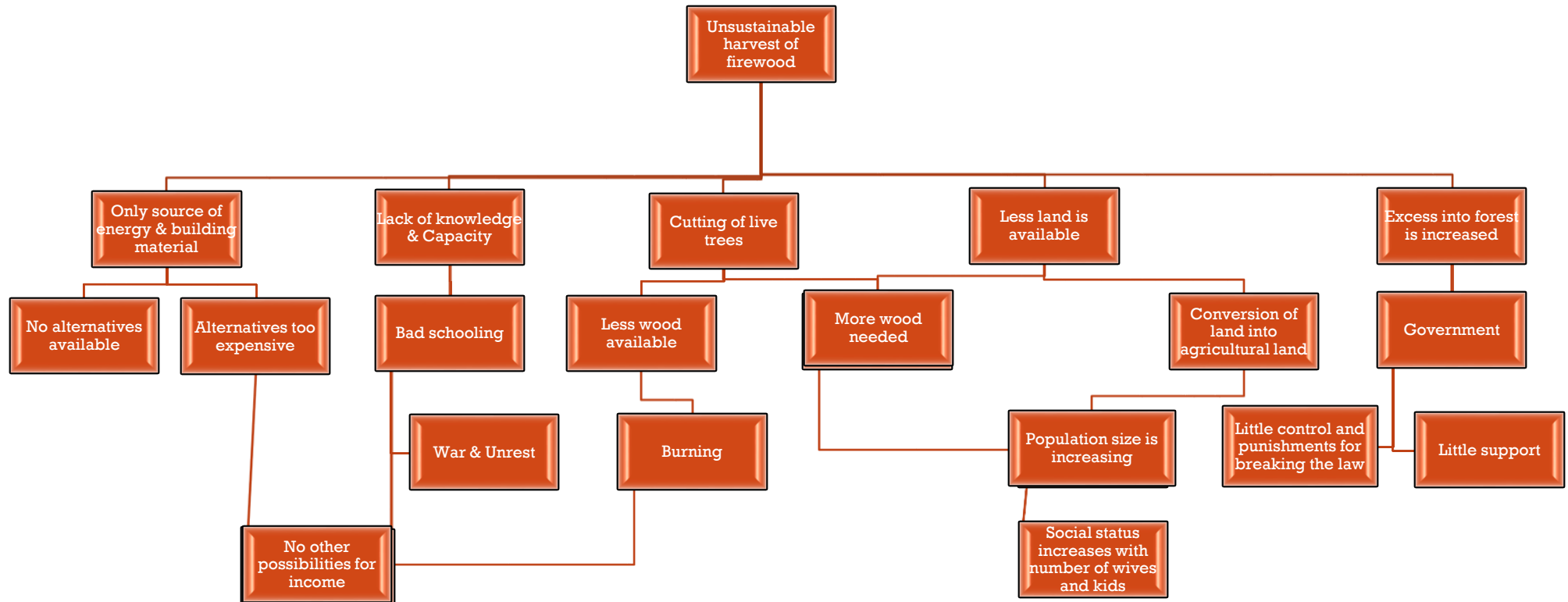




## Appendixes



## 1. Appendix – Problem tree

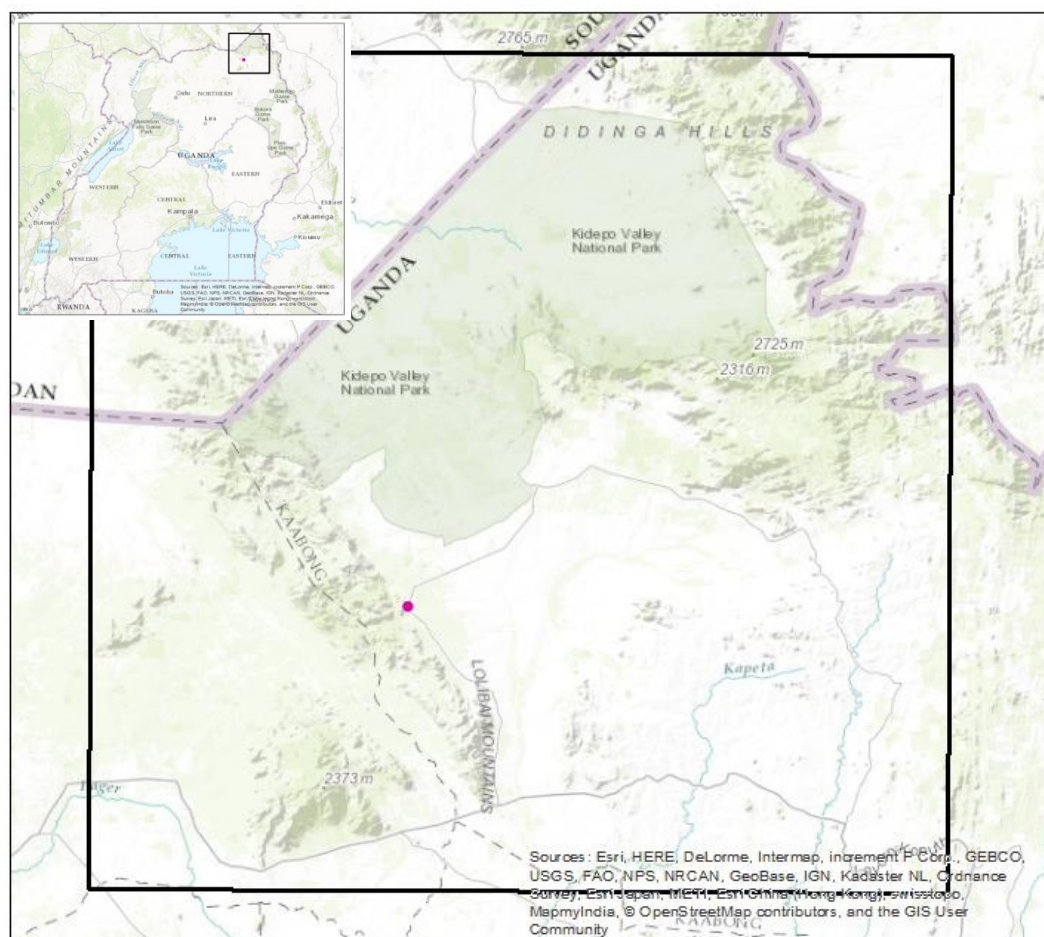


## 2. Appendix – Stakeholder analysis

Stakeholders and their basic characteristics	Interests and how they are affected by the problem(s)	Capacity and motivation to bring about change	Possible actions to address the stakeholders interests
<ul style="list-style-type: none"> <li>• <b>Community Wildlife and Education Centre Ajokis:</b> Centre to assist and help the communities towards a better life.</li> </ul>	<ul style="list-style-type: none"> <li>- Increase well-being of the communities and wildlife.</li> <li>- Educate the communities.</li> </ul>	<ul style="list-style-type: none"> <li>- They have the capacity to bring about change.</li> <li>- They are very motivated to improve the livelihoods of the communities.</li> </ul>	<ul style="list-style-type: none"> <li>- Provide training.</li> <li>- Provide incentive.</li> <li>- Organise group meetings.</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Uganda Wildlife Authority (UWA):</b> The rangers that protect the wildlife, vegetation and people that live in and around the NPs and the corridor.</li> </ul>	<ul style="list-style-type: none"> <li>- Enforce the law and protect the NP and its corridor.</li> <li>- Protect the communities from wildlife.</li> <li>- Educate the communities to prevent human-wildlife conflicts and illegal activities.</li> </ul>	<ul style="list-style-type: none"> <li>- They have the capacity, but are limited; the area is too big, and the corridor is not yet defined.</li> <li>- They are motivated.</li> </ul>	<ul style="list-style-type: none"> <li>- Provide training to increase knowledge of human-wildlife conflicts.</li> <li>- Provide incentive to communities to improve livelihoods. (chilli projects, beehives)</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Karenga cultural group:</b> A voluntary dance and drama club, that works to increase knowledge, improve the livelihoods and preserve their culture.</li> </ul>	<ul style="list-style-type: none"> <li>- They aim to improve the livelihoods of the communities.</li> <li>- They aim to preserve their culture.</li> <li>- They teach communities with their drama.</li> </ul>	<ul style="list-style-type: none"> <li>- They have the capacity to bring about change.</li> <li>- They are very motivated and active in doing so.</li> </ul>	<ul style="list-style-type: none"> <li>- Provide training to increase knowledge on farming and handicraft making.</li> <li>- Provide drama to educate.</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Firewood collectors and users:</b> all members of the community who collect firewood to be able to maintain their livelihood.</li> </ul>	<ul style="list-style-type: none"> <li>- Want to collect firewood for their subsistence.</li> <li>- Firewood extraction is done unsustainable which in the end will lead to a decreased wood availability.</li> </ul>	<ul style="list-style-type: none"> <li>- Limited capacity to bring about change. However, if they work together, they can put pressure on the leaders.</li> <li>- Are motivated because of their need for resources.</li> </ul>	<ul style="list-style-type: none"> <li>- Create a council or group for the management and extraction of firewood, which will also increase their capacity to bring about change.</li> <li>- Set up firewood plantations.</li> <li>- Agroforestry</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Parish Chiefs:</b> The leaders of the parishes, they have some political influence and know what is happening in their parish.</li> </ul>	<ul style="list-style-type: none"> <li>- It is their responsibility to create a healthy environment for the village.</li> <li>- Increase well-being of the community by implementing certain laws and being involved in the guidance of the village.</li> </ul>	<ul style="list-style-type: none"> <li>- They have little capacity to bring about change. They have little political influence.</li> <li>- Their motivation is there, but they lack real capacity to change anything.</li> </ul>	<ul style="list-style-type: none"> <li>- Contact and work together with NGOs to provide training regarding management and sustainability.</li> <li>- Start projects to request funding from REDD or PES.</li> <li>- Improve market availability, awareness and access for villagers regarding NTFPs and food products.</li> </ul>

### 3. Appendix – Map of the research area

#### Location study area



#### Legend

- Karenga
- StudyArea



#### 4. Appendix – Visited villages

Table 16, Overview of the location of the study

District	County	Sub-county	Parish	Village
Kaabong	Dodonth East	Kamion	Morungole	Palakan
	Dodonth West	Karenga	Karenga	Kamkoi North
				Kamkoi South
				Kangole Central
				Kangole North
				Kangole South
				Lokodope Ward
				Lopotuk
				Nalemaru
				Wapakiru
			Lokori	Kachapangole Ward
				Lokori Central
			Loyoro	Geramech
				Lorukul
				Nakitoit Sriti
				New Karenga
				North Loyoro
				South Loyoro
			Opotopot	Kalokudo Ward
				Lokuyon Ward
		Kawalokol	Naseperwai	Lemukul
				Monita

The table above shows first the District in which the research took place then it shows the different sub-counties and its parishes and villages.



## 5. Appendix – Key informant interviews

This appendix shows the interview questions that served as a guideline through the semi-structured interviews that were held with the different key informants. The informants were; the Karenga cultural group, Pastor David, the parish chiefs and three rangers of UWA.

- Important issues in the area
- Problems in the area
- Activities to improve the area; tree planting for example
- Government; support enough?
- Electricity
- About the NP; problems, risks, collection in NP or corridor, etc.
- Firewood; availability, distribution and consumption
- Rules and regulations

Also, a focus group meeting was held with the Karenga cultural group. The aim of this meeting is to get an overview of the current situation near Kidepo Valley NP. Important topics will be discussed, including topics related to this research, thus firewood and charcoal. The topic is written on a piece of paper, and the member can write their ideas and discuss them.

## 6. Appendix – Household Survey

<b>Interview nr:</b>	<b>Date:</b>	<b>Village:</b>	<b>Waypoint:</b>
<b>Interviewee: F / M</b>	<b>Age:</b>	<b>Family size: Cook for:</b>	<b>Family head: F / M</b>
<b>Marital status:</b>	<b>Education level:</b>	<b>Occupation:</b>	<b>Tribe:</b>

1. What type of fuel do you use? Firewood or do you use other types of fuel? Charcoal/gas/bio
2. How do you burn your fuel? Stove or..?
3. How many times a day do you make fire? For what?
4. How many meals do you cook a day and how many time you eat?
5. Do you let it burn after use?
6. Is there any management plan for firewood gathering?
7. Who is allowed to collect where? Are there restricted areas?
8. Do you know of any alternatives to the use of fuel wood?
9. When there is little fuel wood available how do you cope/adapt?
10. Do you buy fuel wood or charcoal? How much money do you spend monthly?
11. Who collects the firewood for the family?
12. How much fuel wood do your family use per day/week | how many bundles?
13. How many times a week do you collect fuel wood? Every day? Alternatively, once a week, or..?
14. How many hours do you spend collecting fuel wood a day/week?
15. How far do you and are you willing to walk to collect fuel wood?
16. Is this different in different seasons?
17. What species do you prefer/ what species do you use? Species you not used? Why
18. What type of wood do you collect? Living or dead?
19. Is there a change in certain species availability? Alternatively, further away/ decline?
20. Are there specific characteristics/ quality of fuel wood you want? A-J
21. Do you worry about availability in future?
22. Have you ever planted a tree? Do you have an interest in setting up a nursery, for enrichment planting?
23. Can I weigh a bundle/head load of firewood?
24. Are there any questions you would like to ask us?

## 7. Appendix – Transect form

Team		Community		Local expert
Transect nr.	Waypoint nr.	Date	Direction(°)	Vegetation Type
Distance on transect (m)	N-coord	E-coord	Circle radiuses:	Observation protocol
			<ul style="list-style-type: none"> <li>11,28 m</li> </ul>	Every 1 km on road, walk 50 m into corridor at a 90° angle from road

Canopy Height (m)	
Density Canopy Estimate (%)	<input type="checkbox"/> 0-50% <input type="checkbox"/> 50-70% <input type="checkbox"/> 70-80% <input type="checkbox"/> 80-90% <input type="checkbox"/> 90-100%
Firewood species local name (visible from transect point)	
Other species local name (visible from transect point)	
Number of stumps inside radiuses	
Small plot >=10cm dbh	
Large plot >=20cm dbh	
Soil texture	<input type="checkbox"/> clay <input type="checkbox"/> sandy <input type="checkbox"/> loam <input type="checkbox"/> rocks <input type="checkbox"/> gravel
Slope (%)	
Signs of human disturbance	<input type="checkbox"/> agriculture <input type="checkbox"/> logging <input type="checkbox"/> hunting <input type="checkbox"/> mining Description:
Remarks	

## 8. Appendix – The mean annual wood biomass yield increment

Here the annual biomass increment of two commonly used firewood species is calculated, the *Acacia albida* and *Eucalyptus tereticornis*. The document used for these calculations is Chapter 6 - Fuelwood productivity from a report of the FAO, in the text, a reference to the used tables is made. (Kassam, 1991)

### 8.1 *Acacia albida*

To be able to calculate mean annual wood biomass yield increment, the tables in the FAO document are needed to be able to fill in the formula, the following input data is used;

• Latitude:	0 Degree North
• Temperature:	20-25 °C
• LGP:	180-270
• Cloudiness:	35%
• Months:	April – October
• Rainfall:	750-1000 mm
• LAI:	2

#### Step 1 – get values needed for formula:

Table 6.1, shows the *Acacia albida* has a productivity class A II and is a nitrogen fixer.

Table 6.2 shows a rate of maximum photosynthesis (Pm) of 7,5 kg CH<sub>2</sub>/ha/hr.

Table 6.3 shows a rotation length of 10-12.5 years is required.

Table 6.4 indicates that *Acacia albida* is an S1 = 0.25

From Table 6.6 the daily gross photosynthesis rate of standard vegetation canopies on very clear (bc) and overcast (bo) days can be calculated. The average of the months of the growing period is calculated;

bc = 420.57	bo = 223.71
LAI =	L = 0.6
Cloudiness =	F = 0.35
LGP =	N = 270

#### Step 2 – Filling in the formulas:

Because Pm < 20, the second formula is used to calculate the daily rate of gross biomass production (Bgm):  $Bgm = F(0,5 + 0,025 * pm) * bo + (1 - F) (0,05 * pm) * bc$

$$Bgm = 0.35*(0,5+0,025*7,5)*223,71 + 0,65*(0,05*7,5)*420,57 = 156,34 \text{ kg CH}_2\text{O/ha/day}$$

The maintenance respiration (Ct) =  $C25 * (0,0044 + 0,0019 * T + 0,0010 * T^2)$

For N-fixing species such as the *Acacia albida* C25= 0,0283

$$Ct = 0.0283*(0,0044 + 0,0019 * 25 + 0,0010 * 25^2) = 0.01915627$$

The annual total net biomass production (Ba) =  $(0,72 * bgm * L) / (1/N + 0,25 * Ct)$

$$Ba = (0.72*156.34*0.6) / (1/270+0.25*0.01915627) = 7.952,51 \text{ kg/ha}$$

#### Step 3 – Converting and finishing up:

The mean annual total biomass increment (Bm) = 0,81Ba

$$Bm = 0.81*7.952,51 = 6.441,54 \text{ kg/ha}$$

The constraint-free mean annual wood biomass yield increment (Bw) = harvest index (Hi) \* Bm

$$Bw = 0.5*6.441,54 = 3.220,77 \text{ kg/ha}$$

#### Here is what was calculated:

• The total annual net biomass production:	Ba = 7.952,51 kg/ha
• The mean annual total biomass increment:	Bm = 6.441,54 kg/ha
• The mean annual wood biomass yield increment:	Bw = 3.220,77 kg/ha

## 8.2 *Eucalyptus tereticornis*

The same input data is used as for the annual increments;

- Latitude: 0 Degree North
- Temperature: 20-25 °C
- LGP: 180-270
- Cloudiness: 35%
- Months: April – October
- Rainfall: 750-1000 mm
- LAI: 2

### Step 1 – get values needed for formula:

Table 6.1 shows the *Eucalyptus tereticornis* has a productivity class B II.

Table 6.2 shows the  $P_m = 15 \text{ kg CH}_2/\text{ha/hr}$ .

Table 6.3 shows a rotation length of 7,5-10 years is required.

Table 6.4 indicates that *Eucalyptus tereticornis* is an  $S1 = 0.25$

From Table 6.6 bc & bo are determined, they are the same as for the annual increment for the crops;

$$\begin{aligned} bc &= 420.57 & bo &= 223.71 \\ LAI &= & L &= 0.6 \\ Cloudiness &= & F &= 0.35 \\ LGP &= & N &= 270 \end{aligned}$$

### Step 2 – Filling in the formulas:

Because  $P_m < 20$ , the second formula is used to calculate the Bgm:

$$Bgm = F(0,5 + 0,025 * p_m) * bo + (1 - F) (0,05 * p_m) * bc$$

$$Bgm = 0,35*(0,5+0,025*15)*223,71 + 0,65*(0,05*15)*420,57 = 273,54 \text{ kg CH}_2\text{O/ha/day}$$

$$Ct = C25 * (0,0044 + 0,0019 * T + 0,0010 * T^2)$$

For N-fixing species such as the *Acacia albida*  $C25 = 0.0108$

$$Ct = 0,0108*(0,0044 + 0,0019 * 25 + 0,0010 * 25^2) = 0,00731052$$

$$Ba = (0,72 * bgm * L) / (1/N + 0,25 * Ct)$$

$$Ba = (0,72*156.34*0,6) / (1/270+0,25*0,00731052) = 12.210,23 \text{ kg/ha}$$

### Step 3 – Converting and finishing up:

$$Bm = 0,81Ba \quad Bm = 0.81*12.210,23 = 9.890,29 \text{ kg/ha}$$

$$Bw = Hi * Bm \quad Bw = 0.5* 9.890,29 = 4.945,14 \text{ kg/ha}$$

### Here is what was calculated:

- The total annual net biomass production:  $Ba = 12.210,23 \text{ kg/ha}$
- The mean annual total biomass increment:  $Bm = 9.890,29 \text{ kg/ha}$
- The mean annual wood biomass yield increment:  $Bw = 4.945,14 \text{ kg/ha}$

## 9. Appendix – Observations

During the first two weeks of the field work, 22 February until 6 March, observations were done about different topics. Below an overview of the observations is given.

Related to the management the following observations were made:

- Goats and cows roam freely, at the start of the growing season they will be herded. In the afternoon the goats and cows are herded towards their home.
- There are more goats than cows.
- It is often just children that herd the cattle.
- Mostly children and women collect water. Men never do.
- Large areas of grass and shrub land are burned to get access to a type of rat.
- Women, men and children plough and plant the fields.
- It is the men that build the fences and houses.

The following observations related to income were made:

- Many people bake bricks.
- People sell clothes, shoes, food along the road.
- There is little option to get income.
- There are a few shops, restaurants and bars in the villages.

Related to the well-being of the communities, the following observations were made:

- All children wear dirty, broken clothes, most adults as well. Except for Sunday, when they go to church they wear nice clean clothes.
- Many children have bloated bellies. Thus many are malnourished.
- There are not many old people.
- There are a lot of pregnant women and many small children. Also, the older kids (7 years) take care of their younger siblings (from 1).
- The men here have multiple wives, only one or two.
- Within the staff of Buffalo base, there was a guy with malaria, a child on medicine (15 months old), a mother and another sister who died of malaria.
- Water is always available, but they have to walk down to the water pump. There is a system to connect households to so that they have a tap at their homestead, but this is often too expensive.
- Many people drink the local alcohol, starts in the morning till dark. Also, children are drinking kwete (alcohol). The kwete they drink instead of eating. To give the adults energy and keep the children quiet.

Finally, there were observations done about the overall topics in the area:

- Harvests have failed. So there is food shortage
- Everybody lives in traditional houses, except for a few who have built a western type house.
- Men sit around and do nothing other than playing card and drink during the dry season. Only women are at work. Alternatively, men built the houses. In the wet season, everybody works.

In Karenga, the community has access to a one new looking tractor. This was given by the government, but most people cannot afford to use it because they need to pay for the gas and driver. Most people use their strength to plough; some use the oxen.

## 10. Appendix - Key informant answers

With these interviews, an overview of the current situation in the area is discovered. The following people were interviewed; three parish chiefs, Pastor David, the Karenga cultural group and three Rangers from the NP. An overview of the interview questions is given in Appendix 4 – Key informant interviews.

### 9.1 Parish chiefs

Three parish chiefs were interviewed for the research. The parish chiefs of Karenga, Loyoro and Opotopot and Lokori. Below a summary of these interviews is given, the summary only includes relevant information to be able to answer the sub-question given above. All these interviews were done on the 26 of February of 2016. First, the parish chiefs and their parish are given:

- |                                 |                            |
|---------------------------------|----------------------------|
| - Chief Opio John Johnnic;      | Loyoro Parish              |
| - Chief Adui Milton;            | Lokori and Opotopot parish |
| - chief Lotyang Fidelis Nakoma; | Karenga parish             |

#### *Problems*

O. J. Johnnic: "Manmade wildfire is the most important problem. Burning is still common because the law enforcement and implementation are too weak, and there is no real punishment. Another problem is deforestation, caused by the production of charcoal (to make money), collection of firewood and wood for fences."

A. Milton: "When burning bricks lot of wood needed."

L. F. Nakoma: "The yield is reduced because of the yearly use, now some soils are poor from over cultivation, while the soils are very fertile. They have to move to different richer unused soils. Bush burning, this causes water to evaporate more quickly, and the water table reduces, as well as the insects and plants are reduced. This problem is seasonal."

#### *Actions to solve problems*

O. J. Johnnic: "Sub-county has a program Local Environment Committee (LEC), funded by the government. This program operates at the village level, parish level and sub-county level. It was founded in 2009. They implement rules like no cutting and no collection of wood on slopes; the improvement can be seen on the hillsides, which is now forested again."

L. F. Nakoma: "Educate people so that they are better at planning and management then production will increase, fewer crops will be lost, and the soil will be over cultivated. Also teach people prevention, tell them Bush burning is bad and provide them with other options of income."

#### *Programs in tree planting or other activities*

O. J. Johnnic: "The LEC has no programs or activities. However, other NGOs have; Northern Uganda Social Action Fund (NUSAF) for instance provides seedlings to groups of people, for them to grow trees for their use. The church and other NGOs have similar activities."

A. Milton: "NUSAF provides organised groups with seedlings, only for organised groups. The AWF, support chilli planting and help with marketing. It has just started, shows promise, good to generate income."

L. F. Nakoma: "The sub-county has tree planting as a priority. They advocate it and try to get ten trees per household planted each year. Also, tree planting activities are held to protect hillsides. LEC was funded for this. The parish protects existing trees; this is important because trees reduce heat, hold water and protect the soil and crops from rain."



### *Electricity and other government support*

O. J. Johnnic: "The government is obligated to provide electricity and good roads. Soon the tar road and electricity will be in Karenga. Mostly the government does this to promote the NP. If everything goes according to plan Karenga will become a district in 2019, this will promote the wellbeing of the area because there will be more finance available. This is also why the tar road and electricity are coming because that is a criterion to be allowed to become a district."

A. Milton: "Even when the electricity will reach here it will not be affordable for most people. To light houses people use candles sometimes, this causes the houses to burn down."

L. F. Nakoma: "Government support is good; they provide finance and have many activities. Electricity is promised but I am not sure it will come; same goes for the tar road. There are multiple governments supported organisations:

- Community Driven Development Fund (CDDF)
- Local Government Management Service Delivery (LGMSD)
- NUSAF, funds tree planting and so far there are five woodlots.
- Wildlife Community Society, support writing an action plan and implementing activities. They have organised the creation of beehives. However, they are not able to sell the honey."

### *Problems and questions of the community members*

O. J. Johnnic: "There are many problems the community members come with, many complaints. This differs from minor problems to big problems, such as; crop destruction by animals, domestic violence and other problems in households. When people come with problems a disaster report is written, this report is given to district office, and they will come to solve the issue if they are able."

A. Milton: "The people come to ask about government activities like food programs and such. Also, they ask about when Karenga will become a district so that Lokori and Opotopot will become a sub-county. When this happens this means an upgrade; the finance will increase, and they will get benefit from the NP."

L. F. Nakoma: "Community members will ask about projects organised by NGOs and in case they are not able to pay the school bill and their kids have to drop out. They will ask for support to pay the school fee (Primary is free, Secondary costs). FAULWE → used to help but not anymore."

### *Firewood in the future*

O. J. Johnnic: "He does not worry. The people are trained to use a stove. They are educated in other improvements in cooking. Already, the cutting for fence material has reduced because people feel safer."

A. Milton: "The community members do not worry a lot about the future. They do not think about the future, they live in the moment and are happy with what they have. This means there is no planning for the future."

L. F. Nakoma: "Firewood will not finish. People do not cut wood but collect dead wood and on the agricultural fields they cut small trees but leave the big ones."

### *Alternatives to firewood*

O. J. Johnnic: "There are not yet many alternatives available but with education, this will improve. As well as when the electricity will be available. Plus more solar powered cooking will be possible."

A. Milton: "There is no alternative to firewood, only charcoal but that is too expensive."

L. F. Nakoma: "Almost everyone uses firewood, like  $\frac{3}{4}$  of the people. The main reason being, it is cheaper. Some people use charcoal but not many. Many people make charcoal to sell it, this causes woodlot to be illegally cut to make the charcoal. Some people build a stove to burn more effectively."

### *Management of firewood*

O. J. Johnnic: "No collection or cutting at Cultural shrines or on hillsides. Most shrines are on slopes. Other than this no further management."

A. Milton: "There are no rules, you can collect dead wood, and you can cut for firewood and building materials. It is not allowed to cut the Sheanut tree. Most people collect too much firewood in the dry season to make a fence from it, this fence they will use in wet season."

L. F. Nakoma: "Law protects shrines; you are not allowed to collect dead wood and live wood. On hills, cutting is not allowed, but the collection of dead wood is ok."

#### *Little firewood*

O. J. Johnnic: "This is not the case, there is still plenty even for building materials."

A. Milton: "There is always enough firewood available. However, still, planting should be promoted."

L. F. Nakoma: "When there is little firewood some people will use grass or sorghum stock instead of wood to cook. In the wet season the firewood is scarce, so in the dry season, they build a fence of dead wood, to use in the wet season. The dry season is the building season and the wet season is the planting season."

## 9.2 Pastor David

Pastor David is the pastor of the Catholic Church in Karenga. He was interviewed on the 25<sup>th</sup> of February of 2016. Below an overview of this interview;

Almost all people use firewood for cooking, some use charcoal, there is no other option. Usually, people make charcoal to sell. The firewood is collected by the women and their children. The collection is done daily and can take up to 6 hours, and people can walk as much as 8 km. During the wet season, the collection is difficult because of the growth of plants, mainly grass and bushes. During the dry season, they collect every day so that they have a surplus. From this surplus, they make a fence so that in the wet season they can use that.

Sub-county Karenga decided that there be no collection of dead or living wood on slopes and mountains allowed. Collection of dead and alive wood, so they also cut trees, this is a danger to the environment. Everybody can collect anywhere; there are no real rules about who collects where. There is no real preference; every species is used and no specific characteristics are required, they take everything. The distance to collect firewood keeps increasing over time.

Cooking is done mostly once in the evening, the next morning the left over is given to the kids. Few people can cook three times a day. People cook mostly on an open fire, using three stones to put the pan on. Only a few have stoves. People do not preserve wood, they just let it burn, even to make the house warm sometimes. When there is little firewood available, they use sorghum and grass to cook. There are no alternative ways for cooking available. Only the educated can buy firewood or charcoal. Charcoal is not often bought; it is expensive.

The church encourages tree planting and has an example in their garden, many eucalyptus trees they have planted. The problem is the burning; fire destroys the planted trees.

People are not aware of the problems; they do not think of the future.

The president promised a tar road all the way through Karenga to South-Sudan as well as electricity. The electricity will have to be paid for, with the airtime system, so only educated can afford it. Most people will not benefit from this. In addition, electricity will not be used for cooking, so it will not stop deforestation.

Possible alternatives for the use of firewood for cooking are; to use paraffin burners but they are expensive or to cook on solar power.

### 9.3 Cultural Group

On the 22<sup>nd</sup> and 23<sup>rd</sup> of February 2016, the Karenga cultural group was interviewed. It was an interactive group session, with the director Albine and 15 members (2 men, 13 women). The topic of firewood was written on a paper, and the people were asked to write down what they thought about it after these topics were discussed.

The Karenga cultural group is a group that has many projects in the area. They have recently received funding for their projects. They have received this funding by writing a project proposal, with the purpose, different objectives, the envisioned results and the different activities. The funding is mostly for what the funder wants: cultural heritage preservation not for tree planting, beekeeping, etc.

The Group is voluntary and consists out of members from different parishes. The group also has members from higher political places, that way the influence of the Cultural Group is extended to the different parishes. If a member is not able to come or do something, a family member will take his/her place. The Cultural Group has activities and educates people in the area. Everyone is welcome; it is voluntary based and for everything, there is someone with knowledge on the topic. Everything is handled; agriculture, handcraft, planting trees, health, etc. The focus is on nature and cultural conversation and health. The Group educates people through the use of drama; with plays with songs and music.

For instance, a play about malaria includes songs about how bad mosquitoes are and how to prevent the disease, etc. Unfortunately, there is a lack of funding for things like computers, etc. This makes the management very difficult; it would go easier and faster with these facilities.

About firewood they said: the community is able and willing to plant trees, but they have no time and money to do it. Another problem is they get seedlings from NGO, when wet season is almost over, thus of no use. They do work efficiently with wood; leftover building material is used as firewood.

In Appendix 10, the paper with the topic the group wrote down is shown. They wrote down the following:

- Firewood is used daily
- Charcoal is for rich people and more destructive for environment
- Firewood collection takes 2,5 km walk → further than before
- Any species is collected. Accept some species that are toxic to cattle
- Collect from everywhere, not in spiritual places
- Yearly replanting of trees

After some further questions and a discussion the following information collected:

- Charcoal is expensive
- Collection of firewood and other products is dangerous
- One bundle a day sometimes two days → depends on family size
- Both men and women but most women // men sell it
- Size of bundle depends on how much you can carry
- Schools need much fuel wood
- Many families use stoves
- Collection of dead wood only (sometimes dead because of elephants)
- Charcoal is destructive! Large scale and for richer people

## 9.4 Rangers of UWA

On the 15<sup>th</sup> of March 2016 three rangers of the UWA were interviewed, two males and one woman. A summary of these interviews is given below.

### *Burning*

Burning inside the park is not allowed all interviewed Rangers agree to that, but it does happen. Martin says: "The neighbouring communities burn inside the park, because then the animals will come outside the park to graze and then they can trap them. It is difficult to catch them, but they are able at times, if they get caught we take them to court."

However, Geoffrey says: "First educate, sensitise them if that does not work than force them by punishment. Punishment can first be community service for a couple of days but after that, they go to court." Morene says: "There is not a fine defined by law, so mostly if we catch someone we give them community service."

To prevent burning from happening inside the park there are prevention measurements taken. Morene says: "By monitoring and having informants in the communities, we educate the communities and get informed on the situation inside the communities. We also make firebreaks with machines to prevent the fire from spreading throughout the park." Also, Martin says: "We have a prevention measurement called early burning, this means we burn small areas to prevent the animals from moving outside the park. Also, we have the community conservation department; they talk to the communities about the dangers and risks of their illegal activities and the change of been taken to court."

### *Collection of firewood inside park*

The interviewed Rangers all say that it is allowed to collect resources from inside the park, but only if they arrange it with UWA. A ranger will escort them to protect them and to tell them where to take the resource. However, this is rarely done. They all agree illegal cutting and gathering of wood takes place inside the park; they see the evidence. Again there is no fine, but if they get caught they first get a warning and after that, if they get caught again they are taken to court. Martin says: "We patrol the park to prevent this from happening." Also, to prevent this, Geoffrey says: "Educate and cooperate with the communities, so that the communities learn to live with the rules and dangers of the park."

### *Collection in corridor*

The Rangers agree that it is allowed to collect firewood from inside the corridor, but cutting is illegal by law. Punishment is the same as above. Martin says: "The corridor is 5 km next to the border and if someone wants to get something from inside the corridor he or she should contact UWA and a ranger will come along for safety. For instance, if women want to collect vegetables." Geoffrey says: "There is much evidence of illegal cutting inside the corridor." While Morene says: "I do not see much evidence of tree cutting here." The NP, border area, corridor and neighbouring towns are patrolled, but not regularly inside the corridor because that is far away from the main office. Patrolling happens by car and mostly by foot, but also aerial surveys are done with a plane.

### *Collection in corridor towards other parks*

Morene says she does not know about the corridor towards the other parks. The men say the rules and patrols are the same as for the border area corridor. Martin says: "We also monitor the movement of the animals, via foot and aerial survey. A plane from Kampala comes here for 3 or 4 days, locates animals and makes pictures. The population has increased; there are now so many animals in the corridor."

#### *Firewood use inside park*

Geoffrey and Morene say they use charcoal and buy it from the local communities. Martin says there are many outposts, and they use charcoal, firewood, and sometimes even gas and they buy it from the local communities.

#### *Assist in security for the villages around the NP and human-wildlife conflicts*

Both in and outside the park UWA handles the human-wildlife conflicts. Geoffrey says: "If there is a problem with for instance a buffalo near the village, we sent rangers they put down or drive the animals back to NP. Also, during and before the harvest time rangers are deployed in villages and at fields, to protect the fields and farmers." Morene says these Rangers are assisted by scouts who are trusted by the communities thus get the message across better. Martin says: "Scouts are hired, they live inside villages and help rangers to make sure communities are safe, and they keep the animals away. During harvest, they stay in the gardens to keep the animals away. Also if there is an animal, wounded or too close, they call, and UWA comes to take care of it, either by killing it or chasing it away." To keep the animals away, they have different measures, which are thought to the communities; the easiest being making noise with music. Another option is bees, animals especially elephants are afraid of bees. UWA buys beehives for communities but unfortunately they are expensive. Thus they cannot provide everyone. The same goes for chilli, elephants do not like it and stay away from the plant. UWA instructs the farmers how to use the chilli in the field and how to plant them; they provide the seeds and help with getting the chilli to the market."

#### *Tree planting:*

Martin says: "20% of UWA's income through tourism is to be invested into the communities bordering the park. That is why we have a tree planting project in Loyoro. We buy eucalyptus seedlings for community members; now they benefit from it." Geoffrey says they do not do any activities with tree planting, and Morene does not know.

## 11. Appendix – Karenga cultural group

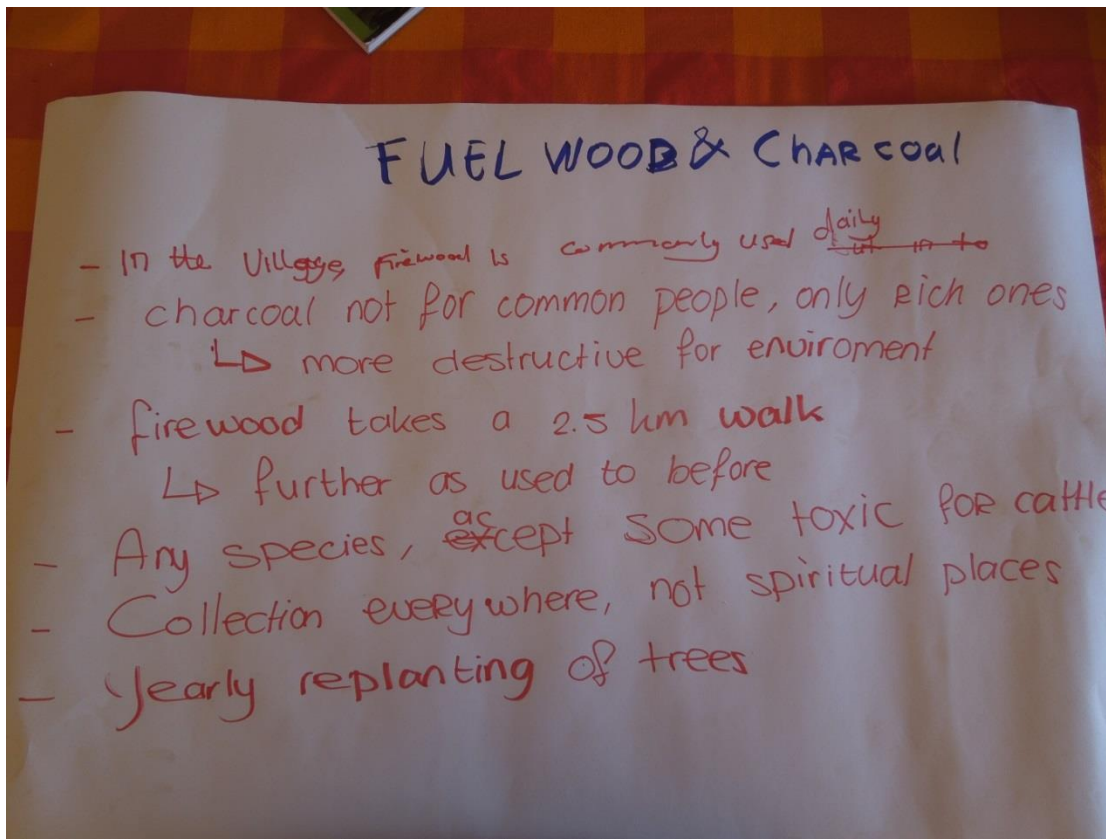
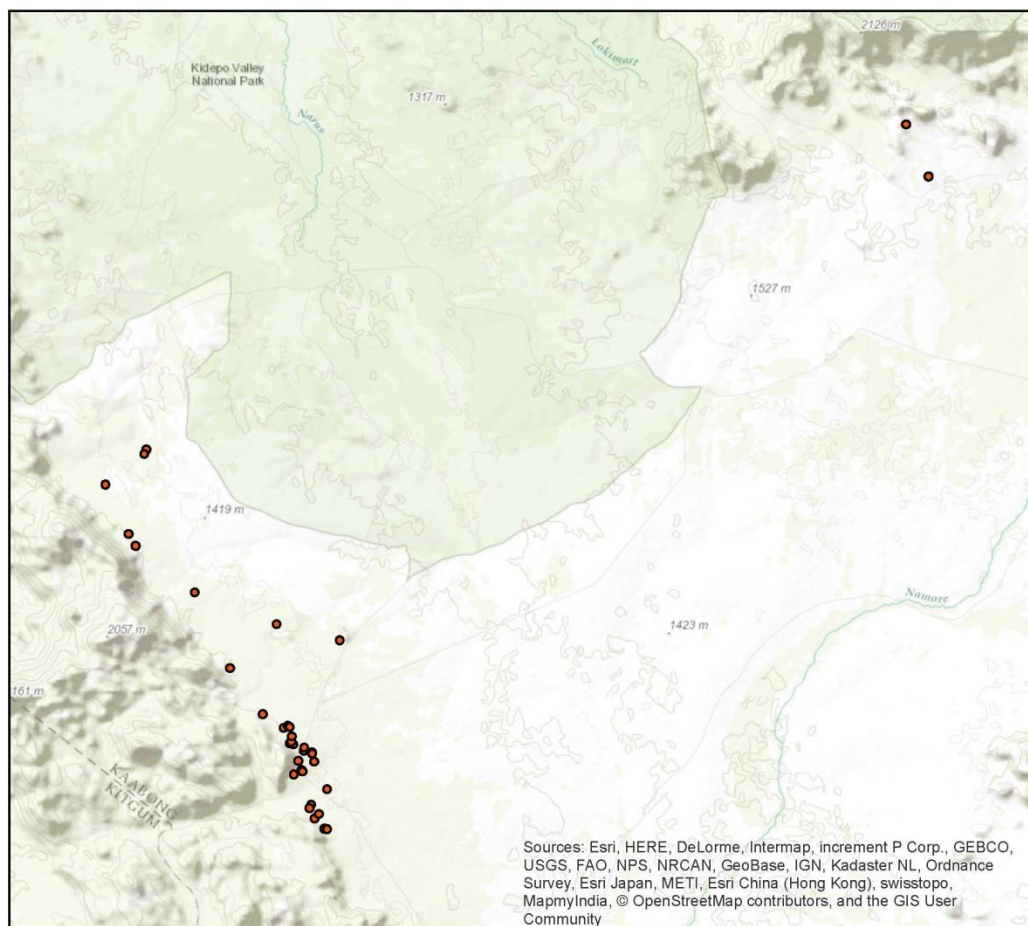


Figure 9, Focus group meeting discussion points



## 12. Appendix – Location household surveys

### Location interviews



#### Legend

- Loc\_Interv





### 13. Appendix – Classified map

## Classified map

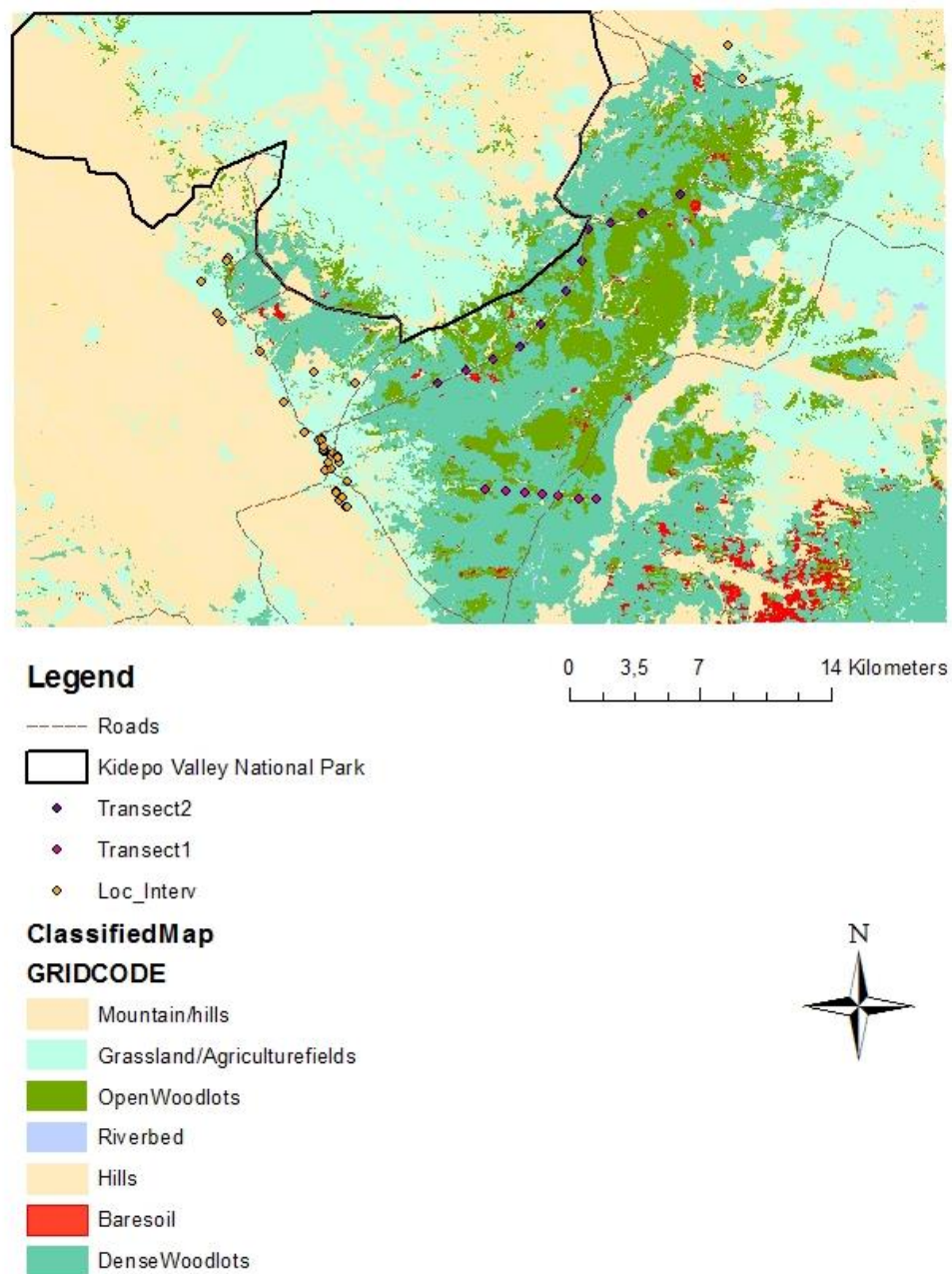


Figure 10, Classified map of the study area

## 14. Appendix – Results; Transects

Table 17, Transect 1

Transect point	Plot number	Direction	Canopy height(m)	Density (%)	Number of stumps	Number of trees	Total trees	Human disturbances
1	1	NNW	4	10	5	5		Logging, Also next to the road
	2	ZZO	5	10	7	4	9	Logging, Collecting leaves to eat
2	3	N	2	<5	0	1		-
	4	ZW	5	<5	1	5	6	Logging, Collecting leaves to eat
3	5	NNO	5	<5	0	3		Early burning
	6	ZW	3	<5	0	4	7	-
4	7	NNO	3	<5	0	2		Early burning
	8	Z	2	<5	0	3	5	Early burning
5	9	N	5	<5	0	3		Natural burning
	10	ZZW	5	<5	0	2	5	-
6	11	NNW	5	15	0	10		-
	12	ZZW	4	15	0	10	20	-
7	13	N	5	10	0	8		Collecting leaves to eat
	14	Z	4	<5	0	2	10	Early burning

## Classified map - Transect 1

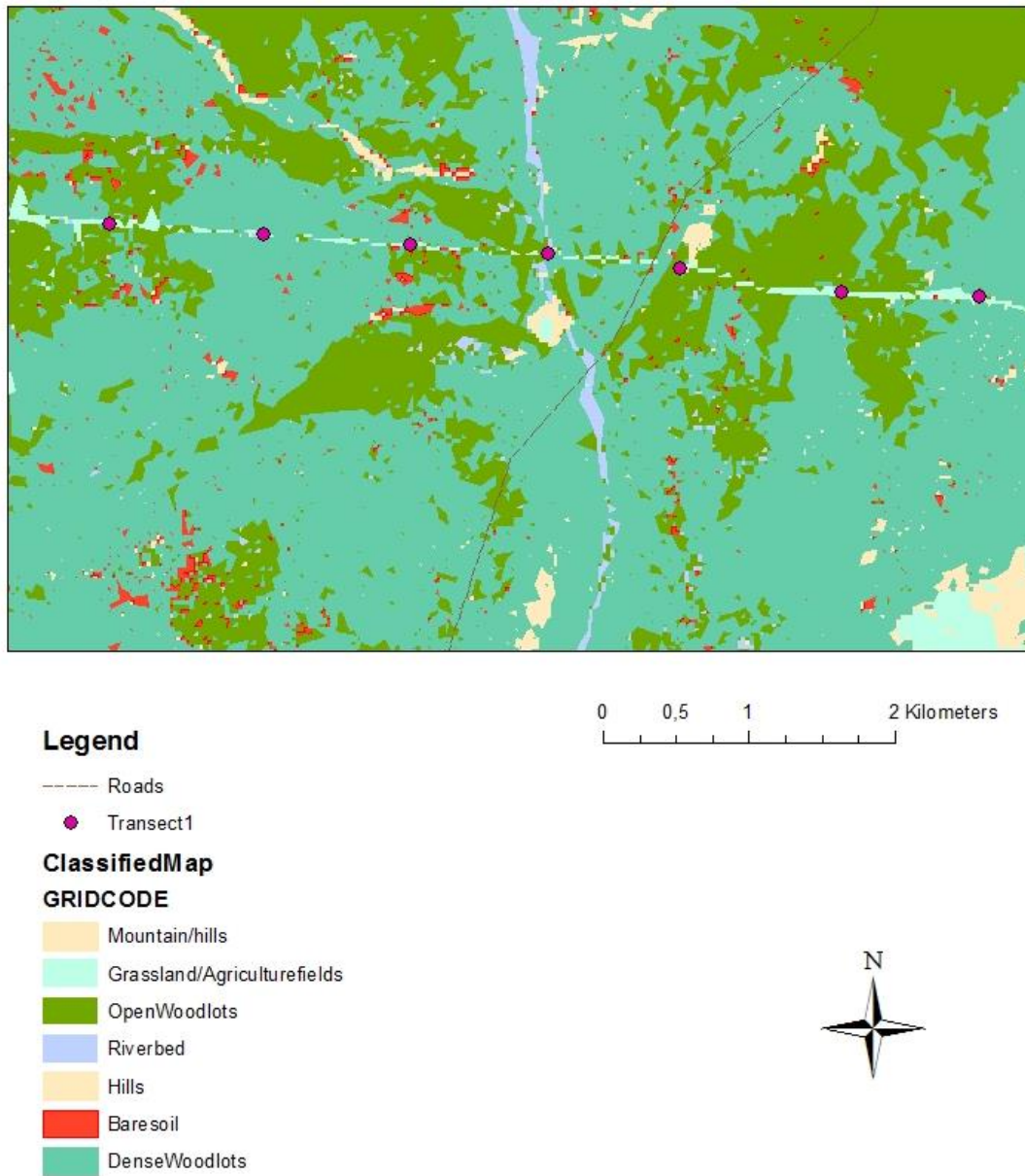
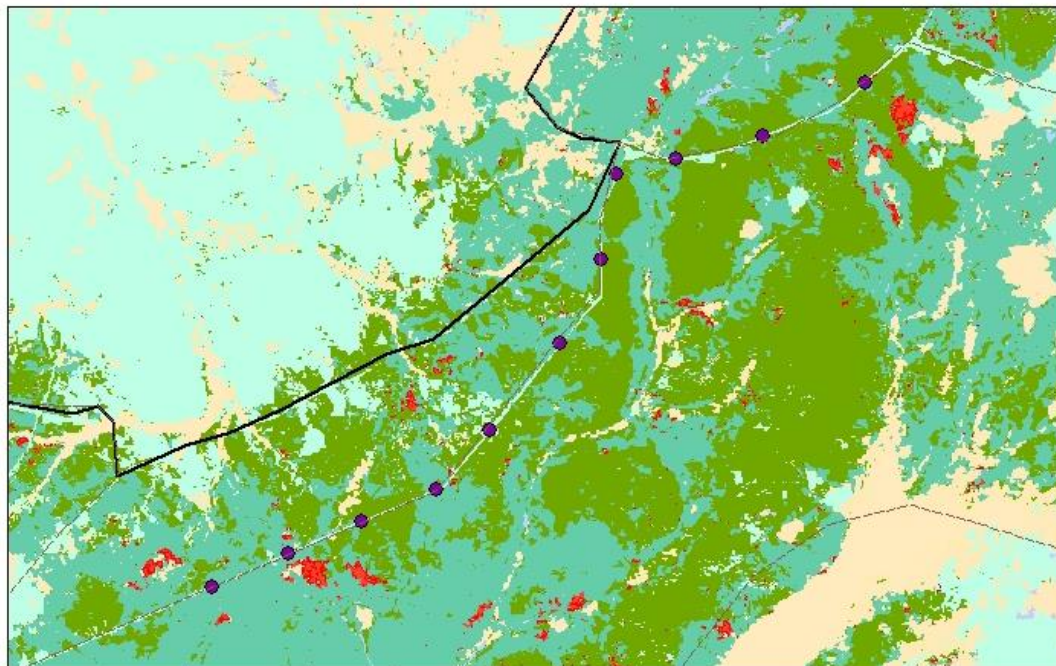


Figure 11, Transect 1

Table 18, Transect 2

Transect point	Plot number	Direction	Canopy height(m)	Density (%)	Number of stumps	Number of trees	Total trees	Human disturbances
1	35	ZZO	5	10	5	3		Early burning, Logging (many in area)
	36	NNW	3	<5	0	5	8	Late burning
2	33	ZZO	5	20	0	9		Late burning, Logging next to road
	34	NNW	6	20	0	10	19	Early burning, Logging next to road
3	31	Z	0	0	0	0		Late burning
	32	NNW	0	0	0	0	0	-
4	29	ZZO	1	0	0	1		Late burning
	30	NNW	3	<5	0	3	4	-
5	27	ZO	3	<5	0	8		Late burning
	28	NW	4	<5	0	6	14	Late burning
6	25	ZO	3	<5	0	9		Early burning
	26	NW	5	<5	0	9	18	Logging
7	23	E	4	30	0	13		Early burning
	24	W	5	25	0	9	22	Early burning
8	21	ZO	3	<5	0	2		Late burning
	22	NW	4	10	0	9	11	Late burning
9	19	Z	5	10	0	6		Late burning
	20	N	0.5	<5	0	1	7	-
10	17	ZZO	5	<5	0	4		Late burning
	18	NNW	4	<5	0	3	7	Early burning
11	15	NW	3	<5	0	5		Late burning
	16	ZO	4	10	0	8	13	Early burning

## Classified map - Transect 2



### Legend

- Roads
- ▬ Kidepo Valley National Park
- Transect2

### ClassifiedMap

#### GRIDCODE

- Mountain/hills
- Grassland/Agriculture fields
- OpenWoodlots
- Riverbed
- Hills
- Bare soil
- DenseWoodlots

0 1,5 3 6 Kilometers



Figure 12, Transect

