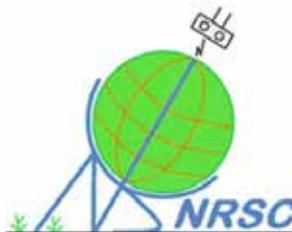




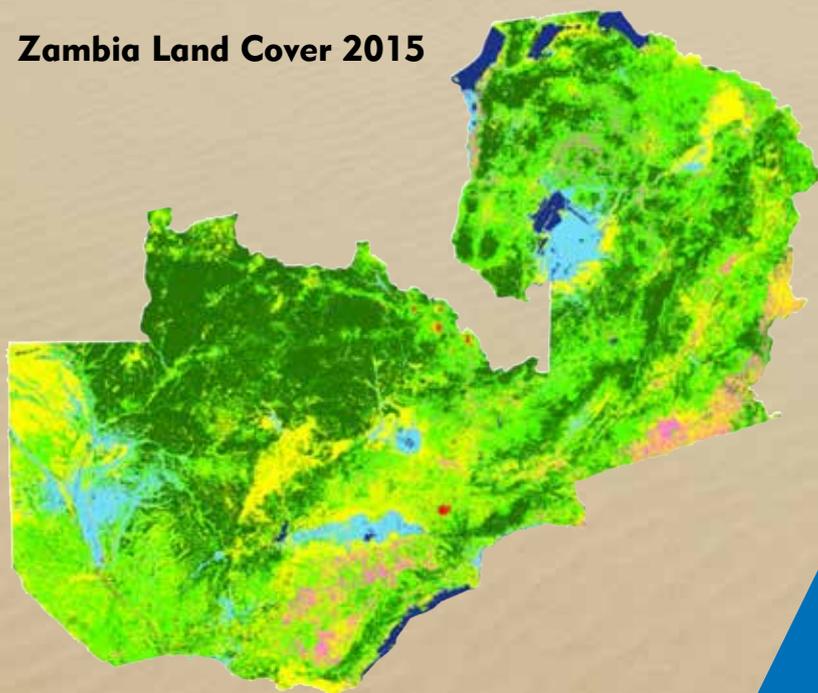
Republic of Zambia



National Remote Sensing Centre

NATURAL CAPITAL ACCOUNTS FOR LAND, 2010-2015:

Zambia Land Cover 2015



Legend
Zambia Landcover_2015
Class

- Bare lands
- Built up Urban
- Cropland
- Dense Forest
- Grassland
- Other
- Seasonally flooded wetland_grassland
- Wooded Grassland (Shrubland)
- Sparse Forest
- Water body
- Wetland

TECHNICAL REPORT

July, 2020



THE WORLD BANK
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The Zambia Natural Capital Accounts for Land, covering the period 2010 - 2015 were produced by the National Remote Sensing Centre (NRSC) and the Ministry of Lands and Natural Resources (MLNR) in collaboration with the Ministry of National Development Planning (MNDP) with assistance from the World Bank and the WAVES Global Partnership. Further information on the land account may be obtained from the addresses below:

The Director, National Remote Sensing Centre, P.O Box 310303, Lusaka, Zambia, Tel: +260 955 120039

The Permanent Secretary, Ministry of National Development Planning, 2251, Fairley Road Ridgeway Lusaka, Zambia, P .O. Box 30147, Tel: +260 211 252 395 or +260 211 252 394

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Forewords



Hon. Brian Mushimba

Honorable Minister of Higher Education
Ministry of Higher Education



Hon Alexander Chiteme

Honorable Minister of National
Development Planning
*Ministry of National Development
Planning*



Hon Jean Kapata

Honorable Minister of Lands
and Natural Resources
Ministry of Lands and Natural Resources

This report presents the first land accounts for Zambia based on the methodology of the System of Ecologic and Economic Accounting (SEEA), where land is defined as a unique environmental asset that delineates the space in which economic activities and environmental processes take place and within which environmental assets and economic assets are located. The land account displays the changes in land cover over time, differentiating between the main land cover classes in Zambia such as forest, cropland, grassland, built up, wetlands and water bodies.

Therefore, it is gratifying to note that Zambia joined the global coalition on Natural Capital Accounting viz-a-viz the Wealth Accounting and Valuation of Ecosystem Services global programme (WAVES) lead by the World Bank. This effort has resulted in the development of the first ever Land accounts for Zambia following the System of Economic Environmental Accounting (SEEA) for Land.

One key finding from the account is that forest cover and wetlands reduced between 2000-2010 and 2015. Built up and crop land area increased at the expense of forest cover (-1.35%). Wetlands reduction of 36,000 ha could be attributed to the changes in soil moisture due to variation in rainfall.

The policy relevance of the land account is that it will enhance the monitoring and understanding of how land space is changing over specified periods, hence understanding the dynamic of competing land use categories. The Land account will influence four of the five pillars of the Zambian Seventh National Development Plan (ZNDP). Specifically, the land account will inform and drive the government policy, direction, and agenda on enhancing land productivity, agricultural expansion, urban and rural development planning. The land account will also help in understanding the relationships between natural (e.g. changes in rainfall) and human-induced land cover changes (e.g. expansion of urban areas and irrigated agriculture), which have impacts on environmental sustainability. In the future the land account could provide data on competing land uses and the two major land tenure categories of Zambia; the customary land held under the vast rural landscapes and state land held under most of the urban areas.

Minister of Higher Education

Minister of National
Development Planning

Minister of Lands and Natural
Resources

Forewords

We cannot emphasize enough the relevance of Natural Capital Accounts (NCA) for the Republic of Zambia. Natural capital forms a large share of Zambia's wealth and is integral to its national development. The sustainable management of these natural resources is vital and keeping track of changes over time is imperative.

Zambia's Vision 2030 and Seventh National Development Plan (7NDP) express both an aspiration to live in a prosperous, sustainable middle-income economy with opportunities for all. This cannot be achieved without the use of NCA which provides detailed statistics on a better management of the resources.

Prioritizing Natural Capital Accounting to contribute to economic development is not an easy task. We commend the Government of the Republic of Zambia for the substantial progress made in completing the three priority accounts for forest, water and land selected in the initial stages of, development and management of its NCA. These three accounts have played and continue to play a key role in providing the data needed for informed decision-making in key sectors of Zambia's economy.

This land account provides information for government to use for policies towards enhancing land productivity and sustainable use of land, as well as the best approaches to managing landscapes for multiple values, including managing climate change risk and adapting to climate change.

Since its inception in 2017, the WAVES program has provided technical support to the Government through its Ministry of National Development Planning (MNDP). This support focused on mainstreaming NCA into national development and extended to training and capacity building for focal points in key ministries. Following the successful completion of the three first accounts, the WAVES program will build on these

results and develop subsequent future iteration of the accounts that will further inform policy and decision-making.

Various studies have shown that Zambia has an abundance of natural resources, but their potential remains underutilized, and in some cases used unsustainably. The continuous development of NCA will give impetus to Zambia to drive and promote sustainable development and shared prosperity.

The World Bank continues to be committed to working with the Government of Zambia to ensure that the information from these accounts provides a strong basis for an optimal management of the natural resources and inform the design of policies that integrate longer-term sustainability and solutions that can boost the economy and deliver positive environmental outcomes simultaneously.

We recognize the tremendous efforts of the Ministry of National Development Planning (MNDP) in collaboration with the Ministry of Lands and Natural Resources, Ministry of Water Development, Sanitation & Environmental Protection (MWDSEP), Ministry of Higher Education and their focal points who continue to build and manage NCA for sustained growth including for resilient ecosystems and livelihoods.



Iain G. Shuker

Practice Manager for Environment
& Natural Resources
The World Bank Group

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Mrs Kayula Siame
Permanent Secretary
Ministry of Higher Education



Mr Chola Chabala
Permanent Secretary
Ministry of National Development
Planning



Mr Ndashe Yumba
Permanent Secretary
Ministry of Lands and Natural Resources

The work presented in this report would not have had been possible without the dedicated effort of the Zambia WAVES Land Account Technical Working group led by Eng. Samuel Chembe Maango, and the following members; Michael Katongo Phiri, Lusekelo Kasunga, Chenje Prassat Mtonga from the National Remote Sensing Centre (NRSC), and Abel Siampale of the Forestry Department. These officials conducted satellite imagery processing to derive land cover and land use data used to compile the Land account. We further acknowledge the Input of Anderson Nkhuwa and Monica Kalima from the Ministry of Lands who guided on policy issues on Land administration.

Special mention is made of the Ministry of National Development Planning led by Permanent Secretary-Mr Chola Chabala, Director of Development Planning-Mr Maketo Mulele and Richard Lungu (Zambia WAVES National Focal Person) from the Ministry of National Development Planning for their strategic oversight and coordinating the various activities that made it possible to develop the Land account. Appreciation is also given to the Zambia WAVES (ZWAVES) project task team at the World Bank who supported account

activities. The ZWAVES team includes Iretomiwa Olatunji, Sofia Ahlroth, Shun Chonabayashi, Prof. Lloyd Chinga'mbo and Rebecca Naomi Munsanda Ngulube. Furthermore, the data supplied by the various stakeholder institutions was key in the compilation of the reports. These comprised the National Remote Sensing Centre, Forestry Department of Zambia (FD), Zambia Survey Department (ZSD), Zambia Statistical Agency (ZamStats), and the Regional Centre for Mapping of Resources for Development (RCMRD) of Kenya.

The team greatly acknowledges the reviewers from the World Bank; Sofia Ahlroth, Shun Chonabayashi, Michael Verdon and the international reviewers, Schenau Sjoerd (Statistics Netherlands) and feedback received from various local experts and stakeholder institutions that helped to shape the report.

Permanent Secretary: Ministry
of Higher Education

Permanent Secretary: Ministry
of National Development Planning

Permanent Secretary: Ministry
of Lands and Natural Resources



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Executive Summary

This report presents the first land accounts for Zambia based on the methodology of the SEEA, where land is defined as a unique environmental asset that delineates the space in which economic activities and environmental processes take place and within which environmental assets and economic assets are located. The land account displays the changes in land cover over time, differentiating between the main land cover classes in Zambia such as forest, cropland, grassland, built up, wetlands and water bodies.

The policy relevance of the land account is that it facilitates the monitoring and understanding of how land cover has changed in Zambia for the period 2000-2015, which is essential for spatial planning at both national and provincial levels. It also provides the platform for development of other SEEA accounts such as ecosystem extent account, ecosystem services supply and use account, and carbon and biodiversity thematic accounts. A Land Technical Working Group (TWG) composed of the National Remote Sensing Centre and the Ministry of Lands and Natural Resources was tasked to compile the Land Account.

The Land TWG used guidelines of the System of Environmental-Economic Accounting Central Framework (SEEA-CF) to produce the land account for Zambia. Specifically, the TWG used the available maps and related spatial data sets to formulate the Land Account. The maps and attribute data have been obtained from various national and regional data sources. Land cover and land use spatial data provided the main data sets and information for the Land Account.

One key finding from the account is that forest cover and wetlands reduced between 2000 and 2015. Built up and crop land area increased at the expense of forest cover (-1.35%). Wetlands reduction of 36,000 ha could be attributed to the change in soil moisture due to variation in rainfall, with the reduction in soil moisture promoting growth of herbaceous vegetation communities such as shrubs.

Natural capital accounting for land will influence four of the five pillars of the Zambian Seventh National Development Plan (7NDP). Specifically, the land account should inform and drive the government policy, direction, and agenda on enhancing land productivity, agricultural expansion, urban and rural development planning. The land account will also help in understanding the relationships between natural (e.g. changes in rainfall) and human-induced land cover changes (e.g. expansion of urban areas and irrigated agriculture), which have impacts on environmental sustainability. In the future the land account could provide data on competing land uses and the two major land tenure categories of Zambia; the customary land held under the vast rural landscapes and state land held under most of the urban areas. The cover accounts can also help to address climate change policy. For example, the ecosystem service of carbon sequestration from different vegetation types can be estimated and potentially sold into international markets.

Finally, the land account can also monitor progress towards the United Nations Sustainable Development Goals (SDG) 2030, particularly goals 15, 13, 12, and 11, which should eventually result in attainment of goals 1 and 2, in the long run.



1.0

Introduction

1.0 Introduction

The Republic of Zambia is located in southern Africa. The country has an area of just over 75 million hectares and had a population of 17.1 million in 2017 (ZamStats 2018). Approximately 57% of the population lived below the poverty line (World Bank 2019). Gross Domestic Product (GDP) was USD\$25.868 billion (current price) in 2017, with an average annual growth rate of 3.4% (World Bank database) while GDP per capita was USD\$3,652 in 2016 (FAO country database). In [add year] Mining contributed 14.8% to GDP while agriculture, forestry and fishing contributed 7.2% (ZamStats national accounts). The development aspirations, opportunities and challenges of the country are outlined in 7th National Development Plan 2017-2021 (Ministry of National Development and Planning 2017).

Zambia is intent on promoting sustainable development by ensuring that natural resources are mainstreamed in development planning and are recognized in the national economic accounts. Further, Zambia is aware that natural capital provides ecosystem services such as provision of clean water, sediment retention and erosion control, eco-tourism, pollination services and carbon storage, that are not explicitly recognized in national accounts. Hence Zambia embarked on producing natural capital accounts, starting with the following:

- Land accounts, with a focus on changes in land cover including forests, wetlands and agricultural lands;
- Water accounts, including water supply, use and quality; and
- Forest accounts, including production of timber and non-timber forest products.

This report presents the land accounts for Zambia based on the concepts and methodology of the SEEA (UN et al. 2014), where land is defined as a unique environmental asset that delineates the space in which economic activities and environmental processes take place and within which environmental assets and economic assets are located. The land account displays the changes in land cover over time, differentiating between the main land cover classes in Zambia such as forest, cropland, grassland, built up, wetlands and water bodies.

The policy relevance of the land account is that it facilitates the monitoring and understanding of land cover change in Zambia for the period 2010-2015, which is essential for spatial planning at both national and provincial levels. It also provides basic information for development of other SEEA accounts such as ecosystem extent account, ecosystem services supply and use account, and carbon and biodiversity thematic accounts. A Land Technical Working Group (TWG) composed of the National Remote Sensing Centre and the Ministry of Lands and Natural Resources was convened to compile the land account.

The Land TWG followed the guidelines of the System of Environmental-Economic Accounting Central Framework (SEEA-CF). Specifically, the team used various maps and related spatial data sets to compile the Land Account. The maps and attribute data were obtained from various national and regional data sources. Land cover and land use spatial data provided the main data sets and information for the land account.



2.0

Methodology, concepts and data sources

2.0 Methodology, concepts and data sources

The Land TWG compiled the land account using the following tools, concepts, methods, components, and data sets:

- **Satellite imagery**
 - Landsat satellite imagery of the years 2000, 2010, and 2015.
- **Land cover maps**
 - Periodic land cover maps for the year 2000, 2010 and 2015. The land cover maps were derived from the Landsat satellite images through computerized image processing.
- **The SEEA**
 - Provided the concepts and methods needed to arrange the data from satellite imagery and land cover maps into accounts.

2.1 Data Sources

The Landsat satellite images were downloaded from the United States Geological Survey (USGS) imagery portal¹. The land cover maps and attribute data were derived through image processing and interpretation using ENVI image processing software, undertaken by a team of experts from the following institutions:

1. The Regional Centre for Mapping of Resources for Development (RCMRD), Kenya.
2. Southern Africa Science Services Centre for Climate Change and Adaptive Land Management (SASSCAL) Project
3. Forestry Department of Zambia (FD)
4. Zambia Survey Department (ZSD)
5. Department of National Parks and Wildlife (DPNW)
6. Department of Water Affairs (DWA)
7. Water Resources Management Authority (WARMA)
8. Technical Services Branch of the Ministry of Agriculture, Zambia
9. Zambia Statistics Agency (ZamStats)

2.2 Compilation of Land cover maps and data

The RCMRD compiled and produced land cover maps for Zambia for the periods 2000 and 2010, in collaboration with the NRSC, Zambia Survey Department and the Forestry Department of Zambia in 2013. The land cover maps were compiled from Landsat 7 ETM satellite images of 30 meters spatial resolution.

The methodology used was office-based image processing and classification using ENVI software. NRSC, with support from SASSCAL, went on to compile and produce subsequent land cover maps for the period 2014 and 2015 using Landsat satellite images of 30 meters spatial resolution, through image processing and classification, followed by field verifications to ascertain classifications accuracy. The field verification was undertaken through random sampling, to compare the interpreted land cover classes with the actual field land cover. More than 2000 field points were selected in each of the six (6) land cover classes and followed up in the field, to compare them to the office interpreted classes. The details of classification errors and explanations are attached in the appendix. Overall image classification accuracy of 85.5% was attained. According to literature on land cover classification accuracy (Congalton, R.G.1991), 75% or more is the acceptable mis-classification accuracy.

Ancillary and supporting topographic spatial datasets, such as national and regional administrative boundaries, were obtained from the Survey General's office. The NRSC refined the spatial data sets from the above sources, using an integrated Geographic Information System (GIS), where maps for the periods 2000, 2010 and 2015 were overlaid and analyzed to determine the area of different land covers and the changes between then in the 2000, 2010 and 2015 periods. Cross and pivot tables were used to generate change matrix, from which land cover accounts were compiled.

The following six (6) Land cover classes, as determined by the Intergovernmental Panel on Climate Change (IPCC, 2003), Good Practice Guidelines for Land Use, Land-Use Change and Forestry (LULUCF), were used to generate the land cover accounts; (1) Forest, (2) Grassland, (3) Wetland, (4) Built up/Settlements, (5) Cropland, (6) Others. Table 1 below show the description of the land cover categories.

¹ USGS Landsat Data Access Portals: https://www.usgs.gov/land-resources/nli/landsat/landsat-data-access?qt-science_support_page_related_con=0#qt-science_support_page_related_con

Table 1: Description of the land cover categories

Land cover categories	Land cover descriptions
1. Built up/Settlements	Land covered mainly by densely populated and organized or irregular settlement patterns surrounding cities, towns, chiefdoms and rural centres commonly referred to as urban and rural built-up areas.
2. Cropland	Land actively used to grow agriculture (annual and perennial) crops which may be irrigated or rain feed for commercial, peasant and small-scale farms around urban and rural settlements.
3. Grassland	Land that includes wooded rangeland that may be covered mainly by grasslands, plains, dambos, pans found along major river basins and water channels.
4. Forests	This is land covered both by natural and planted forest meeting the threshold of 10% canopy cover growing over a minimum area of 0.5 ha with trees growing above 5m height.
5. Wetlands	Land which is waterlogged, may be wooded such as marshland, perennial flooded plains and swampy areas (surface water bodies included).
6. Other land	Barren land covered by natural bare earth / soil such as sandy dunes, beach sand, rocky outcrops and may include old open quarry sites for mines and related infrastructure outside built up and settlement areas.

The pictures below show typical forest, grasslands and wetlands of Zambia

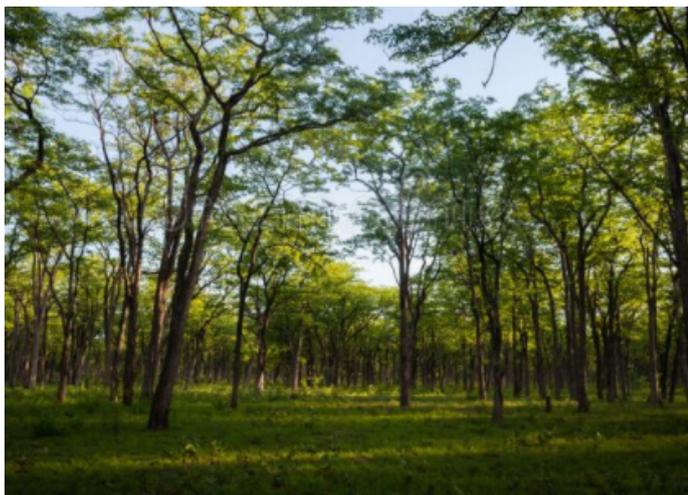


Figure 1: Typical Forest of Zambia

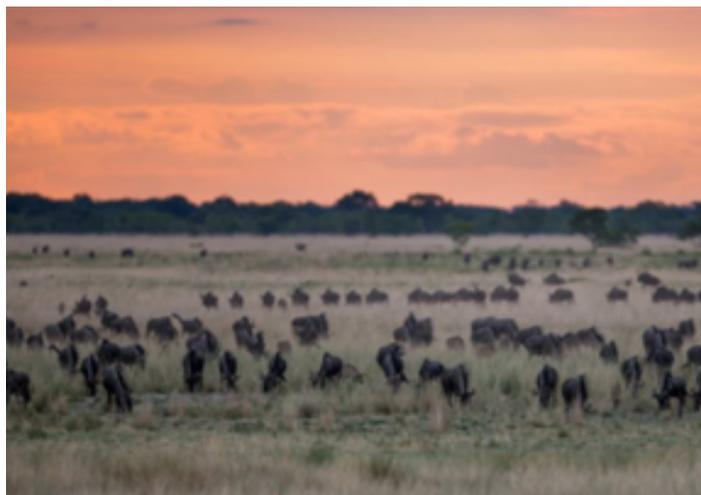


Figure 2: Typical Grasslands of Zambia, teeming with grazing wildlife



Figure 3: Eagle Eye's view of a Wetland of Zambia

Figure 4 shows land cover in Zambia for 2015. The land cover maps for 2000 and 2010 are in the Annex.

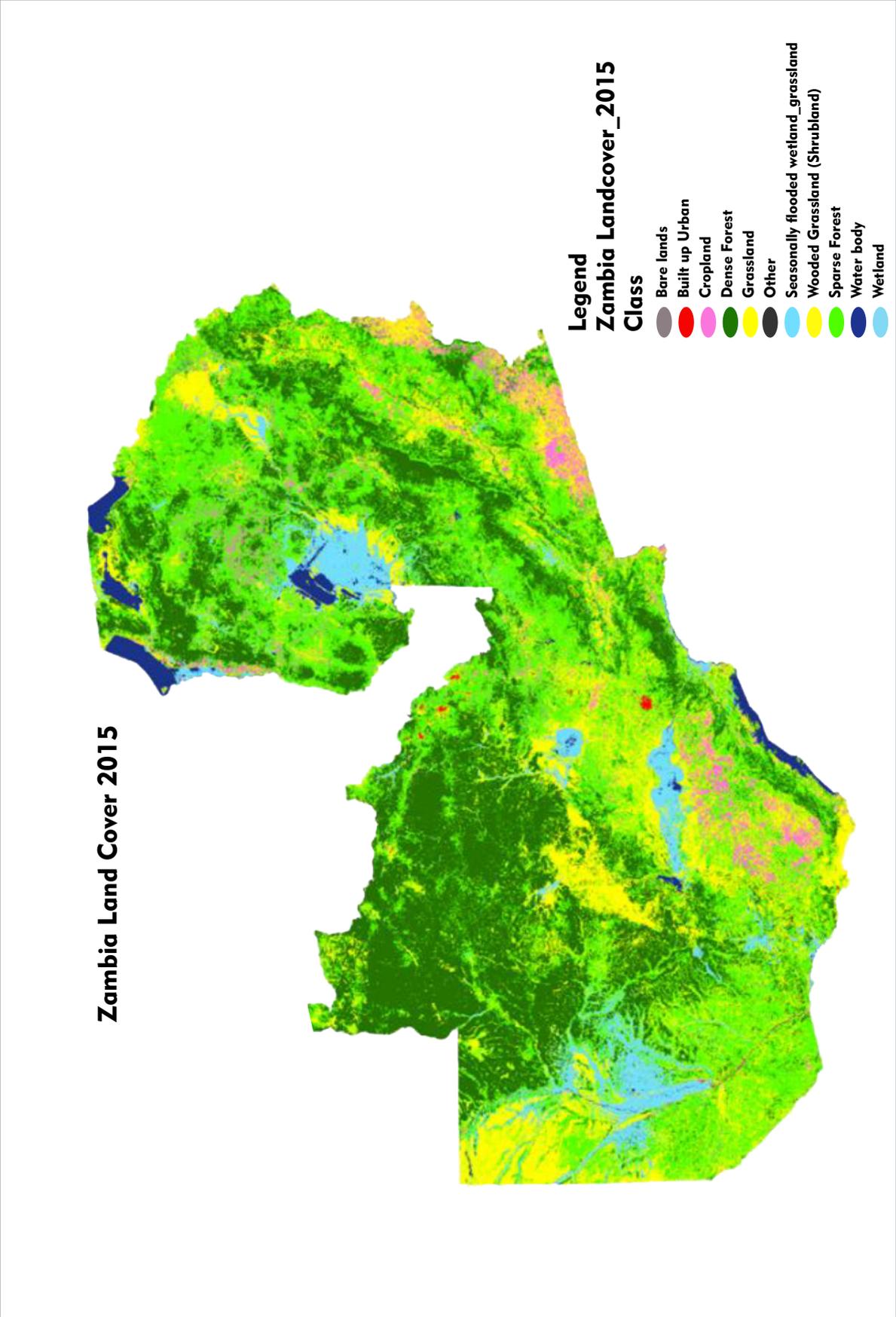


Figure 4: National Land cover Map of Zambia for 2015



3.0

Main Findings

3.0 Main Findings

Table 2 shows area of land cover for the years 2000, 2010 and 2015 in hectares and corresponding percentages. The data from the table has also been plotted into bar graphs outlined by Figure 5 and Figure 6. The bar graphs outline both reductions and increases to different land cover. In Figure 6, the red bars represent reduced land cover quantities while green bars show increased land cover.

Table 2: National Land cover in hectares and percentages, derived from the 2000, 2010 and 2015 land cover maps

No.	Land cover	2000(ha)	2010(ha)	2015(ha)	2000(%)	2010(%)	2015(%)
1	Built up	137 245	208 346	572 346	0,18	0,28	0,76
2	Cropland	6 466 555	6 745 080	7 461 080	8,59	8,96	9,91
3	Grassland	16 426 337	16 375 028	16 373 028	21,83	21,76	21,75
4	Forests	47 054 148	46 696 174	45 684 174	62,52	62,05	60,70
5	Wetland	5 041 472	5 092 781	5 056 781	6,70	6,77	6,72
6	Other lands	135 643	143 991	113 991	0,18	0,19	0,15
	Total	75 261 400	75 261 400	75 261 400	100	100	100

The information in bar graphs (Figures 5 and 6) were all derived from Table 2.

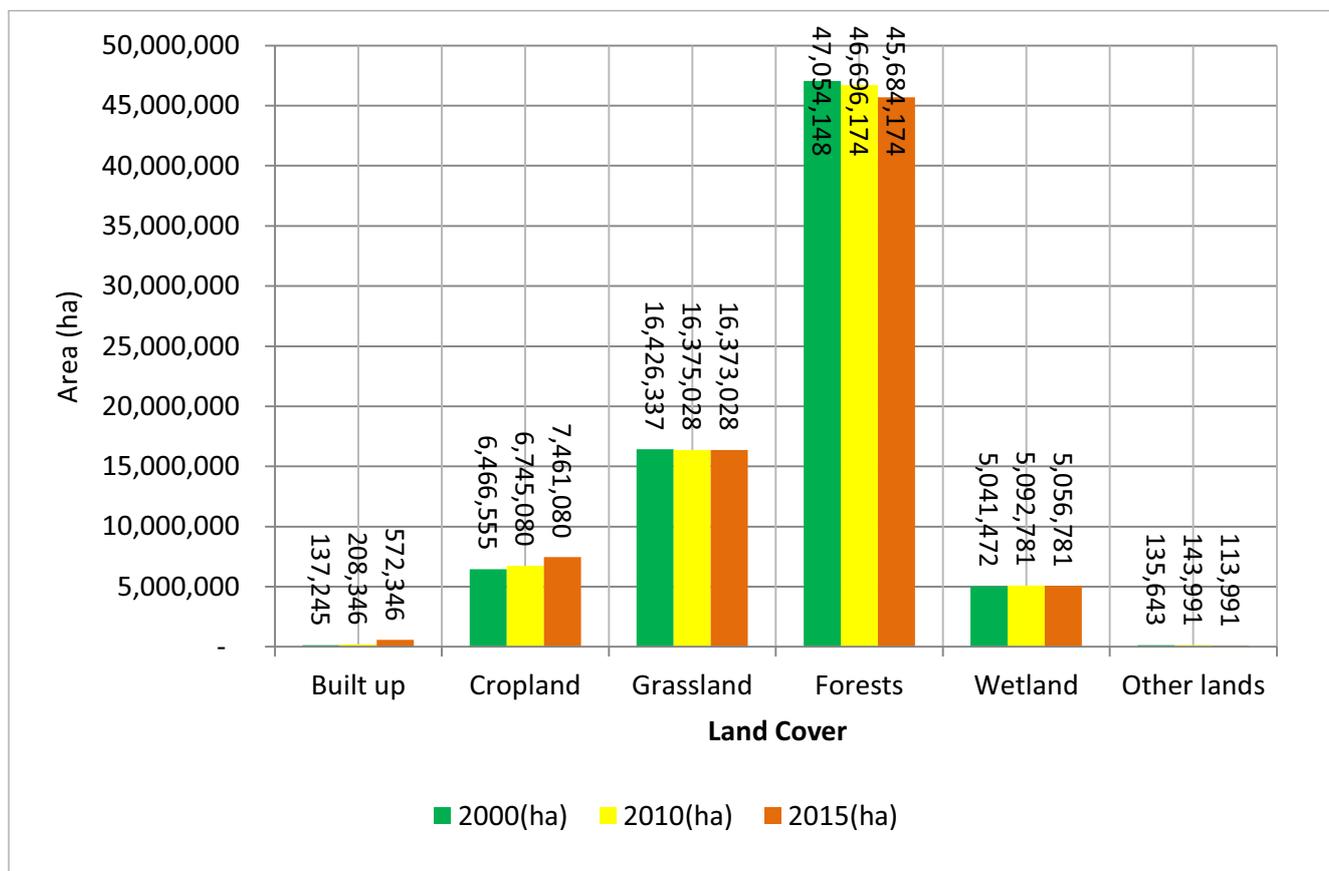


Figure 5: Comparison of the National land cover quantities for the 2000, 2010 and 2015 period

Land cover changes were analyzed for the 2010 and 2015 period using land cover change matrices (Annex 8.3 and 8.4) generated from the pivot table. The following are the main findings:

- Forest cover reduced from 46,696, 174 hectares (62.05%) to 45,684, 174 hectares (60.70% of national area). About 364,000 hectares of forest were converted to built-up areas, while 680,000 hectares of forest were converted to cropland. Forest lost was 1,044,000 hectares which is about 1.35% of the national total area.
- Build up area increased from 208, 346 hectares to 572, 346 hectares, a total addition of 364,000 hectares (0.48% of national area), mostly encroaching into the forest land. There has been massive urban infrastructure development from 2010 to 2015 onwards.
- Cropland increased from 6,745, 080 hectares to 7, 461, 080, by 716,000 hectares (0.95% of national area), at the expense forest land. Agriculture development is being promoted at national level as one of the areas to grow and diversify the economy, but this expansion is occurring at the expense of the forested land.
- Wetlands reduced by 36,000 hectares (0.05% of national area). The slight decrease in wetland areas is attributed to changes in rainfall regimes that have been reducing.
- Grasslands remained relatively stable being approximately 16 million ha in both 2010 and 2015. The very slight reduction of 2000 hectares is attributed to the expansion of cropping into grassland areas.
- The land cover changes are summarised in Table 3 and Figure 6 below. The forest land changes are also evidenced from several forest reserves that have been converted from protected area status to either settlements or agricultural farms. Annex 8.5 shows radar image derived maps, portraying changes that have occurred between 2007/2010 to 2015. The maps were generated under the Satellite Monitoring for Forest Management (SMFM) Project, a World Bank funded project developing remote sensing tools for dry forest monitoring in Southern Africa.

Table 3: National land cover: Opening and closing stocks for 2010 and 2015

Land cover	Opening Stock_2010(Ha)	Closing Stock_2015(Ha)	Change(ha)	Opening Stock (%)2010	Closing stock(%) 2015	Change(%)
Built up	208346	572346	364000	0,28	0,76	0,48
Cropland	6745080	7461080	716000	8,96	9,91	0,95
Grassland	16375028	16373028	-2000	21,76	21,75	0,00
Forests	46696174	45684174	-1012000	62,05	60,70	-1,34
Wetland	5092781	5056781	-36000	6,77	6,72	-0,05
Other lands	143991	113991	-30000	0,19	0,15	-0,04
Total	75261400	75261400	0	100,000	100,000	0,000

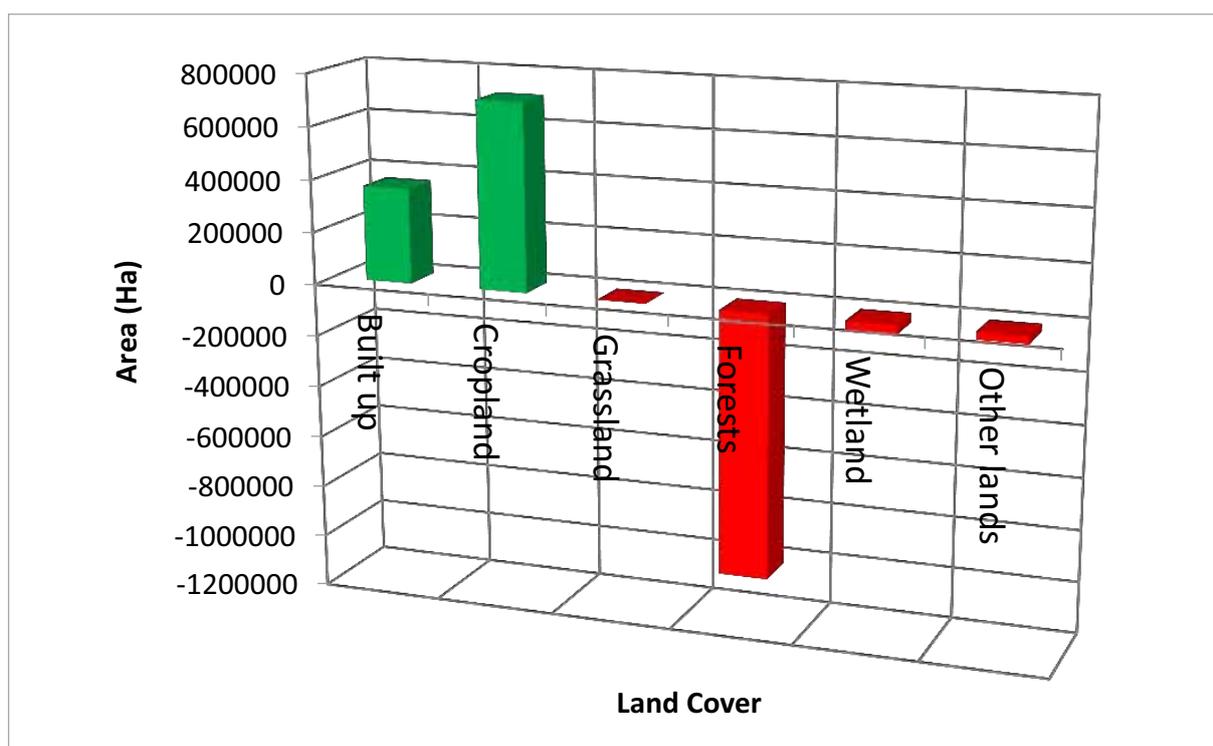


Figure 6: Loss and gains to land cover stocks for the 2010 to 2015 period

The land cover changes were compared at provincial levels as well. Figure 7 below outlines the changes for the 2000-2015 periods. The tables of land cover change for all provinces for the years 2000, 2010 and 2020 are found in the Annex.

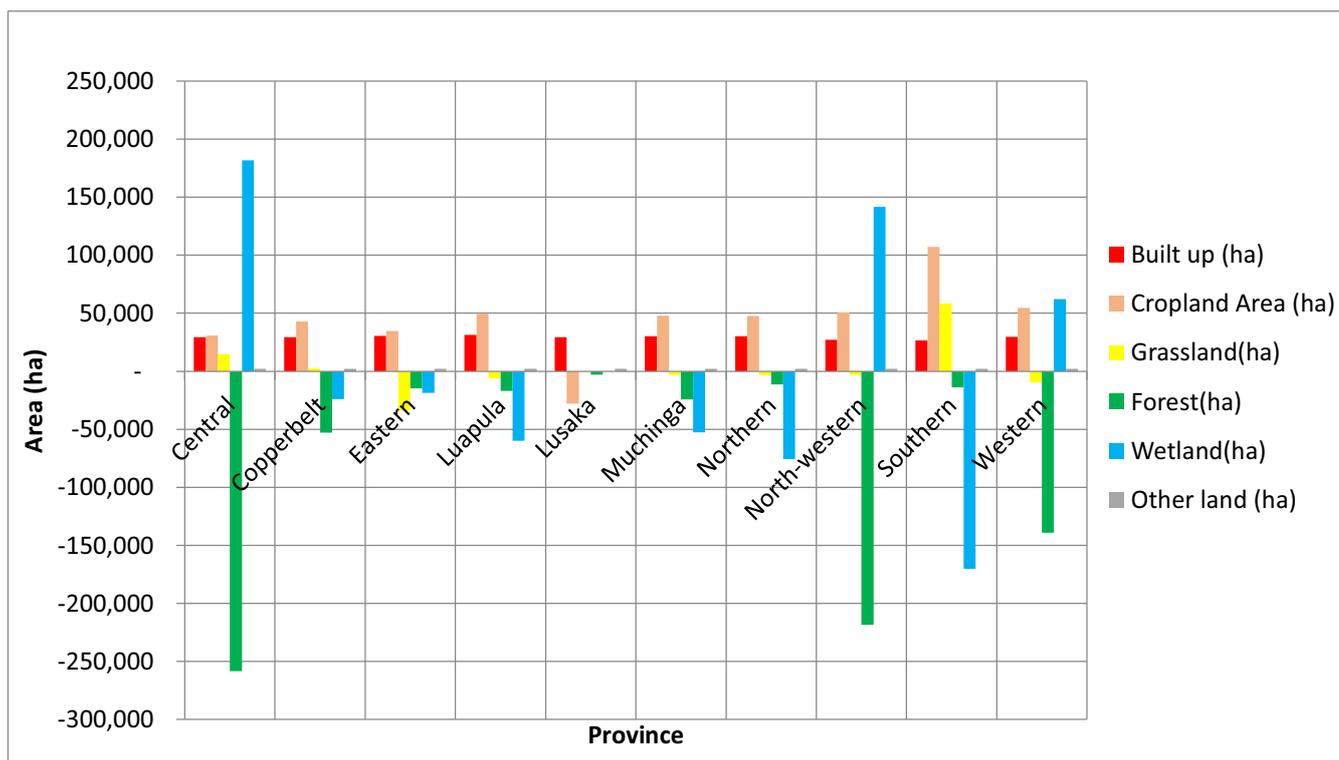


Figure 7: Loss and Gains to land cover for the 2010-2015 periods, at provincial level

At provincial level, there was reduction in forested land for all the ten provinces. In addition, there was increase of built up areas for all the 10 provinces, mostly at the expense of forest. However, in the Lusaka province the increase in built up area was at the expense of cropland. The central province had the greatest reduction in forested land. There was variation in wetlands, with increase in the Western, Central and Northwestern provinces, which can be attributed to changes in seasonal rainfall, while there was a large decrease in wetlands (-170,000 ha) in the Southern province coinciding with increases in cropland and grassland.

An aerial photograph of a river delta, showing a large body of water branching into several smaller channels. The image is partially covered by a semi-transparent green rectangular overlay.

4.0

Relation to policy

4.0 Relation to policy

The following sections examine how the land accounts may be used in national developing planning, land management and the monitoring of the United Nation's Sustainable Development Goals (SDGs).

4.1 National development planning

The land accounts are relatively recent and are only just beginning to inform policy and management of land in Zambia. That said, it is envisaged that the accounts will inform and drive the government policy, direction, and agenda on enhancing land productivity, agricultural expansion, urban and rural development planning, and reducing deforestation. The land accounts may be linked to pillars 1, 2, 4, and 5 of the Zambian Seventh National Development Plan (7NDP). Specifically, the land account has generated data that will help to understand the following issues:

- The interactions between natural and human-induced land cover changes.
- Data on competing land uses (e.g. agricultural development at the expense of natural resources conservation). This will be derived from the noticed changes on cropland cover, which is expanding at the expense of the natural resources land cover, particularly forests.
- Baseline data for development planning and hence well-planned national development programs.

In terms of ecologic and environmental issues, the land account will provide baseline data on how the land resource plays a role in the following issues:

- Environmental and Natural Resources Management and the role of Forests, Water, Wetlands and other natural resources in the production of ecosystem services and how these services may be quantified via ecosystem accounting and their value to industry determined (e.g. the value of water provisioning and water purification services from forests to the water supply industry)
- Sustainable Agricultural practices, in view of understanding the quantities and location of land utilized for agriculture and how the condition of agricultural land changes over time depending on management
- Zambia's implementation of REDD+ strategy for sustainable forestry
- Adaptation and mitigation of climate change impacts, in view of understanding periodic land cover changes. For example, the land accounts could also provide the platform for generating information on the production of ecosystem services and carbon sequestration which could potentially be sold into international markets

4.2 Impact on United Nations' Sustainable Development Goals (SDGs)

The table below summarizes some of the uses of the land accounts of Zambia, and land accounting more generally, relate to the SDGs.

Table 4: How land accounts may impact on national policy and the SDGs

Aspect of Land	Use land accounts to;	To address SDGs	Indicators
Land cover, Land use, and change	Distinguish urban and rural areas	Goal 1: No poverty	1.1.1 Poverty (by urban/rural)
		Goal 4: Quality education and public awareness	Indicators by location
	Distinguish fresh water areas	Goal 6: Clean water and sanitation	Indicators by location
		Goal 9: Industry, innovation and infrastructure	9.1.1 Population with access to clean water
	Provide details in urban and rural areas	Goal 11: Sustainable cities and communities	11.1.1 Urban population living in slums
			11.3.1 Land consumption rate
			11.7.1 Urban open space for public consumption
	Distinguish forest areas	Goal 15: Life on land	15.1.1 Forest area share of total land area
15.2.1 Sustainable forest management			
15.2.2 Net permanent forest loss			
Distinguish degraded land	Goal 15: Life on land	15.3.1 Proportion of land that is degraded	
Distinguish agricultural areas	Goal 2: Zero hunger	2.3.2 Income of small scale farmers	
		2.4.1 Productive and sustainable agriculture	
Land ownership	Agree on land tenure (state and customary land)	Goal 1: No poverty	1.4.2 Land tenure rights
		Goal 5: Gender equality	5.a.1 Rights over agricultural land

Ref: Statistics Canada, 2013. *Human Activity and the Environment: Measuring Ecosystem Goods and Services 2013*. 16-201-XWE. Ottawa: Government of Canada

The land account will help ensure adherence to the United Nations Sustainable Development Goals (SDG) 2030 as follows.

- Life on Land (SDG Goal 15)
 - o The Land account provides the area of different land covers for each accounting period. The quantitative land cover data will stimulate discussion on the conservation of wildlife, possible use of land for tourism and the management of forestry and agriculture practices.
- Climate action (SDG Goal 13)
 - o Periodic land cover maps help in integrating climate change measures into national policies, strategies, and planning. For Zambia, the results from land cover maps, which are showing negative changes in forestry, are used to generate REDD+ implementation strategies.

- Sustainable cities and communities (SDG Goal 11)
 - o The Land account will help to monitor access for all to adequate, safe, and affordable services from the land resource, in view of massive conversion of the customary land to state land.

4.3 Land ownership, distribution, and environmental sustainability

Zambia's land ownership is divided into two major categories; the vast rural land held under customary tenure and the urbanized land under state land. The rural land is where most forests, cropland, wetlands, and grassland are located. The land account has outlined that the forests, cropland, and urban areas are the most rapidly changing, whereby forests are reducing, and cropland and urban areas are rapidly increasing in spatial size. Hence most land cover changes are taking place in customary land space.



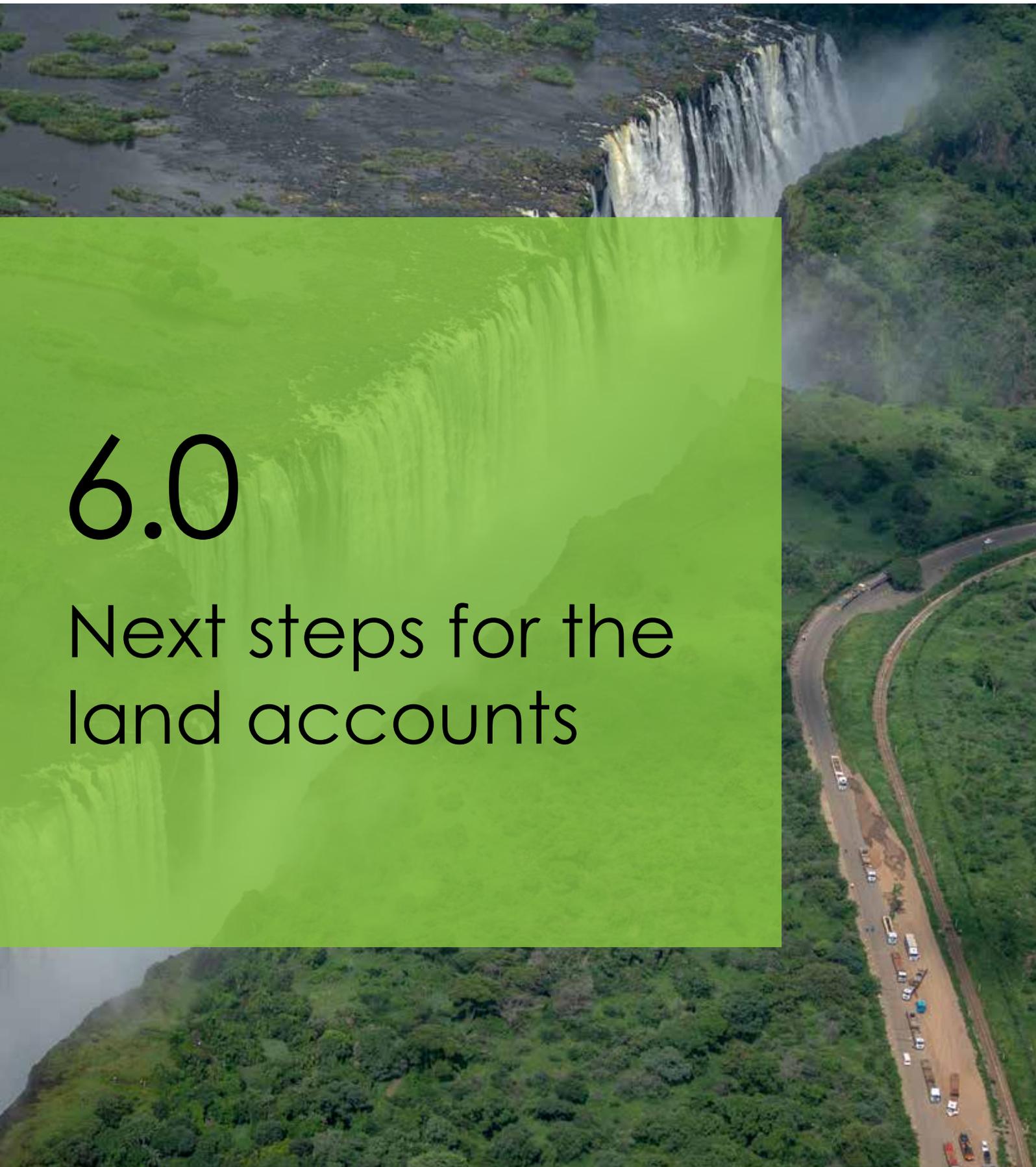
5.0

Discussion

5.0 Discussion

5.1 Data quality and needs assessment

The mapping and spatial data for compiling the Land Account were obtained through image processing of Landsat satellite images of the different periods. The multiple sources of data make data quality assessment difficult, considering that the data derivation protocols, and quality controls for each data set are different. This has been addressed by including all data providers in the generation of the spatial data sets used in the accounts and via review of the accounts by nationally and internationally. In the future, land cover datasets should be generated from one reliable source and have appropriate data quality assurance processes for each of the data sources used.



6.0

Next steps for the land accounts

6.0 Next steps for the land accounts

The land account has outlined the rapid change around forests, cropland, and urban areas. Forests are reducing, at the expense of cropland and urban areas, which are rapidly increasing in size. Land cover is related to land use, but they are not necessarily the same. For example, a grassland (a land cover) may be used to graze cattle or be a national park (a land use). In addition, most land cover changes are taking place in customary land space, which is one of the two major land tenure categories in Zambia, the other one being state land.

There is need to have comprehensive data on rural-to-urban (customary-to-state) conversion rates. Hence the priority for next iterations should be on deriving land tenure and land use accounts. The other task would be to develop monetary land accounts which would show the monetary values of land, using both land cover and land use categories.

The land account provides baseline data for ecosystem accounting, whereby the land cover types are a proxy for ecosystems. The six land cover types used were those used for UNFCCC greenhouse gas reporting. A more detailed classification of ecosystems (i.e. more than the six categories used) would probably be needed for ecosystem accounting to inform provincial level land management decisions. Even without this extension the existing accounts and

supporting data could be combined with other tools to develop accounts for ecosystem services. These accounts would then be useful for identifying areas important for households as well as areas with commercial potential and areas for the ecotourism, carbon sequestration, water provisioning and water filtration.

Moving forward, the Land account has embarked on generating subsequent data for the recent 2018 period. The data has been compiled at national and provincial level but look forward to compiling a subsequent account at district level.

This being the first land account for Zambia, the challenges faced, especially those concerned with data collection and processing, taught the Technical Working Group valuable lessons on how to conduct land accounting. The TWG have particularly learnt that land accounting is timely and efficiently conducted using spatial data and attributes derived through satellite imagery and Geographic Information Systems (GIS). Hence, it is expected that the authorities responsible for Natural Capital Accounting spearhead mobilize of resources that will enable regular spatial data collection, processing and compilation into periodic land and other natural resources accounts.



7.0

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7.0 References

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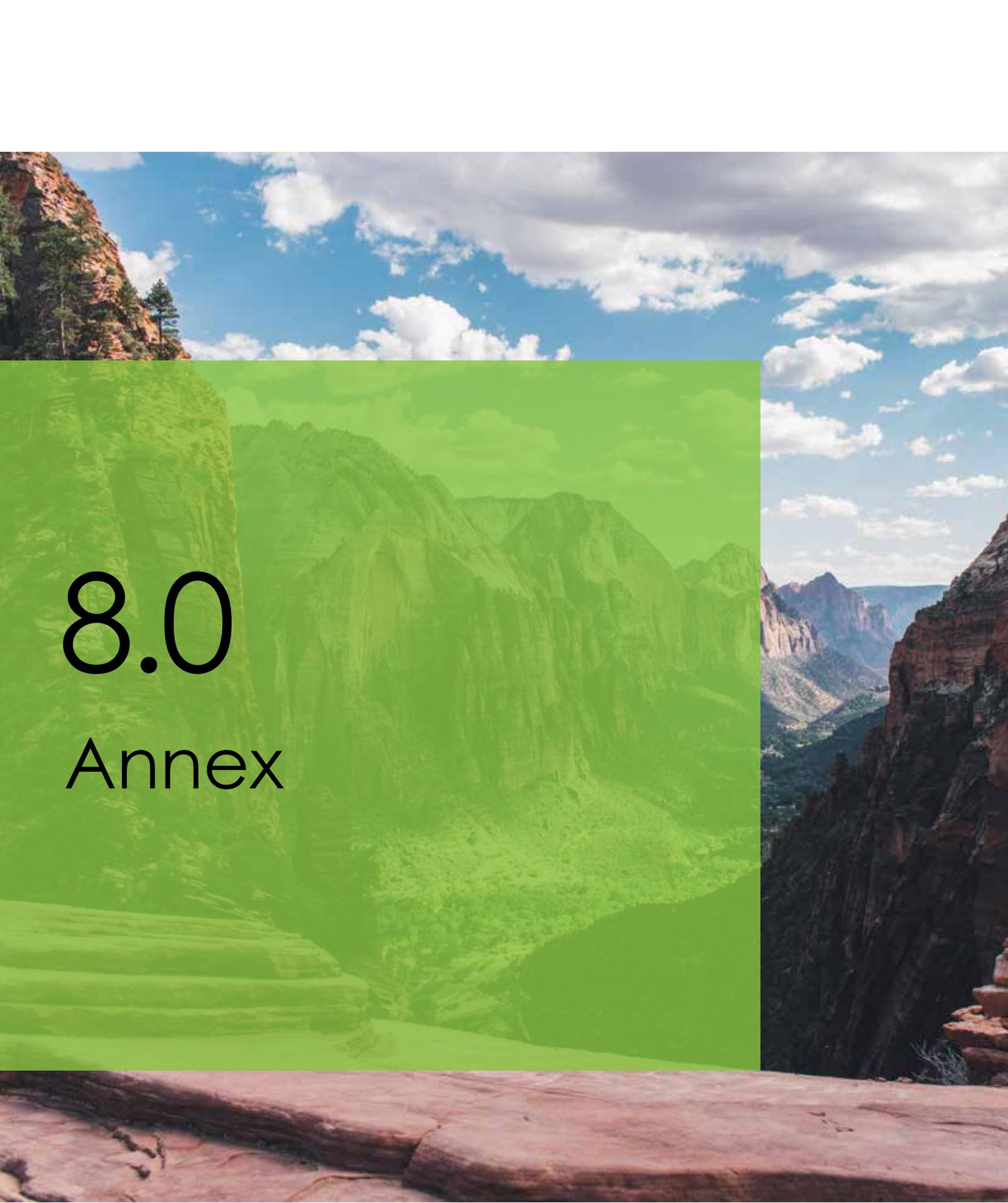
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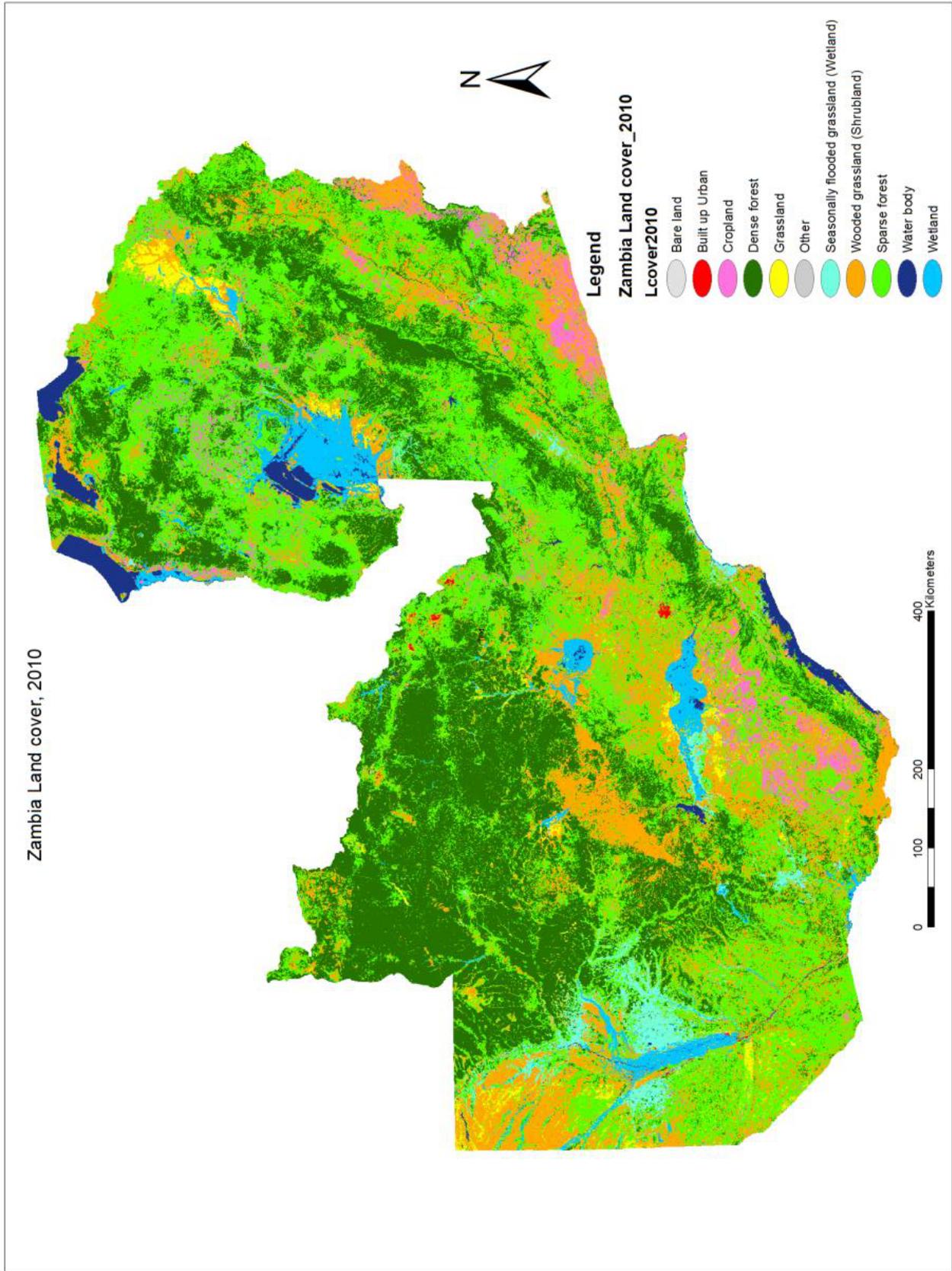
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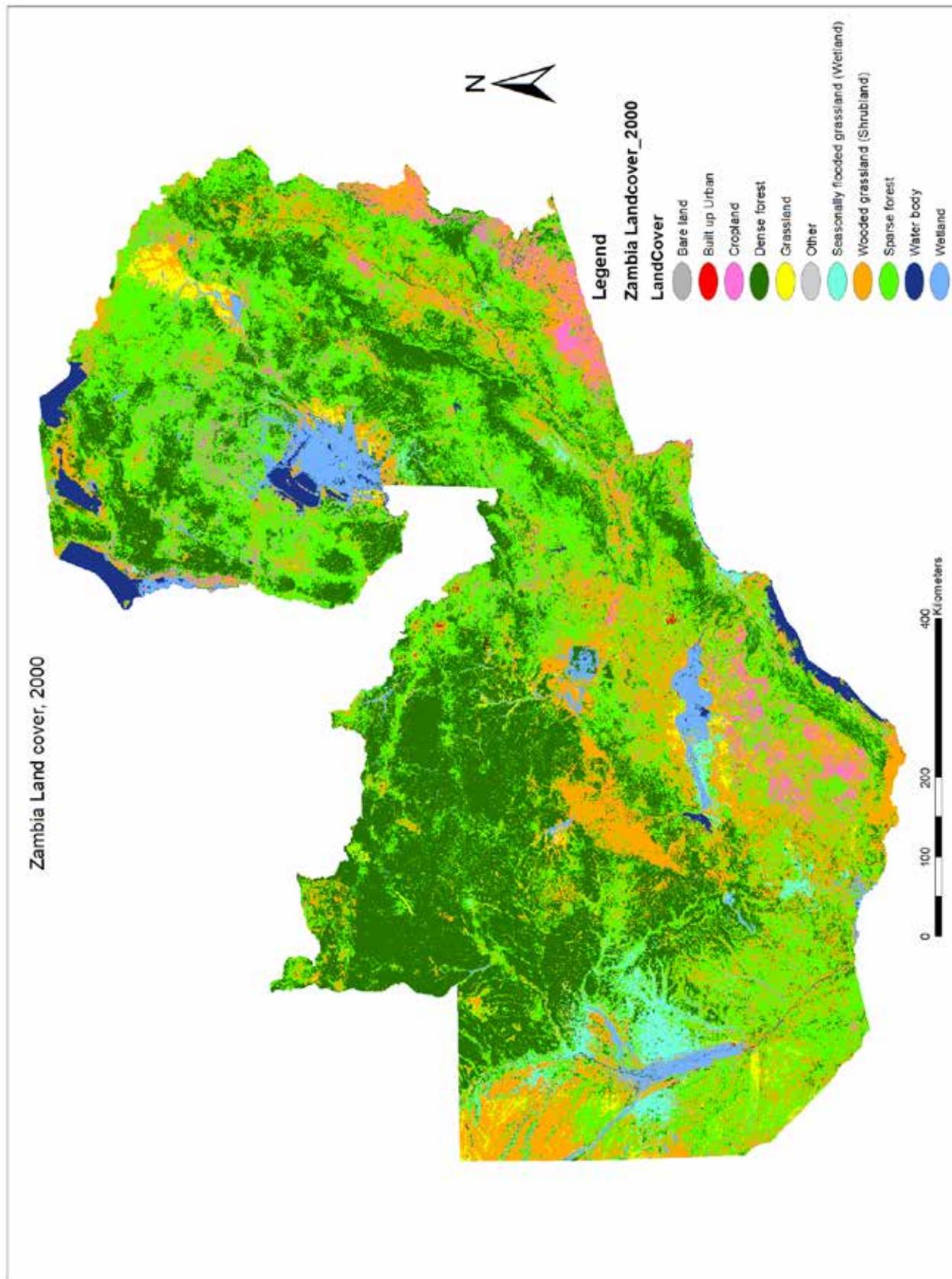
8.0

Annex

8.1 Land cover 2010



8.2 Land cover 2000



8.3 Change matrix for 2010 to 2015

Land cover	Opening Stock_2010(Ha)	Built up	Cropland	Grassland	Forests	Wetlands	Other lands	Closing Stock_2015(Ha)	Gain(+)_Loss(-)
Built up	208346				364,000			572,346	364,000
Cropland	6745080			36,000	680,000			7,461,080	716,000
Grassland	16375028		36,000			27,000	7,000	16,373,028	2,000
Forests	46696174	364,000	680,000			9,000	23,000	45,684,174	1,012,000
Wetland	5092781			27,000	9,000			5,056,781	36,000
Other lands	143991			7,000	23,000			113,991	30,000
Total	75261400							75,261,400	-

8.4 Change matrix for 2000 to 2015

Land cover	Opening Stock_2000(Ha)	Built up	Cropland	Grassland	Forests	Wetlands	Other lands	Closing Stock_2015(Ha)	Gain(+)_Loss(-)
Built up	137,245				435,101			572,346	435,101
Cropland	6,466,555			59,652	934,873			7,461,080	994,525
Grassland	16,426,337		59,652			15,309	97,652	16,373,028	53,309
Forests	47,054,148	435,101	934,873					45,684,174	1,369,974
Wetland	5,041,472			15,309			30,618	5,056,781	15,309
Other lands	135,643			97,652		30,618		113,991	21,652
Total	75,261,400							75,261,400	-

8.5 Map of Land cover changes: 2007/2010 (green forest vegetation) to 2015
(forest cleared to bare grounds; red)



**De-Gazetted Forest Reserve,
2007 (Green), 2015 (Red).
Source: SMIFM Project, Tool 2**

8.6 Provincial land cover accounts, 2015

2015							
	Built up	Cropland	Grassland	Forest	Wetland	Other land	Total (ha)
Central	54,642	1,922,366	2,366,248	5,701,471	954,208	4,009	11002944
Copperbelt	44,720	534,864	573,383	1,896,348	77,208	6,316	3132839
Eastern	43,343	1,058,636	363,508	3,599,412	24,559	8,129	5097587
Luapula	46,231	461,644	838,800	3,269,517	434,426	6,290	5056908
Lusaka	44,651	459,080	611,473	1,409,189	21,023	5,329	2550745
Muchinga	44,098	592,434	970,021	6,359,200	704378	10,465	8680596
Northern	43,955	748,691	1,848,767	4,277,891	756,745	6,699	7682748
North-western	54,701	283,015	2,788,981	8,833,712	589,098	33,130	12582637
Southern	85,464	930,931	1,423,026	3,756,345	635,322	4,728	6835816
Western	39,853	191,235	4,605,976	6,840,231	880,659	80,626	12638580
TOTAL	501658	7182896	16390183	45943316	5077626	165721	75261400
2015(%)	0.67	9.54	21.78	61.04	6.75	0.22	100.00

8.7 Provincial land cover accounts, 2010

2010							
	Built up (ha)	Cropland Area (ha)	Grassland Area (ha)	Forest (ha)	Wetland (ha)	Other land (ha)	Total land Area (ha)
Central	25,435	1,891,666	2,351,527	5,959,915	772,565	1,836	11,002,944
Copperbelt	15,291	491,939	571,108	1,949,123	101,234	4,144	3,132,839
Eastern	12,823	1,024,085	397,293	3,614,115	43,314	5,956	5,097,586
Luapula	15,049	411,971	845,027	3,286,495	494,249	4,117	5,056,908
Lusaka	15,211	486,921	612,201	1,412,234	21,023	3,155	2,550,745
Muchinga	13,946	544,621	973,358	6,383,372	757,007	8,292	8,680,596
Northern	13,784	701,041	1,851,960	4,289,187	832,250	4,526	7,692,748
Northwestern	27,691	232,291	2,792,084	9,052,223	447,388	30,960	12,582,637
Southern	58,907	823,943	1,364,844	3,770,178	805,391	2,553	6,825,816
Western	10,209	136,602	4,615,624	6,979,332	818,360	78,453	12,638,580
TOTAL	208,346	6,745,080	16,375,026	46,696,174	5,092,781	143,992	75,261,399
2010(%)	0.28	8.96	21.76	62.05	6.77	0.19	100.00

8.8 Provincial land cover accounts, 2000

	2000						
	Built up (ha)	Cropland Area (ha)	Grassland Area (ha)	Forest (ha)	Wetland (ha)	Other land (ha)	Total land Area (ha)
Central	18,201	1,849,733	2,237,988	6,123,456	772,565	1,001	11,002,944
Copperbelt	8,278	462,230	538,826	2,018,962	101,234	3,309	3,132,839
Eastern	6,902	986,001	443,028	3,613,221	43,314	5,121	5,097,587
Luapula	9,790	389,010	854,906	3,305,671	494,249	3,282	5,056,908
Lusaka	8,210	460,202	643,077	1,415,912	21,023	2,321	2,550,745
Muchinga	7,657	519,800	999,027	6,389,648	757,007	7,457	8,680,596
Northern	7,513	676,057	1,895,048	4,298,113	802,325	3,692	7,682,748
North-western	18,259	210,381	2,760,652	9,115,834	447,388	30,123	12,582,637
Southern	49,023	794,541	1,403,843	3,781,349	805,341	1,719	6,835,816
Western	3,412	118,600	4,649,942	6,991,982	797,026	77,618	12,638,580
TOTAL	137,245	6,466,555	16,426,337	47,054,148	5,041,472	135,643	75,261,400
2000(%)	0.18	8.59	21.83	62.52	6.70	0.18	100.00

8.9 Error matrix and Accuracy summary (for Field verification of office interpreted maps for 2010 and 2015)

Field Verified (Reference) Data							
Classified (Office) Data	Forestland	Grassland	Cropland	Wetland	Settlement	Otherland	Total
Forestland	1099	72	52	13	0	0	1236
Grassland	63	480	34	20	0	0	597
Cropland	67	45	337	0	5	1	455
Wetland	6	4	2	327	0	0	339
Settlement	0	0	1	1	56	0	58
Otherland	0	2	0	0	0	13	15
Total	1235	605	426	361	61	14	2703

Accuracy calculation template

Class Name	Reference Totals	Classified Totals	Number Correct	Producer Accuracy	User
					Accuracy
Forestland	1236	1236	1099	88.92%	88.92%
Grassland	605	597	480	79.34%	80.4%
Cropland	426	455	337	79.11%	74.07%
Wetland	361	339	327	90.58%	96.46%
Settlement	61	58	56	91.8%	96.55%
Otherland	14	15	13	92.86%	86.67%
Totals	2307	2307	2312		
Overall Classification Accuracy = 85.53%					

Where:

- **Producer Accuracy** is determined by the percentage of correctly interpreted points (Number Correct Points NCP) in relation with the total number of reference (field verified) points (RP) $((NCP/RP) * 100)$.
- **User Accuracy** is determined by the percentage of correctly interpreted points (NCP) in relation with the total number of Classified points (CP) $((NCP/CP) * 100)$
- **Total Accuracy** is determined by the percentage of Total number of correctly classified points (TCCP) in relation with the Total number of classified points $((TCCP/TCP) * 100)$





