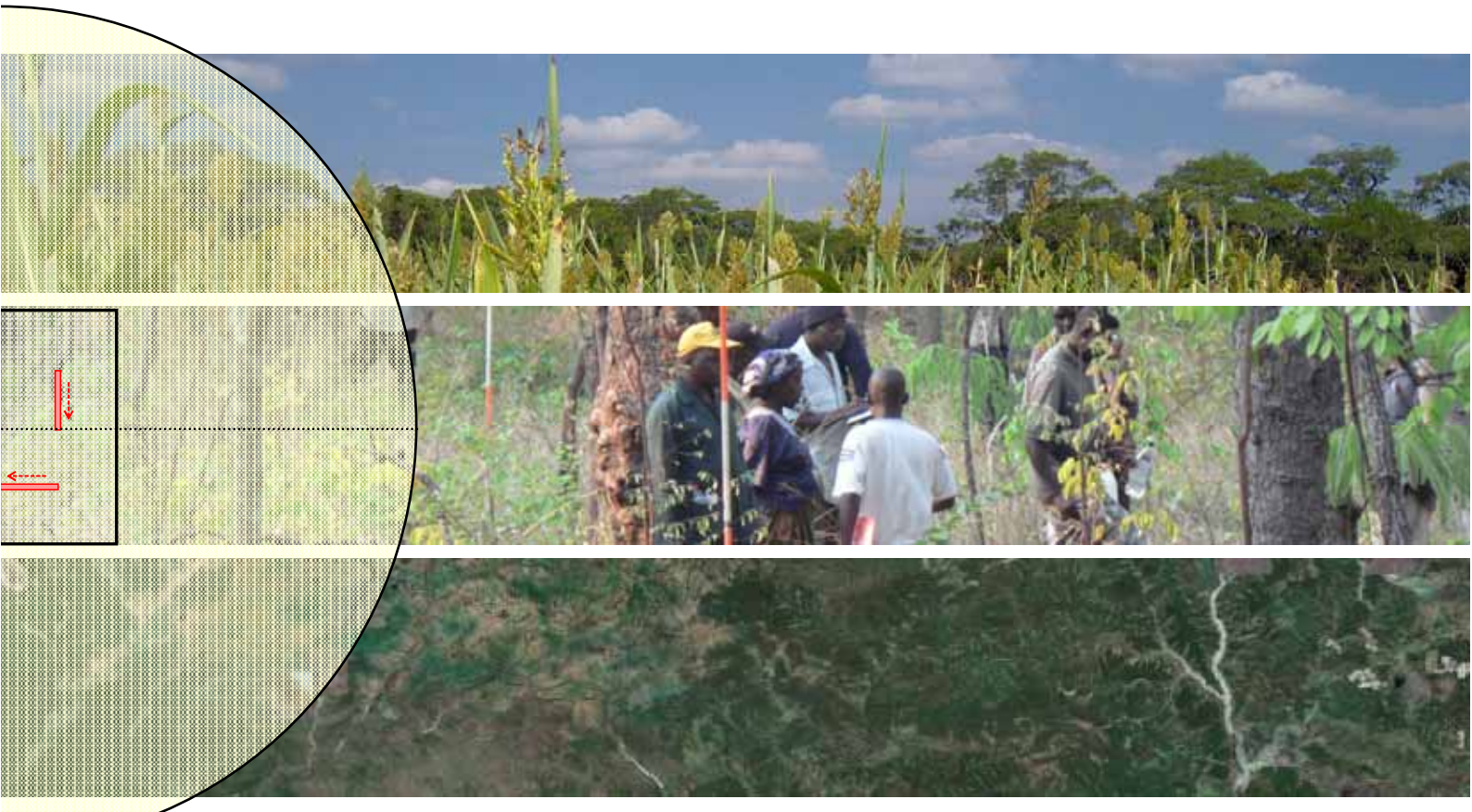
INTEGRATED LAND USE ASSESSMENT (ILUA)

ZAMBIA

2005 – 2008



Zambia Forestry Department
Ministry of Tourism, Environment and Natural Resources

Food and Agriculture Organization of the United Nations

Integrated Land Use Assessment (ILUA) 2005 – 2008 Republic of Zambia

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ACRONYMS AND ABBREVIATIONS

ASIP	Agriculture Sector Investment Programme
AGB	Aboveground Biomass
BCEF	Biomass Conversion and Expansion Factor
BEF	Biomass Expansion Factor
BGB	Belowground Biomass
BSAC	British South African Company
CBD	Convention on Biological Diversity
CSO	Central Statistics Office
DTM	Digital Terrain Modeling
DWB	Deadwood Biomass
ECZ	Environmental Council of Zambia
ETM	Enhanced Thematic Mapper
ENR	Environment and Natural Resources
ESP	Environmental Support Programme
FAO	Food and Agriculture Organization
FAOR	Food and Agricultural Organization Representative in Zambia
FCT	Field Crew Team
FD	Forestry Department
FDHQ	Forestry Department Headquarters
FOMR	Forest Resources Development Service
FNPP	FAO Netherlands Partnership Programme
FRA	Forest Resources Assessment
FRMP	Forest Resource Management Programme
FSP	Forestry Support Programme
GAEZ	Global Agro-Ecological Zones
GIS	Geographical Information System
GLCP	Global Land Cover Project
GOZ	Government of Zambia
GPS	Global Positioning System
GS	Growing Stock
HQ	Headquarters
ID	Institution Development
IIASA	International Institute for Applied Systems Analysis
ILUA	Integrated Land Use Assessment
ILWIS	Integrated Land and Water Information System
IS	Information System
IW	Inland Water
LOA	Letter of Agreement
LU	Livestock Unit
MACO	Ministry of Agriculture and Cooperatives
MAFF	Ministry of Agriculture, Food and Fisheries
MEWD	Ministry of Energy and Water Development
MFNP	Ministry of Finance and National Planning
MOL	Ministry of Lands
MTENR	Ministry of Tourism, Environment and Natural Resources

OL	Other Land
OWL	Other Wooded Land
NC	National Consultant
NFA	National Forest Assessment
NMT	National Multidisciplinary Team
NFMA	National Forest Monitoring and Assessment
NPC	National Project Coordinator
NPTE	National Project Task Force
NWFP	Non-Wood Forest Products
PFAP	Provincial Forestry Action Programme
PFT	Provincial Focal Team
PHS	Post-Harvest Survey
PID	Planning and Information Department - MTENR
PPD	Policy and Planning Division - MTENR
RS	Remote Sensing
SADC	Southern Africa Development Community
SD	Survey Department
SE	Sampling Error
TCDC	Technical Cooperation between Developing Countries
TCP	Technical Cooperation Programme
TM	Thematic Mapper
TOR	Terms of Reference
TSC	Technical Steering Committee
UNCED	United Nations Conference on Environment and Development
UTM	Universal Transverse Mercator
ZAFFICO	Zambia Forestry and Forest Industries Corporation
ZFAP	Zambia Forestry Action Programme

EXECUTIVE SUMMARY

The Integrated Land-Use Assessment (ILUA) 2005-2008, which compiles a wide array of statistical and spatial data on the land-use situation in Zambia, is the first of its kind in the country. The statistical data, acquired through field surveys at 221 sample plots spread across the country consisted of field measurements, observations and local interviews which captured data related to forestry, livestock and agriculture in an effort to assess conditions on the ground and to investigate links between the three sectors.

The Zambia Forestry Department (ZFD), lead institution responsible for implementing the ILUA, carried out the field data collection during 2005 and 2007, while the Ministry of Lands, Survey Department was responsible for the remote sensing survey, employing Landsat TM data from 2005 for mapping land cover and forests. The overall technical support of the ILUA implementation has been provided by the FAO Forestry Department in Rome (FOMR). Capacity building was targeted to methodology development, sampling design, harmonization of land use classifications, mapping, field survey, data management and reporting and included consultations with other government line ministries and departments.

The ILUA field manual contains definitions and procedures used to plan and perform an Integrated Land Use Assessment in Zambia following the definitions, criteria and indicators developed by the Forest Resources Assessment programme (FRA) of the FAO. The methodology is based on a systematic, nation-wide field sampling system. This methodology has also been tested and implemented in several other countries since 2000 (i.e. Costa Rica, Guatemala, Philippines, Cameroon and Lebanon) primarily to assess forestry resources. In Zambia, the assessment has been extended to other sectors, such as agriculture and livestock.

The purpose of the ILUA is to assess forestry and other related resources and land use practices, to provide up-to-date qualitative and quantitative information on the state, use, management and trends of these resources. The assessment covers a large range of biophysical and socio-economic variables, and thus provides a broad view of forest resources and related land uses for the country as a whole. In particular, the information serves the planning, design and implementation of national and international policies and strategies for sustainable use and conservation of forest resources, and to understand the relationship between forests and their users. Aside from serving national data needs, the information produced from ILUA can also enable Zambia to provide accurate information to a variety of international reporting agreements such as CBD, CCD UNFF, FRA and UNFCCC. By integrating the assessment and monitoring across forest and agriculture sectors, possibilities are also created for analyzing land management as a whole.

The report highlights results from both the field inventory and the land use/land cover mapping components of ILUA followed by conclusions on ILUA findings and lastly, recommendations on where to go from here.

Some major key findings are:

(1). Forest cover, according to the ILUA field inventories, is estimated at approximately 49.9 million ha or 66% of the total land cover of Zambia.

(2). The total growing stock (volume) across all land uses for Zambia is estimated at 2.9 billion m^3, with the majority of this volume, 2.1 billion m^3, held in semi-evergreen miombo dominated forests.

(3). The total national biomass (i.e. above and below ground) is estimated at 5.6 billion tonnes, with an additional 434 million tonnes of dead wood biomass, for a total biomass estimate of 6 billion tonnes. Of this biomass, there are approximately 2.8 billion tonnes of carbon stored in the forests. The potential for increased carbon sequestration from the terrestrial forests in Zambia is generally high due to high total growing stock of the forests and potential for reducing emission from forests, as approximately 32% of the forest is considered either moderately or heavily disturbed. Over 65% of the forests are secondary regeneration with active growth potential.

(4). The mean volume of the forests is relatively low, ranging from 40m^3/ha in deciduous Baikiea forests and Mopane woodland to 67m^3/ha in evergreen mavunda forests. Natural forests with tree cover greater than 70% can be regarded as rather intact forestland, where some selective harvesting of valuable species may have occurred. In these forests, the total volume is about 80 m^3/ha, whereas in degraded forests with tree cover between 10 and 40%, the volume is reduced to around 40 m^3/ha.

(5). Degradation of the forests can be analyzed from the recorded disturbance levels in the forests. Some 61% of the forest and OWL area are disturbed in one way or another by human activities in Zambia. However, only some 5% is considered to be heavily disturbed and the rest, 56%, are only slightly or moderately. Areas without disturbances accounted for 33% of the forests. According to the ILUA, the Zambian forests have good potential for regeneration.

(6). Most of the land in Zambia (61%) is practically owned and managed by customary authorities. Of the total forestland, about 31 million hectares (63%) are located on customary land and only 12 million hectares are located on State land (24%). Privately owned forests with legal land titles account for 5 million hectares.

Forests provide an important source of livelihood for rural communities. Based on the household survey, use of NWFPs is less common than the use of major wood products, however, some households indicated that they use a variety of products from forests, which highlights the importance of the multiple uses of forests and the numerous products that can benefit local communities. Different income levels determine which forest products are utilized. In particular, poorer households with incomes of less than 100,000ZKW/year ($18/year) show a higher dependence (44%) on fuelwood than those who earn more than 5,000,000ZKW/year (35%). Poorer households also indicated greater dependence on medicinal plants and plant food.

The ILUA inventory data is a valuable source of data for establishing a national database on the land use resources and with careful filtering and analysis can contribute to planning efforts towards sustainable forest management. Analysis of ILUA data and linking it to ancillary and other geo-spatial data with special attention to pertinent agricultural and climate change issues in the country can also be useful in informing policy decision formulation as well as in monitoring and evaluating policy impacts.

The ILUA data can give policy makers an indication of the land cover and land use and its current status and therefore assist in developing strategies for improving and maintaining sustainable forest management and bio-diversity management. In addition, the ILUA data could shed light on information required to meet food security and poverty reduction needs by providing forest related socio-economic data and giving an indication of cultivated land and other land use patterns.

1. BACKGROUND INFORMATION

The natural resource assessment is essential in the sustainable management of resources. One of the most important objectives of resources assessment is to provide information to support the development of natural resource policies and programs for the sustainable management and conservation of natural resources.

In 1992, the United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro in Brazil. The Government of the Republic of Zambia signed this convention in 1995. The Rio convention explicitly has a provision stating that timely, reliable and accurate information on natural resources is necessary for public understanding and informed decision-making should be made available by the participating countries. As a signatory of Convention of Biological Diversity (CBD) the Government of Zambia has an obligation to furnish needed information on natural resources. The present Integrated Land Use Assessment (ILUA) has adopted a set of national and global harmonized terms and definitions to provide information for national, regional and international reporting. These may be used for the formulation of natural resources policies, forestry programs, overall natural resources management and sustainable development.

Since its creation in 1948, FAO has been reporting on the worldwide status and trends of forest resources, their management and uses. All member countries are involved in the process and are the key players in data generation. The required data are collected, as best they can be, and collated to prepare the report. The data, however, may or may not be based on systematic inventory. In the case of Zambia, estimates reported to FAO were, prior to ILUA, based on 1976 vegetation maps, highlighting the deep need for up-to-date data on forest resources. FAO, in an attempt to enhance the reliability of such data, launched the program of support to National Forest Assessments including the support to the present ILUA in Zambia.

Figure 1: Community participation in forest measurements

1.1 The ILUA project support

In January 2002 the Government of the Republic of Zambia approached FAO to request assistance via the – Technical Cooperation Programme (TCP), to carry out a National Forest Assessment (NFA). The letter of Agreement between Forestry Department of FAO and Ministry of Tourism, Environment and Natural Resources was signed in July 2003. The Integrated Land Use Assessment Project "TCP/ZAM/3007 (A)", was finally endorsed by FAO in January 2005 and signed by the Zambian Government on 1st March 2005. The ILUA was launched in August 2005. Its continuation was made possible as a result of the contribution the FAO (TCP), and the Government of the Republic of Zambia (counterpart funds) channeled throughout the project. The project also received support with limited additional funding provided by the FAO Netherlands Partnership Program (FNPP).

Figure 2: Community sensitization before field measurements

The Government of Finland made available, on a grant basis, a contribution amounting up to (Euros 320,000) to support the Integrated Land Use Assessment of Zambia during the period July 2007 to June 2008. This support was requested to help complete the ILUA.

Table 1: The total cost break down of the ILUA activities

Institution Contribution	**Amount (USD$)**
Forestry Department Contribution	US$ 228,000
FAO Contribution	US$ 309,000
FNPP Contribution	US $105,000
Finnish Embassy Contribution	US$ 438,000
Total	**US$ 1,080,000**

1.2 History and setting

1.2.1 History

Northern Rhodesia was administered by the British South Africa Company from 1891 until it fell under British rule in 1923. During the 1920s and 1930s, development of the mining industry fueled development and immigration. It was liberated and designated as Zambia in 1964 as an independent sovereign country. Forest management in Zambia was initiated before independence, during the British South African Company. Organized Forestry was declared by ordinance of 1947 as the first Forest Policy.

1.2.2 Location and terrain

Zambia is a landlocked country found in the southern region of Africa lying between Latitudes 8^{o} and 18^{o} South of the Equator and Longitudes 22^{o} and 34^{o} East of the Greenwich Meridian. The country is surrounded by the Democratic Republic of Congo, Tanzania, Malawi, Mozambique, Zimbabwe, Namibia, Botswana and Angola. It has a surface land area of 752,614 Km^{2} most of which forms the highest parts of the plateau lying between 1,000 and 1,600 metres above sea level. The highest parts of the country are in the north-eastern of the country, with the plateau gradually sloping to the south-west.

1.2.3 Zambia's climate and hydrology

Zambia's altitude puts it in the broad belt of temperate highlands, which moderates what would otherwise be a harsh tropical climate. The temperatures range from 16^{o} to 27^{o} C in the cool and dry season from 27^{o} C to 38^{o} C in the hot and wet season. These characteristics result into two major climatic extremes, namely the semi-arid western region and the swampy Lake Bangweulu area in the north-eastern part of the country.

The country's main drainage systems are the Zambezi, Kafue, Luangwa and the Chambeshi-Luapula Rivers, which together with the lakes provide Zambia's most important water, fisheries and tourism resources. The annual summer rainfall ranges from 500 to 1,500 mm during the period of November-March, varying with latitude and altitude. Mean annual rainfall decreases from the Equator towards the Tropical of Capricorn and from north and north-eastern to the south and south-west.

1.2.4 Zambia's vegetation types

The ecosystem nomenclature in Zambia is based on vegetation types and Chidumayo and Marjokorpi (1997) have identified five forest types, namely the Dry evergreen, Dry deciduous, Montane, Swamp and Riparian Forests, and five woodland types – the Miombo, Kalahari, Mopane, Munga and Termitaria, and the Grasslands. Under ILUA

classification, these national vegetation classes were re-classified into global classes where the Miombo woodlands (plateau and hills) are the Semi evergreen forests; Baikiaea forests, Munga, Mopane and Kalahari woodlands are the Deciduous forests; Riparian, Swamp, Parinari, Itigi and the Lake basin chipya forests are evergreen forests; while the Termitary associated bushes are the Shrub thickets; and all tree less areas comprising riverlines, plains, dambos are either grasslands and or wooded grasslands.

In addition to the natural vegetation types, plantation forests of tropical pines and eucalyptus covering an area of about 61,000 hectares have been established countrywide with over 80% of these occurring in the Copperbelt Province. About 50,000 hectares of these industrial plantations are managed by a parastatal company called Zambia Forestry and Forest Industries Corporation Limited (ZAFFICO). At the provincial level, the Forestry Department manages 7,000 hectares of regional and local supply plantations, while the remaining balance is managed by private individuals at the semi-commercial and farm levels.

1.3 Expressed need for the ILUA project

The Government of Zambia expressed the need for up-to-date information on the stock and utilization of natural resources to assist in planning and sustainably managing land resources. Currently there is no integrated land use information system in the country which would support natural resources development planning. Therefore, the Government's focus of interest concerning land use is to put in place an integrated land use assessment system that aims to improve the monitoring and hence management of land resources, and thus contribute to poverty alleviation, improved food security and sustainable economic growth. Integrated land use assessments will also encourage cross-sectoral coordination and collaboration, bringing together stakeholders from diverse disciplines related to land use management.

Consequently, the Government of Zambia, through the Ministry of Tourism, Environment and Natural Resources requested technical and financial assistance from FAO to design and implement an integrated land use assessment (ILUA) survey with the objectives of building human capacity, improving the understanding of the nation's natural resource base, reducing poverty and promoting economic growth. A Technical Cooperation Program (TCP) project was initiated in 2005, with additional funding provided by the FAO-Netherlands Partnership Program (FNPP) and by governmental counterpart funds. The Finnish Government also contributed greatly to the study, allowing the project to be completed by providing additional funding. The main activities included assessing the need for and cooperatively designing and implementing an ILUA. FAO's Forestry, Agriculture and Natural Resource Departments collaborated in the design and planning of the ILUA, building upon an approach developed for National Forest Assessments (NFA). Variables related to sectors beyond forestry (cropping, livestock, and environment) were included, and field manuals and survey forms were developed.

1.4 FAO support to the ILUA project

Through the Technical Co-operation Program (TCP), FAO financed the technical assistance to the Government of Zambia through the FAO's Lead Technical Unit which provided the overall supervision of the project implementation. FAO further provided technical assistance through national capacity building in the following main areas:

- Forest and tree inventory methodology development including sampling design, classification system harmonization and variables;
- Livelihoods and land use inventory methodology development including sampling design classification system harmonization and variables;
- Forest and land use mapping;
- Field survey;
- Household survey;
- Data processing, information system development and reporting; and
- Information management.

Capacity building has been carried out over the course of the project through workshops, training events, on-the-job guidance, and through communication and feed-back. The FAO representative of Zambia has, as FAO project budget holder, provided administrative assistance throughout the implementation of the various phases of the project. All Steering Committee Meetings were held at the offices of the FAO Representation and the Ministry of Tourism, Environment and Natural Resources.

Before ILUA, no inventory had been carried out in Zambia spanning the entire area of the country with the same methodological approach to capture data on all the various land use patterns. The ILUA approach is the first of its kind to inventory both biophysical and livelihood aspects of resources, their uses and management across the entire nation.

1.5 The ILUA project objectives

The Integrated Land Use Assessment project's main objectives are to assist the Zambian Government to build up its forestry and related sectors' survey and planning capacity and to facilitate in the creation of a development action program that will coordinate resource use and monitoring. The core considerations of ILUA are to, support land use institutions in developing their capacity to collect, compile, process and disseminate reliable and updated information on land use to policy makers through training national, provincial and district staff on land use assessments in line with modern concepts and integrated approaches. The results of which will be the development of up-to-date and sound baseline information on the state, management and use of natural resources, thus setting up long-term resources monitoring.

1.6 Collaborating institutions

The ILUA was carried out in collaboration with line Government Departments and Ministries. The project's lead institution is the Forestry Department (Ministry of Tourism, Environment and Natural Resources) and collaborating institutions are Agriculture (Ministry of Agriculture and Cooperatives), Survey (Ministry of Lands), Central Statistics Office (Ministry of Finance and National Planning), ZAWA (Zambia Wildlife Authority), University of Zambia, Copperbelt University, Zambia Forestry College and Local Authorities (Council).

During the planning phase of ILUA, a number of these institutions were consulted and participated in refining the assessment plan and methodology. They are also represented in the organizational structure of ILUA at different levels (i.e. National Multi-disciplinary Team, Provincial Focal Team and the Field Crews).

1.7 Review of past forest resource inventories in Zambia

1.7.1 Early regional forest inventories

Organised forestry and forest management in Zambia started in the beginning of the 1930s (Mukosha and Fushike, 2002b). As anywhere else in Southern Africa, the early interest was in the establishment of exotic plantations. In Zambia, the magnitude of indigenous forests, in particular Miombo forests, was so vast and contained such a large number of valuable tree species, that an early interest was also developed in determining the productivity of this resource.

The first forest measurement and inventory attempt in Miombo forest was based on sample plots near Ndola on the Copperbelt, established between 1932 and 1936. This was focused particularly on the requirements of the mining industry, which was growing into the economic backbone of the country. The mining industry in the Copperbelt needed forest inventories to quantify the available timber resource that could be used for refinery poles and mining structural timber.

The need for further information then led to the first extensive, regional forest inventory. This was carried out on the Copperbelt between 1942 and 1944. This encouraged a small-scale, regional forest inventory in Western Province that was completed from 1949 to 1951. That survey was targeted at the location and assessment of the availability of sawn timber for concession harvesting. A special interest existed in Zambezi Teak (Baikiaea plurijuga or Mukusi). Since Livingstone's times (1857) Zambezi Teak had been widely regarded as the most valuable timber resource in the area. It was particularly used to manufacture railway sleepers for much of Southern Africa network (Loyttyniemi, 1988).

1.7.2 District Forest Inventories

During the period from 1952 to 1967 forest inventories became more systematic. They were extended from the Copperbelt and Zambezi Teak areas to other parts of the country. Simultaneously, there was also a policy shift to decentralize the colonial administration that also affected forest management. The district became the unit of forest administration, and forest inventories became a district-level responsibility.

Forest inventory information was gathered into voluminous and massive District Forest Management Books (Forest Department, 1965). The books were later archived in the Forestry Department Offices in Ndola and Lusaka. The detailed forest inventory information found in the District Forest Management Books has been the baseline data for almost all later forest resource assessments in Zambia, although district inventories ceased in 1967.

1.7.3 National Wood Energy Cover and Woody Biomass Inventories

The first rigorous assessment of the total woody biomass volume in Zambia was done in the mid 1980s under the jurisdiction of the National Wood Energy Consumption and Resource Survey (de Backer et al). The survey established a total national forest area of 61.2 million hectares and an associated total woody biomass figure using District Forest Management Books as baseline data and 1965 as reference year. The study estimated that the range of forested and wooded area was between 41.2 and 55.2 million hectares. The corresponding estimate for the total woody biomass volume (the growing stock), ranged from 3,000 to 4,100 million m^3.

1.7.4 Southern Africa Development Community (SADC) Wood Energy Study

The second assessment of Zambia's woody biomass resource was completed by the ETC Foundation in Holland as part of a Southern Africa Development Community (SADC) wood energy study (Erkkila, 1989, ETC Foundation, 1987). The assessment was based on remote sensing techniques using small-scale satellite imagery analysis and covered the whole SADC region. No reference was made to District Forest Management Book data.

The study concluded that the Zambian share of the SADC woody biomass resource was 2,600 million dry tonnes. With an average basic woody density of 714 kg/m^3 for Southern Africa indigenous forest trees the dry woody tonnes correspond to 3,640 million m^3 of wood volume. The independent ETC estimate thus fell within the woody biomass growing stock range of the 1986 de Backer study.

1.7.5 Zambia Forestry Action Programme

The third assessment of Zambia's forest resources base was done in conjunction with the Zambia Forestry Action Programme (ZFAP, 1998). ZFAP again used the District Forest Management Books as a reference point. Based on them in addition to other available

information over the past 30 years as well as computer simulations (Alajarvi, 1996), a thorough province by province analysis was made of Zambia's forest areas and growing and woody biomass stock for ZFAP. Alajarvi concluded that the total area of forests and woodland was 59.5 million hectares. The total growing woody biomass stock estimate was 4,202 million m^3 out of the 59.5 million hectares; forested areas were measured to cover 43.6 million hectares, with scattered woodland covering a further 15.9 million hectares. The estimate for growing woody biomass stock in forested areas was 4,122 million m^3, with a further 80 million m^3 in the scattered woodland.

Following shortly after the ZFAP work, a new estimate for Zambia's forested area was prepared for United Nations, again through SADC. The conference report for the fifth (April, 1997) session of the United Nations Commission on Sustainable Development reported that Zambia's forest coverage was 39%, or 29.4 million hectares (Strid, 1997). The basis for the assessment was not given in the report.

1.7.6 Other Forest Assessments

Chidumayo (1997), reports in his textbook on Miombo ecology and management that the total area of forest and Miombo woodland in Zambia is 44.0 million hectares, with an additional 9.6 million hectares of "savannah woodland". This would produce a total area of forest and Miombo and savannah woodland of 53.6 million hectares. These area estimates were also based on extrapolations from older sources (Chidumayo, 1994), and were mostly derived from ZFAP estimates.

The latest estimate for the forest cover in Zambia was calculated for the Food and Agriculture Organization (FAO) Global Forest Resources Assessment of 2000 (FAO, 2000). That assessment was again based on the District Forest Management Books, although small-scale satellite imagery was also used. Reference points for extrapolations were given by de Backer and Chakanga, 1986 (Reference year 1974) and Mukosha and Wamunyima, 1998 (Reference year 1993). The FRA 2005 FAO report states that forests in Zambia cover 31.2 million hectares. The assessment, compiled through extrapolation rather than forest inventories, is well documented and available online (www.fao.org). No information was given for the woody biomass resource, either by volume, or by dry ton.

In the late 1990s and early 2000s a series of new forest inventories were initiated and carried out by four forestry development programmes as follows:

- The Provincial Forestry Action Programme (PFAP) - The PFAP interest was at the provincial level and initially in selected forest reserves, with the objective of developing effective pilot collaborative forest management programmes. The overall objective of the programme was "improved livelihood and status of forests in Zambia" and the programme purpose was sustainable collaborative forest management practices being implemented in seven pilot forest areas and experience sharing.

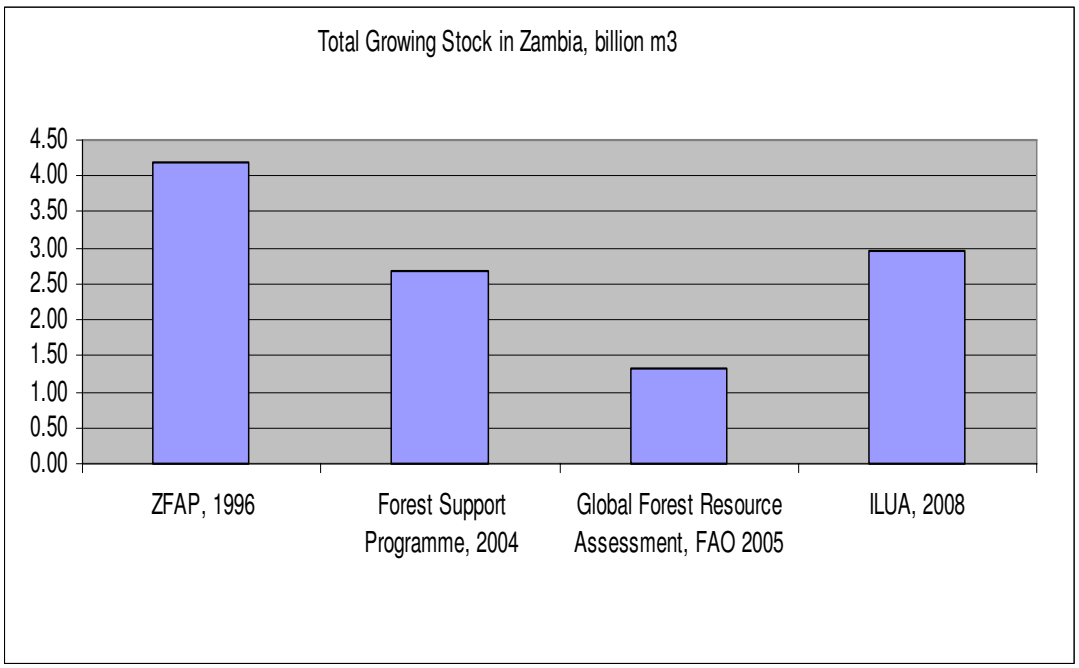


Figure 3: Comparing stock estimates from past studies

- The Environmental Support Programme (ESP) - The Environmental Support Programme had five areas of environmental concern namely: deforestation, wildlife depletion, land degradation, water pollution and sanitation and air pollution. Chibombo district was identified as one of the areas adversely affected by deforestation, hence it requires urgent intervention measures to redress the situation. The forest inventory was conduct for the district from 24th January to 7th February 2001. The objective of this inventory was to quantify the forest resource base in the district for the purpose of enhancing revenue generation.

- The Forestry Support Programme (FSP) - The Forestry Support Programme aimed at facilitating the establishment of an autonomous self-financing forestry management organisation. Under this project a forest resource assessment was implemented over the course of 2002, 2003 and 2004. The methodology used up-to-date satellite imagery to define the limits of forest cover and to classify it into high, medium and low-density classes. These classes were then used as the strata in a stratified random sampling system in each province. This inventory determined that the forested area had decreased to 33.5 million hectares. However, care needs to be considered with the application of data at provincial and local levels when applied to the nation scale.

- The Forest Resource Management Programme (FRMP) - The FRMP interest was at the provincial level and initially in selected forest reserves, with the objective of developing effective pilot collaborative forest management programmes. In the course of time these inventories widened their interest from gazetted forest reserves to include customary land without protected area status known as open areas, and protected wildlife areas under customary known as Game Management Areas (GMA).

The overall objective of FRMP was to increase the incomes of poor people dependent on the exploitation of forest resources, both in the short term through increased productivity and more efficient marketing and in the long term by maintaining production activities at levels that do not deplete the forest resources. The implementation started in June 2002 and ended in December 2008. The project covers two provinces: Luapula province and Northwestern province. The project had three components, namely community development of forests areas, sustainable income generation and project facilitation components.

Table 2: Forest Assessments Conducted in the Past

Period	Inventory
1932 - 1936	Sample plots established near Ndola to determine the productivity of Miombo woodlands.
1942 - 1944	The first extensive forest inventory identifying and estimating the timber volume availability for Copperbelt Province mines.
1949 - 1951	Small-scale forest inventory identifying and estimating the timber volume for Western Province concession harvesting.
1952 - 1967	Large-scale inventory for District Forest Management Books covering all the Districts in the country.
1972	Timber and woodland survey of East Luangwa, PFA No. 170
1984 - 1986	First estimate of Zambia's woody biomass resource: Wood consumption and supply survey at national level.
1987	Second estimate of Zambia's woody biomass resource: SADC wood energy study based on small-scale satellite imagery.
1994 - 1996	Forest resources management study for Zambezi Teak forests in south-western Zambia in co-operation with the Japan International Cooperation Agency (JICA).
1996	Forest inventory for Mulungushi West forest reserve, in Central Province and for Mwewa forest reserve, in Luapula Province under the Provincial Forest Action Programme (PFAP).
1996 - 1998	Forest inventories in Copperbelt, Luapula and Southern Provinces under PFAP, Phase I.
1997	SADC estimate of Zambia's forest area: 29.4 million hectares.
1999 - 2001	Forest inventories in Copperbelt, Luapula and Southern Provinces under PFAP, Phase II.
2000	FAO 2000 estimate for Zambia's forest area: 31.2 million hectares.
2001	Local forest inventories in the Central Province under the Environmental Support Programme (ESP).
2002 - 2003	Forest inventories in all nine provinces: Central, Copperbelt, Eastern, Luapula, Lusaka, Northern, North-Western, Southern and Western Provinces under the Forestry Support Programme (FSP).
2004	Fourth estimate of Zambia woody biomass resource: FSP
2005 - 2008	Integrated Land Use Assessment (ILUA) covering the whole country

1.8 Review of past agricultural assessments in Zambia

The Agriculture and Environment Statistics Division of the Central Statistical Office (CSO), which is in charge with the production of statistics on food, agriculture and environment related issues is sub-divided into two (2) branches, namely: the Agricultural Statistics Branch, and the Environment Statistics Branch. Each of these branches is composed of sections. The Agricultural Statistics Branch has a section that deals with large-scale farm operators, and another section that handles the activities of the small and medium scale farming communities. The sections of the Environment and Fisheries Statistics Branch are: the Land degradation, Air pollution, Water sanitation, Forestry and other Environment Statistics Section, and the Wildlife and Fisheries Statistics Section.

1.8.1 Background information on agriculture assessments

Agricultural statistics have been collected in Zambia since the early fifties. However, statistics that were collected during colonial times and the period six years after attaining political independence related only to farming activities carried out by the white settler community. This was so because it was perceived that whatever agriculture carried out by the indigenous population was primarily of a subsistence nature and thus of no significance to the agricultural development process. The need for including data on activities of the traditional farmers was realized six years after attaining political independence. During the 1970/71 agricultural seasons, a Census of Agriculture covering both the white settler community and the traditional farmers was conducted. But because of their comparatively larger numbers, geographical spread, and low literacy levels, the traditional farmers were contacted on a sample basis using personal interviews.

The 1970/71 Census of Agriculture marked the beginning of the CSO's annual agricultural surveys. The annual surveys cover the three sub-scale holdings, small – scale holdings and large-scale holdings. The 1990-1992 Census of Agriculture was conducted successfully and has since been the main source of frame used for the on going PHS surveys.

CSO, Agriculture Division was engaged by MAFF in October 1996 to undertake the collection of agriculture statistics through sample surveys to enable the Institute for Economic and Social Research to undertake an assessment of the performance of the agriculture sector with respect to the implementation and performance of Agriculture Sector Investment Programme (ASIP). MAFF, under the Agriculture Sector Investment Programme (ASIP), designed a three level Monitoring and Evaluation (M&E) system consisting the Management Information System (MIS), Annual Evaluation of Individual sub programme, and Sector Performance Analysis (SPA). The operation of the M&E system involved: the Policy and Planning Division (PPD) with the responsibility to coordinate the M&E system, the Institute for Economic and Social Research with the responsibility for an annual evaluation of individual sub-programmes and for Sector Performance Analysis, and CSO with the responsibility for providing data to enable the Institute for Economic and Social Research to perform its stipulated functions.

The programme has been active since October 25, 1996. CSO collects agricultural statistics data on crops, livestock, fisheries and any other agricultural data needed by users. In the contract: CSO contribution towards ASIP has been in the form of personnel, furniture, vehicles, bicycles, motorcycles, etc. Agricultural sector outputs have been highly variable. Recurrent drought and, more recently, unusually heavy rains, have often resulted in widespread crop failure. Crop failures have also been attributed to land degradation, poor husbandry practices and lack of appropriate seed varieties. The livestock sub-sector is also economically important in Zambia and accounts for about 35 percent of the total agricultural production. The main livestock produced are cattle, goats, pigs and poultry. However, livestock production remains far below its potential due to several factors that include outbreaks of diseases such as corridor and foot and mouth. Traditional communal grazing has, in part, been blamed for the frequent outbreaks of cattle diseases in many rural areas. The recurrence of drought has often depleted animal grazing resources and drinking water, thus affecting the productivity of the livestock sector.

1.8.2 Types of agriculture assessments conducted

Since the 1982/3 agricultural season, the Central Statistical Office, through the Agriculture and Environment Statistics Division, has been conducting three types of survey. These surveys are: the Crop Forecast Survey (CFS), the Area Measurement and Crop-cutting (AMCC) Survey – which has been discontinued, and replaced by the Agricultural and Pastoral Production Survey (APPS) otherwise known as the Post-Harvest Survey (PHS). Each of these surveys has been conducted at a particular time of the year during the agricultural season:-

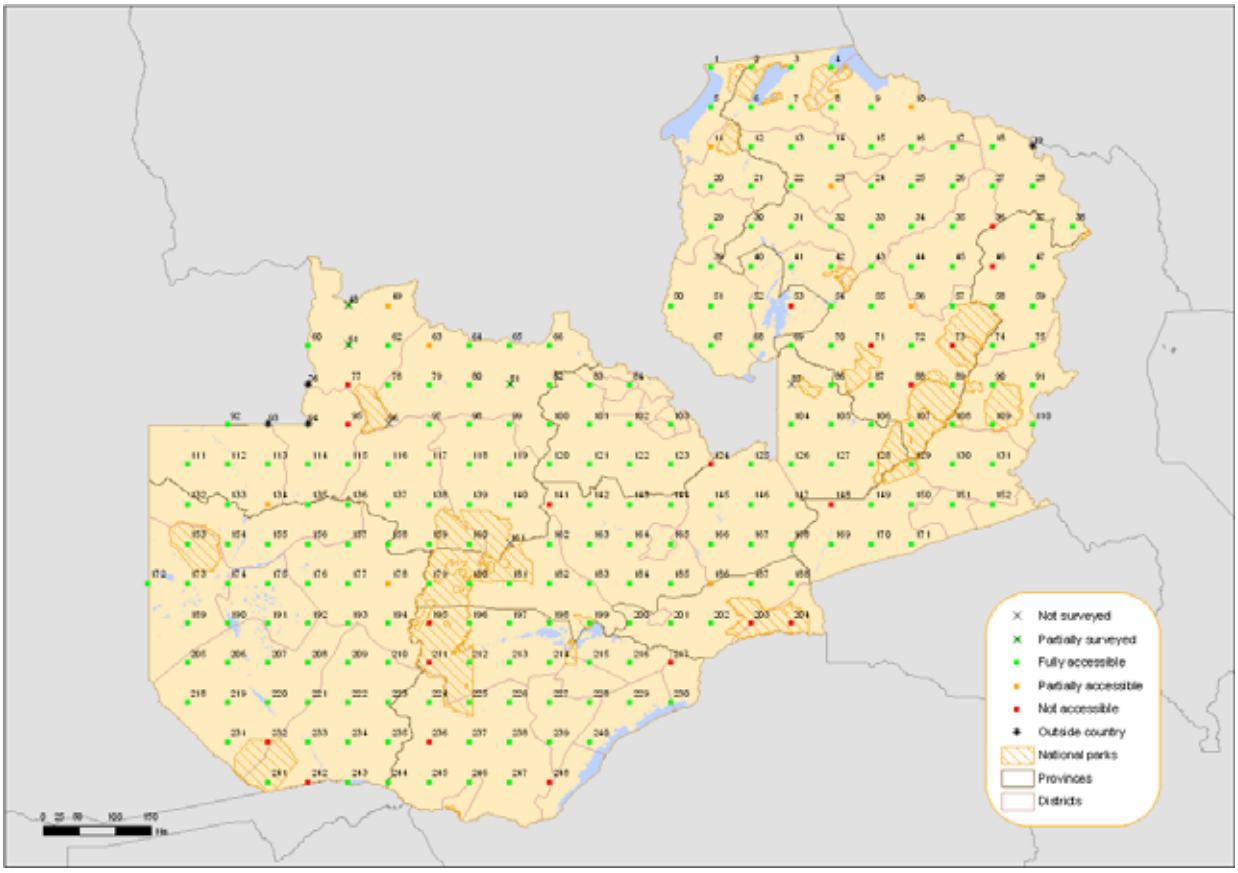
(a) Crop Forecast Survey: Phase1 – Household Listing: December/January Phase II – Crop Forecast (March/April)
(b) Area Measurement and Crop Cutting (April/July)
(c) Post-Harvest Survey (September/October)

1.9 Livelihoods assessments

The latest poverty profile of Zambia was published by the CSO in November 2004, based on the data collected in the Living Conditions Monitoring Survey (LCMSIII 2002/03 (GRZ 2004)). The survey measured that 67 percent of the population fell below an adult equivalent poverty line. Moreover, fifty-two percent of the urban population fell below the poverty line. Rural poverty in Zambia is high even by African standards; it is estimated that 83 percent of the rural population lives in poverty (FAO 2004).

2. ILUA FIELD INVENTORY METHODOLOGY

The sampling design adopted for the ILUA in Zambia is systematic. No stratification was applied. The sample density and distribution in Zambia is shown in map 1 below and is a systematic grid set across the country at 50km between tracts. The tracts were positioned over the surface area of Zambia regardless of the geographical location and topological conditions. The aim was to avoid bias in plotting and data collection.



Map 1: Sampling Layout, Tract Distribution and Accessibility

Table 3: Tract density

Stratum	Tract number	Distance between tracts	
		(minutes)	(km)
1	248	latitude 30' longitude 30'	about 50 km NS about 50 km EW
TOTAL	248	Geographical Coordinates	

Location Map (Tracts Distribution) - Tracts were selected at an intersection of every 30 minutes on the latitude/longitude grid. It resulted in the selection of 221 tracts nation-wide.

Accessibility to all tract sites was approximately 91.1%. Some tracts could not be accessed due difficult terrain (i.e. slope, water bodies). However, some tracts were located in military restricted areas, while others were geographically located outside the country's border. In some areas the local people could not allow our teams to work due to misplaced suspicions (see Table 4).

Table 4: Tract inaccessibility and causes

Total Area	Area inaccessible due to slope	Area inaccessible due to owner refusal	Area inaccessible due to restricted area	Area inaccessible due to water body	Inaccessibility - other	Inaccessible - tract fell outside of country	Total area inaccessible	Total area accessible
ha	16.768	0.5	8	4.86	8.274	4	42.402	433.098
%	3.5%	0.1%	1.7%	1.0%	1.7%	0.8%	8.9%	91.1%

2.1 Survey design and procedures

A major challenge for any project dealing with the problems of natural resources assessment in a country as large and diverse as Zambia is obtaining a sample representative of the range of local situations. Such a task becomes even more exacting when limits of manpower, equipment, and resources, both financial and otherwise, are considered. Typically, provincial level data is needed for national level analysis and decision making, but national level data provides a cost effective means of highlighting the overall status of natural resources for international reporting and can target areas for deeper analysis. In the case of ILUA, the cost involved for field data collection was a major limiting factor for deciding upon sampling intensity.

To overcome some of these obstacles, the project utilized a combination of methods and procedures to ensure a spread among the nation's demographic, economic, and ecological zones. Initially, the intent was to select survey sites and households on a random basis. However, it was not always possible to construct adequate sampling frames. Nor was it certain that probability sampling would provide a sufficient cross-section of environmental and socioeconomic conditions, particularly given the low sampling intensity at both provincial and local level.

Thus the project relied largely on non-probability sampling, deliberately selecting the tracts of assessment. The project adopted systematic sampling in order to avoid bias in choosing tracts on the basis of important variables.

2.2 Tract, plot and subplot description

All data related to ILUA is exclusively collected within the limits of the tract. Data is collected through observations, measurements and interviews at different levels: within the tracts, which represents the highest level, then in smaller subunits (plots and subplots), demarcated within the tracts. A tract is a square of 1 km x 1 km (figure 4 below). The co-ordinates of the south-west corner of the tracts correspond to those of the points selected in the systematic sampling frame. Each tract contains four field plots.

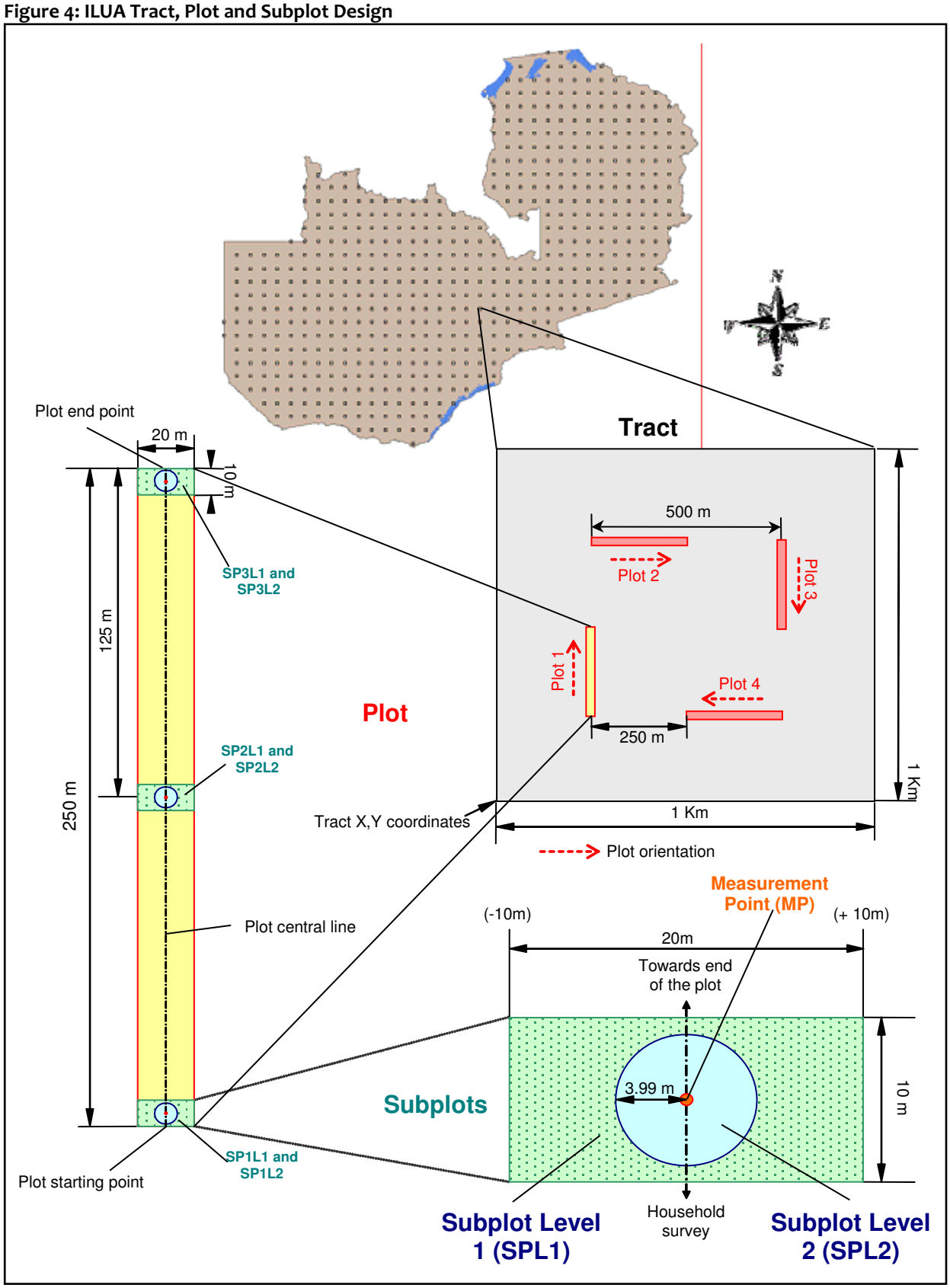
The plots are rectangles 20m wide and 250m long. They start at each corner of an inner 500 m square (same centre as tract), and are numbered clockwise from 1 to 4 as shown in figure 4. The location and orientation of the 4 plots are given in table 5.

Three pairs of subplots were delimited within each plot, corresponding to two different data collection levels: 3 rectangular subplots (SPL1), 20 m x 10 m, corresponding to level 1, and 3 circular subplots (SPL2), with a radius of 3.99 m, corresponding to level 2, located in the centre of the rectangular subplots. Both subplots categories were numbered from 1 to 3, starting at the starting point of the plot. The subplots served to measure tree regeneration (Dbh < 7 cm) and small diameter trees (7 cm ≤ Dbh < 20 cm) in forest. An edaphic and topographic measurement point was established at the centre of each subplot. When the location of the subplots fell in land use classes other than forest, they were not demarcated.

Table 5: ILUA Plot location and orientation

Plot No.	Location of the starting point of the plot, within the 500 m inner square	Orientation	Bearing
Plot 1	South-West corner	South-North	0 / 360 degrees
Plot 2	North-West corner	West-East	90 degrees
Plot 3	North-East corner	North-South	180 degrees
Plot 4	South-East corner	East-West	270 degrees

Figure 4: ILUA Tract, Plot and Subplot Design



2.3 Land use classification system

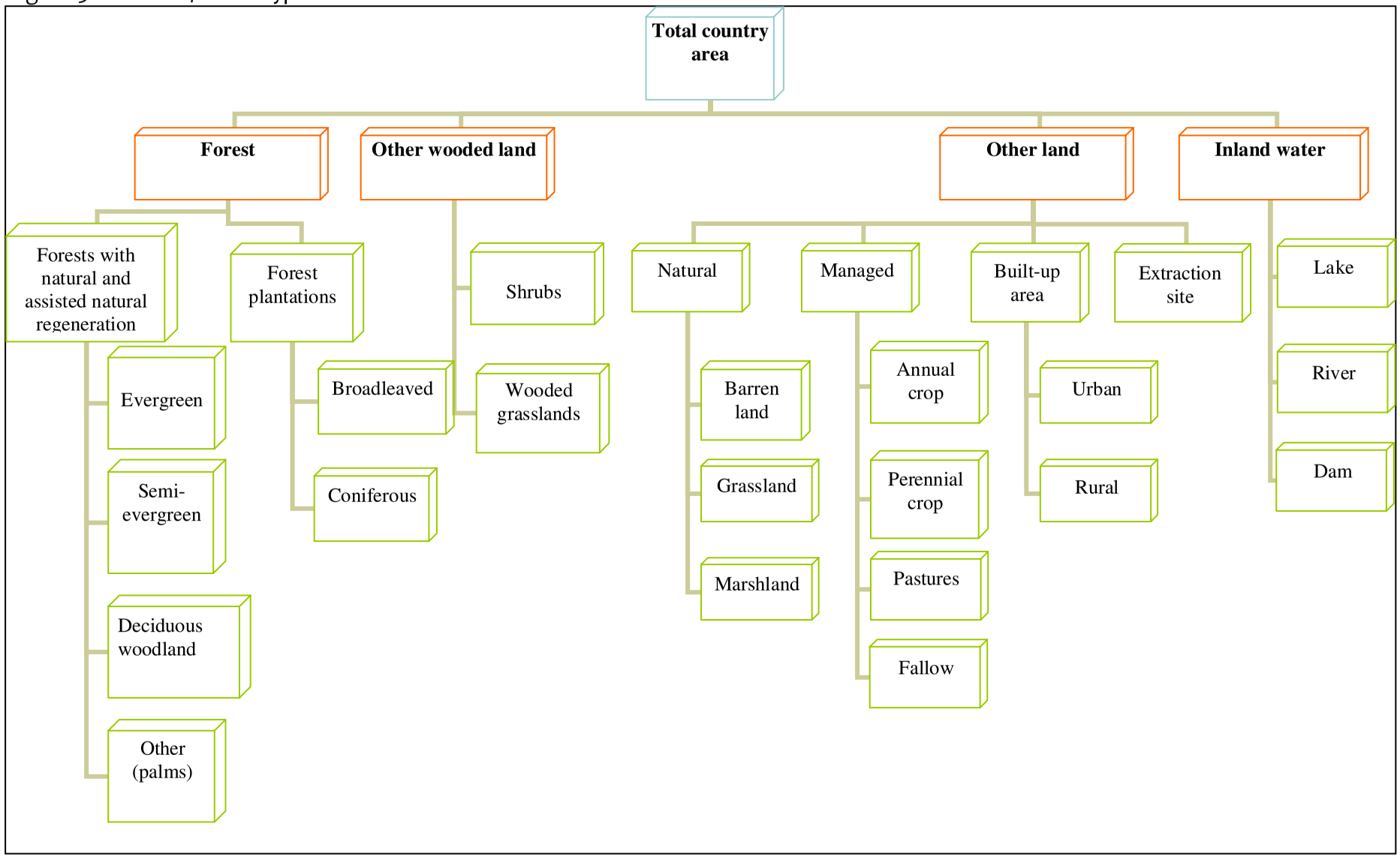
FAO's support to National Forest Monitoring and Assessment (NFMA) aims at building national capacities in long term monitoring of the national forest and tree resources. The globally harmonized major land use classes identified and detailed under the FRA program of FAO were studied in detail and based on that given framework the national land use classes were identified and grouped according to national definitions, thus allowing corroboration with the global criteria.

Table 6: FAO based land use/forest type classification for ILUA

Land uses	Brief description	Code
Forest	Area ≥ 0.5 ha, tree crown cover ≥10%, tree height ≥ 5 m	
Forest with natural or natural assisted regeneration		
Evergreen forest	Includes: • Mavunda forests (*Cryptosepalum exfoliatum*) • Mufinsa (*Syzygium guineense ssp afromontanum*); • Mofu (*Entandrophragma delevoyi*) • Parinari spp., and Syzygium spp. • Riverine/riperian forests	EF
Semi-evergreen forest	Includes : Miombo woodland (*Brachystegia, Isoberlina,Julbernardia and Marquesia macropura sp.*)	SEF
Deciduous forest	Includes: • Baikiea forests (*Baikiea plurijuga*) • Kahalari woodland (*Baikiea, Brachystegia, Isoberlina Guibourtia, Julbernadia and Ricinodendrom spp.*) • Mopane woodland (*Colophospermum mopane*) • Munga woodland (*Acacia, combretum and terminalia spp.*)	DF
Other	Includes: raffia palms, bamboos	OF
Forest plantations		
Broadleaved forest plantations		FPB
Coniferous forest plantations		FPC

Other wooded lands	Area ≥ 0.5 ha, tree canopy cover 5-10% or shrubs/bushes canopy cover ≥10%	
Wooded grassland	Tree canopy cover 5-10% Includes: Dambo/plains with sparse trees (cc 5-10%)	WG
Shrubs/Thicket	Shrubs/bushes canopy cover ≥ 10% Includes: • Bushland and thicket (*Acacia spp.,Commiphora spp.)* - munga woodland • Macchia-type scrub • Termitaria, termite mounds vegetation (some of it with no trees)	SH
Other land	Tree canopy cover <5% or shrubs/bushes <10%	
Natural and semi-natural land		
Barren land		BL
Grassland	Includes: some Dambos	GL
Marshland		MA
Cultivated and managed land		
Annual crop		AC
Perennial crop		PC
Pastures		PA
Fallow		FA
Built up area		BU
Urban		BU
Rural		BR
Extraction site/mining areas	Includes: Copper and quarry mining areas,	EM
Inland water	Area occupied by major rivers, lakes and reservoirs.	IW
Lakes		LA
Rivers		RV
Dams		DA
Outside land area		OA

Figure 5: Land use/forest type classification for the ILUA in Zambia



2.4 Type of data variables

The FAO-developed National Forest Resource Assessment approach comprises the collection of data on the multiple functions of forests and trees, covering their socio economic, environmental as well as productive functions, and the data collection cuts across a wide range of biophysical and socio-economic variables, and thus provides a broad and holistic view of land use for the country as a whole. A list of all the ILUA variables collected may be found in Annex 3.

2.5 Socio-economic survey

In addition to biophysical parameters, it was also vital to gauge the utilization of forest products and services in relation to the biophysical observations and measurements. Therefore external key informants, forest and tree users, as well as user groups for livestock and agriculture were identified and recorded during the survey. Focus group discussions were conducted to collect information with respect to the products and services that the people generally harvest, collect and obtain from various land uses (Table 7). During the focus group discussions the local key informants were interviewed to collect the required data especially with respect to the 'products and services' within 5 or 10km around tracts accessed.

Table 7: Interview groups and information obtained

Groups/ individuals to be interviewed	How to contact, identify them?	Where?	When?	Information
Key external informants - local forest services, organizations and local administration representatives, etc.	By phone, correspondence or visit	At office	During the planning phase of the fieldwork or/and before reaching the site	- Logistics - Background information on the tract - Information on the people living in the tract or in the surroundings - General information on the distance and access to the tract/plots - General information on the land use/forest type section (ownership, protection status, management, ecological problems) - Forest products and services

Focus groups or individuals - tree and forest resources users, forest dependant people (owners, women, men, hunters, residents…)	Recommended by external key informants Rapid rural appraisal exercise to identify the stakeholders.	At their house or in the village On the studied site (transect walk, persons working in the fieldwork) Met close to or within the site	Introduction meeting with the local people Previously fixed meeting (group or individual meeting)	- Information on local population (history etc.) - General information on the land use/forest type section (ownership, protection status, management, ecological problems) - Forest and trees management and uses, forest products and services
Fifteen households within 5 to 10km around the tract	Recommended by external key informant, on the access path of the tract, identified on the map, seen from a far distance. Selected households should be uniformly spread over/around the tract	At the household	It is better after the field work since the crew has had a large idea about the site	- Household composition and activities, crop products and production system, livestock production system, labour inputs, accessibility to services and water resources, poultry and beekeeping products

2.6 Household survey sampling design

ILUA is unique in its extension into livelihood data regarding utilization of land for livestock, crops and forestry. In this aspect of the assessment, ILUA goes beyond forestry status and use data and provides details regarding other land uses that impact forests, obtaining such information as: types of crops & income generated from them, access to credit markets and roads, income level, household activities, crop production system, etc. Annex 2 lists the full ILUA survey forms, including F7, the household survey form. The sampling resulted in to cover 1680 households, which were interviewed in the ILUA household survey.

At each tract, 15 households were randomly selected in a 5km radius from the biophysical tract centre. Where no inhabitants within the circle of 5km radius were found, then no interview was carried out. If there were equal or less than 15 households then all households were interviewed. Otherwise, all populated places within the circle of 5km radius were considered, taking the list of inhabitants and applying random numbering to select the 15 households. For all the households selected for the interviews, the households within the tract limits did not have any preference to the other households within the circle of 5km radius.

2.6.1 Procedure for household selection

The field crew teams started by visiting the traditional leadership (i.e. local chief) to introduce the ILUA field data collection program to the local authorities. They explained the entire field mission and requested for authority to recruit individuals (i.e. early settlers knowledgeable of the surrounding areas) as field guides during data collection. The chiefs and or local headsmen appointed 2 to 3 people (usually men) who provided an overview of the area to the field crew. These are the people that subsequently led the field crew to the village headsmen for the settlements within 5km of the tract centre. They assisted in identifying the distribution and actual number of households within and around the tract (i.e. whether or not the households were clustered and how many were in each settlement).

Households were selected randomly. The intention was that all households within the tract should have the same chance of being selected. Before the selection could be done the total number of households was determined from the village registers provided by the headsmen. Since the maximum number of households to be interviewed was 15, the following selection procedures were used to determine the required sampling interval (SI) for computation:

(a). Divide the total number of households by 15 to get the SI (i.e. 3 villages number as VGE 1, VGE 2, and VGE 3 with 47, 32 and 63 households respectively, the total number of households is then 142). The SI will therefore be 142/15 = 9.46, round-off the derived numbers to the closer whole number so that 9.46 would be 10 as the sampling interval (SI).

(b). The number of households in each settlement divided by the sampling interval gives you the number of households to be selected in each village to represent the total population around each tract. The distribution of the number of households to be selected in each village was determined as follows:

- Village 1 - 47/10 = 4.7, rounded to 5
- Village 2 - 32/10 = 3.2, rounded to 3
- Village 3 - 63/10 = 6.3, rounded to 6

For each village/settlement any crew member may randomly call out any number between 1 and 10 (the SI), and the derived number is called the given number (GN). If 4 was the GN for VGE 1, then the household listed 4^{th} on the village register would be selected as household number 1 for that village/settlement.

Add the SI to the given number (GN); the sum will give the second household on the list to be in the sample (i.e. Household 4 + SI will be household 14 on the list). Continue with the procedure, adding SI to each successive sum until you have the number of households that should be selected for whole village/settlement (i.e. in VGE 1, the selected households will then be no 4; 14; 24; 34; and 44). The above sampling procedure should be carried out in each village/settlement.

In those instances where the selected households are not available for interview, a substitute should be selected simply by continuing the procedure explained in point c. It is allowed to continue the list from above.

2.6.2 The household and household members

The considered definition of a household for this survey is one that consists of all members of one family who are related by blood, marriage, or adoption, including other persons, such as house or farm-helpers/labourers, who normally live together in one house or closely related premises and take or make their meals from a common place. It may also consist of one member. Therefore, a household member is any individual who in the last 12 months has lived with the household for at least six months regardless of whether they have intentions to stay or not. It includes newly born babies, a child attending school, newly wedded and/or individuals who may have come to stay together with others as a family.

However, a non-household member is an individual who may have left the household with no intention of rejoining the household; individuals who are married away and all other members who may have just left and gone into employment elsewhere.

2.7 ILUA fieldwork organization

2.7.1 National Multidisciplinary Team (NMT)

The NMT consisted of 6 members coordinated, executed and monitored the integrated land use assessment at the national level. This was done through the analysis and adaptation of ILUA sampling design, inventoried variables and definitions; training the Provincial Focal and Field Crew Teams; mobilization of ILUA resources; planning and coordination of fieldwork among provinces, in order to ensure data quality and homogeneity; data control and quality evaluation; compilation of database; reporting and dissemination of results.

2.7.2 Provincial Focal Teams (PFT)

The Provincial Focal Team worked in close collaboration with the National Multidisciplinary Team. The Provincial crew teams were set up in all the provinces consisting of 4 members drawn from Forestry, Agriculture, Central Statistics and Zambia

Wildlife Authority and were responsible for setting up Field Crew Teams; mobilization and preparation of necessary resources and equipment such as vehicles, allocations of tracts by field crews; monitoring and backstopping fieldwork, including technical and logistic support to field crew as well as field report checks; control and validation of field forms; and transmission of data to the NMT and reporting to PFT.

2.7.3 Field Crew Teams (FCT)

The Field Crew Teams were responsible for collection of data in the field and transmission of the field forms to the Provincial Focal Teams. The composition of ILUA field crew comprised of technical staff from Forestry Department, ZAWA, Agriculture, Lands, Councils and Local Community members. Each field crew team was headed by a Crew Leader who was responsible for organizing all fieldwork, from the preparation to data collection, contacting and maintaining good relationships with the community and the informants and had an overview of the progress achieved in the field. He was assisted by an assistant field crew leader whose responsibilities was to, among other things, take necessary measurements and observation; made sure the necessary equipment and materials were always complete and operational; supervised and familiarized the workers. There were also two enumerators who recorded data from the field measurements and household interviews. The community members or temporary helpers opened up ways to facilitate access and visibility to the technical team; provided information on access to the tracts in the working area, common/local name of forest species, information about the forest uses and management; and carried the equipment.

2.7.4 Field tools, materials and equipment

A number of specialized inventory tools, materials and equipment were used during data collection. These included the GPS devices for navigation and geographical locations, Suunto Hypsometers for tree height measurements, Suunto Compasses for angles (directions), Suunto diameters for tree diameter measurements, Range finders and rods for calculating distances and ranging out respectively, and metal pegs for starting each plot in a tract. There were 7 different field forms that were used by enumerators in recording field data both for the forest inventories and household surveys (Annex 2).

2.7.5 Training of field crews and project launch

ILUA covered the whole of Zambia and was comprised of three phases: preparatory, fieldwork, and information system development. It is now in its final phase, however data analysis from all the variables captured in the survey will continue until the next survey, meaning that ILUA remains active. The closing of the ILUA was originally earmarked for July 2008, however a series of delays have extended that deadline into 2009. The data collection included forest resources, crops, livestock and social economic data from households and from focus group discussions. The main activities undertaken throughout the implementation of ILUA were:

- Capacity building needs assessment mainly in land use assessment institutions in order to assess equipment available for carrying out ILUA in October 2003;
- First ILUA orientation training held in December, 2003 to give an overview and understanding of the methodology and process entailed;
- Input obtained from participants on how the ILUA can be planned, organized and implemented in the country in a cost effective way;
- Second training was held for field crew teams and aimed at; general approach of ILUA, instruments used establishment of sample plots, measurements of variables and how to conduct household interviews;
- The ILUA TCP/ZAM/3007 (A) was endorsed by FAO in January, 2005 and signed by the Zambian Government on 1st March, 2005; and
- Inception missions from FOMR (LTU) followed the endorsement of the ILUA to stimulate the start-up of the project, logistical and other preconditions for the coming of the TCDC Consultant between April and July 2005.

The following activities followed after the TCDC Consultant's arrival:

- Development of a national land use classification system that correlates with the Global Land Use classes (GLU) identified by FAO
- Fine tuning of forest and tree assessment methodologies for field data collections in line with Zambian conditions
- Identification and training of team leaders and field crews for the field data collection
- Identification and recruitment of the local as well as international experts required for the implementation of the ILUA
- Official launch of ILUA on 4th August, 2005 at Crest Golf Hotel in Lusaka

After the successful launch of the project, the main activities that followed were: mobilization of ILUA equipment, materials and recruitment of international and local consultants. The official launch of field data collection exercise by FAO Country Representative, Ministry of Tourism, Environment and Natural Resources officials and Land Use line Ministries and Institutions was held on 7th December 2005 at tract number 200 in Kafue District.

The launch of field data collection in all the provinces was conducted between 1st January and 31st March 2006. A total of 18 tracts were assessed at the end of the Provincial launch leaving a balance of 230 tracts. The main field data collection started in May 2006 until the end of July 2006 involving all the 11 field crew teams, one per province except for Northern Province, which had two teams, and one at Forestry Department Headquarters. A total of 59 tracts were assessed during this period. There was no further counter part (Government of Zambia) funding up to the end of 2006.

The implementation of ILUA activities was slow in 2006 due to funding setbacks. By 31st December 2006, field data was only collected in 73 tracts or 292 sample plots out of 248 tracts or 992 sample plots which meant that only 29.4% of the total fieldwork was done.

The FAO TCP funds were exhausted in 2006, leaving nothing to complete part of the outputs. The main reason for the budget deficit stems from national currency appreciations. Some funds were also spent to support field visits by the National Task

Force to enlighten them on the project activities in the field. The data collection in the field is the very core of the project. The fieldwork was done mostly during the dry months of the year between May and October.

2.7.6 Field data collection (measurements, observation and interviews)

The field crew teams identified the plot sample points with the use of the Geographical Positioning System (GPS) receivers and placed a metal pole as permanent marker at each starting point. Three reference features at suitable locations were note with respect to the starting point for future identification of the plot starting point. Within the 250 meter long and 20 meter wide plots, the field teams measured and registered related attributes for all trees >10cm Dbh. The land uses were identified and delineated with their dimensions and attributes related to these land uses were recorded accordingly.

Data on the status of forests and trees were measured by the field crew teams using forest inventory equipment, such as; diameter tape, GPS receiver, range finder, compass etc. While some variables can not be measured the field teams made adequate observations to determine their status. Interviews with key informants and user groups were conducted to assess information related to forest and tree resources measurement, uses and users. Due to a variety of constraints, not all 248 tracts could be fully accessed (including two that ended up being located outside of the country), resulting in a total of 221 tracts in which data was collected and recorded. Table 4 lists some of the reasons for inaccessibility.

Further more informal interviews of key informants accompanying the field crew were conducted in-situ in order to get information on general management and use of these forests in terms of services and products extracted. Information collected from these interviews was consolidated by observations made in the field and subsequently the comprehensive household interviews done within the settlements.

2.7.7 Tract assignment to field teams

There were 11 trained ILUA field crew teams. Each province had a team except for Northern, which has two teams. The Forestry Management Division located at Forestry Department Headquarters, which has the most experienced and specialized forest inventory technical staff in the department, constituted one team as well. Below is the table showing how tracts were assigned to each field team.

Table 8: ILUA tract assignment per Field Crew

ILUA Tracts – Provinces and FDHQ												
Team	No.	Cent	Cbelt	East	Luap	Lusk	FDHQ	N/T1	North/T 2	N/Wt n	Southn	Westn
Tract No.	1	105	65	37	1	97	135	3	34	48	195	132
	2	106	66	46	2	98	136	4	35	49	196	133
	3	125	81	47	5	116	156	7	36	60	197	153
	4	126	82	58	6	117	157	8	38	61	198	154
	5	127	83	59	11	118	176	9	41	62	211	155
	6	128	84	74	12	137	177	10	42	63	212	172
	7	145	99	75	20	138	178	13	43	64	213	173
	8	146	100	90	21	139	192	14	44	76	214	174
	9	147	101	91	22	158	193	15	45	77	224	175
	10	161	102	108	29	159	194	16	54	78	225	189
	11	162	103	109	30	160	208	17	55	79	226	190
	12	163	119	110	39	186	209	18	56	80	227	191
	13	164	120	129	40	187	210	19	57	92	228	205
	14	165	121	130	50	188	221	23	69	93	229	206
	15	166	122	131	51	199	222	24	70	94	230	207
	16	167	123	148	52	200	223	25	71	95	236	218
	17	179	124	149	53	201	234	26	72	96	237	219
	18	180	140	150	67	202	235	27	73	111	238	220
	19	181	141	151	68	203	243	28	87	112	239	231
	20	182	142	152	85	204	244	31	88	113	240	232
	21	183	143	168	86	215	X	32	89	114	245	233
	22	184	144	169	104	216	X	33	107	115	246	241
	23	185	X	170	X	217	X	X	X	134	247	242
	24	X	X	171	X	X	X	X	X	X	248	X
TOTAL		**23**	**22**	**24**	**22**	**23**	**20**	**22**	**22**	**23**	**24**	**23**

2.8 Field data entry, processing and analysis

The Province Focal Team members were responsible for submitting the completed field forms to the ILUA NC/TCDC experts for validation. After expert clearance, the field forms were submitted to the data encoders and entered into a database at the Forestry Department Headquarters in Lusaka. A data entry team was responsible for the data entry in the ILUA database application. Field forms found to be incomplete were returned

Figure 6: ILUA Data Processing, FDHQs Lusaka

to the responsible crew leader with instructions on what was missing and how to correct the form.

Figure 7: ILUA Data Entry, FDHQs Lusaka

2.8.1 Field data processing

To ensure high quality data processing and statistical analysis, a FAO expert trained the National Consultant, who in turn trained Forest Officers at occasional intervals. However, the database management and use was almost the full responsibility of the National Consultant.

2.8.2 Field data analysis

The field data was entered in the ILUA database. All other data was readily coded for computer entry, except the tree species identification. The species are often identified firstly by their local names before these are transposed into botanical names. The identification process was greatly assisted by the local community members. As the common local language varies in different parts of the country, the same tree species can have several different names. For data entry every recorded tree species was re-identified by scientific name and then by the corresponding digital code. The species name verification was the most laborious task and as a result caused significant delays in data entry and analysis.

3. FIELD INVENTORY RESULTS

This chapter presents only the biophysical part of the results that were generated from the field assessments. The ILUA survey collected a considerable amount of data with variables related to sectors beyond forestry such as cropping, livestock, and general environmental and demographic features. These results are presented in the context of their importance as a source of livelihoods, food security and poverty reduction. The land area of Zambia is described by the ILUA data according to distinct characteristics such as species diversity, tree cover, utilization and protection levels, ownership status, and the environmental issues among others. The human interaction with natural resources is also discussed in relation to various forest characteristics, in terms of resource availability and use. For the first time biomass and carbon estimates are also presented.

It is important to note that the statistics presented in the following tables throughout the field inventory results section are based on the official total country area of 75,261,400 hectares, according to the Zambian Central Statistics Office 2000 Census Report (GRZ, 2003). Since ILUA captures data on both water and land alike, data have been expanded according to total country area and therefore no further calibration of inventory data beyond this has been made to match official figures on total land area.

Table 9: Field Inventory Baseline Data

Zambia provinces	total tracts/province	total ha surveyed in tracts	overall size of province (ha)
1. Central	30	59.1	9,439,438
2. Copperbelt	9	18.0	3,132,839
3. Eastern	21	42.0	6,910,582
4. Luapula	14	26.0	5,056,908
5. Lusaka	5	10.0	2,189,568
6. Northwestern	37	69.8	12,582,637
7. Northern	43	84.4	14,782,565
8. Southern	23	46.0	8,528,283
9. Western	39	77.8	12,638,580
Total	**221**	**433.1**	**75,261,400**

3.1 Sampling intensity

The sampling intensity is calculated by dividing the total area of field sample plots in a particular stratum by the total area of the stratum in question. The sampling intensity is presented in percentage terms. Therefore, if the whole stratum is measured, the sampling intensity is 100%. With extensive, national-level inventories the sampling intensity was computed with the intensity of the total area of the sample plots of 433

hectares at 0.000006%. In sub-national or local inventories a sampling intensity normally can be much higher.

There were a total number of 1,680 households surveyed under the socio-economic household portion of the assessment. The maximum number of households interviewed per population establishment within and around each tract accessed (5km from center of tract) was 15. Each household contained an average of 6 individuals.

3.1.1 Reliability of estimates

As indicated above, the ILUA field survey is based on systematic field sampling. A total of 221 clusters (tracts) of 4 plots of 0.5 hectare each were visited to measure a series of biophysical and socio-economic variables. According to the pre-defined national list of variables, large numbers of land or forest use attributes were also measured in each sample site.

It should be noted that from an information quality point of view, the ILUA sampling technique is not free from different types of errors. Bias and systematic distortion of the information are due to flaws of measurements, methods of selecting the sample or due to techniques, inaccessibility of sample sites and varying capacity and skills in estimating parameters. ILUA included a large group of people with different readiness to collect data and make measurements in the field.

For a given sample size, the precision of estimates depends largely on the size (frequency of occurrence) of the parameter being estimated. The parameter that has the highest frequency of occurrence in the sample population is estimated at a higher precision. Precision of estimates decreases with reduced frequency of occurrence (rare events) of the parameter in the visited sample plots. As an example in the ILUA, the area of the forest land, estimated at 49,968,000 hectares (66% of the total land area of the country), was assessed with a sampling error (SE) of 7.8% at a 95% probability level. The extent of the other land uses such as Other Wooded Land (OWL) and Other Land (OL) is relatively small. They account respectively for 8% and 21% of the total land area of the country. Thus the sampling error is quite large (36.8%) for OWL and in only an acceptable region (~20%) for OL (Table 10).

Table 10: Estimates of major land use and corresponding SE%

Major Land Use Classes	Total Area ('000 ha)	Proportion (%) Against Total land	Sampling error with 95% PL
1. Forest	49,968	66	7.8
2. Other Wooded Land	6,055	8	36.8
3. Other land	15,771	21	20.4
4. Inland Water	3,467	5	57.2

When the natural forest is broken up into different forest types (table 11), the ILUA estimates show that semi-evergreen forests account for more than 45% of the total land

area and 68% of the total forest area. Deciduous forests sum to nearly 20% of the total land area of Zambia and approximately 30% of the total forest area. The other two forest types of evergreen forest and other natural forest types account respectively for 1.1% and 0.2% of the total land area and 1.6% and 0.3% of the forest area. With the above indicated sampling intensity, the precision of estimates is relative to the size of the population elements. Semi-evergreen forest is estimated with a sampling error (SE) of 13% at a 95% probability level. The second largest forest type of deciduous forest is estimated with a SE of 19.8% at 95% probability level. The other two forest types of evergreen and other natural forest types are relatively small in area. Their SE is logically very high. With such a size, it is not easy to estimate an acceptable SE, even when the sampling intensity is increased significantly. The question is how important it is to get information of the smaller classes or rarer variables and what is the readiness to accept the increased costs of improved precision.

For a given size of a population element, the precision of the estimate depends on the sampling intensity which depends on the available financial resources. A perfect example of these limitations are the estimates for plantations, which were not captured within the ILUA field data, however which are known to exist and to cover approximately 50,000 hectares. Due to their small extent in relation to the total land area and due to the fact that they are localized in one province, ILUA tracts did not happen to land within their boundaries. Thus estimates derived solely from field surveys under-represent plantations when expanded over the whole of Zambia. For this very reason, emphasis is placed on multi-source inventories whereby information is not acquired by inventories alone, but rather remote sensing and pre-existing data records. The table below, however, is meant to highlight those sampling errors derived from inventories alone.

Table 11: Estimates of main forest types and corresponding SE%

Forests (Canopy Cover ≥ 10%)	Total Area ('000 ha)	Proportion % Against Total Land	Sampling error with 95% PL
1. Evergreen Forest	819	1.1	106.2
2. Semi-evergreen Forest	34,145	45.4	13.0
3. Deciduous Forest	14,865	19.8	24.3
4. Other Natural Forests	139	0.2	113.2
5. Broadleaved forest plantations	0	0	(not captured)
6. Coniferous forest plantations	0	0	(not captured)
Total	**49,968**	**66.4**	**7.8**

*****plantations did not fall within any of the 221 ILUA tracts*

Given its resources and declared objectives, the ILUA has therefore delivered well. The trade-off between cost, amount of information and precision of estimates was correctly managed. The combination of field sampling and land use mapping provides sound basis to plan and carry out field surveys of parameters or population elements (e.g. forest plantation, evergreen forest, important tree species, etc) confined in restricted areas at sampling intensity that can produce estimates with acceptable precision.

The estimates of forest types and main species or groups of species attributes like volume (gross and commercial), biomass, tree density, etc are estimated with precisions comparable to precision of the areas of corresponding forest types. It is important to understand that national surveys like ILUA cannot produce high precision of every estimate especially of rare events or objects. Rare events should be covered by targeted stratified field surveys at a higher sampling intensity following a more specific design.

3.2 Land use area

The area of Zambia is classified into 20 national land uses (Table 6) which can be grouped into four major national land use classification: 'Forest', 'Other Wooded Land', 'Other land' (including cultivated and built-up land) and 'Inland water' (Table 12).

The "Forest" definition adopted in ILUA is the one used by FAO, which is "land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent or trees able to reach these thresholds in situ". It does not include land that is predominantly under agricultural or urban land use. Forest is determined both by the presence of trees and the absence of other land uses.

With regard to "Other Wooded Land", the definition adopted in ILUA is again that which is used in FRA 2005 defined as "land with an area equal or greater than 0.5 hectares with a tree canopy cover of 5-10% or shrubs/bush canopy cover of equal or greater than 10%.

"Other land" is comprised of tree canopy cover less than or equal to 5% or with shrubs/bush canopy cover of less than 10%. It consists of a) natural and semi-natural grasslands, marshland and barren land b) cultivated and managed land such as annual and perennial crops, pastures and fallow fields c) built up areas both rural and urban and d) extraction sites/mining areas.

The last category consists of 'Inland Water' and includes lakes, rivers and dam areas.

Table 12: Total area of Zambia by Major Land use classes

Major Land Use	Forest	Other Wooded Land	Other Land	Inland Water
Area ('000 ha)	49,968	6,055	15,771	3,467
%	66.4%	8.0%	21.0%	4.6%

The classification system used in tables 12 and 13 to define the land use/forest type classes is based on a dichotomous approach and includes two levels; the first level is composed of the global classes designed for the assessment of forest and tree resources within the framework of the Global Forest Resources Assessment (FRA) of FAO, while the second level is country specific and includes additional classes integrated to take into account national and sub-national information needs. The terms and definitions used in national assessments are chosen to harmonize national with global level forest assessments.

3.2.1 Area of Zambia divided into all Land-Use Classes and Forest Types

The distribution of tracts across the country did not capture any of our exotic forest plantations. Therefore, the information reflecting the presence and distribution of both the coniferous and broad leaved forest classes are not determined from the field inventory. Hence, the statistics from the ILUA field inventory refer to only the natural forests within Zambia. However, the Zambia Forestry and Forest Industries Corporation (ZAFFICO) report over 55,000 hectares of industrial forest plantations consisting mainly of Pine (79%) and Eucalyptus (20%). This gap is taken care of by the land use (remote sensing) mapping results which capture the forest plantations. Comparisons are presented in the last chapter of this report.

As indicated in table 13, the semi-evergreen, evergreen and deciduous forests cover 66 percent of the total area of Zambia. This is more than the earlier estimations on the Zambian forests as reported from other assessments (i.e. ZFAP 1998, FSP 2003, and FRA 2005). 'Other land' accounts for the next greatest extent of land use, approximately 21%. Within this major land use class, one finds that approximately 10% of the total land area is grasslands and marshland, about 10% of the total land in Zambia is dedicated to crop land and pasture land and less than 1% of the total land is considered to be occupied by built-up rural and urban human settlements.

Figures for inland water extent indicate that over 4% of the Zambia is occupied by rivers and lakes. No dams fell within the surveyed tracts. This figure of 4% or 3.5 million hectares is higher than previously recorded figures from the Central Statistics Office. If one takes into account the 57.2% sampling error at 95% confidence, the inland water figure could be as low as 1.5 million hectares. Increased inland water estimates could be accounted for from the seasonality of the respective surveys, deregulation and subsequent increased construction of small dams throughout Zambia as well as potential underestimation in the original figure. ILUA area results also found that 'other wooded land', consisting of wooded grasslands (including dambo plains) and shrublands (including munga woodland, Termitaria and Macchia-type scrub), account for 8% of the total land area.

Table 13: Total area of Zambia by all land use classes/forest types ('000 ha and %)

Forests (=/> 10% Canopy Cover) Calculated from ILUA survey data	**Area Cover ('000 ha)**	**Proportion %**
Evergreen Forest	819	1.1%
Semi-evergreen Forest	34,145	45.4%
Deciduous Forest	14,865	19.8%
Other Natural Forests	139	0.2%
Broadleaved forest plantations*	0	0%
Coniferous forest plantations*	0	0 %
Total	**49,968**	**66.4%**
Other Wooded Land (5-10% Canopy Cover or shrubs/bushes canopy cover ≥10%	**Area Cover ('000 ha)**	**Proportion %**
Wooded Grasslands	4,897	6.5%
Shrubs/thickets	1,158	1.5%
Total	**6,055**	**8.0%**
Other land (<5% Canopy Cover or shrubs/bushes canopy cover <10%)	**Area Cover ('000ha)**	**Proportion %**
Barren Land	9	0%
Grassland	6,085	8.1%
Marshland	1,332	1.8%
Annual crop	4,700	6.3%
Perennial crop	236	0.3%
Pastures	464	0.6%
Fallow	2,387	3.2%
Urban	7	0%
Rural	551	0.7%
Extraction site/mining area	0	0%
Total	**15,771**	**21.0%**
Inland Water (area occupied by major rivers, lakes and reservoirs)	**Area Cover ('000ha)**	**Proportion %**
Lake	2,693	3.6%
River	774	1.0%
Dam	0	0%
Total	**3,467**	**4.6%**
Total Country Area of Zambia	**75,261**	**100%**

*****plantations did not fall within any of the 221 ILUA tracts*

3.2.2 Area of forest cover expressed as a proportion of total land per Province

The levels of forest cover per province takes into account the entire area currently covered by forests with a minimum of 10% tree canopy cover expressed over an area of 0.5 ha in extent. It aggregates all types of vegetation and land management systems that may be available in each province (i.e. forest reserves, national parks, customary land, Game Management Areas, and forests on farm land).

According to the field inventory results the area of forest cover expressed per respective total provincial area indicates that Central Province is the most forested with 83.8% of forest cover, while Northern Province has the lowest with 48.8% of forest cover against its provincial area. However, the results are different when expressed for the national forest cover.

Table 14: Area of forest ('000 ha) and its proportion per Province

Provinces	Land area ('000 ha)	Forest area ('000 ha)	% of total forest cover
Central	9,439	7,910	15.8
Copperbelt	3,133	1,609	3.2
Eastern	6,911	5,152	10.3
Luapula	5,057	3,465	6.9
Lusaka	2,190	1,651	3.3
Northwestern	12,583	10,043	20.1
Northern	14,783	7,212	14.4
Southern	8,528	4,672	9.3
Western	12,639	8,254	16.5
Total	**75,261**	**49,968**	**100.0**

Total forested land is estimated to be 66% of Zambia's total land of which 20.1% is in Northwestern; 16.5% is in Western; 15.8% is in Central; 14.4% is in Northern; 10.3% is in Eastern 9.3% is in Southern; while 6.9% is in Luapula; 3.3% is in Lusaka and 3.2% is in the Copperbelt province.

3.2.3 Area of forest types and proportion of total forest and total land cover

Two main categories of forest cover classes were considered for the forest types, these include forest cover distribution (table 15) and forest canopy cover (table 16). In both tables we derive the current status of our forest types.

Table 15: Area of forest type ('000 ha) and its proportion to total land cover

Forest types (=/> 10% Canopy Cover) Calculated from ILUA survey data	Area Cover ('000 ha)	% of total forest cover	% of total land cover
Evergreen Forest	819	1.6%	1.1%
Semi-evergreen Forest	34,145	68.3%	45.4%
Deciduous Forest	14,865	29.7%	19.8%
Other Natural Forests	139	0.3%	0.2%
Broadleaved forest plantations*	0	0%	0%
Coniferous forest plantations*	0	0%	0%
Total	**49,968**	**100%**	**66.4%**

**plantations did not fall within any of the 221 ILUA tracts*

Similar to the total forest cover, the forest types were defined based on their respective status qualifying them to estimates of 10% tree canopy cover and measuring in height over 5m. Four (4) main natural forest types were expressed as a percentage of total forest cover. As it can be seen in Table 15, the semi-evergreen forest, which includes the dominating miombo woodland, comprises the majority of forest cover (68.3%), covering nearly half of the total land cover for the entire country. The deciduous forests, which include kalahari mopane and munga woodland as well as baikiea forests, represent the second largest proportion of total forest cover estimated at 29.7%.

On average, tree canopy cover in trees and other wooded land in Zambia is between 10-70%. Closed canopies of 70% cover or more constitute only 10% of the total forest and other wooded land area (table 16). This is due to both natural and anthropogenic reasons. Tree cover within miombo woodlands is naturally low, however, human activities have certainly reduced densities to below natural levels.

Table 16: Area ('000 ha) of forest and other wooded land by tree canopy cover classes

Tree Cover <5%	Tree Cover 5-10%	Tree Cover 10-40%	Tree Cover 40-70%	Tree Cover >70%	Unreported
7,925	9,476	15,876	15,237	5,376	2,132
14.1%	16.9%	28.3%	27.2%	9.6%	3.8%

3.2.4 Area of Zambia divided into ownership

According to the ILUA assessment, 61% of the area has been classified as customary land, 19% as state land, while 14% of the land is under some form of private ownership and 7% is unknown.

Table 17: Major land use class by ownership ('000 ha)

Major Land Uses	Private Individual ownership	Private Industrial ownership	Other private ownership	State ownership	Customary ownership	Other/ Unknown ownership
Forests	3,581	659	1,043	11,825	30,751	2,109
Other Wooded Land	816	87	0	487	4,550	115
Other Land	3,806	326	0	451	9,192	1,997
Inland Water	72	0	0	1,392	1,368	635
TOTAL	**8,275**	**1,072**	**1,043**	**14,155**	**45,862**	**4,855**
%	**11.0%**	**1.4%**	**1.4%**	**18.8%**	**60.9%**	**6.5%**

As table 17 and figure 8 indicate, the majority of forestland (63%) is under customary ownership, with most of the rest (24%) residing in state hands. A mere 10% is under private ownership with legal land titles. The majority of 'other wooded land' (75%), comprised of bushland and thicket, munga woodland and wooded grasslands (dambo plains), is also under customary ownership.

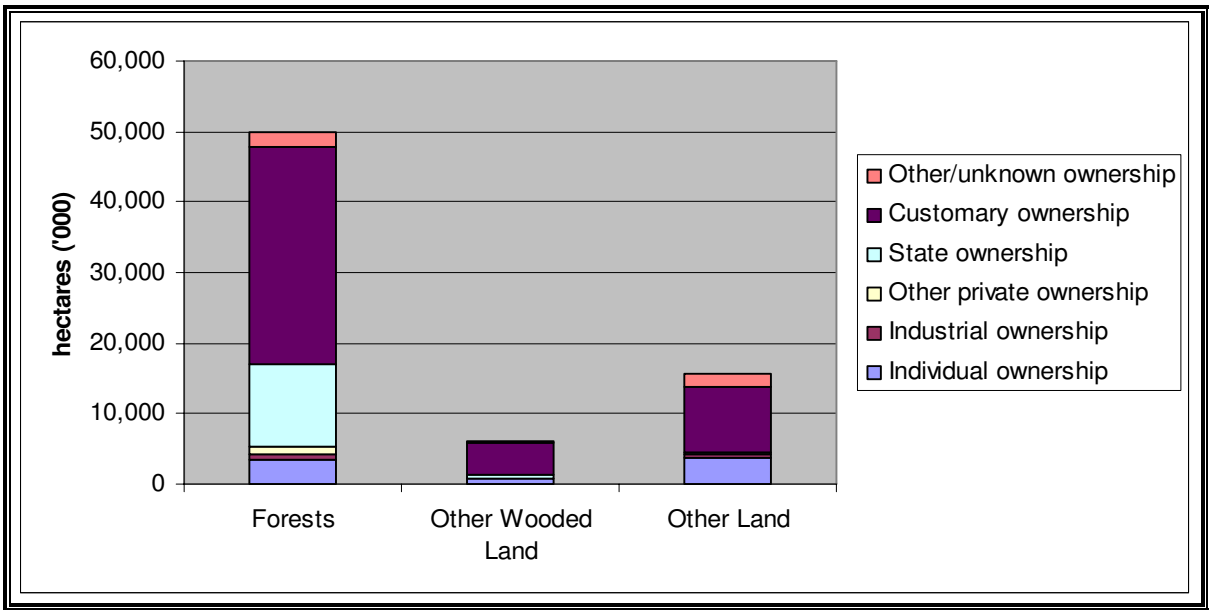


Figure 8: Major national land use classes by ownership (%)

As can be seen below in Table 18, the land tenure system with the highest percentage of tree cover is state-owned land. This is as expected since state-owned land hosts a variety of protected areas such as forest reserves, natural parks and wildlife management areas, where harvesting is limited or prohibited. In fact, over half of the publicly owned land has tree canopy cover over 40%. It is also important to note that roughly 7% of the surveyed land had no known land tenure, indicating a lack of clarity on user rights and an increased potential for over-exploitation.

Table 18: Area of tree canopy cover by land tenure

Land tenure type	Tree Cover <5%	Tree Cover 5-10%	Tree Cover 10-40%	Tree Cover 40-70%	Tree Cover >70%
Private-Individual	23.7%	21.1%	24.3%	21.6%	9.4%
Public - State	7.3%	16.4%	23.4%	**40.4%**	12.5%
Customary	23.7%	16.1%	28.4%	23.6%	8.2%
Not known	25.1%	12.5%	**48.6%**	5.2%	8.6%
Total	**20.4%**	**16.7%**	**27.5%**	**26.2%**	**9.2%**

3.2.5. Area of forests by designated functions & protection status in Zambia

From the interviews made during the field assessments, seven different designations of protection status for the natural forests were recorded: forests designated strictly as reserve 6.5%; forests known to be designated as national parks 9.1%, forests designated for natural monuments 0.3%; forests designated for habitat management 5.5%, forests designated for multipurpose 16.9%; forests designated for production 23.7%. Approximately 16% of the natural forests assessed could not be identified under any designation while 21.8% of the area was unanswered for in terms of protection status.

The recordings were based purely on the level of understanding of the users of the forest resources in the areas visited. Results reflect perceptions of management designations of forests rather than legal definitions of the land surveyed. As can be seen below in figure 9, the protection status of a large proportion of the forests surveyed was either not known or considered outside of the options granted. In many cases, those considered 'other' indicated are under customary ownership and not under any particular protection status.

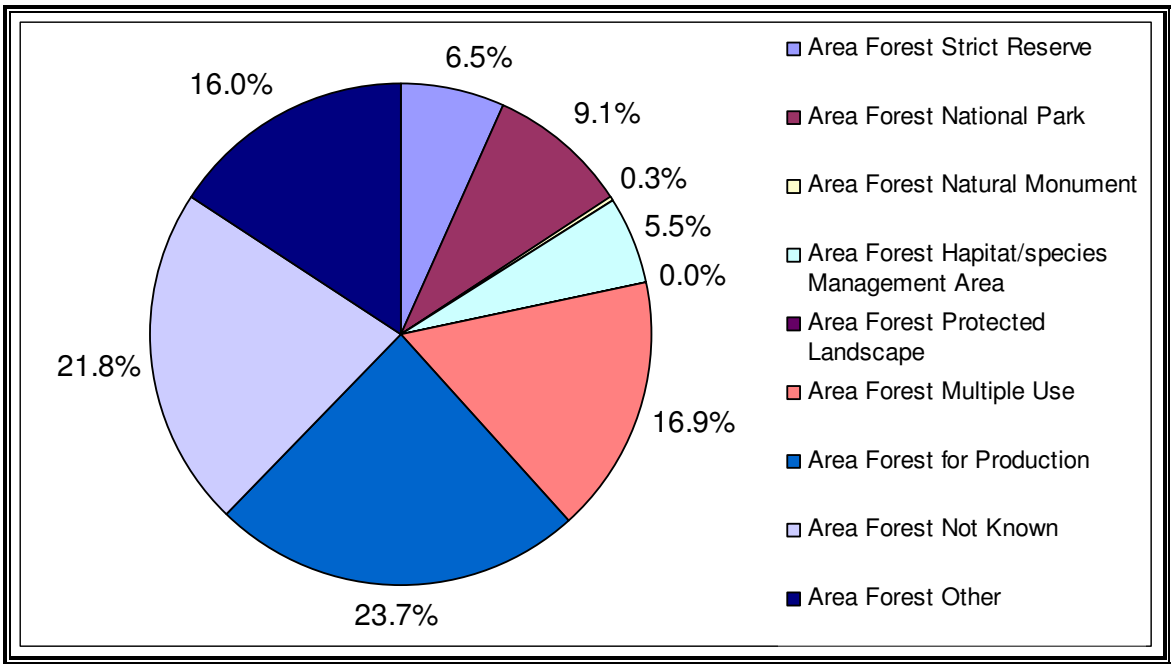
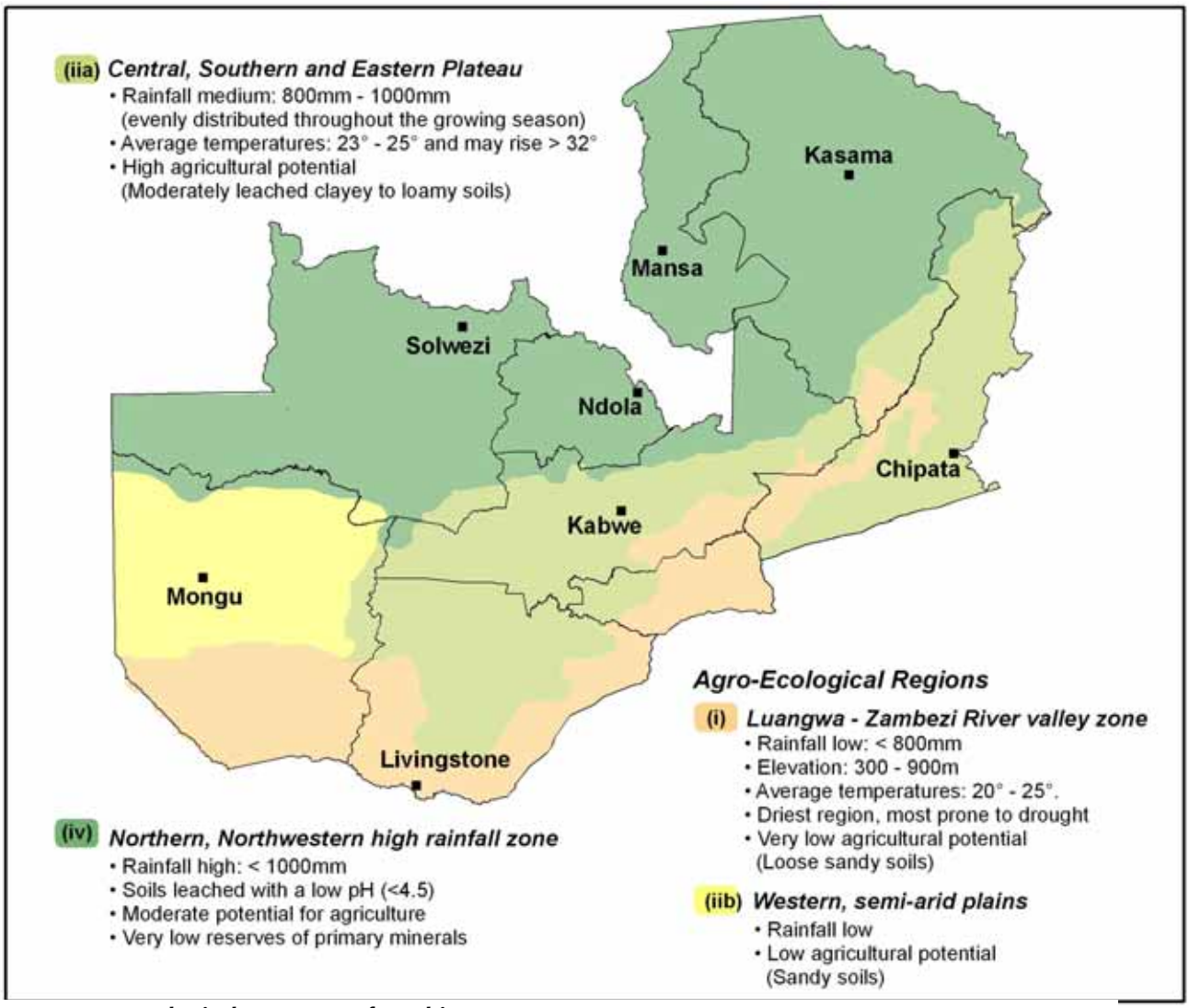


Figure 9: Proportion of all forests by protection status

3.2.6 Area of forest by Agro-Ecological Zones per Province

Global agro-ecological zones (GAEZ) have been developed by FAO and the International Institute for Applied Systems Analysis (IIASA) with the use of digital global databases of climatic parameters, topography, soil and terrain, and land cover to predict crop suitability and land productivity potentials. GAEZ maps indicated that Zambia consists of four agro-ecological zones (Map 2). The first, AEZ 1, comprises the low rainfall (semi-arid, 800mm) low altitude (400-900m), hot and dry areas along the Luangwa and Zambezi Rift Valleys. AEZ IIa consists of a sub-region of the medium rainfall (800-1000mm) plateau including main farming areas on the plateau of Central, Eastern and Southern Provinces. The altitude ranges between 900 and 1300m. AEZ IIb relates to a sub-region of the medium rainfall (800-1000mm) plateau comprising the kalahari (Barotse) sand plateau and the Zambezi flood plains. The altitude ranges between 900 and 1200m. AEZ III comprises an area of high rainfall (>1000mm) in the north and on the plateau, the altitude ranges between 1100 and 1500m.



Map 2: Agro-Ecological Zone Map of Zambia

According to table 19 below, about 49% of Zambia's natural forests are located in the Agro-Ecological Zone 3 which is shared by Luapula, Northern, Northwestern, Copperbelt, and northern Central and Western provinces. Approximately 23% are in Agro-Ecological Zone 2a shared almost by all provinces except for Copperbelt and Luapula provinces; while 17% of the forests are in Agro-Ecological Zone 1 shared by Western, Southern, Lusaka, Central and Eastern provinces, and 11% in Agro-Ecological Zone 2b existing primarily in Western and a very small portion of Northwestern. These results, as expected, neatly correspond to rainfall amounts.

Table 19: Forests by Agro-ecological zones per province ('000 ha)

Name of Province	AEZ I (Ha)	AEZ IIa (Ha)	AEZ IIb (Ha)	AEZ III (Ha)	Total Forest Cover
Central	1,215	2,987	0	3,708	7,910
Copperbelt	0	0	0	1,609	1,609
Eastern	2,118	3,034	0	0	5,152

Luapula	0	0	0	3,465	3,465
Lusaka	1,355	296	0	0	1,651
North Western	0	315	102	9,624	10,043
Northern	0	1,268	0	5,945	7,212
Southern	1,024	3,649	0	0	4,672
Western	2,679	176	5,190	209	8,254
TOTAL	**8,391**	**11,725**	**5,292**	**24,560**	**49,968**
%	**17%**	**23%**	**11%**	**49%**	**NA**

3.2.7 Area of forest by Global-Ecological Zones

The ILUA inventory classified the forests in Zambia also according to Global Ecological Zones (GEZ), which is a system based on the Forest Resources Assessment (FRA) Global Ecological Zones map. Zambia has three different zones, including 'tropical moist deciduous forest', 'tropical dry forest' and 'tropical mountain'. The majority of Zambian forests (57%) fall within the tropical moist deciduous forest zone (table 20) and only 6% of the total land area is considered to be tropical mountain.

Table 20: Forest area ('000 ha) by Global-ecological zones

Global Ecological Zones	Tropical moist deciduous forest	Tropical dry forest	Tropical mountain
Total area ('000 ha)	28,668	18,752	2,548
%	**57.2%**	**37.2%**	**5.6%**

3.2.8 Management arrangement of forests

Table 21 shows the proportion of forest area under management. Management plan refers to any existing forest or woodland management plan. Overall, most forests in Zambia fall under traditional customary management, meaning that no formal management arrangement is formulated. According to the inventory, a large percentage of forests, 36%, were recorded as not having a known management plan, while 23% of forests have a formal management arrangement, referring most likely to state land (including national parks and forest reserves).

Table 21: Proportion of forest area under management arrangement

Formal Management	Traditional Management	Management Not Known
23.0%	**41.0%**	**36.0%**

3.2.9 Area of forest by stand origin

As Table 22 indicates, the large majority of Zambian forests (nearly 48 million hectares of the total 50 million hectares of forest) originated as natural regeneration. While they were not captured in the ILUA survey due to sampling intensity and their small relative size, plantations account for approximately 50,000 hectares, primarily located in Copperbelt province (ZAFFICO, 2009).

Table 22: Forest area ('000 ha) – Stand origin per Province

Zambian provinces	Natural regeneration	Plantation*	Coppice	Not known
Central	7,911	0	0	0
Copperbelt	987	0	622	0
Eastern	5,112	0	41	0
Luapula	3,110	0	354	0
Lusaka	1,652	0	0	0
North Western	9,981	0	62	0
Northern	7,214	0	0	0
Southern	4,673	0	0	0
Western	7,187	0	0	1,063
Total	**47,827**	**0**	**1,079**	**1,063**
%	**96%**	**0%**	**2%**	**2%**

*none of the 221 ILUA tracts fell within plantations and therefore this information was not captured within this survey

Table 23 displays stand origin by forest type. While all forest types show natural regeneration as the primary stand origin, a small portion (2%) within the semi-evergreen forests (primarily in Copperbelt and Luapula Provinces) indicate some amount of coppicing as their origin.

Table 23: Forest area ('000 ha) – Stand origin per forest type

Forest type	Natural regeneration	Plantation	Coppice	Not known
Evergreen	819	0	0	0
Semi-evergreen	33,049	0	1,079	18
Deciduous	13,821	0	0	1,045
Other natural forests	139	0	0	0
TOTAL	**47,827**	**0**	**1,079**	**1,063**
%	**96%**	**0%**	**2%**	**2%**

*none of the 221 ILUA tracts fell within plantations and therefore this information was not captured within this survey

3.2.10 Area of forest by stand structure

Stand structure refers to the distinct canopy layers in a stand and gives an idea of how varied and textured the forest is. Single layer stands only have one well-defined layer formed by the tree canopies. Two-layer stands have two distinct canopy layers, an upper layer (a dominant canopy layer with two thirds above the lower layer, forming a clearly defined layer with at least 20% canopy cover) and a lower layer (understory). The three-layer stand is comprised of three distinct canopy layers, each with at least 20% canopy cover: a dominant upper layer two-thirds above the lowest layer, an intermediate layer where the canopy is from one to two thirds above the lower layer and the lowest layer (understory) growing at a maximum height of one third of the dominant layer.

Table 24: Area of forest ('000 ha) by stand structure per Province

Zambian province	One-layer forest	Two-layer forest	Three-layer forest
Central	4,343	3,477	90
Copperbelt	1,354	255	0
Eastern	1,721	2,614	817
Luapula	2,647	392	427
Lusaka	0	1,303	348
North Western	2,797	3,758	3,488
Northern	1,615	5,092	506
Southern	759	3,533	381
Western	470	6,224	1,559
Total	**15,706**	**26,647**	**7,616**
%	**31.4%**	**53.3%**	**15.2%**

In general, the more layered the canopy, the older the forest stand. In Zambia, more than half of the forests are considered to have a two-layered canopy, while only 15% surveyed have three distinct layers. Taken in isolation, these figures might be alarming, however, they could also be a product of forest type rather than degradation. Northwestern province, with the highest extent of natural forests (10 million hectares), also reports the highest percentage of multi-layered canopy, indicating more primary forests (figure 10). According to table 25, these highly structured forests are primarily (70%) composed of semi-evergreen trees, or miombo woodland.

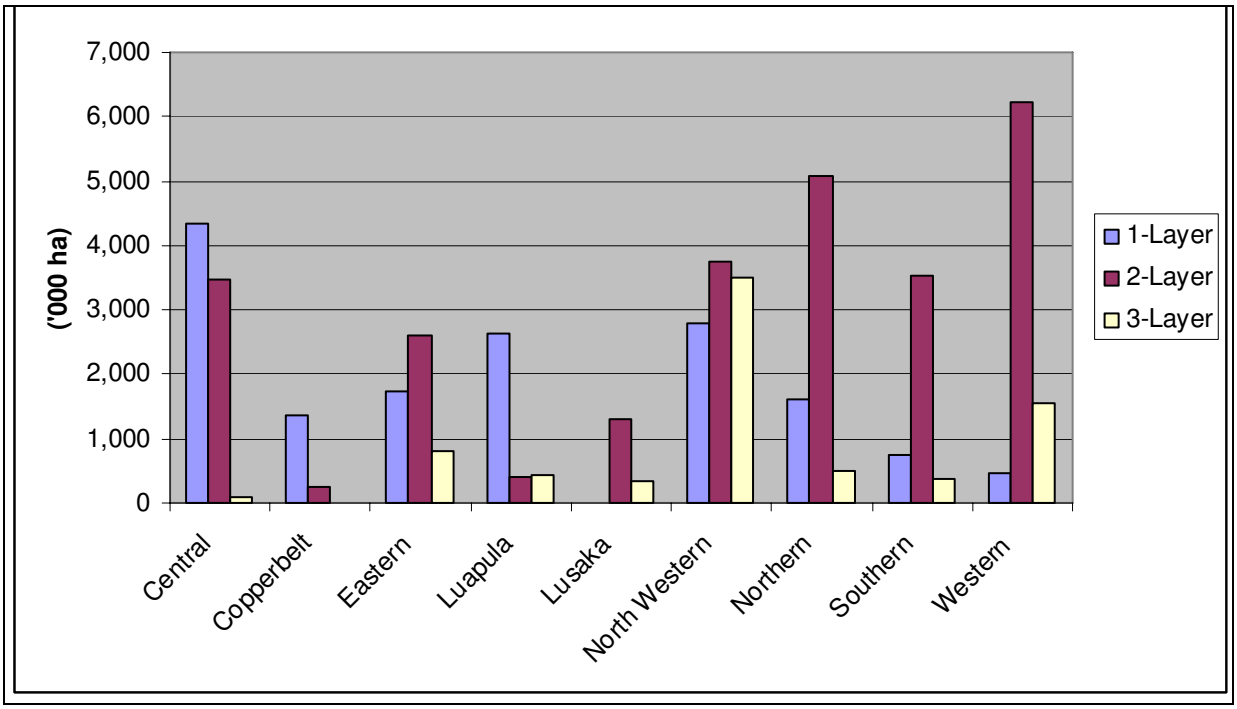


Figure 10: Forest area ('000 ha) – stand structure per Province

Table 25: Area of forest ('000 ha) by stand structure and forest type

Forest type	One-layer forest	Two-layer forest	Three-layer forest
Evergreen	207	587	24
Semi-evergreen	12,687	16,104	5,353
Deciduous	2,560	10,098	2,207
Other natural forest	96	0	43
Total	**15,550**	**26,790**	**7,628**
%	**31.1%**	**53.6%**	**15.3%**

3.2.11 Area of forest by shrub coverage per Province

Shrub coverage refers to the vertical projection of the shrub canopies as a percentage of the total ground area. Shrub coverage gives an indication of forest texture, much like stand structure. Table 26 shows the extent of shrub coverage over all forest types and indicates that the majority (63%) of Zambian forests have minimal shrub coverage of less than 10%. Around 30% of the forest area consists of shrub coverage ranging from 10-40%. This is similar to the findings on stand structure, indicating that in Zambia highly structured forest stands are in the minority. This is both due to the types of forests found in Zambia as well as due to human-induced clearing for wood products and non-timber forest products. Northern and Western Provinces reveal the largest extent of high shrub

coverage, most likely due to the fact that they are remote and therefore forests are very difficult to access.

Table 26: Extent of shrub coverage in forests ('000 ha) per Province

Zambian province	Shrub coverage <10%	Shrub coverage 10-40%	Shrub coverage 40-70%	Shrub coverage >70%
Central	4,612	1,304	102	0
Copperbelt	7,44	129	23	0
Eastern	1,714	2,094	299	0
Luapula	895	123	178	0
Lusaka	1,390	261	0	0
North Western	6,561	1,842	425	0
Northern	1,081	2,945	1,134	24
Southern	2,677	1,384	436	0
Western	5,647	1,792	452	0
Total	**25,323**	**11,874**	**3,050**	**24**
%	**62.9%**	**29.5%**	**7.6%**	**0.1%**

3.2.12 Area of forest & other wooded land by degree of disturbance

ILUA also captured the extent of forest disturbance within Zambia, with 'disturbance' defined as the impact level of human activity in the forest or other wooded land. Those areas characterized as 'not disturbed' are where all resources are conserved and there is no extraction of forest goods by humans. Protected areas would be defined as 'not disturbed'. Forests defined as 'slightly disturbed' are where there is some exploitation of forest goods and services. Those forests characterized as 'moderately disturbed' are where many products are collected without management plans and where sustainable forest management is endangered. 'Heavily disturbed' forests are those forests where there is high human pressure for forest products and services or encroachment of agriculture and where removal of forest products does not conform to management plans. In heavily disturbed forests, the notion of sustainability is not respected and removal of forest products is above mean annual increment.

As can be seen from the Figure 11 below, a large portion of Zambian forests are in good conditions (undisturbed or slightly disturbed, 63%), with the forestland being nearly unexploited and resources conserved. The majority of these forests are semi-evergreen forest types and are typically isolated forests located on difficult terrain (i.e. hills and escarpments) where man can not reach.

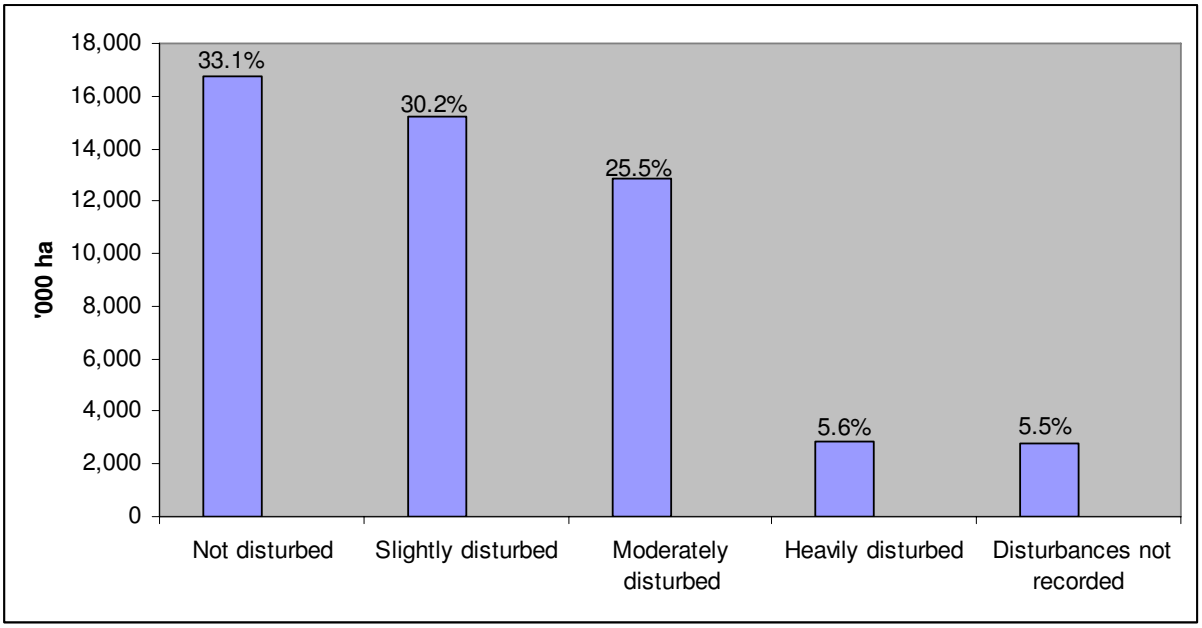


Figure 11: Proportion of forest and other wooded land area and degree of disturbance

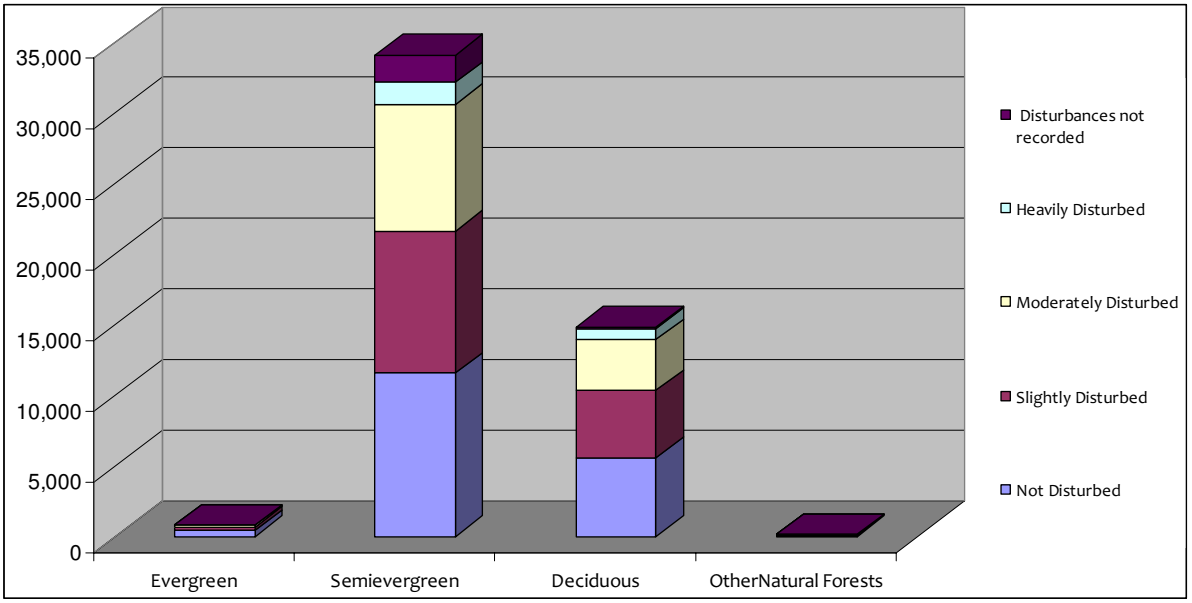


Figure 12: Proportion of Disturbance (level of human activity) over all forest types

Another 30% of forests are considered to be 'slightly disturbed'. Approximately 26% of the forest surveyed is considered to be 'moderately disturbed'. Only 5.6% of the forestland is considered heavily disturbed, with removal higher than mean annual increment. This underscores the necessity for promotion of sustainable forest management, particularly given that most of the forestland in Zambia is almost intact and capable of providing a wide array of livelihood benefits to the people of Zambia.

3.3 Volume Results

Growing stock (tree volume) estimates are based on the field inventory data collected in each province following the number of tracts accessed by the field teams. There were 221 tracts that were accessible with total area coverage of 433.1ha. In this assessment growing stock (GS) refers to the gross volume of all living trees more than 7cm in diameter at breast height and includes defective and diseased trees. From growing stock, one can obtain commercial (utilizable) volume up to bole height, which excludes trees with irregularities of the bole shape caused by normal growth in addition to those irregularities not part of natural growth. Commercial volume also considers only those species which are considered merchantable or potentially merchantable under current market conditions.

The tree volumes have been divided into 'Gross growing stock volume' and 'Commercial volume' according to measured total height and commercial height of living trees. Commercial volume also takes into account only those species considered merchantable under current market conditions, while growing stock considers all species. At the time of this report, 19 species (Table 32) in Zambia were listed as merchantable under current market conditions.

The Gross Tree stem Volume (growing stock) has been calculated as:

$Dbh^2/4 * \pi * H_{tot} * \pi * f_{gross}$

Where

Dbh	=	Tree diameter at breast height
H_{tot}	=	Tree total height
π	=	3.1416
f_{gross}	=	0.74

The Commercial Tree stem Volume has been calculated as:

$Dbh^2/4 * \pi * H_{comm} * \pi * f_{comm}$

Where

Dbh	=	Tree diameter at breast height of commercial species
H_{comm}	=	Tree commercial height
π	=	3.1416
f_{comm}	=	0.68

3.3.1 Growing stock by Major Land-Use Class

Based on the total area of accessible sample plots (433.1ha) across 221 tracts, the total growing stock by major land-use is calculated and expanded as 2.8 billion m^3 for natural forests; 58 million m^3 for other wooded land; 97 million m^3 for other land and 1 million m^3 in inland water. Therefore, the total tree volume over the major land-use combined is 2.9 billion m^3 distributed over the whole country (table 27).

Table 27: Total growing stock (million m^3) and sampling error for major land use classes

	Total	Forest	Other Wooded Land	Other Land	Inland Water
Million m^3	**2,941**	2,785	58	97	1
%	**100%**	95%	2%	3%	0%
Sampling error with 95% PL	**12.9%**	11.2%	42.7%	32.4%	202.4%

Forests are prevalent throughout the Zambian landscape (66% of the total land area) and they were assessed with the lowest sampling error (SE) of 11.2% at a 95% probability level, meaning that the 'true' volume of natural forests may fall between 2,473 million m^3 and 3,097 million m^3. Likewise, with a sampling error at a 95% probability level of 12.9%, the 'true' overall growing stock volume falls between 2,562 million m^3 and 3,320 million m^3.

3.3.2 Growing stock by all Land Use Classes and Forest Types

The highest volume per hectare (67.2m^3/ha) can be found within the Evergreen forest type. This is closely followed by semi evergreen miombo-dominated forests, which contain on average, 62m^3/ha. Due to their large extent over the landscape, semi-evergreen forests hold the largest volume, when expanded over the entirety of Zambia. Volume per hectare rates predictably decline as we leave the forest into wooded grasslands and shrublands, with 8.2m^3/ha and 9.9 m^3/ha respectively. Fallow cropland has the highest volume of any land use outside of forests, containing on average 10.1 m^3/ha.

Table 28: Volume per hectare (m^3/ha) and expanded volumes over all land use classes and forest types

Forest Type/Land Use Class	m^3/hectare	Overall volume (m^3)	%
Evergreen Forest	67.2	54,839,495	1.9%
Semi Evergreen Forest	62.4	2,127,816,974	72.4%
Deciduous Forest	40.0	595,379,737	20.2%
Other Natural Forest	50.9	6,597,149	0.2%
BroadLeaved Forest Plantation	0.0	0	0.0%
Coniferous Forest Plantation	0.0	0	0.0%
Shrubs	8.2	9,472,969	0.3%
Wooded Grasslands	9.9	48,542,691	1.7%
Barren Land	0.0	0	0.0%
Grassland	3.7	22,660,849	0.8%
Marshland	3.8	5,007,266	0.2%
Annual Crop	8.5	40,060,745	1.4%
Perennial Crop	3.8	897,457	0.0%
Pastures	1.3	604,190	0.0%
Fallow	10.1	24,057,007	0.8%
Urban	0.0	0	0.0%
Rural	6.6	3,656,402	0.1%
Lake	0.0	0	0.0%
River	1.5	1,144,057	0.0%
Dam	0.0	0	0.0%
Total	**39.1**	**2,940,736,988**	**100.0%**

Table 29 below shows total volume distributed over all 9 provinces within each of the major land use classes. As can be seen, Northwestern Province holds the largest growing stock, with over 30% of the total volume of the entire country. This is followed by Central and Western provinces with 17 and 13% respectively. Lusaka province has the lowest recorded growing stock accounting for 3% of the total growing stock.

Table 29: Volume per hectare (m^3/ha) and gross volume (million m^3) by major land-use per Province

	Forest		Other Wooded Land		Other Land		Inland Water		Total		
	m^3/ha	vol	m^3/ha	vol	m^3/ha	vol	m^3/ha	vol	m^3/ha	**vol**	%
Central	59.7	471.2	6.7	3.7	6.7	11.0	0.0	0.0	37.0	**485.9**	**16.5%**
Copperbelt	101.0	162.3	5.5	1.8	7.9	9.2	0.0	0.0	47.8	**173.3**	**5.9%**
Eastern	47.8	246.0	14.6	6.0	7.0	11.7	19.5	1.1	29.9	**264.8**	**9.0%**
Luapula	45.3	156.6	0.0	0.0	4.3	1.7	0.0	0.0	30.1	**158.3**	**5.4%**
Lusaka	53.5	88.2	0.0	0.0	7.0	0.6	0.0	0.0	34.9	**88.8**	**3.0%**
North Western	88.6	890.0	52.3	7.4	3.9	6.6	0.0	0.0	61.2	**904**	**30.7%**
Northern	41.0	295.6	6.4	14.6	10.2	34.8	0.0	0.0	19.4	**345**	**11.7%**
Southern	24.2	113.0	5.9	4.0	8.4	18.2	0.0	0.0	14.5	**135.2**	**4.6%**
Western	43.9	361.7	15.0	20.5	0.9	3.2	0.0	0.0	24.9	**385.4**	**13.1%**
TOTAL	**55.7**	**2784.6**	**9.6**	**58.0**	**6.1**	**96.9**	**0.3**	**1.1**	**39.1**	**2940.7**	**100 %**
%		**94.7%**		**2%**		**3.3%**		**0%**		**100%**	

3.3.3 Growing stock by Forest Type

The distribution of the expanded national growing stock (volume) by forest type is as follows: evergreen forest has 55 million m^3 or 2%, deciduous forest has 595 million m^3 or 21%; semi-evergreen forest has 2.1 billion m^3 or 76%; while the other natural forests have a total of 7million m^3 or 0.2% of the total forest growing stock of 2.79 billion m^3.

Table 30: Growing stock volume (million m^3) for all forest types

Total	Evergreen Forest	Semi Evergreen Forest	Deciduous Forest	Other Natural Forest
2,784.6	54.8	2,127.8	595.4	6.6
%	2.0%	76.4%	21.4%	0.2%

Table 31: Volume per hectare (m^3/ha) and Gross Volume (million m^3) by forest type per Province

	Evergreen		Semi-evergreen		Deciduous		Other Natural Forest		Total		
	m^3/ha	vol	m^3/ha	vol	m^3/ha	vol	m^3/ha	vol	m^3/ha	**vol**	%
Central	0	0	60.4	455.1	47.8	16.1	0	0	59.7	471.2	16.9%
Copperbelt	0	0	101.1	162.3	0	0	0	0	101	162.3	5.8%
Eastern	0	0	39.9	83	53.1	163	0	0	47.8	246	8.8%
Luapula	0	0	45.3	156.6	0	0	0	0	45.3	156.6	5.6%
Lusaka	0	0	51.7	66.7	60.1	21.5	0	0	53.5	88.2	3.2%
North Western	85.8	47.7	89.4	815.6	65	20.1	119.4	6.6	88.6	890	32.0%
Northern	6.7	0.7	35.7	157	50.7	137.9	0	0	41	295.6	10.6%
Southern	36.1	6.4	32	14.8	22.9	91.8	0	0	24.2	113	4.1%
Western	0	0	52.7	216.7	35	145	0	0	43.9	361.7	13.0%
TOTAL	**67.2**	**54.8**	**62.4**	**2127.8**	**40**	**595.4**	**50.9**	**6.6**	**55.7**	**2784.6**	
%		**2.0%**		**76.4%**		**21.4%**		**0.2%**			**100%**

3.3.4 Commercial volume by Major Land Use Class

In Zambia the minimum diameter for merchantable (timber) trees species (i.e. trees that can be cut for timber) is 30cm over bark measured at 1.3m above ground. A forest license stipulates that a concessionaire may only cut for timber any commercial tree species (i.e. trees considered to be of high value by the wood industries) with diameter more than 30cm. Such trees may have high value in terms of timber strength and durability properties and will provide reasonable recovery percentage for timber pieces. There are 19 commercial species considered by the wood industries to be of high value and good quality in the construction industry (table 32). These are the species that are also listed by the Forestry Department's species price list licensed for timber exploitation across the country.

Figure 13: *Brachystegia spiciformis*

The merchantable volume is computed from trees whose minimum diameter is 30cm measured over-bark at breast height (DBH) with bole height measured to the first big branch.

Table 33 shows the commercial volume expansion at the country scale, computed from each tract and distributed by major land use as follows: forests have 340 million m^3; other wooded land has 9 million m^3; other land has 16 million m^3 and inland water holds approximately 100,000 m^3. The total merchantable volume for these species distributed across all land uses is estimated at 365.8 million m^3. This volume represents 12% of the total national growing stock.

Table 32: 19 Commercial Tree Species in Zambia

Afzelia quanzensis	*Entandrophragma excelsum*
Albizia adianthifolia	*Erythrophleum africanum*
Albizia antunesiana	*Faurea saligna*
Baikiaea plurijuga	*Gulbourtia coleosperma*
Brachystegia floribunda	*Isoberlinia angolensis*
Brachystegia longifolia	*Julbernadia globiflora*
Brachystegia spiciformis	*Khaya nyasica*
Dalbergia nitidula	*Pericopsis angolensis*
Entandrophragma caudatum	*Pterocarpus angolensis*
Entandrophragma delevoyi	

Table 33: Total commercial volume (million m^3) and volume per hectare for major land use classes

Total	Forest	Other Wooded Land	Other Land	Inland Water
365.8	340.1	9.3	16.4	0.1
%	93	2.5	4.5	0

3.3.5 Commercial volume by Major Land Use Class by Province

Table 34 shows commercial volume per hectare alongside of total commercial volume by Province. As with the gross volume, Northwestern Province contains the highest commercial volume of 116 million cubic meters and 9.2 m^3/ha followed by Western and Central Provinces, which hold 18% and 13% respectively. Copperbelt has the second highest commercial volume per hectare, 7.5 m^3/ha.

Table 34: Commercial volume per hectare (m3/ha) and total commercial volume (million m3) by major land-use per Province

	Forest		**Other Wooded Land**		**Other Land**		**Inland Water**		**Total**		
	m^3/ha	vol	m^3/ha	vol	m^3/ha	vol	m^3/ha	vol	m^3/ha	**vol**	%
Central	5.8	46.0	0.6	0.3	0.9	1.4	0.0	0.0	**5.1**	**47.7**	13.0%
Copperbelt	13.6	21.9	0.0	0.0	1.3	1.5	0.0	0.0	**7.5**	**23.4**	6.4%
Eastern	5.4	27.8	3.7	1.5	1.1	1.9	2.0	0.1	**4.5**	**31.3**	8.6%

Luapula	4.9	16.9	0.0	0.0	1.5	0.6	0.0	0.0	**3.5**	**17.5**	4.8%
Lusaka	3.1	5.2	0.0	0.0	0.0	0.0	0.0	0.0	**2.4**	**5.2**	1.4%
North Western	11.3	113.5	7.6	1.1	0.9	1.4	0.0	0.0	**9.2**	**116.0**	31.7%
Northern	5.0	35.8	0.9	2.1	1.5	5.0	0.0	0.0	**2.9**	**42.9**	11.7%
Southern	2.8	13.3	0.6	0.4	1.7	3.7	0.0	0.0	**2.0**	**17.3**	4.7%
Western	7.2	59.8	2.9	3.9	0.2	0.9	0.0	0.0	**5.1**	**64.5**	17.6%
TOTAL	**6.8**	**340.1**	**1.5**	**9.3**	**1.0**	**16.4**	**0.03**	**0.1**	**4.9**	**365.8**	**100.0%**
%		**93.0%**		**2.5%**		**4.5%**		**0.0%**		**100%**	

3.3.6 Commercial volume vs. growing stock volume by Province

As can be seen in table 35 and figure 14, commercial volume accounts for roughly 12% of the total growing stock volume. The highest proportion of commercial to gross volume (17%) occurs in Western Province. Lusaka Province holds the lowest total commercial volume, 5.2 million m^3, which represents a mere 5.8% of the total gross volume.

Table 35: Proportion of commercial volume to total growing stock by Province

Provinces	Gross Volume (million m^3)	Comm. Volume (million m^3)	Proportion %
Central	485.9	47.7	9.8%
Copperbelt	173.3	23.4	13.5%
Eastern	264.8	31.3	11.8%
Luapula	158.3	17.5	11.0%
Lusaka	88.8	5.2	5.8%
North Western	904	116.0	12.8%
Northern	345	42.9	12.4%
Southern	135.2	17.3	12.8%
Western	385.4	64.5	16.7%
Total	2940.7	365.8	12.4%

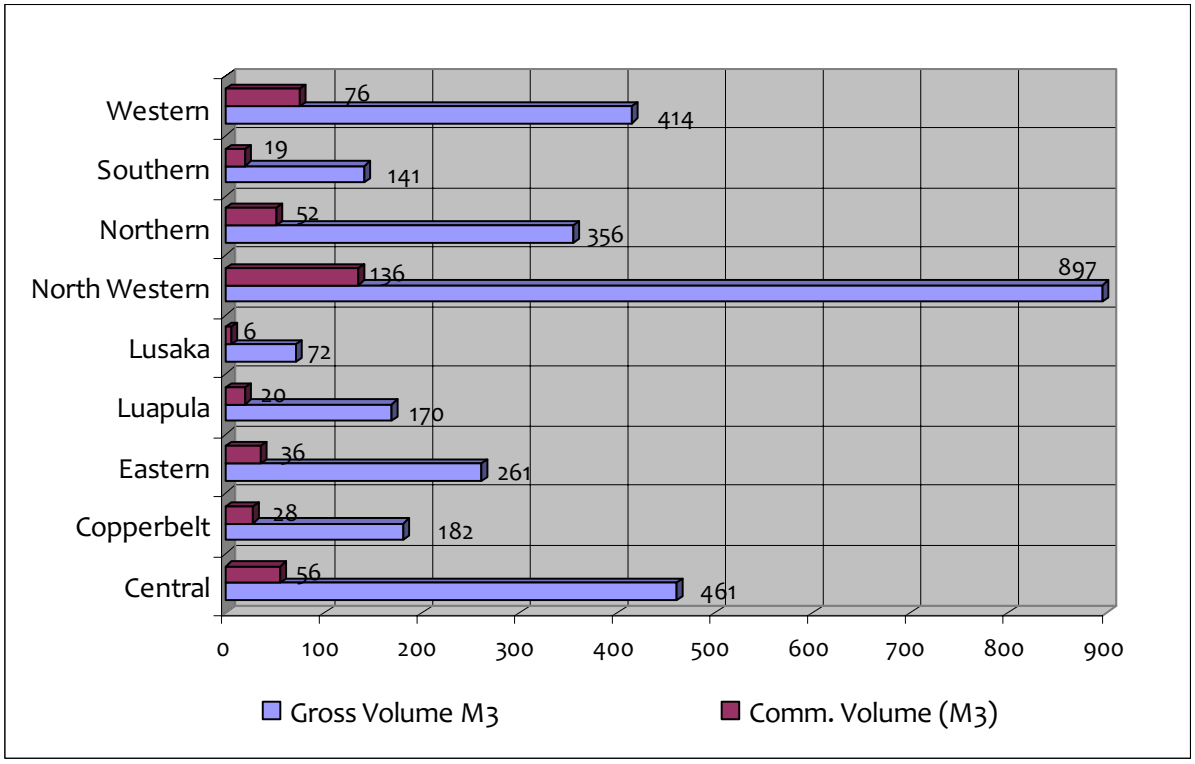


Figure 14: Comparison of Commercial Volume to Total Growing Stock by Province (million m3)

3.3.7 Commercial volume vs. growing stock volume by Major Land Use Class

Table 36 lists the proportion of commercial volume to total growing stock by major land use. On average, the proportion of total commercial volume to gross volume is approximately 12.4%. 'Other Land', which includes cultivated and managed lands, built-up areas as well as marshland, grassland and barren lands, accounts for the highest proportion, with 16.5%, while inland water constitutes the lowest proportion of commercial to gross volumes at 10%.

Table 36: Proportion of Commercial Volume (million m^3) to Total Growing Stock by Major Land-use

Major Land-use	Gross Volume (m^3)	Commercial Volume (m^3)	Proportion (%)
Natural Forests	2785	340	12.2%
Other wooded land	58	9	15.5%
Other land	97	16	16.5%
Inland Water	1	0.1	10.0%
Total	**2,941**	**365**	12.4%

3.3.8 Commercial volume by Forest Type

The distribution of commercial species volume by forest type is directly influenced by the area cover for individual land use/forest types. However, some forest types may have higher commercial species frequency and distribution than the other. The merchantable volume is expanded from the tract level computation (table 37) and distributed by forest type as follows: evergreen forests have a total of 10 million m^3 or 3%; semi-evergreen forests have 256 million m^3 or 75.3%; deciduous forests have 73 million m^3 or 21.3%; and other natural forests have 1 million m^3 or 0.4%.

Table 37: Distribution Commercial Volume (million m^3) by Forest Type

Total	Evergreen Forest	Semi Evergreen Forest	Deciduous Forest	Other Forests
340.1	10.2	256.0	72.6	1.2
%	3.0%	75.3%	21.3%	0.4%

3.3.9 Commercial volume by Forest Type and Province

Table 38 lists commercial volume per hectare and total commercial volume by forest type per Province. As with gross volume, the largest commercial volume (113.5 million m^3) can be found within Northwestern Province, the majority of which is held within semi-evergreen forests. Semi-evergreen forests hold the majority (75.3%) of commercial tree volume, followed by the deciduous (baikiea, kalahari and mopane woodlands) forest type at 21.4%. Copperbelt Province has the highest commercial volume per hectare at 13.6m^3/ha, much of which is semi evergreen forest. This represents twice as much as the total rate for all forests of 6.8m^3/ha.

Table 38: Commercial Volume per hectare (m^3/ha) and total Commercial Volume (million m^3) by forest type per Province

	Evergreen		Semi-evergreen		Deciduous		Other Natural Forest		Total		
	m^3/ha	vol	m^3/ha	vol	m^3/ha	vol	m^3/ha	vol	m^3/ha	**vol**	%
Central	0.0	0.0	5.9	44.5	4.5	1.5	0.0	0.0	5.8	46.0	13.5%
Copperbelt	0.0	0.0	13.7	21.6	10.0	0.3	0.0	0.0	13.6	21.9	6.4%
Eastern	0.0	0.0	4.4	9.1	6.1	18.7	0.0	0.0	5.4	27.8	8.2%
Luapula	0.0	0.0	4.9	16.9	0.0	0.0	0.0	0.0	4.9	16.9	5.0%
Lusaka	0.0	0.0	4.0	5.2	0.0	0.0	0.0	0.0	3.1	5.2	1.5%
North Western	17.1	9.5	10.9	99.9	9.6	2.9	23.5	1.2	11.3	113.5	33.4%
Northern	0.7	0.1	4.9	21.6	5.2	14.2	0.0	0.0	5.0	35.8	10.5%
Southern	3.9	0.7	5.2	2.5	2.5	10.1	0.0	0.0	2.8	13.3	3.9%
Western	0.0	0.0	8.4	34.8	6.1	25.0	0.0	0.0	7.2	59.8	17.6%
TOTAL	**12.5**	**10.2**	**7.5**	**256.0**	**4.9**	**72.6**	**8.8**	**1.2**	**6.8**	**340.1**	
%		**3.0%**		**75.3%**		**21.3%**		**0.4%**			**100.0%**

3.3.10 Commercial volume by diameter distribution

The tree species in table 39 list those species which are considered to be the most highly valued and in demand, frequently harvested by timber traders across the country both at small, medium and large scale sawmilling. *Brachystegia spiciformis* is recorded as the most voluminous commercial species, with approximately 4.4 m^3/ha across the whole of Zambia.

Table 39: Volume per hectare (m^3/ha) by DBH for top 19 Commercial Tree Species

Tree Species	7 - 10	10 - 20	20 - 30	30 - 40	40+ DBH	TOTAL
Brachystegia spiciformis	0.06	0.56	0.97	1.22	1.55	4.36
Isoberlinia angolensis	0.05	0.51	0.55	0.57	0.69	2.37
Pterocarpus angolensis	0.04	0.29	0.32	0.32	0.35	1.33
Erythrophleum africanum	0.01	0.27	0.31	0.34	0.34	1.28
Brachystegia longifolia	0.02	0.21	0.25	0.19	0.17	0.84

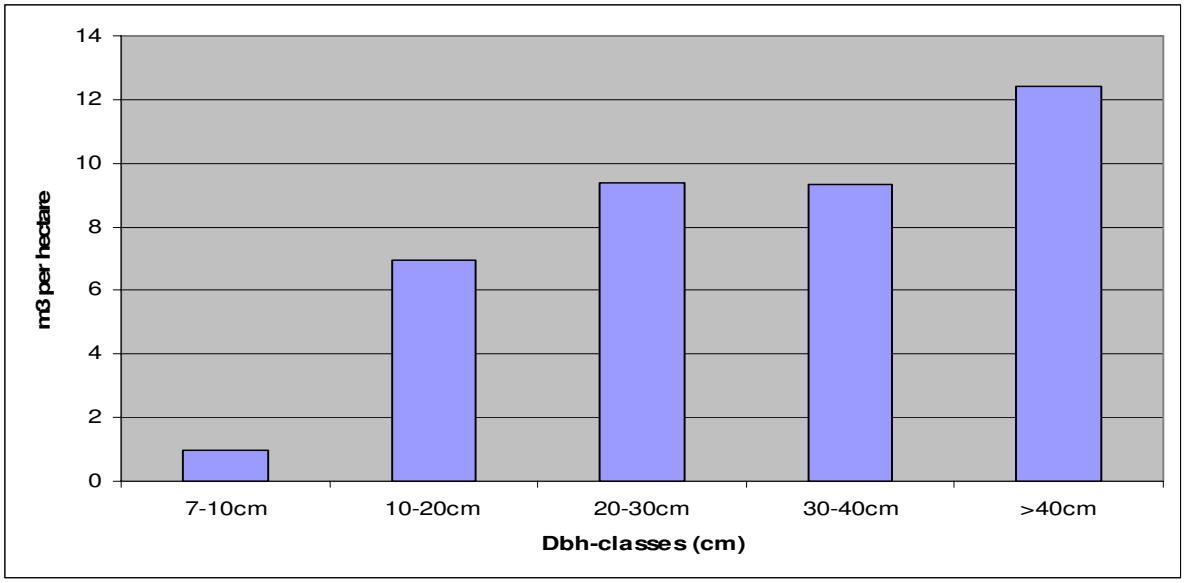
Pericopsis angolensis	0.03	0.14	0.16	0.25	0.15	0.74
Julbernadia globiflora	0.04	0.21	0.15	0.17	0.15	0.72
Gulbourtia coleosperma	0.01	0.07	0.06	0.07	0.22	0.43
Brachystegia floribunda	0.00	0.06	0.07	0.08	0.10	0.31
Albizia adianthifolia	0.00	0.04	0.02	0.02	0.05	0.13
Albizia antunesiana	0.01	0.05	0.02	0.01	0.00	0.09
Faurea saligna	0.01	0.04	0.01	0.01	0.02	0.08
Dalbergia nitidula	0.01	0.04	0.01	0.01	0.00	0.07
Baikiaea plurijuga	0.00	0.01	0.00	0.00	0.00	0.01
Entandrophragma caudatum	0.00	0.00	0.00	0.00	0.00	0.00
Khaya nyasica	0.00	0.00	0.00	0.00	0.00	0.00
Afzelia quanzensis	0.00	0.00	0.00	0.00	0.00	0.00
Entandrophragma delevoyi	0.00	0.00	0.00	0.00	0.00	0.00
Entandrophragma excelsum	0.00	0.00	0.00	0.00	0.00	0.00
Total (m^3)	0.29	2.51	2.92	3.26	3.80	**12.78**
%	2.3%	19.6%	22.8%	25.5%	29.8%	100.0%

3.3.11 Growing stock volume and stems per hectare by diameter distribution -

For the total area of Zambia, the average tree volume is 39 m^3/ha. Approximately 32% of the volume is found within the largest Dbh class, consisting of trees greater than 40 centimeters at Dbh. About 20% of the overall volume is found in trees with a Dbh smaller than 20 cm. Half of the tree volume can be found in trees with a Dbh between 20-40 cm (Figure 15).

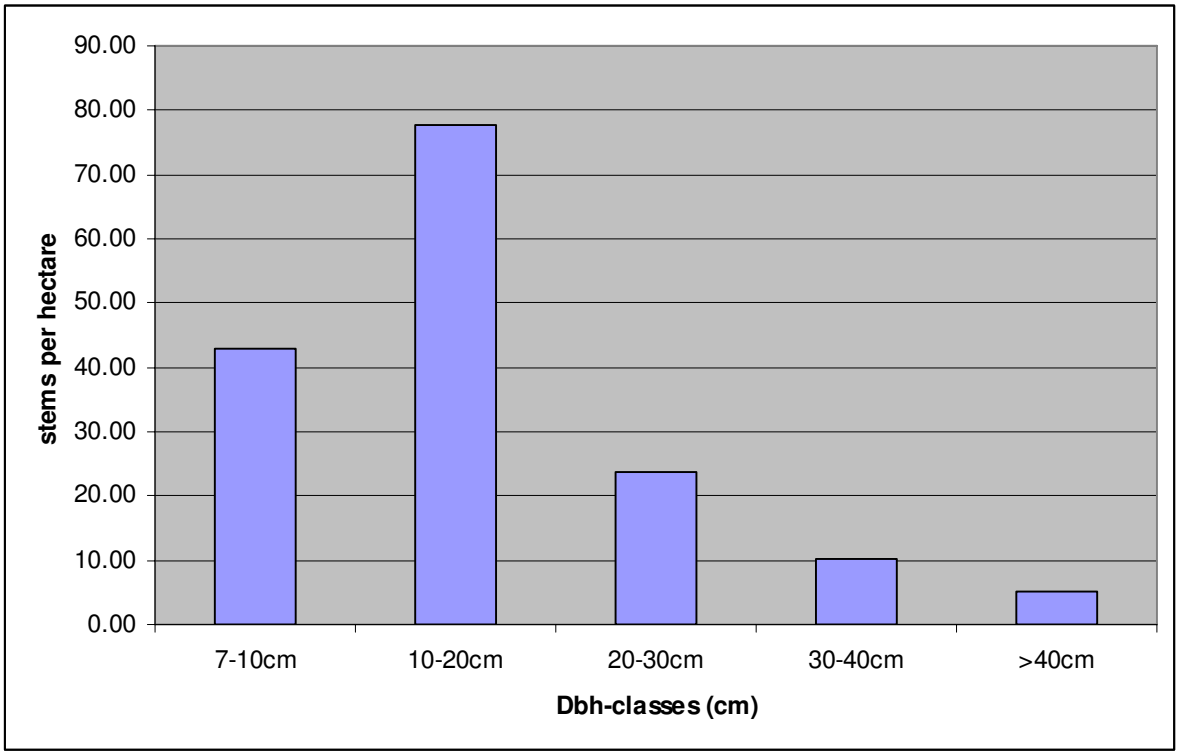
The total area of Zambia has on average 160 stems per hectare (>7cm). About 75% of these stems have a Dbh of 7-20cm and only 3% of these stems have a Dbh greater than 40cm (Figure 16).

Within forests, the average tree volume increases to approximately 56 m^3/ha (Figure 17). Since forests hold the majority (80%) of the tree volume, there are very similar volume distributions as with the volume per hectare over the whole of Zambia. The diameter class that holds the greatest volume (31.4%) is the largest class, consisting of trees with diameters greater than 40cm. The average number of stems per hectare in forests is 231 and approximately 75% of these stems have a Dbh 7-20 cm (Figure 18).



	7-10cm	10-20cm	20-30cm	30-40cm	>40cm	total
m^3/ha	1.00	6.94	9.39	9.33	12.42	39.07
%	2.5%	17.8%	24.0%	23.9%	31.8%	100%

Figure 15: Gross volume per hectare by Dbh class over total area of Zambia



	7-10cm	10-20cm	20-30cm	30-40cm	>40cm	total
stems/ha	42.94	77.58	23.73	10.31	5.20	159.77
%	26.9%	48.6%	14.9%	6.5%	3.3%	100%

Figure 16: Stems per hectare by Dbh class over total area of Zambia

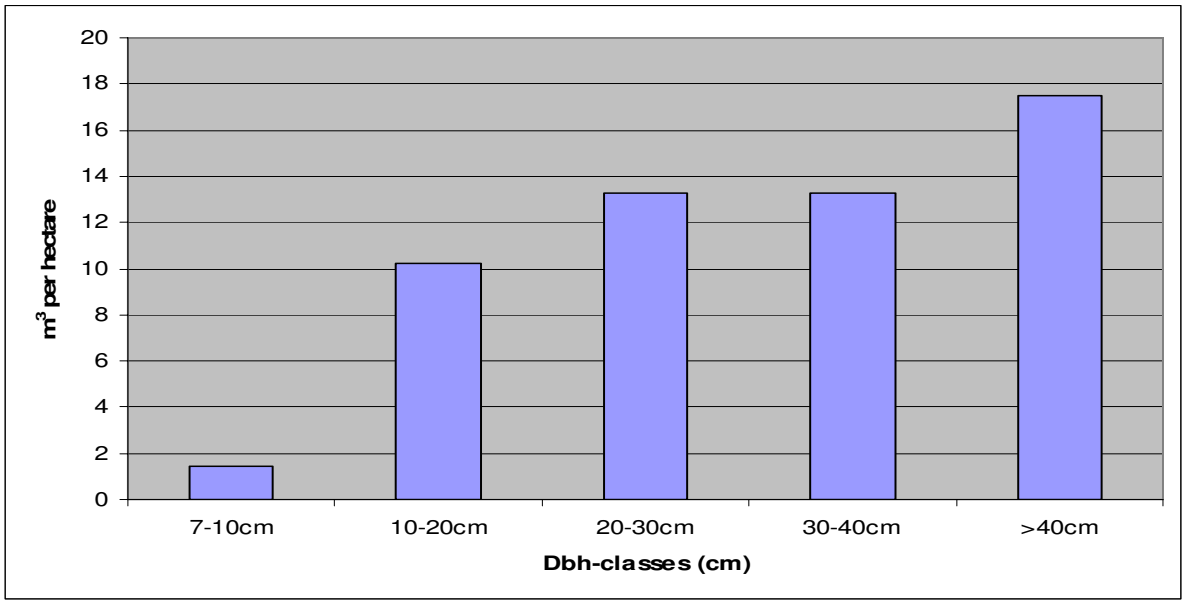


Figure 17: Gross volume per hectare by Dbh class in all forests

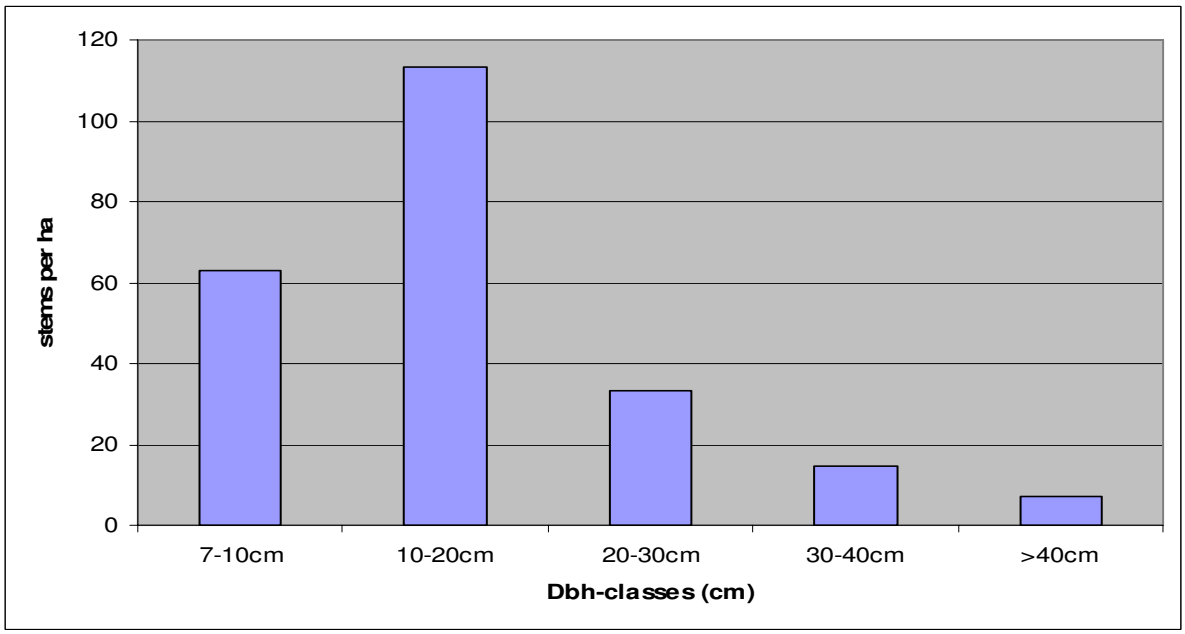


Figure 18: Stems per hectare by Dbh class in all forests

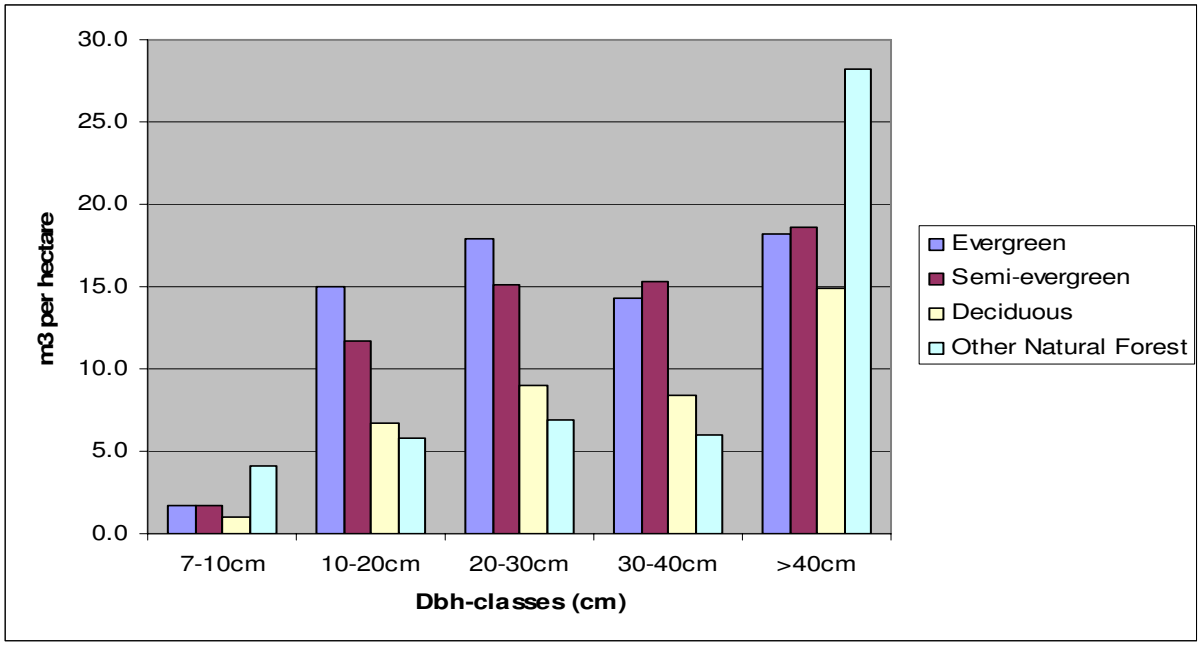


Figure 19: Gross volume per hectare by Dbh class for the different forest types

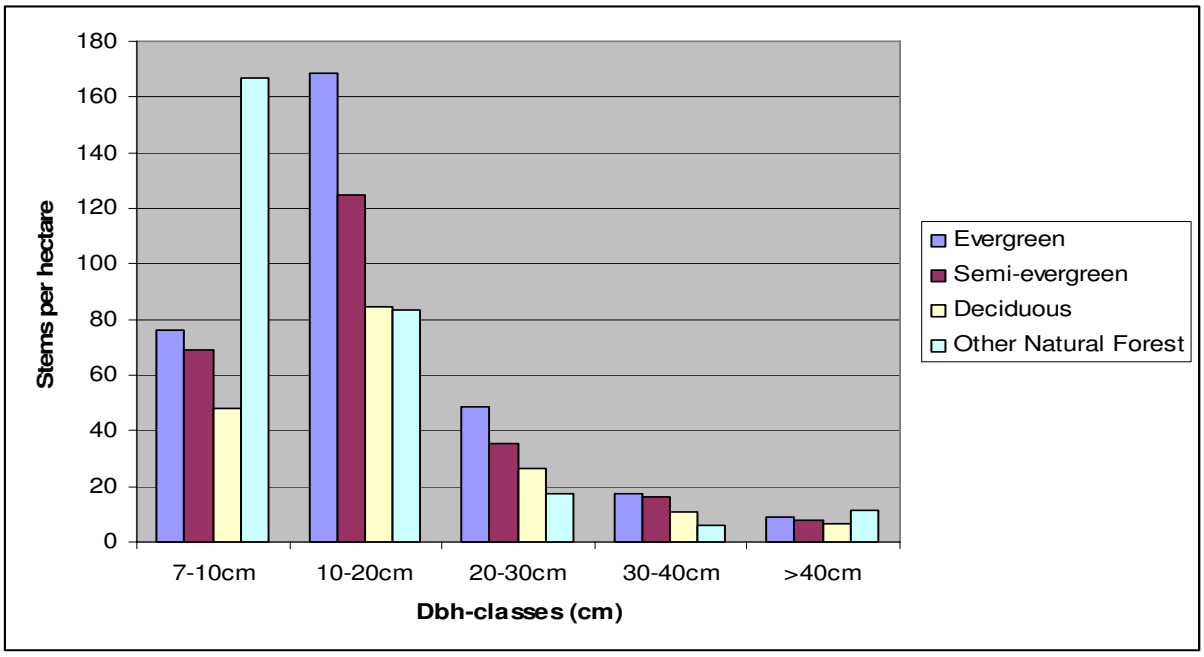


Figure 20: Stems per hectare by Dbh class for the different forest types

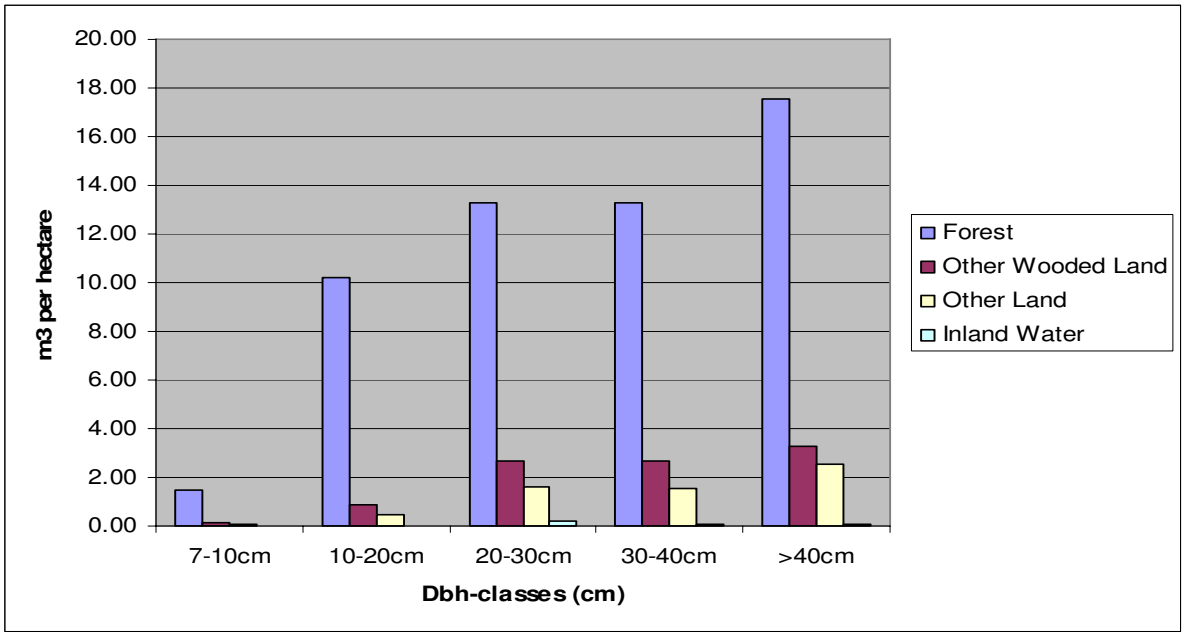


Figure 21: Gross volume per hectare by Dbh class over major land use classes

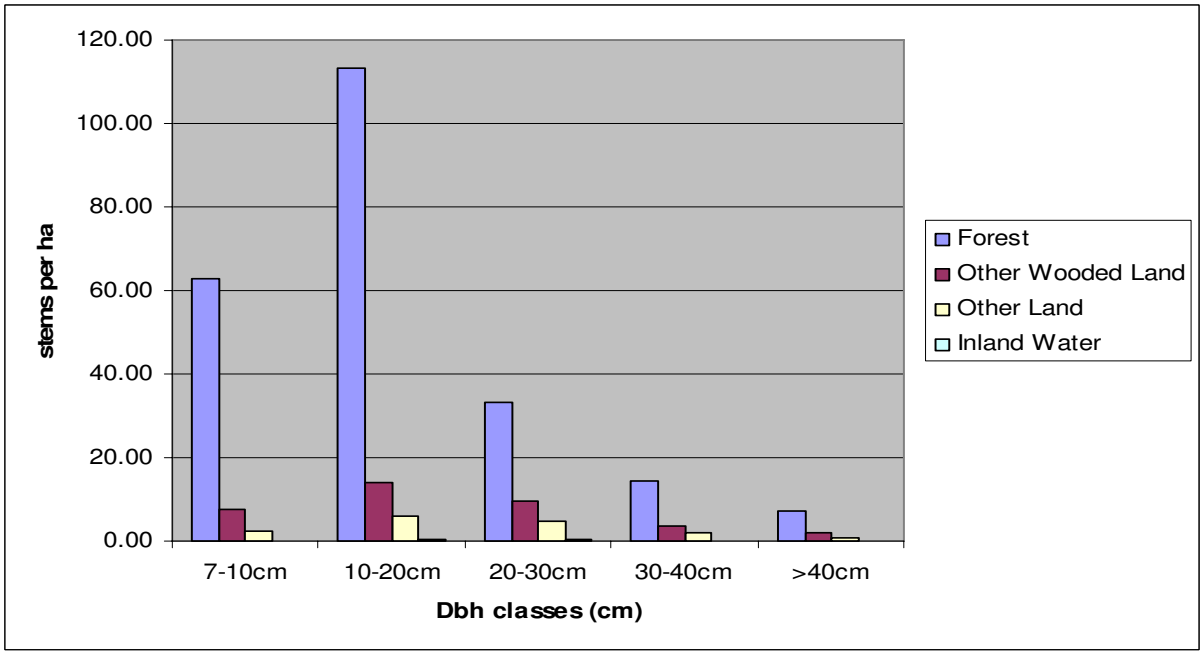


Figure 22: Stems per hectare by Dbh class over major land use classes

3.4 Tree density, frequency and species distribution

There are generally over 500 different tree species in the Zambian vegetation types, but during the ILUA only 282 total number of tree species (or genus) were measured and identified. As described in the methodology chapter, tree identification (particularly if unknown to the field crew) was typically done through the help of local guides who would give local names that would then be translated into their taxonomic names in Lusaka.

As seen in table 40, all 282 tree species were located both in forests and outside of forests (Other Wooded Land, Other Land and Inland Water land use classes). This underscores the importance of trees outside forests in the larger context of sustainable forest management and biodiversity. Forests are not the only land use/land cover to target with respect to conservation and sustainable management. Table 40 also lists the comparative frequencies of forests and trees outside forests, with forests (by their very definition) holding 4.5 times the density of trees as those other land uses containing trees outside of forests.

Table 40: Number of stems/ha and frequency in forests and trees outside forests

Land Use Type	Number of known tree species
Forest	282
Trees Outside Forests	282
Land Use Type	**Frequency of tree /ha**
Forests	231
Trees Outside Forests	54

The most frequent tree species of the 282 represented within forests are *Julbernadia paniculata, Diplorhynchus condylocarpon* & *Brachystegia boehmii* and the most frequent tree species represented outside of forests are *Amblygonocarpus andongensis, Brachystegia taxifolia* & *Bridelia micrantha.*

Table 41, listing the diameter distributions and stems per hectare of the top 20 frequent tree species, indicates that *Julbernadia paniculata* is the most prevalent tree species with approximately 18.3 trees per hectare, followed closely by *Diplorhynchus condylocarpon* at 17.6 stems per hectare. The *Brachystegia* genus is also one of the most commonly found trees throughout all of Zambia. Over 80% of these frequently found trees can be found in the 7-20 cm diameter class, with the highest stem per hectare rate (82 trees/ha) found in the 11-20cm class.

Table 41: Stems per hectare by DBH class for 20 most frequent species

Tree Species	Diameter Classes (Number of Stems/Ha)					
	7-10	11-20	21-30	31-40	41+	TOTAL
Julbernadia paniculata	5.27	8.55	2.82	1.16	0.48	**18.28**
Diplorhynchus condylocarpon	5.88	10.21	1.01	0.32	0.17	**17.59**
Brachystegia boehmii	4.54	8.56	1.84	0.79	0.28	**16**
Colophospermum mopane	2.98	6.58	1.18	0.54	0.69	**11.97**
Brachystegia spiciformis	2.27	4.81	2.29	1.32	0.62	**11.3**
Pseudolachnostylis maprouneifolia	2.57	5.49	0.8	0.33	0.12	**9.32**
Isoberlinia angolensis	1.78	4.32	1.32	0.59	0.28	**8.29**
Pterocarpus angolensis	1.8	3.67	0.85	0.38	0.18	**6.88**
Combretum molle	2.28	3.75	0.4	0.13	0.04	**6.61**
Uapaca kirkiana	2.12	3.65	0.38	0.09	0.02	**6.26**
Monotes africanus	1.56	2.9	0.53	0.18	0.04	**5.21**
Julbernadia globiflora	1.61	2.7	0.48	0.23	0.07	**5.1**
Parinari curatellifolia	1.1	2.38	0.63	0.29	0.13	**4.53**
Lannea discolor	1.5	2.71	0.2	0.06	0.04	**4.51**
Uapaca nitida	1.44	2.18	0.48	0.15	0.06	**4.31**
Erythrophleum africanum	0.53	2.46	0.78	0.39	0.14	**4.29**
Diospyros batocana	1.08	2.17	0.51	0.17	0.11	**4.03**
Pericopsis angolensis	1.04	1.87	0.51	0.33	0.09	**3.84**
Brachystegia longifolia	0.77	2.09	0.59	0.21	0.08	**3.74**
Burkea africana	0.63	0.92	0.26	0.15	0.07	**2.03**
Total	**42.73**	**81.97**	**17.85**	**7.83**	**3.70**	**154.08**
%	**27.7%**	**53.2%**	**11.6%**	**5.1%**	**2.4%**	**100.0%**

Table 42 displays tree densities for the 19 commercial tree species. The distribution of the total stems per hectare of all commercial species shows that the majority of the trees inventoried (74.7%) rest in the smallest diameter classes, from 7-20cm, indicating a healthy supply of regeneration. Those commercial species in the largest diameter class of 40cm and above indicate a very low frequency of only 1.62 trees per hectare.

Table 42: Stems per hectare by DBH for 19 Commercial Tree Species

Tree Species	Diameter Classes (Number of Stems/Ha)					
	7 - 10	10 - 20	20 - 30	30 - 40	40+DBH	Total
Brachystegia spiciformis	2.27	4.81	2.29	1.32	0.62	**11.3**
Isoberlinia angolensis	1.78	4.32	1.32	0.59	0.28	**8.29**
Pterocarpus angolensis	1.8	3.67	0.85	0.38	0.18	**6.88**
Julbernadia globiflora	1.61	2.7	0.48	0.23	0.07	**5.1**
Erythrophleum africanum	0.53	2.46	0.78	0.39	0.14	**4.29**
Pericopsis angolensis	1.04	1.87	0.51	0.33	0.09	**3.84**
Brachystegia longifolia	0.77	2.09	0.59	0.21	0.08	**3.74**
Gulbourtia coleosperma	0.41	0.76	0.17	0.08	0.1	**1.51**
Albizia antunesiana	0.43	0.63	0.06	0.01	0	**1.14**
Brachystegia floribunda	0.12	0.56	0.18	0.1	0.04	**0.99**
Faurea saligna	0.45	0.49	0.04	0.01	0.01	**0.99**
Dalbergia nitidula	0.27	0.53	0.03	0.01	0	**0.84**
Albizia adianthifolia	0.09	0.58	0.06	0.02	0.01	**0.77**
Baikiaea plurijuga	0.01	0.19	0.01	0	0	**0.21**
Entandrophragma excelsum	0.06	0.03	0	0	0	**0.09**
Afzelia quanzensis	0	0.06	0	0	0	**0.06**
Entandrophragma delevoyi	0.06	0	0	0	0	**0.06**
Khaya nyasica	0	0.03	0.01	0	0	**0.04**
Entandrophragma caudatum	0.03	0	0	0	0	**0.03**
Total stems/ha of commercial species	**11.73**	**25.76**	**7.38**	**3.69**	**1.62**	**50.18**
%	**23.4%**	**51.3%**	**14.7%**	**7.3%**	**3.2%**	**100%**

3.5 Regeneration potential in natural forest cover types

There are between 1,900 and 16,000 stems/ha of different tree seedlings (<7cm) by forest types. This estimate may appear low, but since the inventory was conducted only once in the dry season (after the farming season), the mortality rate could not be estimated, and therefore the estimated number of stems for tree seedlings could be two to three times higher than what was captured and reported in some forest types. Generally, the regeneration potential in most forest types is good especially where land is left to regenerate for 2 to 3 years after disturbance. However, it was more common to find high regeneration potential in areas where fires may have occurred as compared to land where intensive agriculture may have been practiced. This is attributed to the difference in levels of disturbance and or effect on the root and shoots system. Intensive fire will cause high mortality to tree seedlings, but the vigor and potential for trees to regenerate is normally stable, while intensive cultivation significantly reduces that vigor.

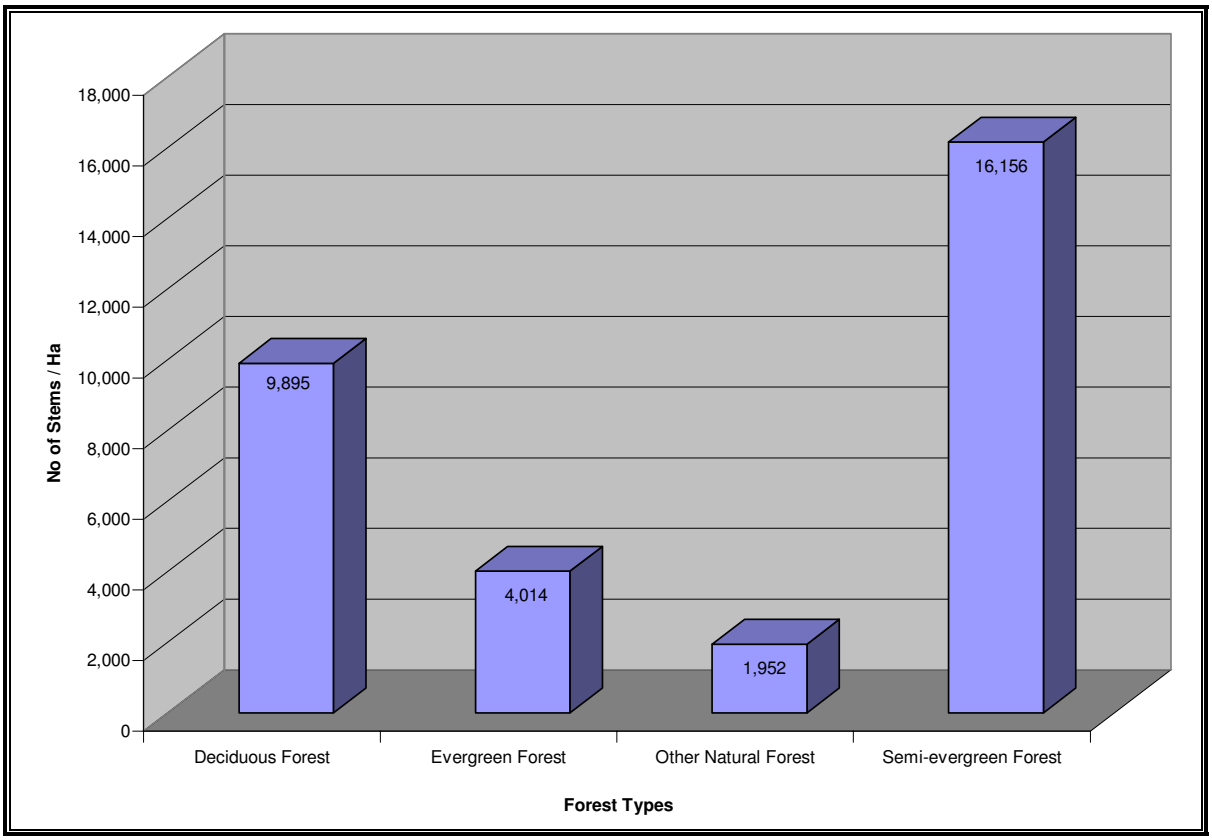


Figure 23: Regeneration potential (stems/ha) by forest type

Unfortunately in many parts of Zambia much of the subsistence farm land is managed under shrub vegetation, which people return to cut just before the rain season. The number of stems for tree species with diameter between 7 and 10cm Dbh (figure 18) are low (62 stems/ha) because they are susceptible to fire damage and cutting for opening up fields for cultivation, while only a few may be cut for other uses. The highest density of regeneration was found in semi-evergreen forests, which holds approximately 50% of the total regeneration out of all the forest types (figure 20).

3.6 Biomass and carbon stocks results

Growing stock estimates for the forest, other wooded land, other land and inland water form one of the fundamental principles used for reporting the amount of biomass and carbon stock for Zambia. In order to compute and generate the biomass and carbon stocks estimates for Zambia, the ILUA process used the methodological framework developed by the IPCC documented in the 2006 IPCC Guidelines for National Greenhouse Gas (GHG) Inventories Volume 4, chapters 2 and 4.

The following general formulas were used for calculating biomass, and eventually carbon, from growing stock figures reported in chapter 3.3.2

Figure 24: Formulas used for calculating biomass and carbon (IPCC Guidelines, 2006)

$AGB = GS \times WD \times BEF$
or
$AGB = GS \times BCEF$

$BGB = AGB \times R$
$DWB = GS \times BCEF$
$C = C_f (AGB+BGB+DW)$

Where:

AGB	=	Above-ground biomass (tonnes)
BGB	=	Below-ground biomass (tonnes)
C	=	Carbon from aboveground, belowground and deadwood biomass
C_f	=	Carbon fraction of aboveground biomass (0.47)
DWB	=	Deadwood biomass
GS	=	Growing stock (Volume, m3 over bark)
WD	=	Basic wood density (Dry weight / green volume expressed in tonnes/m3)
BCEF	=	Biomass conversion and expansion factor (Above ground biomass / growing stock, tonnes/m3)
BEF	=	Biomass expansion factor (Above ground biomass / stem biomass)
R	=	Root-shoot ratio (Below-ground biomass / Above-ground biomass)

As seen in the figure 24 above, there are two options available for calculating above-ground biomass (AGB). The ILUA directly applied the second option which uses the biomass conversion and expansion factors (BCEF) to the growing stock figures. Based on these equations, the ILUA data was initially computed to generate aboveground, belowground and deadwood biomass results based on the tract level data. These results were then expanded for the whole country as in tables 43, 44 and 45 below. These figures would be enough for Zambia to report to the UNFCCC on forest carbon stocks as a non-Annex 1 country. Figures derived from the ILUA can assist Zambia in providing Tier 1 and possibly Tier 2 carbon estimates. Carbon estimates from litter and soil could also be derived, however, these rely solely on IPCC default values rather than inventoried data.

As can be seen from the tables below, Zambian forests hold a considerable amount (90%) of the total aboveground biomass for the entire country. The total aboveground biomass over all land use classes totals to 4.7 billion metric tonnes. Belowground biomass is estimated at 932 million metric tons for a total biomass figure of 5.6 billion metric tonnes. Deadwood accounts for an additional 434 million metric tonnes. Adding up these figures and multiplying them by the carbon fraction of 0.47 gives us total carbon estimates of 2.8 billion tonnes of carbon stored in trees for the country at large. The bulk of this carbon, 1.9 billion tonnes (69%), is found within the semi-evergreen forest type, dominated by miombo woodland. While evergreen forests hold the highest density of biomass (108 tonnes/ha), since their extent is rather small, they only constitute 2% of the total tree carbon. Overall aboveground biomass density is estimated at 62 tonnes/ha with a +/-10% sampling error at 95% confidence. This sampling error naturally increases for biomass located in rarer land uses, such as inland water.

Table 43: Total aboveground biomass and biomass density in the major land use classes

ABOVE GROUND BIOMASS AND BIOMASS DENSITY IN THE MAJOR LAND USE CLASSES				
Land Use Class	Aboveground Biomass Density (tonnes/ha)	Total Aboveground Biomass (million metric tonnes)	% of total aboveground biomass	Sampling Error %
Forest	83.8	4,185	89.8%	8.2%
Other Wooded Land	29.7	180	3.9%	30.6%
Other Land	18.5	292	6.3%	26.7%
Inland Water	0.2	.79	0.0%	201.7%
TOTAL	**61.9**	**4,658**	**100%**	**10.0%**

Table 44: Total Biomass, Deadwood and Carbon stocks (million metric tonnes) in Zambia

BIOMASS, DEADWOOD AND CARBON STOCKS IN MILLION METRIC TONNES							
Land Use Class	Aboveground Biomass Density (tonnes/ha)	Aboveground Biomass (mill metric tonnes)	Belowground Biomass (mill metric tonnes)	Total Biomass (mill metric tonnes)	Deadwood (mill metric tonnes)	Carbon Stock (mill metric tonnes)	% of Total Carbon
Evergreen Forest	108.2	88.6	17.7	106.3	20.8	**59.8**	2.1%
Semi-evergreen Forest	93.1	3,178.3	635.7	3,813.9	319.2	**1,942.6**	68.6%
Deciduous Forest	61.2	909.8	182.0	1,091.8	67.0	**544.6**	19.2%
Other Natural Forests	67.2	9.3	1.9	11.2	3.1	**6.7**	0.2%
Shrub Thickets	42.9	49.6	9.9	59.6	2.6	**29.2**	1.0%
Wooded Grasslands	26.6	130.5	26.1	156.6	4.4	**75.7**	2.7%
Grasslands	11.0	67.1	13.4	80.5	1.0	**38.3**	1.4%
Marshlands	6.0	8.0	1.6	9.6	0.0	**4.5**	0.2%
Annual Crop	25.5	119.7	23.9	143.6	7.7	**71.1**	2.5%
Perennial Crops	11.9	2.8	0.6	3.4	1.6	**2.3**	0.1%
Pasture	6.5	3.0	0.6	3.6	0.0	**1.7**	0.1%
Fallow	34.5	82.4	16.5	98.9	6.4	**49.5**	1.7%
Rural Built up	16.1	8.9	1.8	10.6	0.2	**5.1**	0.2%
Riverine areas	1.0	0.8	0.2	0.9	0.0	**0.4**	0.0%
TOTAL	**61.9**	**4,658.8**	**931.8**	**5,590.6**	**434.1**	**2,831.6**	100%

Table 45: Spatial distribution of biomass by Province

Province	Size of Province (ha)	Aboveground Biomass (tonnes/ha)	Expanded above and below ground biomass (million metric tonnes)	% of total biomass	Ranking
Central	9,439,438	76.0	**861.3**	15.4%	3
Copperbelt	3,132,839	65.3	**245.4**	4.4%	8
Eastern	6,910,582	64.7	**536.3**	9.6%	5
Luapula	5,056,908	69.8	**423.7**	7.6%	6
Lusaka	2,189,568	46.3	**121.7**	2.2%	9
North Western	12,582,637	102.0	**1540.7**	27.6%	1
Northern	14,782,565	50.7	**898.9**	16.1%	2
Southern	8,528,283	36.4	**372.2**	6.7%	7
Western	12,638,580	38.9	**590.4**	10.6%	4
Total	**75,261,400**	61.9	**5590.6**	**100%**	**Na**

3.7 ILUA socio-economic results

The ILUA socio-economic results were based on four main thematic areas; Poverty reduction and food security; Access to resources, Environment and natural resources; Energy and climate change related issues. Socio-economic data i.e. the information on income levels, access to resources which includes access to extension services and products from both forestry and agriculture, employment opportunities in forestry was also useful in identifying trends, especially in the context of public expectations, government policies, industry development and the socioeconomic importance of forests. In particular, the socio-economic results will be used to plan, design and implement national and international policies and strategies for sustainable use and conservation of natural ecosystems, and to understand the relationship between resources and users of these resources.

Therefore, comprehensive socio-economic issues are well covered and documented in the ILUA socio-economic report titled "The use of the ILUA data for Forestry and Agricultural policy review and analysis in Zambia", which is a supportive ILUA final output based on the field assessment.

3.7.1 Local communities population around tracts

The average population per household is 6 people. There were 1,680 households assessed over 139 populated tracts accessed by the field crews with an estimated total population of 10,080 people (table 46). A total of 71 tracts representing 51% of the 139 populated tracts had 15 to 16 households assessed with a total population of 6,408 people. There were 35 tracts representing 25% of the 139 populated tracts with 10 to 14 households per tracts with a total population of 2,586 people; while 20 tracts (14%) had 5 to 9 households with an estimated population of 900 people; and 13 tracts (9%) had between 1 and 4 households with an estimated population of 186 people as shown in table 46 below. Based on the population estimates, a good number of tracts are highly populated and therefore may be depleted, encroached and or threatened with encroachment.

Table 46: Number of years for settlements

Years since settlement established	Number of tracts	Number of Households	Estimated Population	Status of forest
1 - 5	31	102	612	Intact (*high forest content*)
6 - 10	18	134	804	Threatened (*high forest content*)
11 - 15	19	150	900	Partially encroached (*moderate forest content*)
16 - 20	19	345	2,070	Encroached (*low forest content*)
21 - 25	25	665	3,990	Heavily encroached (*low forest content*)
25 - 30	13	185	1,110	Under fallow (*low forest content*)
30+	14	99	594	Depleted (*very low forest content*)
Total	**139**	**1680**	**10,080**	**Full Details**

The results in the table above compare well with the remote sensing analysis (reflected in chapter 4 below) on access to resources and the likely impact over time. Highly populated centers or areas and along the roads are prone to land cover change due to population pressure over the available resources within their reach.

According to records retrieved from the field data the oldest settlements are well over 80 years, though a number of these settlements have experienced migrations and immigrations over the years. Approximately 6% of the settlements and households assessed were as young as 1 to 5 years at the date of the field assessments. Most of these settlements were established following the presence and access to major forest products and services such as water and intact forests (virgin land) for agriculture expansion. Therefore, the forest resources around high populated tracts are in a dynamic state due to human presence.

3.7.2 Forest products and services

Besides such wood products as poles, firewood and sawn timber forests produce many non-wood forest products (NWFP), which are very essential for the livelihoods of the local communities. The NWFPs are divided into four categories:

(1). **Plant products** - (Fruits, nuts, seeds, roots, mushrooms, animal and bee fodder, medicinal plants etc.)

(2). **Animal products** - (Bee products, meat provided by vertebrates, etc.)

(3). **Forest services and benefits** - (local employment, environmental services including soil conservation, watershed protection, protection against erosion, ecotourism, fishing as leisure activity etc.)

(4). **Grazing** - for household animals

According to the table below, results from respondents revealed that the largest spread of forestland within settlements is dedicated to the collection of non-wood forest products (NWFPs) than any other product. The trend is similar across all provinces with the least amount of forest land being used for animal grazing in all the provinces. Western Province, known for large herds of cattle, indicates a larger amount of forestland used for grazing. Figure 25 displays the household ranking of each product or service derived from natural forests, rather than the extent of forestland used for harvesting (as in table 47). The highest proportion of households (20%) listed fuelwood, which is the major energy source for the rural people, as the highest fetched product of all followed by construction materials such as poles and thatching grass.

Table 47: Proportion of area used for different products and services by Province

Provinces	% of Area Used for Major Wood Products	% of Area for NWFP Plant Products	% of Area for NWFP Animal Products	% of Area for Forest Services and benefits	% of Area Used for Grazing
Central	10.8	22.7	3.3	3.3	2.2
Copperbelt	39.5	35.6	9.0	9.0	0.0
Eastern	37.9	45.6	8.6	8.6	2.2
Luapula	5.7	33.7	1.5	1.5	5.9
Lusaka	11.7	11.7	1.9	1.9	6.8
Northern	30.6	48.4	10.9	10.9	3.3
North western	29.6	39.5	14.7	14.7	0.7
Southern	1.9	11.1	18.0	18.0	1.9
Western	30.0	36.9	6.8	6.8	8.5
Total	**29.1**	**39.2**	**12.0**	**7.9**	**2.9**

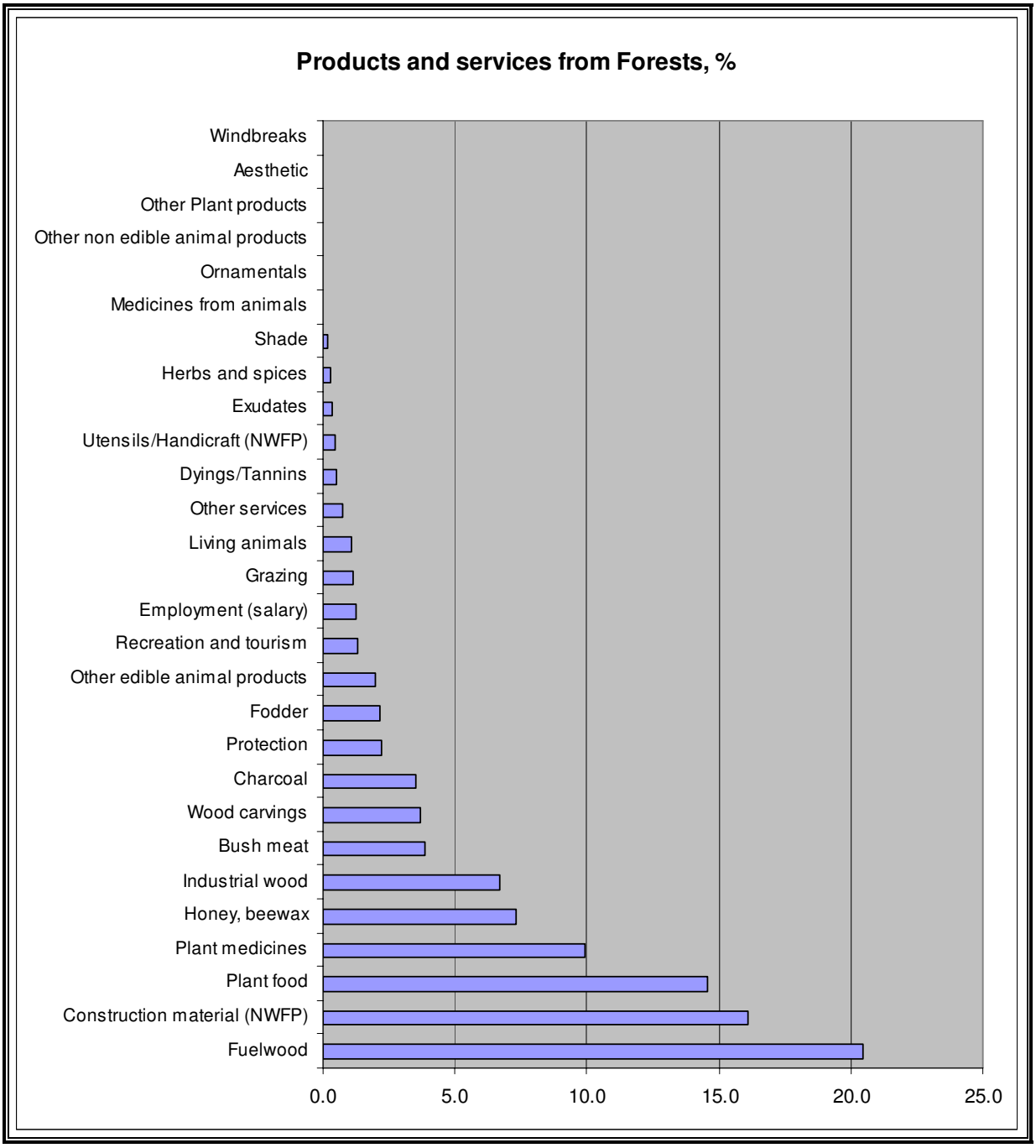


Figure 25: Rank of products and services derived from natural forests amongst households

As seen from figure 25 based on household rankings, the use of NWFPs is less common than the use of major wood products, however, most households indicated that they use a variety of products from forests, which highlights the importance multiple use of forests and the numerous products that can benefit the local communities.

Table 48: Area of Forest for Timber exploitation by Forest Type

Zambian Provinces	No felling	Clear-cutting	Selective felling	Group Felling	Strip felling	Other	Unrecorded
Deciduous Forest	9,085	411	4,340	0	0	0	961
Evergreen Forest	362	45	446	0	0	0	0
Other Natural Forest	140	0	0	0	0	0	0
Semi-evergreen Forest	13,678	1,469	16,035	122	0	175	2,840
Total	**23,265**	**1,924**	**20,821**	**122**	**0**	**175**	**3,800**
%	**46.4%**	**3.8%**	**41.6%**	**0.2%**	**0.0%**	**0.3%**	**7.6%**

Table 48 shows that clear cuttings were recorded only on 4 percent of the forest areas, whereas observations on selective fellings could be found on 40 percent of the forests areas. On the other hand the portion of forests with no felling totalled almost to 50 percent. These data is very much in line with the findings on disturbance levels in the forests (Figure 11).

3.7.3 Importance of tree species

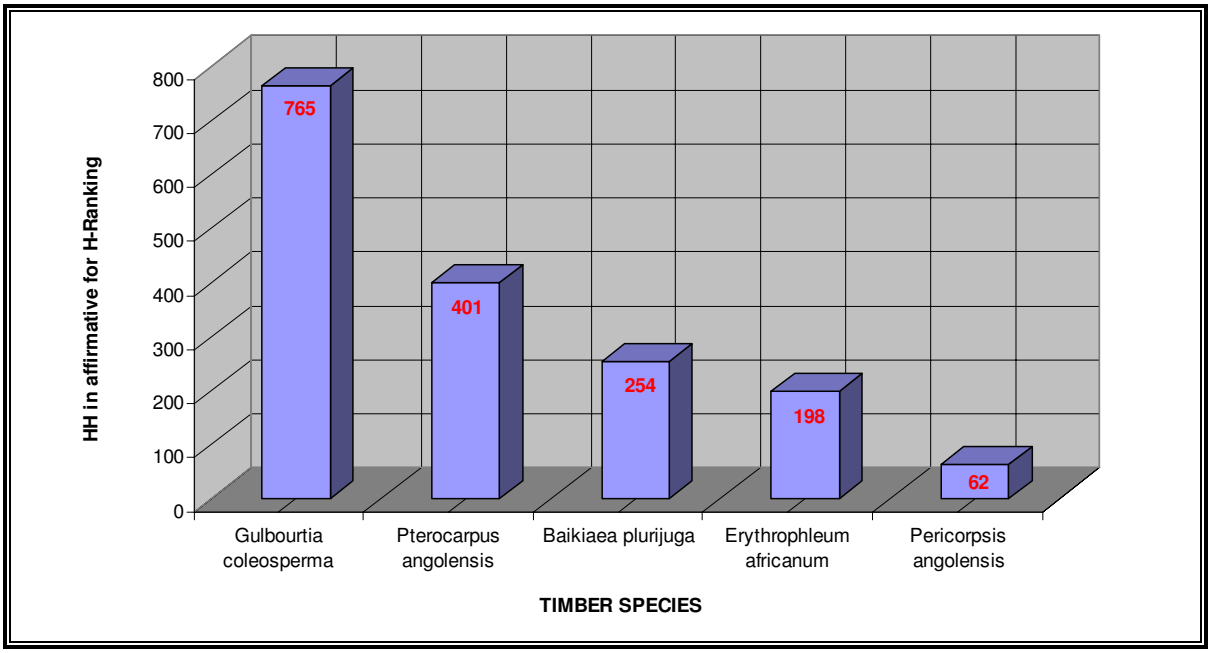


Figure 26: Important 5 timber species by ranked highest (H)

According to the household survey the most important three species for timber among the vast number of species in Zambia are *Guilbourtia coleosperma* and *Pterocarpus angolensis* (Figure 26). *Guilbourtia coleosperma* was mentioned nearly by half of the interviewed people. *Julbernardia paniculata* and *Brachystegia* spp. were most common for fuel-wood. Medicinal use of trees has an important role in the local communities, the most common species for that are *Cassia abreviata* and *Diplorhynchus condylocarpon.*

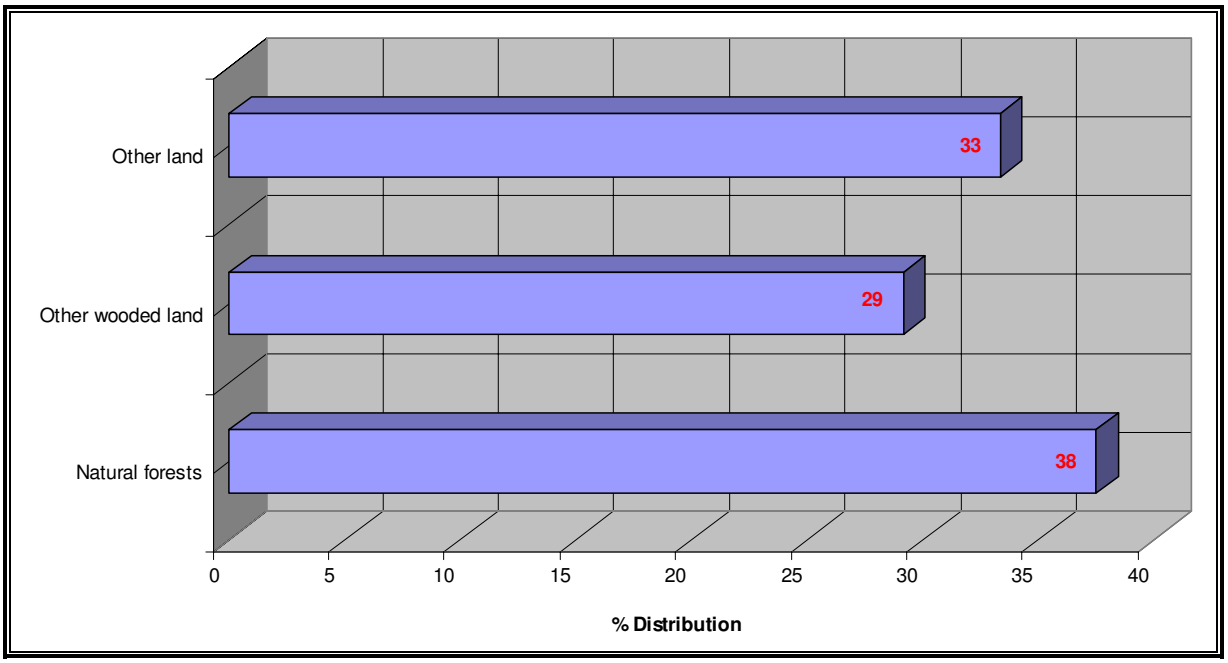


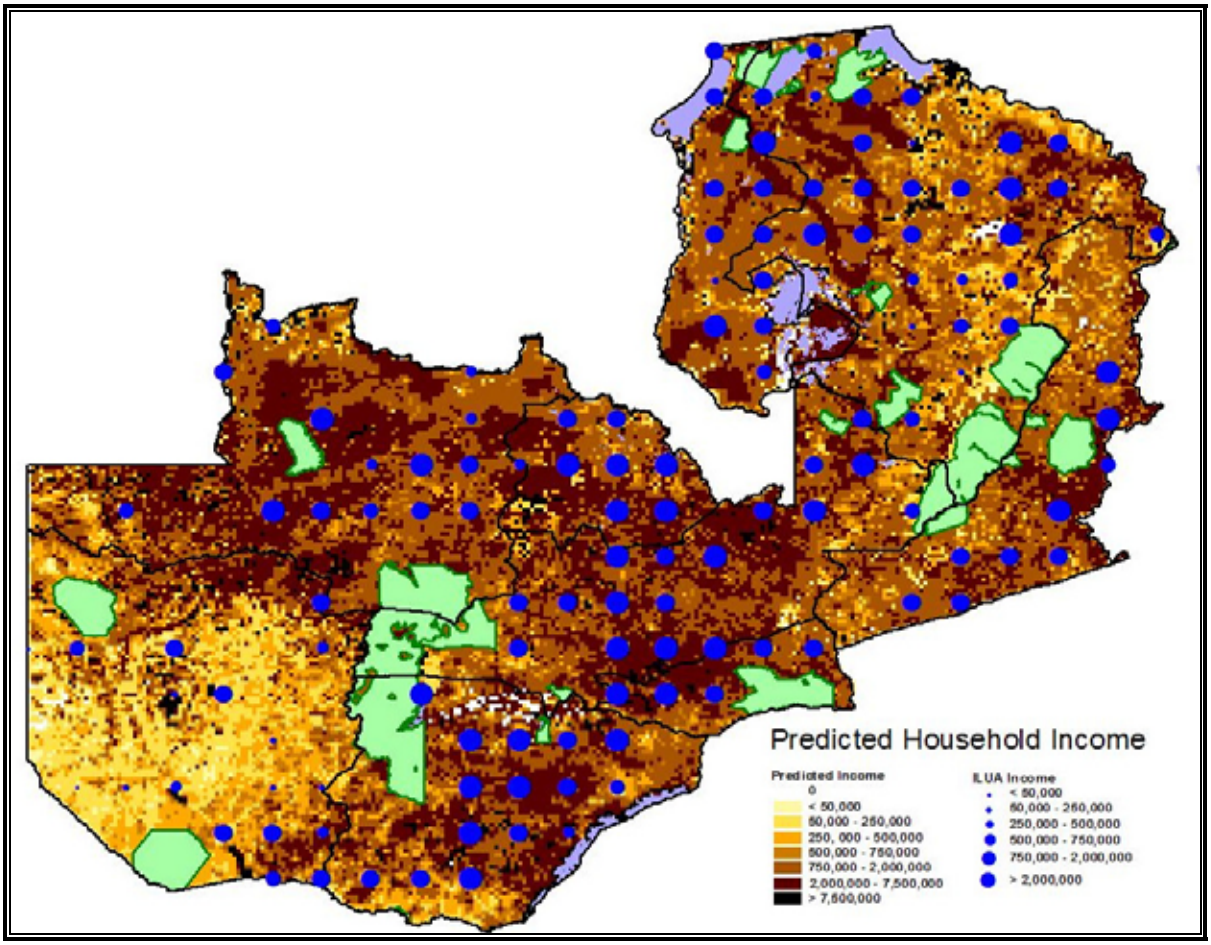
Figure 27: Products and services assessed by major land-use

There were a total of 31 different products and services accessed over all tracts by major land-use/cover class. Some products were almost found in every tract, while others were area or tract specific. These most common products and services were recorded over 72 times in 221 tracts assessed. As can be seen from the Figure 27 differences between major land use classes in provision of products and services were not significant. About 27 (38%) different products and services accessed by respondents were reported in the natural forests, while 21 (29%) were recorded in other wooded land and 24 (33%) in other land as shown in figure 28 above.

3.7.4 Annual household income

The ILUA data shows that the households derive a wide range of products and services from forests or woodland areas underscoring the importance of this resource to their livelihood strategies and in poverty reduction. A majority of households indicated that they derive income from the sales of livestock products like meat, milk, honey and eggs thus reflecting the importance of livestock and in the livelihoods of the rural households in all the Provinces. There is variation in the types of livestock products sold by Province and by season.

Most of the rural community households surveyed indicated that they earn less than K500,000 (90 USD) annually. These figures have to be taken with caution since it is usually difficult to get accurate income data for obvious reasons. Map 3 shows the modelled distribution of total household income, and clearly identifies areas where income is significantly lower than elsewhere – most notably a large area in Western Province and in parts of the north and the east. Income is relatively high around the major cities. This translates into relatively high income in the mixed rain fed production systems along the old line of rail in Southern, Central, Lusaka and Copperbelt Provinces. These are areas with emergent commercial and large-scale commercial farmers as well as some level of other economic activities in the industrial and manufacturing sectors.



Map 3: Modelled distribution of total household income

3.7.5 Crop production

The main food and cash crop is maize, both local and hybrid varieties, which were cultivated by the majority of the surveyed households. As indicated in Figure 28 below, other important crops are groundnuts, taking 15% of the cultivated area by the surveyed households, cassava (14%), beans (10%), Millet (8%); Sweet potatoes (7%) and others. Maize (25%), which accounts for most of the land under cultivation, is the staple food for local people. It is largely regarded as a subsistence crop, although the bulk of the produce is marketed.

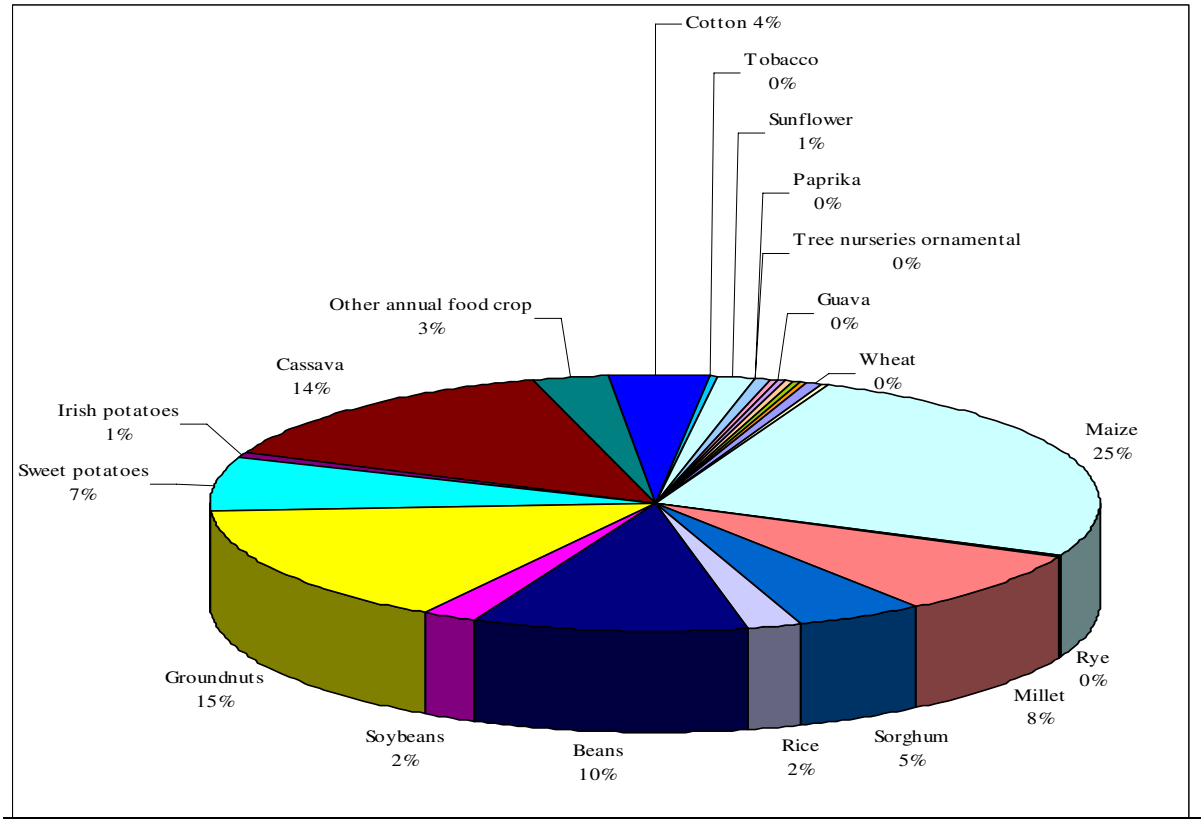


Figure 28: Proportion of Land under Cultivation in Sample Households

The dominance of maize cultivation has policy implications in terms of promoting appropriate land use, diversification of crops and the provision of research and extension services. Government can consider promotion of crop diversification in order to improve food security especially in marginal areas which fail to support maize production which is highly dependent on high cost inputs like fertilizer. Alternative grains like sorghum or millet as well as tubers like cassava can be promoted for production by smallholder farmers in areas where the agro-ecological conditions support these crops.

3.7.6 Livestock production activities

Livestock production is important due to the numerous goods and services offered both to rural households and the national economy and the society. One of the main constraints to increased livestock production in Zambia is the problem of diseases. Disease outbreaks particularly those affecting cattle are of economic importance given the high losses that the country incurs when they occur.

Table 49 shows the relative contribution of the different livestock to total Livestock Units (LU) among the sample households. Livestock Units measure the contribution of livestock to household income. An individual LU is a unit that represents an animal of 250 kg live weight, and is used to aggregate different species and classes of livestock as follows: cattle: 0.5; goat and sheep: 0.1; pig: 0.2; chicken and other poultry: 0.02 (Chilonda and Otte, 2006). Clearly cattle are a major contributor to the total LU for the households

especially in Central, Lusaka, Eastern, Southern and Western Provinces where they account for more than 75% of the total LU.

Table 49: Total and Mean number of livestock owned by sample households

Total Livestock Units										
Livestock	Central	Copperbelt	Eastern	Luapula	Lusaka	N.Western	Northern	Southern	Western	Total
Cattle	904	53	175.5	10	332.5	84.5	83	711.5	680	3034
Sheep	4.3	0	2.7	5.5	0	3.3	1.3	1.9	0	19
Goats	52.5	13.9	20.6	17.8	5.7	50.3	56.7	85.6	11.7	314.8
Pigs	24	5.6	58.4	27.2	1.4	35.2	78.6	43.8	18.2	292.4
Poultry	24.96	2.73	8.76	3.89	7.29	8.81	11.39	25.17	15.68	108.7
Total LU	1009.8	75.23	265.96	64.39	346.9	182.11	231	868	725.6	3769
Average Livestock Units										
Cattle	4.05	0.69	0.94	0.07	5.45	0.45	0.22	3.39	3.08	1.80
Sheep	0.02	0.00	0.01	0.04	0.00	0.02	0.00	0.01	0.00	0.01
Goats	0.24	0.18	0.11	0.13	0.09	0.27	0.15	0.41	0.05	0.19
Pigs	0.11	0.07	0.31	0.19	0.02	0.19	0.21	0.21	0.08	0.17
Poultry	0.11	0.04	0.05	0.03	0.12	0.05	0.03	0.12	0.07	0.06
Average LU	4.53	0.98	1.43	0.46	5.69	0.97	0.61	4.13	3.28	2.24
No. of H/Hs	**223**	**77**	**186**	**141**	**61**	**187**	**377**	**210**	**221**	**1683**

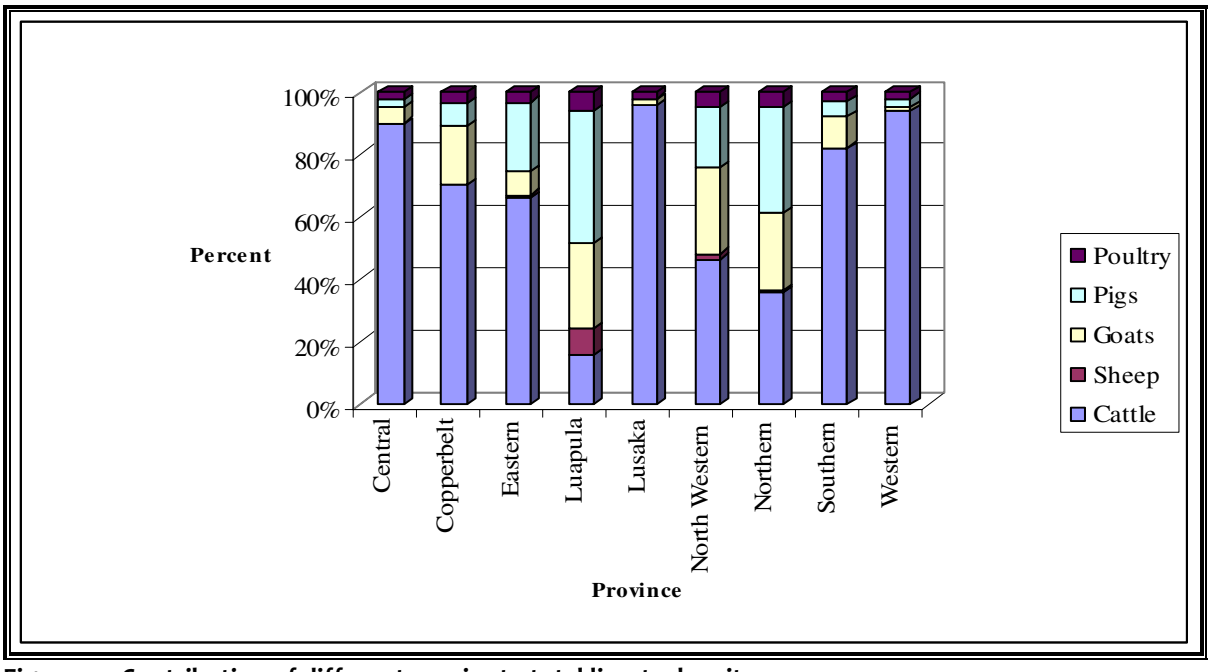


Figure 29: Contribution of different species to total livestock units

In order to estimate an aggregate herd size for the sample households and be able to compare different livestock (cows, goats, pigs, etc), the Livestock Unit (Unit) equivalence measure was used. Based on the LU equivalence measure we find that among the sample

households, on an average, the households which have the largest herd sizes are in Lusaka Province (5.7) followed by those in Central (4.5), Southern (4.1) and Western Province (3.4) and Eastern with 1.4 LU (figure 29). These survey findings are consistent with what is generally known about these areas of the country in terms of livestock production. Lusaka, Southern and Central Provinces are predominantly commercial farming areas with farmers who produce beef and milk for sale along the line of rail or urban centers of the country. Western and Eastern Provinces also have a large traditional small-scale cattle keeping population among the local people which supports a relatively large animal population. On the other hand, compared to the others, Provinces like Northern and Luapula also have a large population of traditional small-scale farmers but they are not traditional cattle keepers and are mainly involved in crop production and production of smaller livestock species like goats, pigs and poultry.

3.7.7 Access to Resources

Sample households were asked to indicate their level of utilization of inputs like fertilizer as well as their level of access to land and services like veterinary, extension and credit as well as to give estimates of approximate distances to the places where they get these services.

3.7.7.1 Access to land

In Zambia, farm households rely on traditional land tenure system to acquire farm land. In general the land is often held by a group, community lineage or clan, family or individuals and traditional leaders in the community may give out a piece of it to another person for use, with the local leaders' knowledge. Once acquired, land may be passed on from generation to generation, based on local customary law. As shown in Figure 30 below, the predominant forms of agricultural land ownership is customary (66%) followed by access through title deeds (34%), and very few (less than 1%) have access through rent.

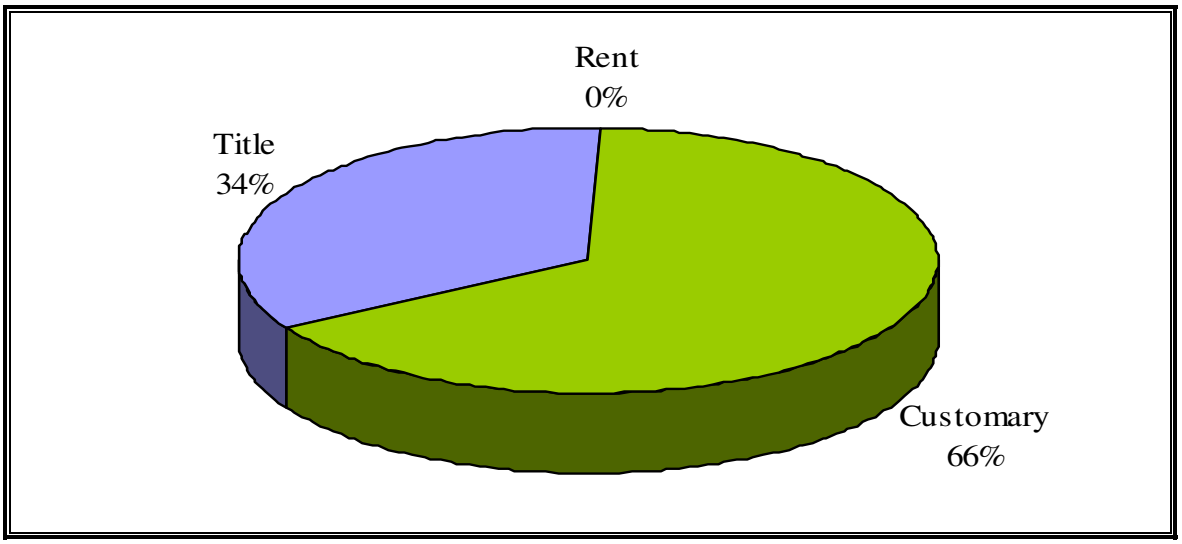


Figure 30: Distribution of land ownership on agricultural land

Very few households are using rented land or have formal title deeds for their land. These few households had just recently converted their land that they held under customary tenure to leasehold tenure under the provisions of the 1995 Land Act. Despite this provision, the customary land tenure system is still predominant in the country and very few households have converted their customary land into leasehold land tenure. This is probably because the act is still relatively new and a majority of people in rural communities may not be aware of these changes and their implications.

The other reason is that arable land is still abundant in most districts in Zambia and farmers hardly complain of lack of access to land. The predominance of the customary tenure system in the country is an indication of the importance of the use value rather than the commodity value of land among the small-scale farm households. However, this should not obscure the fact that land is increasingly gaining commodity value in parts of the country as indicated by the growing number of land disputes, purchases and registrations to convert land held under customary tenure to leasehold tenure.

3.7.7.2 Level of agricultural input utilization

The household survey asked respondents to indicate their level of utilization of several types of agricultural inputs as shown in Figure 31 below.

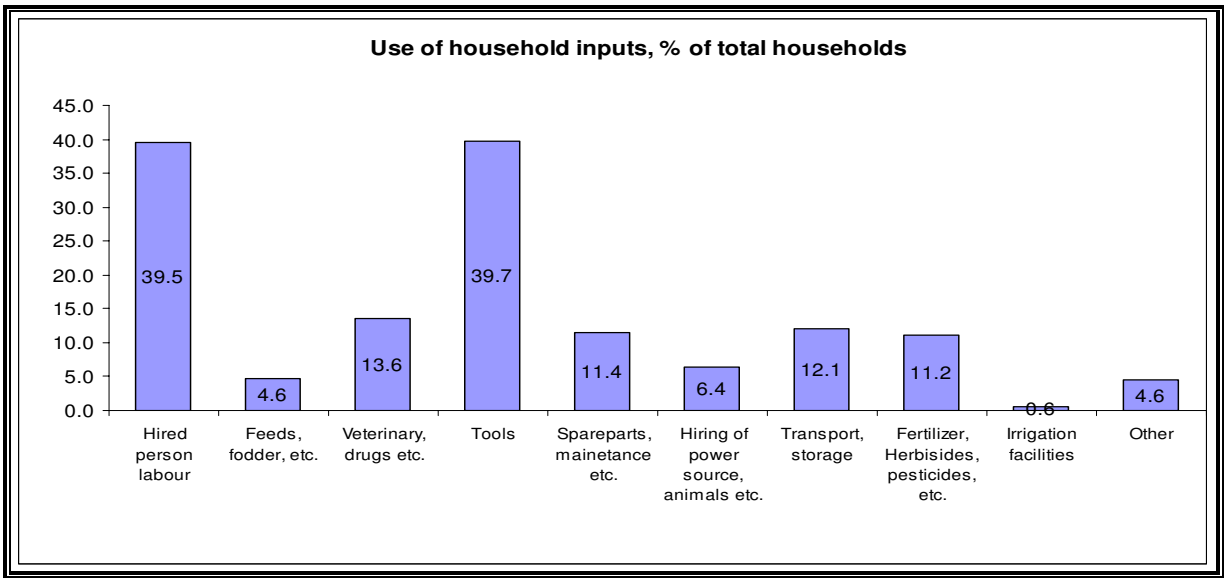
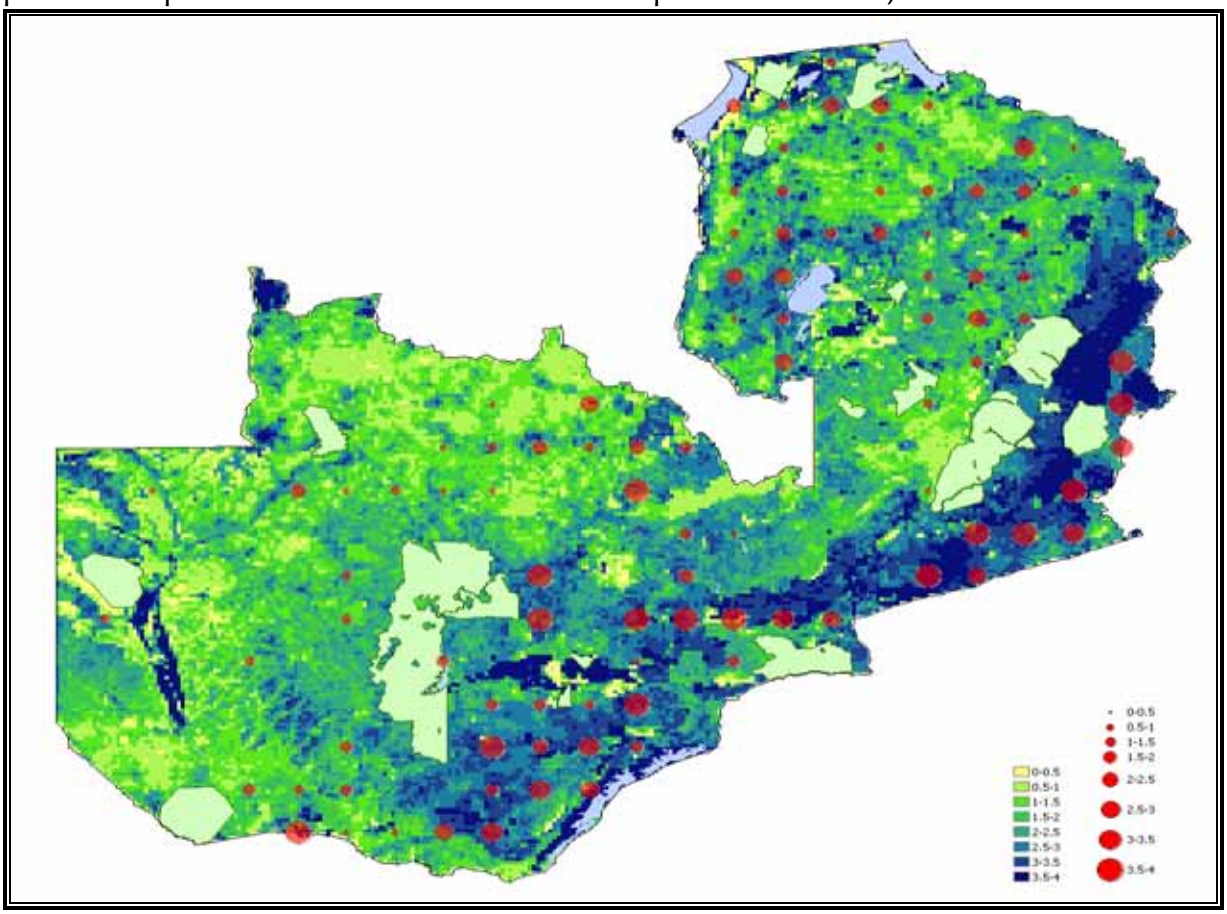


Figure 31: Level of agriculture input utilization amongst surveyed households

Most smallholder farmers cannot afford to buy enough fertilizer to meet their production requirements. The limited use of fertilizer has implications on land use. It means that farmers can only increase production by expanding the area under cultivation and thus they are opening up new areas or practicing shifting cultivation. Area expansion or shifting cultivation impacts negatively forest reserves or wooded areas.

3.7.7.3 Access to credit

Most farmers generally lack cash resources to meet immediate cash needs (including farm inputs) and access to credit from financial institutions. Because credit is acknowledged to be in short supply, it is often very costly when available. The Government and NGOs attempt to fill the vacuum of lack of access by providing either cash or input credits to farmers. Some farmers sometimes receive input credit from private companies for the cultivation of cash crops such as cotton, tobacco etc.

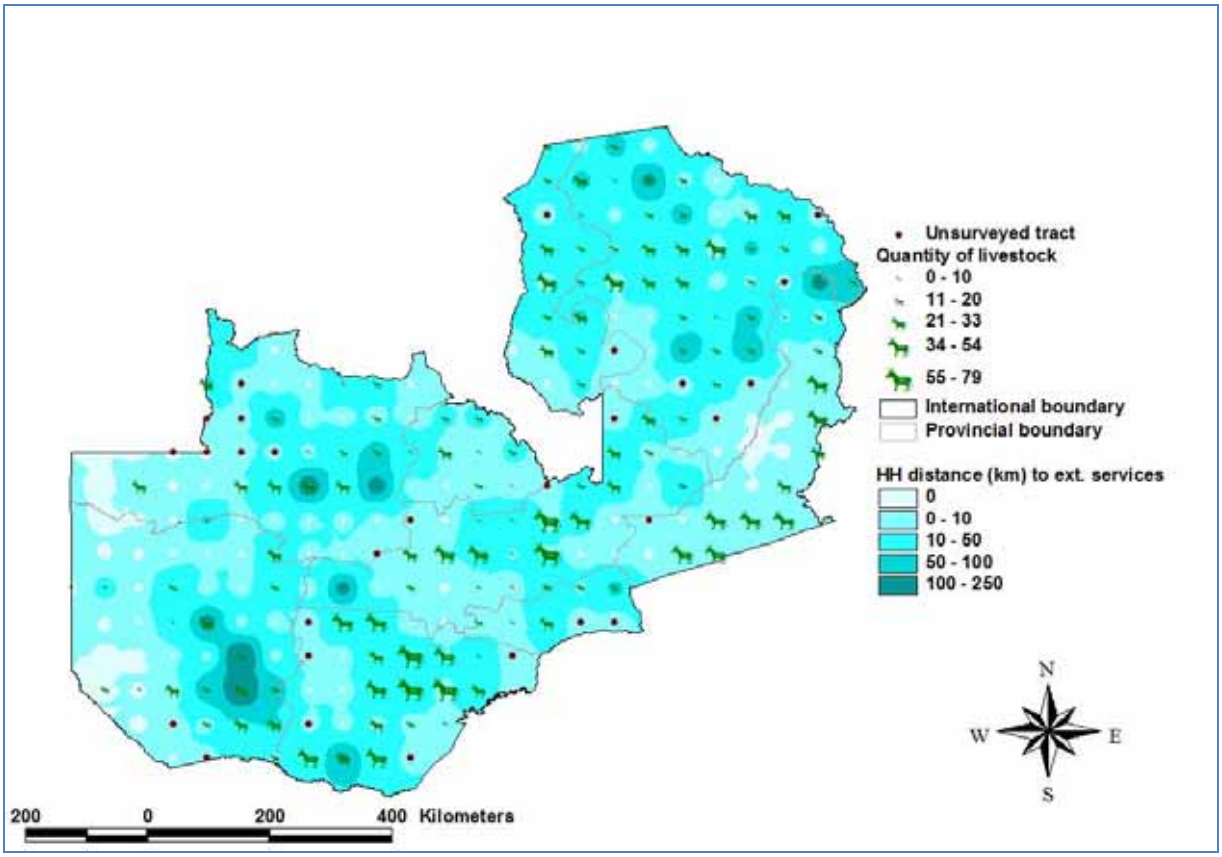


Map 4: Access to Credit

In terms of access to credit services, the survey results show that Provinces like Eastern, Luapula, Northern and Southern have high levels of access as compared to the others. The high access to credit in these Provinces is simply a reflection of the fact that the households in these areas are beneficiaries of the input credit under the Fertilizer Support Programme. Credit for livestock production activities for smallholder farmers is almost non-existent in the country. There has been a gap in the provision of financial services in the rural areas. This followed the collapse of most of the subsidized and publicly funded rural finance institutions in the mid-1990s. This situation has been further aggravated. Many small-scale farmers who could have borrowed from the development banks or other institutions are unable to meet the more stringent collateral requirements. This limited and often complete lack of access to rural financial services hampers smallholder's efforts to improve or expand their farm activities so as to earn income (ILUA, 2008).

3.7.7.4 Access to extension services

An important responsibility of the government to the farming population is to provide them with extension services through extension workers of the Ministry of Agriculture, Food and Fisheries (MAFF). The effectiveness of government in providing this vital service is affected by trained personnel. Given the limited coverage of extension services in the country in general, it was not surprising to observe that about a half of the households surveyed in North Western, Western, Copperbelt and Lusaka Provinces do not have access to agricultural extension staff.



Map 5: Total livestock in relation to distance to extension services

It can also be observed that the majority of all the sample households in most of the Provinces were at distances of over 5km from their sources of extension services. Map 5 shows the proportion of total livestock in relation to the distance to extension services. It can be seen that livestock is greater where distances to extension services are shorter. The relatively low access to extension in most rural Provinces relative to the others is due to several factors. Some of these have to do with public expenditure cutbacks which have meant that there are fewer extension workers being recruited to service the rural communities. In relative terms, the rural Provinces like Western and North Western Province also have higher poverty levels as compared to the others and some of these remote rural areas tend to be shunned in terms of service provision.

4. LAND USE AND LAND COVER MAPPING RESULTS

The Survey Department in the Ministry of Lands was contracted to produce a national land use map of Zambia based on medium resolution satellite imagery. The Survey Department collaborated with TCP project experts, in particular the ILUA National Consultant for the design, image processing and classification as well as map production.

A total of 44 Landsat 5 TM and ETM+ images were freely provided through the Global Land Cover Network (GLCN) for the production of the map. These images were geometrically corrected. Due to non availability of good quality and cloud free scenes for a single year, 38 scenes were from the year 2005, captured between April and August, while 6 scenes were for the year 2004. All the images were originally acquired under UTM projection, WGS84 datum . Since Zambia covers 3 UTM zones (zone 34 South, 35 South and 36 South), it was decided to convert them into the "Geographic coordinate system with its datum being WGS 84" to facilitate the interpretation and production of a nationwide land use/forest layer.

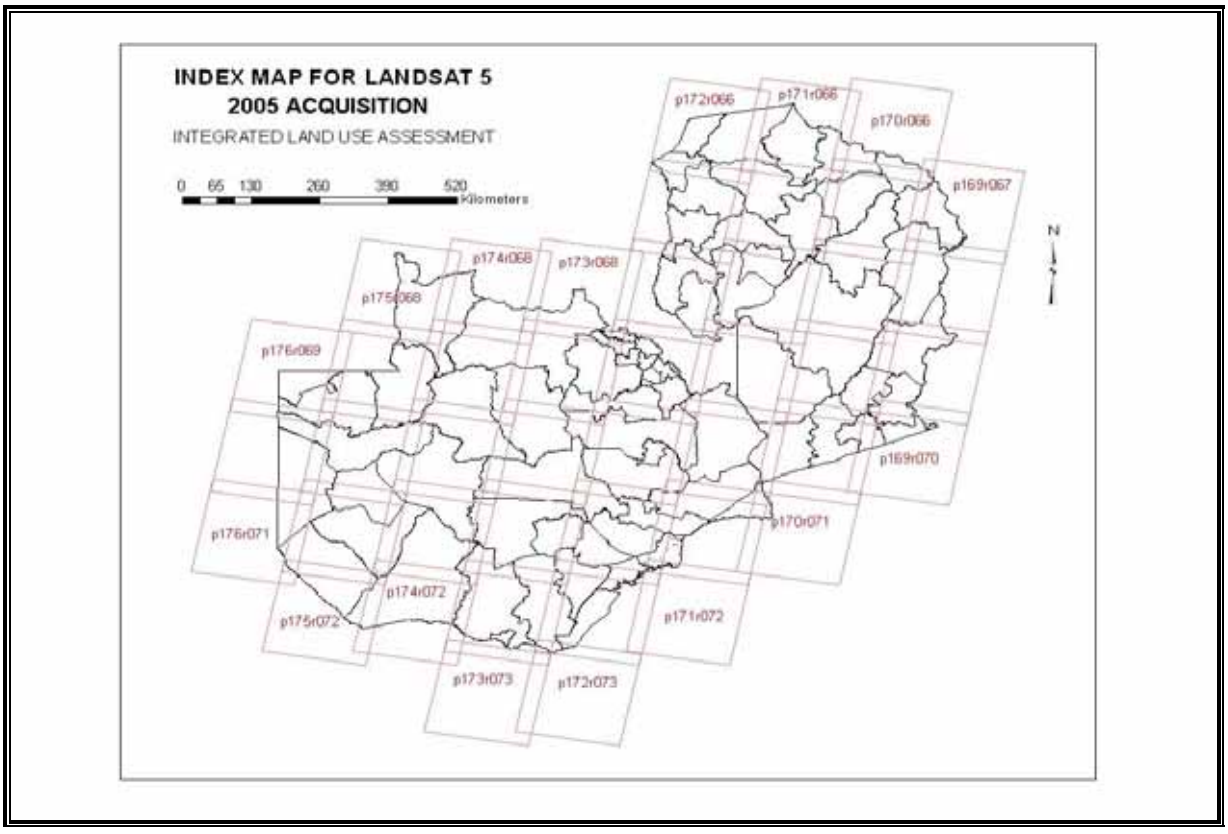


Figure 32: Thumbnail of Landsat TM/ETM+ Images for Zambia

4.1 Image processing methodology

Image mosaicing was first carried out, by combining 5 main blocks of mosaics (i.e. north, south, west, east and central blocks). Later-on, these blocks were merged into a complete national mosaic. The final mosaic was finally checked and aligned using the

national boundary which in most areas is marked by natural features (rivers). During the mosaicking process at least 4 to 8 control points corresponding to an adjacent image were identified and used in aligning one image to the other. The control points corresponded to natural features (i.e. confluence, bends and sources of rivers) or infrastructures (i.e. roads, bridges, railway lines, etc). It was time consuming, and required consistence, commitment and dedication, thorough checking, and alignment with the national digital topographic map layers.

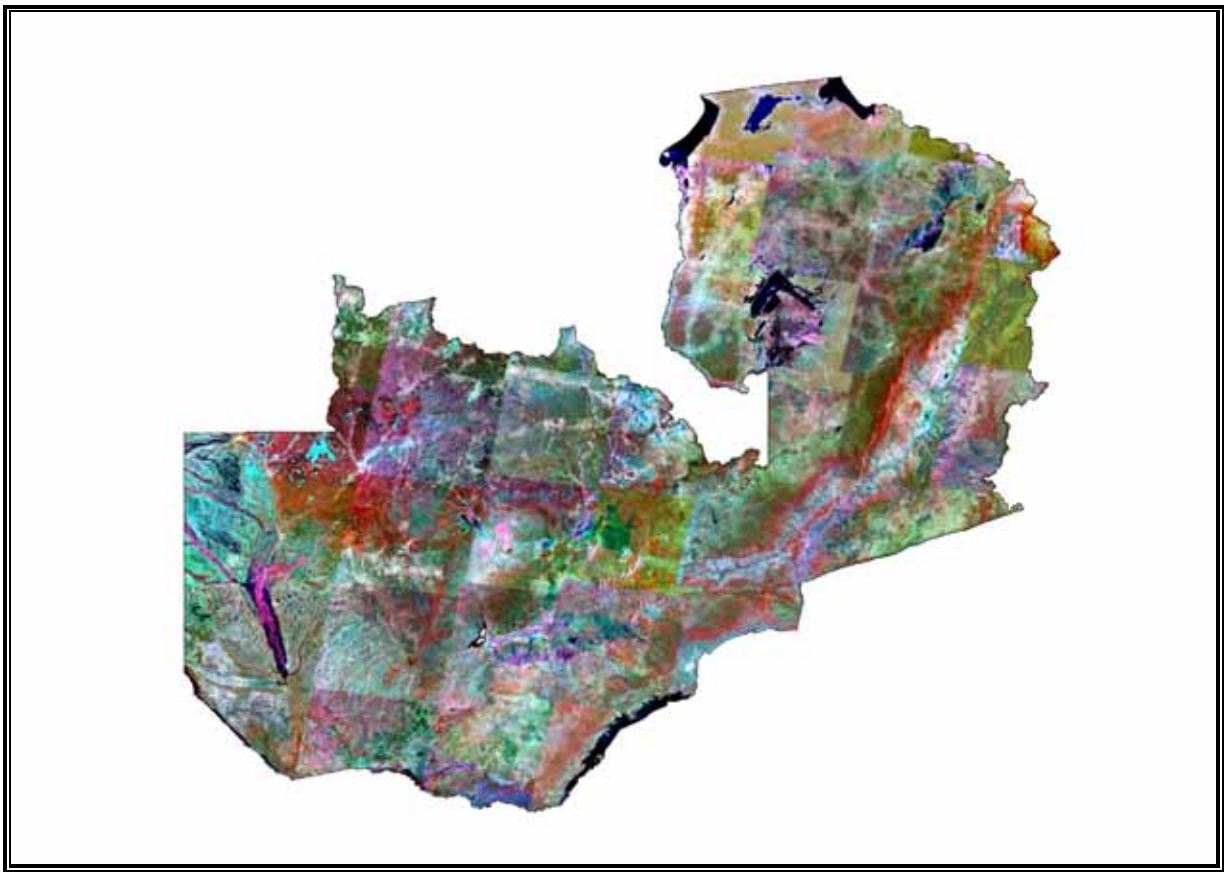


Figure 33: National Mosaic for Zambia

The Landsat 5 TM and ETM+ sensor is passive and captures data in the range 400 to 2500nm of the electromagnetic spectrum. The images used have a total of 8 bands, but considering that vegetation was a key component in the land use mapping, band 5 in the near-infrared and band 4 in the visible were used in combination with band 2.

4.2 Land use/cover classification methodology

The land use/ cover interpretation was carried out visually on screen at 1:50,000 scale, with a minimum mapping unit of 30m wide (for linear feature). ILWIS, ArcView 3.2, 8.0 and ARCGIS 9.2 software were used for drawing polygons, but the vector layers were then exported into ArcGIS 9.2 for topology building (generation of statistics).

For the ILUA land use mapping, the adopted methodology was visual image interpretation, where polygons were visually identified by their spectral characteristics and digitized on-screen. The interpretation work was facilitated by image enhancement

(contrast stretching) and relied on the interpreter's ability to relate colors and patterns in an image to real world features. Collateral materials and spatial datasets, such as national topographic and vegetation maps were used to build selective and elimination keys based on the image interpretation elements (color/tone, shape, size, texture, pattern, site, and association) that guided the visual interpretation and served as a reference for the interpreters.

4.2.1 Feature interpretation and extraction for land use mapping

Technical difficulties were encountered in working with a national mosaic on a single PC. Therefore, the mosaic was segmented into provincial tiles for feature interpretation and generation of the final map layers. A total of nine (9) land-use maps for respective Provinces in Zambia were generated under this exercise.

Due to image resolution limitations in extracting high detailed features according to ILUA classification system, some land use/cover classes were grouped (i.e. pasture, grassland and marshland were considered as part of "wooded grasslands"). Other classes such as fallow, rural built-up and extraction sites which also caused difficulties in isolating (though was possible in some areas) from cultivated land reflectance was also generalized so that the revised classification structure for the final outputs was as in the table 50 below. However, in very rare cases and also depending on the feature extent, it was possible to isolate and separate some generalized classes such as the rural built-up, extraction sites, fallow land all from annual crops and therefore placed them under appropriate legend categories. The move significantly reduced on the level and demand for extensive ground verification.

Table 50: Applied land use and forest type classification for remote sensing mapping

Country Area	**Forests**	Natural Forests (1. semi-evergreen, 2. evergreen and 3. deciduous forests)
		Forest plantations (4. broad leaved and 5. coniferous)
	Other wooded land	Shrub thickets (6. shrubs)
		Wooded grassland (7. all grasslands)
	Other land	Managed (8. perennial and 9. annual crop)
		Built-up areas (10. urban)
		Barren land (11. outcrop/rocky faces)
	Inland water	12. Lake
		13. River
		14. Dam
Note: This is an extraction from the main ILUA classification system based on the resolution of the satellite images used for land use mapping. It does not change the original classification system, but rather provides a feasible legend managed for some areas due to the limitations in satellite image detail.		

4.2.2 Provincial land use map validation

A point map of all inventoried tracts (field plots) and observed land use units were used as a main source of ground information to validate the land use maps. This validation was further consolidated with data collected from 25 training sites visited in each Province during the ground truthing/verification exercise. Informal, but extensive consultations with GIS and remote sensing experts from key land use institutions were conducted by the National Consultant as a way of getting independent technical and professional comments over the land use mapping outputs.

The point map of all tracts and the provincial land use maps were overlaid to create a cross table from which a confusion matrix was created, comparing predicted and actual cases. The confusion matrix can help us to understand just how accurate land use/cover observations done via remote sensing are by ground truthing and comparing predictions to reality. The overall accuracy and the Kappa statistic of 0.59 was computed using the formula; K = (po - pe)/(1- pe), where K is the Kappa statistic, po is the observed proportion of the correctly classified cases; pe is the correctly classified cases expected by chance. This implies that there was moderate agreement between predicted and actual land use/land cover.

4.3 ILUA land use mapping results

The land use mapping results are based on the satellite imagery for 2005 covering the whole country. The compiled results are mainly on area estimates for different land use and forest classes by Province. The results are used simultaneously with the detailed field inventory results reported under chapter 3.0 and have further been used to compare area estimates under chapter 5.0 of this report. Therefore, definition of terms for all land use classes under this chapter are the same as those used for the ILUA field inventory results.

Based on the final land use mapping statistics from all the Provinces, the area under forests and non-forest land is estimated at 46.5 million ha or 61.9% and 28.7 million ha or 38.1% of Zambia's total land area respectively. The area estimates of land under forests based on land use mapping is slightly lower than that of the field inventory which is at 49.9 million ha or 66% of Zambia's total land area. However, the estimate is within the acceptable sampling error of 7.8 at 95% probability level. The uncertainties of the classification of the images from 2000 and 1995 have to be taken into consideration. Additionally, what may explain the differences between field survey results and mapping results are difficulties in identifying low forest canopy cover via satellite images as well as seasonality of the images (i.e. when each mosaic was taken). Low forest cover is considerably difficult to detect through remote sensing, and given the natural low cover of mopane miombo woodlands, this further increases the chances that they will be under-represented through satellite imagery interpretation alone. Therefore, it is not surprising that the estimate of forest extent acquired through these means is lower than the estimate acquired by field inventories.

Table 51: Overall forest area estimates (land use mapping)

Forests (=/> 10% Canopy Cover)	Area Cover (Million ha)	Proportion %
1. Evergreen Forest	1.840	2.4
2. Deciduous Forest	12.249	16.3
3. Semi-evergreen Forest	26.240	34.9
4. Shrub Thickets	1.400	1.9
5. Other Natural forests	4.828	6.4
Total	**46.557**	**61.9**
Non-forest land (<10% Canopy Cover)	Area Cover (Million ha)	Proportion %
6. Grassland	7,254	10.0
7. Other Land (Crop land + Built-up land)	18,426	24.0
8. Inland Water (Land under water)	3.024	4.1
Total	**28.704**	**38.1**
Grand Total	**75.261**	**100.0**

Source: "ILUA Land use mapping – 2005 Landsat Imagery for Zambia"

The most threatened forest type (i.e. by extensive and intensive cultivation) is the munga woodlands classified under the broad class of the deciduous forests. This forest type is pre-dominantly occupied by the acacia tree species which are associated by fertile soils targeted by subsistence farmers throughout the country. It has a deciduous or semi-deciduous thicket under-storey divided into; [a] upper valley sites mainly in Central Province; [b] lower valley in the Luangwa and mid Zambezi valley; and [c] Kalahari sites on the kalahari sands. On the first two sites there tends to be a combretum-terminalia variant on the more elevated, better-drained sites and an acacia variant on the lower, poorer drained sites. The penultimate stage in the degradation of munga woodland is what is usually referred to as dambo-margin vegetation which is wide and so spread throughout the territory. This gives evidence to dambo encroachment by cultivation.

The least threatened is the miombo woodlands grouped under the semi-evergreen forests. However, much of this is secondary re-growth as a result of extensive cultivation in the past. It is derived from most of the degraded evergreen forests such as the parinari, marquesia, cryptosepalum, and the baikiaea.

4.3.1 Area of land under forests by Province

The proportion of forest cover against the total Province land area based on satellite imagery indicates that Eastern Province has the best case scenario with 74.2% of its land being forests, while Lusaka Province has the lowest case scenario with only 45% of its land

is forests. However, the proportion against the total forest cover indicates that Northern Province accounts for 19.1%; followed by Western Province with 18.1%; North-western with 17.2%; while 11.0% of the forests is shared between Eastern and Southern Provinces. Others are Luapula Province with 6.8%; Copperbelt Province with 4.1% and Lusaka Province scoring only 2.1% of the total land under forests in Zambia.

Table 52: Proportion of forests by Province and total Forest cover

Provinces	Total Land area (ha)	Total Forest area (ha)	% of total provincial cover	% of total forest cover
Central	9,439,438	4,913,115	52.0	10.6
Copperbelt	3,132,839	1,893,522	60.4	4.1
Eastern	6,910,582	5,128,460	74.2	11.0
Luapula	5,056,908	3,162,225	62.5	6.8
Lusaka	2,189,568	986,260	45.0	2.1
Northwestern	14,782,565	8,023,022	54.3	17.2
Northern	12,582,637	8,915,325	70.9	19.1
Southern	8,528,283	5,101,232	59.8	11.0
Western	12,638,580	8,433,420	66.7	18.1
Total	**75,261,400**	**46,556,581**	**61.9**	**100.0**

Source: ILUA Land use mapping (2005 Landsat Imagery for Zambia)

Table 53: Distribution of land under forests by Forest Types

Province	Total Forest area (ha)	Evergreen forest (ha)	Deciduous forest (ha)	Semi ever green (ha)	Shrub thickets (ha)	Grasslands (ha)
Central	4,913,115	196,525	1,287,236	2,770,997	147,393	510,964
Copperbelt	1,893,522	75,741	496,103	1,067,946	56,806	196,926
Eastern	5,128,460	205,138	1,343,657	2,892,451	153,854	533,360
Luapula	3,162,225	126,489	828,503	1,783,495	94,867	328,871
Lusaka	986,260	39,450	258,400	556,251	29,588	102,571
Northern	8,023,022	320,921	2,102,032	4,524,984	240,691	834,394
Northwestern	8,915,325	356,613	2,335,815	5,028,243	267,460	927,194
Southern	5,101,232	204,049	1,336,523	2,877,095	153,037	530,528
Western	8,433,420	337,337	2,209,556	4,756,449	253,003	877,076
Total	**46,556,581**	**1,862,263**	**12,197,824**	**26,257,912**	**1,396,697**	**4,841,884**
%	**100**	**4.0**	**26.2**	**56.4**	**3.0**	**10.4**

Source: ILUA Land use mapping (2005 Landsat Imagery for Zambia)

4.3.2 Area of non-forested land by Province

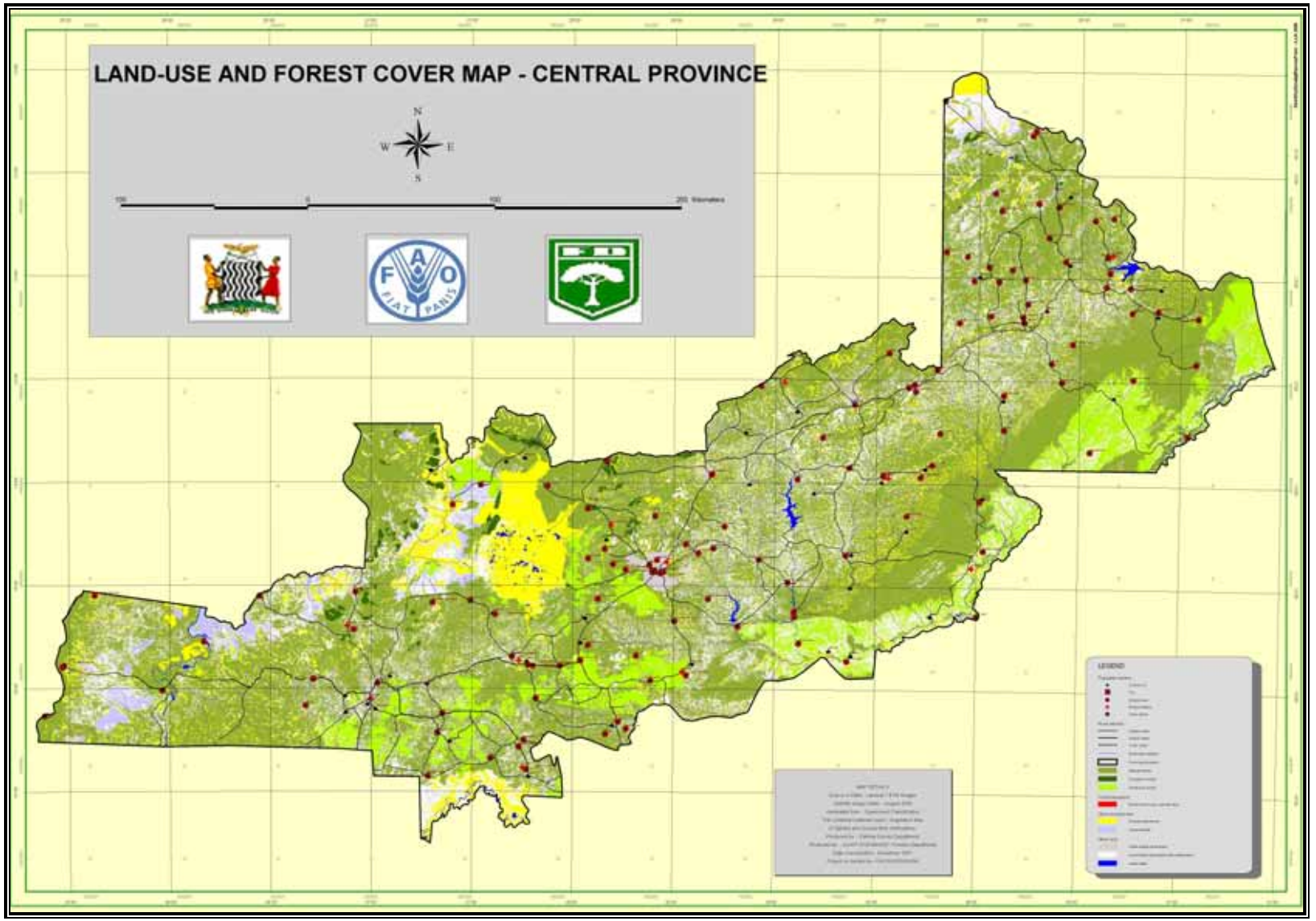
The largest proportion (52.6%) of the non-forested land is found under the annual and perennial crop (cultivated) land use, while 28.3% is under rural/urban built-up and 19.1% is other land which includes inland water, plains, and river-lines areas. This means that 52.6% of non-forested land in Zambia is under extensive and intensive cultivation. However, the analysis of the cultivated land against total land area per Province may not show a serious impact as compared to when it is measured against the non-forested land in each Province. Therefore, the table below shows the distribution of land devoid of forest cover by Province based on satellite data. The spread and distribution of this land use by Province varies depending on rainfall intensity, soils and crops grown.

Table 54: Distribution of non-forested land in Zambia

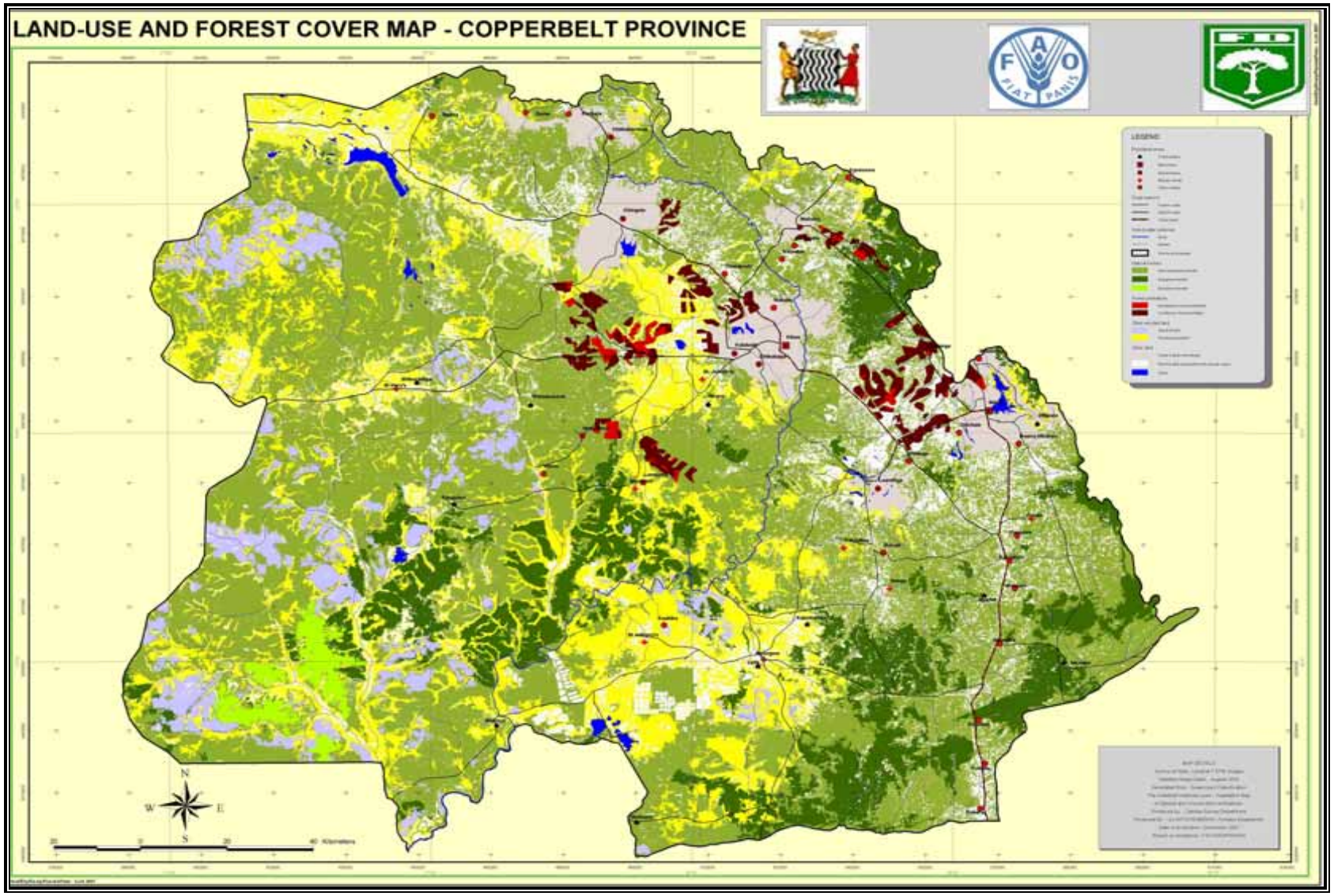
Province	Non-forested land (ha)	Total Crop land (ha)	Rural & Urban Built up (ha)	Total Inland Water (ha)	Other land areas (ha)
Central	4,537,323	2,767,876	1,421,635	247,812	100,000
Copperbelt	1,350,855	730,178	572,843	31,987	15,847
Eastern	1,875,951	1,368,143	369,877	83,990	53,941
Luapula	3,205,881	1,467,175	917,138	810,987	10,580
Lusaka	1,297,141	659,867	593,111	19,978	24,185
Northern	6,768,363	3,575,413	1,671,461	722,199	799,290
Northwestern	1,815,094	727,004	676,103	391,456	20,531
Southern	3,638,051	2,259,323	1,251,606	115,987	11,136
Western	4,216,160	1,550,124	658,468	599,876	1,407,692
Total	**28,704,819**	**15,105,104**	**8,132,242**	**3,024,272**	**2,443,202**

Source: ILUA Land use mapping (2005 Landsat Imagery for Zambia)

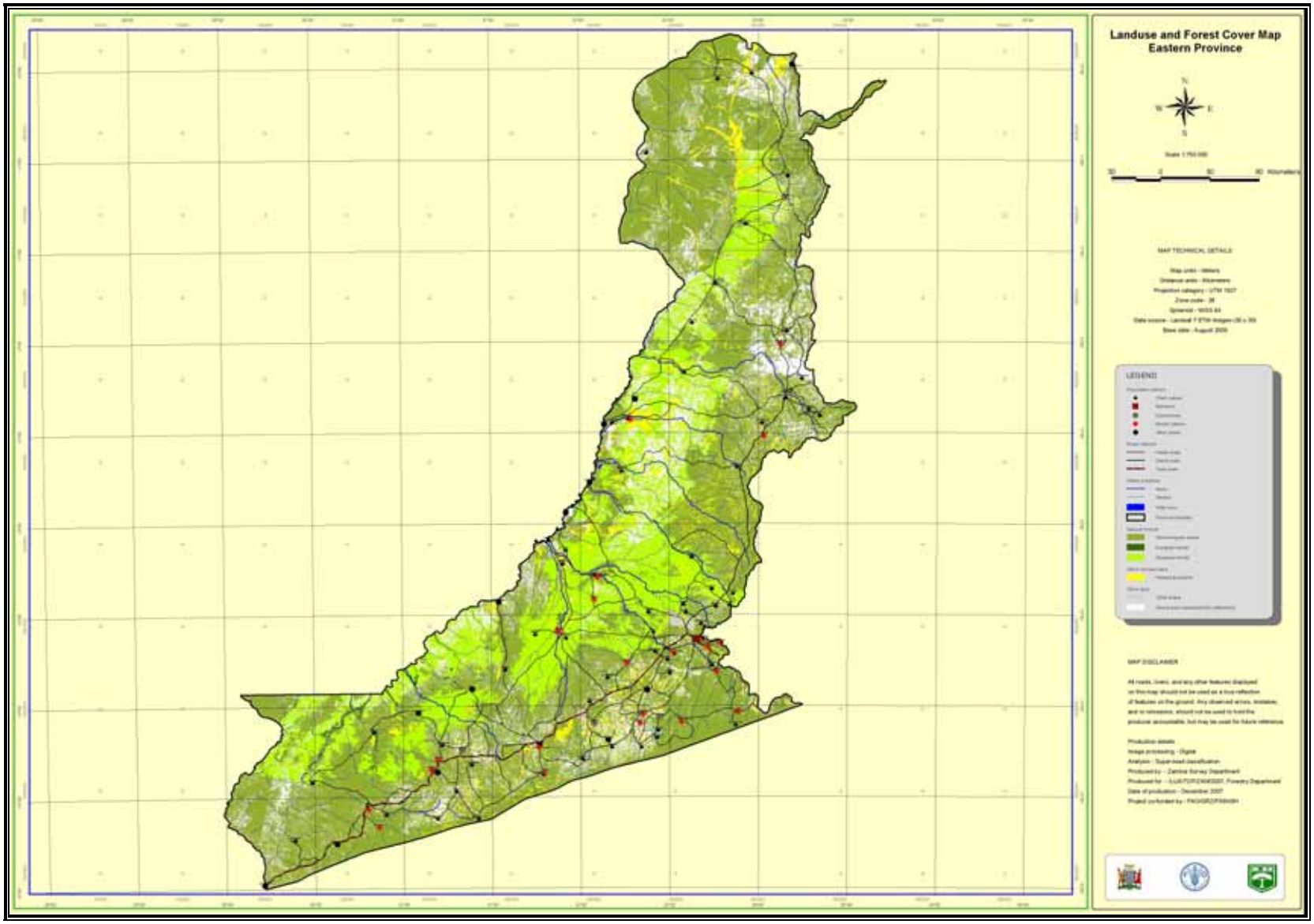
To a larger extent the results above present the status and levels of land degradation by Province and could be used to plan for reforestation programmes. There are supportive land-cover and land-use maps for each Province showing the current status of vegetation and the pressure due to competing developmental activities. The nine provincial land use/forest cover maps produced from ILUA are presented in the following pages.



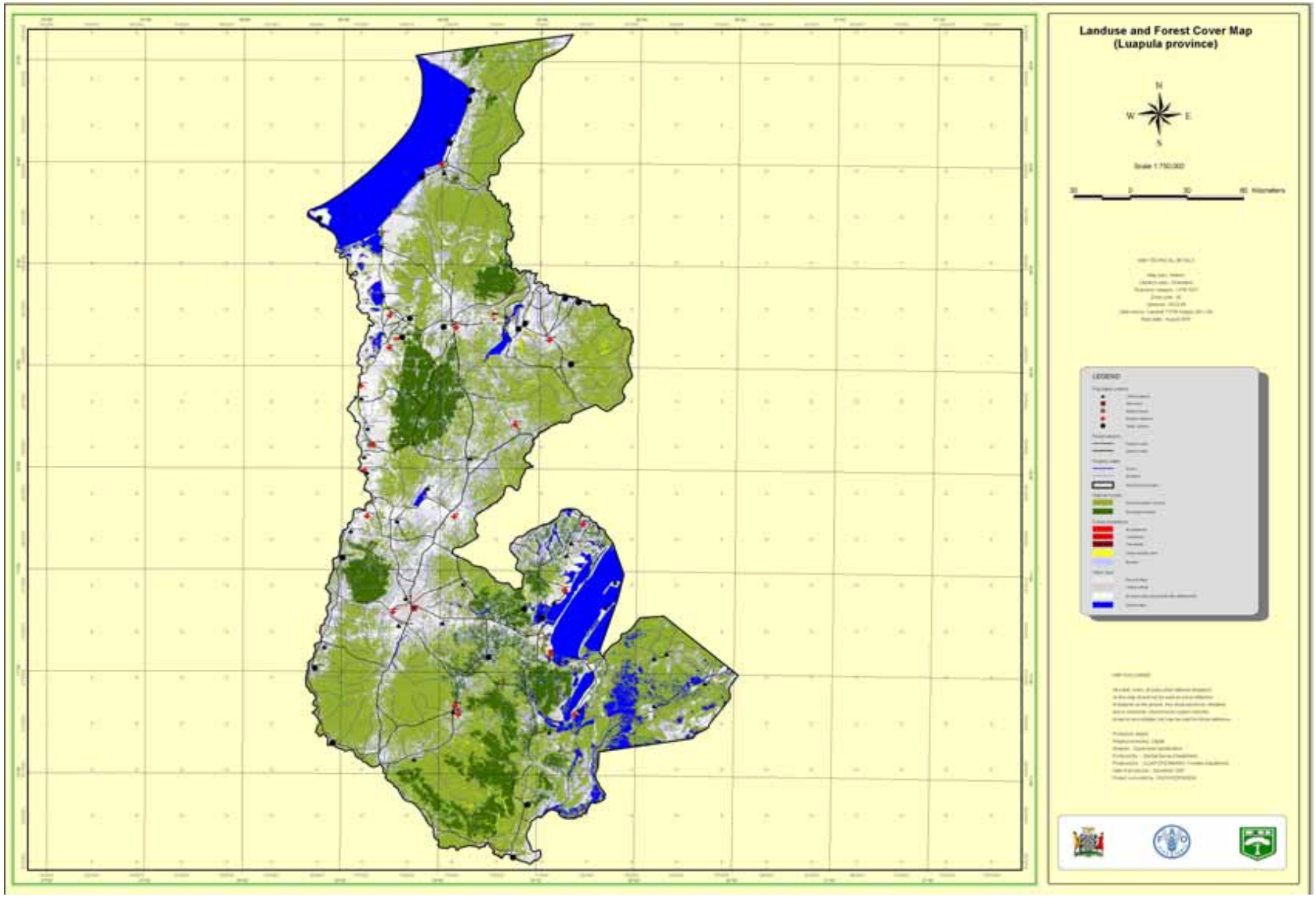
Map 6: Land-use and forest cover map Central Province



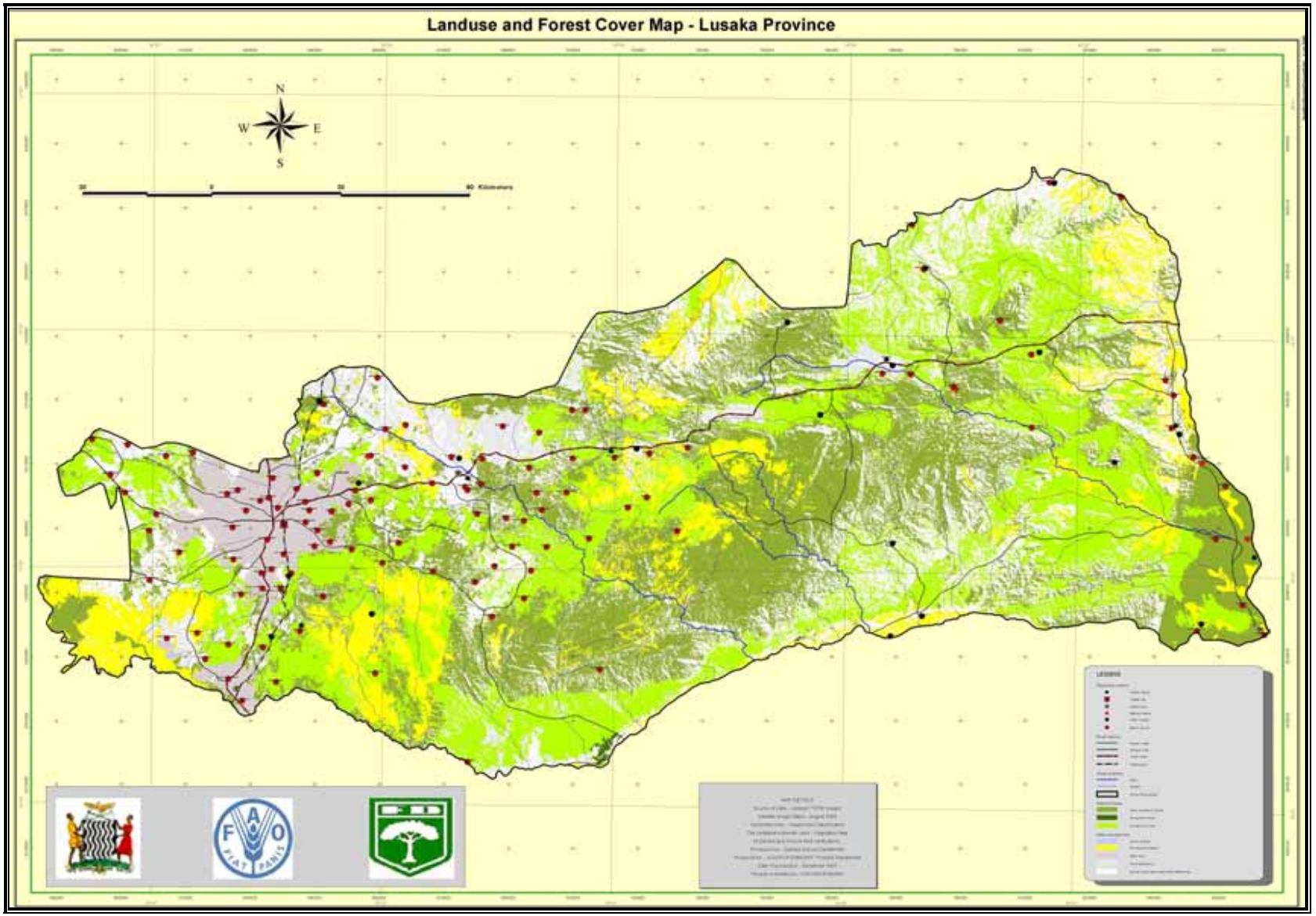
Map 7: Land-use and forest cover map -Copperbelt Province



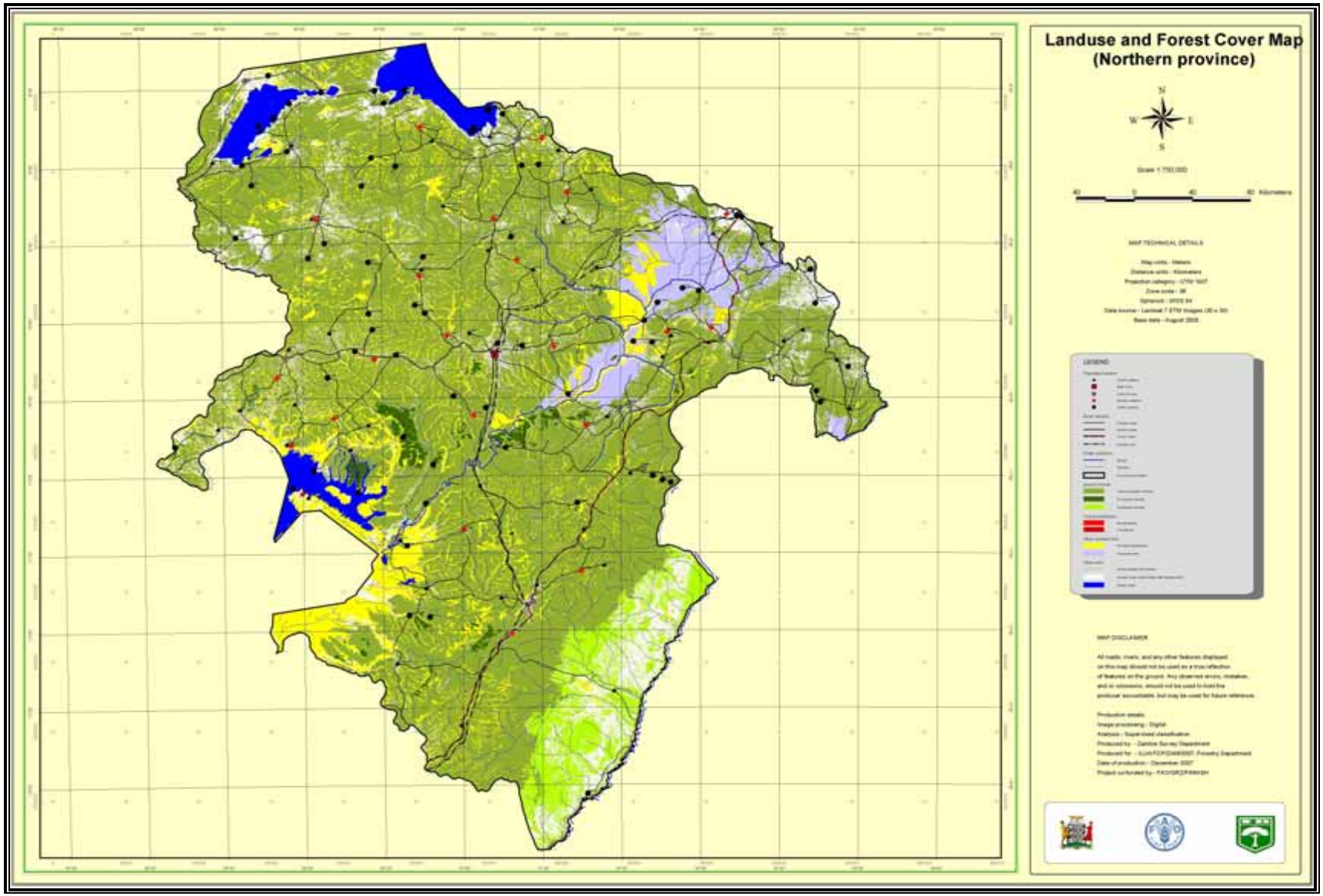
Map 8: Land-use and forest cover map Eastern Province



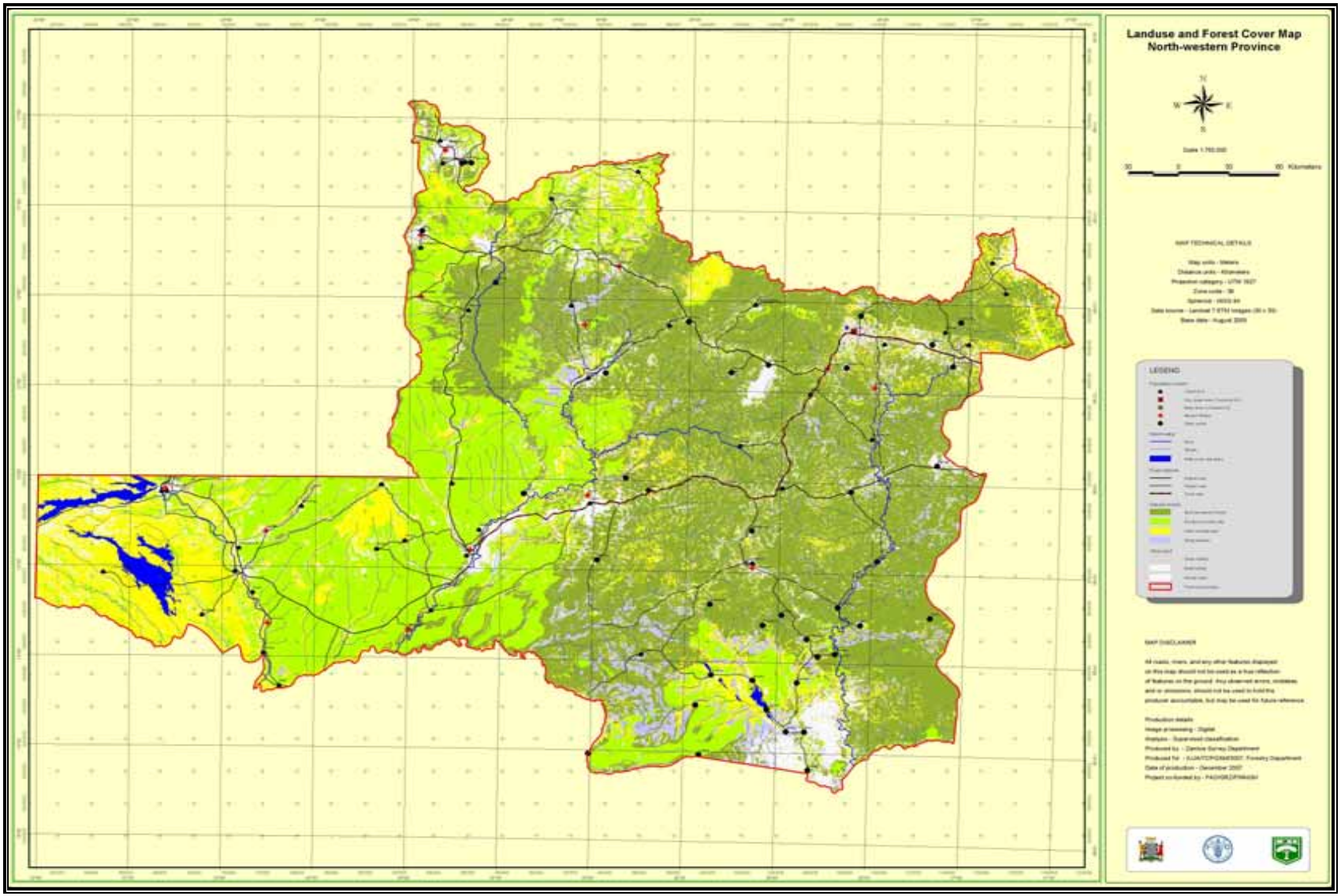
Map 9: Land-use and forest cover map Luapula Province



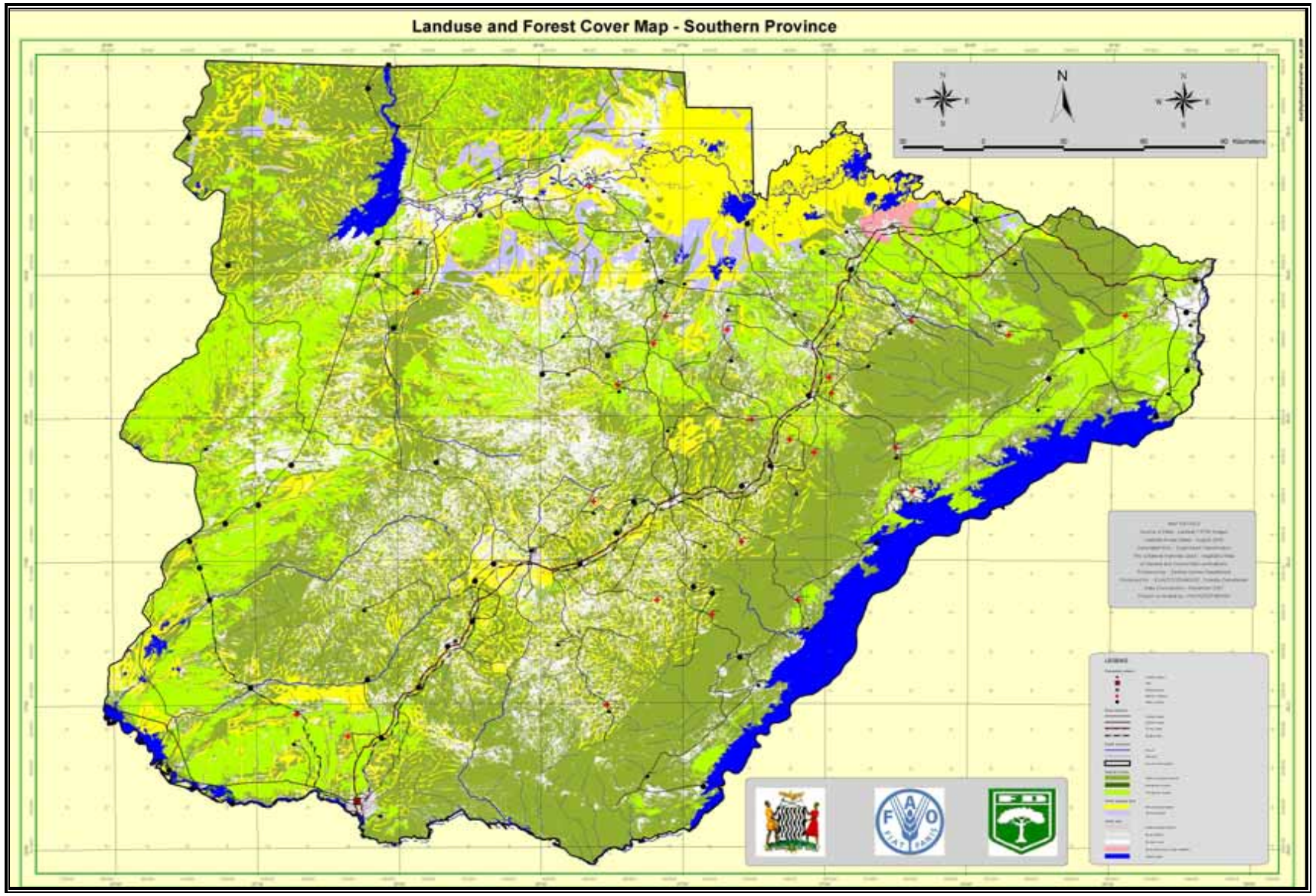
Map 10: Land-use and forest cover map Lusaka Province



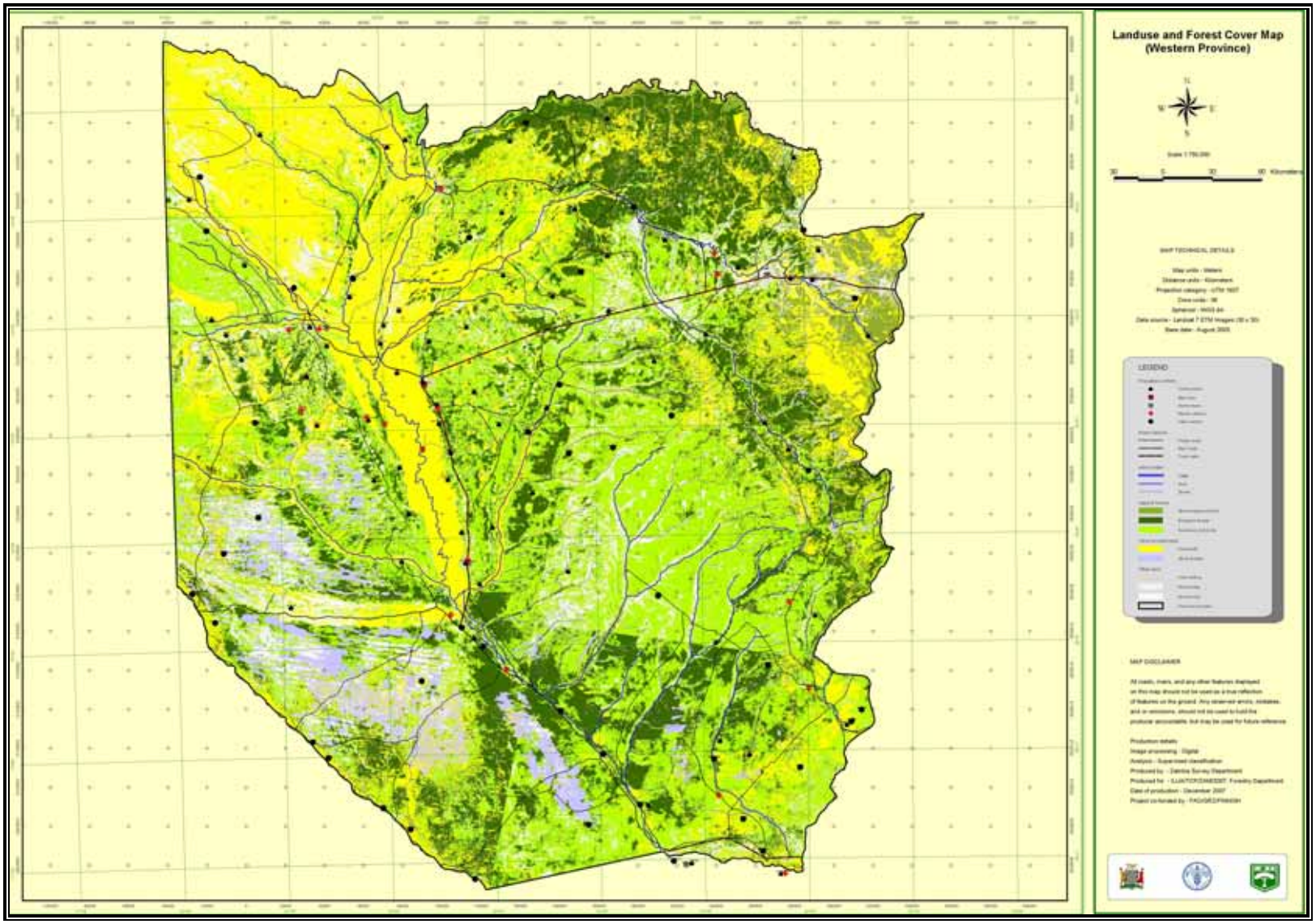
Map 11: Land-use and forest cover map Northern Province



Map 12: Land-use and forest cover map Northwestern Province



Map 13: Land-use and forest cover map Southern Province



Map 14: Land-use and forest cover map Western Province

4.4 Land cover change detection

Given the lack of national-level forest inventory data collected prior to ILUA, reporting on forest cover change, i.e. deforestation and degradation, using inventory data alone is challenging. Since previous data is either unavailable or unreliable on a national scale, rates of change must be assessed through other means, such as reviewing past images of forest cover and comparing their change over time. This is precisely the exercise the Zambian Forest Department explored in a special study they conducted alongside of the ILUA inventory data analysis. The study, "Land cover change detection in Zambian Forests, 1990-2005" produced by Abel Siampale, Forest Officer ZFD, found that the rate of land cover change (deforestation rate) based on remote sensing results is estimated at 284,000 hectares per annum or 0.62% of the forests cover for Zambia. The computation was generated from satellite image change detection analysis over a period of 15 years. The study reports that the national deforestation rate is in the range of 250,000 to 300,000 ha per year (Siampale, 2008).

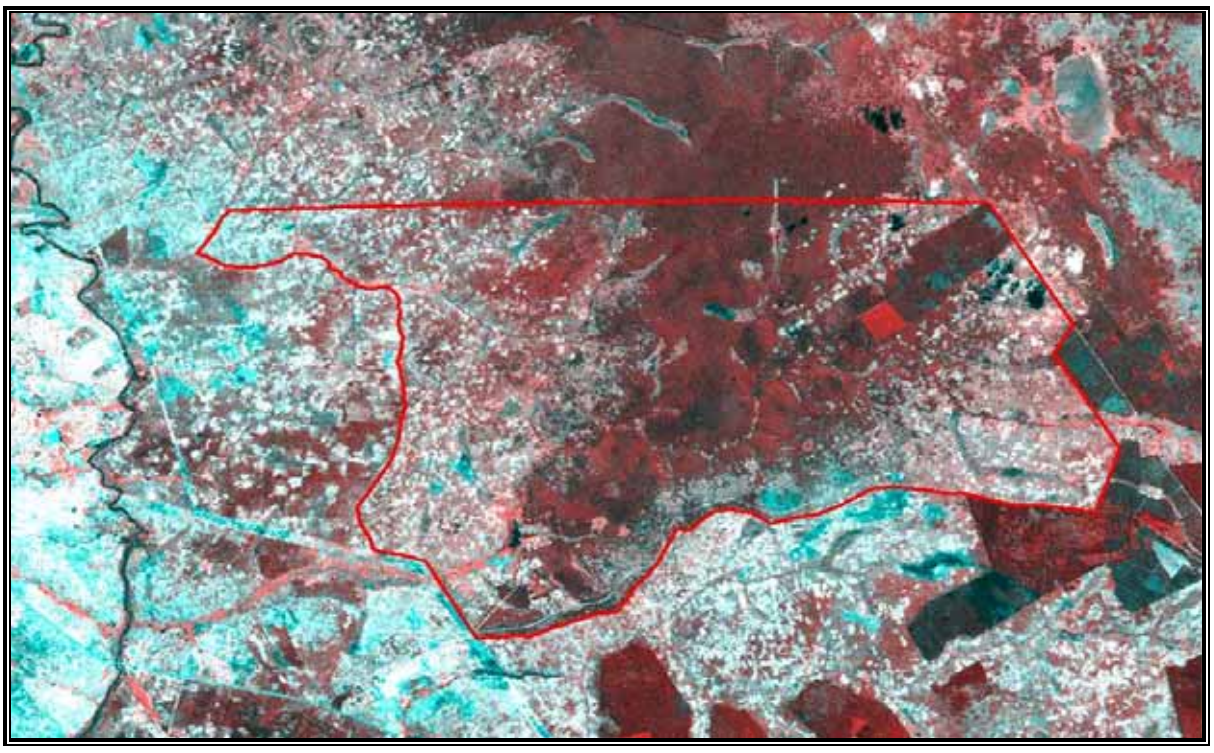


Figure 34: Satellite Image Thumbnail for 2005 (Mwekera NF 6)

5. CONCLUSIONS

There have been several forest inventories or expert estimations on the forest resources in Zambia during the last decades. They have given variable results based on the method, definitions used and available resources. In general, the inventories have not been consistent. Therefore, the results of previous inventories are not comparable as such and their use for defining historical trend for deforestation, for example, is a demanding task.

ILUA remains the very first of its kind to bring together experts from different sectors to carry out such a wide-reaching national land use inventory. The assessment was supported by FAO technical assistance and managed under the Ministry of Tourism, Environment and Natural Resources. Active participation and coordination, both in design and implementation, was made with a variety of collaborating institutions such as Agriculture (Ministry of Agriculture, Food and Fisheries), Survey (Ministry of Lands), Central Statistics Office (Ministry of Finance and National Development Planning), ZAWA (Zambia Wildlife Authority), University of Zambia, Copperbelt University, Zambia Forestry College and Local Authorities (Council). During the planning phase of ILUA, these institutions were consulted and participated in refining the assessment plan and methodology. They were also represented in the organization structure of ILUA at different levels (i.e. National Multi-disciplinary Team, Provincial Focal Team and the Field Crews). Such a model, aside from being unprecedented, has given national ownership and responsibility to ensure the long term sustainability of the ILUA findings to a number of interested and significant actors, thus strengthening the use of the ILUA data and supporting its continuation into the future.

One of the major conclusions of ILUA is that Zambia still has relatively abundant forest resources. In ILUA the forest cover is estimated according to the FAO forest definition at 49.9 million hectares or 66% of the total land area of Zambia. The annual and perennial crop (cultivated land) is at 7.5 million hectares or 10%, built-up area is at 0.5 million hectares or 1%, and water bodies occupy 3.0 million hectares or 4% of the total land area of the country.

The total volume (growing stock) of the forest and trees outside forests amounts to 2.9 billion m^3, which, compared to the latest Zambian Forest Department estimation of 1.4 billion m^3 for the FRA 2005, is remarkably more than expected. Another interesting reference is the ZFAP expert estimation from 1997 totalling 4.2 billion m^3, which is an obvious overestimation compared to the actual ILUA result.

According to the results, some 70% of the forest areas are closed forests with the tree canopy at more than 70 percent. The rest of the forests are fragmented either for natural reasons or due to degradation of the forests from human-induced activities, especially by other land uses such as shifting cultivation.

Semi-evergreen forests consisting of Miombo woodlands are the dominant forest type covering some 45% of the land area in Zambia. Baikiaea forests, Munga, Mopane and Kalahari woodlands are classified as deciduous forests, which cover some 20% of the land. These are the major forest types in Zambia leaving other forest types e.g. evergreen forests to a fraction of the total forest area. Semi-evergreen forests account for 2.1 billion m^3 or 72% of the total tree volume and deciduous forests account for 595 million m^3 or 20%. The minor shares are represented by evergreen forests with 55 million m^3 or 2% and the other natural forests with a total volume of 7 million m^3 or 0.2%. Wooded grasslands and shrubs account for 58 million m^3 or collectively 2% and the remaining 4% of tree volume, 98 million m^3, can be found in grasslands and croplands.

The total national above and belowground biomass stock is estimated at 5.6 billion tonnes out of which 2.6 billion tonnes is total carbon stocks. There are an additional 434 million tonnes of deadwood found in Zambia's forests out of which 204 million tonnes is carbon. Total estimates for these three carbon pools (aboveground + belowground + deadwood) equal 2.8 billion tonnes of carbon. The potential for carbon sequestration from the terrestrial forests in Zambia is generally high due to experienced human and ecological disturbances on the existing forests.

Although the results are only indicative on the provincial level, the most abundant forest resources are located in the Northern, North-Western, Central and Western Provinces, which correspond to the general perception. According to the inventory, however, only less than half of the Northern Province is covered by forests, which is much lower than the other forest rich Provinces (varying from 65% in Western to 84% in the Central Province). This does not necessarily conform to the general perception of forest cover in Northern Province.

The mean volume of the forests is relatively low, ranging from 32m^3/ha in deciduous Baikiea forests and Mopane woodland to 50m^3/ha in evergreen mavunda forests. Natural forests with tree cover greater than 70% can be regarded as rather intact forestland, where some selective harvesting of valuable species may have occurred. In these forests, the total volume is about 80 m^3/ha, whereas in degraded forests with tree cover between 10 and 40%, the volume is reduced to around 40 m^3/ha.

Degradation of the forests can be analysed from the recorded disturbance levels in the forests. Some 61% of the forest and OWL area are disturbed in one way or another by human activities in Zambia. However, only some 5% is considered to be heavily disturbed and the rest, 56%, are only slightly or moderately. Areas without disturbances accounted for 33% of the forests. According to the ILUA, the Zambian forests have good potential for regeneration. Over 65% of the forests are secondary regeneration with active growth potential. ILUA results confirm the disturbance of the selective cuttings, which covers some 42% of the forest areas. There was no exploitation recorded in 47% of the forest area.

These figures indicate the potential and importance for developing policies, approaches and management practices for sustainable forest management, particularly given that most of

the forest areas are in rather good condition and capable of providing a wide array of livelihood benefits to the people of Zambia.

The total volume of commercial species (list in table 33) is estimated at 366 million cubic meters, or roughly 12% of the total gross volume. Commercial species volume is concentrated in the forest rich Provinces and especially in North-Western Province where approximately one third of the commercial total volume is growing. As expected, the total commercial volume is very low in Southern and Lusaka Provinces.

Most of the total land in Zambia (62%) is owned and managed by customary authorities. Of the total forestland, about 31 million hectares (62%) are located on customary land and only about 12 million hectares are located on State land. State land includes such conserved areas as national parks and forest reserves which cover some 13 million hectares (FAO, 2005). Privately owned forests with legal land titles, accounting for approximately 5 million hectares, fall under State land because no legal title is issued on customary land. To be successful, the solutions for sustainable forest management, mitigation or adaptation to climate change in Zambia must recognize the importance of land tenure and ownership, especially in regards to customary lands, which account for nearly two thirds of all forestland. These areas are also increasingly deforested and degraded because they have traditionally been under the most pressure for alternative land-uses. Lack of confidence in secure title to rangeland, particularly on communal lands, has also been shown to reduce the incentive to manage the land sustainably.

Poverty of the rural people is striking in all parts of Zambia. The majority of households earn less than 500,000ZKW annually ($90/year). High poverty levels mean that people can rarely afford to buy such agricultural inputs as fertilizers or veterinary services, with only 11% and 13% percent purchasing them respectively. The interviews also indicated that other services/inputs were seldom used, except for hired persons for labour and ordinary tools, which were both utilized by 40% of the interviewed households. The lack of capital to spend on inputs to increase crop and animal productivity has an obvious impact on health and nutrition, but it also has consequences on the surrounding lands which come under pressure in an effort to expand agricultural needs.

Forests provide an important source for livelihood for rural communities. Based on the household survey, use of NWFPs is less common than the use of major wood products, however, some households indicated that they use a variety of products from forests, which highlights the importance of the multiple uses of forests and the numerous products that can benefit local communities. Different income levels determine which forest products are utilized. In particular, poorer households with incomes of less than 100,000ZKW/year ($18/year) show a higher dependence (44%) on fuelwood than those who earn more than 5,000,000ZKW/year (35%). Poorer households also indicated greater dependence in the use of medicinal plants and plant food.

Aside from establishing a rich national database of land use information and the public's use and management of the land, ILUA's overwhelming contribution has been in developing technical in-country capacity for designing and implementing a national-level integrated inventory that seeks to capture information not only on 'what' but also on 'why', producing results that will become even more significant with each successive assessment. It has assisted in: information framework harmonization, national land use inventory and monitoring, mapping using remote sensing techniques, database development, data processing and reporting. Moreover, the ILUA process has focused on supporting the establishment of a permanent monitoring system that reaches beyond the Forestry Department and into related sectors such as the Ministry of Lands, Ministry of Agriculture and Fisheries and Ministry of Finance and National Development Planning. The project has established a foundation for long term monitoring. Additional parameters can be included in future measurements if deemed relevant. The value of the ILUA, therefore, will increase with every subsequent inventory.

The ILUA approach has the potential to enhance institutional collaboration and dialogue among Government Ministries and Institutions, encouraging them to work together and avoid duplication of efforts in sustainable natural resources management at all levels in the country.

6. RECOMMENDATIONS

6.1 Future monitoring

The Zambian Forestry Department collaborated with FAO in setting up a long term monitoring system of the country's forest and land use resources. The ILUA and the monitoring system were a Government request that reflected the country's need for updated and sound information to feed into the national decision making process when needed. It is of utmost importance that the results of the project are valued and the monitoring system becomes a lasting activity of the Forestry Department and related sectors. To guarantee continuity of the monitoring system, it is recommended that the Zambian Forest Department:

- Institutionalize the ILUA process, continue strengthening the Forestry Management and Planning Unit at Forestry Department Headquarters and collaborating institutions by additional training in information technology skills of the national personnel, maintain the personnel assigned to the ILUA project in their position and allocate means and resources for implementation of the natural resources monitoring related activities.
- Maintain the ILUA database, introduce new technologies of information management and continue updating the baseline information to increase its relevance to the national policy processes and the international reporting.
- Link the ILUA database to other sectors, institutions and organizations and influence cross-cutting issues such as HIV/AIDS and Gender, Environment and Biodiversity Conservation, Infrastructure, the need for access roads to forest resources.

- The ILUA should be carried out on a continuous basis to enable maintenance and development of competence and limit the annual needs of resources.
- The re-measurement cycle of ILUA established permanent sample plots should be 10 years and the results feed into national population census. A shorter cycle would not be cost effective, however, for localized information needs the ILUA sampling frame could be used to increase the precision in the specific area.
- A mix of permanent and temporary plots is recommended. Information from new temporary plots during year 1-2 of the ILUA could be used to increase the precision in some specific area.
- Maintain the network of the permanent sample plots by safeguarding the records and undertaking periodic visits to the plot location.
- Develop an advisory board involving experts from stakeholders e.g. FD and other relevant Departments in the MTENR, regional offices of forests, Ministries of Lands, Agriculture, Environmental Council of Zambia, Zambian Land Alliance, etc. to provide guidance on the land use monitoring system, facilitate inter-institutional collaboration and ensure generalized benefit of it.
- To take note that localized Forest Management Inventories and the Integrated Land Use Assessment (ILUA) have totally different objectives in their approach and that they should not be integrated or mixed.

6.2 Additional information needs

- The ILUA sampling design represents relatively low intensity and it gives relatively high accuracy for major parameters, such as total land use classes or the total growing stock. For a large number of other parameters the accuracy remains low or very low. For those parameters and depending on additional information needs, in the future, ILUA may need to increase its sampling intensity in order to produce higher accuracy, particularly if desired use is at the provincial or district level. At its current intensity, ILUA can most accurately respond to national level information needs. Given the decentralized context of natural resource decision making in Zambia, increased sample size will most likely be needed in order to most effectively support local decision making processes.
- The policy domain analysis could be substantially extended to incorporate more variables into the indices, and perhaps combined with parameters yet to be extracted from the forest and cropping sections of the database.
- The NFA and the monitoring system be continually adapted to the shifting needs of information by timely identification and inclusion of the new variables.
- The information framework be widened to further cover variables related to climate change (biomass and carbon accounting) such as information on soil and litter.

- Zambian Forest Department work to count on its own technical capacity to plan and implement future surveys based on the new identified information needs and generate the required knowledge.
- Zambian Forest Department work to assign dedicated personnel who ensure that the interest of the forestry sector and interest of Zambia in general prevail by optimizing the available resources and ensuring high quality delivery.

6.3 Policy actions

- Sustainable management of natural forests depends, to a large extent, on the land tenure system. Legal title granted on customary land has unfortunately caused fragmentation of customary land, as conversion of customary to leasehold tenure continues to increase as available state land for allocation diminishes. In order to achieve sustainable development in the area of land policy, the government needs to address the following priority areas: formulation and implementation of land tenure policies to improve access and legal title to land by disadvantaged groups; modifications of land tenure systems to promote rural development under indigenous and common property resource management; institutional support for land registration and titling; and land administration services.
- The ILUA data highlights the enormous potential that exists in the forest sector, particularly for the poorest communities. Optimal management of forests will require instituting payment mechanisms or benefit sharing that will ensure that forest benefits utilized in downstream sectors are appropriately shared with the forest sector. At present, these benefits are not shared with the forest sector to help defray the cost of forestry management. This tends to suppress forest values thereby leading to sub-optimal provision of forest conservation. Forest carbon payments for sustainably managed forests through such mechanisms as Reduced Emissions from Deforestation and Degradation (REDD) could provide an optimal opportunity for capturing these benefits and rewarding adjacent communities who are able to maintain and manage high forest cover.
- The ILUA data highlights the imperative for improved extension, veterinary and other support services, most critically those associated with input supply and marketing infrastructure. Without adequate input markets such as fertilizers and seeds, forest fragmentation and degradation will accelerate. There is therefore a need for the government to invest and support public extension and veterinary services in order to assist farmers improve their productivity.

6.4 Extension Phase of ILUA

Integrated Land Use Assessment Project (ILUA) has produced a remarkable set of information not only on forest resources, but also on crops, livestock, local communities and their use of the resource. There are many improvements to be made in terms of dissemination and use of the information in the forestry sector, stakeholder organisations and communities. Especially important is the utilisation of the latest information in the development of the new forest policy and legislation and land use planning in pilot

Province(s) to allow for the greatest benefits to local communities. Additionally, the extension of ILUA is able to contribute to the sectoral programme by providing support to its planning and initiation.

In view of the foregoing, policy and decision makers have always changing demand of new information. It is further recommended that:

- The ILUA database with derived informative products, such as statistics and maps, contain a valuable source of information for ministries, NGOs and the public. To make it available for wider use, there is a need to agree on a common data sharing policy and protocol and then implement sharing of the information.
- Testing and developing RS methodologies that will serve not only Zambian needs by providing more cost-effective means of obtaining accurate land use data, but will also feed into international processes such as the coming Copenhagen negotiations on REDD mechanisms and developing monitoring systems in other countries.
- Develop a strategy for the Integrated Land Use Assessment project database and the monitoring system for continually adaptation to the shifting needs of information by timely identification and inclusion of new variables.
- The ILUA database information needs be widened to include issues of sustainable management and use of the resources, certification, biodiversity, climate change (carbon and biomass accounting), and livelihoods in relation with the Fifth National Development Plan, the National Poverty Reduction Strategy and the vision twenty thirty (2030).
- The Forestry Department through the Ministry of Tourism, Environment and Natural Resources work to maintain its own technical capacity and enhanced collaboration with line Ministries and Departments to plan and implement future integrated land use assessments based on the new identified information needs and generate the required knowledge and skills.

6.5 Capacity Building

To ensure the continuity of natural resources monitoring in the country, there will be need to build and maintain national capacities related to sampling design, field data collection, data processing and analysis, remote sensing and reporting.

ILUA is the first project in Zambia that conducted an Integrated Land Use Assessment (ILUA) since the 1960s'. There is a high demand for this information. Regarding the dissemination of information, ILUA Phase II aims to operate in deep coordination with other departments increasing potential impacts throughout the entire country. The project will continue the inter-sectoral multi-stakeholder process through involvement of non-forestry stakeholders in its implementation.

ILUA information portal will be hosted and maintained by the Forestry Department in collaboration with Planning and Information Department (PID) in MTENR, operating on FD/MTENR's Web server. The content for the portal will be provided by FD, PID, Department of Survey, National Remote Sensing Centre, and consultants. The portal will follow the standards set by FAO's statistical framework 'CountrySTAT'[1].

The dissemination and the web-based systems will be established at Forestry Department Headquarters in collaboration with the PID's Data Management Office at the MTENR and will be supported by local consultants. The ultimate aim is continuation of the information system and future inventory data into the future to ensure the greatest amount of usability.

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Annex I - List of ILUA contacts

ILUA National Project Coordinators

Name	Organization	Station
(1). Mrs. A.M.C. Masinja, NPC	Forestry Department	Lusaka
(2). Mr. J.M. Mukosha, A/NPC	Forestry Department	Lusaka

FAO Country Office

Name	Organization	Station
(1). Mr. N. Mona, FAO Representative	FAO – Country Office	Lusaka
(2). Ms. D. Jere, Programme Assistant	FAO – Country Office	Lusaka

FAO Technical Support

Name	Organization	Station
(1). Mr. M. Saket	FAO	Rome
(2). Ms. A. Branthomme	FAO	Rome
(3). Ms. Y. Melin	FAO	Rome
(4). Mr. G. Hubert	FAO	Rome
(5). Mr. K. Kamelarcyzk	FAO	Rome
(6). Mr. P. Lowe	FAO	Harare
(7). Mr. M. Bassil	FAO	Lebanon
(8). Ms. R. Tavani	FAO	Rome
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ILUA National Consultants

Name	Organization	Station
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(2). Dr. T. Kalinda	University of Zambia	Lusaka
(3). Dr. H. Haantuba	Agricultural Consultative Forum	Lusaka
(4). Dr. S. Bwalya	Zambia Revenue Authority	Lusaka
(5). Mr. S. Wamunyima	Forestry Department	Lusaka
(6). Mr. A. M. Siampale	Forestry Department	Lusaka

ILUA National Task Force Members

Name	Organization	Station
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(2). Mr. Lupenga Augustine	ECZ	Lusaka
(3). Mr. Richard Banda	Zambia Forestry College	Kitwe
(4). Mr. Chilemo Oliver	ZAFFICO	Ndola
(5). Mr. Sakala Isaac	Africare	Lusaka
(6). Mr. Muleya Zook	Zambia Wildlife Authority	Chilanga
(7). Mr. Shitima E. Mwepya	ENR, Dept	Lusaka
(8). Mr. Sishekanu N. Martin	MACO	Lusaka
(9). Mr. Mwanza Peter	Survey Department	Lusaka

ILUA National Multidisciplinary Team

Name	Organization	Station
(1). Dr. A. Mulowa	University of Zambia	Lusaka
(2). Mr. M. Lungu	Agriculture	Lusaka
(3). Mr. P. Mwanza	Survey	Lusaka
(4). Mr. B.K. Haachongo	CSO	Lusaka
(5). Mrs. P.S. Mukanga	ZAWA	Chilanga
(6). Mr. J.M. Mukosha	Forestry	Lusaka

ILUA Field Crew Teams

Name	Province	Organization
(1). Mr. C. Siame	Central	Forestry Department
(2). Mr. E. Phiri	Central	Central Statistical Office
(3). Mr. N. Mvula	Central	Lands Department
(4). Mr. Tonga	Central	Agriculture
(5). Mr. F. Tembo	Copperbelt	Forestry
(6). Mr. M. Mwila	Copperbelt	Forestry

(7).	Mr. G. silungwe	Copperbelt	Agriculture
(8).	Mr. H. Lukonde	Copperbelt	Central Statistical Office
(9).	Mr. E. D. Mwanza	Eastern	Forestry
(10).	Mr. Chabulembwa	Eastern	PPU
(11).	Mr. Chilabi	Eastern	Agriculture
(12).	Mr. Njovu	Eastern	Central Statistical Office
(13).	Mr. F. Mvula	Luapula	Forestry
(14).	Mr. F. Kunda	Luapula	Agriculture
(15).	Mr. D. Chikopela	Luapula	Central Statistical Office
(16).	Mr. A. Muketukwa	Luapula	Lands
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(22).	Mr. w. Mwape	FDHQ	Forestry
(23).	Mr. B. Nkandu	FDHQ	Forestry
(24).	Mr. B. Mutasha	FDHQ	Forestry
(25).	Mrs. P. Zulu	FDHQ	Forestry
(26).	Mr. H. Musitini	FDHQ	Forestry
(27).	Mr. E. Muwaya	Northern Team (1)	Forestry
(28).	Mr. Chileshe	Northern	
(29).	Mr. Ngo'ma	Northern	
(30).	Mrs. Dowati	Northern	Forestry

(31). Mr. Nyirongo	Northern Team (2)	Forestry
(32). Mr. Kanyanja	Northern	Lands
(33). Mr. Muzengeza	Northern	ZAWA
(34). Mrs. M. Sibuku	Northern	ZAWA
(35). Mr. M. Songolo	Northwestern	Forestry
(36). Mr. Sumbukeni	Northwestern	Central Statistical Office
(37). Mr. G. Sicheba	Northwestern	Agriculture
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(39). Mr. Haang'andu	Northwestern	Forestry
(40). Mr. C. Chisanga	Southern	Forestry
(41). Mr. F. siachitema	Southern	Lands
(42). Ms. M. Musonda	Southern	ZAWA
(43). Mr. K. C. Kuheza	Southern	Agriculture
(44). Mr. J. Chomba	Southern	Agriculture
(45). Mr. J. Mulomba	Southern	Forestry
(46). Mr. D. Chimbao	Western	Forestry
(47). Mr. E. Malumo	Western	Central Statistical Office
(48). Mr. A.C. Hampungani	Western	Forestry
(49). Mr. V. Michelo	Western	Agriculture

ILUA Provincial Focal Teams

Name	Province	Organization
(1). Mr. B.M. Chomba	Central	Forestry
(2). Mr. H. Shamwende	Central	Lands
(3). Mr. D. Daka	Central	Central Statistical Office
(4). Mr. A. Mbewe	Central	Agriculture

(5).			
(6).	Mr. M.M. Yambwa	Copperbelt	Central Statistical Office
(7).	Ms. H.M. Chama	Copperbelt	Forestry Research
(8).	Mr. H. Lusambo	Copperbelt	Agriculture
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(10).			
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(14).			
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(18).	Mr. C. Chewe	Luapula	Agriculture
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(21).	Mr. J. Mutemwa	Lusaka	Central Statistical Office
(22).	Mr. B. Choongo	Lusaka	PPU
(23).	Mr. M. Pande	Lusaka	Forestry
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(25).	Ms. S. Namonje	Northern	Forestry
(26).	Mr. F. Mumbi	Northern	Agriculture
(27).	MR. M.K. Mangaba	Northern	Lands
(28).			
(29).	Ms. O. Chilekwa	Northwestern	Forestry
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(33).			
(34).	Mr. Chiiba	Southern	Forestry
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(36).	Ms. J. Sinyangwe	Southern	Agriculture
(37).			
(38).	Mr. P. Sekeli	Western	Forestry
(39).	Ms. Tolosi	Western	Central Statistical Office
(40).	Mr. C.A. Chinambu	Western	Agriculture

ILUA Steering Committee

Official Titles	Ministry/Department	Station
(1). Permanent Secretary	MTENR	Lusaka
(2). Permanent Secretary	MACO	Lusaka
(3). Permanent Secretary	MoL	Lusaka
(4). Permanent Secretary	MEWD	Lusaka
(5). Permanent Secretary	MFNP	Lusaka
(6). Director General	ZAWA	Chilanga, Lusaka
(7). Surveyor General	ZSD – MoL	Lusaka
(8). Director	ENR – MTENR	Lusaka
(9). Director	FD - MTENR	Lusaka

ILUA Secretariat

Official Title	Institution	Station
(1). ILUA Assistant National Coordinator	Forestry Department	Lusaka
(2). ILUA Project Officer	FAO	Lusaka

Annex 2 - ILUA Field Forms

1. **ILUA Zambia** **- F1a -**

2. **Tract N° .....** **TRACT**

A. Tract Location

7. Province .....
8. District .....
9. Township.....
10. Village/locality.....

11a. GEZ C
11b Agro-ecological zone…….C
12. Altitude Tract centre .....m
13. Maps & aerial photos.....
.....

Coordinates Tract SW corner
14a. Latitude _ _ , _ _ _ _ _ ° N
14b. Longitude _ _ , _ _ _ _ _ ° E
14c Coordinate system: UTM (Projection)

34	35	36

B. Crew/Owner/Informant list

15. **Name**	16. **Address**	17. **Phone number**	18a. **Crew leader**	18b. **Crew member**	19. **Owner**	20. **Informant***				
						O	E	M	S	X

*Code indicates the informant's relation to the area, i.e. O=Estate Owner, E=Employee, M=Manager of site, S=Settler, X= External key informant

C. Population

21. Population distribution

	Total	F	M
21c. Number of households *			
21f. Average household size *			
21. Population on site **			
21d. Adult literacy rate (%) **			

* In 21c and 21f: F= Female headed / M= Male headed;
** In 21 and 21d: F= Female / M= Male.

21e. Ethnic group ☐ C
22. Population since ☐
23. Population dynamics ☐ C
24. Population main activity ☐ C
24b. Secondary activity ☐ C

	25. *Settlement history*	25a. *Year /Period*
0	Not Applicable (no inhabitants…)	
1	Wars, conflicts	
2	Change of ownership/land tenure	
3	Expansion of agriculture	
4	Urban development	
5	Infrastructure, electric power	
6	Socio-economic crisis	
7	Natural disaster	
8	Rural-to-urban migration	
9	Urban-to-rural migration	
10	Rural-to-rural migration	
11	Urban-to-urban migration	
12	Immigration	
13	Emigration	
Others		

D. Proximity to Infrastructure

Distance from Tract centre to:

26. All-weather road _ _ , _ km
27. Seasonal road _ _ , _ km
28. Settlement _ _ , _ km
29. Health institution _ _ , _ km
30. School _ _ , _ km
31a. Food Market _ _ , _ km
31b. Input Market _ _ , _ km

E. Tract Access

Starting position coordinates:
32a. UTM E _ _ _ _ _ _ _ m
32b. UTM N _ _ _ _ _ _ _ m

Access time:
33a. Start time:_ _ : _ _ h
34a. End time: _ _ : _ _ h
34b. Arriving at plot No ☐

Reference points of access path *(Itinerary sketch to be attached)*

35. **ID**	36. **Description**	37a. **X**	37b. **Y**	36b. **Photo #**	36d. **Bearing**

1. **ILUA Zambia** **- F1b -**

2. **Tract N°** ..... **TRACT**

B. Crew/Owner/Informant list (contd)

15. **Name**	16. **Address**	17. **Phone number**	18a. **Crew leader**	18b. **Crew member**	19. **Owner**	20. **Informant***				
						O	E	M	S	X

38. *Notes*: .....

.....

.....

.....

1. **ILUA Zambia** **- F1c -**

2. **Tract N°** ……. **TRACT**

P…./….

F. List of households (in 5 km radius of tract centre)

195. **No**	196. **Name of household head**	197a. **X**	197b. **Y**	198. **Selected households for survey**

195. **No**	196. **Name of household head**	197a. **X**	197b. **Y**	198. **Selected households for survey**

38. *Notes*: ……….

……..........

1. ILUA Zambia **- F2 -**

2. **Tract N° .....** 3. **Plot N°** ☐ **PLOT**

A. Plot Access

Starting position:

34g. X _ _ _ _ _ _ _ m

34h. Y _ _ _ _ _ _ _ m

Access Time:

34i. Start time: _ _ : _ _ h

34j. End time: _ _ : _ _ h

B. Time record of work within Plot

Day 1:

48. Date 1**: _ _ /_ _ /_ _

49a. Start time: _ _ : _ _ h

51a. End time: _ _ : _ _ h

** *dd/mm/yy*

Day 2*:

50. Date 2**: _ _ /_ _ /_ _

49b. Start time: _ _ : _ _ h

51b. End time: _ _ : _ _ h

**If work in the plot takes more than one day.*

C. Plot Starting Point description

Plot starting point (calculated):

39a. X _ _ _ _ _ _ _ m

39b. Y _ _ _ _ _ _ _ m

Marker position (GPS reading):

40a. X _ _ _ _ _ _ _ m

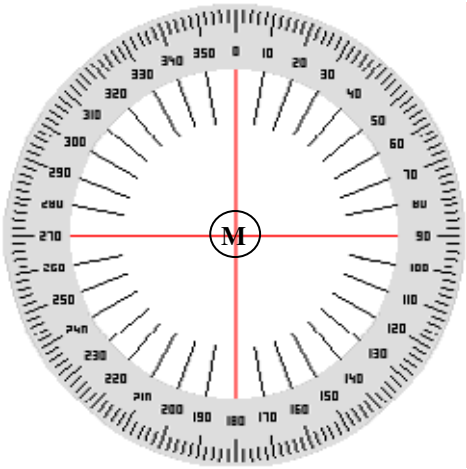
40b. Y _ _ _ _ _ _ _ m

41. Distance from Marker to Plot starting point ☐ m

42. Bearing from Marker to Plot starting point ☐ °

43. **Plot starting point plan:**

M = Marker position
P = Plot starting point, if P ≠ M for any reason



Reference points surrounding Marker position

44. **ID**	45. **Description**	46. **Bearing*** (°)	47. **Distance*** **(m)**	**36c ID Photo**

* From Marker position

53. *Notes*: .....

.....

.....

.....

.....

.....

——— LU (Land use limit)

Rd1 (Paved road)
_ _ _ Rd2 (Primary road unpaved)
Rd3 (Secondary road)
Rd4 (Track)

_ . _ W1 (Perennial stream)
W2 (Intermittent stream)

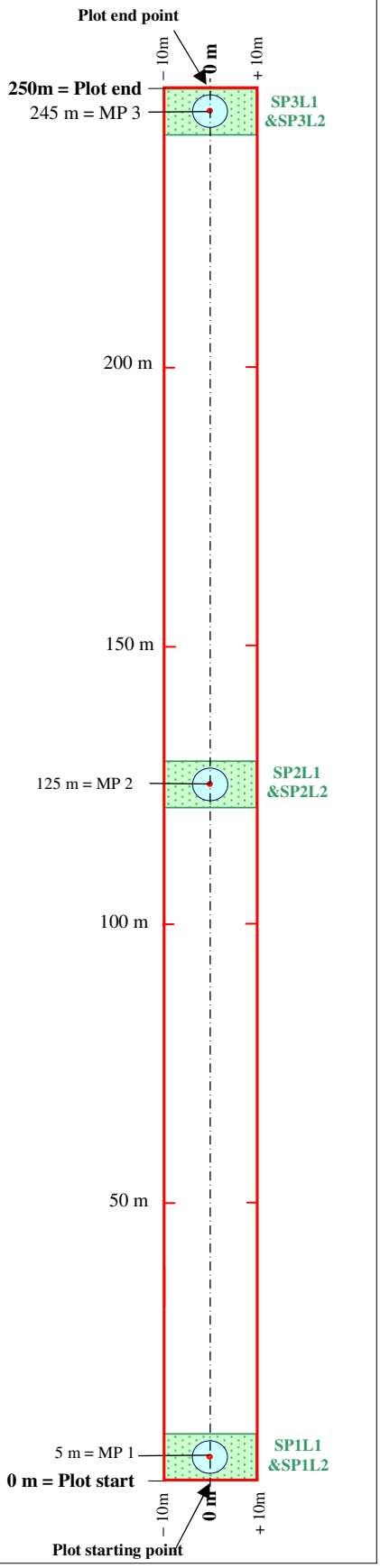
D. Plot Plan (52)

Central line bearing:
Plot # 1 = 0° Plot # 2 = 90°
Plot # 3 = 180° Plot # 4 = 270°

Plot end point:

39e. X _ _ _ _ _ _ _ m

39f. Y _ _ _ _ _ _ _ m



1. **ILUA Zambia** **- F3a -**

2. **Tract N°** ……. 3. **Plot N°** ☐

PLOT – TREE AND STUMP MEASUREMENTS

P…./….

			56. *Species*		*57. Tree/Stump location*									*Health*	
4. **LUS N°**	55. **Tree N°**	55b **Stump**	56a. **Common name**	56b. **Scientific name**	57a. **Along plot axis**	57b.**Left axis**	57b. **Right axis**	58. **Dbh**[1]	59. **Diameter height**[2]	60. **Year(s) since cut**	61. **Total height**	62. **Bole height**	63. **Stem quality**	64. **Condition**	65. **Causative agents**[3]
					(m)	**(m)**	**(m)**	**(cm)**	**(m)**	**C**	**(m)**	**(m)**	**C**	**C**	**C**

[1] Or Dsh if stump height <1.3m [2] To be indicated if different from breast height (1.3 m) [3] Multiple choice

68. Notes: ……

………

.

1. **ILUA Zambia** **- F3b -**

2. **Tract N°** ..... 3. **Plot N°** ☐

PLOT – TREE AND STUMP MEASUREMENTS

P…./….

4. LUS N°	55. Tree N°	55b. Stump	56. *Species*		*57. Tree/Stump location*			58. Dbh[1]	59. Diameter height[2]	60. Year(s) since cut	61. Total height	62. Bole height	63. Stem quality	*Health*		*Branches*[4]							
																B1		B2		B3		B4	
			56a. **Common name**	56b. **Scientific name**	57a. **Along plot axis**	57b. **Left axis**	57b. **Right axis**							64. **Condition**	65. **Causative agents**[3]	66a. **D1**	67a. **L1**	66b. **D2**	67b. **L2**	66c. **D3**	67c. **L3**	66d. **D4**	67d. **L4**
					(m)	(m)	(m)	(cm)	(m)	C	(m)	(m)	C	C	C	(cm)	(m)	(cm)	(m)	(cm)	(m)	(cm)	(m)

[1] Or Dsh if stump height <1.3m [2] To be indicated if different from breast height (1.3 m) [3] Multiple choice [4] For branches with minimum diameter ≥20cm and length ≥2m

68. Notes:……

1. **ILUA Zambia** **- F4a -**

2. **Tract N° .....** 3. **Plot N°** ☐ **SUBPLOTS & MEASUREMENT POINTS**

P…./….

A. Measurement points - Topography and soil (in all LUS)

Measurement point N°1			**Measurement point N° 2**			**Measurement point N° 3**		
4a. LUS N°	☐		4b. LUS N°	☐		4c. LUS N°	☐	
70a. Exposition	☐	°	70b. Exposition	☐	°	70c. Exposition	☐	°
71a. Slope	☐	%	71b. Slope	☐	%	71c. Slope	☐	%
72a. Relief	☐	C	72b. Relief	☐	C	72c. Relief	☐	C
73a. Soil texture	☐	C	73b. Soil texture	☐	C	73c. Soil texture	☐	C
74a. Soil drainage	☐	C	74b. Soil drainage	☐	C	74c. Soil drainage	☐	C
75a. Organic matter	☐	C	75b. Organic matter	☐	C	75c. Organic matter	☐	C

B. Subplots level 1 and level 2 – Area covered by forest (in all LUS)

54aa. SP1L1 width (≤10m)	☐	m	54ba. SP2L1 width (≤10m)	☐	m	54ca. SP3L1 width (≤10m)	☐	m
54ab. SP1L1 length (≤20m)	☐	m	54bb. SP2L1 length (≤20m)	☐	m	54cb. SP3L1 length (≤20m)	☐	m
76a. SP1L2 area (≤50m^2)	☐	m^2	76b. SP2L2 area (≤50m^2)	☐	m^2	76c. SP3L2 area (≤50m^2)	☐	m^2

C. Subplots level 2 –Trees measurements (height≥1.3m and Dbh ≤ 7 cm) (in Forest LUS)

77. *Species*		**SP1L2**		**SP2L2**		**SP3L2**	
77a. **Common name**	77b. **Scientific name**	78a. **Counts**	78b. **Total**	78a. **Counts**	78b. **Total**	78a. **Counts**	78b. **Total**

79. *Notes*: .....

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.....

1. **ILUA Zambia** **- F4b -**

2. **Tract N°** …… 3. **Plot N°** ☐ **SUBPLOTS & MEASUREMENT POINTS - contd**

P…./….

C. Subplots level 2 –Trees measurements (height ≥1.3m and Dbh ≤ 7cm) – Contd

77. ***Species***		**SP1L2**		**SP2L2**		**SP3L2**	
77a. **Common name**	77b. **Scientific name**	78a. **Counts**	78b. **Total**	78a. **Counts**	78b. **Total**	78a. **Counts**	78b. **Total**

79. *Notes*: ……

………

1. **ILUA Zambia** **- F5 -**

2. **Tract N° .....** 3. **Plot N°** ☐ **LAND USE SECTION**

4. **LUS N°** ☐

A. General

80. Land use ☐ C

81a. Width ☐ m

81b. Length ☐ m

80b. Accessibility ☐ C

92a. Tree canopy cover ☐ C

82. Designation/ Protection status ☐ C

83. Ownership ☐ C

88. Trees Expected ☐ C

84. *Environmental problems**	
0	Not Applicable (urban areas…)
1	Not existing
2	Loss of water levels in rivers...
3	Drought
4	Inundation
5	Poor water quality
6	Pests
7	Erosion
8	Loss of soil fertility
9	Burning
10	Landslide
11	Windthrow
12	Overexploiting forest resources
14	Overgrazing
90	Not known
Other	

Fire

85. Occurrence ☐ C

86. Area ☐ m^2

87. Type* ☐ C

** Multiple choice*

B. Forest and other wooded land management and structure

	N	P	C	nk
90. Stand origin*				

91. Stand structure ☐ C

92b. Shrub coverage ☐ C 92c. Shrub height ☐ m

93. Management plan ☐ C 93b. Management agreement ☐ C

94. Disturbances ☐ C

95.*Timber exploitation**	
1	No felling
2	Clear cutting
3	Selective felling
4	Group felling
5	Strip felling
Other	

96.*Silviculture**	
1	No practice
2	Improvement
3	Release of desirable trees
4	Removal of undesirable veg.
5	Enrichment planting
6	Sanitary cutting
7	Prescribed burning
Other	

97.*Technology used**	
0	Not Applicable
1	Manual
2	Chainsaw
3	Mechanised (tractors)
90	Not known
Other	

** Multiple choice*

C. Crop / grazing products / services and management

	146. Crop products category C	147. Products Ranking
Other:		
Other:		
Other:		

140. *Cropping system*	
1	Multiple cropping
2	Improved cultivars
3	Crop rotation
4	Fallow
90	Not known
Other	

141. *Water*	
1	Rain fed
2	Irrigation - manual construction, gravity fed
3	Irrigation - major equipment
4	Adequate drainage of excess water
90	Not known
Other	

142. *Nutrients*	
1	Adequate fallow
2	Organic fertilizer
3	Mineral fertilizer
90	Not known
Other	

143. *Pest / Weed*	
1	Pesticides
2	Fungicides
3	Herbicides
4	Mechanical control
5	Biological control
90	Not known
Other	

144. *Erosion*	
1	Tillage
2	Crop residue incorporation
3	Cover Crops
4	Leveling, contour tillage, terracing
90	Not known
Other	

145. *Power Sources*	
1	Manual
2	Animal
3	Mechanized means
90	Not known
Other	

138. Grazing activity ☐

148. ***Service categories outside forest and wooded lands****					
	1	Climate regulation		10	Communal
	2	Disease control		11	Symbolic
	3	Flood control / Water regulation		12	Food
	4	Detoxification / Water purification		13	Fresh water
	5	Religious / Spiritual		14	Fuel
	6	Recreation / Tourism		15	Biochemical / Medicines
	7	Aesthetic		16	Ornamental
	8	Inspiration		17	Fresh Water
	9	Education / Scientific studies	Other		

98. *Notes:* ……

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** Multiple *choice - Services from forests, wooded lands and trees outside forest are reported under F6.*

1. **ILUA Zambia**

2. **Tract N°** .... 3. **Plot N°** ☐ 80. **Land Use** ☐

FOREST and TREE PRODUCTS AND SERVICES

P…./….

														Extraction			Legislation		Forestry incentives	
99. **Product /Service category**	99a. **P/S Rank**	111a. **Species Rank**	111. **Species**	104. **Conflicts**	105. **Demand trend**	106. **Supply trend**	101. **Harvester / User**	101a. **Rank**	103. **User rights**	102. **End-Use**	101b. **Organization level**	101c. **Gender balance**	101d. **Child labor**	108. **Frequency**	109. **Trend**	110. **Change reason**	101e. **Awareness**	101f. **Compliance**	101g. **Awareness**	101h. **Application**
C	**C**			**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**				
		H					**I**													
		M					**C**													
		L					**X**													
		H					**I**													
		M					**C**													
		L					**X**													
		H					**I**													
		M					**C**													
		L					**X**													
		H					**I**													
		M					**C**													
		L					**X**													
		H					**I**													
		M					**C**													
		L					**X**													
		H					**I**													
		M					**C**													
		L					**X**													

68. Notes:………

1. **ILUA Zambia** **F7a**

2. **Tract N°** ..... **Household N°** …… **HOUSEHOLD**

200. Enumerator (s)……

A. General information on the household

201. **Household N°** ☐ 202. **Village**…… …… 203. **Distance to tract __ __, __**Km

A1. Household composition

Household composition					
204. **Member name**	205. **Relationship to Head**	206. **Sex**	207. **Age**	208. **Education**	209. **Respondent**
	C	M/F		Y/N	

A2. Household activities

210a. Activities			*210b.* **Main activity**
	1	Crop production	
	2	Livestock/ Herding	
	3	Forestry	
	4	Urban/ Peri-urban	
	5	Tourism	
	6	Fishery	
	7	Mining/extraction	
Others		Others	

A3. Total annual household income

211. *Total household income*		
	1	< 100,000 ZKW
	2	100,000 – 500,000 ZKW
	3	500,000 – 1,000,000 ZKW
	4	1,000,000 – 5,000,000 ZKW
	5	≥ 5,000,000 ZKW

A4. Distribution of agricultural area and land tenure

Category	**Total area (ha)**	*273. Land tenure*			
		1. Title	**2.Customary**	**3. Rent**	**99. Other:**
270. Agricultural land					
271. Crop land					
272. Fallow					

A5. Value of inputs including labour during the last 1 year

226. *Input category*			227. **Expenses** ('000 ZMK)
	1	Hired person, labour	
	2	Feeds, fodder, etc	
	3	Veterinary fees, drugs, vaccinations, etc	
	4	Tools	
	5	Spareparts, maintenance of machinery, housing, etc.	
	6	Hiring of power sources; animals, machinery, etc.	
	7	Transport, storage, etc.	
	8	Herbicides, pesticides, fertilizer, etc.	
	9	Irrigation facilities	
Other			
Total expenses			

CROPPING

B1. Crop products

146. **Product category**	147.**Product ranking**	151. **Number of fields**	152. **Total area**	153. **End-use**	154. **Income**
C			ha	C	'000 ZKW
Total income **					

B2. Crop production system

140. *Cropping system* *		
	1	Multiple cropping
	2	Improved cultivars
	3	Crop rotation
	4	Fallow
	90	Not known
Other		

141. *Water* *		
	1	Rain fed
	2	Irrigation - manual construction, gravity fed
	3	Irrigation - major equipment
	4	Adequate drainage of excess water
	90	Not known
Other		

142. *Nutrients* *		
	1	Adequate fallow
	2	Organic fertilizer
	3	Mineral fertilizer
	90	Not known
Other		

143. *Pest / Weed* *		
	1	Pesticides
	2	Fungicides
	3	Herbicides
	4	Mechanical control
	5	Biological control
	90	Not known
Other		

144. *Erosion* *		
	1	Tillage
	2	Crop residue incorporation
	3	Cover Crops
	4	Leveling, contour tillage, terracing
	90	Not Known
Other		

145. *Power Sources* *		
	1	Manual
	2	Animal
	3	Mechanized means
	90	Not known
Other		

155. *Notes (cropping):*.....…….....……

…….....…….

**Multiple choice possible* ** *To be calculated by the enumerator*

1. **ILUA Zambia** **F7b**

2. **Tract N°** ..... **Household N°** …… **HOUSEHOLD**

LIVESTOCK

C1. Livestock production system

Livestock category			Cattle	Sheep	Goats	Pigs	Poultry	Other
220. **Grazing***	Common grazing							
	Fenced unimproved							
	Fenced improved							
	Tethering							
	Zero grazing							
221. **Feeds***	Crop residues							
	Fallow land for grazing							
	Specific fodder							
222. **Housing**	Livestock housing at night							
223**. Breeds**	Share of local breeds	%						
Management	224. **Decisions**	C						
	225. **Herder**	C						

C2. Accessibility to services

Service category		228. **Did you use it?**	229. **Do you need it?**	230. **How accessible is it ?**	231. **How far?**
		Y/N	Y/N	C	Km
1	Credit services				
2	Extension services				
3	Veterinary services				
4	Veterinary drugs				
Other					
Other					
Other					

C3. Accessibility to water resources

Water source type*		*Dry season*		*Wet season*	
		232a. **Access**	233a. **Distance**	232b.**Access**	233b. **Distance**
			Km		Km
1	Well				
2	Natural (river, stream, lake)				
3	Dam				
4	Borehole				
5	Seasonal drinking water				
6	All weather drinking water				
Other					

C4. Total sales of livestock, poultry and bee-keeping products (last one year)

234. **Products**		234b. **Unit of quantity**	*Dry season*			*Wet season*		
			235a. **Quantity sold**	236a. **Income from sale**	237a. **Ranking importance**	235b. **Quantity sold**	236b. **Income from sale**	237b. **Ranking importance**
				'000 ZMK	C		'000 ZMK	C
1	Meats							
2	Milk							
3	Butter and cheese							
4	Eggs							
5	Hides and skins							
6	Honey							
Other								
Other								
Other								
Total income								
Sum income (dry + wet)**								

** Multiple choice possible* *** To be calculated by the enumerator*

C5. Income received other than through sale of products in last one year

238.**Income***			239**. Value** ('000 ZMK)
	1	Hire of draft power	
	2	Rental of bulls	
Other			
Other			
Total income**			

240. *Notes (Livestock):* ……

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1. **ILUA Zambia** **F7c**

2. **Tract N° .....** 201. **Household N° ……** **HOUSEHOLD**

C6. Total sales of poultry and livestock during the last 1 year

	241. **Livestock type**	242. **Unit of quantity**	243. **Current stock**	*Inputs*				*Output*						252. **Opening stock**
				244a. **Purchased quantity**	244b. **Expense of purchase**	245. **Born**	246. **Gifted in**	247. **Died**	248. **Stolen**	249. **Consumed**	250. **Gifted out**	251a. **Sold quantity**	251b. **Income from sale**	
		C	Unit	Unit	'000 ZMK	Unit	Unit	Unit	Unit	Unit	Unit	Unit	'000 ZMK	Unit
1	Cattle -Young stock													
2	Cattle - Weaners male													
3	Cattle - Weaners female													
4	Cattle - Adult male													
5	Cattle - Adult female													
6	Cattle - Oxen													
7	Sheep													
8	Goats													
9	Pigs													
10	Chicken - Layers													
11	Chicken - Broilers													
12	Chicken - Free range													
13	Turkeys													
14	Ducks													
15	Other poultry													
16	Guinea pigs													
17	Rabbits													
Other														
Other														
Other														
Other														
Other														
Other														
			Total expenses **							**Total income ****				

** Multiple choice possible* *** To be calculated by the enumerator*

1. **ILUA Zambia** **F7d**

2. **Tract N°** .... 201. **Household N°** …… **HOUSEHOLD**

P…./….

FOREST AND TREE PRODUCTS AND SERVICES

																Extraction			Legislation		Forestry incentives	
80. **Land Use / Forest type**	99. **Product /Service category**	99a. **P/S Rank**	111a. **Species Rank**	111. **Species**	104. **Conflicts**	105. **Demand trend**	106. **Supply trend**	103. **User rights**	102. **End-Use**	262. **Income from P/S**	101b. **Organization level**	101c. **Gender balance**	101d. **Child labor**	261. **Distance to the P/S**	108. **Frequency**	109. **Trend**	110. **Change reason**	101e. **Awareness**	101f. **Compliance**	101g. **Awareness**	101h. **Application**
C	**C**	**C**			**C**	**C**	**C**	**C**	**C**	**'000 ZMK**	**C**	**C**	**C**	Km	**C**	**C**	**C**				
			H																		
			M																		
			L																		
			H																		
			M																		
			L																		
			H																		
			M																		
			L																		
			H																		
			M																		
			L																		
			H																		
			M																		
			L																		
			H																		
			M																		
			L																		
Total annual income from P/S (to be calculated by interviewer/enumerator)																					

68. Notes: ....

Annex 3 - ILUA Variables

Variable ID	Field form	NFMA / ILUA Variables	Variable type			Land Use Resources							Themes for Sustainable Resource Management										Data Collection Source						Level								Description of variable
			Administrative	Socio-economic	Bio-physical	Forestry (Forests and TOF)	Cropping	Livestock	Wildlife	Water	Fisheries and acquatic systems	Cross cutting	Spatial distribution (extent)	Quantitative/qualitative status of resource	Health and vitality	Biodiversity	Resource management	Physical accessibility	Uses and users (products and services)	Products	Services	Institutional and legislation	Other (socio-economic and environment)	Office (GIS, maps...)	Input during the field work	Field measurement	Interviews Key informants / focus groups	Household Survey	Estimation	Tract (Sampling Unit)	Plot	Land Use/Cover Section (LUCS)	Land Use/Cover Class (LUCC)	Sub-plot L1 (rectangular, RSP)	Sub-plot L2 (circular, CSP)	Measurement point (MP)	Household (HH)	
	F1	**TRACT**																																			
	F1	**Headline (Tract ID)**																																			
1	F1	Country name																																			
2	F1	Tract Nº																																			Identification number of the tract (from 1 to total tract number).
	F1	**Tract location**																																			General information on tract location
7	F1	First Administrative Division Level (e.g. State)																																			Name of the first administrative division level (e.g. state)
8	F1	Second Administrative Division Level (e.g. Province)																																			Name of the second administrative division level (e.g. province)
9	F1	First Administrative Division Level (e.g. District)																																			Name of the third administrative division level (e.g. district)
10	F1	Fourth Administrative Division Level (e.g. Municipalities, localities)																																			Name of the village/locality where the tract is located
11a	F1	Global Ecological Zone (GEZ)																																			Name of the global ecological zone where the tract is located, based on the FRA Global Ecological Zones map
11b	F1	Agro-ecological zone																																			Name of the agro-ecological zone where the tract is located
12	F1	Altitude																																			Altitude in meters above the sea level of the central point of the tract.
13	F1	Maps and aerial photos																																			Name of used maps (reference code, date, aerial photo or satellite images (acquisition date, coord.)
14	F1	Coordinates tract SW corner																																			Latitude (14a) and longitude (14b) in decimal degrees of the south-western corner of the tract.
14c	F1	Coordinate system																																			Projected coordinated system used for GPS reading
	F1	**Team/Owner/Informant list**																																			
15	F1	Name																																			Of team members
16	F1	Address																																			Of team members
17	F1	Telephone number																																			Of team members
18a	F1	Team leader																																			The leader of the team in current tract.
18b	F1	Team members																																			Other team members working in the tract.
19	F1	Owner																																			Owner(s) of all, or part of the land where the tract is located
20	F1	Informant																																			The persons interviewed in the tract
	F1	**Population**																																			
21c	F1	Number of households																																			Estimate of the number of households in the tract
21f	F1	Average household size																																			Average size (number of persons) of households in the tract
21	F1	Population on site																																			Estimate of the number of people living in the tract
21d	F1	Adult literacy rate																																			Refers to percentage of adult population
21e	F1	Ethnic group																																			Name of the main ethnic group found in the area
22	F1	Population since																																			Approximate year when the settlement was established in the tract.
23	F1	Population dynamics																																			Trend of the population living in or close to the tract
24	F1	Population main activity																																			Main income generation and employment source of most of the population living within the tract or in the surroundings.
24b	F1	Secondary activity																																			Secondary income generation and employment source of most of the population living within the tract or in the surroundings
25	F1	Settlement history																																			Major historical events that have affected the local people and land use in the area and date or periods of these events
	F1	**Proximity to infrastructure**																																			
26	F1	Distance to nearest all-weather road																																			Distance, in km, from the centre of the tract to the closest all-weather road
27	F1	Distance to nearest seasonal road																																			Distance, in km, from the centre of the tract to the closest seasonal road
28	F1	Distance to nearest Settlement																																			Distance, in km, from the tract centre to the closest inhabited area
29	F1	Distance to nearest Health institution																																			Distance, in km, from the tract centre to reach the closest hospital
30	F1	Distance to nearest School																																			Distance, in km, from the tract centre to reach the closest school
31a	F1	Distance to nearest Food Market																																			Distance, in km, from the tract centre to reach the closest food market
31b	F1	Distance to nearest Input Market																																			Distance, in km, from the tract centre to reach the closest agriculture and forestry market
	F1	**Tract access**																																			
32a	F1	Starting position, easting																																			Starting position where the field team starts accessing the tract by foot
32b	F1	Starting position, northing																																			
33a	F1	Access Time - Start time																																			Time when leaving vehicle to access the tract by foot
34a	F1	Access Time – End time																																			Time when arriving at the first plot
34b	F1	Arriving at plot No																																			Number of the first surveyed plot
35	F1	ID Reference point																																			Reference point ID (number from 1 to a series of reference points)
36	F1	Description Reference poin Point																																			Brief description of reference point (i.e. road, river, house, rock).
37a	F1	Easting Reference Point																																			Position given by GPS
37b	F1	Northing Reference Point																																			
36b	F1	Photo ID Reference Point																																			"Three-digit tract number" + "-0." + "running photo on the access path to tract"
36d	F1	Bearing Photo Reference Point																																			Compass bearing in which the photo is taken
38	F1	**Notes on Tract**																																			General notes concerning the tract

Variable ID	Field form	NFMA / ILUA Variables	Variable type			Land Use Resources							Themes for Sustainable Resource Management										Data Collection Source						Level								Description of variable
			Administrative	Socio-economic	Bio-physical	Forestry (Forests and TOF)	Cropping	Livestock	Wildlife	Water	Fisheries and acquatic systems	Cross cutting	Spatial distribution (extent)	Quantitative/qualitative status of resource	Health and vitality	Biodiversity	Resource management	Physical accessibility	Uses and users (products and services)	Products	Services	Institutional and legislation	Other (socio-economic and environment)	Office (GIS, maps...)	Input during the field work	Field measurement	Interviews Key informants / focus groups	Household Survey	Estimation	Tract (Sampling Unit)	Plot	Land Use/Cover Section (LUCS)	Land Use/Cover Class (LUCC)	Sub-plot L1 (rectangular, RSP)	Sub-plot L2 (circular, CSP)	Measurement point (MP)	Household (HH)	
	F2	**PLOT**																																			
	F2	**Headline (Plot ID)**																																			
1	F2	Country name																																			
2	F2	Tract Nº																																			Identification number of the tract (from 1 to total tract number
3	F2	Plot Nº																																			Identification number of the plot (1 to 4).
	F2	**Plot access**																																			
34g	F2	Starting position, easting																																			
34h	F2	Starting position, northing																																			
34i	F2	Access time - Start time																																			Time when the field crew starts accessing the plot by foot
34j	F2	Access time - End time																																			Time when arriving at the plot
	F2	**Time record of work within Plot**																																			
48	F2	Date 1																																			First date of measurement in the plot
50	F2	Date 2																																			Second date of measurement if the work in the plot cannot be completed within one day
49	F2	Start time																																			Start time of measurement in the plot at the first (49a) or second (49b) measurement day.
51	F2	End time																																			End time of measurement in the plot (hour : minutes)) at the first **(50a)** or second **(51b)** measurement day
	F2	**Plot starting point description**																																			
39a	F2	Starting point, easting																																			Coordinates of the plot starting point according to the projection system adopted
39b	F2	Starting point, northing																																			Coordinates of the plot starting point according to the projection system adopted
40a	F2	Marker position, easting																																			Coordinates in the projection system adopted
40b	F2	Marker position, northing																																			Coordinates in the projection system adopted
41	F2	Distance from Marker to Plot starting point																																			Distance in meters from the plot starting point to the marker
42	F2	Bearing from Marker to Plot starting point																																			Compass bearing (from 0 to 360 degrees) from marker to the plot starting point
43	F2	Plot starting point plan																																			
44	F2	ID Reference point																																			Identification of the reference points
45	F2	Description Reference Point																																			Description of the reference points
46	F2	Bearing Reference Point																																			Orientation of the reference points from the marker
47	F2	Distance from Marker to Reference Point																																			Distance of the reference points to the marker
36e	F2	ID Photo Reference Point																																			The photo ID corresponding to the reference
36c	F2	Photo ID Reference Point																																			"Three-digit tract number" + "-" + "plot number" + "." + "running photo number within plot"
	F2	**Plot plan**																																			Scheme displaying plot layout
52	F2	Plot plan																																			Scheme displaying plot layout (Land use sections limits, Intersections with roads/paths and water course)
39e	F2	Plot end point easting																																			X (longitude) coordinate of the plot end point in meters, in the coordinate system adopted
39e	F2	Plot end point northing																																			Y (latitude) coordinate of the plot end point in meters, in the coordinate system adopted
53	F2	**Notes on Plot**																																			General notes concerning the whole plot
	F3	**TREES AND STUMPS MEASUREMENTS**																																			
	F3	**Headline (Plot ID)**																																			
1	F3	Country name																																			
2	F3	Tract Nº																																			Identification number of the tract (from 1 to total tract number
3	F3	Plot Nº																																			Identification number of the plot (1 to 4).
	F3	**Tree Records (table)**																																			
4	F3	LUS No																																			Identification number (from 1 to nb of land use/forest type sections within the plot) of the LUS where the tree/stump is found
55	F3	Tree No																																			Tree/stump identification number
55b	F3	Stump																																			Indicates if the measurement is for a stump
56a	F3	Species common/local name																																			Common/local species name of the tree
56b	F3	Species scientific name																																			Scientific species name
57a	F3	Along plot axis																																			Horizontal distance in meters along the plot axis from plot starting point to the tree (from 0 to 250 m)
57b	F3	Left or right axis																																			Horizontal distance in meters from the plot central axis to the tree (from 0 to 10 m).
58	F3	Dbh																																			Tree or stump diameter, in centimetres
59	F3	Diameter height																																			Height of diameter measurement in meters, if different from breast height (1.3 m)
60	F3	Year since cut																																			Only for stumps. Estimated time since the tree was cut
61	F3	Total height																																			Total tree or stump height in meters
62	F3	Commercial height																																			Tree height at the first big branch in meters
63	F3	Stem quality																																			Estimated stem quality (only for trees)
64	F3	Health condition																																			Intensity of the symptom
65	F3	Causative agents																																			Causative agents that have been identified (diseases, insects, animals, etc.)
	F3b	**Branches**																																			Up to four major branches per tree measured if the branches represent a large proportion of the tree woody volume
66a	F3b	D1 (Mean Diameter Branch 1)																																			Mean diameter, in centimetres, of measured part of branch
66b	F3b	D2 (Mean Diameter Branch 2)																																			Mean diameter, in centimetres, of measured part of branch
66c	F3b	D3 (Mean Diameter Branch 3)																																			Mean diameter, in centimetres, of measured part of branch
66d	F3b	D4 (Mean Diameter Branch 4)																																			Mean diameter, in centimetres, of measured part of branch
67a	F3b	L1 (Length Branch 1)																																			Length, in meters, of measured branch.
67b	F3b	L2 (Length Branch 2)																																			Length, in meters, of measured branch.
67c	F3b	L3 (Length Branch 3)																																			Length, in meters, of measured branch.
67d	F3b	L4 (Length Branch 4)																																			Length, in meters, of measured branch.
68	F3b	Tree Notes																																			Notes concerning the trees and stumps

Variable ID	Field form	NFMA / ILUA Variables	Variable type: Administrative	Variable type: Socio-economic	Variable type: Bio-physical	Land Use Resources: Forestry (Forests and TOF)	Land Use Resources: Cropping	Land Use Resources: Livestock	Land Use Resources: Wildlife	Land Use Resources: Water	Land Use Resources: Fisheries and acquatic systems	Land Use Resources: Cross cutting	Themes for Sustainable Resource Management: Spatial distribution (extent)	Themes for Sustainable Resource Management: Quantitative/qualitative status of resource	Themes for Sustainable Resource Management: Health and vitality	Themes for Sustainable Resource Management: Biodiversity	Themes for Sustainable Resource Management: Resource management	Themes for Sustainable Resource Management: Physical accessibility	Themes for Sustainable Resource Management: Uses and users (products and services)	Themes for Sustainable Resource Management: Products	Themes for Sustainable Resource Management: Services	Themes for Sustainable Resource Management: Institutional and legislation	Themes for Sustainable Resource Management: Other (socio-economic and environment)	Data Collection Source: Office (GIS, maps...)	Data Collection Source: Input during the field work	Data Collection Source: Field measurement	Data Collection Source: Interviews Key informants / focus groups	Data Collection Source: Household Survey	Data Collection Source: Estimation	Level: Tract (Sampling Unit)	Level: Plot	Level: Land Use/Cover Section (LUCS)	Level: Land Use/Cover Class (LUCC)	Level: Sub-plot L1 (rectangular, RSP)	Level: Sub-plot L2 (circular, CSP)	Level: Measurement point (MP)	Level: Household (HH)	Description of variable
	F4	**SUBPLOTS AND MEASUREMENT POINTS**																																				Information on tree regeneration on circular subplots as well as on edaphic and topographic variables from measurement points
	F4	**Headline (Plot ID)**																																				
1	F4	Country name																																				
2	F4	Tract Nº																																				Identification number of the tract (from 1 to total tract number
3	F4	Plot Nº																																				Identification number of the plot (1 to 4).
	F4	**Measurement points: Topography and Soil**																																				Variables on topography and soil collected on measurement points at centre of each subplot
70	F4	Orientation																																				Slope orientation at measurement point
71	F4	Slope																																				Average inclination at the measurement point
72	F4	Relief																																				Position of subplots. Characterized by micro-relief.
73	F4	Soil texture																																				Texture class (grain or basic particles of the soil dimensions) of a soil sample collected at the measurement point level
74	F4	Soil drainage																																				Average soil drainage within subplot
75	F4	Organic matter																																				Defined by the thickness of the organic matter stratum, excluding litter.
	F4	**Subplots level 1 and level 2 – Area covered by forest**																																				
54a	F4	SP1L1, SP2L1, SP3L1 width																																				Width of the part of subplot level 1 (SPL1) covered by forest in meters.
54a	F4	SP1L1, SP2L1, SP3L1 length																																				Length of the part of subplot level 1 (SPL1) covered by forest in meters.
76a	F4	SP1L2																																				Area of the subplot level 2 (SPL2) covered by forest in square meters.
76b	F4	SP2L2																																				Area of the subplot level 2 (SPL2) covered by forest in square meters.
76c	F4	SP3L2																																				Area of the subplot level 2 (SPL2) covered by forest in square meters.
	F4	**Subplots level 2 - Tree <= 10cm counts**																																				
77a	F4	Common/local species name																																				Common/local species name of the tree
77b	F4	Scientific species name																																				Scientific species name of the tree
78a	F4	Counts																																				Allows to count individual trees equal to or more than 1.3 m
78	F4	Total																																				Total number (sum of counts) of individual trees over 1.3 m
79	F4	**Notes on subplots level 2 and Measurement points**																																				Notes concerning measurement points and subplots level 1 and level 2.
	F5	**LAND USE SECTION (LUS)**																																				Information on Land use/forest type section (LUS) found in a given Plot will be registered
	F5	**Headline (LUS ID)**																																				
1	F5	Country name																																				
2	F5	Tract Nº																																				Identification number of the tract (from 1 to total tract number
3	F5	Plot Nº																																				Identification number of the plot (1 to 4).
4	F5	LUS number																																				Identification number of the LUS, from 1 to the number of LUS identified.
	F5	**General**																																				
80	F5	Land use																																				Alphanumeric code describing the land use (LU) class in the LUS
81a	F5	Width																																				Average width of the LUS in meters
81b	F5	Length																																				Average length of the LUS in meters
80b	F5	Accessibility																																				Condition of accessibility of the LUS.
92a	F5	Tree Canopy cover																																				Ground surface covered by the vertical projection of the tree canopies, expressed as % of the total ground area in the LUS
82	F5	Designation / Protection status																																				Protection status and legal/official designation.
83	F5	Ownership																																				Land ownership designation under which most of the LUS is defined.
84	F5	Environmental problems																																				Main environmental problems observed/identified within the LUS.
88	F5	Trees expected																																				Trend in tree density expected in LUS within 5 years
85	F5	Fire occurrence																																				The presence or absence of fire evidence in the LUS
86	F5	Fire area																																				Surface of fire in the LUS
87	F5	Fire type																																				
	F5	**Forest and other wooded land management and structure**																																				
90	F5	Tree origin																																				Natural, plantation or coppice
91	F5	Stand structure																																				Distinct canopy layers in the stand
92b	F5	Shrub coverage																																				Vertical projection of the shrub canopies as percentage of the total ground area.
92c	F5	Shrub height																																				Average height of the shrubs
93	F5	Management plan																																				Any existing forest or woodland management plan
93b	F5	Management agreement																																				Management arrangement between the land owner and other groups
94	F5	Disturbances																																				Impact level of human activity in the forest or other wooded land
95	F5	Timber exploitation																																				Exploitation system applied in the LUS
96	F5	Silviculture																																				Visible silvicultural practices
97	F5	Logging technology																																				Technology used for tree exploitation (cutting and removal).
	F5	**Product and services provided by crop and grazing land areas**																																				Products and services (P/S) provided by managed land (annual or perennial crops and pastures
146	F5	Crop products category																																				Categories of products provided by the managed land use section
147	F5	Product ranking																																				According to importance of the product from 1 to number of services
148	F5	Service category																																				Categories of services and benefits provided by the land use section outside forest and wooded lands.
138	F5	Grazing activity																																				Indicates if grazing activity (domestic animals) is carried out in the land use section
	F5	**Crop management**																																				
140	F5	Cropping system																																				Cropping system applied in the LUS
141	F5	Water																																				Water treatment, drainage and use
142	F5	Nutrients																																				Use of fertilizer or other soils amendments
143	F5	Pest/Weeds control																																				Pest, weed and disease management applied
144	F5	Soil conservation (Erosion)																																				Protection against erosion, terrain and slope modifications.
145	F5	Power sources																																				Power sources applied in the farming activities
98	F5	**Notes on Land Use Section**																																				General notes concerning the LUS

Variable ID	Field form	NFMA / ILUA Variables	Variable type: Administrative	Variable type: Socio-economic	Variable type: Bio-physical	Land Use Resources: Forestry (Forests and TOF)	Land Use Resources: Cropping	Land Use Resources: Livestock	Land Use Resources: Wildlife	Land Use Resources: Water	Land Use Resources: Fisheries and acquatic systems	Land Use Resources: Cross cutting	Themes for Sustainable Resource Management: Spatial distribution (extent)	Themes for Sustainable Resource Management: Quantitative/qualitative status of resource	Themes for Sustainable Resource Management: Health and vitality	Themes for Sustainable Resource Management: Biodiversity	Themes for Sustainable Resource Management: Resource management	Themes for Sustainable Resource Management: Physical accessibility	Themes for Sustainable Resource Management: Uses and users (products and services)	Themes for Sustainable Resource Management: Products	Themes for Sustainable Resource Management: Services	Themes for Sustainable Resource Management: Institutional and legislation	Themes for Sustainable Resource Management: Other (socio-economic and environment)	Data Collection Source: Office (GIS, maps...)	Data Collection Source: Input during the field work	Data Collection Source: Field measurement	Data Collection Source: Interviews Key informants / focus groups	Data Collection Source: Household Survey	Data Collection Source: Estimation	Level: Tract (Sampling Unit)	Level: Plot	Level: Land Use/Cover Section (LUCS)	Level: Land Use/Cover Class (LUCC)	Level: Sub-plot L1 (rectangular, RSP)	Level: Sub-plot L2 (circular, CSP)	Level: Measurement point (MP)	Level: Household (HH)	Description of variable
	F6	**FOREST and TREE PRODUCTS AND SERVICES**																																				Information on products and services (P/S) provided by trees, forests and other wooded lands
	F6	**Headline (Land Use Class)**																																				
1	F6	Country name																																				
2	F6	Tract Nº																																				Identification number of the tract (from 1 to total tract number)
80	F6	Land Use Class																																				
200	F6	Enumerator(s)																																				Name of interviewer.
	F6	**Products and services (P/S) provided by trees and forests**																																				
99	F6	Product/service category																																				Categories of products and services provided by the trees, forest and other wooded land in a given Land use class
99a	F6	P/S Ranking																																				Ranking of the product or service according to importance
111	F6	Species																																				List of species collected in the P/S category by land use.
111a	F6	Species ranking																																				The species will be ranked according to their importance (high, medium or low)
104	F6	Conflicts																																				Existence of conflicts between different users of the P/S.
105	F6	Demand trend																																				Trend of P/S demand during the last 5 years
106	F6	Supply trend																																				Trend of P/S supply or stock during the last 5 years.
101	F6	Harvester/User																																				Harvester/user group of the P/S
101a	F6	Harvester/User Rank																																				Ranking of the user groups according to the harvested quantity/frequency of Use of the product/service
103	F6	User rights																																				user rights to harvest/use the P/S
101b	F6	Organization level																																				Regime which the activity is carried out
101c	F6	Gender balance																																				Gender balance of harvesters/users
101d	F6	Child labor																																				Proportion of children involved in the work related to harvesting/activity.
102	F6	End-use																																				Main end-use of P/S
108	F6	Frequency																																				Frequency of harvesting/use of the P/S
109	F6	Trend																																				Trend of harvesting/use of the P/S during the last 5 years
110	F6	Change reason																																				Reason of change in trend of harvesting/use of the P/S during the last 5 years
101e	F6	Awareness of legislation																																				Awareness of the legislation regarding the P/S related to the harvester/user
101f	F6	Compliance with legislation																																				Compliance with legislation for the P/S
101g	F6	Awareness of forestry incentives																																				Awareness of forestry incentives for the product/service by legal users.
101h	F6	Application of forestry incentives																																				Application to forestry incentive for the product/service by legal users.
	F6	**Notes on Forest and Tree P/S**																																				Notes regarding forest products and services in the plot
	F7	**HOUSEHOLD SURVEY**																																				
	F7	**Headline (LUS ID)**																																				
1	F7	Country name																																				
2	F7	Tract Nº																																				Identification number of the tract (from 1 to total tract number).
200	F7	Enumerator(s)																																				Identification number of the household (from 1 to 15 household)
	F7a	**General information on household**																																				
201	F7a	Household Nº																																				Identification number of the household (from 1 to 15 household)
202	F7a	Village																																				Village name
203	F7a	Distance to tract																																				Distance from the household to the tract
	F7a	**Household composition**																																				
204	F7a	Member name																																				Full name of all persons who usually live in the household
205	F7a	Relationship to head																																				Member's relationship to head of household
206	F7a	Sex																																				Male or female
207	F7a	Age																																				Age in completed years
208	F7a	Literacy																																				Indicates if the household member is literate in any language
209	F7a	Respondent																																				If the person is the respondent to the interview,
	F7a	**Household activities**																																				
210a	F7a	Activities																																				Income generation sources for the household
210b	F7a	Main activity																																				Main income generation sources for the household
	F7a	**Annual household income**																																				
211	F7a	Total annual household income																																				Range of the total household income from all activities
	F7a	**Distribution of agricultural area**																																				
270	F7a	Agricultural land																																				Total agricultural area used by the household
271	F7a	Crop land																																				Total crop area cultivated by the household
272	F7a	Fallow																																				Fallow area
	F7a	**Value of inputs including labour during the last 1 year**																																				
226	F7a	Input category																																				Inputs that have been used for main income generating activities during the last 1 year.
227	F7a	Expenses																																				Expenses from inputs to main income generating activities during the last 1 year
	F7b	**Accessibility to services**																																				
228	F7b	Service category																																				Service category
228	F7b	Service used																																				Specifies if the household has used the service during the past one year by indicating
229	F7b	Service need																																				Specifies if the household needs the service
230	F7b	Service accessibility																																				Indicates how accessible the service is to the household
231	F7b	Distance to service																																				Distance to the service from the house
	F7b	**Accessibility to water resources**																																				
	F7b	**Water sources type**																																				
232a	F7b	Water source access dry season																																				Indicated which type of water source is used by the household during the dry season
232b	F7b	Water source access wet season																																				Indicated which type of water source is used by the household during the wet season
233a	F7b	Distance to water resources dry season																																				Distance to the water resources from the house during dry season
233b	F7b	Distance to water resources wet season																																				Distance to the water resources from the house during wet season

Variable ID	Field form	NFMA / ILUA Variables	Variable type			Land Use Resources							Themes for Sustainable Resource Management										Data Collection Source						Level								Description of variable
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	F7a	**Cropping**																																			
	F7a	**Crop products and services**																																			
146	F7a	Crop products category																																			Categories of crops cultivated by the household
147	F7a	Product ranking																																			According to importance of the product for the household (from 1 to number of products)
151	F7a	Number of fields																																			Number of field in the corresponding crop category cultivated by the household
152	F7a	Total area																																			Crop area of in the corresponding crop category cultivated by the household
153	F7a	End-use																																			Main end-use (s) of the product
154	F7a	Incomes																																			Income received during the past 1 year from sale of the products
148	F7a	Crop/pasture service category																																			Categories of services provided by the land use section outside forest
149	F7a	Services ranking																																			According to importance of the service (from 1 to number of services)
140	F7a	Cropping system																																			Cropping system applied by household
143	F7a	Pest/Weeds																																			Pest, weed and disease management applied
142	F7a	Nutrients																																			Use of fertilizer or other soils amendments
144	F7a	Soil conservation (Erosion)																																			Protection against erosion, terrain and slope modifications.
145	F7a	Power sources																																			Power sources applied by household in the farming activities
141	F7a	Water																																			Water treatment, drainage and use.
	F7b	**Livestock**																																			
	F7b	**Livestock production system**																																			
	F7b	Livestock category																																			Livestock categories
220	F7b	Grazing																																			Type of grazing system
221	F7b	Feeds																																			Feed supply used for the livestock
222	F7b	Housing																																			If the livestock is housed at night
223	F7b	Breeds																																			Share of local breeds, in percent
224	F7b	Management decision																																			Person making decisions for livestock management in the household
225	F7b	Management working																																			Person who looks after the animals in the household
	F7b	**Total sales of livestock, poultry and bee-keeping products during the last year**																																			
234	F7b	Livestock product category																																			Type of products provided by livestock
234b	F7b	Unit of quantity																																			Unit in which the quantity is expressed for the product type
235a	F7b	Quantity sold during dry season																																			Quantity of product sold during the dry season.
235b	F7b	Quantity sold during wet season																																			Quantity of product sold during the wet season
236a	F7b	Income from sale during dry season																																			Income from sale of product sold during the dry season
236b	F7b	Income from sale during wet season																																			Income from sale of product sold during the wet season
237b	F7b	Ranking importance during dry season																																			Importance of the product to the household during the dry season.
237a	F7b	Ranking importance during wet season																																			Importance of the product to the household during the wet season
	F7b	**Income received other than through sale of products**																																			
238	F7b	Other income sources from livestock (hire, rental)																																			Description of income source from livestock, other than sale of products, used through over the last 1 year
239	F7b	Income value																																			Value of corresponding (to 238) income during the last 1 year
240	F7b	**Notes on Livestock**																																			Notes on livestock production
	F7c	**Total sales of poultry and livestock during the last year**																																			Quantity and values of holdings and sales for different livestock categories.
241	F7c	Livestock type																																			Types of domestic or domesticated animals in the household
242	F7c	Unit of quantity																																			Unit in which all quantity will be expressed for a given livestock type.
243	F7c	Current stock																																			Total livestock holdings, in number of heads
244a	F7c	Purchased quantity																																			Total number of heads purchased during the last one year
244b	F7c	Expense of purchase																																			Expense of livestock heads purchased during the last one year,
245	F7c	Born																																			Total number of heads born during the last one year
246	F7c	Gifted in																																			Total number of heads gifted in during the last one year
247	F7c	Died																																			Total number of heads that have died during the last one year
248	F7c	Stolen																																			Total number of heads that have been stolen during the last one year
249	F7c	Consumed																																			Total number of heads consumed during the last one year.
250	F7c	Gifted out																																			Total number of heads gifted out during the last one year.
251a	F7c	Sold quantity																																			Total number of sold heads during the last one year.
251b	F7c	Income from sale																																			Value of heads sold during the last one year
252	F7c	Opening stock																																			Total livestock holdings

Variable ID	Field form	NFMA / ILUA Variables	Variable type			Land Use Resources							Themes for Sustainable Resource Management										Data Collection Source						Level								Description of variable
			Administrative	Socio-economic	Bio-physical	Forestry (Forests and TOF)	Cropping	Livestock	Wildlife	Water	Fisheries and acquatic systems	Cross cutting	Spatial distribution (extent)	Quantitative/qualitative status of resource	Health and vitality	Biodiversity	Resource management	Physical accessibility	Uses and users (products and services)	Products	Services	Institutional and legislation	Other (socio-economic and environment)	Office (GIS, maps...)	Input during the field work	Field measurement	Interviews Key informants / focus groups	Household Survey	Estimation	Tract (Sampling Unit)	Plot	Land Use/Cover Section (LUCS)	Land Use/Cover Class (LUCC)	Sub-plot L1 (rectangular, RSP)	Sub-plot L2 (circular, CSP)	Measurement point (MP)	Household (HH)	
	F7d	**Forestry, Crop, Wildlife, Fishery products and services**																																			
80	F7d	Land Use/Forest type																																			Alphanumeric code describing the land use (LU) class in the LUS
99	F7d	Product/service category																																			Categories of products and services provided by the trees, forest and other wooded land in a given Land use class
99a	F7d	P/S Ranking																																			Ranking of the product or service according to importance
111	F7d	Species																																			List of species collected in the P/S category by land use.
111a	F7d	Species ranking																																			The species will be ranked according to their importance (high, medium or low)
104	F7d	Conflicts																																			Existence of conflicts between different users of the P/S.
105	F7d	Demand trend																																			Trend of P/S demand during the last 5 years
106	F7d	Supply trend																																			Trend of P/S supply or stock during the last 5 years.
103	F7d	User rights																																			User rights to harvest/use the P/S
101b	F7d	Organization level																																			In which regime activity is carried out
101c	F7d	Gender balance																																			Gender balance of harvesters/users
101d	F7d	Child labor																																			Proportion of children involved in the work related to harvesting/activity.
102	F7d	End-use																																			Main end-use of P/S
108	F7d	Frequency																																			Frequency of harvesting/use of the P/S
109	F7d	Trend																																			Trend of harvesting/use of the P/S during the last 5 years
110	F7d	Change reason																																			Reason of change in trend of harvesting/use of the P/S during the last 5 years
101e	F7d	Awareness of legislation																																			Awareness of the legislation regarding the P/S related to the harvester/user
101f	F7d	Compliance with legislation																																			Compliance with legislation for the P/S
101g	F7d	Awareness of forestry incentives																																			Awareness of forestry incentives for the product/service by legal users.
101h	F7d	Application of forestry incentives																																			Application to forestry incentive for the product/service by legal users.
261	F7d	Distance to P/S																																			Distance to the Product / Services from the house
262	F7d	Income from P/S																																			Annual income derived from selling of Products / Services
98	F7d	Notes on Forest and Tree P/S																																			Notes regarding forest products and services in the plot
Variables f		**333**	**98**	**149**	**111**	**151**	**91**	**116**	**50**	**61**	**51**	**90**	**54**	**105**	**28**	**45**	**60**	**44**	**150**	**130**	**62**	**33**	**68**	**72**	**110**	**80**	**80**	**115**	**44**	**60**	**69**	**48**	**34**	**36**	**20**	**19**	**122**	

Note: Additional variables have been used in Integarted Natural Resources Assessment in Kenya

Annex 4 - List of Tree species measured in the ILUA field inventory

Annex 4 – Trees species measured in the ILUA field inventory

Tree Species	Tree stems		Gross stem volume		
	Total Number	stems/ha	Total volume (m3)	m3/ha	% of total gross volume
Julbernadia paniculata	1,375,778,392	18.28	332,687,179	4.42	9.96%
Brachystegia spiciformis	850,453,820	11.30	328,139,704	4.36	9.82%
Brachystegia boehmii	1,204,182,400	16.00	243,715,413	3.24	7.29%
Colophospermum mopane	900,878,958	11.97	235,780,619	3.13	7.06%
Isoberlinia angolensis	623,917,006	8.29	178,369,518	2.37	5.34%
Diplorhynchus condylocarpon	1,323,848,026	17.59	144,548,394	1.92	4.33%
Pseudolachnostylis maprouneifolia	701,436,248	9.32	103,011,576	1.37	3.08%
Pterocarpus angolensis	517,798,432	6.88	100,097,662	1.33	3.00%
Erythrophleum africanum	322,871,406	4.29	96,334,592	1.28	2.88%
Parinari curatellifolia	340,934,142	4.53	76,330,556	1.01	2.28%
Diospyros batocana	303,303,442	4.03	64,957,892	0.86	1.94%
Brachystegia longifolia	281,477,636	3.74	63,219,576	0.84	1.89%
Pericopsis angolensis	289,003,776	3.84	55,693,436	0.74	1.67%
Marquesia macroura	79,835,721	1.06	54,287,561	0.72	1.62%
Julbernadia globiflora	383,833,140	5.10	54,188,208	0.72	1.62%
Monotes africanus	392,111,894	5.21	53,384,728	0.71	1.60%
Uapaca nitida	324,376,634	4.31	49,371,944	0.66	1.48%
Combretum molle	497,477,854	6.61	49,237,749	0.65	1.47%
Unknown	249,963,752	3.32	42,817,066	0.57	1.29%
Uapaca kirkiana	471,136,364	6.26	42,563,917	0.57	1.27%
Brachystegia	97,541,569	1.30	40,940,809	0.54	1.23%
Lonchocarpus nelsii	109,643,534	1.46	35,883,473	0.48	1.07%
Lannea discolor	339,428,914	4.51	35,768,247	0.48	1.07%
Burkea africana	152,780,642	2.03	34,627,105	0.46	1.04%
Gulbourtia coleosperma	113,644,714	1.51	32,362,402	0.43	0.97%
Newtonia buchanani	98,555,484	1.31	26,416,726	0.35	0.79%
Brachystegia floribunda	74,508,786	0.99	23,251,594	0.31	0.70%
Mangifera indica	97,329,485	1.29	22,564,528	0.30	0.68%
Anisophyllea	74,439,134	0.99	20,786,645	0.28	0.62%
Diospyros mespiliformis	101,128,582	1.34	19,149,981	0.25	0.57%
Brachystegia utilis	57,447,539	0.76	17,785,422	0.24	0.53%
Strychnos innocua	56,569,089	0.75	17,233,571	0.23	0.52%
Steganotaenia aralicaea	90,035,744	1.20	16,888,444	0.22	0.51%
Ochna pulchra	188,862,159	2.51	16,426,856	0.22	0.49%
Brachystegia manga	46,335,547	0.62	16,022,516	0.21	0.48%
Ricinodendron rautanenil	110,474,097	1.47	15,820,746	0.21	0.47%
Terminalia mollis	156,785,701	2.08	15,249,217	0.20	0.46%
Hymenocardia acida	111,704,885	1.48	14,989,191	0.20	0.45%
Swartzia madagascaiensis	144,655,005	1.92	14,549,893	0.19	0.44%
Vangueriopsis lancifiora	46,147,406	0.61	14,190,347	0.19	0.42%
Garcinia huillensis	74,946,092	1.00	14,160,399	0.19	0.42%
Balanites	185,560,443	2.47	12,257,412	0.16	0.37%
Cryptosepalum exfoliatum	73,382,121	0.98	12,102,252	0.16	0.36%
Syzigium guineense	86,222,281	1.15	11,171,422	0.15	0.33%
Berlinia	47,706,588	0.63	11,034,405	0.15	0.33%
Terminalia stuhlmannii	47,532,814	0.63	10,122,937	0.13	0.30%

Albizia adianthifolia	57,951,278	0.77	9,772,437	0.13	0.29%
Combretum collinum	101,480,920	1.35	9,656,595	0.13	0.29%
Parinari polyandra	52,572,275	0.70	9,525,756	0.13	0.29%
Piliostigima thonningii	87,086,366	1.16	9,468,841	0.13	0.28%
Terminalia sericea	49,280,136	0.65	8,529,472	0.11	0.26%
Brachystegia taxifolia	23,435,618	0.31	8,494,520	0.11	0.25%
Commiphora mollis	76,143,359	1.01	8,282,078	0.11	0.25%
Kirkia acuminata	7,815,065	0.10	8,125,224	0.11	0.24%
Vitex doniana	32,269,387	0.43	7,587,471	0.10	0.23%
Pteleopsis anisoptera	28,962,883	0.38	7,520,179	0.10	0.23%
Dalbergia melanoxylon	41,976,818	0.56	7,510,144	0.10	0.22%
Cryptosepalum maraviense	6,767,629	0.09	7,236,055	0.10	0.22%
Albizia antunesiana	85,797,996	1.14	7,035,630	0.09	0.21%
Mimusops zeyheri	48,565,884	0.65	6,121,507	0.08	0.18%
Faurea saligna	74,508,786	0.99	6,020,912	0.08	0.18%
Bridelia micrantha	40,586,621	0.54	6,008,863	0.08	0.18%
Zyziphus abyssinica	25,680,321	0.34	5,869,779	0.08	0.18%
Strychnos cocculoides	48,570,673	0.65	5,857,028	0.08	0.18%
Maytenus cymosus	27,756,038	0.37	5,768,962	0.08	0.17%
Annona	29,334,375	0.39	5,727,041	0.08	0.17%
Erythrophleum suaveolens	31,048,177	0.41	5,696,515	0.08	0.17%
Dalbergia nitidula	63,219,576	0.84	5,459,380	0.07	0.16%
Flacourtia indica	40,938,959	0.54	4,965,191	0.07	0.15%
Monotes glaber	14,225,568	0.19	4,869,398	0.06	0.15%
Bysorcarpus orientalis	53,933,740	0.72	4,816,138	0.06	0.14%
Garcinia jovis-tonantis	14,404,131	0.19	4,752,213	0.06	0.14%
Phyllocomus lemaireanus	58,620,863	0.78	4,639,626	0.06	0.14%
Faurea intermedia	31,226,740	0.41	4,456,197	0.06	0.13%
Lonchocarpus capassa	17,705,847	0.24	4,401,174	0.06	0.13%
Cassia abbreviata	35,909,075	0.48	4,371,284	0.06	0.13%
Azanza	30,010,318	0.40	4,263,700	0.06	0.13%
Pterocarpus chrysothrix	20,302,888	0.27	4,170,355	0.06	0.12%
Erythrina abyssinica	24,111,562	0.32	4,125,274	0.05	0.12%
Maprounea africana	44,400,084	0.59	4,120,092	0.05	0.12%
Brachystegia wangermeeana	16,658,412	0.22	4,016,606	0.05	0.12%
Ximenia americana	3,644,476	0.05	3,954,455	0.05	0.12%
Sclerocarya caffra	18,217,594	0.24	3,919,284	0.05	0.12%
Monotes elegans	27,756,038	0.37	3,772,358	0.05	0.11%
Uapaca sansibarica	23,247,478	0.31	3,701,587	0.05	0.11%
Syzigium cordatum	40,070,087	0.53	3,627,301	0.05	0.11%
Combretum zeyheri	45,099,971	0.60	3,585,666	0.05	0.11%
Chrysophyllum bangweolense	14,573,117	0.19	3,545,033	0.05	0.11%
Stereospermum kunthianum	6,424,869	0.09	3,420,524	0.05	0.10%
Terminalia brachystemma	37,463,469	0.50	3,406,197	0.05	0.10%
Diospyros kirkii	47,344,674	0.63	3,356,565	0.04	0.10%
Borassus	15,958,525	0.21	3,326,159	0.04	0.10%
Protea angolensis	28,624,911	0.38	3,292,610	0.04	0.10%
Brachystegia microphylla	11,102,415	0.15	3,211,288	0.04	0.10%
Brachystegia bussei	22,895,140	0.30	3,080,180	0.04	0.09%
Combretum fragrans	50,641,601	0.67	3,076,306	0.04	0.09%
Albizia versicolor	11,623,739	0.15	3,045,941	0.04	0.09%
Dichrostachys cinerea	46,494,955	0.62	3,037,837	0.04	0.09%

Cassia	3,818,251	0.05	3,024,301	0.04	0.09%
Oncoba spinosa	10,233,543	0.14	2,947,776	0.04	0.09%
Amblygonocarpus andongensis	40,755,607	0.54	2,927,212	0.04	0.09%
Zanha africana	22,895,140	0.30	2,879,274	0.04	0.09%
Anisophyllea boehmii	7,984,051	0.11	2,833,282	0.04	0.08%
Peltophorum africanum	26,882,377	0.36	2,745,904	0.04	0.08%
Albizia harveyi	5,034,673	0.07	2,682,761	0.04	0.08%
Hexalobus monopetalus	9,543,233	0.13	2,468,219	0.03	0.07%
Markhamia obtusifolia	22,373,816	0.30	2,357,837	0.03	0.07%
Gardenia jovi-tonantis	16,479,848	0.22	2,226,437	0.03	0.07%
Syzigium	38,675,102	0.51	2,176,327	0.03	0.07%
Xylopia odoratissima	7,462,727	0.10	2,103,568	0.03	0.06%
Dalbergiella nyasae	17,865,256	0.24	2,088,868	0.03	0.06%
Securidaca longepedunculata	17,691,481	0.24	2,073,592	0.03	0.06%
Bersama	30,869,614	0.41	1,933,937	0.03	0.06%
Cussonia arborea	15,437,201	0.21	1,822,393	0.02	0.05%
Strychnos spinosa	30,005,530	0.40	1,818,468	0.02	0.05%
Garcinia livingstonei	13,187,710	0.18	1,683,635	0.02	0.05%
Danniella aslteeniana	1,042,647	0.01	1,657,870	0.02	0.05%
Oldfieldia dactylophylla	10,407,317	0.14	1,655,103	0.02	0.05%
Uvariustrum hexaloboides	12,661,597	0.17	1,648,106	0.02	0.05%
Hyphaene ventricosa	1,563,971	0.02	1,620,258	0.02	0.05%
Mitragyna stipulosa	8,326,811	0.11	1,603,521	0.02	0.05%
Zyziphus mauritiana	3,296,927	0.04	1,589,846	0.02	0.05%
Canarium	19,424,438	0.26	1,584,322	0.02	0.05%
Viridivia suberosa	14,568,329	0.19	1,560,308	0.02	0.05%
Terminalia stenostachya	8,326,811	0.11	1,538,455	0.02	0.05%
Vitex potersiana	1,563,971	0.02	1,508,420	0.02	0.05%
Sterculia quinqueloba	3,296,927	0.04	1,494,821	0.02	0.04%
Vitex amboinensis	6,246,306	0.08	1,457,079	0.02	0.04%
Ficus capensis	3,470,702	0.05	1,433,493	0.02	0.04%
Bridelia	10,059,768	0.13	1,410,152	0.02	0.04%
Ficus verruculosa	9,021,910	0.12	1,404,542	0.02	0.04%
Pterocarpus rotundifolius	3,823,040	0.05	1,396,290	0.02	0.04%
Isoberlinia tomentosa	6,593,855	0.09	1,357,985	0.02	0.04%
Berchemia	22,552,380	0.30	1,353,736	0.02	0.04%
Acacia sieberana	27,577,475	0.37	1,321,233	0.02	0.04%
Craibia affinis	5,551,208	0.07	1,285,536	0.02	0.04%
Bauhinia petersiana	14,404,131	0.19	1,282,641	0.02	0.04%
Canathium zanzibaricum	11,449,964	0.15	1,257,957	0.02	0.04%
Ekebergia banguelensis	16,822,609	0.22	1,190,914	0.02	0.04%
Afzelia bipindensis	25,318,406	0.34	1,187,511	0.02	0.04%
Faurea speciosa	12,835,372	0.17	1,183,362	0.02	0.04%
Xeroderris stuhlmannii	5,555,996	0.07	1,121,671	0.01	0.03%
Borassus aethiopium	13,882,808	0.18	1,119,898	0.01	0.03%
Ficus wakefieldii	6,246,306	0.08	1,078,372	0.01	0.03%
Rauvolfia caffra	3,123,153	0.04	1,074,716	0.01	0.03%
Ochthocosmus lemaireanus	11,792,725	0.16	1,055,850	0.01	0.03%
Entada abyssinica	868,873	0.01	1,047,634	0.01	0.03%
Brachystegia allenii	12,145,062	0.16	1,012,675	0.01	0.03%
Combretum celastroides	1,390,196	0.02	1,010,738	0.01	0.03%
Zanthoxylum chalybeum	4,513,349	0.06	999,990	0.01	0.03%

Strychnos pungens	8,153,037	0.11	968,262	0.01	0.03%
Indigofera rhynchocarpa	5,898,757	0.08	968,145	0.01	0.03%
Canathium	27,398,912	0.36	946,971	0.01	0.03%
Combretum imberbe	7,631,713	0.10	927,319	0.01	0.03%
Becium	9,712,219	0.13	919,368	0.01	0.03%
Boscia	5,029,884	0.07	887,191	0.01	0.03%
Ozoroa reticulata	7,805,488	0.10	858,512	0.01	0.03%
Uvaria angolensis	3,123,153	0.04	847,320	0.01	0.03%
Memecylon flavovirens	695,098	0.01	834,558	0.01	0.02%
Parinari excelsa	7,805,488	0.10	792,305	0.01	0.02%
Kigelia africana	6,593,855	0.09	783,552	0.01	0.02%
Tabernaemontana angolensis	9,712,219	0.13	768,663	0.01	0.02%
Trichilia emetica	7,110,390	0.09	752,214	0.01	0.02%
Magnistipula butayei	3,470,702	0.05	729,452	0.01	0.02%
Harungana madagascariensis	5,724,982	0.08	728,738	0.01	0.02%
Bauhinia	18,208,016	0.24	725,929	0.01	0.02%
Uapaca pilosa	2,949,378	0.04	685,873	0.01	0.02%
Magnistipula bangweolensis	1,216,422	0.02	678,143	0.01	0.02%
Lannea stuhlmannii	3,296,927	0.04	660,242	0.01	0.02%
Rothmannia englerana	8,153,037	0.11	634,318	0.01	0.02%
Bridelia cathartica	14,568,329	0.19	624,557	0.01	0.02%
Raphia	4,508,560	0.06	605,125	0.01	0.02%
Baphia	9,538,445	0.13	599,615	0.01	0.02%
Pterocarpus brenanii	2,775,604	0.04	598,851	0.01	0.02%
Uapaca guineensis	5,029,884	0.07	586,695	0.01	0.02%
Parinari capensis	4,856,110	0.06	583,059	0.01	0.02%
Gardenia imperialis	14,047,005	0.19	563,667	0.01	0.02%
Schrebera alata	2,775,604	0.04	562,373	0.01	0.02%
Strychnos potatorum	2,949,378	0.04	558,432	0.01	0.02%
Combretum psidioides	1,042,647	0.01	522,535	0.01	0.02%
Brachystegia stipulata	695,098	0.01	514,934	0.01	0.02%
Cryptosepalum pseudotaxus	2,775,604	0.04	474,561	0.01	0.01%
Markhamia acuminata	2,775,604	0.04	471,989	0.01	0.01%
Agauria salicifolia	173,775	0.00	458,041	0.01	0.01%
Monotes katangensis	6,762,841	0.09	454,400	0.01	0.01%
Vitex madiensis	2,775,604	0.04	449,002	0.01	0.01%
Cussonia spicata	2,428,055	0.03	445,529	0.01	0.01%
Canthium lactescens	3,470,702	0.05	445,355	0.01	0.01%
Cassia angolensis	4,856,110	0.06	429,946	0.01	0.01%
Syzigium owariense	347,549	0.00	409,375	0.01	0.01%
Adansonia digitata	6,762,841	0.09	400,710	0.01	0.01%
Albizia	2,428,055	0.03	398,073	0.01	0.01%
Erythrina excelsa	347,549	0.00	396,817	0.01	0.01%
Baikiaea	868,873	0.01	394,243	0.01	0.01%
Harungana massaeinsis	3,123,153	0.04	392,691	0.01	0.01%
Ochna schweinfurthiana	4,856,110	0.06	392,156	0.01	0.01%
Rhus longipes	2,949,378	0.04	382,916	0.01	0.01%
Baikiaea plurijuga	15,804,894	0.21	381,847	0.01	0.01%
Baphia massaiensis	4,170,589	0.06	354,339	0.00	0.01%
Strychnos stuhlmanni	521,324	0.01	352,300	0.00	0.01%
Ficus carica	7,110,390	0.09	346,371	0.00	0.01%
Colophospermum	6,762,841	0.09	341,128	0.00	0.01%

Tarinna neurophylla	5,203,659	0.07	338,609	0.00	0.01%
Lannea schimeri	347,549	0.00	336,411	0.00	0.01%
Ixora rhodesiaca	868,873	0.01	308,995	0.00	0.01%
Khaya nyasica	2,949,378	0.04	306,243	0.00	0.01%
Entandrophragma caudatum	2,601,829	0.03	301,177	0.00	0.01%
Allophylus	1,042,647	0.01	297,376	0.00	0.01%
Acacia polyacantha	695,098	0.01	287,745	0.00	0.01%
Dombeya rotundifolia	1,563,971	0.02	285,757	0.00	0.01%
Ficus sycomorus	347,549	0.00	279,741	0.00	0.01%
Pteleopsis myritifolia	173,775	0.00	276,389	0.00	0.01%
Olax obtusifolia	2,775,604	0.04	268,388	0.00	0.01%
Uapaca benguelensis	9,364,670	0.12	268,294	0.00	0.01%
Canthium	173,775	0.00	245,056	0.00	0.01%
Ximenia caffra	2,601,829	0.03	241,158	0.00	0.01%
Afzelia quanzensis	4,682,335	0.06	239,014	0.00	0.01%
Acacia tortilis	7,284,164	0.10	229,253	0.00	0.01%
Trema Orientalis	695,098	0.01	227,330	0.00	0.01%
Ficus brachypoda	2,428,055	0.03	226,142	0.00	0.01%
Gmelina arborea	521,324	0.01	222,434	0.00	0.01%
Acacia nigrescens	521,324	0.01	221,596	0.00	0.01%
Carica papaya	173,775	0.00	217,073	0.00	0.01%
Protea welwitschii	2,775,604	0.04	209,600	0.00	0.01%
Entandrophragma delevoyi	4,682,335	0.06	205,231	0.00	0.01%
Lannea humilis	2,601,829	0.03	199,168	0.00	0.01%
Bridelia duvigneaudi	2,428,055	0.03	192,705	0.00	0.01%
Fagara macrophylla	6,762,841	0.09	192,236	0.00	0.01%
Eugenia bukobensis	2,428,055	0.03	183,814	0.00	0.01%
Xylopia katangensis	2,254,280	0.03	177,046	0.00	0.01%
Phoenix reclinata	347,549	0.00	169,791	0.00	0.01%
Burttia prunoides	173,775	0.00	164,895	0.00	0.00%
Jatropha	173,775	0.00	161,301	0.00	0.00%
Entandrophragma excelsum	6,762,841	0.09	159,237	0.00	0.00%
Magnistipula thonninge	173,775	0.00	156,345	0.00	0.00%
Diospyros mweroensis	521,324	0.01	155,981	0.00	0.00%
Schrebera trichoclada	4,856,110	0.06	149,048	0.00	0.00%
Baphia bequaertii	1,216,422	0.02	146,674	0.00	0.00%
Zyziphus	2,254,280	0.03	142,606	0.00	0.00%
Acacia	173,775	0.00	139,820	0.00	0.00%
Toona ciliata	173,775	0.00	138,800	0.00	0.00%
Tamarindus indica	173,775	0.00	134,540	0.00	0.00%
Ficus brachylepsis	347,549	0.00	131,209	0.00	0.00%
Burkea	1,216,422	0.02	120,610	0.00	0.00%
Heeria reticulata	347,549	0.00	119,621	0.00	0.00%
Azanza garckeana	3,470,702	0.05	116,707	0.00	0.00%
Rothmannia whitefieldii	173,775	0.00	104,660	0.00	0.00%
Cordia africana	2,428,055	0.03	98,129	0.00	0.00%
Dialiopsis africana	173,775	0.00	97,009	0.00	0.00%
Milletia bequarti	2,254,280	0.03	95,071	0.00	0.00%
Maytenus ovatus	173,775	0.00	94,970	0.00	0.00%
Euphorbia candelabrum	173,775	0.00	93,031	0.00	0.00%
Combretum mossambicense	173,775	0.00	91,578	0.00	0.00%
Salix subserrata	695,098	0.01	87,278	0.00	0.00%

Burttia	173,775	0.00	87,217	0.00	0.00%
Ekebergia capensis	173,775	0.00	84,895	0.00	0.00%
Monopetalanthus richardsiae	173,775	0.00	80,948	0.00	0.00%
Lonchocarpus eriocalyx	2,254,280	0.03	79,225	0.00	0.00%
Pterocapus antunesii	2,428,055	0.03	78,886	0.00	0.00%
Bysorcarpus	173,775	0.00	63,515	0.00	0.00%
Zyziphus pubescens	173,775	0.00	63,091	0.00	0.00%
Ficus ingenis	173,775	0.00	59,427	0.00	0.00%
Vitex mombasae	2,254,280	0.03	58,666	0.00	0.00%
Euphorbia ingens	173,775	0.00	58,145	0.00	0.00%
Cassine aethiopica	2,254,280	0.03	53,035	0.00	0.00%
Xylopia tomentosa	173,775	0.00	52,492	0.00	0.00%
Sterculia africana	2,254,280	0.03	52,380	0.00	0.00%
Becium obovatum	1,042,647	0.01	50,372	0.00	0.00%
Diospyros chamaethamnus	173,775	0.00	43,972	0.00	0.00%
Balanites aegyptiaca	868,873	0.01	43,164	0.00	0.00%
Boscia albitrunca	173,775	0.00	42,720	0.00	0.00%
Garcinia volkensii	173,775	0.00	42,720	0.00	0.00%
Euphorbia cooperi	2,254,280	0.03	39,285	0.00	0.00%
Cassia singueana	868,873	0.01	32,111	0.00	0.00%
Chrysophyllum magalismontanum	173,775	0.00	22,259	0.00	0.00%
Diplorhynchus	2,254,280	0.03	19,250	0.00	0.00%
Sapium ellipticum	2,254,280	0.03	12,833	0.00	0.00%
Parkia filicoidea	173,775	0.00	12,113	0.00	0.00%
Annona senegalensis	347,549	0.00	10,993	0.00	0.00%
Berlinia giorgi	173,775	0.00	4,088	0.00	0.00%
Grewia spp	173,775	0.00	3,876	0.00	0.00%
Cassia petersiana	173,775	0.00	3,230	0.00	0.00%
Combretum	0	0.00	0	0.00	0.00%