NATIONAL BIOMASS STUDY





Technical Report
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National Biomass Study

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Acronyms

AEZ	Agro-ecological Zone
CFR	Central Forest Reserve
Dbh	Diameter at breast height
DFS	District Forestry Service
DGPS	Differential Global Positioning System
DJM	Dual Joint Management
FAO	Food Agricultural Organization
FD	Forest Department
GDP	Gross Domestic Product
GIS	Geographical Information System
GoU	Government of Uganda
GPS	Global Positioning System
Ha	Hectare
HI	High
Km	Kilometres
LCCS	Land Cover Classification System
LFR	Local Forest Reserve
LO	Low
M	Meters
ME	Medium
MIC	Mapping and Inventory Centre
NBS	National Biomass Study
NFA	National Forestry Authority
NORAD	Norwegian Agency for Development Cooperation
PIP	Public Investment Plan
PPA	Priority Programme Areas
PVT	Private
REDD	Reduced Emissions form Deforestation and Forest Degradation
THF	Tropical High Forest
UBOS	Uganda Bureau of Statistics
UGX	Uganda Shillings
UWA	Uganda Wildlife Authority

Executive Summary

The National Biomass study project started in 1989 with a view of monitoring the dynamics of woody biomass in Uganda under the Forest Department. The major source of funding for the project was from NORAD. It was later inherited by NFA after an Act of Parliament that brought NFA into existence in 2004. As a continuous project, it entails processes that aim at supplying national land cover information and national woody biomass both of which include data collection in and outside the CFRs. Among the information provided to government and stakeholders are the trends in the forest resources and implications to other related sectors such as water, environment, agriculture, tourism, energy and construction.

This report takes great effort to discuss the procedures involved in data capture, processing, analysis and presentation of facts on land cover and biomass within and outside CFR. While a land cover map was an output in itself, it was also an input in computation of national woody biomass. The land cover map was a result of a series of activities such as purchase of relevant satellite images, image processing and interpretation, a series of field trips for ground truthing, final delineation and editing. Landsat imagery of late 2004 and early 2005 were used as remote sensing inputs for land cover mapping and stratification. All land cover types were delineated and given appropriate classes using LCCS from FAO. For most of the land cover types, the cartographic mapping scale was at 1:50,000. During analysis, the LCCS codes were translated to NBS class codes for consistence with the existing land cover map of Uganda produced in 1996. This also made change analysis possible

Biomass Monitoring is done by physical assessment of land cover and trees in a grid of sample plots that are distributed at predefined locations throughout the country. Data analysis and integration with land cover mapping yielded biomass per hectare for every land cover polygon.

Biomass distribution directly relates to the tree content in a land cover type. Land cover and biomass change was obtained by comparing the 1990 and 2005 land cover. In most of the country, biomass standing stock had reduced and on the land cover side, classes that contain high stocks of biomass had reduced in size. This is because biomass changes are huge when land cover is altered from or to a forest type because forests contain large amount of biomass per unit area. Well stocked tropical high forests have the highest biomass of up to 328,885 tons per hectare while grass lands have the lowest of 1,787 tons per ha. Districts that have Tropical high forests have the highest biomass stocks and these include Masindi, Bushenyi, Kyenjojo, Hoima, Kibaale, Mukono and Kasese. Masindi has the highest biomass stock amounting to 24.8 million tons while Kampala has the lowest with 0.3 million tons. Comparison using biomass density which is the amount of biomass per unit area of a district, showed that districts with less biomass stocks experienced highest biomass density reductions. They include Kaliro, Wakiso, Mayuge, Iganga, Luweero and others.

The 2005 land cover mapping, the second to cover the whole of Uganda after the 1990 one, revealed that forest cover was reducing fast. Many have been converted to either agriculture or deteriorated to shrub land which are low biomass land cover types. Mayuge district lost almost all its forest cover, Kibaale lost 46%, Hoima 22% and Mukono 36%.

There is a remarkable difference in the degree of deforestation inside protected areas as compared to forests on private land. Forest estate outside protected areas (PA) reduced from 3.46 million ha (70%) in 1990 to 2.3 million ha (64%) in 2005; a difference of about 1.2 million ha. Inside PAs, forests reduced from 1.47 million ha to 1.3 million ha, a difference of about 0.20 million ha.

The total (inside and outside PAs) deforestation rate per year is 1.8%. Inside protected areas the deforestation rate is 0.7% while outside protected areas; it is 2.27 % triple the rate in PAs. The figures translate to an absolute loss of about 88,638 ha per year, overall.

Mukono District has the largest acreage of commercial agriculture amounting to 20,000ha rising from 15,137ha in 1990. The highest increment in commercial agriculture was in Kasese where it rose from 4,253ha to 18,714ha. Rakai and Kalangala districts also had significant increments.

Built up area was largest in Kampala followed by Wakiso and Mukono. In 1990, the built up area in Kampala was almost three times that of Wakiso. By 2005 they were at par and by the time of writing this report, built up in Wakiso district could have been bigger than that of Kampala.

Population growth escalates demand for forest resources and it has thus proved to be the major driving factor in their depletion. Forest lands deteriorated into woodlands, but mostly into shrub lands; which became targets for cultivation. Consequently, where protection can be ensured like Mabira, the tree cover and hence biomass are recovering. Otherwise, politicians and decision makers should also formulate policies that encourage homesteads to plant and own woodlots to cater for their fuel demands accordingly reducing pressure on the diminishing resources. The findings presented in this report on both land cover and biomass can as well be used as inputs for the generation of other reports on carbon sequestration potential and its dynamics in Uganda.

1. INTRODUCTION

1.1 Background

Uganda is a land locked country in East Africa, bordered by Kenya to the East, Tanzania to the South, Rwanda to the South West, Democratic Republic of Congo, (DR-Congo) to the West and the Sudan in the North.

Out of the total area of 241,551 sq. km, about 37,000 sq. km of Uganda is open water (NBS, 2003). Generally the altitude is between 900m and 1500m, save for the Western rift valley and mountainous areas which are above and below the stated elevation range respectively.

The elevation and location of Uganda being astride the equator causes favourable rainfall and temperature for a diversity of fauna and flora and subsequently, human settlement and a variety of land use types.

1.1.1 Land cover change

Land use affects land cover but the distribution of the land use types is influenced by technology and prevailing socioeconomic and political conditions. Similarly, the impacts and adaptability to land cover also vary in space and time. In response to such change and impacts, the resilience of fragile and ecologically sensitive areas such as the hilly and mountainous areas, riverbanks, lake shores, arid and semi arid areas and wetlands is weaker.

Human interference in natural ecosystems can take different forms among which are, land use change due to agriculture, over exploitation of woody biomass and forest clearance for human settlement. The type of human interference, the area affected and the nature of resource extraction affect the severity of the effect to a natural ecosystem. For example forests can be negatively affected by human disturbance through direct clearance of trees leading to a reduction of the forest area (deforestation) or the forest area can be maintained while plant and animal diversity is substantially reduced leading to forest degradation. The resilience to different interference situations differs.

The major categories of ecosystem services include *supporting* such as soil formation, *Regulatory* such as wind breaking and control of soil erosion, *provisioning* such as poles, timber and fruits as well as *socio-cultural* such as the use of ecosystems as religious shrines. However, Deforestation and degradation affect ecosystem resiliency and subsequently the quality of goods and services accruing from the affected ecosystems.

In general different land cover types are associated with different biomass stocking levels. Therefore land cover mapping and biomass monitoring provide useful information for both socio-economic development and conservation. Conversely, the trends in the political and economic development trigger changes in land use and land cover.

1.1.2 The political and economic situation

Uganda was under British colonial rule from 1888 to 1962 when it attained independence. During 1960s, the country's economy was vibrant, but between 1970 and 1985, the economy almost collapsed due to military rule and wars. Since 1986, Uganda experienced rapid economic recovery average Gross Domestic Product (GDP) growth rates in excess of 6% per year (Table 1-1).

Table 1-1: GDP Growth Rates at Basic and Market Prices 2002/03-2008/09

Year	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
GDP at Market prices	6.6	6.8	6.3	10.8	8.4	9.0	7.0
GDP at basic prices	6.6	6.4	6.6	10.3	6.9	8.3	6.7
Forestry			6.5	4.1	2.0	2.8	3.3
Construction			14.9	23.2	13.2	10.8	2.2
Electricity Supply			2.1	-6.5	-4.0	5.4	4.2
Hotels and restaurants			6.5	8.7	11.3	10.7	7.9

Source: Adopted form Background to the Budget 2008/09 and 2009/10

Construction has been growing in excess of 10% sometimes shooting to 23.2% as the case in 2005/06 although in 2008/09 it plummeted to 2.2%. Hotels and restaurants grew and 11.3% and10.7% in 2006/07 and 2007/08 respectively. Electricity supply grew by -6.5% and -4.0% in 05/06 and 06/07 respectively but rose from negatives in subsequent years (GoU, 2009). These are factors that increase demand for wood resources in form of construction material furniture or energy production.

Additionally, the population growth rate in the past had been only 2.5% (Censuses 1969, 1980 and 1991) but it projected to increase from an estimated 3.3% per annum in 2007 to 3.5% per annum in 2011 and then start to decline back to 3.3% per annum in 2017. The population of Uganda is estimated to increase from 28.6 million in 2007 to 40.6 million in 2017 in the in the Low Variant, while in the High Variant it is estimated to increase from 30.2 million in 2007 to 43.4 million in 2017. Urban population has grown from 1.7million in 1991 to estimated 3.7million in 2007 (UBOS, 2007). Such population growth puts a lot of pressure on wood resources. Urban population in particular promotes harvesting of wood for fuel on commercial scale.

The trend of population and economic growth has implications to the demand for natural resources in general and biomass resources in particular. Therefore, there is a need for consistent monitoring of the natural resources which also form the basis for most of the economic activities in the country. Besides, studies have shown a relatively higher dependency on natural resources for poorer societies, which is a characteristic of the Uganda's population (Narain, 2006). Considering that different biomass stocking levels are associated with different land cover types; land cover mapping provides a strong evidence for trends in biomass. Trends in national biomass are an indicator of the availability of woody biomass energy, food security, exploitable biomass resources and the potential for economic growth as well as trends in livelihood strategies.

Growing urbanisation also increases demand for charcoal. If that demand grows faster than the ability of the forest resource to supply, then deforestation, degradation and subsequently poor resiliency of the woody resources may be eminent at the cost of the biophysical and socio economic goods and services they provide. Policy, institutional and legal framework has strong influence on the success of interventions.

1.1.3 The legal, policy and institutional framework

There are a number of enabling legislations such as the National Environment Statute (1995), the 2001 Forest Policy, National Forestry and Tree planting Act 2003, the Wildlife Statute (1996), Local Government Act (1997), Water Act (1999) and the Land Act (1998).

A project called The National Biomass Study (NBS) was started in 1989 to address the issue of providing data and information for better planning and use of biomass derived energy at national, regional and local levels. The study was initiated to address the extent of land cover distribution and a scenario based analysis for different land cover types.

The National Forestry Authority (NFA) was constituted in 2004 by an Act of Parliament replacing the Forestry Department. NFA also inherited the National Biomass Study Project along with its tasks of land cover mapping and biomass monitoring. The roles of the NBS project have since been assigned to the newly constituted Mapping and Inventory Centre (MIC) at NFA.

The vision of NFA is to have *a **sufficiently forested, ecologically stable and economically prosperous Uganda*** and the mission is to manage the Central Forest Reserves on a sustainable[1] basis and to supply high quality forestry-related products and services to Government, local communities and the private sector".
One of the objectives of NFA is to supply other goods and services. Some of the goods and services involve supplying national land cover information and the national woody biomass both of which include data collection outside the CFRs. Among the information provided to government and stakeholders are the trends in forest resources and implications to other related sectors such as water, environment, agriculture, tourism, energy and construction.

1.1.4 Forests and the economy

The three types of forests differentiated in National Biomass Technical Report (2003) are; Tropical High Forest (THF), woodlands, and plantations. Previously, THFs covered mountainous areas and most of the central region between Lake Victoria and Lake Albert. Savannah woodlands and bush lands were common in the drier parts of the country. Forest resources are spread wide in the country in and outside forest reserves. Forest Department records and individual studies were the main sources of data on the acreage, extent and the status of forests in Uganda. This information mostly covered central and local forest reserves. Therefore national land cover mapping exercise presented the opportunity for monitoring trends in forest resources not only in forest reserves but also outside, and subsequently support planning decisions in related areas.

Uganda's population is primarily agrarian, poor and rural based. The population characteristics highlight the importance of the forests and woodland resources to Uganda's economy in general and the populations' survival strategies in particular. The functions include direct provisioning ones like fruits, building poles, timber, and aesthetic beauty as well as indirect regulatory and supportive functions which bear on public expenditure. The supportive and regulatory functions enhance avoidance of natural hazards such as floods, soil erosion, mass wasting and strong winds. It is also clear that forests and woodlands can create public revenue as well as reduce public expenditure on natural hazards thus saving money for the country.

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1 Sustainable in the meaning of both social, economic and environmental

The supportive function to micro climatic influence favours agriculture which is the back-borne of Uganda's economy. It is partly for this reason that regions of Uganda that produce tea, coffee and bananas such as the Central and Western are associated with forested areas.

However the co-existence of forestry with agriculture is a challenge. That is partly because increased agricultural production often requires more land. The challenge is also due to the multiplier effects of high food production such as better food security leading to a higher population and more demand for land for settlement. This is one of the drivers for land cover change in general and deforestation in particular.

Previous statistics estimated the contribution of the forestry sector to the national economy to be 2% (GoU, 1996). Such low figure could be due to insufficient empirical data on forestry products and services (monetary and non-monetary). However studies conducted by the Forestry Department and Department of Energy revealed that the contribution of the Forest Sector to GDP was about 6% although Food and Agricultural Organisation (FAO, 1998) put it at 23%. The most recent figures in the background to the budget 2009/10 show that contribution of forestry rose from 2.8 to 3.3 percent

A political and cultural bias towards 'modern' forms of energy like electricity and petroleum make them appear important energy sources, but compared to charcoal and firewood, these forms of energy are less important for economic growth and well being. Biomass supplies energy to most of Ugandans population especially for cooking and provides thousands of jobs. The main challenge in the energy sector is therefore how to increase the biomass resource base as well as use the present resources more efficiently. Such a challenge cannot be tackled without data and information on the biomass resource base.

The linkage of above ground woody biomass to micro climatic regulation and subsequent favourable influence to agricultural activities, energy needs, provision of harvestable timber for taxable income, supply of construction material are among the many positive impacts of forests to the economy. Such impacts are affected by changes in the forest cover often caused by deforestation and degradation.

1.2.1. Deforestation

NBS (2003) gave a detailed assessment of deforestation by previous researchers like Hamilton (1982), Aluma (1987) and FAO in 1980. From the findings of the biomass exercise, it was revealed that deforestation was greater in local forest reserves than in central forest reserves by 43 % and 9 % respectively. Yet degradation or depletion was only 5% of the total 1.17 million Ha of Central Forest Reserves.

The reduction in the forest estate implies a reduction in the potential for the remaining resource to supply the anticipated biophysical and socio-economic goods and services to the ever growing national population. Therefore a deliberate effort to provide data and information regarding land cover and biomass changes in time and space is vital

1.2 The National Biomass study

The National Biomass Study Project started in 1989 in the Forest Department and was fully funded by The Norwegian Agency for Development Co-operation, NORAD. The project had several Phases i.e. Phase I (1989-1992), Phase II 1992-1996 and Phase III 1986-2000.

Phases I and II, were initially planned to take four years, but the scope of the project was expanded in Phase II and extended it to a total of 6.5 years that is until June

1996. Phase III followed thereafter and is goal was to promote economic, environmentally sound and sustainable management and development of natural resources in Uganda, while simultaneously providing knowledge, information, and datasets necessary to increase the resource base. The project was to provide knowledge, information, analyses, and scientific/political scenarios to all relevant users within and outside Uganda, and in particular to the Forest Department and other actors in the forestry sector. The tasks of the NBS Project are now executed by NFA with NORAD financial support.

2 MATERIALS AND METHODS

The materials and tools used in the production of the land cover map include satellite images, topographic maps, Global Positioning systems, Computers, and an assortment of office hardware and software. The main source of data and information on land cover mapping were satellite images and existing datasets inherited from NBS.

Mapping covered the whole country (full enumeration) therefore no sampling was done. Full enumeration is however impossible when it comes to biomass monitoring. In the case of biomass monitoring, there has been no major shift in the methodology and materials from how the exercise has been carried out since the late 1990s. Details of the methodology are given in the Biomass Technical report 2003. Biomass plots have been maintained and few new ones have been established. Data from the sample plots was analysed to drive biomass stock by sub-stratum. Details of how the land cover mapping and Biomass monitoring were undertaken are shown in sections 2.1 and 2.2 respectively

2.1 Land cover mapping

While a land cover map is an output in itself, it is also an input in computation of national biomass. The land cover map is a result of a series of activities such as purchase of relevant satellite images, image processing, image interpretation, a series of field trips for ground truthing, final delineation and editing among others, as detailed below.

2.1.1 Acquisition and preparation of satellite imagery

The major data source used for the mapping was digital Landsat TM imagery received on CD ROMs. Purchase of the Landsat imagery was initiated in 2004 and in December of that year the images were received. Owing to problems with the Landsat TM sensor the purchased images were sent back and later Landsat sent a set of gap filled images. The procurement process ended in the second quarter of 2005 and land cover mapping activities promptly began.

2.1.2 The mapping process

Mapping started with Landsat scene (path)172/(row)059 which covers the areas of Masindi, Nakasongola and Kiboga. It was followed by scene 171/059 which covers the L. Kyoga region. This was followed by scenes that fall south and west of the above and stretch from Mayuge to Bundibugyo and down to Kisoro districts basically covering central south and western Uganda. In mid 2007, areas worked on stretched from Busia to Kaabong. Image interpretation and ground truthing for these areas was completed.

The last and remaining part was Northern Uganda and West Nile. Interpretation for these areas was done and ground truthing was done in December of 2007. In the first quarter of 2008, final interpretation was done for this area. Edge-matching was also done so as to join it to the rest of the country.

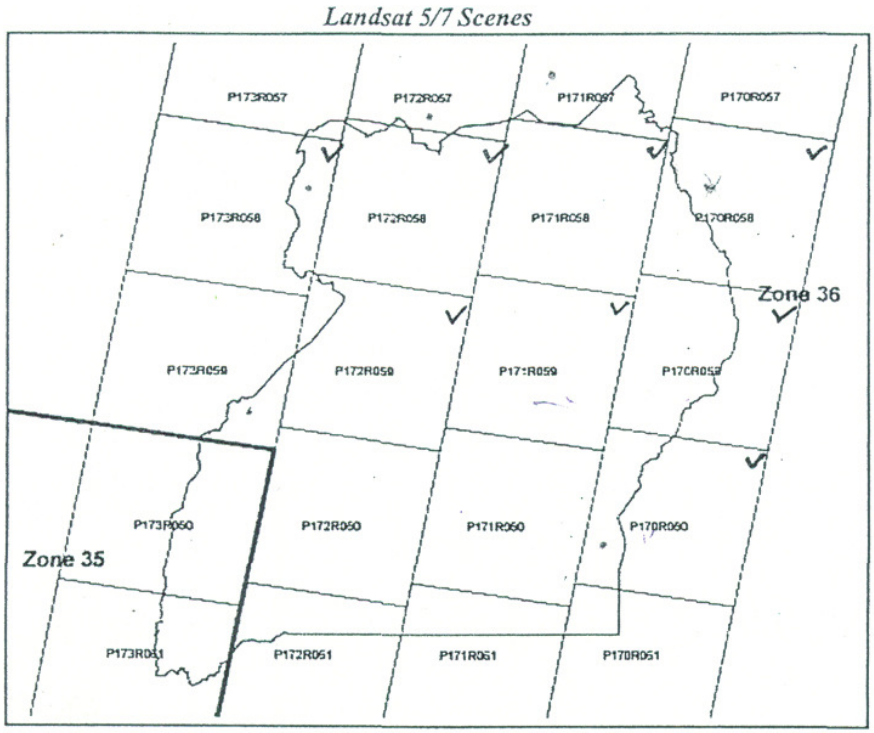


Figure 2-1 Landsat TM scenes for Uganda

2.1.3 Preliminary image interpretation

Landsat imagery was used for land cover mapping and stratification. Image interpretation was done using an application called GeoVIS and a classification system called Land Cover Classification System (LCCS) which is being used by FAO AFRICOVER. This is a detailed classification system that has been used in other African countries and neighbours to the project area such as Tanzania, Kenya, Sudan and Rwanda.

Landsat satellite images were pan-sharpened (enhanced) using the panchromatic band 8 to attain imagery of a spatial resolution of about 14 meters per pixel. Such resolution is ideal for detailed mapping especially while mapping small important features such as urban centres or water bodies. Later image pan-sharpening was abandoned due to the enormous file sizes that were difficult to handle in the computers available then.

The GeoVIS application used for interpretation was not capable of handling full scene images. Therefore a Landsat scene had to be split into four quarters. A Landsat image was then loaded into GeoVIS and enhanced for ideal contrast to enable better visibility. An LCCS legend was also loaded for use in coding the interpreted map. The legend used was the one developed with FAO in Nairobi 2002. All land cover types were delineated and given appropriate classes.

Digital images were used and therefore on-screen digitizing method was possible. For most of the land cover types, the cartographic mapping scale is at 1:50,000. This scale is however overridden to 1:30,000 in some cases. The scale of 1:30,000 gives enough detail for small important features like towns and water bodies that are important for this exercise. This means that small urban areas and water bodies were mapped whereas they would have been left out at 1:50,000 scale. This scale is for the purpose of producing precise and clean polygon boundaries but the final map production is at a scale of 1:50,000. The minimum mappable units were in accordance with the LCCS cartographic principles.

According to LCCS, the following major land cover classes are used. Under these classes, specific land cover classes are derived based on satellite image signatures.

1 A11 = Cultivated and Managed Terrestrial Areas

2 A12 = Natural and Semi-Natural Areas

3 A23 = Cultivated Aquatic or Regularly Flooded Areas

4 A24 = Natural and Semi- Natural Aquatic

5 B15 = Artificial Surfaces and Associated Areas

6 B16 = Bare Areas

7 B27 = Artificial Water Bodies Snow and Ice

8 B28 = Natural Water Bodies Snow and Ice

Areas of similar signature were delineated and given one class. Many of the classes occur mixed with others and difficult to delineate or are under the minimum mappable area. This is a function of land management practices and ownership. After interpretation, delineation and labelling were done, the land cover map was ready for edge matching. At this stage, the data was exported from GeoVIS as a shapefile which is ready to be used in ArcView or any other application that can handle shapefiles.

2.1.4 Edge matching

After interpretation, maps from adjacent quarter scenes were joined to make a seamless map covering the whole scene. Before joining them however, care was taken to make sure adjacent polygons had the same classification codes. Edge matching is the process of comparing polygons and their codes at the edge of adjacent maps for similarity ant joining the maps. Edge matching is also done between scenes

2.1.5 Ground Truthing

Ground truthing was carried out as a standard procedure in land cover mapping. Field checks were done to assess the accuracy of image interpretation. Emphasis was put on checking cover types whose signatures were ambiguous and areas of high human activity. During interpretation, sample sites were selected in such signatures for further verification during field visits. Coordinates of the sample sites were loaded into a GPS as waypoints for navigating to them.

Field maps were printed at a scale of 1:100,000 on A0 paper to be used during ground truthing. The maps showed sample sites, roads, interpreted polygons with their class labels and the enhanced interpreted satellite image in the background.

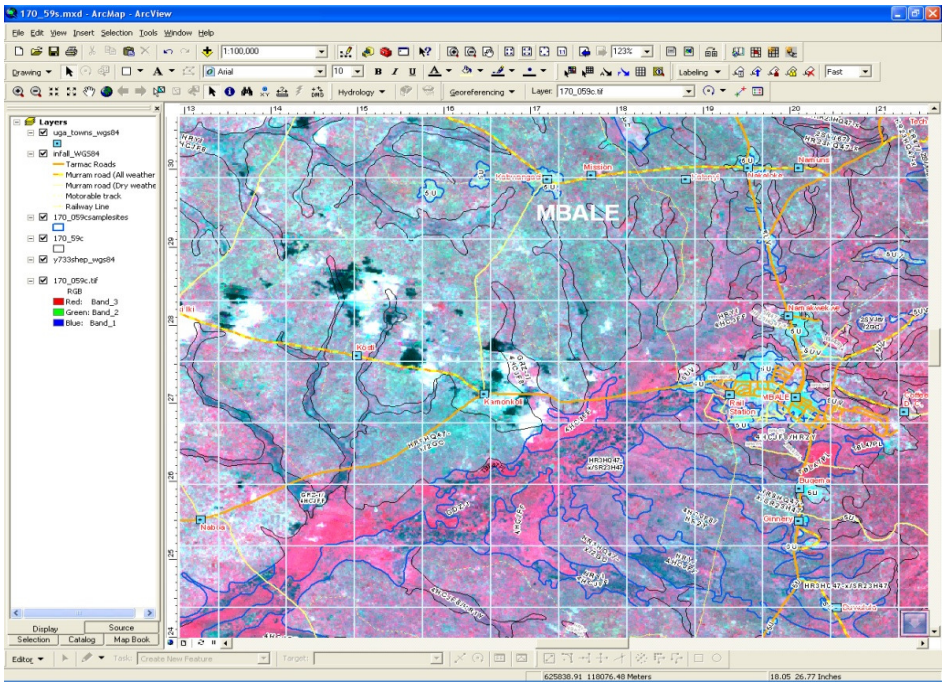


Figure 2-2 A field map for ground truthing

The ground truthing team travelled to the selected sample site and within this site selected a point that best represented the cover and signature. For each sample site, descriptive information was recorded on a pre-designed form. Using a Needle compass, and sometimes a GPS, cardinal directions of north, east, south and west were determined. Coordinates of the location were saved into a GPS and also recorded on a sheet of paper in large font. Labels ‘N’ for north, ‘E’ for east, ‘S’ for south and ‘W’ for west were also written. One person stood on the recorded location while holding the sheet of coordinates and label ‘N’ and faced south. Another person holding a camera stood facing north and took a picture to capture coordinates of the location, label indicating compass direction and the land cover in the background. The label was changed to ‘E’ and the person holding it with coordinate sheet faced west and the camera person faced east. The picture showing the eastern perspective was also taken. The process was repeated for south and west perspectives. Figure 2-3 is an illustration of a photograph taken at a sample point. A total of four pictures were taken at each point, namely one to the East and the others to the West, South and North respectively.

Figure 2-3 Southern perspective

Information collected this way from the field was used as ground truth data for final image interpretation in the Lab. Signatures that could have formally been misinterpreted were corrected. The pictures were also archived for future reference.

2.1.6 Final Interpretation

Ground truthing may reveal many things such as misinterpreted signatures or changes in wetland cover that are newer than the satellite image. There may also be need to combine classes that look much similar in the field or split classes that look different in the field. Other signatures are unexpected economic development activities such as the large continuous cotton fields of Kasese. Such modifications were incorporated into the interpreted map where applicable before a final map was produced.

2.1.7 Legend translation

There is an existing land cover map of Uganda published in 1996. It was produced using the National Biomass Classification which has 13 classes and a number of classifiers which indicate soil water seasonality, woody biomass stock, bush type and bush percentage. A lot of land cover statistics were produced using this data set.

The current land cover mapping was produced using the FAO LCCS classification. Without a translation, it would be very difficult to compare this land cover map with the previous one. Already, the 1990 map is used as reference and as a standard classification for Uganda by many users. Comparison of both datasets is necessary to establish land cover trends over the years since the first map was produced, as well as checking for errors in the new map. For example, a polygon which was previously grassland being coded as a high forest would be questionable and need checking.

These two classifications have many similarities. Both classifications indicated absence or presence of crops, trees, bush, soil moisture and intensity of the major

cover. There are also differences such as mixed classes which make direct comparison of the two data sets difficult. It was therefore found necessary to create a translation that would make comparison of the two data sets possible.

Table 2-1shows the NBS classification and corresponding LCCS classes that have been grouped together.

Water seasonality

In the NBS classification, soil moisture is denoted by letters “n”, “s” or “p” depending on quantity and period of inundation. In LCCS, any class with a prefix digit 4 is either seasonally or permanently wet. A suffix F denotes seasonally wet while suffix “FF” denotes permanently wet. Seasonally wet areas are those that are inundated for at least two months but less than four while permanently wet areas are inundated for four or more months of the year.

Table 2-1Generalised NBS-LCCS classification translation

NBS Class	NBS Code	LCCS Classes
1	Broad leaved plantations	Broad leaved trees
2	Coniferous plantation	Needle leaved trees
3	Tropical High Forest well stocked	Closed multi-storied high trees
4	Tropical high forest low stock	Open high trees
5	Woodland	Closed trees, Open trees, generally open trees, very open trees, woody areas
6	Bush	Closed, Open or very open shrubs
7	Grassland	Graminoids and herbaceous areas
8	Wetland	Permanently wet Graminoids and herbaceous areas
9	Small scale farmland	Shrub and herbaceous crops on small fields
10	Commercial farmland	Shrub or herbaceous crops on Medium or large size fields
11	Built up area	Artificial surfaces- urban, airport, refugee camp
12	Open Water	Standing and flowing water and water dams
13	Impediments	Bare soil and bare rocks, quarry, snow

Table 2-2 Soil Water Seasonality NBS-LCCS translation

Soil water seasonality	NBS Code	LCCS Code
Seasonally wet	S	F
Permanently wet	P	FF

2.1.8 Description of Land Cover Classes

This section contains descriptions of the different land cover classes used.

Figure 2-4 Class 1- Deciduous Plantations or Woodlots (TBR47PL)

Plantations (Classes 1 and 2) - These are forests of planted trees and they fall in two main classes. Class 1 consists of broad-leaved trees mainly *Eucalyptus spp.,* (Figure 2-4), *Maesopsis eminii, Acacia mearnsii* (Black Wattle) and some *Markhamia lutea.* Class 2 (Figure 2-5) include the *Conifers*; *Pine spp.* and *Cypress spp.* In many cases, class one comprising of *Eucalyptus* is planted in small woodlots below the minimum mappable area and therefore they were therefore not mapped as individual polygons. Their presence was mostly recognized by including it as a second class. Such phenomenon is common in Bushenyi, Kabarole, Masaka and Rakai.

Figure 2-5 Class 2 - Coniferous plantation (TNEL47PL-pi,cu)

Figure 2-6 Class 3 Tropical High Forest (2TCI177)

Figure 2-7 Tropical High Forest Low Stocked (2TOl178)

Tropical High Forest (THF) (Classes 3 and 4) - These are natural forests rich in species biodiversity i.e. flora and fauna. THF are grouped into Class 3 (Figure 2-6) i.e. normally stocked forest , for example Mabira Forest along Kampala-Jinja

Highway, and, Class 4 (Figure 2-7) i.e. depleted or encroached with reduced species richness and composition dominated by secondary growth of bush and shrubs, in particular *Solanum gigantea*.

Class 4 occurrence is not widespread when using LCCS classification. Whereas the NBS classification implies that this is a degraded forest, LCCS states what is actually on the ground as land cover and eliminates sentiments of management that this was a forest. A degraded forest in NBS classification can therefore be mapped as open trees, very open trees, shrub land or even crops depending on the level of degradation.

Figure 2-8 Woodland (2TO8)

Woodlands (Class 5) - Wooded areas (Figure 2-8) where trees and shrubs are predominant. There are wet and dry types. The wet type occurs as a zone along wetlands (riverine forest) and the dry type is found on grass-covered upland areas. To qualify as woodland the average height of the trees must exceed 4 m. In LCCS woodlands are classified as closed trees, open trees or very open trees whereas in NBS classification they are classified by stock levels of “high”, “medium” or “low”.

Bush lands (Class 6) - refers to vegetation dominated by bush, scrub and thicket growing together (see Figure 2-9) as an entity, but not exceeding an average height of 4 meters. Bush; called shrubs in LCCS is also graded as closed, open or very open. Shrubs can occur naturally as a climax on its own but in many cases occur as a result of forest or woodland degradation.

Figure 2-9 Bush (2SVJ6)

Grasslands (Class 7) – These are rangelands, grazing grounds, improved pastures or natural savannah grassland. Various trees - bush/woody vegetation frequently occur on this land, but grass dominates the landscape (Figure 2-10).

Grasslands normally have some trees, but many areas cleared for pasture were devoid of trees and therefore had little woody biomass.

Figure 2-10 Grassland (2GC)

Figure 2-11 Wetland (4GCFF7)

Wetlands (Class 8) - comprises of permanent wetland; usually with papyrus and reeds or seasonally flooded areas. Both types can be identified by presence or absence of certain species

Wetlands are found along lakeshores and in valleys with impeded drainage. Various vegetation types may occur although grass tends to be the most frequent and dominant species (Figure 2-11). Common trees include *Acacia siberiana* and palms such as *Phoenix reclinata.*

Figure 2-12 Subsistence farmland (HR3HQ47-x)

Farmland Area (Class 9) - Farmland areas including small holder subsistence farm (Figure 2-12) units cover 50-90% of the land cover of Uganda. Scattered trees are frequently found in the vicinity of the homesteads. Examples include fruit trees and various multipurpose trees integrated in the farming system (agro forestry), The cropping systems include mono-and mixed cropping. In densely populated areas like in the west and east, agricultural fields are continuous. In sparsely populated areas, fields are scattered clustered or scattered isolated. In all cases, the area is still referred to as agricultural land despite the intensity.

Large scale or Commercial farmlands (Class 10) – These are large fields of farmland usually under one crop type. In Uganda these are traditionally Sugar and tea estates (Figure 2-13), but in Masindi, Kabarole and Kasese districts, maize and cotton were found grown on large scale.

Figure 2-13 Large scale farmland of shrub crop in Kabarole (SD47)

Figure 2-14 Large scale farmland of herbaceous crop in Masindi (HD4)

Figure 2-15 Internally Displaces People's Camp in Pader P(5UC)

Figure 2-16 Built up area in Entebbe (5U)

Built up area (Class 11) – these are artificial surfaces (Figure 2-15 and Figure 2-16) including built up urban areas, airports, village trading centres, internally displaced peoples camps, schools, and recreational grounds.

Figure 2-17 Bare Soil in Nakasongola (6S)

Figure 2-18 Bare rock (6R)

Impediments (Class 13) - These include bare rocks, bare soil, quarries and usually have little or no biomass.

2.1.9 Quality Control

After completing the general process of interpretation coding and edge-matching, focus was turned on error checks as a method of quality control. The 1990 land cover map was used as baseline to spot where major land cover changes had taken place.

The issues looked at included:

- Checking for polygons without codes and giving them appropriate class codes

- Highly unlikely changes; such as grassland turning into a high forest, occurrence of new and extensive urban areas, new water polygons, wetlands on dry land, etc
- Wrong LCCS codes; such as scattered clustered or scattered isolated codes written as the first code in a mixed unit, terrestrial and aquatic codes in one mixed unit, etc
- Minimize occurrence of very similar codes in one mixed unit such as open general woody and open trees.

2.1.10 Analysis

In LCCS, many polygons have mixed classes. During analysis, the dominant class code was taken to represent the polygon. The mixed units were used to determine the biomass stocking of the polygon as shown in Table 2-4. The exception here was agriculture. The cross cutting criteria here was that wherever agriculture appears, that polygon would be classified as agriculture irrespective of whether agriculture is the dominant cover or scattered. Other classes mixed with agriculture served to determine biomass stocking level of the farmland.

2.2 Biomass Monitoring

Biomass monitoring is an inventory that deals with periodically determining the status woody biomass stocks all over the country both within and outside protected areas. It is done by physical assessment of land cover and trees in a grid of sample plots, data analysis and integration with land cover mapping.

2.2.1 Methodology

The methodology used in biomass monitoring is given in detail in the Biomass Technical report, 2003. A systematic sampling method was used to assess biomass in different parts of the country. It is a methodology that has been developed and fine-tuned in house.

The country is overlaid with a grid of 5km by 10km. At every intersection of the grid there is a cluster of three plots; one at the intersection, one 300m north and one 300m south. There may exist a sound reason that may hinder measurement of any of the three plots. Alternative plots are provided at 300m and 600m west or east of the intersection

Sampling intensity is based on population density and ecological zones. High population has high impact on biomass and land cover. Areas with high populations are given more sampling plots than low population areas. A Review mission (1994) recommended that Uganda be stratified into 3 priority zones as follows.

Priority Zone I - High population density (over 100 persons per square km covering approximately 64,013 km^2), i.e. Kampala, Jinja, Kisoro, Mbale, Kabale, Tororo, Pallisa, Mpigi, Iganga, Mukono, Masaka, Bushenyi, Rukungiri, Kamuli, Kasese, Nebbi, Rakai, Kumi, Mbarara and Kapchorwa districts.

Priority Zone II - Medium population density (50 – 100 persons per square km covering approximately 56,375 km^2), i.e. Kabarole, Arua, Lira, Mubende, Apac, Hoima, Bundibugyo and Soroti districts.

Priority Zone III - Low population density (Less than 50 persons per square Km covering approximately 76,708 km^2), i.e. Kibaale, Kiboga, Moyo, Kalangala, Masindi, Gulu, Kitgum, Kotido and Moroto districts.

Since greater biomass changes are expected in priority Zone I, than in priority zone II and priority III, a sampling intensity at a ratio of 3:2:1 was adopted. This means that three intersections (9 plots) were measured in Zone I, two intersections (6 plots) in Zone II, and one intersection (3 plots) in Zone III. In all, 1,500 grid intersections (4,500 plots) were required for priority zone I, 1000 intersections (3,000 plots) for Zone 2 and 500 intersections (1,500 plots) for zone 3. See (Fig 2-19). Theoretically totalling to 9,000 sample plots. Population size and distribution has since changed a lot and this may call for modification of the priority zoning.

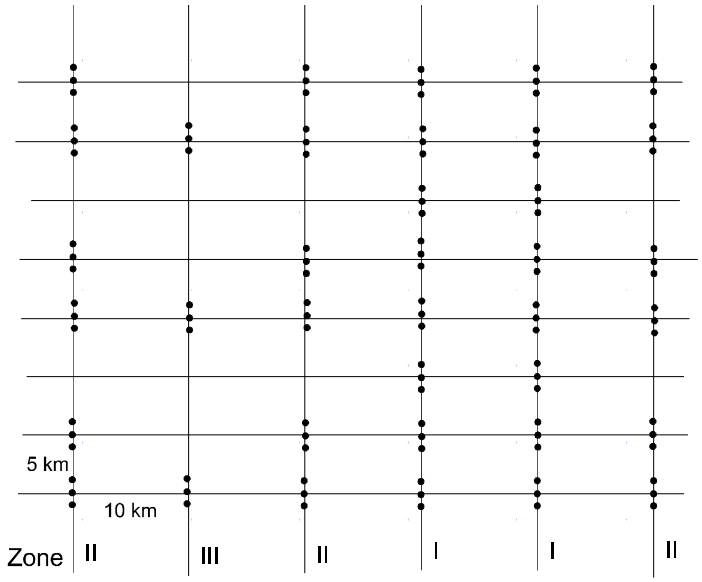


Figure 2-19 Biomass plot Sampling Design

Biomass growth is affected by soil types and climatic conditions. In determining biomass stocks and growth agro-ecological zones are used. Four main zones have been curved out of the 11 common ones.

Agro ecological zone 1, i.e. High altitude areas covering south western corner of Uganda (Kigezi/Kabale) and Mt. Rwenzori in Kabarole district; Mt. Elgon (Mbale, Kapchorwa in the east, and a small part of Nebbi and Arua districts. These areas produce temperate zone like crops e.g. wheat, Irish potatoes, and Arabica coffee.

Agro ecological zone 2, i.e. Pastoral dry to Semi Arid rangeland areas covering: Mbarara and Western Masaka in the south west and Moroto and Kotido in the north east. The dominant agricultural system is pastoralism.

Agro ecological zone 3, Semi-moist lowland Savannah areas covering Northern and Eastern Uganda districts e.g. Arua, Adjumani, Moyo, Nebbi, Yumbe, Gulu, Kitgum and Lira characterised by short grass and growing of cotton, millet and sorghum.

Agro ecological zone 4, i.e. Moist lowland and medium altitude areas covering most of Southern and Western Uganda in the Districts of Mpigi, Masaka, Kabarole, Hoima, Kabale, Kisoro, Nebbi and Mbale.

This agro ecological zoning is particularly important not only in ensuring that sample plots or the sampling intensity cover all ecological systems but also improves the precision of estimating the biomass stock.

Plots,

Biomass monitoring plots measure 50m by 50m in all areas except in forest plantation. These plot sizes were arrived at through research during the development of the biomass monitoring program (Knut, 1997; Forest Department 1994 and 1995).

Plots are located on the ground using differential GPSs. Coordinates of all plots are known. The coordinate of the plot marks its south-western corner. Demarcation of the plot and tree measurement start from this corner. A plot is subdivided into five 10-meter wide strips running in the east-west direction and tree measurement is done systematically from one strip to another. Even tree numbering is based on the location of the tree in the strip. This is intended to make tree re-identification easier during subsequent visits. Figure 2-20 show strips in a 50x50 m plot. The arrows show the direction taken while measuring trees from strip to strip

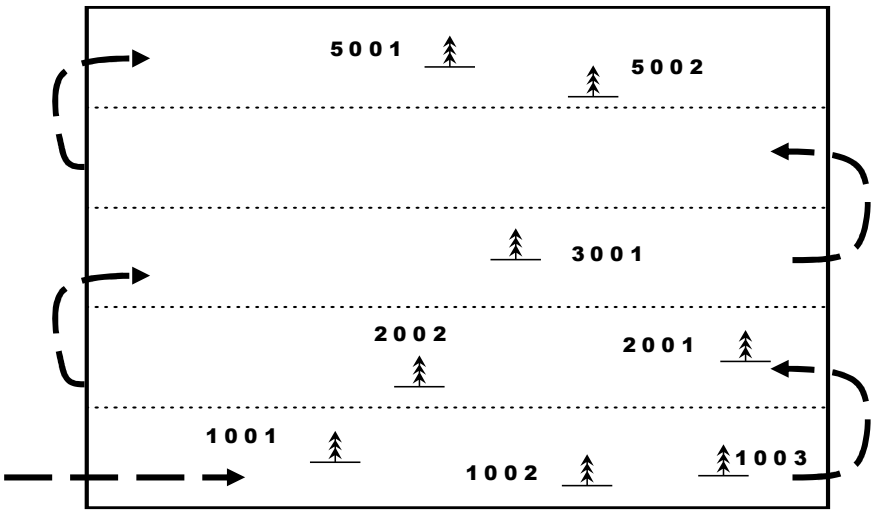


Figure 2-20 Plot design

Tree measurement

Tree measurement was done by field teams and each team composed of a team leader, assistant team leader and a casual labourer. Casual labourers could be two or more depending on the difficulty in accessing the plot, and the trees within the plot. A field team carried

1. A GPS for locating the position and recording the coordinates of the plot
2. a compass for determining orientation of the plot
3. Distance tape (30m or 50m) for demarcating the plot
4. Diameter tape for measuring the girth of big trees
5. Callipers for measuring dbh
6. Ranging poles for marking the limits of the plot during measurement

In the plot, all trees equal or more than 3cm in diameter are measured at breast height level which is traditionally 1.3m above the ground. Parameters recorded for every tree were:

1. Dbh- diameter at breast height corrected to the nearest centimetre
2. Bole – height from the ground to the first major branching
3. Height – total height of the tree
4. Crown – width of the crown of the tree as distended on the ground
5. Species- the species of the tree is identified and recorded.

Stems growing on the same stump but forking below 1.3cm were measured as separate trees.

There were other factors to note if the visit to the plot was the second or more. On a revisit, there could be any of the following scenarios:

1. Recruits- trees which were below 3cm during the first visit and had attained 3 dbh or more centimetres on the next visit
2. A tree no longer existed. It was either cut or died a natural death.
3. Broken top- part of the crown of the tree had been removed. This could again be by man or by force of nature such as wind.
4. Plot class (land cover type) had completely changed
5. Access to the plot was denied

Cover assessment

When all the trees had been measured, cover of the plot was assessed. Each land cover type or crop in the plot was given a percentage of the area it covers. Care was taken not to award more that 100%. Percentages are given to the nearest 5%.

These parameters were recorded on a predesigned field form. The filled forms were checked by a field coordinator before they were entered into a computer. Data were entered into a dbase data entry program but work is going on to shift data entry to a relational SQL database.

Data Management

Data entry was done when field teams returned to office therefore data entry clerks also were hired as and when field forms were available.

Field data were in two parts and were also entered into two separate files that could be linked. Plot data described the plot. This included plot number location, class, land cover types, coordinates of the plot, name of team leader, access to the plot etc. These were stored in a plot file. Tree data included plot number, tree number and the tree parameters. These were stored in a tree file. The two files could be linked by plot number.

Plot number is unique and can be used for linking but this is only possible for first visits only. After a revisit the plot number is repeated and it ceases to be unique in the database. To have unique records in relational database the following fields were used as primary keys:

1. Plot number
2. Date- when the plot was visited
3. Tree number

Again dbase and treecal program in particular, was used to do volume calculations. Tree volume was computed using one of 3 models depending on the diameter class the tree falls. The models were for

3 to 20cm

21 to 50cm and

More than 50cm

Volume was converted to weight and trees of the same plot were summed up to give total weight of the plot. A 50 by 50m plot is 2,500 square meters which is a quarter of a hectare. To extrapolate plot data to a hectare, plot weight was multiplied by 4. After this, analysis could be done to extract various information such as average biomass stock per class, sub-strata, region etc.

2.2.2 Challenges dealt with in biomass monitoring

DGPS

1. The DGPSs used were OMNIstar and they got their differential signal from a satellite. To get the signal, each DGPS needed an annual licence that cost USD 2000. The signal was uploaded in South Africa after payment. Uploading was cumbersome and involved many minutes of talking on phone
2. Dbase that was used for data entry and calculation was becoming obsolete and known by limited number of staff
3. Filing system: as visits to each plot increased naming of the files became inadequate, files were not stored in the same place and there was also duplication
4. Numbering of trees in view of recruits and removals in a plot disrupted the continuous numbering system on the form and made locating trees in the same plot difficult during subsequent visits

Mean stocks per stratum

Biomass Stock was categorised in three major classes namely Low (LO), Medium (ME) and High (HI). Each land cover class had its own thresholds biomass stocking in terms of tons per hectare. That is, 6LO (bush-low stock) was not the same as 7LO (grassland low stock)

Previous studies (Forest Department, 2003) showed that even within the same substratum such as 9LO, there are variations across the 4 different agro-ecological zones. Attempts were made to push analysis down to variations at this level. able 2-3 shows biomass variations at substratum and agro-ecological zone level. These figures were used to calculate biomass stocking at district and regional levels. Mean stock per class per AE Zone was arrived at by averaging plot weight. As it turned out not all units of disaggregation were covered by enough plots to give statistically valid means.

T**able 2-3 Mean Biomass Stock by stratum**

AE-ZONE	CLASS	STOCK	MEAN
1	1	AV	96,846.1
1	3	HI	328,885.71
1	3	ME	328,885.71
1	5	LO	17,604.99
1	5	ME	33,066.12
1	5	HI	73,364.28
1	6	LO	9,447.61
1	6	ME	14,504.15
1	6	HI	30,431.55
1	7	LO	2,588.23
1	7	ME	8,925.89
1	9	LO	3,996.49
1	9	ME	10,027.27
1	9	HI	29,787.18
2	1	AV	96,846.10
2	3	HI	328,885.71
2	4	HI	155,374.12
2	5	LO	17,181.86
2	5	ME	37,766.13
2	5	HI	57,532.21
2	6	LO	6,368.47
2	6	ME	14,707.13
2	6	HI	30,431.55
2	7	LO	2,588.23
2	7	ME	8,925.89
2	7	HI	15,297.64
2	9	LO	3,996.49
2	9	ME	10,027.27
2	9	HI	29,787.18
3	1	AV	96,846.10
3	3	HI	328,885.71
3	4	HI	155,374.12
3	5	LO	17,181.86
3	5	ME	37,766.13
3	5	HI	57,532.21
3	6	LO	4,868.98
3	6	ME	14,707.13
3	6	HI	30,431.55
3	7	LO	2,414.33
3	7	ME	10,276.52
3	7	HI	18,994.76
3	9	LO	4,966.78
3	9	ME	14,331.41
3	9	HI	29,787.18
4	1	AV	96,846.10
4	3	HI	328,885.71
4	4	HI	155,374.12
4	5	LO	17,604.99
4	5	ME	33,066.12
4	5	HI	73,364.28
4	6	LO	9,447.61
4	6	ME	14,504.15
4	6	HI	30,431.55
4	7	LO	1,787.98
4	7	ME	12,966.08
4	7	HI	19,240.28
4	9	LO	4,821.26
4	9	ME	13,167.83
4	9	HI	31,776.83

Determining Biomass Stock from LCCS Classification

In the NBS classification, classes 3, 4, 5, 6, 7 and 9 had a stock classifier of LO (Low) or ME (Medium) or HI (High). To introduce stock levels in the translated legend, mixed units were used. A major class followed by a second class of high biomass would take a stock level of high. For example, herbaceous crops with mixed class of open trees would become 9HI. In LCCS it would be written as HR3HQ47-x/2TO8. On the other hand, if a class of high biomass such as woodland is mixed with a class of low biomass such as grassland, its stock level would drop. Table 2-4 shows the criteria used to determine stock levels of different classes. Class column is the class of the dominant land cover. Stock is the biomass stocking level the class would get if it was mixed with any of the classes in the classifier column.

Table 2-4 Criteria for biomass stock determination

Class	Stock	Classifier
9	HI	2TOI178, 2TO8, 2WC7, 2WP67
9	ME	2TV8, 4TVF8, 4TVPF8, 2TBR147PL, 2SCJ7
9	LO	Agriculture as single class, All types of grasslands, open and very open shrubs, very open trees if they are a second class to agriculture.
7	LO	Grassland alone, Rocks or bare soil
7	ME	Shrubs, very open trees, Generally open trees
7	HI	Closed and open trees, woodlands and woodlots
6	LO	Single very open shrubs or shrubs mixed with grasslands, rocky or bare soil
6	ME	Open Shrubs, Very and generally open trees
6	HI	Open and very open trees, shrub land and woodlands
5	LO	All very open trees, Open woodlands mixed with grasslands
5	ME	Dominant class is open or generally open trees or woodlands
5	HI	Closed trees and woodlands, generally open woodlands mixed with open trees
4	HI	High open trees
3	HI	High Closed trees (multi-storied Forest)

2.2.3 Mixed Units

According to Antonio *et al.* (2005), a mixed unit is where there are two land cover types in one polygon. The two cover types exist in such proportions that the dominant type is not dominant enough for the polygon to be classified by that type. At the same time the less dominant cover type is not too sparse to be ignored completely. So both cover types are considered. The dominant cover type is written first and the less dominant cover type second. It is possible also to have three cover types in one polygon. The class codes are separated by a forward slash. For example Open trees with patches of grassland can be written as 2TO8/2GC78. In such cases open trees (2TO8) cover about 60% and grassland (2GC78) about 40% of the polygon area. In case of three classes, the first takes 40%, the second and third take 30% each.

2.2.4 Linking Biomass to land cover

To display and analyse biomass data geographically, it must be linked to a map. The most logical map in this case is a land cover map. Consequently we can query how much biomass we can expect to find in particular land cover type, in a particular agro ecological zone.

Biomass data is linked to a map by linking the biomass stock table and the attribute table of the land cover map. Both of these tables must have a unique field so that a specific biomass class can only lock on to a specific land cover type. This was done by concatenating fields of agro ecological zone, class and stock into one code. For example in table 6 in the first row, AEZONE 3 + Class 3 + Stock HI becomes 33HI with a mean stock of 328,885.7Kg. This code will only link to 33HI in the map and attach the mean weight of 328,885.7Kg to that polygon.

Table 2-5 Biomass Table with a unique code for AEZONE 3 and 4

AEZONE	CLASS	**STOCK**	Zone class-**code**	**Mean** (kg)
3	3	HI	33HI	328,885.71
3	4	HI	34HI	155,374.12
3	5	LO	35LO	17,181.86
3	5	ME	35ME	37,766.13
3	5	HI	35HI	57,532.21
3	6	LO	36LO	4,868.98
3	6	ME	36ME	14,707.13
3	6	HI	36HI	30,431.55
3	7	LO	37LO	2,414.33
3	7	ME	37ME	10,276.52
3	7	HI	37HI	18,994.76
3	9	LO	39LO	4,966.78
3	9	ME	39ME	14,331.41
3	9	HI	39HI	29,787.18
4	1	AV	41AV	96,846.10
4	3	HI	43HI	328,885.71
4	4	HI	44HI	155,374.12
4	5	LO	45LO	17,604.99
4	5	ME	45ME	33,066.12
4	5	HI	45HI	73,364.28
4	6	LO	46LO	9,447.61
4	6	ME	46ME	14,504.15
4	6	HI	46HI	30,431.55
4	7	LO	47LO	1,787.98
4	7	ME	47ME	12,966.08
4	7	HI	47HI	19,240.28
4	9	LO	49LO	4,821.26
4	9	ME	49ME	13,167.83
4	9	HI	49HI	31,776.83

To get total biomass per polygon, the area of the polygon is multiplied with its mean stock. For convenience, area is converted into hectares by dividing by 10,000 and weight is converted into tons by dividing by 1000. Biomass of a district is therefore a sum of biomass from all polygons that make that district. The same method is used to get biomass total at parish, region or national level.

3 Distribution and extent of Uganda land cover

In this chapter the extent of different land cover types, their distribution and statistics are presented and compared for two time periods (1990 and 2005). Attempts are also made to project into the future for forest land cover. More attention was given to thematic areas where dramatic changes have occurred and hotspot illustrations are included whenever appropriate. The details are presented below.

3.1 National land cover statistics

About 37 percent of Uganda is under small scale farming, representing an increment of about 2% since 1990.The corresponding absolute area converted to agriculture amounts to about 480,000 ha. Subsistence farming is the largest Land cover type representing about one third of Uganda. It is followed by grass land and open water which constitute 16% and 15% respectively. The relative composition of the land cover types is indicative of the potential livelihood strategies of Uganda's population.

Apart from Coniferous forest plantations, forest cover (Classes 1-5 in Table 3-1 and Table 3-2) show reduction between 1990 and 2005. Figure 3-2 shows that Tropical high forests, Broadleaved plantations and coniferous plantations represent only 4% of Uganda. Similarly the grasslands show a reduction of over 4% since 1990. The reduction in the grassland is partly representative of the expansion in subsistence agriculture, built-up areas, and tree planting in former grasslands. The 2005 land cover also shows evidence of increasing bare areas especially in Nakasongola and Nakaseke districts, further affecting the extent of grass lands. The reduction in the grasslands has implications on livestock keeping.

Table 3-1 Land cover of Uganda by Class

Class	Class description	AREA 2005 (HA)	AREA 1990 (ha)
0	Unmapped	87.64	699.58
1	Broad leaved	14,840.72	18,682.01
2	Conifer	18,766.63	16,384.13
3	THF well stocked	542,787.27	651,110.41
4	THF low stocked	201,644.44	273,061.51
5	Woodland	2,816,423.13	3,974,508.13
6	Bush	2,970,317.94	1,422,193.00
7	Grassland	4,064,331.51	5,115,425.81
8	Wetland	753,041.37	484,030.25
9	Small scale farmland	8,854,670.83	8,400,789.52
10	Large scale farmland	106,630.08	68,446.68
11	Built up area	97,270.38	36,571.72
12	Open Water	3,706,731.64	3,689,602.94
13	Impediments	7,804.18	3,740.71
Total		24,155,347.78	24,155,246.39

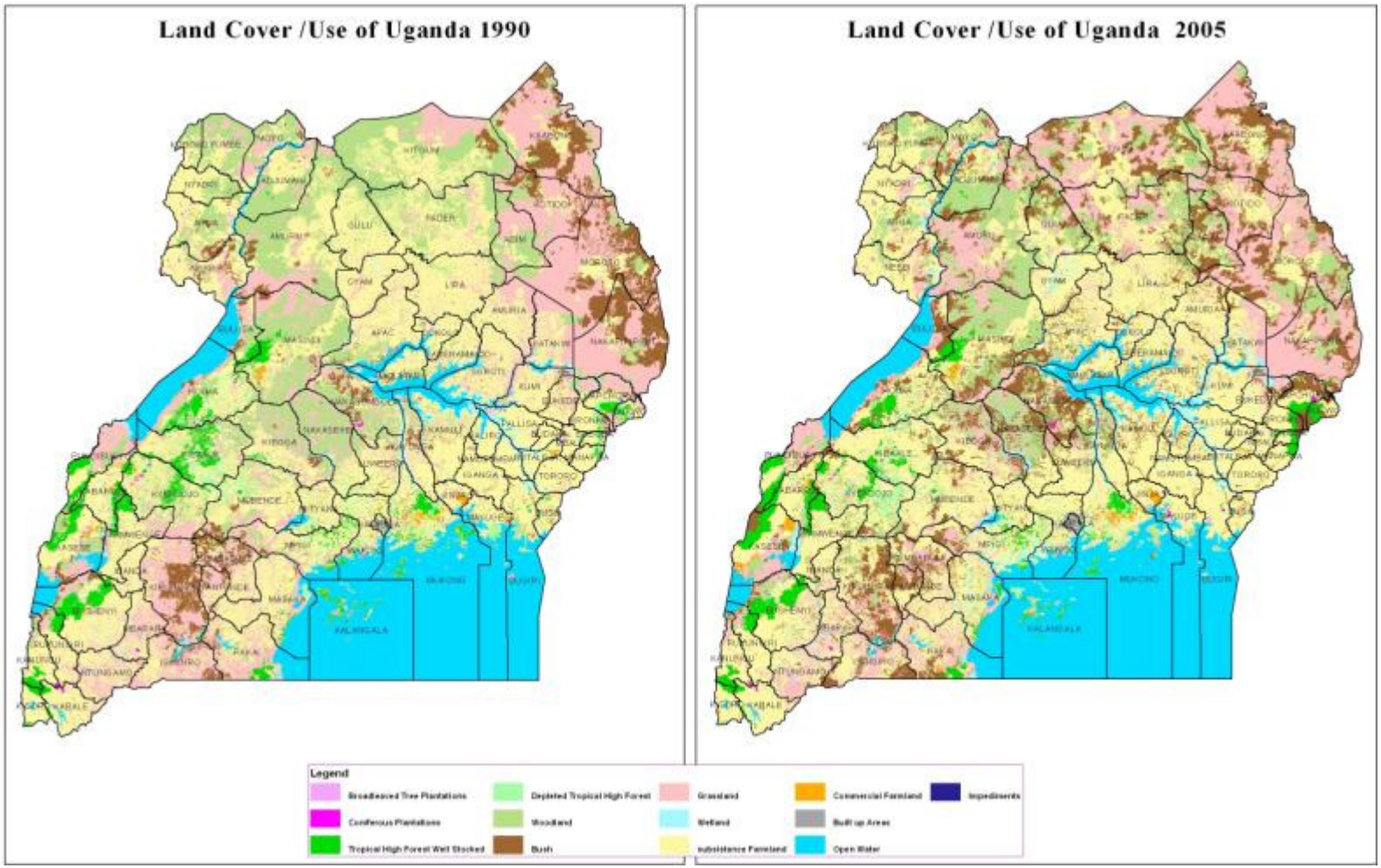


Figure 3-1 Land Cover/Use of Uganda for 1990 and 2005

3.2 Land cover change/Change Analysis

The major result included the extent and distribution of woody biomass and land cover at national, regional or district level with possibilities of going down to the lowest administrative unit i.e. parish. Land cover change was obtained by overlaying (using union) the 1990 and 2005 land cover maps. Fields for change analysis in the input layers were renamed in such a way that their origin can still be identified after the union. These were: CLASS90 and STOCK90 for the 1990 layer, and CLASS05 AND STOCK05 for the 2005 layer.

From the union, areas that change from one class to another or from one stock to another could be identified. From such analysis, it was realised that unexpected changes had occurred such as an area changing from a farmland into a multi-storied forest in just 15 years. Close scrutiny showed that there were two major sources of errors.

The first was a problem of geo-referencing the imagery that were used for interpretation. As a reminder, 1990 interpretation was done on hardcopy images on to transparencies. Tic marks were drawn on transparencies and then digitised and transformed. The 2005 interpretation was done from digital satellite imagery and efforts were made to rectify them to fit the existing 1990 digital layers.

Secondly there was a difference in the level of generalisation in interpretation. The 1990 classification aimed at delineating almost all polygons that could be identified and isolated at the scale of 1:50,000. The minimum mappable areas were as low as 1ha for built up areas, and 4ha for forest plantations, tropical high forests and wetlands. On the other hand, the LCCS classification uses more generalisations. It also uses mixed classes to take care of non-dominant land cover types. Consequently the minimum mappable areas are larger in the tune of 6ha for built up areas; six times the NBS classification at the same scale.

Nevertheless, analysis was done to determine in general, where major land cover and biomass changes have taken place.

Biomass changes are huge when land cover changes from or to a forest type because forests contain large amount of biomass per unit area.

Table 3-2 Land cover distribution by district 2005

REGION	DISTRICT	District Area (HA)	Broad leaved Plantation	Conifer Plantation	THF well stocked	THF low stocked	Woodland	Bush	Grassland	Wetland	Small scale farmland	Large scale farmland	Built up area	Open Water	Impediments
Central	KALANGALA	906,864			9,973	7,479	8,700	872	7,959	2,566	5,452	3,119	29	860,632	82
	KAMPALA	19,700	33				489	202	41	822	1,456		14,951	1,690	16
	KAYUNGA	170,240	139		433	277	26,831	16,051	9,199	20,300	84,095		631	12,284	
	KIBOGA	404,552		397		4,977	76,177	77,478	94,792	16,217	133,734	103	561	5	111
	LUWEERO	222,170	208		98		22,527	29,870	22,888	10,622	134,541	339	1,004	70	2
	LYANTONDE	87,361					66	39,771	14,864	278	32,191		142	50	
	MASAKA	469,174	292		6,289	10,895	13,858	20,833	68,374	27,775	206,160	70	1,841	112,424	365
	MITYANA	157,131	425		4,385	2,975	10,275	3,310	3,983	10,694	112,311	1,480	913	6,379	
	MPIGI	360,562	159		16,414	14,532	17,597	31,571	43,245	38,661	163,079	325	1,650	33,189	139
	MUBENDE	462,643	91	276	2,861	6,529	30,652	42,755	44,459	19,367	309,579	1,069	1,866	2,937	202
	MUKONO	1,265,581	498		34,310	29,667	31,667	7,541	18,539	23,906	165,820	20,035	6,236	927,207	155
	NAKASEKE	347,225	87				137,860	74,152	49,355	22,463	61,933	282	928	165	
	NAKASONGOLA	350,997		2,332			63,301	151,449	40,182	15,276	51,718	179	828	25,732	
	RAKAI	403,511	796		17,430	1,537	8,008	34,515	130,089	13,480	119,372	3,742	1,026	73,390	126
	SEMBABULE	231,917					5,561	49,352	65,331	2,814	108,476		271	112	
	WAKISO	280,775	663			3,782	16,620	1,614	3,427	19,934	126,929	3,412	14,933	89,451	11
Eastern	AMURIA	258,298					3,075	29,201	26,407	9,272	188,171	10	2,149		13
	BUDAKA	41,060	63							2,187	37,879	788	144		
	BUDUDA	27,390	72		7,884		1,440	3,288			14,689		17		
	BUGIRI	567,097		703	652	921	4,119	1,649	5,587	9,575	131,064	686	642	411,359	53
	BUKEDEA	105,466					124	6,945	21,314	6,070	70,807		163	33	11
	BUKWO	52,557	34	547	12,801	8	4,312	14,590	307		18,703	1,254			
	BUSIA	75,940	17		24	6	1,323	7,247	958	5,083	58,038	104	273	2,867	
	BUTALEJA	65,545					25	123	580	13,105	46,690	4,792	221	9	
	IGANGA	166,965					67	2,286		7,534	154,635	1,127	1,302		14
	JINJA	72,268	746	256			61	720	1,329	529	50,249	10,925	2,495	4,959	
	KABERAMAIDO	162,396					8,735	9,020	5,276	12,242	96,139		332	30,653	
	KALIRO	86,853						8,377	203	15,032	54,482		152	8,608	
	KAMULI	343,304	85				4,558	30,243	9,771	22,063	213,885	13	781	61,784	120
	KAPCHORWA	120,616		2,382	14,762	6	5,600	54,780	3,506	3,275	34,709	1,412	185		
	KATAKWI	243,152					6,215	12,264	87,353	25,129	103,559		231	8,225	177
	KUMI	179,351					741	9,619	10,741	30,092	118,062		302	9,793	
	MANAFWA	58,077	54		7,845		2,268	2,067	77		45,645		120		
	MAYUGE	463,859	565	2,365		451	6,847	666	2,590	5,648	85,940	2,006	1,301	355,450	30
	MBALE	51,816	266		1,504		1,638	630	316	975	43,402	1,251	1,835		
	NAMUTUMBA	81,268						3,392	999	13,438	63,206		87	147	
	PALLISA	158,114	34				96	793	147	35,523	115,044		258	6,220	
	SIRONKO	109,391			9,095	483	3,720	22,400	13,573	7,521	51,948	205	445		
Eastern	SOROTI	337,770		376			1,582	30,600	18,041	38,001	193,269		1,731	54,104	67
	TORORO	119,383	68				547	1,535	1,428	5,572	108,263	1,342	555	48	24
Northern	ABIM	235,271					74,476	88,769	35,296		35,957		364	25	384
	ADJUMANI	308,703	375		1,262		149,950	44,035	22,011	13,697	70,449	51	666	6,148	59
	AMOLATAR	170,944					5,478	8,298	11,163	10,144	57,827		377	77,657	

REGION	DISTRICT	District Area (HA)	Broad leaved Plantation	Conifer Plantation	THF well stocked	THF low stocked	Woodland	Bush	Grassland	Wetland	Small scale farmland	Large scale farmland	Built up area	Open Water	Impediments
	AMURU	842,700		6			307,997	101,189	310,878	6,388	103,698	37	1,137	11,353	17
	APAC	433,545	148				26,019	62,889	38,747	16,261	251,632	104	317	37,362	66
	ARUA	311,287	802	402			61,829	19,791	25,705	12,978	184,065		1,732	3,944	38
	DOKOLO	108,732		237			295	8,755	7,313	9,696	72,714		187	9,535	
	GULU	328,861	1,629	507			112,823	67,121	35,100	4,754	103,372	160	2,723	590	83
	KAABONG	726,372					61,462	214,749	373,028	455	75,808		134		735
	KITGUM	963,459				5	178,160	229,281	342,893	3,890	204,779	338	3,404	181	527
	KOBOKO	75,622	7				8,426	9,305	6,191		51,247		441		4
	KOTIDO	362,892					27,403	80,475	154,646	506	99,587		31	7	238
	LIRA	440,405	143				16,312	40,231	26,024	4,497	348,284		3,689	1,116	109
	MOROTO	851,769					138,110	208,274	376,849		128,135		55		346
	MOYO	189,072	21				48,809	34,785	31,533	8,282	54,818		520	10,161	144
	NAKAPIRIPIRIT	583,388					85,480	114,881	353,293	2,613	26,716	34	343		26
	NEBBI	291,726	210	1,833		4	26,085	21,308	41,493	8,295	182,543	607	322	9,028	
	NYADRI	160,722	887				9,816	2,742	25,362	3,293	118,436		176	11	
	OYAM	220,586	519				4,202	8,953	10,240	20,500	175,498	139		534	
	PADER	692,934				210	172,271	109,349	172,088	834	230,365		6,071	453	1,294
	YUMBE	240,302					89,432	27,229	14,058	2,195	106,291		95	949	54
Western	BULIISA	188,484			15,917	74	2,192	47,553	23,592	4,217	18,370	84	90	76,397	
	BUNDIBUGYO	226,170			37,513		35,541	11,255	88,512	333	35,660		170	17,187	
	BUSHENYI	429,257	713		64,199	966	34,793	23,203	57,491	8,747	200,553	1,265	352	36,976	
	HOIMA	577,873	128		37,345	21,424	39,246	64,390	45,856	4,966	150,412	1,154	1,099	211,816	37
	IBANDA	97,168	16		3,915	78	6,704	4,234	13,838	1,260	66,809		314		
	ISINGIRO	265,087	142				730	58,081	95,231	9,893	97,294		36	3,678	
	KABALE	172,964	330	1,468	8,745		418	1,069	9,138	1,392	144,488		834	5,045	36
	KABAROLE	182,446	1,838	161	34,498	1,455	18,950	15,150	7,360	1,309	94,772	5,479	604	870	
	KAMWENGE	243,944			25,519	571	27,022	9,704	15,365	7,602	151,559		168	6,435	
	KANUNGU	129,214	472	1,253	19,170		4,409	4,029	17,360	390	79,897	220	252	1,760	
	KASESE	338,962	28		38,086	56	39,044	30,196	67,784	15,478	85,867	18,714	1,921	41,088	701
	KIBAALE	440,020	21		27,945	33,145	45,221	22,043	17,162	8,780	267,870	711	594	15,381	1,148
	KIRUHURA	460,266				28	45,412	169,931	74,978	9,232	158,549	211	152	1,772	
	KISORO	72,967	270		7,677		3,763	1,459	269	334	55,885	309	193	2,809	
	KYENJOJO	405,440	253	1,102	29,226	54,582	57,495	25,089	21,482	7,846	204,428	3,632	249	40	16
	MASINDI	755,829	20	73	27,410	4,523	309,612	123,480	88,378	9,847	174,883	12,632	870	4,092	7
	MBARARA	179,395	449	1,354			2,700	9,488	69,938	9,843	83,014	669	1,876	64	
	NTUNGAMO	205,551	28	729			2,283	9,576	88,101	8,955	94,591	11	814	447	16
	RUKUNGIRI	156,678		7	17,601		8,766	4,212	21,353	302	92,224		366	11,848	
	TOTAL	24,155,348	14,841	18,767	542,787	201,644	2,816,423	2,970,318	4,064,332	753,041	8,854,671	106,630	97,270	3,706,732	7,804

Woodlands have shown the largest reduction. This could be attributed to expansion of the shrub lands. However the trend in reduction of both forest cover and woodland and the alternate increase of shrub land is indicative of reducing above ground biomass which is attributed to mainly human factors. The factors can be listed as population growth with corresponding increase in demand for land for settlement, higher demand for fuel wood and timber as well as conversion of land for agricultural production. Another factor was the difference in the two classifications used, namely the NBS and LCCS. Some woodlands in the NBS classification did not qualify to remain as woodlands in LCCS.

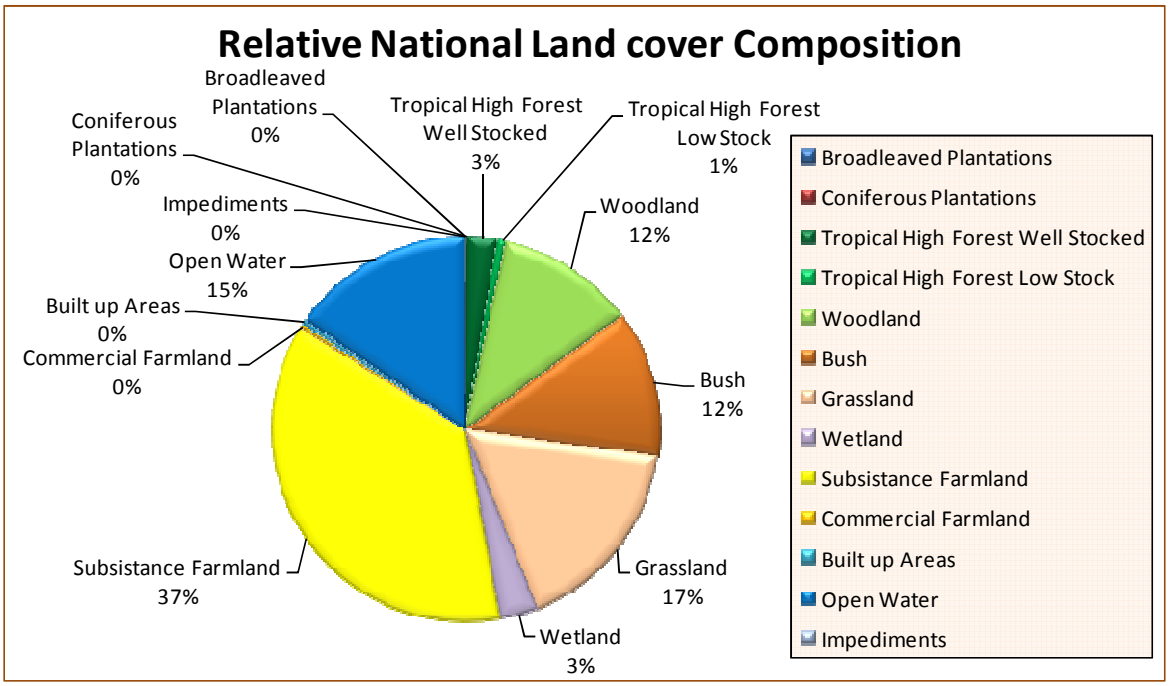


Figure 3-2 Proportion of Land cover types

Table 3-3 and Table 3-4 show differences in the land area under different ownership, disaggregated by land cover types. The area under plantation hardwoods and Tropical high forests generally reduced including in Local Forest Reserves and Central Forest Reserves while plantation soft woods increased across the board. The reason could be because eucalyptus plantations were not mapped because they were below the minimum map-able areas.

The built up area has also increased across the board including inside CFRs and LFRs. That could be attributed to urban expansion and encroachment driven by both economic and population growth. Some of the IPDs in northern Uganda were located in central forest reserves. Similarly commercial farmland has increased although it reduced in CFRs and LFRs.

Table 3-3 Land cover by ownership in 1990

CLASS_90	Area_ha	AS	CFR	DJM	GR	LFR	NP	PVT
UNMAPPED	700		0				0	700
Plantations Hardwoods	18,682	10	6,041		0	560	27	12,044
Plantations softwoods	16,384		13,395			15	2,273	701
THF- Normal	651,110		261,918	24,176	3,058	309	187,595	174,055
THF-Low Stocked	273,062	58	57,564	1,573		235	37,204	176,428
Woodlands	3,974,508	98	413,467	11,863	144,846	512	304,452	3,099,269
Bush lands	1,422,193	31	107,216	9,025	103,180	473	75,619	1,126,650
Grasslands	5,115,426	998	200,805	41,141	523,805	570	383,781	3,964,325
Wetlands	484,030	20	5,919	318	4,784	177	21,074	451,738
Subsistence farmlands	8,400,790	829	103,292	1,421	15,502	2,108	14,462	8,263,175
Commercial Farmlands	68,447		1,203	0		4	81	67,159
Built up areas	36,572	1,437	321		33	11	169	34,600
Water	3,689,603	2,067	901	113	902	22	10,517	3,675,082
Impediments	3,741	21	377		10	1	335	2,996
Total Area of category	24,155,246	5,568	1,172,420	89,632	796,121	4,996	1,037,588	21,048,921
Forest Cover in category	4,933,746	166	752,385	37,612	147,904	1,631	531,550	3,462,497
Forest % in that category	20%	3%	64%	42%	19%	33%	51%	16%

Table 3-4Land cover by ownership in 2005

CLASS_05	Area_ha	AS	CFR	DJM	GR	LFR	NP	PVT
UNMAPPED	88				0			88
Plantations Hardwoods	14,841	25	4,863			351	27	9,575
Plantations softwoods	18,767		14,091			19	2,430	2,226
THF- Normal	540,289		237,665	20,996	3,340	107	211,268	66,913
THF-Low Stocked	201,644		43,063		86	120	2,265	156,110
Woodlands	2,818,922	135	328,216	9,752	135,690	614	285,870	2,058,644
Bush lands	2,970,318	31	188,332	11,417	148,674	413	169,494	2,451,957
Grasslands	4,064,332	888	179,470	44,233	457,990	202	307,314	3,074,234
Wetlands	753,041		9,073	2,196	5,488	296	28,478	707,511
Subsistence farmlands	8,854,671	478	161,566	741	43,591	2,725	17,053	8,628,517
Commercial Farmlands	106,630	18	2,977	56	35	6	875	102,662
Built up areas	97,270	1,971	1,084		26	118	266	93,807
Water	3,706,732	2,023	889	149	1,055	24	11,666	3,690,927
Impediments	7,804		1,145	116	146		583	5,814
Total Area of category	24,155,348	5,568	1,172,433	89,657	796,121	4,996	1,037,589	21,048,983
Forest Cover in category	3,594,462	160	627,897	30,748	139,117	1,211	501,861	2,293,468
Forest % in that category	15%	3%	54%	34%	17%	24%	48%	11%

3.2.1 Land cover changes by region

Table 3-1 shows a description of the thirteen land cover classes used in NBS. Classes 1-5 show the different forest cover types. The other classes include built up areas, wetlands, open water and impediments. Figure 3-3 shows the absolute changes in the different land cover types comparing area in ha covered by land cover

type in 1990 and 2005 Figure 3-4 shows net changes respectively at larger scale to show the differences. Most land cover types show a reduction between 1990 and 2005, save for subsistence farming, built-up areas and bush lands. The dramatic differences across the regions are indicative of the land management issues there in.

Tropical high forests reduced dramatically in western, central and in some districts in eastern region. The change in forest area is negligible in the north while it increased in western Uganda. The largest threat to hardwood has always been charcoal production.

Commercial farmland increased in the central and eastern region. These could be attributed to the upland rice campaign of the Vice president's office and BIDCO oil palm plantations in Kalangala.

The reduced subsistence farming is attributable to insecurity which resulted into settlement in Internally Displaced People Camps and making most production areas inaccessible.

Central region also represented the largest increase in built up areas as reflected by the expansion in Kampala and Wakiso districts.

At national level, there was a significant reduction in woodlands and subsistence farming. The reason for the apparent reduction in woodland area is attributed partly to the change in classification system used. An area north of Kitgum which had been classified as woodland in NBS classification was this time classified as grassland and shrub land in LCCS. The trees spread in this area cannot be classified as woodland in LCCS.

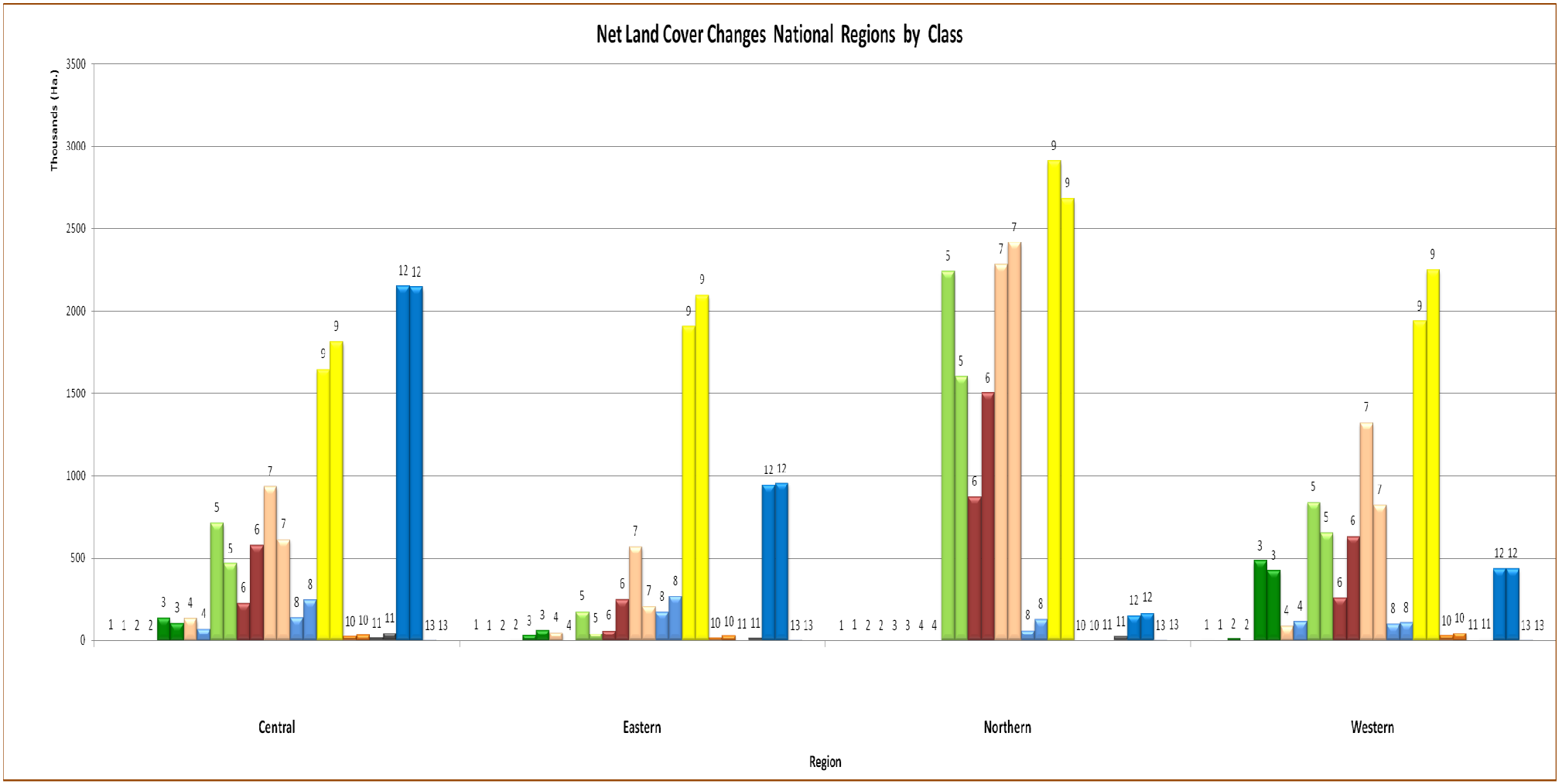

Net Land Cover Changes National Regions by Class
Thousands (Ha.)
3500
3000
2500
2000
1500
1000
500
0
Central
Eastern
Northern
Western
Region

Figure 3-3 Land cover change by region

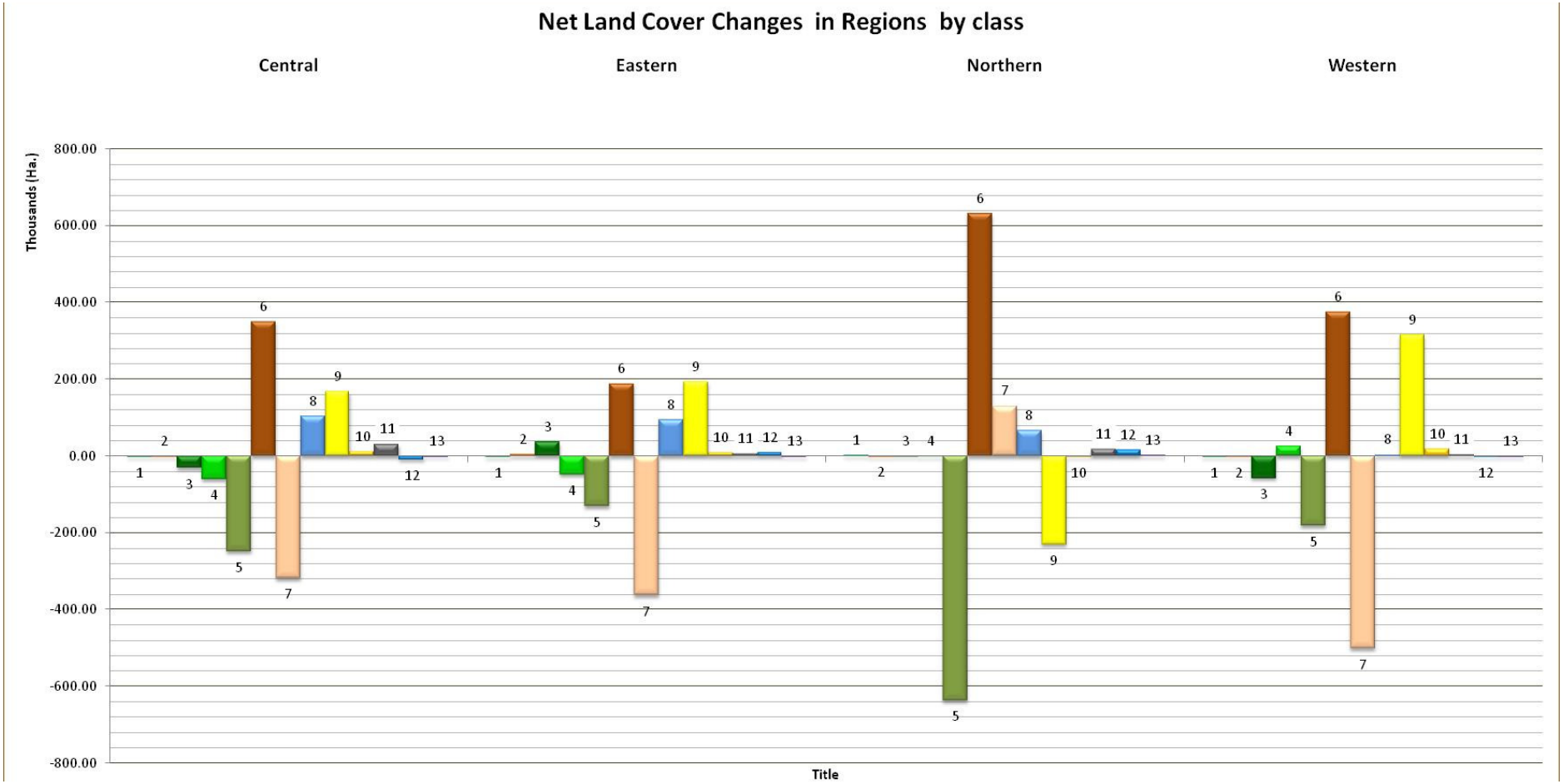


Figure 3-4 Net land cover change by region

3.3 Forest cover status

3.3.1 Change in per-capita forest

The statistics shown in Section 3.1 reflect a general reduction in forest cover. Per capita forest has been reducing and the trend is expected to continue if nothing is done. Reduction is attributed to deforestation while the population of Uganda is increasing resulting to increased pressure on land and forests. Figure 3-5 Forest per Capita shows a projection for forest per-capita which confirms a downward trend.

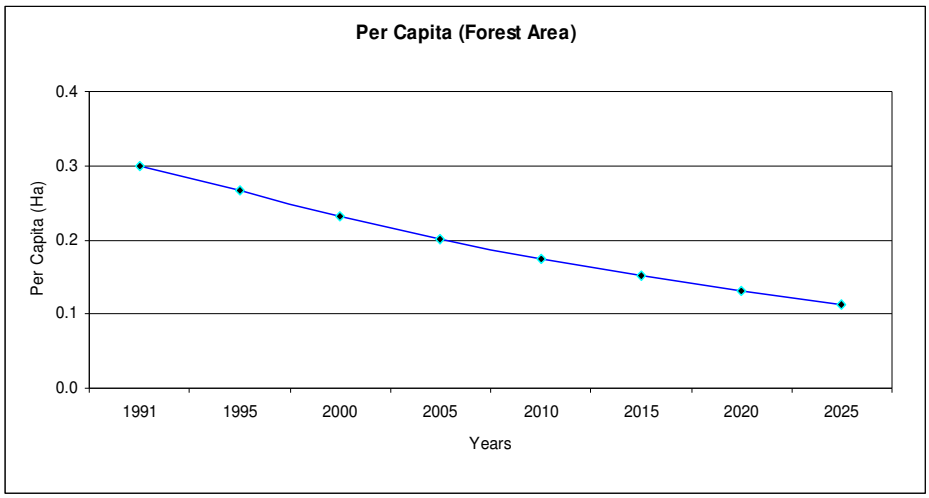


Figure 3-5 Forest per Capita

However, the status of forests had improved at the time of writing this report. That is because the data sources for this work were Landsat satellite images of 2004/2005. That is the time when NFA was born and started transforming forestry landscape by planting. A number of private tree planters also started planting or increased their forest acreage.

3.3.2 Change in forest cover by ownership

Table 3-5 shows changes in the proportion of forest cover by ownership. Forests are found in National parks, Wildlife reserves, and other lands under the care of UWA, in Central Forest Reserves under NFA, and on private land. There are also lands jointly manage by UWA and NFA referred to as Dual Joint Management (DJM). Private land includes land owned by individuals, families, communities or companies. There was general reduction in forest cover for all the three different types of ownership at various rates. However the proportion of the national forest cover in protected areas (UWA and NFA) increased while the one outside protected areas decreased. Figure 3-6 and Figure 3-13 also clarify the changes in the forest covered areas by different land ownership.

Uganda covers 241,550 square kilometres and of this, open water covers slightly over 3,700 square kilometres. The proportions given at the bottom of Table 3-5 are calculated based on land area excluding open water.

Table 3-5 Forest cover statistics

Statistic	1990	2005
Area of the country	24,155,245.00	**24,155,348**
Area of open water	3,720,511.20	**3,706,732**
Land Area	20,434,034.20	**20,448,616**
Area of PAs	3,105,761.20	**3,106,364**
Area under NFA	1,171,948.00	**1,172,433**
Area under UWA	1,839,250.30	**1,839,278**
Area under DJM	89,567.00	**89,657**
Area of PVT land (excluding water)	17,328,273.00	**17,342,252**
Area of forests in PAs	1,470,823.20	**1,300,994**
Area of forests under NFA	752,142.90	**627,897**
Area of forests under UWA	679,492.20	**641,138**
Area of forests under DJM	37,559.50	**30,748**
Area of forests under DFS	1,628.70	**1,211**
Area of forests in the Country	4,933,746.00	**3,594,550**
Area of forests on PVT land	3,462,922.80	**2,293,468**
% of All country under forests	20%	**15%**
% of country under forests (excluding water)	24%	**18%**
% of private forests of land area	17%	**11%**
% of protected forests of land area	7%	**6%**
Proportion of forest estate on PVT land	70%	**64%**
Proportion of forest estate under UWA	14%	**18%**
Proportion of forest estate under NFA	15%	**17%**
Proportion of forest estate under DJM	0.76%	**0.86%**
Proportion of forest estate under DFS	0.03%	**0.03%**

3.3.3 Deforestation

Uganda has a total of 3.6 million hectares of forest land. This is a reduction from 4.9 million ha in 1990. As a proportion, in 1990 forests covered 24% of the land area of the country. By 2005 the forests had reduced to 18% which is equivalent to 1.3million ha, in the 15 years. The cause of this deforestation is mostly the conversion of forest land to other land use types such as agriculture.

There is a remarkable difference in the degree of deforestation inside protected areas as compared to forests on private land. Forest estate outside protected areas (PA) reduced from 3.46 million ha (70%) in 1990 to 2.3 million ha (64%) in 2005.; A difference of about 1.2 million ha. Inside PAs, forests reduced from 1.47 million ha to 1.3 million ha; a difference of about 0.20 million ha (See Figure 3-6 to Figure 3-13).

The total (inside and outside PAs) deforestation rate per year is 1.8%. Inside protected areas the deforestation rate is 0.7% while outside protected areas; it is 2.27 % triple the rate in PAs. The figures translate to an absolute loss of about 88,638 ha per year, overall.

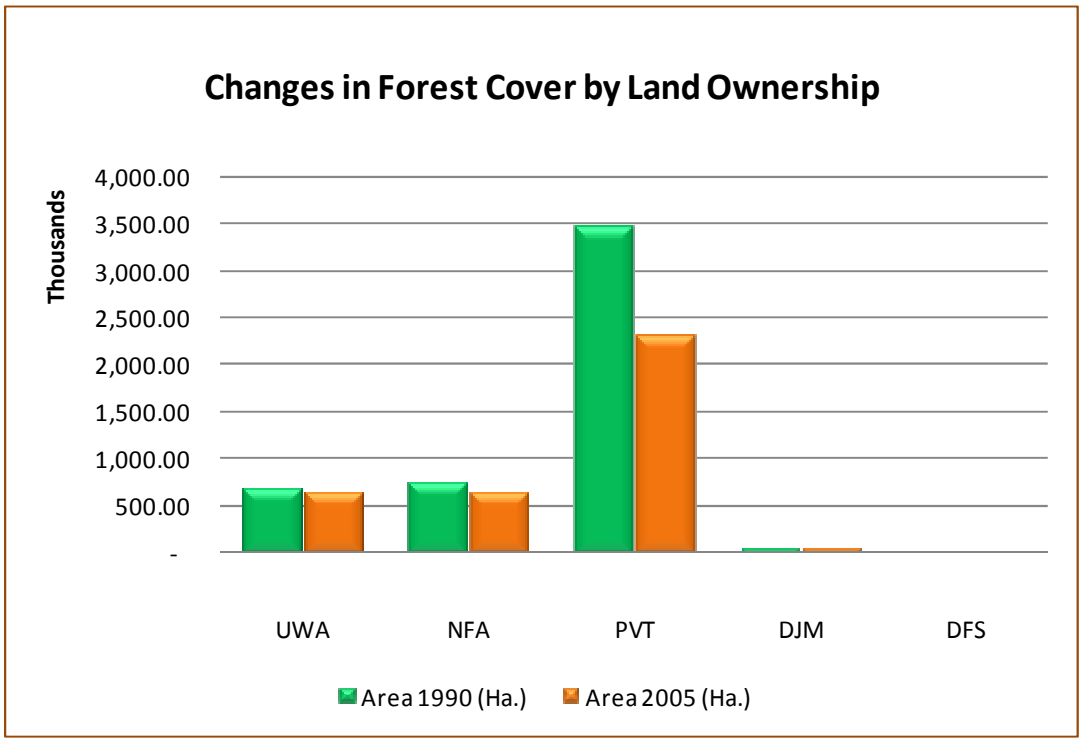


Figure 3-6 Change in forest area by ownership

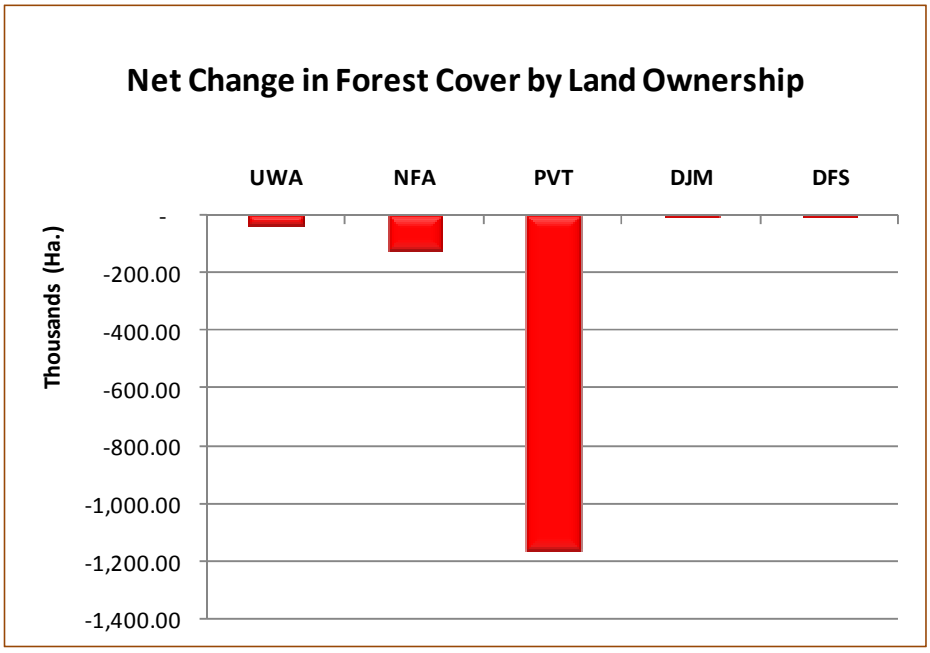


Figure 3-7 Net change in forest area by ownership

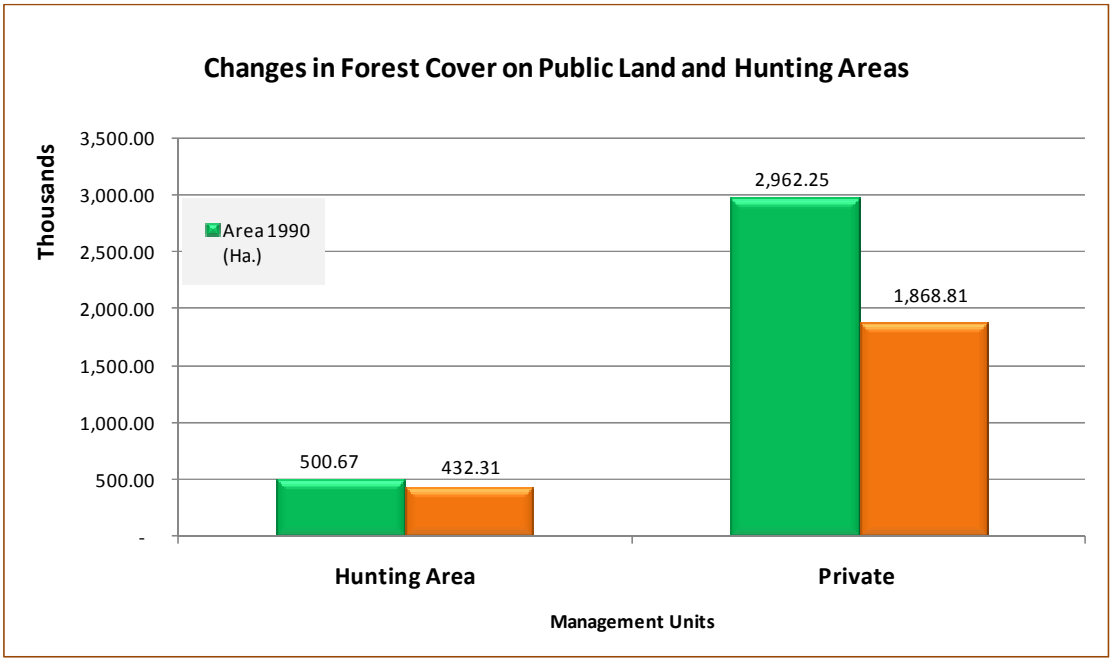


Figure 3-8 change in forest area in public land and hunting areas

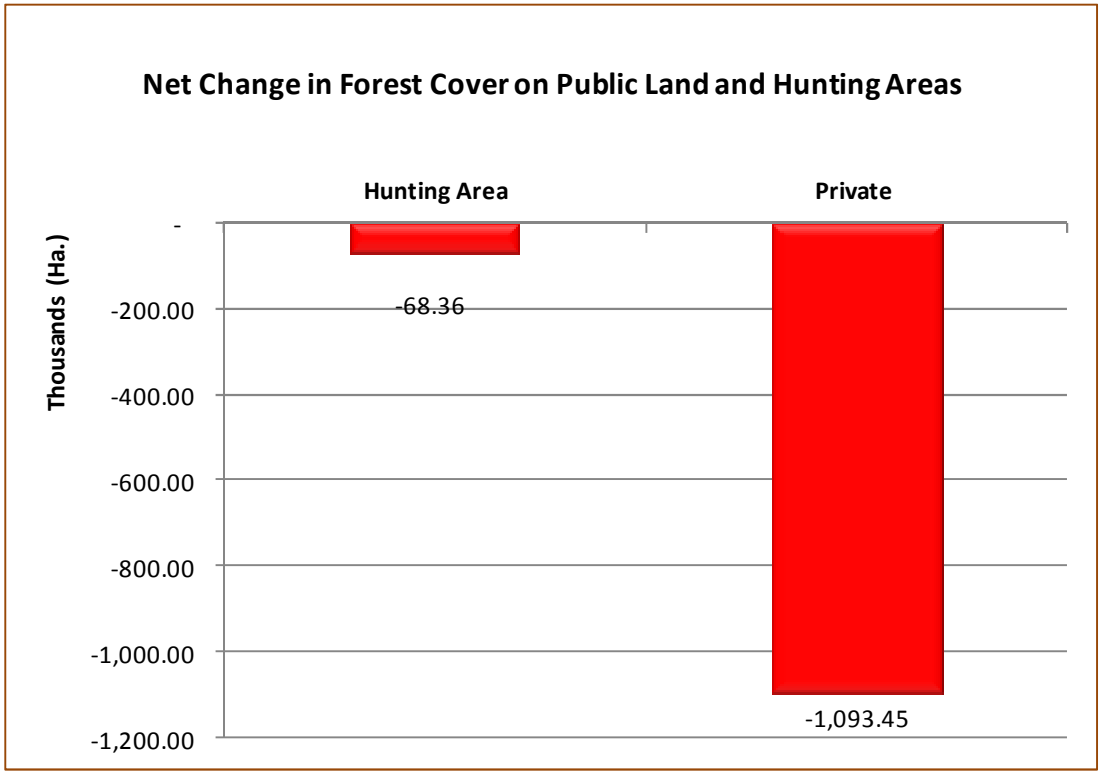


Figure 3-9 Net change in forest area in public land and hunting areas

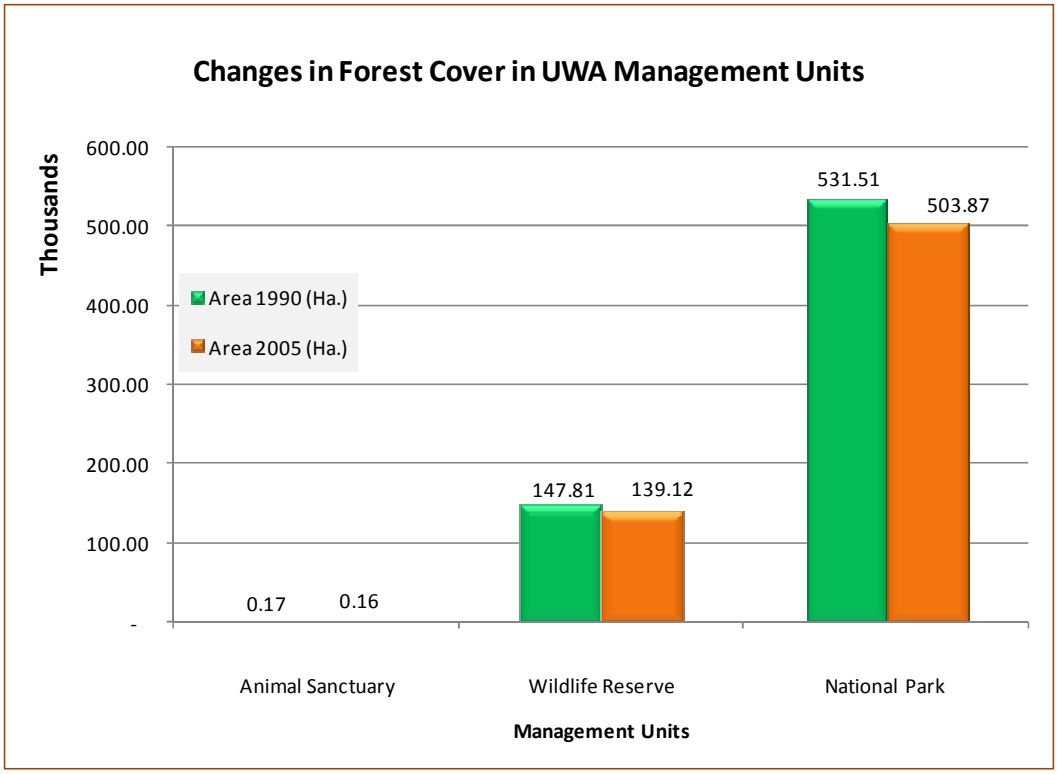


Figure 3-10 change in forest area in UWA management Units

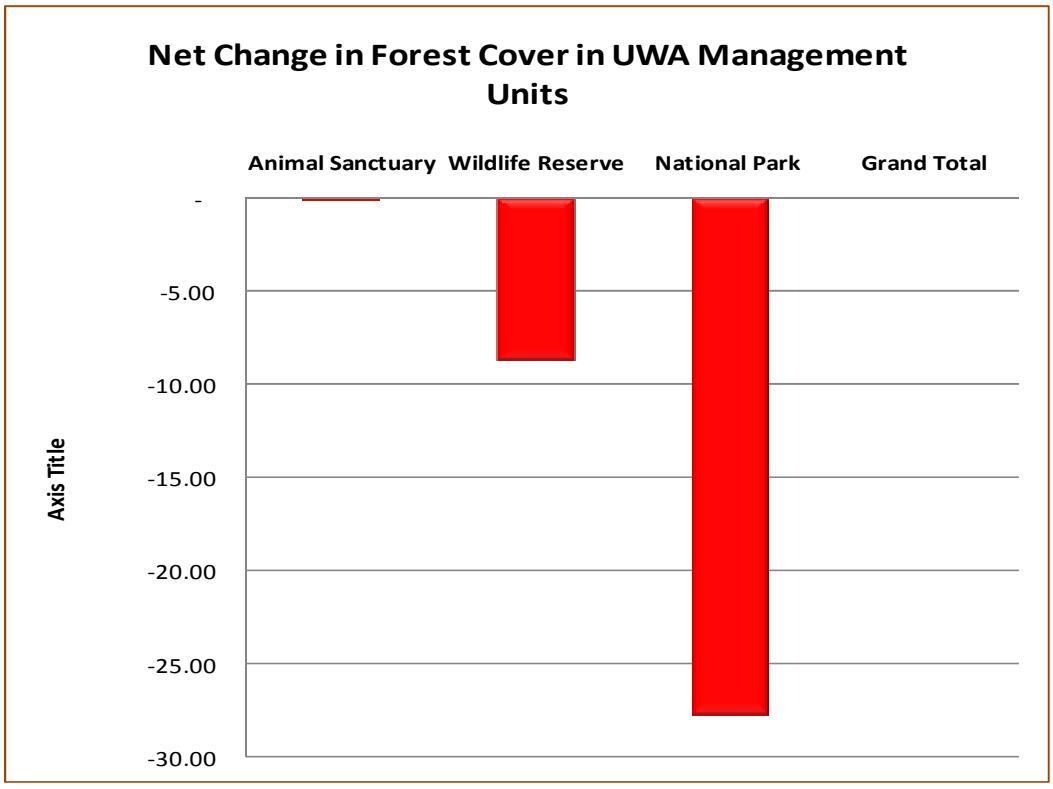


Figure 3-11 Net change in forest area in UWA management Units

3.3.4 Land Cover Change in Central Forest Reserves by Class

All land cover types were represented in CFRS. Woodlands covered the biggest area and they were the ones that had had the biggest change. Second in abundance was tropical high forests but change in cover had been much smaller than in woodlands (see Figure 3-12 and Figure 3-13). As forests disappeared, they were replaced by shrubs (Class 6) a fact that explains high acreage increase in this class.

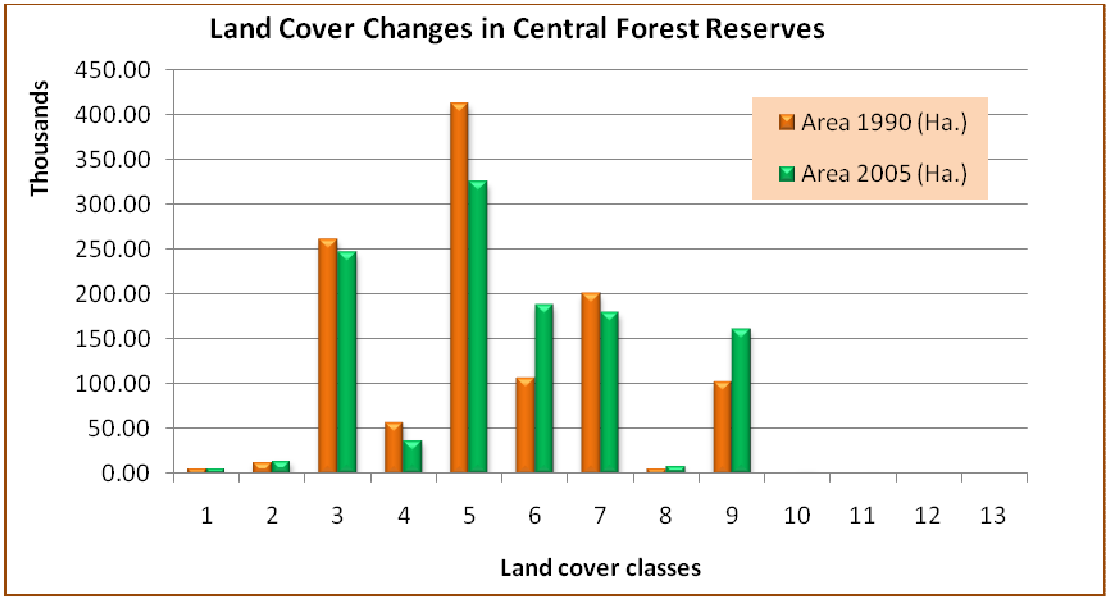


Figure 3-12 change in forest area in CFRs

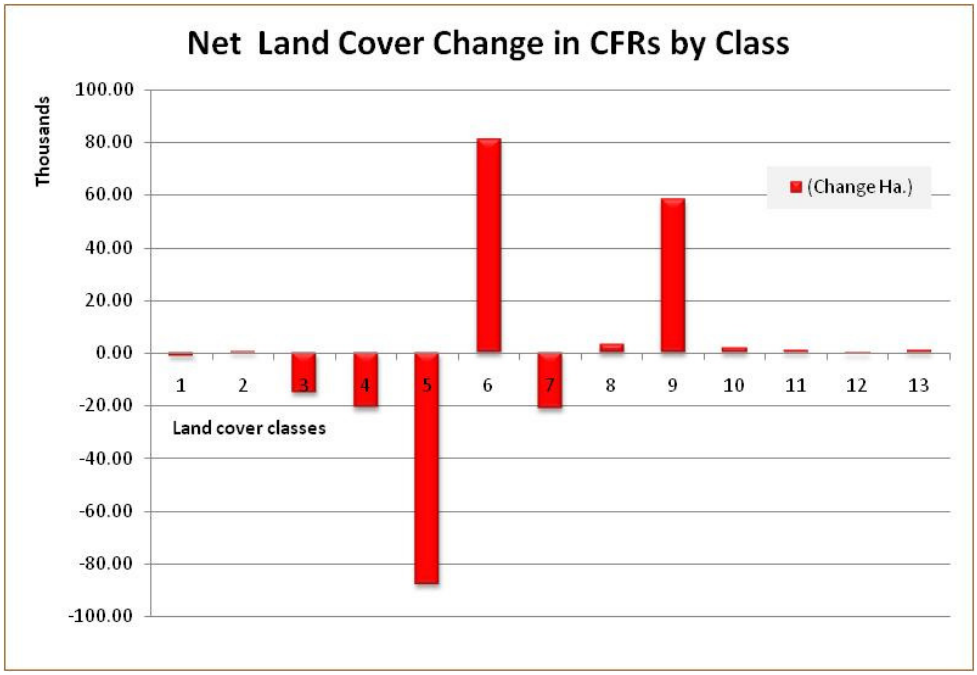


Figure 3-13 Net change in forest area in CFRs

3.3.5 Change in forest cover by district

Table 3-6 shows the performance of various districts per region with regard to forest cover. In the table, the two districts with the highest loss of forest cover and two districts with lowest loss or net gain in forest cover.

Kibaale was one of the districts where forest cover had reduced by about 43%, from over 187,000ha to 106,460ha. Much of the unprotected forest land, in this district, had been converted to agricultural land. In the central region Kiboga district lost over 87,000 ha, which was more than half of its forest cover. On the other hand, forest cover in Kayunga district increased by over 12,000 ha, representing a net gain of 83% in the district's forest estate. Kayunga's forests are mainly woodlands in the northern part of the district which were formerly shrub land.

Table 3-6 Best and worst forest change statistics by district and region

REGION	DISTRICT	Forest Area 1990	Forest Area 2005	Change	%Change
Central	KIBOGA	168,681	81,551	-87,131	-52%
	NAKASONGOLA	128,760	65,633	-63,127	-49%
	MASAKA	21,990	31,333	9,342	42%
	KAYUNGA	15,145	27,680	12,535	83%
Eastern	BUGIRI	26,692	6,395	-20,297	-76%
	KAMULI	24,641	4,643	-19,998	-81%
	MBALE	4,036	3,408	-627	-16%
	BUDAKA	195	63	-133	-68%
Northern	KITGUM	475,313	178,166	-297,147	-63%
	AMURU	389,409	308,003	-81,406	-21%
	NAKAPIRIPIRIT	45,855	85,480	39,625	86%
	MOROTO	68,367	138,110	69,743	102%
Western	KIBAALE	187,045	106,332	-80,714	-43%
	HOIMA	160,513	98,143	-62,370	-39%
	BUSHENYI	89,440	100,671	11,231	13%
	KIRUHURA	10,590	45,440	34,850	329%

In Kiruhura district, what used to be improved pasture land in the northern part, turned into woodlands. These woodlands have come up as a result of pasture management. Trees are deliberately allowed to grow, to provide shade for livestock and they have over time developed into a wood-land.

3.3.6 Change in Tropical High forest by district

Table 3-7 shows the performance of various districts per region with regard to THF. The two districts with the highest loss of THF and two districts with lowest loss or net gain are shown.

Kibaale was one of the districts where well stocked Tropical high forest reduced by about 46%, from 114,102ha to 61,358ha. In this case most of the forest land had been turned into agriculture.

Table 3-7 Best and worst Tropical High Forest by district and region

REGION	DISTRICT	THF Area 1990 (Ha.)	THF Area 2005(Ha.)	Change	%Change
Central	MUKONO	100,626.65	63,977.12	-36649.53	-36%
	WAKISO	28,461.12	3,781.68	-24679.44	-87%
	KAYUNGA	494.02	710.27	216.25	44%
	MASAKA	15,612	17,183	1,571	10%
Eastern	MAYUGE	15,162.05	450.54	-14711.51	-97%
	KAPCHORWA	19,180.51	14,768	-4,413	-23%
	MANAFWA	6,858	7,845	987	14%
	SIRONKO	8,192	9,578	1,386	17%
Northern	NEBBI	190	4	-186	-98%
	ADJUMANI	1,268	1,262	-6	0%
	KITGUM	0	5	5	
	PADER	0	210	210	
Western	KIBAALE	114,103	61,090	-53,013	-46%
	HOIMA	75,144	58,769	-16,375	-22%
	KAMWENGE	25,412	26,089	677	3%
	KYENJOJO	54,242	83,807	29,565	55%

Mayuge district in the Eastern region lost almost all its forest cover. Starting with 15,000 ha in 1990, only 450 ha were remaining by 2005.

3.3.7 Areas of particular interest

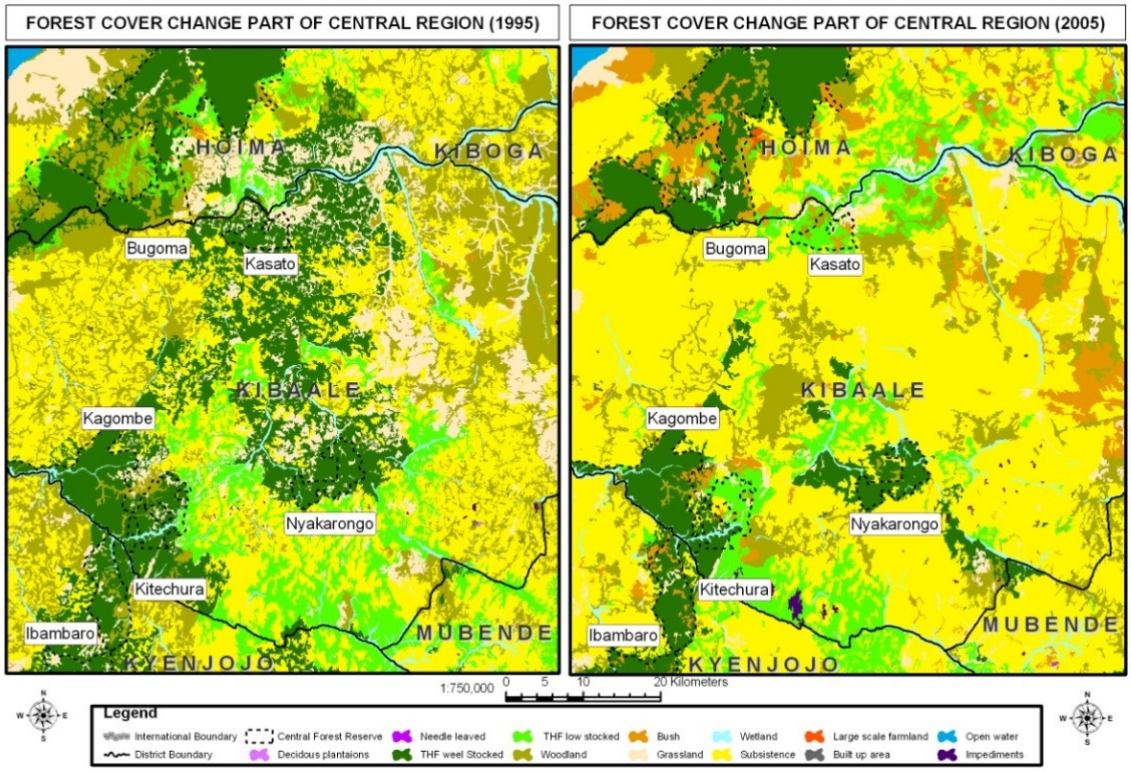


Figure 3-14 Deforestation in Hoima/Kibaale

Figure 3-15 Evidence of deforestation in Hoima district

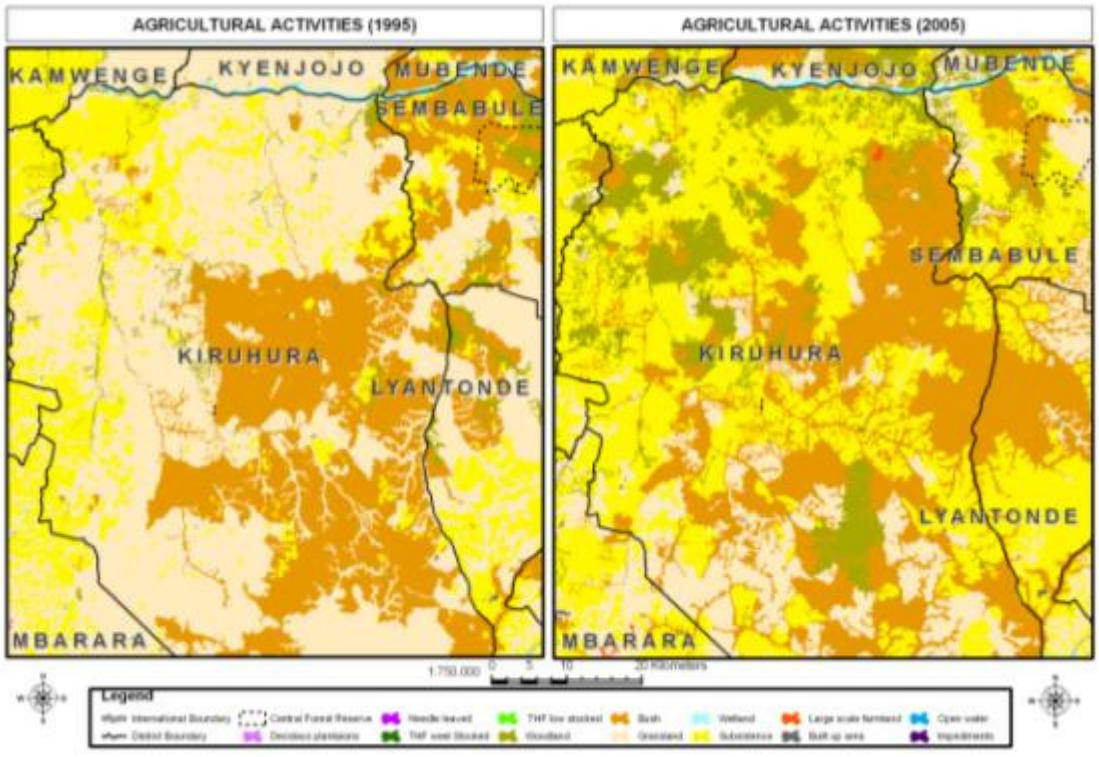


Figure 3-16 Increase in Agriculture in Kiruhura District

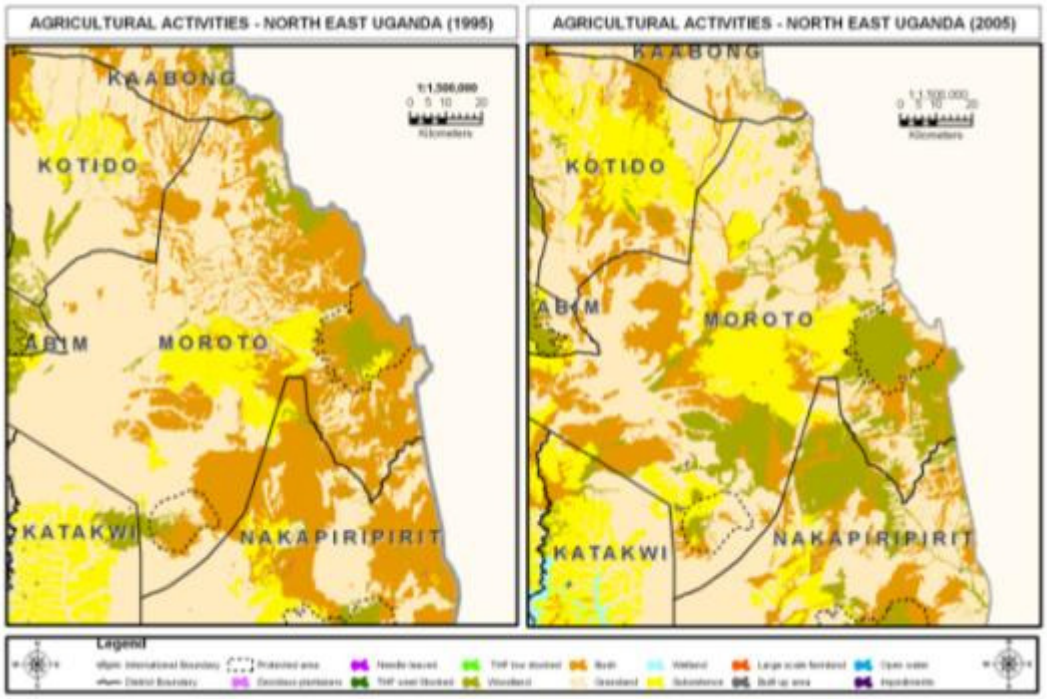


Figure 3-17 Increase in Agriculture in Karamoja

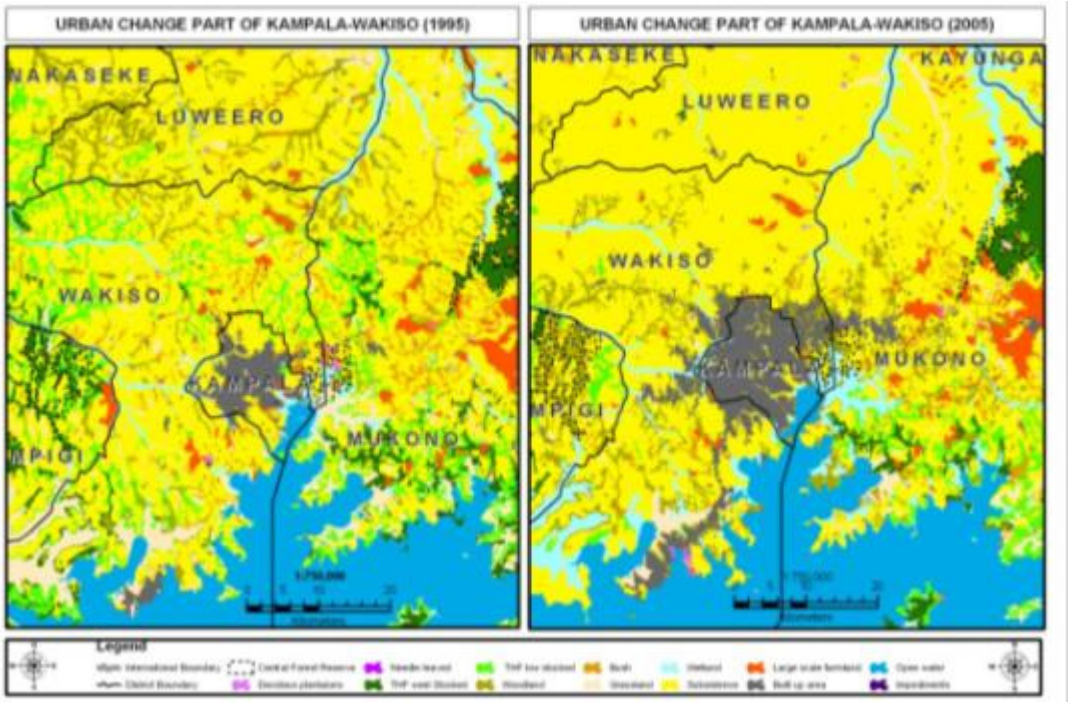


Figure 3-18 Urban expansion in Kampala and Wakiso

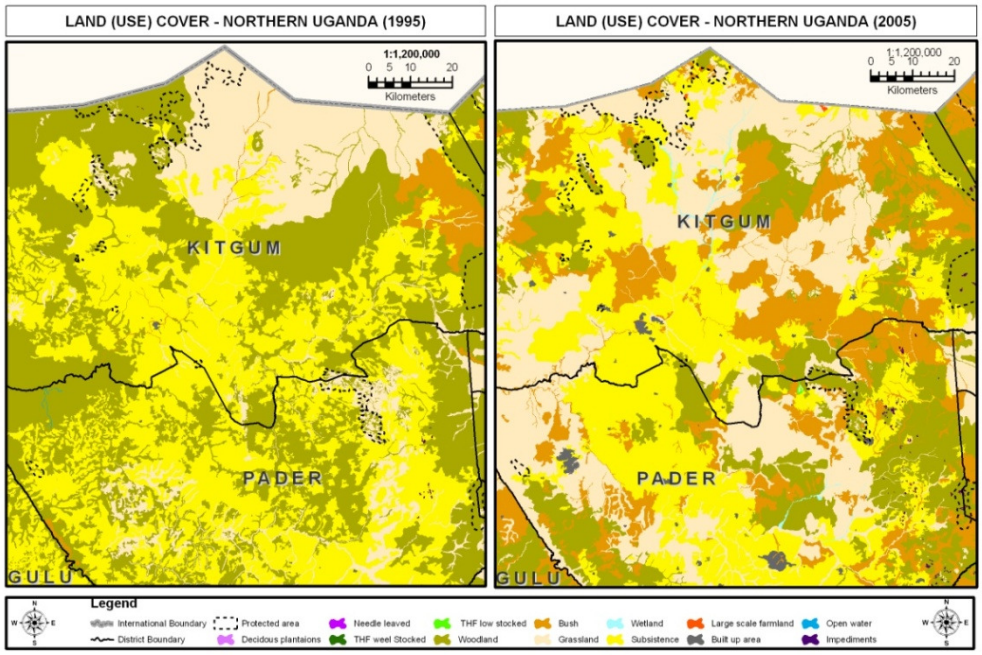
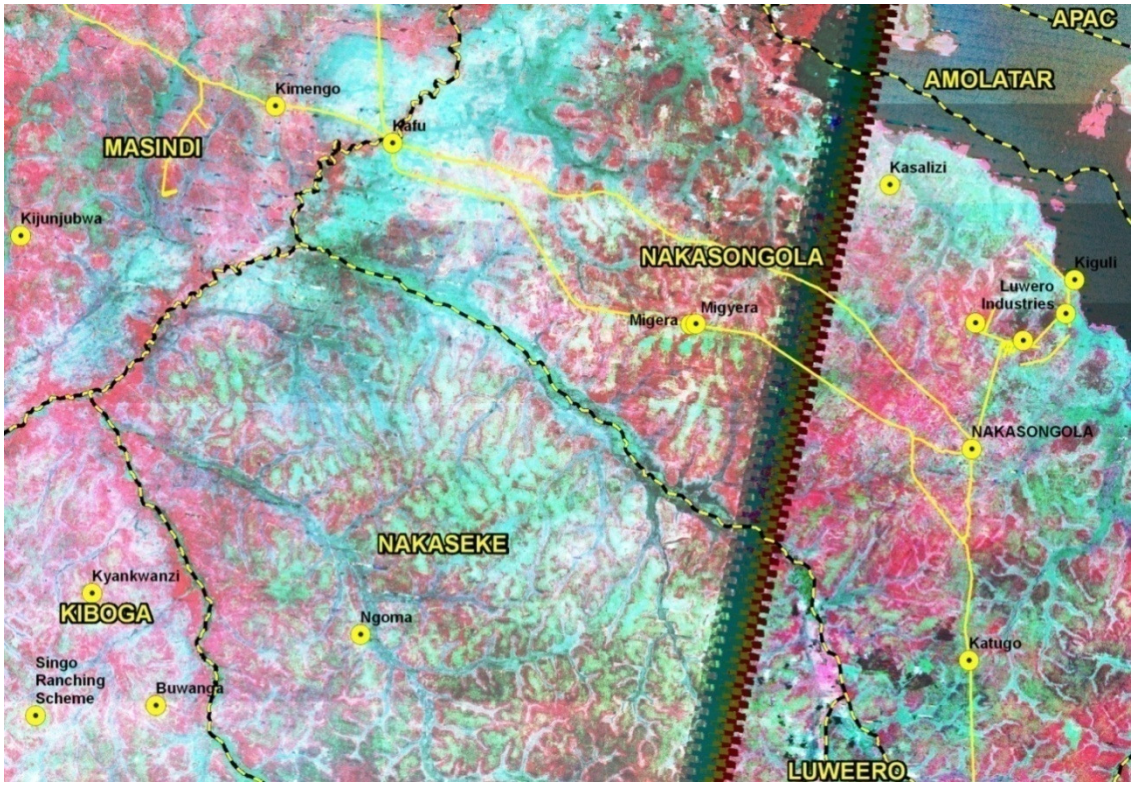


Figure 3-19 Shrinking Agriculture in Northern Uganda

Figure 3-20 IDP Camp in Northern Uganda

Figure 3-21Charcoal burning in Nakasongola, Nakaseke & Luweero

Figure 3-22 Desertification in Nakasongola & Nakaseke from a satellite image



3.3.8 Change in Commercial agriculture by district

Table 3-8 Districts with the highest acreage of commercial agriculture

Districts With the Highest Acreage of Commercial Agriculture				
District	Class	Area 2005 (Ha.)	Area 1990 (Ha.)	Difference
MUKONO	10	20035.26	15136.85	4898.41
KASESE	10	18714.02	4253.20	14460.82
MASINDI	10	12631.62	10892.06	1739.56
JINJA	10	10924.55	8192.51	2732.04
KABAROLE	10	5479.01	5273.92	205.09
BUTALEJA	10	4791.64	3296.96	1494.68
RAKAI	10	3741.56	160.64	3580.92
KYENJOJO	10	3631.97	2908.43	723.53
WAKISO	10	3411.52	2401.30	1010.22

Table 3-8 shows some of the districts with the highest acreage of commercial agriculture in Uganda. The crops grown include sugar cane, tea, rice, palm oil, cotton, sun flower and maize. Figure 3-23, is an illustration of forest clearance to give way for growing of palm trees for oil production in Kalangala and **Figure 3-24** shows a young Palm oil tree plantation. The entourage

Figure 3-23 Evidence of deforestation for commercial Farmland Kalangala

Figure 3-24 A young Palm oil tree plantation in Kalangala

3.3.9 Highest increments in commercial farmland by district

Table 3-9 Districts with the highest increment in commercial agriculture.

District	Class	Area 2005 (Ha.)	Area 1990 (Ha.)	Difference
KASESE	10	18714.02	4253.20	14460.82
MUKONO	10	20035.26	15136.85	4898.41
RAKAI	10	3741.56	160.64	3580.92
KALANGALA	10	3118.61		3118.61
JINJA	10	10924.55	8192.51	2732.04
MASINDI	10	12631.62	10892.06	1739.56
BUTALEJA	10	4791.64	3296.96	1494.68
KAPCHORWA	10	1411.54	18.32	1393.22
MAYUGE	10	2006.27	660.41	1345.86
MBALE	10	1251.23		1251.23

Table 3-9, shows districts which have shown the dramatic increment in commercial agriculture. For example Kalangala had no commercial agriculture at all in 1990. By 2005, over 31,000 ha of land had been put under commercial agriculture. The crop cultivated is palm tree. However, Kasese district had the highest increment in commercial agriculture where by cotton and maize the main crops grown.

Figure 3-25 A cotton field in Kasese District

3.3.10 Change in Built up areas

Table 3-10, shows districts with the largest change in built up areas. The highest change took place in Wakiso district which absorbs the expansion of Kampala city.

Table 3-10 Districts with the highest change in built up areas

District	Class	Area 2005 (Ha.)	Area 1990 (Ha.)	Difference
WAKISO	11	14,933.32	3,084.83	11,848.49
KAMPALA	11	14,951.49	8,150.31	6,801.17
PADER	11	6,071.26	325.63	5,745.64
MUKONO	11	6,236.12	1,441.26	4,794.86
KITGUM	11	3,403.60	333.85	3,069.75
LIRA	11	3,688.88	891.29	2,797.59
GULU	11	2,722.89	679.34	2,043.55
AMURIA	11	2,149.21	295.79	1,853.42
MUBENDE	11	1,866.48	323.42	1,543.06
MPIGI	11	1,650.04	383.13	1,266.92
ARUA	11	1,732.50	475.57	1,256.93

More urbanisation around Kampala is evidently spilling into Mukono as well. The dramatic expansion of built up areas in the Northern Uganda districts of Pader, Gulu, Lira and Kitgum is due to creation of Internally Displaced People (IDP) Camps such as Palabek and Unyama.

Table 3-11 Districts with the highest acreage of built up area

District	Class	Area 2005 (Ha.)	Area 1990 (Ha.)	Difference
KAMPALA	11	14,951.49	8,150.31	6,801.17
WAKISO	11	14,933.32	3,084.83	11,848.49
MUKONO	11	6,236.12	1,441.26	4,794.86
PADER	11	6,071.26	325.63	5,745.64
LIRA	11	3,688.88	891.29	2,797.59
KITGUM	11	3,403.60	333.85	3,069.75
GULU	11	2,722.89	679.34	2,043.55
JINJA	11	2,494.54	1,825.39	669.15
AMURIA	11	2,149.21	295.79	1,853.42
KASESE	11	1,920.73	1,230.90	689.82
MBARARA	11	1,875.66	885.22	990.44
MUBENDE	11	1,866.48	323.42	1,543.06

Table 3-11 shows some of the districts with the highest acreage of built areas in Uganda. On top of the list is Kampala district. As it runs short of space for expansion, Wakiso is catching up very fast and will soon over take it in terms of built up area. For example in 1990, the built up area in Kampala was almost three times that of Wakiso. By 2005 they were at par and by the time of writing this report, built up in Wakiso district could have been bigger than that of Kampala. From 1990, built up area in Wakiso has grown five times.

3.4 Biomass Stock

The Biomass monitoring exercise covered most of the country but some classes were not covered. This means mean biomass stock per sub-stratum is not available. Data collection for some of these strata was deliberately delayed for various reasons. It was hoped that biomass for forest plantations would be got from traditional forest inventories and that of wetlands would be got from the Wetlands Department. In addition, these are areas that do not normally produced woody biomass for harvesting for energy. Therefore the national and district biomass figures given here do not include biomass from these land cover types. Classes that lack biomass mean stock are:

- Coniferous plantation
- Wetland
- Commercial farmland
- Built up area
- Open Water
- Impediments

Table 3-12 shows the amount of woody biomass calculated for different classes. In 1990, Tropical High Forests and woodlands contained the most biomass but were competing with small scale farmland. In 2005, biomass reduced considerably in low stocked tropical high forests, woodlands and small scale farmland. The area of well stocked high forests reduced from about 650 to 540 thousand hectares but the biomass increased. This is because forests in protected areas (such as Mabira Central Forest Reserve and Mt. Elgon National Park) improved in quality and hence biomass, but those outside decreased a lot in acreage and quality. Small scale farmland remained almost the same in acreage but the amount of biomass reduced. This shows that many large trees and patches of forests within farmland reduced.

3-12 National woody Biomass by Class

Class	Biomass (Tons) 1990	Biomass (Tons) 2005	Area(ha) 1990	Area (ha) 2005
Broad leaved	1,702,827	1,438,177	18,682	14,841
Coniferous plantations			16,384	18,767
THF well stocked	129,591,090	162,126,739	651,110	540,289
THF low stocked	25,906,891	30,882,558	273,062	201,644
Woodland	132,468,709	86,044,859	3,974,508	2,818,922
Bush	17,865,384	26,883,367	1,422,193	2,970,318
Grassland	44,247,586	29,559,256	5,115,426	4,064,332
Wetland			484,030	753,041
Small scale farmland	112,569,687	53,160,922	8,400,790	8,854,671
Large scale farmland			68,447	106,630
Built up area			36,572	97,270
Open Water			3,689,603	3,706,732
Impediments			3,741	7,804

3.4.1 Biomass Distribution

Biomass distribution is directly related to the tree content in a land cover type. Well stocked tropical high forests have the highest biomass while grass lands have the lowest. It therefore follows that areas with forests and large trees have high biomass as opposed to pasture and rangelands. The western axis forest system; L. Victoria Shoreline System and Mount Elgon have the highest biomass. The farmlands of Eastern Uganda and the range lands of the cattle corridor have the lowest biomass.

Total biomass per district range from 30,000 tons to 25 million tons as Table 3-12 shows. Figure 3-26 to Figure 3-29 show comparisons of biomass analysed to compare total district biomass, biomass density and changes in total biomass and density.

Table 3-13 District Biomass Standing Stock 2005

REGION	DISTRICT	District Tons (000)	Broad leaved Plantation	THF well stocked	THF low stocked	Wood land	Bush	Grass land	Small scale farmland
Central	KALANGALA	4,628		2,652	1,162	604	14	53	143
Central	KAMPALA	30	3			17	2	0	8
Central	KAYUNGA	1,544	13	142	43	669	146	25	506
Central	KIBOGA	4,877			773	1,971	912	350	871
Central	LUWEERO	1,830	20	18		463	320	132	876
Central	LYANTONDE	625				2	342	152	129
Central	MASAKA	4,898	28	1,373	1,598	398	180	338	983
Central	MITYANA	3,031	41	1,435	462	373	42	35	643
Central	MPIGI	7,870	15	3,515	2,010	782	225	310	1,012
Central	MUBENDE	5,529	9	884	1,012	1,172	312	290	1,851
Central	MUKONO	17,679	48	10,274	4,570	1,080	81	192	1,434
Central	NAKASEKE	5,014	8			3,845	575	128	457
Central	NAKASONGOLA	3,486				1,305	1,510	217	455
Central	RAKAI	5,941	77	3,641	239	297	341	787	558
Central	SEMBABULE	1,556				147	449	505	455
Central	WAKISO	2,265	64		588	555	18	11	1,030
Eastern	AMURIA	1,431				74	195	114	1,048
Eastern	BUDAKA	194	6						188
Eastern	BUDUDA	1,694	7	1,539		65	23		59
Eastern	BUGIRI	1,487		214	143	211	13	64	842
Eastern	BUKEDEA	459				2	47	51	359
Eastern	BUKWO	2,718	3	2,365	1	147	126	2	75
Eastern	BUSIA	513	2	8	1	56	104	5	337
Eastern	BUTALEJA	234				0	1	1	232
Eastern	IGANGA	1,113				1	14		1,098
Eastern	JINJA	395	72			2	7	12	301
Eastern	KABERAMAIDO	890				278	92	15	505
Eastern	KALIRO	337					44	0	293
Eastern	KAMULI	2,271	8			117	283	26	1,837
Eastern	KAPCHORWA	3,472		2,712	1	252	356	13	139
Eastern	KATAKWI	1,620				222	76	674	647
Eastern	KUMI	711				14	74	31	592
Eastern	MANAFWA	2,681	5	2,355		79	20	1	221
Eastern	MAYUGE	953	55		70	269	9	23	528
Eastern	MBALE	840	26	495		119	3	1	196

Eastern	NAMUTUMBA	341					21	2	318
Eastern	PALLISA	583	3			4	4	0	572
Eastern	SIRONKO	2,384		1,690	21	193	154	111	216
Eastern	SOROTI	1,267				35	217	55	960
Eastern	TORORO	587	7			20	7	8	544
Northern	ABIM	3,096				1,887	761	253	195
Northern	ADJUMANI	8,200	36	415		6,640	503	200	407
Northern	AMOLATAR	509				131	58	27	294
Northern	AMURU	14,668				11,064	919	2,045	641
Northern	APAC	2,635	14			684	513	117	1,307
Northern	ARUA	3,038	78			1,466	129	165	1,201
Northern	DOKOLO	457				8	70	18	361
Northern	GULU	4,818	158			3,366	412	336	547
Northern	KAABONG	6,567				1,600	1,831	2,833	303
Northern	KITGUM	10,338			1	4,230	1,637	3,234	1,236
Northern	KOBOKO	778	1			274	107	63	334
Northern	KOTIDO	2,790				493	698	1,182	417
Northern	LIRA	2,629	14			455	218	68	1,875
Northern	MOROTO	8,661				3,170	2,118	2,654	719
Northern	MOYO	1,901	2			1,093	197	269	341
Northern	NAKAPIRIPIRIT	5,960				2,001	1,165	2,681	114
Northern	NEBBI	2,246	20		1	617	141	319	1,147
Northern	NYADRI	1,489	86			373	13	258	760
Northern	OYAM	1,268	50			176	102	35	904
Northern	PADER	7,995			33	4,129	840	1,527	1,467
Northern	YUMBE	3,302				2,285	240	140	638
Western	BULIISA	6,079		5,235	11	55	525	162	91
Western	BUNDIBUGYO	14,609		12,337		791	136	876	469
Western	BUSHENYI	24,501	69	20,882	145	1,359	303	608	1,134
Western	HOIMA	19,068	12	12,175	3,329	1,297	1,060	288	907
Western	IBANDA	1,963	2	1,263	12	147	50	136	353
Western	ISINGIRO	1,696	14			21	446	818	397
Western	KABALE	3,244	32	2,576		14	8	31	583
Western	KABAROLE	13,165	178	11,263	226	588	154	79	679
Western	KAMWENGE	10,362		8,336	89	947	99	81	811
Western	KANUNGU	7,419	46	6,305		164	50	205	649
Western	KASESE	14,892	3	12,468	6	1,006	354	519	536
Western	KIBAALE	18,158	2	8,244	5,150	1,528	285	113	2,836
Western	KIRUHURA	3,884			4	1,024	1,534	635	686
Western	KISORO	2,932	26	2,434		231	14	1	226
Western	KYENJOJO	20,814	25	8,064	8,479	1,916	268	161	1,900
Western	MASINDI	24,825	2	9,015	703	12,382	1,299	552	873
Western	MBARARA	1,140	43			53	88	598	357
Western	NTUNGAMO	949	3			74	89	335	449
Western	RUKUNGIRI	6,993		5,772		419	92	206	505

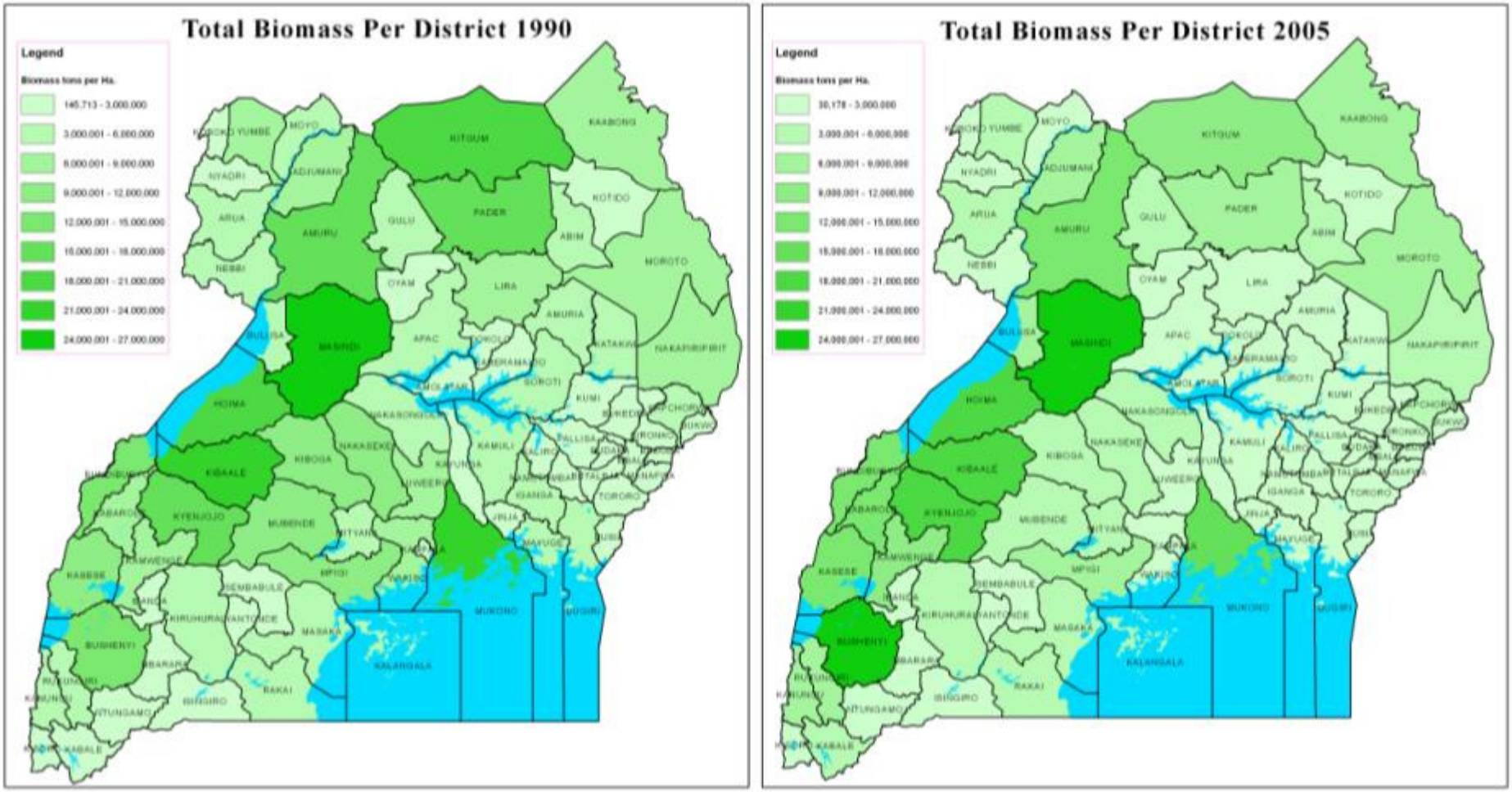


Figure 3-26 Biomass by District

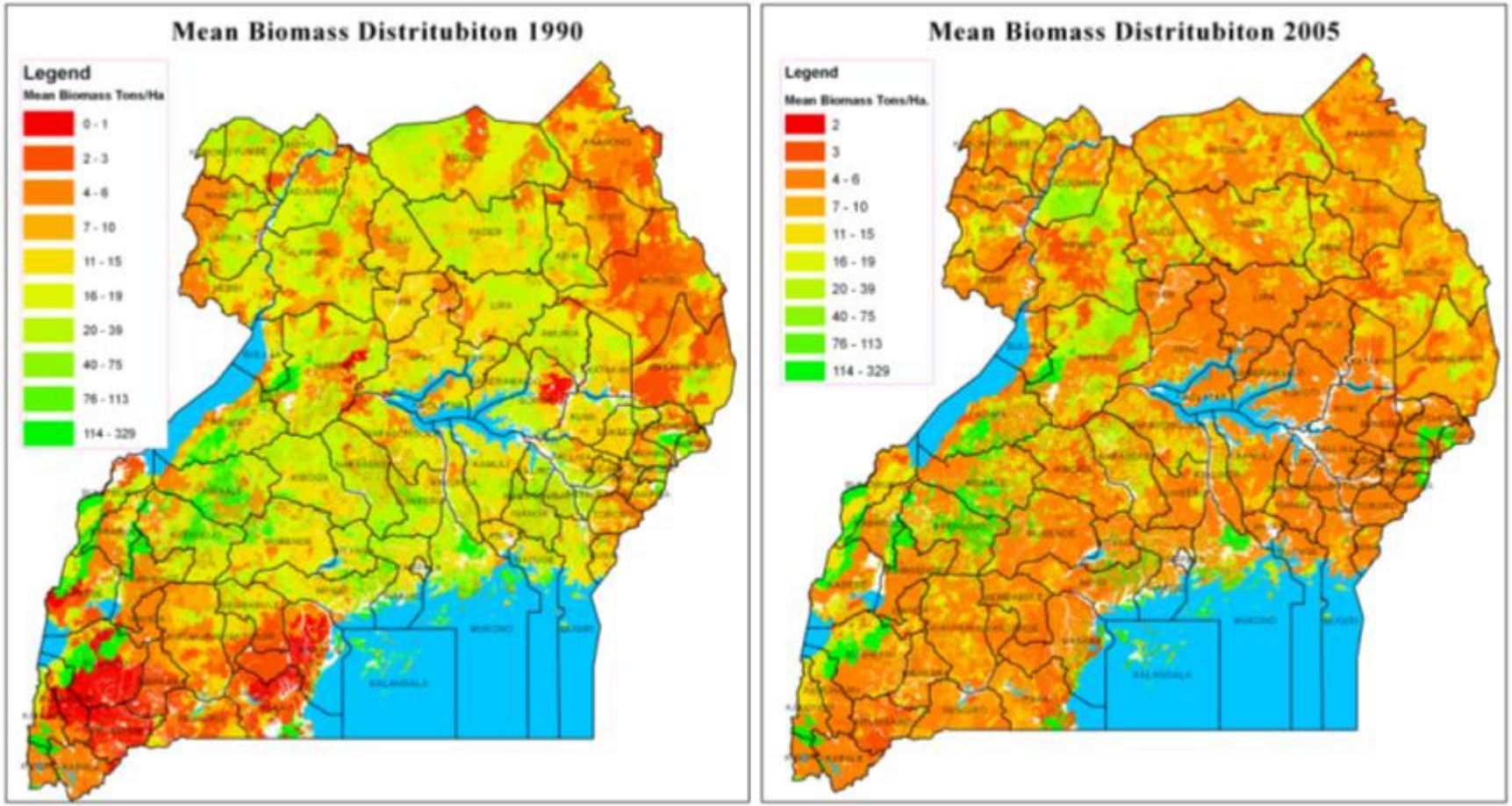


Figure 3-27 Mean biomass per hectare

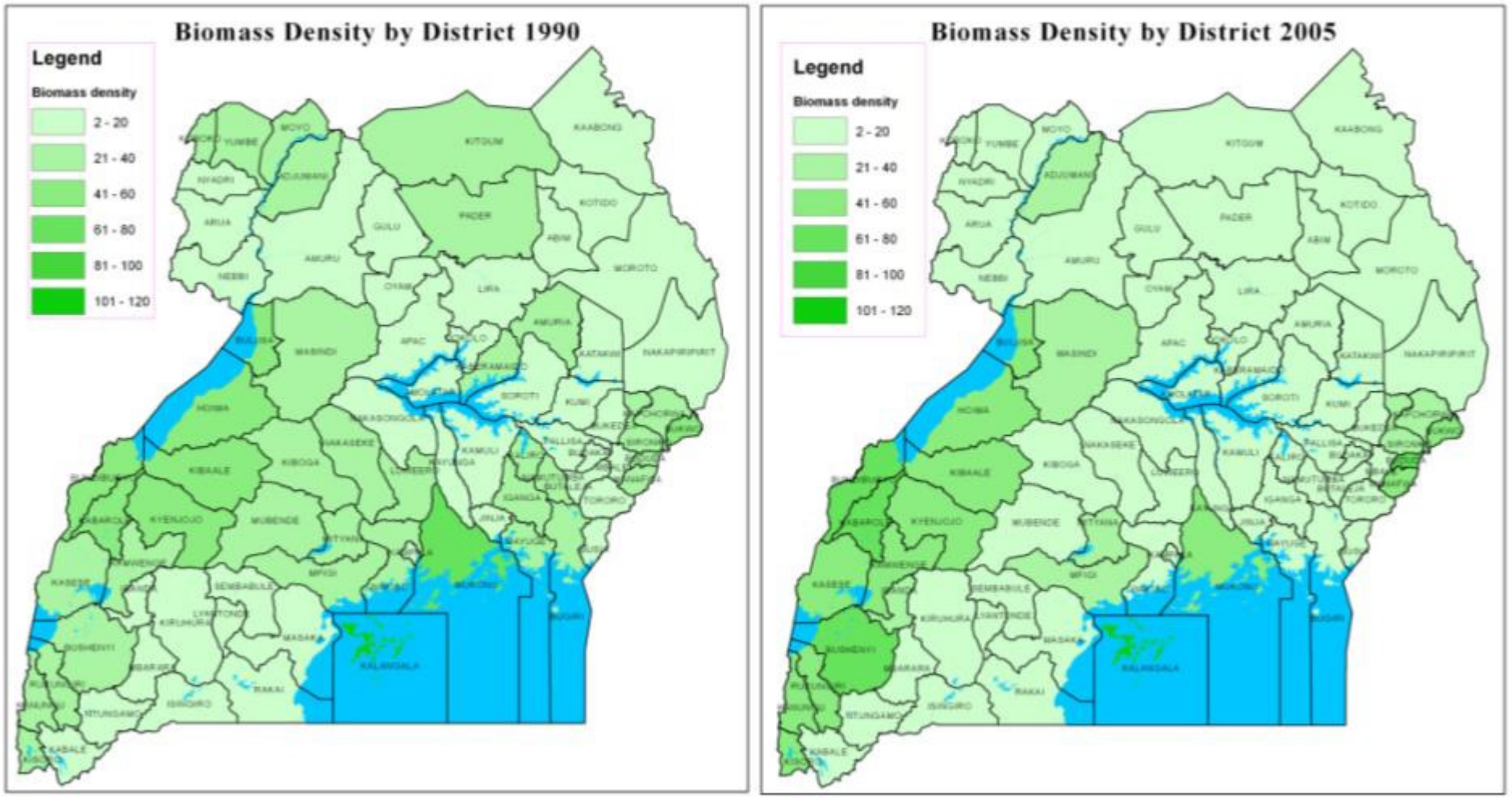


Figure 3-28 Mean Biomass Density by District

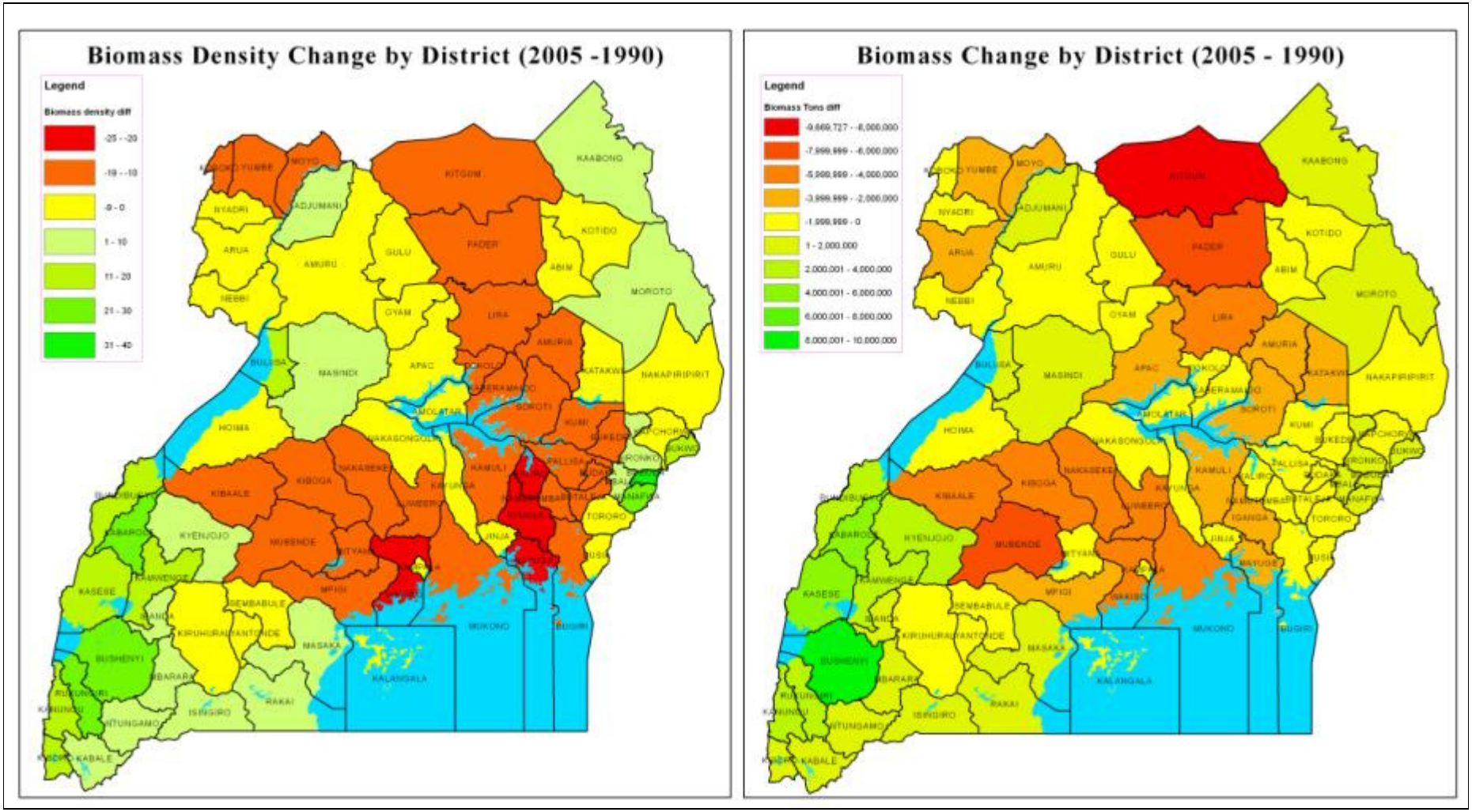


Figure 3-29 Biomass Density and Total Biomass Change

3.4.2 Comparison of 1990-2005 biomass Stocks

Table 3-14 shows districts that had more than 10 million tons of woody biomass. Total biomass in a district is a function of the biomass stocking per ha and the size of the land cover class. Districts shown in the table contain tropical high forests of well stocked woodlands. Masindi, Kibaale and Mukono districts had the highest amount of biomass. The northern districts of Kitgum Pader and Amuru have big chunks of woodlands that accounted for their high biomass stocks.

Table 3-14 Districts that had more than 10 million tons of biomass

REGION	DISTRICT	AREA(ha)	Tons_Ha_1990	Tons_Ha_2005
Western	MASINDI	755,829	24,048,438.20	24,824,503.50
Western	KIBAALE	440,020	23,527,335.89	18,157,621.41
Central	MUKONO	1,265,581	21,761,689.08	17,684,324.50
Northern	KITGUM	963,459	20,007,440.52	10,337,713.24
Western	HOIMA	577,873	19,631,097.06	19,067,633.67
Western	KYENJOJO	405,440	16,882,705.27	20,813,692.84
Northern	AMURU	842,700	16,150,838.40	14,668,018.30
Northern	PADER	692,934	15,764,262.08	7,995,248.93
Western	BUSHENYI	429,257	14,951,200.27	24,500,662.47
Western	BUNDIBUGYO	226,170	12,026,151.45	14,614,052.12
Central	MUBENDE	462,643	11,539,634.61	5,529,190.46
Central	MPIGI	360,562	11,353,567.91	7,870,293.47
Central	KIBOGA	404,552	10,605,032.88	4,876,714.04

Table 3-15 shows districts which had more that 10 million tons of woody biomass in 2005. Masindi District still tops the list but there is a change in the order of superiority as you go down the list. Kibaale district drops from the second to the fifth position with biomass dropping from 23.5 million to just above 18 million tons. Bushenyi which was in the 9th position is elevated to the second. The boost in Bushenyi biomass is due to the development of the low stocked THF of 3LO and 3ME to high stocked THF of 3HI.

In Kibaale there were also some development of 3LO and 4ME into 3HI but there was also areas of 3LO and 5HI the turned into farmland such as 9LO and 9HI. In Masindi, there was development of 5LO to 5HI and 3LO to 3HI which compensated for woodlands that turned into farmland.

Table 3-15 Districts that had more than 10 million tons in 2005

REGION	DISTRICT	AREA(ha)	Tons_Ha_1990	Tons_Ha_2005
Western	MASINDI	755,829	24,048,438.20	24,824,503.50
Western	BUSHENYI	429,257	14,951,200.27	24,500,662.47
Western	KYENJOJO	405,440	16,882,705.27	20,813,692.84
Western	HOIMA	577,873	19,631,097.06	19,067,633.67
Western	KIBAALE	440,020	23,527,335.89	18,157,621.41
Central	MUKONO	1,265,581	21,761,689.08	17,684,324.50
Western	KASESE	338,962	9,401,726.98	14,914,835.14
Northern	AMURU	842,700	16,150,838.40	14,668,018.30
Western	BUNDIBUGYO	226,170	12,026,151.45	14,614,052.12
Western	KABAROLE	182,446	8,155,275.77	13,165,267.12
Western	KAMWENGE	243,944	7,848,612.08	10,362,077.76
Northern	KITGUM	963,459	20,007,440.52	10,337,713.24

3.4.3 Biomass Density

Biomass density is a measure of the total amount of biomass in a district compared to the size of the district. Biomass density is a good measure to determine the trend of biomass stocks in a district. If total biomass per district is used as a measure for comparison districts with huge chunks of forests or those that are big in size would come on top giving an impression that they are doing well. On the other hand small districts with less acreage of wood resources would look as performing poorly.

Table 3-16 shows biomass density of districts that came top on the list in the whole country. The eastern districts of Bududa, Manafa and Bukwo are districts that contain part of Mt. Elgon national Park. Conservation efforts led to some of the very degraded areas in the 1980 and early 1990s revert back to forests. There was a development of 3LO and 4LO into 3HI.The other districts on the list have forests and some of them are protected. Thus an increment in stocking in those areas led to a positive change in biomass density.

Table 3-16 Districts with increment in biomass density

REGION	DISTRICT	AREA	Bio_den90	Bio_dens05	Change
Eastern	BUDUDA	27,390.09	24.26	63.44	39.18
Western	KABAROLE	182,445.57	44.91	72.51	27.59
Eastern	MANAFWA	58,076.88	20.16	46.17	26.01
Western	BUSHENYI	429,257.33	38.11	62.46	24.34
Western	RUKUNGIRI	156,677.91	27.93	48.29	20.36
Western	KANUNGU	129,213.93	38.34	58.21	19.87
Western	KASESE	338,962.30	31.56	50.07	18.51
Western	BUNDIBUGYO	226,169.93	57.55	69.93	12.38
Western	BULIISA	188,483.84	43.06	54.23	11.18
Western	KISORO	72,966.70	30.88	41.80	10.92
Western	KAMWENGE	243,944.08	33.05	43.63	10.58
Eastern	BUKWO	52,556.91	41.59	51.71	10.13
Western	KYENJOJO	405,440.48	41.64	51.34	9.70

Table 3-17 shows districts that have experienced decrease in bio-density. On top of the list is Kaliro district whose bio-density had dropped from 29 to just above 4 tons; a reduction of 25tons per hectare. Biomass density change brings out the severity better than total district biomass change as shown in .Note that Kaliro and other districts in Eastern Uganda such as Mayuge, Iganga Namutumba, Butaleja and others were famous for high Biomass within the farmland areas. In fact some the districts like Kamuli and Iganga were classified as districts with surplus biomass in the Phase I Biomass Technical report. In most of these districts, the reduction in bio-density is the change of biomass stock in farmland namely 9HI and 9ME to 9LO. This came as a result of felling the huge Mvule trees that were a common land mark of the region. This has translated into a rolling landscape that lacks trees.

Table 3-17 Districts with decrease in biomass density

REGION	DISTRICT	AREA (HA)	Bio_den90	Bio_dens05	Change
Eastern	KALIRO	86,852.93	29.23	4.31	-24.92
Central	WAKISO	280,775.36	32.97	11.84	-21.13
Eastern	MAYUGE	463,858.91	29.91	8.79	-21.12
Eastern	IGANGA	166,965.49	26.94	6.66	-20.28
Central	LUWEERO	222,170.26	27.84	8.24	-19.60
Eastern	NAMUTUMBA	81,268.41	22.21	4.20	-18.01
Northern	KOBOKO	75,622.40	25.96	10.29	-15.67
Eastern	AMURIA	258,298.29	20.34	5.54	-14.80
Eastern	KABERAMAIDO	162,396.50	21.06	6.75	-14.31
Central	KIBOGA	404,551.93	26.21	12.05	-14.16

Eastern	BUTALEJA	65,544.96	17.50	3.58	-13.92
Central	NAKASEKE	347,224.91	28.33	14.45	-13.88
Central	MUBENDE	462,643.02	25.10	12.03	-13.07
Western	KIBAALE	440,020.08	55.41	42.76	-12.65
Central	MUKONO	1,265,581.38	64.31	52.26	-12.05
Northern	YUMBE	240,301.88	25.57	13.80	-11.78
Northern	LIRA	440,405.07	17.57	5.99	-11.59
Eastern	KAMULI	343,303.60	19.53	8.07	-11.46
Northern	MOYO	189,072.45	21.92	10.63	-11.29
Northern	PADER	692,933.95	22.76	11.55	-11.22
Eastern	KUMI	179,350.56	15.21	4.19	-11.02
Northern	DOKOLO	108,731.54	15.36	4.61	-10.75
Eastern	BUGIRI	567,097.37	20.24	9.54	-10.69
Central	MPIGI	360,561.67	34.68	24.04	-10.64
Eastern	BUKEDEA	105,466.09	14.85	4.36	-10.49
Eastern	PALLISA	158,114.01	14.31	3.84	-10.47
Eastern	SOROTI	337,770.03	14.75	4.47	-10.28
Eastern	BUDAKA	41,060.42	15.00	4.73	-10.27
Northern	KITGUM	963,458.81	20.77	10.73	-10.04
Central	MITYANA	157,130.91	30.11	20.11	-10.00

In Mukono, biomass stock in farmland has reduced from 9HI to 9LO. There are also many places where low stocked tropical high forests have change to farmland and woodlands. Nakaseke District which is a major source of fuel wood for Kampala has seen its woodlands of 5ME converted to shrub lands of 6LO and farmlands of 9LO. Highly stocked farmlands of 9HI have degenerated to 9LO. This is a similar case to neighbouring Mubende where most 9HI and 5ME have changed to 9LO.

It is therefore not only areas with tropical high forests and woodlands that have experienced significant reduction in biomass but even predominantly farmland areas that used to have large trees that are no longer standing.

3.5 Drivers of Land Cover/Biomass Change

In most of the country, biomass standing stock has reduced and on the land cover side, classes that contain high stocks of biomass have reduced in size.

The Eastern districts of Uganda have been and are still under agriculture. Previously, there were many big trees which contributed to high levels of biomass of 9HI. Most of these trees and shrubs have been removed and currently, these areas are now 9LO. So even though areas have remained under the same land cover type, biomass levels have reduced. This is largely due to harvesting of biomass for fuel or for timber. Note that the big Mvule trees that used to be common in the east contributed greatly and removal of even a few can cause a big difference in biomass standing stock.

Areas that had forest lands especially in central and western Uganda have shrunk and land continues to be converted into agriculture. Other forest lands have deteriorated into woodlands, but mostly into shrub lands. Indeed the acreage under shrub land has greatly increased. Converting 1 hectare of well stocked forest into shrub land means a reduction in biomass from about 328 tons/ha to about 10 tons/ha. Where forested land has not been converted to agriculture, the cause of deforestation has been largely due to harvesting wood for fuel. Deforestation due to excessive timber logging degrades a forest but at least some trees that are not good for timber may be left standing. Such trees include those of poor form and the species are not good for timber. In the case of harvesting for fuel, all the wood irrespective of form or species, are harvested.

In the case of charcoal production, there is preference for particular species of high density like Combretum species. However, as scarcity comes in, such preferences

cease. What matters is wood that can produce charcoal for sale. Areas near markets such as those in one hours' drive to Kampala have suffered a lot.

Forest areas degraded into shrub land immediately become targets for cultivation. After all, such areas are believed to be very fertile. This has been common in the central region and partly in the eastern region. In the western parts of the country such as Kibaale, forests are deliberately cut to clear land for cultivation. It is not uncommon to find huge logs charred and laying in newly opened gardens.

Forested areas that were near urban areas have eventually also been cleared for infrastructure and construction. Forests around Kampala and in Wakiso districts have become built up areas or have been cut to feed energy-hungry urban activities such as brick making, bakery, and domestic cooking. Economic development and urbanisation has also contributed in terms of construction. For example built up areas in Kampala covered 8,000ha and Wakiso 3,000ha in 1990. By 2005, built up areas in Kampala and Wakiso had each grown to about 15,000ha (see Table 3-10). Wood is used in construction right from the pegs that mark the foundation of the building through scaffolding and roofing to furnishing. In a nutshell, factors that have influence Uganda's landscape are very well interlinked and include:

- Harvesting of wood fuel for domestic and industrial use such as brick making, schools, bakery, domestic cooking, hotels etc.
- Agricultural expansion to produce more food and cash crops
- Population growth that increases demand for resources from land
- Timber production to supply timber to a fast growing economy and fast growing population
- Turbulence in the Institutional framework for managing forests

By 1990, 70% of the forest estate was located on private land. By 2005, it had reduced to 64%. Meaning government was controlling 30% but by 2005, it was controlling 36%. Either way, the majority of the forest estate is not under planned management. Even protected forests have not been unscathed.

Between 1990 and 2005, forests have gone through institutional turbulent periods that led to wanton destruction of forest. Central Forest Reserves were decentralised in 1993 from Forest Department to local governments presumably for easier conservation and management. Anarchy ensued as the forest resources were harvested unprofessionally with a sole aim of generating revenue. Local governments needed this revenue to inject in their institutions such as education health water etc.

It soon became clear that Local governments lacked capacity to manage forests and the forests were recentralised in late 1995. According to Nsiita, 2004 the damage had already been done. Local governments had tasted the revenue from forests and were not willing to let go. Deforestation and encroachment that had begun could not easily be reversed. Local politicians used forests as baits to the local people for votes. This pitted forest managers against the populations and this trend still persists. Encroachers learn that they can occupy and live on forest reserves and politically bargain for their stay. Up to now, many forest reserves are under encroachment.

A similar situation happened during the process of dissolving the Forest Department and the birth of National Forestry Authority. During that period of uncertainty, there was no effective management of the forest resource. There was discriminate harvesting of the resource and even encroachment on Forest reserves escalated.

In conclusion, the major drivers of forest degradation and depletion have been the high demand for fuel wood both in towns and in villages for both domestic and industrial purposes. There has also increasing demand for timber for the construction

and furniture industries bearing in mind that the national economy has been growing in excess of 6% annually for past two decades. Lastly, institutional turbulence in forest management left forest resources vulnerable and most of the problems created then are yet to be solved.

3.6 Intervention

The most logical intervention measure would be to reverse the deforestation trend and increase on the forest estate. The time when the satellite images were taken in 2004/05, is when NFA was taking root to effectively manage the central forest reserves. Since then forest protection measures have been put in place and tree growing has gone up to increase on the size of the forest estate. Some of the increment in area of forests by planting is of course cancelled by the harvesting of existing plantations that are already over-mature and must be harvested or salvaged.

Lack of raising forest plantations for many years has left a gap that will cause severe timber shortage. Therefore fast growing timber species need to be planted. Planting is being carried out by NFA in forest reserves. The private sector has been encouraged and supported to plant both on their land and land provided by NFA in forest reserves. Grassland forest reserves have been planted by both parties but much more still need to be done.

Degraded areas have been protected and forests are recovering. A good example is the eastern part of Mabira CFR which had turned into banana plantations but is now completely covered by a young colonising forest. Forest protection must be a collective responsibility encompassing NFA surrounding communities and politicians.

Households should be encouraged to raise woodlots as a subsistence or even commercial source of wood for fuel and construction. High fuel wood consumers such as schools should emulate tea companies in raising private woodlots. Areas that have long lost their wild bushes like Bushenyi Ntungamo, Masaka already have such woodlots.

A good solution to wood energy would be increased rural electrification so that some cooking and water heating can be done using electricity. However, electricity is in short supply and prohibitively expensive that even the majority of the population in urban areas use wood energy for cooking.

Legislation on forests is in place but is not functional in many aspects. Whereas local governments are supposed to be fully engaged in managing forests outside Central Forest Reserves, they still lack capacity. Forests on private land are still facing forces of high population growth and economic development unabated.

4 Conclusions and recommendations

4.1 Conclusions

The 2005 land cover map is a public good which fulfils the mandate of NFA as prescribed in The National Forests and Tree planting Act of 2003. The 2005 map is the second land cover map to cover the whole of Uganda after the 1990 land cover map. Besides providing information on the spatial distribution and extent of different land cover types, the 2005 map also provides more detail in distinguishing land cover types, as well as the first evidence to assess land cover change and also project into the future.

The map confirms land cover change and it provides evidence that forest cover, and especially Tropical High Forest as well as hardwood plantations are shrinking. A lot have been converted to shrub land or agriculture; land cover types of low biomass

There has been major expansion of major urban areas like Entebbe, Kampala and Mukono almost growing into a conurbation. Built up areas also increased in northern Uganda when we consider large internally displaces peoples' camp although these are winding up as peace returns to the region. The Land cover map 2005 also confirms that insecurity in Northern Uganda had negatively affected agriculture in the region. In other areas, there has been high percentage increase in farmland the increase being more dramatic in Kiruhura district. Karamoja area has also seen a dramatic increase in subsistence agriculture which is indicative of diversification of livelihood strategies to supplement livestock.

Commercial agriculture increased in the central and eastern parts of Uganda, while the change was insignificant in the North and Western parts of Uganda.

Land degradation has been seen to be more severe in Nakasongola and Nakaseke districts which are already reflecting signs of desertification. Bare hill and soil erosion are very evident in the highlands of Rakai.

Deforestation and degradation was most in Local Forest Reserves followed by Central forest Reserves and least in National parks. This is directly proportion with the level of protection enforcement. Although other means such as sensitisation helped in protecting National parks, armed personnel has help to discourage encroachers in national parks.

There are districts especially in eastern and central Uganda which did not have forests but had high biomass on farmland. Many of them have shown severe decline in biomass leaving behind a population with less and less wood resources.

4.2 Recommendations

This report contains the most recent detailed land cover information for Uganda. From the information revealed by this report, it is recommended that:

1. Districts with low biomass density be encouraged to plant woodlots for the supply of fuel wood and building materials
2. Remaining woodlands should be managed more scientifically. Inventories should be carried out to establish biomass available after which harvesting should be controlled through licensing.
3. Livestock in the central cattle corridor like Luwero, Nakasongola and Nakaseke be controlled to avoid overgrazing which is contributing to exposing soil to erosion

4. Search for fresh land for agriculture has contributed to forest cover loss and biomass reduction. Increasing agricultural productivity on the current cultivated areas could reduce the urge to cut down more forests.
5. Districts that have shown deforestation and forest degradation should take this as a warning for hard times to come in terms of adverse climatic change, lack of wood resource for timber and fuel wood. They should use this eye opener to mobilise their populations to stop wanton deforestation and start tree growing.
6. Many protected areas have been encroached upon and degraded of converted to other land uses. The government should politically and financially support bodies involved in management of these areas. Armed enforcement should be considered as a deterrent to keep away enchroachers
7. In view of the rate of deforestation and degradation, the government should step up planting quick maturing timber trees such as Pine and Cypress to mitigate imminent severe timber shortage in the country.
8. Area under shrub land doubled from 1.4million ha to 2.9million ha. In most cases, this has been as a result of degradation of high forests and woodlands. If protected, they are likely to recover just like Mabira CFR.
9. There should be more protection of the high biomass land cover types such as woodlands and high forests. Bare hills should also be protected and then planted. Protection could be through collaboration with the land owner, community forestry or outright gazettement
10. This Technical Report be used as a policy and planning tool to enhance interventions in land management for sustainable development.
11. This report gives a good entry point for those dealing with Reduced Emissions form Deforestation and Forest Degradation (REDD).
12. The population of Uganda is now estimated to be over 30 million people. It is recommended that priority zones for biomass monitoring be reviewed and re-demarcated based on the current population density and distribution
13. Uganda land cover maps 1990 and 2005 be adopted as teaching material at secondary and tertiary level as it is the only strong basis for reflecting land cover change in Uganda.
14. Data collected during the mapping period and biomass inventories are more detailed than those presented in this report. Researchers, planners and Resource Managers who may need more detailed information could contact NFA.
15. Last but not least, the government of Uganda should recognize and upscale funding for the land cover mapping exercise in order to enable automation of the processes and faster delivery of results. That will shorten the interval between the mapping exercises.

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6 Appendix

Appendix 1 Biomass by District

REGION	DISTRICT	OPEN WATER	LAND AREA	DISTRICT AREA	Tons_Ha_1990	Tons_Ha_2004	Area_ha	Bio_Diff
Central	KALANGALA	860,632	46,232	906,864	4,944,206	4,628,362	906,864	-315,844
Central	KAMPALA	1,690	18,011	19,700	145,713	30,178	19,700	-115,534
Central	KAYUNGA	12,284	157,956	170,240	2,771,430	1,544,202	170,240	-1,227,228
Central	KIBOGA	5	404,547	404,552	10,605,033	4,876,714	404,552	-5,728,319
Central	LUWEERO	70	222,100	222,170	6,183,295	1,830,409	222,170	-4,352,886
Central	LYANTONDE	50	87,311	87,361	958,976	625,011	87,361	-333,965
Central	MASAKA	112,424	356,750	469,174	3,485,663	4,898,366	469,174	1,412,702
Central	MITYANA	6,379	150,752	157,131	4,538,952	3,031,339	157,131	-1,507,612
Central	MPIGI	33,189	327,373	360,562	11,353,568	7,870,293	360,562	-3,483,274
Central	MUBENDE	2,937	459,706	462,643	11,539,635	5,529,190	462,643	-6,010,444
Central	MUKONO	927,207	338,374	1,265,581	21,761,689	17,684,324	1,265,581	-4,077,365
Central	NAKASEKE	165	347,060	347,225	9,830,898	5,013,632	347,225	-4,817,266
Central	NAKASONGOLA	25,732	325,265	350,997	4,836,317	3,486,007	350,997	-1,350,310
Central	RAKAI	73,390	330,121	403,511	4,868,809	5,940,876	403,511	1,072,067
Central	SEMBABULE	112	231,804	231,917	2,950,193	1,555,673	231,917	-1,394,520
Central	WAKISO	89,451	191,324	280,775	6,308,391	2,265,161	280,775	-4,043,230
Eastern	AMURIA		258,298	258,298	5,254,967	1,431,176	258,298	-3,823,791
Eastern	BUDAKA		41,060	41,060	615,832	194,201	41,060	-421,631
Eastern	BUDUDA		27,390	27,390	664,414	1,737,593	27,390	1,073,179
Eastern	BUGIRI	411,359	155,739	567,097	3,151,792	1,486,520	567,097	-1,665,272
Eastern	BUKEDEA	33	105,434	105,466	1,565,764	459,440	105,466	-1,106,324
Eastern	BUKWO		52,557	52,557	2,185,658	2,717,878	52,557	532,219
Eastern	BUSIA	2,867	73,074	75,940	1,157,392	513,191	75,940	-644,201
Eastern	BUTALEJA	9	65,536	65,545	1,146,605	234,331	65,545	-912,274
Eastern	IGANGA		166,965	166,965	4,498,371	1,112,824	166,965	-3,385,546
Eastern	JINJA	4,959	67,309	72,268	940,845	394,842	72,268	-546,003
Eastern	KABERAMAIDO	30,653	131,743	162,396	2,774,282	889,663	162,396	-1,884,619
Eastern	KALIRO	8,608	78,245	86,853	2,287,119	337,357	86,853	-1,949,762
Eastern	KAMULI	61,784	281,519	343,304	5,498,013	2,271,001	343,304	-3,227,012
Eastern	KAPCHORWA		120,616	120,616	3,813,276	3,472,133	120,616	-341,143

REGION	DISTRICT	OPEN WATER	LAND AREA	DISTRICT AREA	Tons_Ha_1990	Tons_Ha_2004	Area_ha	Bio_Diff
Eastern	KATAKWI	8,225	234,927	243,152	3,778,151	1,619,598	243,152	-2,158,552
Eastern	KUMI	9,793	169,558	179,351	2,579,714	710,743	179,351	-1,868,970
Eastern	MANAFWA		58,077	58,077	1,170,768	2,681,152	58,077	1,510,384
Eastern	MAYUGE	355,450	108,409	463,859	3,242,579	953,316	463,859	-2,289,264
Eastern	MBALE		51,816	51,816	578,802	839,868	51,816	261,066
Eastern	NAMUTUMBA	147	81,122	81,268	1,801,784	340,928	81,268	-1,460,856
Eastern	PALLISA	6,220	151,894	158,114	2,173,847	582,833	158,114	-1,591,015
Eastern	SIRONKO		109,391	109,391	2,314,059	2,383,855	109,391	69,796
Eastern	SOROTI	54,104	283,666	337,770	4,183,276	1,267,045	337,770	-2,916,231
Eastern	TORORO	48	119,336	119,383	1,290,693	586,646	119,383	-704,047
Northern	ABIM	25	235,246	235,271	4,695,338	3,096,325	235,271	-1,599,013
Northern	ADJUMANI	6,148	302,555	308,703	6,337,364	8,200,196	308,703	1,862,833
Northern	AMOLATAR	77,657	93,288	170,944	1,322,179	509,064	170,944	-813,115
Northern	AMURU	11,353	831,347	842,700	16,150,838	14,668,018	842,700	-1,482,820
Northern	APAC	37,362	396,182	433,545	5,758,126	2,635,082	433,545	-3,123,044
Northern	ARUA	3,944	307,343	311,287	5,792,205	3,038,318	311,287	-2,753,887
Northern	DOKOLO	9,535	99,196	108,732	1,523,867	457,289	108,732	-1,066,578
Northern	GULU	590	328,272	328,861	5,913,795	4,818,170	328,861	-1,095,626
Northern	KAABONG		726,372	726,372	6,433,570	6,566,888	726,372	133,318
Northern	KITGUM	181	963,278	963,459	20,007,441	10,337,713	963,459	-9,669,727
Northern	KOBOKO		75,622	75,622	1,963,155	778,210	75,622	-1,184,944
Northern	KOTIDO	7	362,885	362,892	2,966,702	2,790,019	362,892	-176,684
Northern	LIRA	1,116	439,289	440,405	7,720,484	2,629,472	440,405	-5,091,012
Northern	MOROTO		851,769	851,769	6,974,067	8,661,415	851,769	1,687,347
Northern	MOYO	10,161	178,912	189,072	3,921,171	1,901,158	189,072	-2,020,014
Northern	NAKAPIRIPIRIT		583,388	583,388	6,503,214	5,960,484	583,388	-542,730
Northern	NEBBI	9,028	282,699	291,726	4,038,710	2,245,584	291,726	-1,793,126
Northern	NYADRI	11	160,711	160,722	2,670,381	1,489,424	160,722	-1,180,957
Northern	OYAM	534	220,052	220,586	2,760,745	1,267,505	220,586	-1,493,241
Northern	PADER	453	692,481	692,934	15,764,262	7,995,249	692,934	-7,769,013
Northern	YUMBE	949	239,353	240,302	6,121,393	3,302,238	240,302	-2,819,155
Western	BULIISA	76,397	112,087	188,484	4,826,010	6,078,944	188,484	1,252,933
Western	BUNDIBUGYO	17,187	208,983	226,170	12,026,151	14,614,052	226,170	2,587,901
Western	BUSHENYI	36,976	392,282	429,257	14,951,200	24,500,662	429,257	9,549,462
Western	HOIMA	211,816	366,057	577,873	19,631,097	19,067,634	577,873	-563,463
Western	IBANDA		97,168	97,168	1,288,885	1,962,798	97,168	673,913

REGION	DISTRICT	OPEN WATER	LAND AREA	DISTRICT AREA	Tons_Ha_1990	Tons_Ha_2004	Area_ha	Bio_Diff
Western	ISINGIRO	3,678	261,408	265,087	1,654,883	1,695,768	265,087	40,885
Western	KABALE	5,045	167,919	172,964	2,291,103	3,244,393	172,964	953,290
Western	KABAROLE	870	181,576	182,446	8,155,276	13,165,267	182,446	5,009,991
Western	KAMWENGE	6,435	237,509	243,944	7,848,612	10,362,078	243,944	2,513,466
Western	KANUNGU	1,760	127,454	129,214	4,886,682	7,419,189	129,214	2,532,508
Western	KASESE	41,088	297,874	338,962	9,401,727	14,914,835	338,962	5,513,108
Western	KIBAALE	15,381	424,639	440,020	23,527,336	18,157,621	440,020	-5,369,714
Western	KIRUHURA	1,772	458,494	460,266	4,516,393	3,883,838	460,266	-632,555
Western	KISORO	2,809	70,158	72,967	2,166,202	2,932,258	72,967	766,056
Western	KYENJOJO	40	405,401	405,440	16,882,705	20,813,693	405,440	3,930,988
Western	MASINDI	4,092	751,737	755,829	24,048,438	24,824,503	755,829	776,065
Western	MBARARA	64	179,331	179,395	647,185	1,140,273	179,395	493,088
Western	NTUNGAMO	447	205,104	205,551	467,634	949,284	205,551	481,649
Western	RUKUNGIRI	11,848	144,829	156,678	4,044,877	6,993,094	156,678	2,948,217
	TOTAL	**3,706,732**	**20,448,616**	**24,155,348**	**464,352,174**	**390,095,878**	**24,155,348**	**-74,256,296**

Appendix 2 Forest Area by District

REGION	DISTRICT	AREA_HA90	AREA_HA05	DIFF
Central	KIBOGA	168,681.13	81,550.61	-87,130.52
Central	NAKASONGOLA	128,760.17	65,633.35	-63,126.82
Central	MUBENDE	99,569.35	40,408.66	-59,160.69
Central	NAKASEKE	189,734.16	137,946.71	-51,787.45
Central	LUWEERO	47,717.86	22,833.39	-24,884.47
Central	MPIGI	71,950.27	48,702.15	-23,248.11
Central	WAKISO	38,028.34	21,064.95	-16,963.39
Central	MUKONO	107,980.78	96,141.69	-11,839.09
Central	SEMBABULE	15,839.92	5,560.88	-10,279.04
Central	MITYANA	24,589.23	18,060.08	-6,529.15
Central	RAKAI	33,157.55	27,770.50	-5,387.06
Central	LYANTONDE	3,146.95	66.07	-3,080.88
Central	KALANGALA	26,783.60	26,152.45	-631.15

REGION	DISTRICT	AREA_HA90	AREA_HA05	DIFF
Central	KAMPALA	551.93	522.32	-29.62
Central	MASAKA	21,990.39	31,332.85	9,342.46
Central	KAYUNGA	15,144.55	27,679.58	12,535.03
Eastern	BUGIRI	26,691.96	6,395.25	-20,296.70
Eastern	KAMULI	24,641.12	4,642.74	-19,998.38
Eastern	KAPCHORWA	36,914.03	22,749.61	-14,164.42
Eastern	MAYUGE	22,390.59	10,228.70	-12,161.89
Eastern	SIRONKO	25,428.17	13,297.56	-12,130.61
Eastern	KABERAMAIDO	17,546.03	8,734.93	-8,811.11
Eastern	BUSIA	9,922.39	1,370.57	-8,551.82
Eastern	BUKWO	25,682.79	17,702.26	-7,980.53
Eastern	KATAKWI	12,121.51	6,215.02	-5,906.49
Eastern	SOROTI	6,772.64	1,957.38	-4,815.27

REGION	DISTRICT	AREA_HA90	AREA_HA05	DIFF
Eastern	IGANGA	4,736.79	66.97	-4,669.82
Eastern	BUKEDEA	4,407.81	124.01	-4,283.80
Eastern	KUMI	3,769.64	741.40	-3,028.25
Eastern	JINJA	3,994.49	1,062.34	-2,932.15
Eastern	AMURIA	5,605.22	3,075.00	-2,530.22
Eastern	BUDUDA	10,897.14	9,395.90	-1,501.24
Eastern	BUTALEJA	1,323.46	25.21	-1,298.25
Eastern	TORORO	1,782.71	615.98	-1,166.73
Eastern	MANAFWA	10,910.14	10,167.40	-742.74
Eastern	PALLISA	770.94	129.20	-641.74
Eastern	MBALE	4,035.90	3,408.42	-627.48
Eastern	BUDAKA	195.39	62.59	-132.80
Northern	KITGUM	475,312.55	178,165.65	-297,146.90
Northern	AMURU	389,409.24	308,002.94	-81,406.30
Northern	PADER	252,709.21	172,480.44	-80,228.78
Northern	YUMBE	138,575.04	89,432.44	-49,142.60
Northern	NYADRI	52,630.10	10,702.67	-41,927.43
Northern	APAC	66,119.50	26,166.41	-39,953.09
Northern	ABIM	104,793.12	74,476.26	-30,316.86
Northern	KOBOKO	38,720.43	8,433.72	-30,286.70
Northern	LIRA	45,047.81	16,454.83	-28,592.98
Northern	ARUA	87,491.84	63,033.23	-24,458.61
Northern	MOYO	70,717.68	48,829.54	-21,888.14
Northern	KAABONG	81,904.80	61,462.11	-20,442.68
Northern	KOTIDO	45,444.44	27,403.10	-18,041.34
Northern	DOKOLO	10,134.64	531.91	-9,602.73
Northern	AMOLATAR	13,603.01	5,477.90	-8,125.10
Northern	ADJUMANI	151,120.72	151,587.13	466.40

REGION	DISTRICT	AREA_HA90	AREA_HA05	DIFF
Northern	NEBBI	26,769.52	28,132.05	1,362.53
Northern	OYAM	2,969.79	4,721.65	1,751.86
Northern	GULU	79,980.56	114,958.29	34,977.73
Northern	NAKAPIRIPIRIT	45,855.15	85,480.25	39,625.10
Northern	MOROTO	68,366.68	138,109.90	69,743.22
Western	KIBAALE	187,045.31	106,331.67	-80,713.64
Western	HOIMA	160,512.50	98,142.99	-62,369.51
Western	MASINDI	396,105.83	341,639.45	-54,466.39
Western	BULIISA	50,653.15	18,182.72	-32,470.43
Western	KASESE	108,758.12	77,214.01	-31,544.11
Western	KANUNGU	35,147.75	25,304.85	-9,842.90
Western	ISINGIRO	3,931.68	872.63	-3,059.05
Western	KABALE	12,621.07	10,961.36	-1,659.71
Western	BUNDIBUGYO	74,086.00	73,053.53	-1,032.47
Western	RUKUNGIRI	26,050.06	26,373.26	323.20
Western	NTUNGAMO	2,555.28	3,040.48	485.20
Western	KAMWENGE	52,573.57	53,111.50	537.93
Western	KYENJOJO	142,062.75	142,657.45	594.70
Western	KISORO	10,781.90	11,709.63	927.74
Western	KABAROLE	55,424.35	56,901.79	1,477.45
Western	MBARARA	2,617.59	4,503.49	1,885.90
Western	IBANDA	6,847.30	10,713.29	3,865.99
Western	BUSHENYI	89,440.05	100,670.99	11,230.94
Western	KIRUHURA	10,589.57	45,440.03	34,850.46
		3,268.24		-3,268.24
		831.26		-831.26
TOTAL		4,933,746.19	3,594,462.19	

Appendix 3 Permanent and Seasonal wetlands by District

REGION	DISTRICT	Area_ha90	Area_ha05
Central	KALANGALA	4,355	3,363
Central	KAMPALA	3,265	2,004
Central	KAYUNGA	55,322	53,760
Central	KIBOGA	85,947	81,659
Central	LUWEERO	61,648	47,273
Central	LYANTONDE	20,621	21,782
Central	MASAKA	88,389	102,280
Central	MITYANA	14,943	23,448
Central	MPIGI	68,816	61,838
Central	MUBENDE	64,776	41,753
Central	MUKONO	45,443	48,147
Central	NAKASEKE	92,093	97,462
Central	NAKASONGOLA	87,729	98,216
Central	RAKAI	107,165	94,476
Central	SEMBABULE	56,696	43,287
Central	WAKISO	37,469	34,290
Eastern	AMURIA	83,471	64,243
Eastern	BUDAKA	11,749	8,516
Eastern	BUDUDA	392	0
Eastern	BUGIRI	32,053	36,678
Eastern	BUKEDEA	39,794	34,498
Eastern	BUKWO	851	61
Eastern	BUSIA	17,094	17,051
Eastern	BUTALEJA	26,195	23,878
Eastern	IGANGA	42,714	45,107
Eastern	JINJA	10,399	10,099
Eastern	KABERAMAIDO	33,479	22,818

REGION	DISTRICT	Area_ha90	Area_ha05
Eastern	KALIRO	23,442	27,025
Eastern	KAMULI	85,388	75,148
Eastern	KAPCHORWA	9,669	10,374
Eastern	KATAKWI	107,490	66,812
Eastern	KUMI	59,120	51,397
Eastern	MANAFWA	3,264	1,377
Eastern	MAYUGE	19,158	20,028
Eastern	MBALE	9,588	8,113
Eastern	NAMUTUMBA	27,763	24,709
Eastern	PALLISA	59,342	52,276
Eastern	SIRONKO	22,369	12,904
Eastern	SOROTI	97,152	78,029
Eastern	TORORO	34,301	26,644
Northern	ABIM	17,425	9,864
Northern	ADJUMANI	28,503	22,175
Northern	AMOLATAR	24,572	20,056
Northern	AMURU	44,651	39,270
Northern	APAC	76,477	77,359
Northern	ARUA	21,699	26,617
Northern	DOKOLO	22,808	22,276
Northern	GULU	20,620	13,095
Northern	KAABONG	46,893	18,658
Northern	KITGUM	39,395	39,497
Northern	KOBOKO	215	1,193
Northern	KOTIDO	45,191	34,313
Northern	LIRA	69,859	71,429
Northern	MOROTO	136,244	106,132

REGION	DISTRICT	Area_ha90	Area_ha05
Northern	MOYO	31,220	28,039
Northern	NAKAPIRIPIRIT	85,402	46,440
Northern	NEBBI	11,144	14,587
Northern	NYADRI	4,871	11,433
Northern	OYAM	38,105	41,360
Northern	PADER	47,689	49,329
Northern	YUMBE	8,677	11,274
Western	BULIISA	10,887	11,089
Western	BUNDIBUGYO	91,166	18,655
Western	BUSHENYI	18,554	24,350
Western	HOIMA	20,236	10,341
Western	IBANDA	4,104	3,804
Western	ISINGIRO	29,899	26,472
Western	KABALE	10,858	9,534
Western	KABAROLE	10,616	7,447
Western	KAMWENGE	26,366	20,499
Western	KANUNGU	7,458	4,789
Western	KASESE	40,687	27,224
Western	KIBAALE	54,580	17,346
Western	KIRUHURA	62,370	77,133
Western	KISORO	3,341	1,715
Western	KYENJOJO	57,907	40,198
Western	MASINDI	85,721	65,955
Western	MBARARA	16,763	20,544
Western	NTUNGAMO	10,754	11,184
Western	RUKUNGIRI	7,117	2,651

Appendix 4 Land Cover in Parks 2005

NAME	CATEGORY	Broad leaved Plantation	Conifer Plantation	THF well stocked	THF low stocked	Woodland	Bush	Grassland	Wetland	Small scale farmland	Large scale farmland	Built up area	Open Water	Impediments
Ajai's	GR					10,197	387	1,375	2,543	1,306			56	
Bokora Corridor	GR					18,815	74,114	108,475		11,573				77
Bugungu	GR			130		6,145	16,674	10,897		2,426		4		
Bwindi	NP			31,454		70	21		89	385				
Chambura	GR			329		3,824	1,506	9,221	94	125			423	
Entebbe Animal Sanctuary	AS	25				135	31	888		478	18	1,971	2,023	
Jie	GR					15	476	4,312		2,263				
Karuma	GR			427		51,873	92	4,067	34	418		3	521	
Katonga	GR					5,953	7,691	3,566	425	3,202				
Kibale	NP		41	47,256	1,611	9,827	3,430	6,536	2,312	2,752	435		192	
Kidepo	NP					1,372	10,620	75,845		1		12		134
Kigezi	GR			2,455	86	2,590	266	6,686	126	6,127	35			
Kisangi	DJM			9		1,402		473	2,196	738	56		3	
Lake Mburo	NP					117	22,452	7,999	5,003	1,257			1,732	
Lomej	DJM						162	241						
Lopeichubei	DJM						70	1,059						
Matheniko	GR					16,268	29,192	89,258		14,394		19		69
Mgahinga	NP					3,297	564			214				
Morongole	DJM					580	5,362	1,415						
Mt. Elgon	NP	0	2,389	51,339	455	18,061	32,941	540		6,376				
Mt. Rwenzori	NP			59,040		18,299	21,333	96		437				272
Murchison Falls	NP				195	182,531	53,467	141,340	3,221	542		60	5,388	
North Maramagambo	DJM			20,080		6,273	1,815	978		3			146	
Nyangea-Napore	DJM					1,366	3,621	53						
Pian-Upe	GR					7,268	6,272	191,192	2,202	31				
Queen Elisabeth	NP	27		1,755	4	52,296	24,373	74,434	17,848	4,283	440	195	4,353	176
Semuliki	NP			20,425			293	523	4	806				
South Maramagambo	DJM			907				2						
Toro	GR					12,743	12,003	28,940	64	1,728			55	
Zulia	DJM					131	386	40,012						116
DJM	Dual Joint Management													
GR	Wildlife Reserve													
NP	National Part													

Appendix 5 Land Cover in Parks 1990

NAME	CATEGORY1990	Broad leaved Plantation	Conifer Plantation	THF well stocked	THF low stocked	Woodland	Bush	Grassland	Wetland	Small scale farmland	Large scale farmland	Built up area	Open Water	Impediments
Ajai's	GR					9,770	226	3,964	1,076	810			17	
Bokora Corridor	GR					1,311	14,492	194,869		2,381				
Bugungu	GR			363		25,713	3,510	4,383	468	1,838		3		
Bwindi	NP	0		31,046		10	0	137	5	821				
Chambura	GR			223		1,626	6,611	4,718	540	1,511			293.81	
Entebbe Animal Sanctuary	AS	10			58	98	31	998	20	829		1,437	2,067	21
Jie	GR					135	2,637	4,294						
Karuma	GR			611		43,856	325	11,430		659			553	
Katonga	GR					1,149		18,806	330	552				
Kibale	NP	21	782	44,091	5,351	3,885	6	11,072	1,159	7,789	81	10	146	
Kidepo	NP					4,246	11,951	71,558		194		35		
Kigezi	GR	0		1,861		2,738	511	7,465		5,788		7		
Kisangi	DJM			610	1,440	1,049	102	626	43	1,005	0		1	
Lake Mburo	NP					2,583	9,044	21,045	3,950	417			1,492	30
Lomej	DJM					10		393						
Lopeichubei	DJM					42		1,088						
Matheniko	GR					18,235	54,263	76,704						
Mgahinga	NP			2,221	290			1,324	32	208				
Morongole	DJM					1,812		5,545						
Mt. Elgon	NP		1,491	26,220	30,337	29,502	6,430	18,121		1	0	0		
Mt. Rwenzori	NP			59,950	46	34,430	3,004	1,296		656			95	
Murchison Falls	NP					167,742	19,592	188,701	5,275	876			4,558	
North Maramagambo	DJM			22,658	133	4,759	691	665	275	1			112	
Nyangea-Napore	DJM					3,595	1,024	6		415				
Pian-Upe	GR					15,638	19,297	170,562	1,417	25		15		10
Queen Elisabeth	NP	6		4,523		62,048	25,592	69,589	10,637	3,338		124	4,023	305
Semuliki	NP			19,544	1,180	7		938	17	161			204	
South Maramagambo	DJM			907				2						
Toro	GR					24,675	1,309	26,610	953	1,939		8	38	
Zulia	DJM					596.73	7,208.04	32,815.94						
DJM	Dual Joint Management													
GR	Wildlife Reserve													
NP	National Part													

Appendix 6 Land cover in Central Forest Reserves 2005

DISTRICT	NAME	District Area (HA)	Broad leaved Plantation	Conifer Plantation	THF well stocked	THF low stocked	Woodland	Bush	Grassland	Wetland	Small scale farmland	Large scale farmland	Built up area	Open Water	Impediments
ABIM	Akur	6,279					3,541	1,339	575		822		2		
ABIM	Alerek	7,410					3,170	742	3,417		46				35
ABIM	Ating	1,254					908	77	155		114				
ABIM	Kano	8,241					5,913	1,335	31		962				
ABIM	Nangolibwel	19,740					14,036	1,329	1,061		3,289				24
ABIM	Napono	1,480					1,069	315							96
ABIM	Otukei	620					573				47				
ADJUMANI	Wiceri	250					214	16		12	8				
ADJUMANI	Zoka	6,148			1,252		4,895		2						
AMOLATAR	Ajuka	256					56	0	88		111				
AMOLATAR	Along-Kongo	154						140			14				
AMOLATAR	Atungulo	185						98			87				
AMOLATAR	Ocamo-Lum	239					68	1		82	88				
AMURIA	Akileng	601					19	168	3		381		30		
AMURIA	Alungamosimosi	4,762						594	1,831		2,337				
AMURIA	Ochomai	233						138			96				
AMURU	Got-Gweno	2,251					2,032	1	219						
AMURU	Gwengdiya	170					150		19		0				
AMURU	Keyo	781		6					170		605				
AMURU	Kilak	10,298					7,849		2,436	13					
AMURU	Labala	1,673					1,542	7	124						
AMURU	Olwal	1,390					648				742				
AMURU	Wiceri	6,257					4,484	878		63	811		22		
APAC	Aboke	13									13				
APAC	Aduku (North)	12						4			8				
APAC	Aduku (South)	16									16				
APAC	Alito	18									18				
APAC	Aminakulu	261						250			11				
APAC	Aminkec	246						210			36				

DISTRICT	NAME	District Area (HA)	Broad leaved Plantation	Conifer Plantation	THF well stocked	THF low stocked	Woodland	Bush	Grassland	Wetland	Small scale farmland	Large scale farmland	Built up area	Open Water	Impediments
APAC	Aminteng	228						194			35				
APAC	Apac	5									3		3		
APAC	Arweny	323					17	198	18		89				
APAC	Ayer (1959 eucalyptus)	3							3						
APAC	Ayer (Bala Road)	9									9				
APAC	Ayer (Lira Road)	11									11				
APAC	Bala (North)	7									7				
APAC	Bala (South)	9									9				
APAC	Gweri	156						130			26				
APAC	Ilera	153							32		122				
APAC	Kulo-Obia	213						1			211				
APAC	Maruzi	6,101					1,358	4,716			27		0		
APAC	Obel	230									230				
APAC	Olia	27									27				
ARUA	Ajupane	471					420				50				
ARUA	Arua	237	202					4			20		11		
ARUA	Ave	783					117		50		616				
ARUA	Enjeva	729					637				92				
ARUA	Enyau	2	2								0				
ARUA	Iyi	2,402	13				1,873		9		507				
ARUA	Kafu	2,635					1,489				1,146				
ARUA	Laura	2,744					2,602		22		120				
ARUA	Lokiragodo	38	29								8		1		
ARUA	Luku	3,989					3,575	89	116		207				3
ARUA	Okavu-Reru	415		341					30		45				
ARUA	Suru	369						110	71	34	154				
BUGIRI	Bugiri	16									16				
BUGIRI	Igwe	1,123			515	526					83				
BUGIRI	Irimbi	288					124				164				
BUGIRI	Kyabona	122					99				23				

DISTRICT	NAME	District Area (HA)	Broad leaved Plantation	Conifer Plantation	THF well stocked	THF low stocked	Woodland	Bush	Grassland	Wetland	Small scale farmland	Large scale farmland	Built up area	Open Water	Impediments
BUGIRI	Luvunya	884		632				119	74		59				
BUGIRI	Sitambogo	0									0				
BUKEDEA	Bukedea	7									7				
BULIISA	Budongo	26,797			15,875	66	48	9,877	821		81	29			
BULIISA	Maseege	938						938							
BUNDIBUGYO	Bundikeki	401									401				
BUNDIBUGYO	Kabango-Muntandi	361									361				
BUNDIBUGYO	Mataa	107									107				
BUNDIBUGYO	North Rwenzori	3,532			15		6	160	2,563		788				
BUNDIBUGYO	Nyaburongo	172						0			172				
BUSHENYI	Kalinzu	13,984	203		12,326	628	91		27		595	115			
BUSHENYI	Kasyoha-Kitomi	34,328	227		29,103	228	516	1,691	777		1,758			27	
BUSHENYI	South Maramagambo	0			0				0						
BUSIA	Monikakinei	159						50		6	103				
BUSIA	Sitambogo	628				6	166	204	114		137				
BUSIA	West Bugwe	2,996					179	2,343	260		213		0		
BUTALEJA	Nakwiga	104									104				
DOKOLO	Abuje	250							56		194				
DOKOLO	Alit	193						160			33				
DOKOLO	Awer	220						3			217				
DOKOLO	Kachung	3,635		230				1,590	343		1,472				
DOKOLO	Onekokeo	258							12		246				
GULU	Abera	1,186		200			471		27		488				
GULU	Abili	5											5		
GULU	Amuka	1,100					1,020		80						
GULU	Bobi	5								1	1		3		
GULU	Gulu	94									88		6		
GULU	Lagute	341					221		120						
GULU	Lukodi	153					105				47				
GULU	Opaka	208									208				

DISTRICT	NAME	District Area (HA)	Broad leaved Plantation	Conifer Plantation	THF well stocked	THF low stocked	Woodland	Bush	Grassland	Wetland	Small scale farmland	Large scale farmland	Built up area	Open Water	Impediments
GULU	Opit	3,519	1,482	271						196	1,552		19		
GULU	Opok	536									536				
HOIMA	Budongo	664				509	56	27			73				
HOIMA	Bugoma	39,950			32,251	662	1,805	4,040	713		476	0	1		
HOIMA	Bujawe	4,965				11	389	3,703			863				
HOIMA	Ibamba	311						202	59		51				
HOIMA	Kahurukobwire	1,047			9	348	45	377		27	241				
HOIMA	Kandanda-Ngobya	2,563				3	300	1,192	443		625				
HOIMA	Kasongoire	1,848					33	1,145	32		639				
HOIMA	Kyahaiguru	427					4	269	82		72				
HOIMA	Kyamugongo	119					40	49			30				
HOIMA	Mpanga	548					20	508			20				
HOIMA	Mukihani	3,672				28	2,097	740	183		622				
HOIMA	Wambabya	3,422				1,923	379	672	104		345				
IBANDA	Kasyoha-Kitomi	4,139			3,810			86			243				
IGANGA	Busembatya	15									15				
IGANGA	Iziru	301									301				
IGANGA	Kaliro	15									15				
IGANGA	Walugogo	41									41				
ISINGIRO	Kyahi	1,776	142				14		1,165	52	402				
ISINGIRO	Kyalwamuka	0								0					
ISINGIRO	Rwoho	1,948					119	1,210	390		229				
JINJA	Butamira	1,248						0			236	1,012			
JINJA	Iziru	314	8								297	10			
JINJA	Kagoma	278		88							190				
JINJA	Kalagala Falls	2									1			0	
JINJA	Kimaka	47	21						4		22			0	
JINJA	Lubani	473									473				
JINJA	Mutai	262	12								247	3			
JINJA	Mwiri	135	49	11					16		57	2			

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JINJA	Namasiga-Kidimbuli	315	103						107		106				
JINJA	Namavundu	684							405		273			5	
JINJA	Namazingiri	214							165		32	16			
JINJA	Ngereka	753						6			748				
JINJA	Nile Bank	553									26	517		11	
JINJA	Nsube	858	354	124							380				
KAABONG	Lomej	360						357	3						
KAABONG	Lotim-Puta	1,894						1,894							
KAABONG	Lwala	5,876						4,512	887		478				
KAABONG	Morongole	8,127					575	7,324	132		96				
KAABONG	Nyangea-Napore	22,658					18,835	1,405	419		1,585				413
KAABONG	Timu	12,179					412	9,685	2,083						
KAABONG	Zulia	51,624					7,741	9,949	33,902						32
KABALE	Echuya	2,863			2,197		393		215		57				
KABALE	Kabale	133						1		43	77		12		
KABALE	Mafuga	1,830		1,282				9	87		451		1		
KABALE	Muko	167		26							137			4	
KABAROLE	Fort Portal	72					52				4		15		
KABAROLE	Itwara	4,177			2,948	175	179				845	30			
KABAROLE	Kisangi	142							59	82					
KABERAMAIDO	Achwali	369							324		45				
KABERAMAIDO	Angutewere	281					265				17				
KABERAMAIDO	Anyara	123					118	0			5				
KABERAMAIDO	Atigo	962					797	12			153				
KABERAMAIDO	Bululu Hill	426					19	333	26	35	5			8	
KABERAMAIDO	Kachogogweno	407					398	8			2				
KALANGALA	Banga	176			152			1	19		0				3
KALANGALA	Bufumira	339			90				132	2	105			10	
KALANGALA	Buga	268			187				66					15	
KALANGALA	Bugana	154			140									13	

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KALANGALA	Bukone	139				108		1	26					4	
KALANGALA	Bunjazi	80			74									6	
KALANGALA	Busowe	1,756				1,250	235		247	2				21	
KALANGALA	Buturume	189			137									52	
KALANGALA	Buziga	90				89								1	
KALANGALA	Funve	165			97				59					8	
KALANGALA	Gala	871					624		177	50		14		5	
KALANGALA	Kamera	124				109					15			1	
KALANGALA	Kampala	137				84		40						14	
KALANGALA	Kamukulu	5												5	
KALANGALA	Kijogolo	282			16		227		34					5	
KALANGALA	Kitemu	65			64									1	
KALANGALA	Kubanda	213			181				29					3	
KALANGALA	Lajabwa	45				31								14	
KALANGALA	Linga	38			30									8	
KALANGALA	Lukalu	225			206									18	
KALANGALA	Lutoboka	380			270				71		1		6	25	7
KALANGALA	Luwungulu	26					16							10	
KALANGALA	Makoko	35			19				9					7	
KALANGALA	Mugoye	949			767				52			103		27	0
KALANGALA	Mulega	93				92								1	
KALANGALA	Namatembe	248			113					41		88		7	
KALANGALA	Nkese	7												7	
KALANGALA	Nkose	128			85									43	
KALANGALA	Sekazinga	0												0	
KALANGALA	Tonde	74			39				28					7	
KALANGALA	Towa	1,486				69	1,042		207	153	5			10	
KALIRO	Kaliro	89									89				
KALIRO	Namalemba	51								37	14				
KAMPALA	Banda Nursery	2											2		

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KAMPALA	Nakawa Forestry Research	5											5		
KAMPALA	Namanve	0					0			0					
KAMULI	Bulogo	8									8				
KAMULI	Buwaiswa	34									34				
KAMULI	Namasagali	55						50			3		1		
KAMULI	Ngereka	455									455				
KAMWENGE	Kakasi	781			754						27				
KAMWENGE	Kasyoha-Kitomi	0									0				
KANUNGU	Kaniabizo	39						24			15				
KANUNGU	Kyantuhe	204									204				
KANUNGU	Mafuga	1,867		1,070					13		785				
KANUNGU	Mburamaizi	505	180						32		293				
KAPCHORWA	Kapchorwa	6									0		6		
KASESE	Kisangi	339					54		2	33	1	249			
KASESE	Mubuku	1,689						672	430		394	194			
KATAKWI	Onyurut	156									156				
KAYUNGA	Bajo	3,313					1,113	518	1,659	23					
KAYUNGA	Kalagala Falls	98									97			2	
KAYUNGA	Kiula	2,181					513	585	38	80	964				
KAYUNGA	Mabira	272				247			15		10				
KAYUNGA	Namawanyi & Namananga	430			384						46				
KAYUNGA	Wamale	1,925					1,301	66	489	17	52		2		
KIBAALE	Bugoma	0				0									
KIBAALE	Bumude-Nchwanga	4					0			3	0				
KIBAALE	Guramwa	1,526					107	219		71	1,130				
KIBAALE	Kagadi	12					12								
KIBAALE	Kagombe	17,751			11,730	1,996	720	933	267	1,351	753	0			
KIBAALE	Kanaga	660			617			17			27				
KIBAALE	Kasato	2,600				1,651	300	316	217		115				
KIBAALE	Kihaimira	551					384			96	70				

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KIBAALE	Kijuna	1,159			333	21	0		99	57	648				
KIBAALE	Kitechura	0								0					
KIBAALE	Kyamurangi	423				344		18	22		39				
KIBAALE	Muhangi	0			0										
KIBAALE	Muhunga	412				264					148				
KIBAALE	Nakuyazo	348					59			39	250				
KIBAALE	Nyabiku	374					374								
KIBAALE	Nyakarongo	3,490			3,072		21			226	171				
KIBAALE	Rukara	450			414	2			30		4				
KIBAALE	Ruzaire	1,195			869	0	84		4	2	236				
KIBAALE	Rwengeye	324				262	6				56				
KIBOGA	Bwezigolo-Gunga	3,518				445		44	844		2,163				22
KIBOGA	Goyera	987						491			496				
KIBOGA	Kabindo	1,415					89	348	761		218				
KIBOGA	Kagogo	757						8	628		122				
KIBOGA	Kasega	105							99		6				
KIBOGA	Kijwiga	260									260				
KIBOGA	Kikonda	12,042		372		514	5,740	2,527	1,596	15	1,263		16		
KIBOGA	Luwunga	9,160						2,235	295	39	6,590				
KIBOGA	Nakwaya	457							279		177				
KIBOGA	Taala	8,784				808	557	5,592	337		1,488				
KIBOGA	Zimwa	846							618		227				
KIRUHURA	Kyahi	27						2	6	0	19				
KIRUHURA	Rugongi	5						5							
KISORO	Echuya	723			642				78		3				
KITGUM	Achwa River	8,545					346	420	7,752					27	
KITGUM	Agoro-Agu	26,265					2,566	2,755	17,681		3,260	4			
KITGUM	Aram	139					27	9			102				
KITGUM	Aringa River	38								21	18				
KITGUM	Lalak	2,198					1,337	222	438		201				

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KITGUM	Lamwo	2,407					2,349	17	4		32				5
KITGUM	Lokung	1,426					149				1,277				
KITGUM	Matidi	121					121								
KITGUM	Nyangea-Napore	14,487					12,393	1,704	1		242				147
KITGUM	Ogili	887					752	1	135						
KITGUM	Pajimu	166									64		102		
KITGUM	Paonyeme	361					1		1		360				
KITGUM	Rom	10,863					10,538	4			135				187
KOBOKO	Kadre	267					132				135				
KOBOKO	Liru	496					209		37		250				
KOBOKO	Mt. Kei	11,431					4,704	3,548	2,574		605				
KOBOKO	Ozubu	700					54				647				
KUMI	Abuya	110						39			70				
KUMI	Bukedea	8									8				
KUMI	Kumi	29						11			19				
KYENJOJO	Buhungiro	1,046				598	145	204	57		42				
KYENJOJO	Ibambaro	3,696			3,333		55	129	16	24	138				
KYENJOJO	Itwara	4,503			4,311	15	165		8		0	3			
KYENJOJO	Kagombe	0					0	0		0					
KYENJOJO	Kagorra	4,302			149	996	782	1,236			1,138				
KYENJOJO	Kibego	1,275			1,119	5	72		46	6	27				
KYENJOJO	Kikumiro	721		502			0	1	55		164				
KYENJOJO	Kitechura	5,331			3,892	6	420	542	329	89	53				
KYENJOJO	Kyehara	481		290			2				189				
KYENJOJO	Matiri	5,473			4,762	8	76	165	270	17	175				
KYENJOJO	Muhangi	1,881			1,733		54	56			37				
KYENJOJO	Nkera	750				748			0		3				
KYENJOJO	Oruha	344		15			37	5	56	3	229				
KYENJOJO	Rwensambya	672				586	3				83				
LIRA	Abunga	233									233				

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LIRA	Acwao	249							13		235				
LIRA	Adero	251									251				
LIRA	Ayami	332						222			109				
LIRA	Ayito	231							20		211				
LIRA	Epor	223					54				168				
LIRA	Lira	142							121		3		19		
LIRA	Ngeta	15									15				
LIRA	Ogur	10									7		3		
LIRA	Okurango	244					227				18				
LIRA	Olia	185									185				
LIRA	Oliduro	210					138	65			1		6		
LIRA	Ongom	220							16		204				
LIRA	Otukei	1,404					1,389	3	10		1				
LIRA	Telwa	310							37		273				
LUWEERO	Mbale	1,212					6	912			294				
LUWEERO	Wangu	31									31				
LYANTONDE	Buyaga Dam	3,709						1,843			1,864		2		
MASAKA	Bugonzi	385					334			13	38				
MASAKA	Bukakata	13							5		8				
MASAKA	Buyaga Dam	6,955						875	877		5,204				
MASAKA	Jubiya	4,766			153	3,553		20	786	116	94		11	33	
MASAKA	Kasonke	131				126	0		5						
MASAKA	Kigona	95			13	81									
MASAKA	Kigona River	254			50	129		0	75		0				
MASAKA	Kisasa	318			6	203			80		29				
MASAKA	Kitasi	279					106		3	72	98				
MASAKA	Kumbu (North)	15								9			6		
MASAKA	Kumbu (South)	47					26			20			1		
MASAKA	Kyirira	94					71		0		22				
MASAKA	Manwa (South East)	176					88		87						

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MASAKA	Mujuzi	5,723			3,493	517	7	23	1,485	1	196				0
MASAKA	Mulundu	92					30		3		59				
MASAKA	Nabukonge	185				53	91				40				
MASAKA	Nakitondo	172			23	79	28	11	17		13				
MASAKA	Wabitembe	284			17	119	113		18		17				
MASINDI	Budongo	54,200			26,186	2,374	20,991	2,957	1,322		345	10	15		
MASINDI	Fumbya	423						135	273		15				
MASINDI	Kaduku	557					500	57			0				
MASINDI	Kasokwa	69				57		3			8	1			
MASINDI	Kasongoire	1,232					192	623			417	0			
MASINDI	Kibeka	9,628					6,033	1,334			2,262				
MASINDI	Kigulya Hill	412						33	271		108				
MASINDI	Kitonya Hill	299						185	22		92				
MASINDI	Masindi	40								32	8		0		
MASINDI	Musoma	271					118	2		35	5	111			
MASINDI	Nsekuro Hill	131						131			0				
MASINDI	Nyabyeya	355	16	57	7		3				259		13		
MASINDI	Nyakunyu	461					448				13				
MASINDI	Nyamakere	3,934					3,067	122			745				
MASINDI	Rwensama	122				108					14				
MASINDI	Sirisiri	474						459			15				
MAYUGE	Bukaleba	9,535	525	1,729			1,090	163	900	257	4,728	5	53	85	
MAYUGE	Namafuma	104		51					30		23		0		
MAYUGE	Namasiga-Kidimbuli	159	8						87		65				
MAYUGE	South Busoga	16,115		444			5,302	155	177	319	9,620		48	50	
MAYUGE	Walulumbu	120						63			57				
MBALE	Mbale	556	212								275	51	18		
MBARARA	Bugamba	1,209		1,002				51	139		16				
MBARARA	Kyahi	2,475	144				2	655	991	166	517				
MBARARA	Mbarara	193	34						33	22	84		20		

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MBARARA	Rwoho	1,100		192			37		240		630				
MITYANA	Bulondo	466			387			8	7	22	43				
MITYANA	Kabukira	460					63	47			350				
MITYANA	Kajonde	346			295		1				49				
MITYANA	Kasa	1,165			981					50	134				
MITYANA	Katabalalu	20				17				3	0				
MITYANA	Kitonya	862					15	11	502	1	333				
MITYANA	Lukuga	108						20	58		30				
MITYANA	Mukambwe	195			178				1		16				
MITYANA	Musamya	739			655						84				
MITYANA	Nakalere	0			0					0	0				
MITYANA	Nakwaya	23							11		12				
MITYANA	Nambale (Kasa South)	0			0										
MITYANA	Navugulu	15			15		0			0	0				
MITYANA	Walugondo	153			75					48	17			13	
MOROTO	Moroto	48,262					27,989	9,440	10,570		253				9
MOROTO	Napak	21,924					3,132	2,797	11,262		4,733				
MOYO	Atiya	199					167				31				
MOYO	Ayipe	891					344				547				
MOYO	Era	7,404					3,800	2,142	780		682				
MOYO	Eria	533	12				201				321				
MOYO	Lobajo	112					74				38				
MOYO	Otzi (East)	18,527					6,830	3,354	7,665		664		15		
MOYO	Otzi (West)	421					333				89				
MPIGI	Buvuma	1,092				1,014		3		15	60				
MPIGI	Buwa	360					312			23	25				
MPIGI	Degeya	252			179					32	41				
MPIGI	Gangu	1,081			669	262				69	74		7		
MPIGI	Jumbi	356			31	232			68	1	23				
MPIGI	Kabulego	168			8	151					9				

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MPIGI	Kabuye	147					142				5				
MPIGI	Kagongo	123			6		112				5				
MPIGI	Kalandazi	137					102			29	6				
MPIGI	Kalombi	3,804						1,926	1,811	64	3				
MPIGI	Kasa	0			0										
MPIGI	Katabalalu	1,323			35	1,063	64			61	101				
MPIGI	Kavunda	140				77	49			11	4				
MPIGI	Kinyo	260				247					14				
MPIGI	Kyansonzi	692				512	141	13		1	25				
MPIGI	Lufuka	269					238			4	26				
MPIGI	Lukolo	168			133					35					
MPIGI	Luwafu	397			388						7			1	
MPIGI	Lwamunda	4,456			462		3,406	55		12	509		13		
MPIGI	Makokolero	100									100				
MPIGI	Mpanga	464			411					8	45				
MPIGI	Nakaga	268			66	192				3	6				
MPIGI	Nakalere	687			610					6	70				
MPIGI	Nakaziba	98			94						5				
MPIGI	Naludugavu	174				160				8	5				
MPIGI	Nambale (Kasa South)	230			221	2					7				
MPIGI	Nanfuka	296			277						20				
MPIGI	Navugulu	2,575			2,141	86	6			183	158				
MPIGI	Nawandigi	3,952			3,604	68	0	87		8	184				
MPIGI	Nsowe	5,048						20	501	2	4,490		33	0	
MPIGI	Wabinyomo	243			19	219		4			1				
MPIGI	Walumwanyi	279					261	0	1		17				
MPIGI	Wamasega	196			171	1				18	5				
MPIGI	Wantagalala	230			8	219					3				
MPIGI	Wantayi	241				225					16				
MUBENDE	Bumude-Nchwanga	313			200		50		20	15	28				

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MUBENDE	Bwezigolo-Gunga	1,625							379		1,246				
MUBENDE	Kabugeza (Kasanda)	279	27						67		185				
MUBENDE	Kanangalo	2,652				23	1,824	167	192	65	381				
MUBENDE	Kasana-Kasambya	5,085		140	20		3,435	519	873		97				
MUBENDE	Kasenyi	199				145		8			36		9		
MUBENDE	Kasolo	3,168							659	85	2,421		2		
MUBENDE	Kaweri	1,231			1,209						21		1		
MUBENDE	Kisombwa	2,903						2,242	240		421			0	
MUBENDE	Kyampisi	1,261				414	106		129		605	9			
MUBENDE	Lusiba	656						19	99	3	536				
MUBENDE	Luwunga	224						109		40	75				
MUBENDE	Mpinve	1,839						979	244		616				
MUBENDE	Muinaina	1,041				5	278		14		723		0		20
MUBENDE	Namwasa	8,146					141	2,116	2,126		3,762				
MUBENDE	Nfuka-Magobwa	1,640	2					252	721		663		2		
MUBENDE	Nsowe	2									2				
MUBENDE	Taala	0									0				
MUKONO	Bira	309					279		24	6				1	
MUKONO	Bugomba	270					23			3	242		3		
MUKONO	Bugusa	259					94			27	136			3	
MUKONO	Bukaibale	1,164				40	931		65	6	109			9	6
MUKONO	Bulijjo	114					15				99				
MUKONO	Buloba	272					259		13		1				
MUKONO	Buluku	295					72			1	222			1	
MUKONO	Buuka	320			248					44	18			9	1
MUKONO	Buwanzi	472					128			46	264			35	
MUKONO	Izinga Island	107					26	71						11	
MUKONO	Kafumbi	335				183		10		90	38			15	
MUKONO	Kakonwa	756					683		25	8	38			3	
MUKONO	Kande	238					107		122	2				7	

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MUKONO	Kasala	289				39	188				62				
MUKONO	Kifu	1,411					463	69			845	27	1	5	
MUKONO	Kifunvwe	189				140		10		33	5				
MUKONO	Kisakombe	213			56	141	0			1	15				
MUKONO	Kisisita	831				646	0	34	47	25	77			2	
MUKONO	Kizinkuba	636			387	164				52	33	0		1	
MUKONO	Koja	246					170		60	1			2	13	
MUKONO	Koko	234				217	0			10	1			6	
MUKONO	Kuzito	153				143			10						
MUKONO	Kyampisi	275									275				
MUKONO	Lukale	383					58			16	247		48	15	
MUKONO	Luleka	405				336			59	8	2			0	
MUKONO	Mabira	29,294			20,009	7,237	413	253	104	175	875	215	13		
MUKONO	Mala Island	1												1	
MUKONO	Mwola	621				391	0	1		183	45			1	
MUKONO	Nabanga	463			325					127	11				
MUKONO	Nadagi	457	119				116				195	27			
MUKONO	Nakalanga	1,632			1,035	198	111	90	103	34	57	3		1	
MUKONO	Nakiza	665				621	7		5	9	20			2	
MUKONO	Nakunyi	121					103		8	1	4			5	
MUKONO	Namabowe	129					103		10	15					
MUKONO	Namakupa	285			188	51	0			30	16				
MUKONO	Namanve	1,487					500			349	567	8	64		
MUKONO	Namatiwa	1,616			396	565	11	474	3	95	71	0		0	
MUKONO	Namawanyi & Namananga	27			6						21				
MUKONO	Namyoya	399					279				109	11			
MUKONO	Natyonko	1,232			428	443	242			70	49	1			
MUKONO	Ngogwe (Bwema Island)	63			34				29					1	
MUKONO	Nimu	330			10	211			78	3	0		2	27	
MUKONO	Nkogwe	296				211		1	4	75	4				

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MUKONO	Olamusa	400					201		158				15	26	
MUKONO	Sozi	232					119		81	0	19			12	
MUKONO	Yubwe	188				99					51		10	28	
MUKONO	Zirimiti	912			365	398	40	23		24	60	0			
NAKAPIRIPIRIT	Kadam	40,825					17,324	13,039	9,378		1,083				
NAKASEKE	Kabwika-Mujwalanganda	8,277					1,650	6,628							
NAKASEKE	Kagogo	639					480	159							
NAKASEKE	Kamusenene	6,122					1,999	2,358	1,591	112			61		
NAKASEKE	Kapimpini	6,068					2,706	1,629	1,730	3					
NAKASEKE	Wankweyo	4,938					3,920	392	626						
NAKASONGOLA	Kasagala	10,105		248			2,023	3,177	1,657		3,000		1		
NAKASONGOLA	Katuugo	3,481		1,952			496	928		55	50				
NAKASONGOLA	Kyalubanga	4,505					2,599	397	1,233		276				
NAKASONGOLA	Wabisi-Wajala	4,457					1,062	2,425	872		99				
NAMUTUMBA	Budunda	105								2	103				
NAMUTUMBA	Bugaali	116								29	88				
NAMUTUMBA	Buyenvu	632								32	600				
NEBBI	Abiba	2,008					1,511				496				
NEBBI	Alui	574					437	48		89					
NEBBI	Awang	164	24	58					72		11				
NEBBI	East Uru	465					376				89				
NEBBI	Iyi	0					0								
NEBBI	Lendu	2,358	49	1,295			99	268	320		326				
NEBBI	Lul Kayonga	111						109			3				
NEBBI	Lul Oming	366					365	1	0						
NEBBI	Lul Opio	247					104	110	33						
NEBBI	Omier	2,314					1,723	177			414				
NEBBI	Usi	433		382							51				
NEBBI	Wadelai	578					452			20	99			7	
NEBBI	West Uru	288					160	65			63				

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NTUNGAMO	Ntungamo	13								13			0		
NTUNGAMO	Rwoho	6,007		729			2,222	1,331	1,248		476				
NYADRI	Barituku	151						127			24				
NYADRI	Enyau	378	130				97				152				
NYADRI	Kadre	509					234	44	6		225				
NYADRI	Kulua	107						0			107				
NYADRI	Lokiragodo	81	72								7		2		
NYADRI	Otrevu	562							152		410				
NYADRI	Wati	771						382	164		225				
OYAM	Acet	262								15	247				
OYAM	Aloro	253									253				
OYAM	Aneneng	259							39		220				
OYAM	Apworocero	237									221	16			
OYAM	Gung-Gung	301						2			299				
OYAM	Lela-Olok	219									219				
OYAM	Obel	3									3				
OYAM	Ojwiting	262									262				
OYAM	Olia	0									0				
OYAM	Opit	1,537	233					38		203	1,063				
PADER	Matidi	116					116								
PADER	Napono	2,282					1,642	524							115
PADER	Ogili	4,388					3,336	320	701		31				
PADER	Ogom	794							626		165		3		
PADER	Parabongo	2,805					1,776	395	339		192		83		20
PALLISA	Sala	320								193	128				
RAKAI	Bikira	28	14						1		12				
RAKAI	Kabira	123					64		59						
RAKAI	Kaiso	1,892			1,771		3	43	75			0			
RAKAI	Kigona	256			5	213			38						
RAKAI	Kigona River	649			296			6	276		71				

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RAKAI	Kijanebalola	3,019	3						269		2,693		37	18	
RAKAI	Kyalwamuka	6,526					12	250	2,911	563	2,789				
RAKAI	Kyamazzi	4,828						74	3,492		1,262				
RAKAI	Malabigambo	11,078			10,597		154	66	262						
RAKAI	Namalala	2,397			1,729		354		311	3					
RAKAI	Tero (East)	1,070					889		69	112					
RAKAI	Tero (West)	2,683			1,422		102	416	743						
RUKUNGIRI	Bwambara	37									37				
RUKUNGIRI	Ihimbo	477			351						126				
RUKUNGIRI	Rukungiri	24									11		14		
RUKUNGIRI	Rushaya	29									29				
RUKUNGIRI	Rwengiri	155						2			153				
RUKUNGIRI	South Maramagambo	14,398			13,428		592	48	201		129				
SEMBABULE	Buyaga Dam	5,199						1,045	48		4,107				
SEMBABULE	Kazooba	7,325					412	1,940	3,196		1,777				
SOROTI	Achuna	164								5	159		0		
SOROTI	Bugondo Hill	1,002					260	288	213	39	202				
SOROTI	Kagwara	373						20			353				
SOROTI	Kateta	159					98				60				
SOROTI	Lemutome	692		354				30			308				
SOROTI	Madoci	357						327		0	30				
SOROTI	Ochomil	264					186				79				
SOROTI	Ogera Hill	427					193		214		21				
SOROTI	Sambwa	522					376				147				
SOROTI	Soroti	134						19	65		13		37		
TORORO	Nagongera (East)	158	6								153				
TORORO	Nakwiga	13									13				
TORORO	Pokoli	18									18				
TORORO	Tebakoli	20									20				
TORORO	Tororo	388								49	338		0		

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WAKISO	Kajansi	312					164	1			42	94	11		
WAKISO	Kalandazi	454				0	218		30		207				
WAKISO	Kalangalo	333				290					43				
WAKISO	Kanjaza	319								61	258				
WAKISO	Kasozi	41									41				
WAKISO	Kisubi FR	22					20		1				2		
WAKISO	Kitubulu	76	51										17	7	
WAKISO	Kyewaga	229	155								25		48		
WAKISO	Luwawa	363				263				33	68				
WAKISO	Mako	144					85			25	34				
WAKISO	Mugomba	698					140		66	393	99				
WAKISO	Nakindiba	140				129					11				
WAKISO	Nalubaga	249					206				43				
WAKISO	Namagaza FR	154					86			50	18				
WAKISO	Namanve	742					335			251	115		42		
WAKISO	Nonve	724					603			4	118				
WAKISO	Semunya	717				21	347	124			225				
WAKISO	Tumbi	518				480	4			9	25				
WAKISO	Wakayembe	172					171			0	1				
WAKISO	Walumwanyi	23					4			6	13				
YUMBE	Kulua	499						312	20		166				
YUMBE	Lodonga	106									106				
YUMBE	Mt. Kei	30,102					20,929	4,062	735		4,377				