REPUBLIC OF ZAMBIA

# NATURAL CAPITAL ACCOUNTS FOR LAND, 2018-2021:

## TECHNICAL REPORT

WORLD BANK GROUP

GPS Global Program on Sustainability

WAVES

The Zambia Natural Capital Accounts for Land, covering the period 2018 – 2021 were produced by the National Remote Sensing Centre (NRSC) and the Ministry of Lands and Natural Resources (MLNR) in collaboration with the Ministry of Finance and National Planning (MoFNP) with assistance from the World Bank and the Global Program on Sustainability (GPS). Further information on the land account may be obtained from the addresses below:

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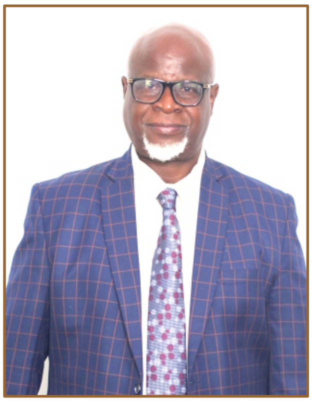
# Foreword



This report presents the second Land account for the Republic of Zambia. The accounts are based on the System of Environmental-Economic Accounting (SEEA), where land is defined as a unique environmental asset that demarcates the space in which economic activities and environmental processes occur and within which environmental assets and economic assets are found. The land account presents the changes in land cover over time and differentiates between land cover classes such as water, trees, flooded vegetation, crops, built area, bare grounds and rangeland.

Therefore, it is pleasing to note that Zambia remains an active member of the Wealth Accounting and Valuation of Ecosystem Services global programme (WAVES) and its successor the Global Program on Sustainability (GPS) both led by the World Bank, and continues to update and develop natural capital accounts. This is encapsulated by the updated Land account for Zambia, which continues to follow the System of Environmental-Economic Accounting (SEEA) for Land.

One of the key results from the updated Land account is that trees (forests) continued to reduce between 2018 and 2021, decreasing from 41,002,568.01 hectares (55.28% of national coverage) to 39,723,590.76 hectares (53.55%). On the other hand, built-up and crop areas increased from 332,193.95 hectares and 2,571,702.10 hectares to 405,259.58 hectares and 2,809,215.78 hectares, respectively.

The policy relevance of the Land account is that it enhances the nation's capability to monitor and understand a continuously changing land space, hence understanding the dynamic of competing land use categories. The Land account will directly influence the Strategic Development Area of Environmental Sustainability in the Zambian Eighth National Development Plan (8NDP). Specifically, the Land account will provide information on the strategy to enhance natural resources management, which aims to reduce deforestation rates from 172,000 hectares per annum in 2021 to 120,000 hectares in 2026. The Land accounts shall continue to be a source of information for the current and future national plans by providing timely information on land use and land cover change and the status of various ecosystem services. Future land accounts 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. Furthermore, future land accounts could be localized to the different provinces found in Zambia.

Hon. Situmbeko Musokotwane
**Minister of Finance and National Planning**

Hon. Elijah Muchima
**Minister of Lands and Natural Resources**

# Foreword

The development of the second iteration of the Land Accounts for Zambia in addition to the Forest, Tourism, and Water Accounts is noteworthy, as it shows the country's continued commitment to Natural Capital Accounting (NCA) as a tool to achieving sustainable economic growth.

Land as an essential finite natural resource is a fundamental life support system that has competing uses as the population grows and urbanizes, and agricultural production continues to expand. The report brings attention to the impacts of climate change and demographic pressures that are negatively affecting land cover; forests, wetlands, and agricultural lands and reducing Zambia's ability to manage weather shocks such as a low rainfall season experienced in 2019.

Globally, efforts are being made to increase awareness of the effects of climate change and human activity on land degradation and deforestation through initiatives such as the United Nations (UN) Sustainable Development Goals (SDG). The findings from the land accounts will inform the general public, and policy makers as they develop strategies to achieve the targets set in SDG 15 *"Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss."* Now that Zambia can update the land cover accounts at national level annually, this will enhance the development of mitigation and adaptation policies related to climate change.

We wish to acknowledge the implementing institutions; Ministry of Lands and Natural Resources (MLNR), National Remote Sensing Centre, Ministry of Water Development and Sanitation (MWDS), Ministry of Tourism (MoT), Zambia Statistics Agency (ZamStats), University of Zambia (UNZA), Copperbelt University (CBU) and the program coordinators under the Ministry of Finance and National Planning (MoFNP) and for their dedication to building Zambia's natural capital accounts.

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**Practice Manager for Environment, Natural Resources & Blue Economy**
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# Acknowledgements

The work presented in this report would not have been possible without the dedicated effort of the Zambia WAVES Land Account Technical Working group that consisted of the following members; Michael Katongo Phiri, Lusekelo Kasunga and Chenje Prassat Mtonga from the National Remote Sensing Centre (NRSC), and Samuel Chembe Maango, of the Ministry of Mines. These officials used satellite-derived land cover products to conduct a land cover change analysis, the results of which were used to compile the second 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, and Charles Chisanga of the Copperbelt University who provided technical input.

Special mention is made of the Ministry of Finance and National Planning led by the Permanent Secretary-Monitoring and Evaluation Mr. Trevour Kaunda, Director of Development Planning, Mrs. Mwaka Mukubesa, Richard Lungu (Zambia WAVES National Focal Person), Stanley Nkhuwa and Brian Musonda from the Ministry of Finance and National Planning for their strategic oversight and coordinating the various activities that made it possible to develop and update 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 Ngao Mubanga, Rebbeca Naomi Munsanda Ngulube and Prof. Lloyd Ching'ambo. Furthermore, the data supplied by the various stakeholder institutions were key in the compilation of the reports. These comprised the National Remote Sensing Centre, Forest Department, Ministry of Mines, 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 reviewer from the World Bank; Michael Vardon and feedback received from various local experts and stakeholder institutions that helped to shape the report.

Ms. Daphne Chabu
**Permanent Secretary Ministry of Lands and Natural Resources**

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**Permanent Secretary**
**Ministry of Finance and National Planning - Monitoring and Evaluation**

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# Executive Summary

This report presents the second Land account for the Republic of Zambia based on the methodology of the System of Environmental-Economic Accounting (SEEA), which defines land as a unique environmental asset that outlines the space in which economic activities and environmental processes occur and within which environmental assets and economic assets are found. The Land account presents a time series of land cover change and discerns the main land cover classes in Zambia such as water, trees, flooded vegetation, crops, built area, bare grounds and rangeland.

To policy, the relevance of the Land account is that it enables monitoring and provides an understanding of land cover change in Zambia from 2018 to 2021, which is crucial for spatial planning at both national and sub-national levels. It also provides the platform for the development and improvement of other SEEA accounts such as ecosystem extent accounts, ecosystem services supply and use accounts, 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 utilized the System of Environmental-Economic Accounting Central Framework (SEEA-CF) to develop and update the Land account for Zambia. Distinctively, the TWG used the available maps and related spatial data sets to update the Land Account. The maps and attribute data have been obtained from various global, national and regional data sources. Land cover data produced by Impact Observatory, Microsft and Environmental Systems Research Institute (ESRI) were the main data sets and information for the Land Account.

One of the key results from the updated Land account was that trees (forests) had a net reduction between 2018 and 2021, decreasing from 41,002,568.01 hectares (55.28% of national coverage) to 39,723,590.76 hectares (53.55%). On the other hand, built-up areas and crops increased from 332,193.95 hectares and 2,571,702.10 hectares to 405,259.58 hectares and 2,809,215.78 hectares, respectively.

The Land account will directly influence the Strategic Development Area of Environmental Sustainability in the Zambian Eighth National Development Plan (8NDP). Particularly, the Land account advises and drives government policy, direction, and agenda on enhancing land productivity, agricultural expansion, and urban and rural development planning. The Land account aids in understanding the relationships between natural and anthropogenic land cover changes, which impact environmental sustainability. In the future the Land account could provide information on competing uses of land and the two major land tenure categories of Zambia; customary and state land.

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

# 1.0 Introduction

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The Republic of Zambia is a landlocked Southern African country that is 752,614,000 million hectares in size. The country is bordered by Angola, Botswana, Democratic Republic of Congo, Malawi, Mozambique, Namibia, Tanzania and Zimbabwe. Zambia is divided into ten provinces and these are the Central, Copperbelt, Eastern, Luapula, Lusaka, Muchinga, Northern, North-western, Southern and Western Provinces. The capital city is Lusaka. The population of Zambia was estimated to be 17,885,422 in 2020 and is projected to reach 26,923,658 by 2035 (CSO, 2013). The Gross Domestic Product (GDP) stood at approximately 18.11 billion United States Dollars and the growth rate was -2.8% (World Bank Group, 2022).

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 cultural, provisional and regulatory ecosystem services such as carbon sequestration, food and water supply and ecosystem services, which are not explicitly recognized in national accounts. Hence, Zambia embarked on producing natural capital accounts. The first three accounts were:

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

Three new accounts have been developed and these include:

- Accounts to support nature-based tourism, which focuses on biodiversity;
- Energy account, with a focus on energy production and consumption; and
- Mining account, which focuses on mineral extraction and reserves.

Zambia has also updated the first three accounts for land, water and forests. This report presents the updated land account based on the principles and methodologies of the System of Environmental-Economic Accounting (SEEA) (UN, European Commission, FAO, IMF, OECD, World Bank, 2014). In the SEEA (UN, European Commission, FAO, IMF, OECD, World Bank, 2014). In the SEEA, land is defined as a unique environmental asset that demarcates the space in which economic activities and environmental processes occur and within which environmental assets and economic assets are found. The first iteration of the land account was for the years 2000, 2010 and 2015. The new iteration covers the years 2017 to 2021 and it gives land cover change information that is important for spatial planning. The land account also provides a foundation on which other accounts, and especially ecosystem accounts, can be created.

# 2.0 Methodology, concepts and data sources

# 2.0 Methodology, concepts and data sources

The following tools, concepts, methods, components, and data sets were used to compile the land account:

- **Land cover**
  - The account was created using the Sentinel-2 10-meter Land Cover/Land Use (LULC) time-series data (2017-2021) produced by Impact Observatory, Microsoft and Environmental Systems Research Institute (ESRI).
- **The SEEA**
  - Provided the concepts and methods needed to arrange the data from satellite imagery and land cover maps into accounts.

## 2.1 Sources of Data

The land cover/land use imagery was downloaded from the ArcGIS website (ESRI) using the Sentinel-2 10-meter Land Use/Land Cover time-series downloader. It is a global dataset and is available under a Creative Commons BY-4.0 license.
The dataset has 11 classes of land cover/land use (LULC) (Table 1) and is available for each year from 2017 to 2021. All the years were generated using the Impact Observatory deep learning Artificial Intelligence land classification model which utilized billions of human-labelled image pixels developed by the National Geographic Society(ESRI, 2022).

Ancillary data was collected from the Zambia Statistical Agency, (ZamStat), the National Remote Sensing Centre and the Ministry of Lands and Natural Resources.

## 2.2 Compilation of Sentinel 2 10-meter LULC

The maps were produced using a deep learning model which was trained by over five billion hand-labelled Sentinel-2 pixels that were sampled from over twenty thousand locations distributed through all the major biomes of the world (ESRI, 2022). The model made use of six Sentinel-2 surface reflectance bands and these are the blue, green, red, near-infrared (NIR) and two shortwave bands. The model was run across multiple dates within each year. The resulting maps were 10 meters in spatial resolution and were projected in Universal Transverse Mercator (UTM). The datasets had 9 classes and these are described in Table 1 below(ESRI, 2022).

## 2.3 LULC Change Detection Analysis

The initial year of the dataset was 2017. However, the 2017 map was not accurate as it was derived from fewer images (ESRI, 2022). Therefore, the results of 2017 were excluded from the time series and only the data from 2018 to 2021 were used. Land Use/Land Cover change detection was performed using the post-classification tools of the Semi-Automatic Classification plugin of QGIS. Each preceding year served as the initial observation of the next year. The change was analysed 10-meter pixel by pixel, checking each initial class against the new class. Areas of consistency (areas of no change) were also included in the analysis. The results were presented in maps (Figure 1 and Annex 8.1 to 8.4), change matrices (Annex 8.5 to 8.8) and physical supply and use tables.

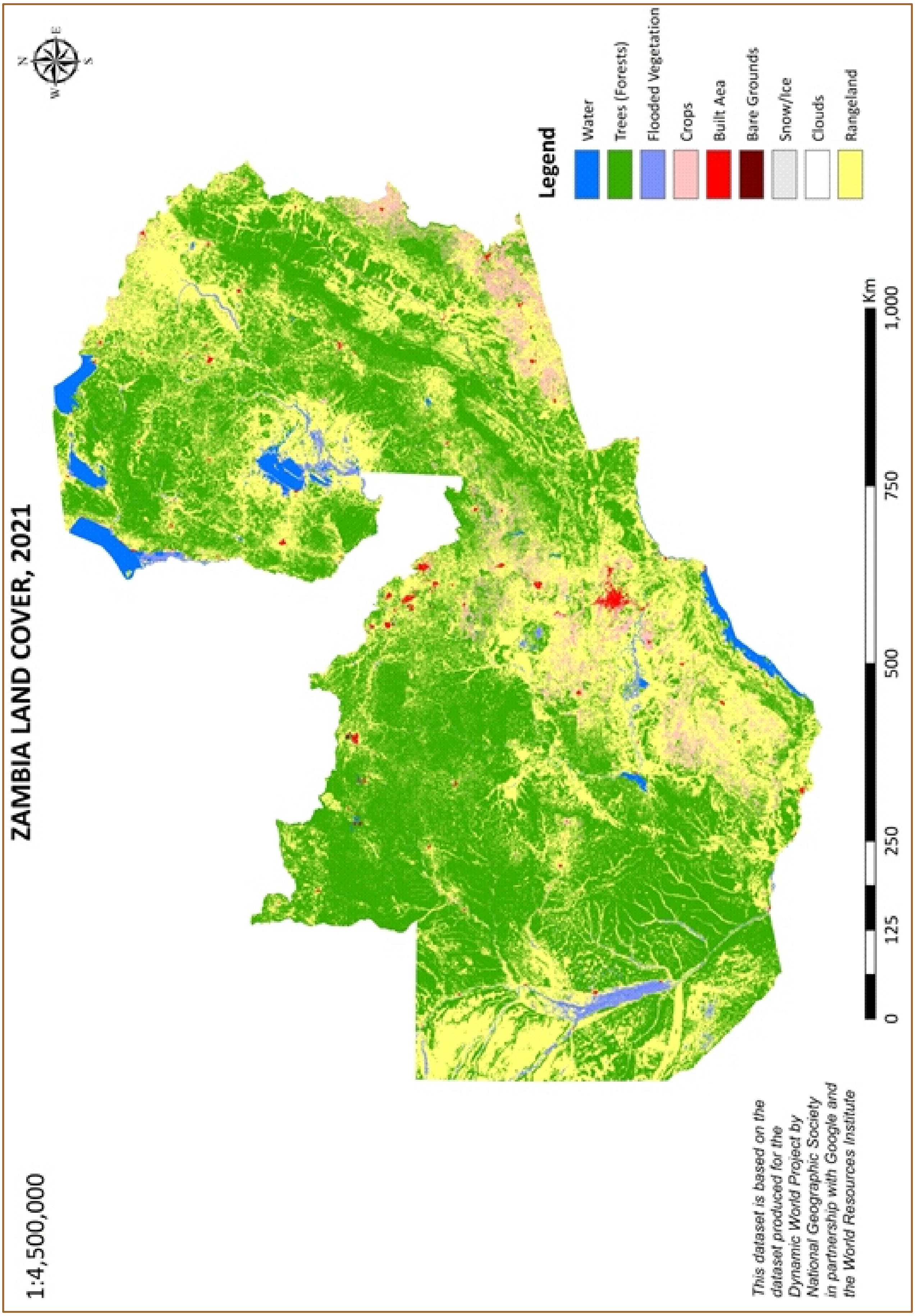



Figure 1: National Land cover Map of Zambia for 2021

[1]Sentinel-2 10m Land Use/Land Cover Timeseries Downloader: https://www.arcgis.com/apps/instant/media/index.html?appid=fc92d38533d440078f17678ebc20e8e2

**Table 1:** Description of land use/land cover classes of the Sentinel-2 10-meter Land Cover/Land Use (LULC) time-series data

| Land Cover | Code | Description |
|---|---|---|
| Water | 1 | Areas where water was predominantly present throughout the year; may not cover areas with sporadic or ephemeral water; contains little to no sparse vegetation, no rock outcrops or built-up features like docks; examples: rivers, ponds, lakes, oceans, and flooded salt plains. |
| Trees | 2 | Any significant clustering of tall (~15-m or higher) dense vegetation, typically with a closed or dense canopy; examples: wooded vegetation, clusters of dense tall vegetation within savannas, plantations, swamps or mangroves (dense/tall vegetation with ephemeral water or canopy too thick to detect water underneath). |
| Flooded vegetation | 4 | Areas of any type of vegetation with obvious intermixing of water throughout a majority of the year; seasonally flooded area that is a mix of grass/shrub/trees/bare ground; examples: flooded mangroves, emergent vegetation, rice paddies and other heavily irrigated and inundated agriculture. |
| Crops | 5 | Human-planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land. |
| Built area | 7 | Human-made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings and residential housing; examples: houses, dense villages/towns/cities, paved roads, asphalt. |
| Bare grounds | 8 | Areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation; examples: exposed rock or soil, desert and dunes, dry salt flats/pans, dried lake beds, mines. |
| Snow/Ice | 9 | Large homogenous areas of permanent snow or ice, typically only in mountain areas or highest latitudes; examples: glaciers, permanent snowpack, and snow fields. |
| Clouds | 10 | No land cover information due to persistent cloud cover. |
| Rangeland | 11 | Open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting (i.e., not a plotted field); examples: natural meadows and fields with sparse to no tree cover, open savanna with few to no trees, parks/golf courses/lawns, pastures. A mix of small clusters of plants or single plants dispersed on a landscape that shows exposed soil or rock; scrub-filled clearings within dense forests that are not taller than trees; examples: moderate to a sparse cover of bushes, shrubs and tufts of grass, savannas with very sparse grasses, trees or other plants. |

### 2.4 Limitations and possible issues

It should be noted that the results of the analysis totalled 74,176,989.84 hectares which were 1,084,410.16 hectares short of the 75,261,400 hectares that cover Zambia. The deficit represented 1.44% of the total area of Zambia. The reasons for this discrepancy are being investigated and could result from a variety of factors. For instance, there could have been a loss of data during the processes of reprojection, mosaicking, clipping and land cover change analysis. Another factor could be the different vector files (polygons) used to define the border of Zambia. As an interim solution, the deficit was moved to a category named "Unclassified". It should also be noted that the class Snow/Ice was present in the maps, an occurrence that is highly unlikely in Zambia. However, this was always under 1 hectare, with the highest hectarage being 0.68 in 2020. This was deemed insignificant at both the national and provincial levels. The last point to note was the presence of the class Clouds. Similarly to Snow/Ice, the hectarage of Clouds was insignificant with the highest hectarage being 5.23 in 2018.

# 3.0 Main findings

# 3.0 Main findings

The results of the LULC change analysis for the years 2018, 2019, 2020 and 2021 are presented in tables and graphs. Table 2 presents the stocks (area) of each LULC class in hectarage and percentage, whereas Figure 2 depicts the information in a bar graph. Figure 2 also depicts the year-on-year gains and losses of each land cover category.

**Table 2:** National Land cover in hectares and percentages, derived from 2018, 2019, 2020 and 2021 land cover maps

| No. | Land Cover Class | 2018 (ha) | 2019 (ha) | 2020 (ha) | 2021 (ha) | 2018 (%) | 2019 (%) | 2020 (%) | 2021 (%) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Water | 1,377,855.22 | 1,331,444.28 | 1,386,025.39 | 1,384,530.44 | 1.83 | 1.77 | 1.84 | 1.84 |
| 2 | Trees | 41,002,568.01 | 39,017,574.48 | 38,899,290.28 | 39,723,590.76 | 54.48 | 51.84 | 51.69 | 52.78 |
| 3 | Flooded Vegetation | 970,844.19 | 598,182.77 | 800,643.46 | 988,751.23 | 1.29 | 0.79 | 1.06 | 1.31 |
| 4 | Crops | 2,571,702.10 | 3,152,100.41 | 2,971,463.34 | 2,809,215.78 | 3.42 | 4.19 | 3.95 | 3.73 |
| 5 | Built Area | 332,193.95 | 361,325.67 | 378,909.78 | 405,259.58 | 0.44 | 0.48 | 0.50 | 0.54 |
| 6 | Bare Grounds | 33,980.39 | 56,035.76 | 49,589.22 | 42,655.75 | 0.05 | 0.07 | 0.07 | 0.06 |
| 7 | Snow/Ice | 0.27 | 0.46 | 0.68 | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8 | Clouds | 5.23 | 0.21 | 1.08 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | Rangeland | 27,887,840.48 | 29,660,325.80 | 29,691,066.61 | 28,822,985.99 | 37.05 | 39.41 | 39.45 | 38.30 |
| 10 | Unclassified | 1,084,410.16 | 1,084,410.16 | 1,084,410.16 | 1,084,410.16 | 1.44 | 1.44 | 1.44 | 1.44 |
| | **TOTAL** | **75,261,400.00** | **75,261,400.00** | **75,261,400.00** | **75,261,400.00** | **100.00** | **100.00** | **100.00** | **100.00** |

Figure 2 is a bar graph showing the distribution of land cover from 2018 to 2021.

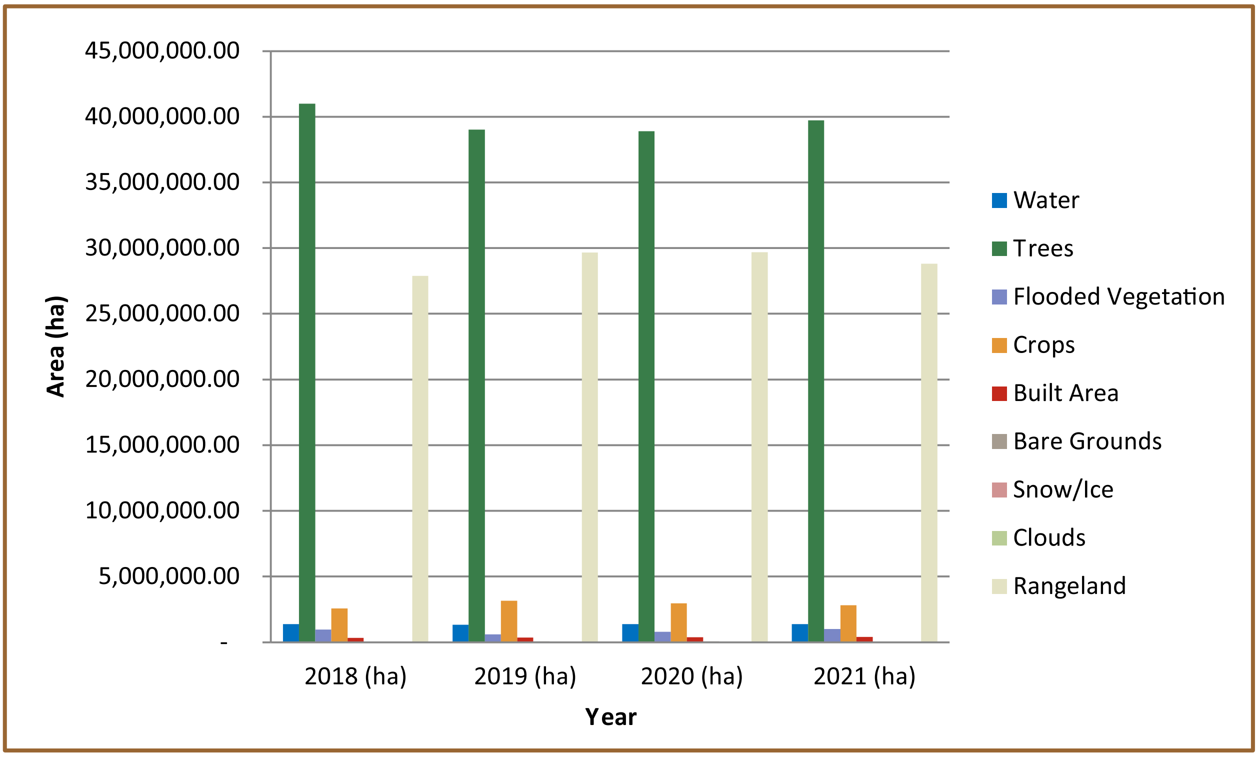



**Figure 2:** Comparison of the National land cover quantities for the period 2018 to 2021

The following were the findings of the land cover change analysis for the years 2018 to 2019. Changes in each LULC class are discussed in turn and the discussion trees are equated with forests and rangelands with grasslands:

- There was very little change in the overall area covered by water, with a small net increase between 2018 and 2021 of 6,675.22 hectares or from 1.83% to 1.84% of the total area of Zambia. The change was a result of an increase in area from the construction of new reservoirs (such as at the Kafue Lower for power generation and within major farming blocks) although there was a reduction in water due to rescinding lakes (such as the Kariba and the Bangweulu). Water gained the most cover from rangeland (possibly gorges and valleys) and flooded vegetation.

- There was a net reduction in Trees (forests) which decreased from 41,002,568.01 hectares (55.28% of national coverage) to 39,723,590.76 hectares (53.55%) between 2018 and 2021. This reduction is encapsulated by the decrease in trees within protected (national) forests over the same period. Within protected forests, trees reduced from 5,474,978.15 hectares in 2018 to 5,327,215.93 hectares in 2021. The reduction in trees in the national forests was mainly to the benefit of rangelands.

- Rangelands increased in area at the expense of forests, increasing by 3.9 million hectares from 2018 to 2019, 3.5 million hectares between 2019 and 2020, and 3.1 million between 2020 and 2021. On the other hand, forests gained the most from grassland loss, gaining above 3 million hectares each year.

- Flooded vegetation (wetland) ultimately gained hectarage between 2018 and 2021, increasing from 970,844.19 hectares (1.29% of national coverage) to 988,751.23 hectares (1.31%). However, there was a sharp drop in between the study period, with flooded vegetation standing at 598,182.77 hectares in 2019. This rose to 800,643.46 hectares in 2020. The drop in coverage could be attributed to the drought season of 2019/2020 in which Zambia received little rainfall. This may have resulted in fewer areas being inundated in water. Flooded vegetation gained and lost the most to rangeland (grasslands), which was expected as the majority of flooded vegetation in Zambia occurs with mashes and grass.

- Similar to flooded vegetation, crops ultimately increased in coverage despite an observed drop in 2020. This drop could also be attributed to the low rainfall season in 2019 in Zambia. Crops opened at 2,571,702.10 hectares (3.42 of national coverage) in 2018 and sharply increased by the close of 2019 (3,152,100.41 hectares). This was followed by a steady drop in 2020 and 2021 with the two years closing at 2,971,463.34 hectares and 2,809,215.78 hectares, respectively.

- Built area (built-up) rose steadily from 332,193.95 hectares in 2018 to 361,325.67 hectares in 2019, to 378,909.78 hectares in 2020, and to 405,259.58 hectares in 2021. This steady growth was expected as the country experienced an infrastructure boom in the last decade which resulted in the expansion of urban centres around the country.

- Bare grounds increased sharply from 33,980.39 hectares (0.05% of national cover) in 2018 to 56,035.76 (0.07%) hectares in 2019. The increase can be attributed to the increased number of bare fields resulting from a dry spell in 2019. Bare grounds reduced steadily to 49,589.22 hectares (0.07% of national cover) in 2020 and 42,655.75 hectares (0.06%) in 2021.

- Rangeland (similar to grassland in the first iteration) displayed a pattern similar to that of bare grounds in that it peaked in the years 2019 and 2020 (29,660,325.80 hectares and 29,691,066.61 hectares, respectively). Like bare grounds, rangelands benefited from other classes such as crops, flooded vegetation and trees, which suffered during the dry spell. Ultimately rangelands gained from 27,887,840.48 hectares (37.05% of the national cover) in 2018 to 28,822,985.99 hectares (38.30%) in 2021.

The net land cover changes are summarised in Table 3 and Figure 3. The table and the graph depict the opening (2018) and closing (2021) stocks, and the net changes, respectively.

**Table 3**: National land cover: Opening and closing stocks and Net Change for 2018 and 2021

| No. | Land Cover Class | Opening Stock 2018 (ha) | Closing Stock 2021 (ha) | LULC Net Change (ha) | Opening Stock 2018 (%) | Closing Stock 2021 (%) | LULC Net Change (%) |
|---|---|---|---|---|---|---|---|
| 1 | Water | 1,377,855.22 | 1,384,530.44 | 6,675.22 | 1.83 | 1.84 | 0.01 |
| 2 | Trees | 41,002,568.01 | 39,723,590.76 | (1,278,977.25) | 54.48 | 52.78 | (1.70) |
| 3 | Flooded Vegetation | 970,844.19 | 988,751.23 | 17,907.04 | 1.29 | 1.31 | 0.02 |
| 4 | Crops | 2,571,702.10 | 2,809,215.78 | 237,513.68 | 3.42 | 3.73 | 0.32 |
| 5 | Built Area | 332,193.95 | 405,259.58 | 73,065.63 | 0.44 | 0.54 | 0.10 |
| 6 | Bare Grounds | 33,980.39 | 42,655.75 | 8,675.36 | 0.05 | 0.06 | 0.01 |
| 7 | Snow/Ice | 0.27 | 0.29 | 0.02 | 0.00 | 0.00 | 0.00 |
| 8 | Clouds | 5.23 | 0.02 | (5.21) | 0.00 | 0.00 | (0.00) |
| 9 | Rangeland | 27,887,840.48 | 28,822,985.99 | 935,145.51 | 37.05 | 38.30 | 1.24 |
| 10 | Unclassified | 1,084,410.16 | 1,084,410.16 | 0.00 | 1.44 | 1.44 | 0.00 |
| | **TOTAL** | **75,261,400.00** | **75,261,400.00** | **0.00** | **100.00** | **100.00** | **(0.00)** |

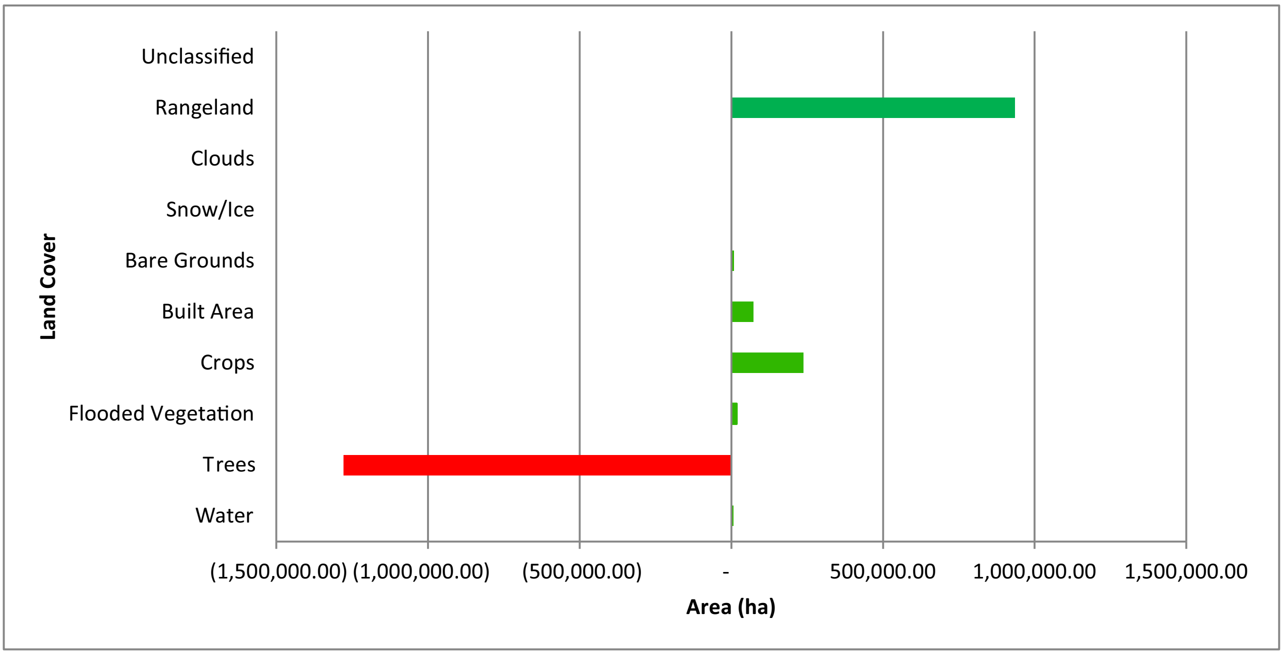


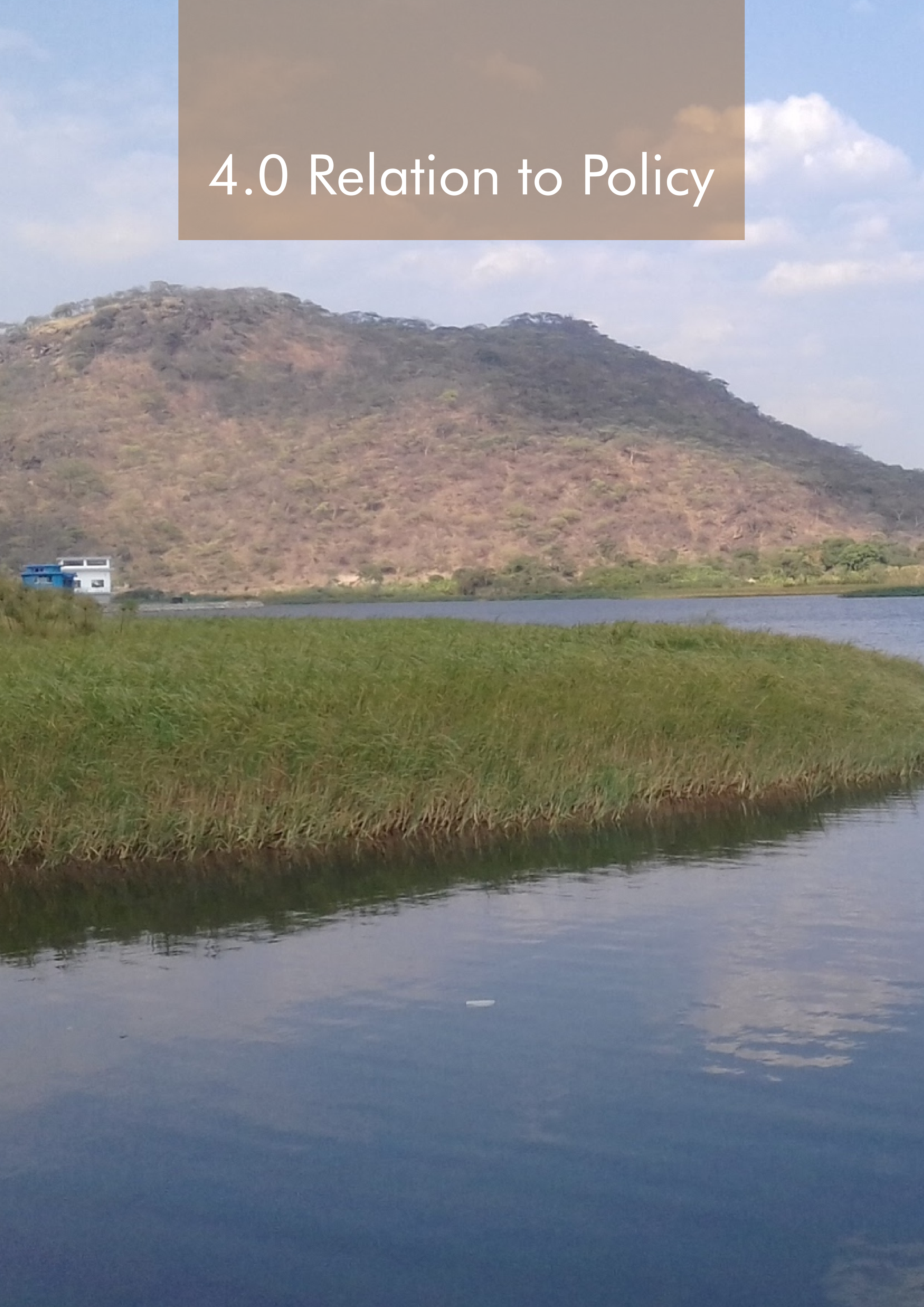

**Figure 3:** Net change to land cover/land use for the 2018 to 2021 period

## 3.1 Similarities and Differences to the First Iteration of Land Account

Compared to the results of the first iteration of the land account, certain similar patterns emerged. There was a net decrease in forests (or trees, as classified by Impact Observatory) whilst there was a steady increase in built-up areas (there was a decline in urban areas). A key difference was observed with regards to crops. In the second iteration, there was a sharp net increase between 2018 and 2019 and a steady net decrease from 2019 to 2021. This can be attributed to the drought year experienced by Zambia at that time. Compared to the first iteration, the area covered by croplands (crops in the second iteration) steadily rose (GRZ, NRSC, MLNR, & MNDP, 2020).

A particular observation between the two iterations was that the quantities of comparable classes were starkly different. The first iteration used land cover datasets that were broader than those in the second. Furthermore, the land cover classes used in the first iteration were fewer than those in the second. The study period was also longer in the first iteration. However, the second iteration used shorter time intervals. The differences between the two accounts mean that comparisons between the first and second set of accounts must be made with caution.

# 4.0 Relation to Policy



# 4.0 Relation to Policy

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

### 4.1 National Development Planning

In 2022, the Government of the Republic of Zambia launched the 8th National Development Plan(8NDP) (MFNP, 2022), which was set to run from 2022 to 2026. One of the Strategic Development Areas identified in the plan was Environmental Sustainability. Describing the current situation at the time, the plan underlined the unsustainable exploitation of natural resources in Zambia is evidenced by deforestation and forest degradation, land degradation, encroachment of protected areas, unsustainable fishing and loss of biodiversity, among others. Further, the plan referenced the loss of forests from 47.05 million in 2000 to 45.94 million in 2015, as stated in the first land account (GRZ, NRSC, MLNR, & MNDP, 2020). This was evidence that the first land account was a source of information in national planning. Subsequent land accounts can also continue to be sources of information for the current and future national plans by providing timely information on land use and land cover change and on the status of various ecosystem services.

Under the Environmental Sustainability strategic development area, the 8NDP proposes to enhance- natural resources management as a strategy. With this strategy, deforestation rates are expected to reduce from 172,000 hectares per annum in 2021 to 120,000 hectares in 2026. Natural resources valuation and accounting is a programme under this strategy and the land and forest account can serve as sources of information to information for policy formulation.

The land account also keeps stock of built-up areas and agricultural land. This information can be used to inform policy in urban expansion and infrastructure development. Future land accounts may also make a distinction between rainfed and irrigated fields. This can inform policy on agricultural expansion, both in extent and intensity.

As was the case with the first land account, the second iteration has continued to generate information that will aid to understand the following issues:

- The interaction between human-induced and natural land cover changes;
- Competing land uses; and
- Baselines for urban and rural planning

The land account will provide baseline data for REDD+, climate resilience and sustainable agriculture programmes.

The land account could also be used to inform biodiversity conservation and ecotourism. For example accounts of land cover change within protected areas would show undesired changes in these areas (e.g. loss of forest).

### 4.2 Impact on the Sustainable Development Goals (SDGs) of the United Nations

Like the first land account, the second iteration will have an impact on the achievement of specific SDGs. For instance, regular land accounts will provide information and aid in the integration of climate change measures in national planning, strategy and policy formulation, which shall impact Goal 14 on Climate Action. Land cover accounts form the basis of accounts for the ecosystem service of climate regulation.

# 5.0 Discussion

# 5.0 Discussion

### 5.1 Data quality and needs assessment

The first iteration faced challenges with available satellite imagery-derived land cover maps. Land cover maps for Zambia were available for 2000, 2010 and 2015. This situation with information has changed with the emergence of new dynamic land cover maps that are generated yearly by organisations such as the European Space Agency (ESA) and Environmental Systems Research Institute (ESRI). Furthermore, algorithms such as Continuous Change Detection Classification are now available for use on platforms such as Google Earth Engine (GEE) and can generate yearly land cover maps so long as there are adequate training areas. All these improvements, in data and the tools available to process data, enable land accounts to be compiled at yearly intervals.

While there are broad-level data on land cover and land use and new classification algorithms, detailed data on land use remains scarce and difficult to discover and collect as it is held by different entities. This is one of the reasons preventing the development of monetary accounts which require information on land values and the value of the economic activities occurring on land. The challenge of land use data is being addressed by the Zambia Statistical Agency (ZamStat) and the National Spatial Data Infrastructure (NSDI) which have been established and may provide information useful for the compilation of future and improved land accounts.

# 6.0 Next Steps for subsequent land accounts

# 6.0 Next Steps for subsequent land accounts

The first and second iterations of the land account both highlight the rapid change that the forests, agricultural land and urban areas continue to undergo. Built-up areas and crop fields continue to expand at the expense of forests. However, whilst the land account has continued to depict changes in land cover, changes in land use have been difficult to quantify except for cropland. Land cover maps are a representation of physical features that are present within space. On the other hand, land use pertains to how people utilise these physical features. For instance, a building is likely to be classified as built-up when considering land cover whereas the same building can be classified as institutional, commercial or cultural land use depending on how people interact with it. This fundamental difference is the reason why a land cover map is easier to derive than that of land use. Land cover only requires the spectral signature of each class whereas land use requires more secondary data to define specific locations in space.

In the first iteration (GRZ, NRSC, MLNR, & MNDP, 2020), deriving land tenure and land use accounts were identified as a priority for the iterations that followed. However, this task has continued to be a challenge in the second iteration as data is still scarce. Therefore, land use and land tenure accounts continue to be a priority for future iterations. Monetary accounts also continue to be a priority for the land accounts that follow. Valuation in the land account continues to be a challenge due to the absence of a national land use map and information on the economic activities occurring on land. Furthermore, Zambia has a dual land tenure system (customary and state). Whereas the Zambian government is the main custodian of state land, customary land is primarily under the control of different chiefs.

The establishment of ecosystem services accounts also continues to be a priority. These accounts would be useful in identifying and evaluating different provisional, regulatory and cultural services provided by land. However, this would require more detailed land cover data and the use of models to estimate the level of ecosystem services. Whereas the data used in the second iteration had more land cover classes and better spatial resolution, it was still not sufficient for the creation of ecosystem services accounts.

The second iteration of the land account was done for an annual time series. Going forward, the account will continue to be compiled annually as several remote sensing land cover datasets have become available along with tools for data processing. Furthermore, the subsequent accounts could also be produced at the provincial and district levels and for special areas such as conservation areas.

# 7.0 References

# 7.0 References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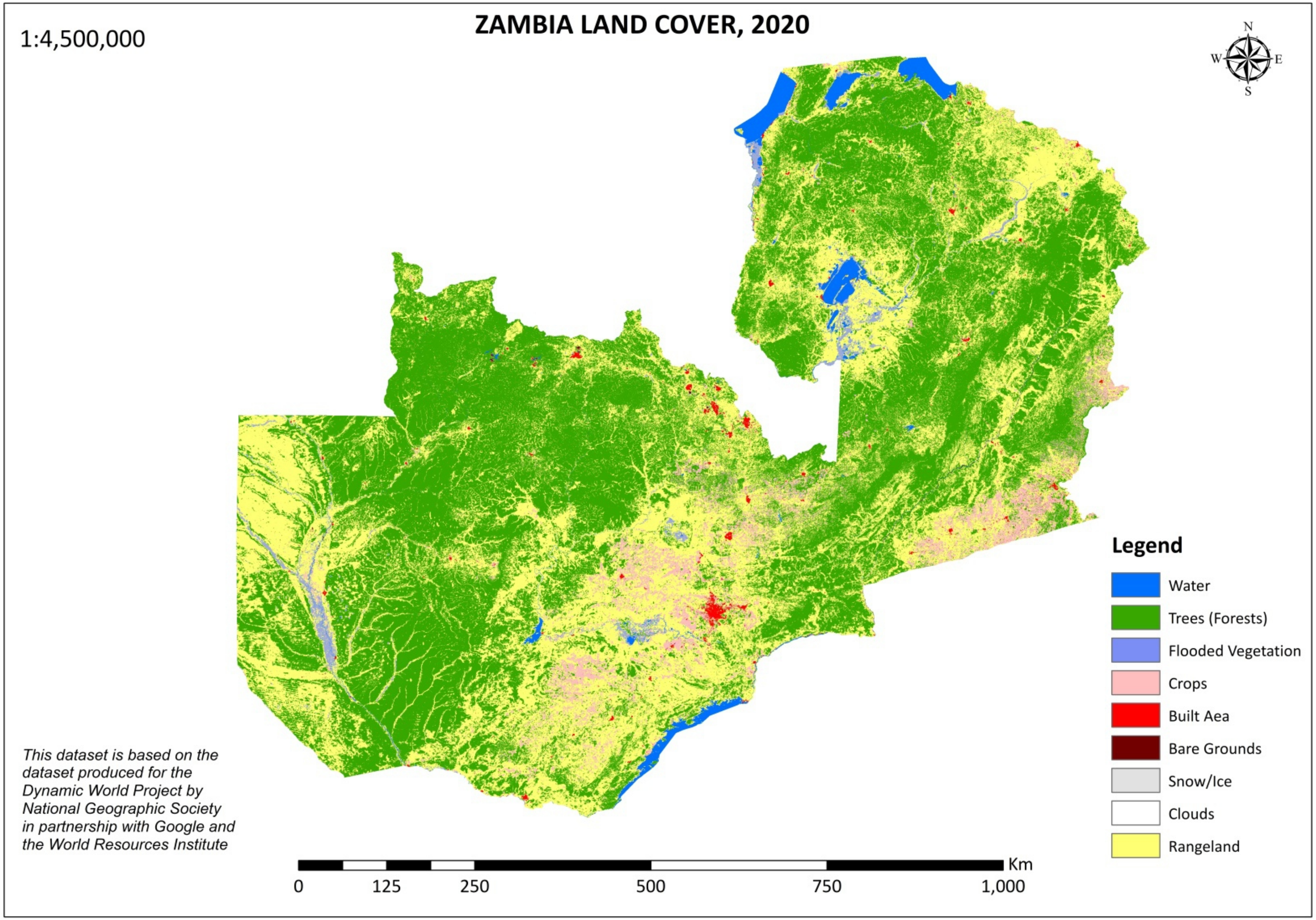
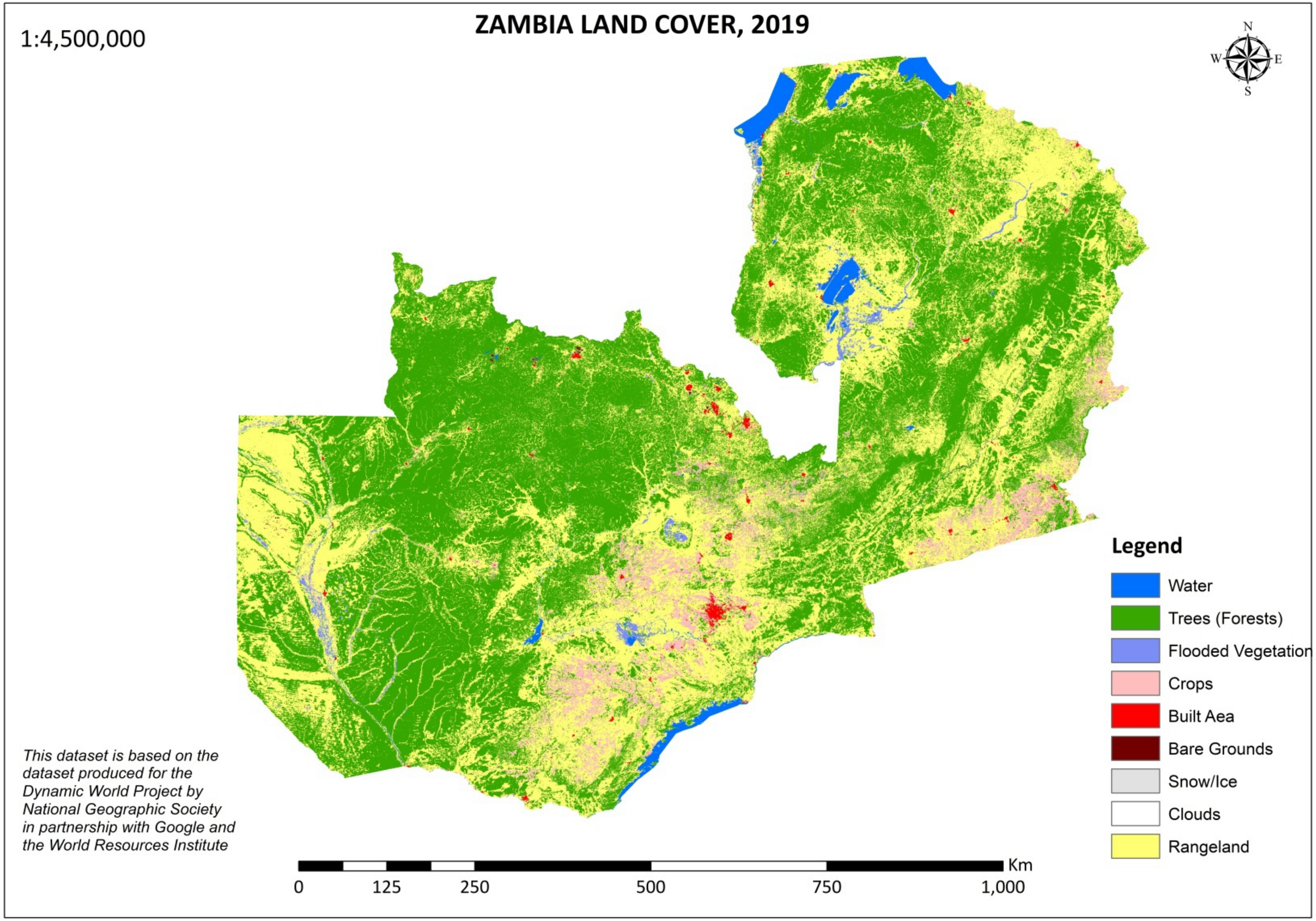
# 8.0 Annex

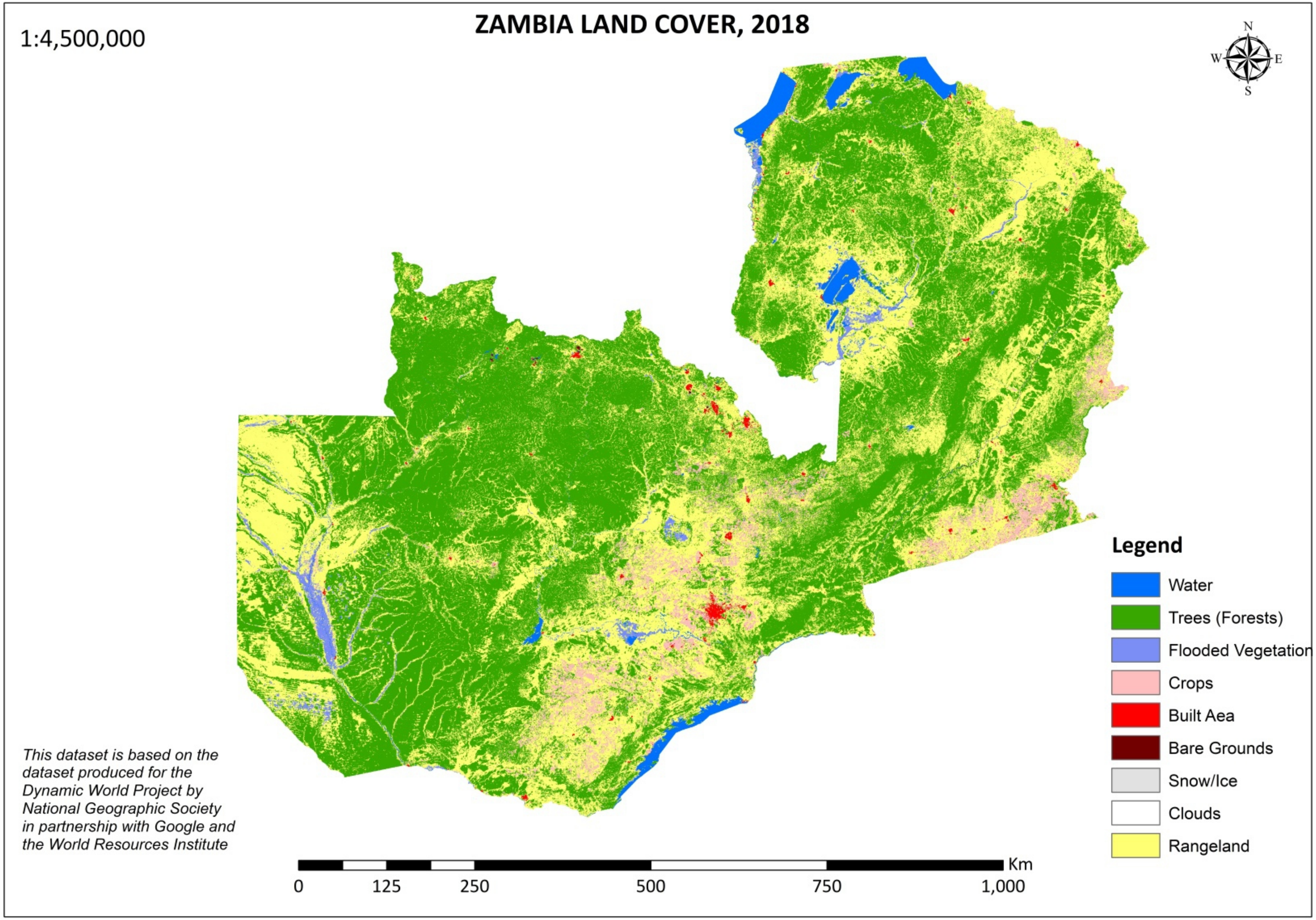
## 8.1 Land cover. 2020



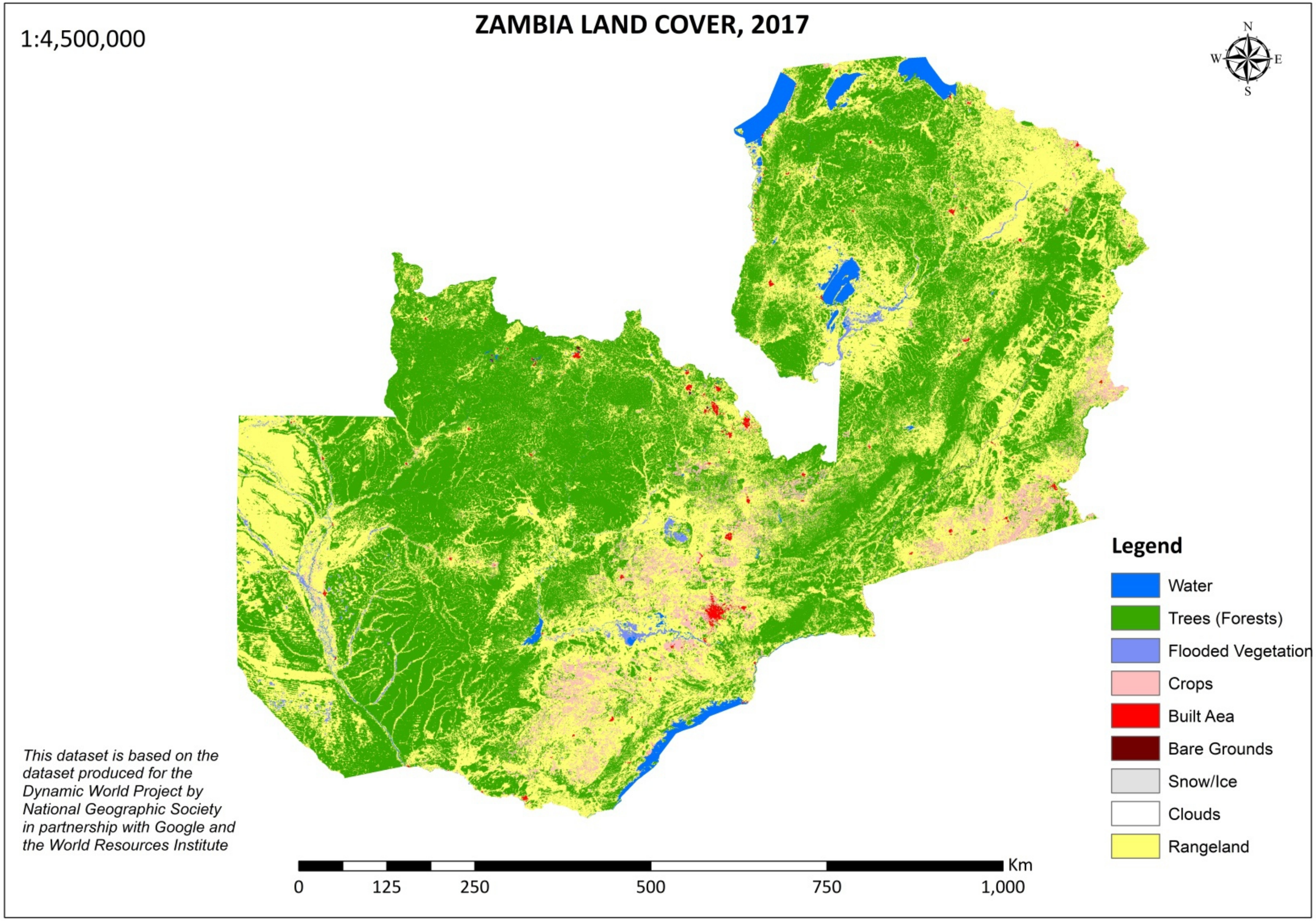
## 8.2 Land cover, 2019



## 8.3 Land cover. 2018



## 8.4 Land cover. 2017



## 8.5 Change matrix for 2017 to 2018

| Land Cover | Opening stock, area(ha) 2017 | Water | Trees | Flooded Vegetation | Crops | Built Area | Bare Grounds | Snow/Ice | Clouds | Rangeland | Closing stock, area (ha) 2018 | Total loss (2017 to 2018) | Total gain (2017 to 2018) | Net change (2017 to 2018) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | 1,336,015.27 | | 2,584.82 | 14,485.69 | 190.45 | 110.17 | 2,167.18 | 0.21 | - | 15,663.51 | 1,377,855.22 | 35,202.03 | 77,041.98 | 41,839.95 |
| Trees | 39,257,063.64 | 10,975.74 | | 24,863.77 | 33,411.19 | 1,290.08 | 580.99 | 0.02 | - | 1,899,652.38 | 41,002,568.01 | 1,970,774.17 | 3,716,278.54 | 1,745,504.37 |
| Flooded Vegetation | 543,144.06 | 12,712.98 | 8,273.85 | | 1,314.51 | 189.53 | 110.96 | - | - | 66,220.87 | 970,844.19 | 88,822.70 | 516,522.83 | 427,700.13 |
| Crops | 2,479,373.77 | 1,108.38 | 31,016.40 | 29,895.57 | | 13,127.25 | 483.43 | - | 2.15 | 487,385.87 | 2,571,702.10 | 563,019.05 | 655,347.38 | 92,328.33 |
| Built Area | 285,382.18 | 194.28 | 762.73 | 316.27 | 2,942.15 | | 348.29 | - | 0.13 | 12,510.26 | 332,193.95 | 17,074.11 | 63,885.88 | 46,811.77 |
| Bare Grounds | 38,205.14 | 3,297.83 | 319.03 | 835.17 | 308.12 | 354.61 | | - | - | 8,388.85 | 33,980.39 | 13,503.61 | 9,278.86 | (4,224.75) |
| Snow/Ice | 1.01 | 0.19 | 0.66 | 0.01 | - | 0.02 | 0.09 | | - | 0.01 | 0.27 | 0.98 | 0.24 | (0.74) |
| Clouds | - | - | - | - | - | - | - | - | | - | 5.23 | - | 5.23 | 5.23 |
| Rangeland | 30,237,804.77 | 48,752.58 | 3,673,321.05 | 446,126.35 | 617,180.96 | 48,814.22 | 5,587.92 | 0.01 | 2.95 | | 27,887,840.48 | 4,839,786.04 | 2,489,821.75 | (2,349,964.29) |
| **Total LC Area** | **74,176,989.84** | **77,041.98** | **3,716,278.54** | **516,522.83** | **655,347.38** | **63,885.88** | **9,278.86** | **0.24** | **5.23** | **2,489,821.75** | **74,176,989.84** | **7,528,182.69** | **7,528,182.69** | **-** |

## 8.6 Change Matrix for 2018 to 2019

| Land Cover | Opening stock, area(ha) 2018 | Water | Trees | Flooded Vegetation | Crops | Built Area | Bare Grounds | Snow/Ice | Clouds | Rangeland | Closing stock, area (ha) 2019 | Total loss (2018 to 2019) | Total gain (2018 to 2019) | Net change (2018 to 2019) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | 1,377,855.22 | | 5,850.43 | 7,711.93 | 3,382.70 | 307.92 | 3,416.72 | 0.23 | - | 58,991.03 | 1,331,444.28 | 79,660.96 | 33,250.02 | (46,410.94) |
| Trees | 41,002,568.01 | 4,705.84 | | 13,995.31 | 76,443.71 | 2,315.21 | 914.92 | - | - | 3,912,409.81 | 39,017,574.48 | 4,010,784.80 | 2,025,791.27 | (1,984,993.53) |
| Flooded Vegetation | 970,844.19 | 15,533.68 | 25,017.29 | | 21,354.77 | 563.99 | 3,632.88 | - | - | 431,006.41 | 598,182.77 | 497,109.02 | 124,447.60 | (372,661.42) |
| Crops | 2,571,702.10 | 175.94 | 19,047.09 | 837.19 | | 8,914.59 | 627.26 | - | - | 416,851.99 | 3,152,100.41 | 446,454.06 | 1,026,852.37 | 580,398.31 |
| Built Area | 332,193.95 | 96.50 | 768.74 | 158.06 | 7,632.77 | | 284.85 | 0.02 | - | 19,455.07 | 361,325.67 | 28,396.01 | 57,527.73 | 29,131.72 |
| Bare Grounds | 33,980.39 | 2,672.35 | 97.59 | 51.57 | 411.92 | 334.98 | | 0.02 | - | 4,712.06 | 56,035.76 | 8,280.49 | 30,335.86 | 22,055.37 |
| Snow/Ice | 0.27 | 0.10 | - | - | - | - | - | | - | - | 0.46 | 0.10 | 0.29 | 0.19 |
| Clouds | 5.23 | - | - | - | 2.22 | 1.13 | - | - | | 1.67 | 0.21 | 5.02 | - | (5.02) |
| Rangeland | 27,887,840.48 | 10,065.61 | 1,975,010.13 | 101,693.54 | 917,624.28 | 45,089.91 | 21,459.23 | 0.02 | - | | 29,660,325.80 | 3,070,942.72 | 4,843,428.04 | 1,772,485.32 |
| **Total LC Area** | **74,176,989.84** | **33,250.02** | **2,025,791.27** | **124,447.60** | **1,026,852.37** | **57,527.73** | **30,335.86** | **0.29** | **-** | **4,843,428.04** | **74,176,989.84** | **8,141,633.18** | **8,141,633.18** | **-** |

## 8.7Change matrix for 2019 to 2020

| Land Cover | Opening stock, area(ha) 2019 | Water | Trees | Flooded Vegetation | Crops | Built Area | Bare Grounds | Snow/Ice | Clouds | Rangeland | Closing stock, area (ha) 2020 | Total loss (2019 to 2020) | Total gain (2019 to 2020) | Net change (2019 to 2020) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | 1,331,444.28 | | 2,599.59 | 14,093.30 | 526.61 | 126.89 | 3,233.38 | 0.05 | - | 9,293.55 | 1,386,025.39 | 29,873.37 | 84,454.48 | 54,581.11 |
| Trees | 39,017,574.48 | 11,692.12 | | 32,292.64 | 71,719.70 | 2,769.99 | 664.52 | - | 0.67 | 3,511,561.75 | 38,899,290.28 | 3,630,701.39 | 3,512,417.19 | (118,284.20) |
| Flooded Vegetation | 598,182.77 | 15,261.97 | 14,175.86 | | 7,161.04 | 403.74 | 203.03 | - | - | 136,342.94 | 800,643.46 | 173,548.58 | 376,009.27 | 202,460.69 |
| Crops | 3,152,100.41 | 1,127.21 | 32,981.41 | 7,322.04 | | 16,228.81 | 489.19 | - | - | 896,186.04 | 2,971,463.34 | 954,334.70 | 773,697.66 | (180,637.04) |
| Built Area | 361,325.67 | 231.26 | 991.33 | 972.73 | 6,458.29 | | 171.34 | - | - | 36,682.08 | 378,909.78 | 45,507.03 | 63,091.14 | 17,584.11 |
| Bare Grounds | 56,035.76 | 3,872.79 | 197.14 | 2,037.63 | 1,235.36 | 627.90 | | 0.08 | - | 21,729.28 | 49,589.22 | 29,700.18 | 23,253.64 | (6,446.54) |
| Snow/Ice | 0.46 | 0.18 | 0.01 | - | - | 0.01 | 0.02 | | - | - | 0.68 | 0.22 | 0.44 | 0.22 |
| Clouds | 0.21 | - | - | - | 0.01 | 0.14 | - | - | | 0.06 | 1.08 | 0.21 | 1.05 | 0.84 |
| Rangeland | 29,660,325.80 | 52,268.95 | 3,461,471.85 | 319,290.93 | 686,596.65 | 42,933.66 | 18,492.16 | 0.31 | 0.38 | | 29,691,066.61 | 4,581,054.89 | 4,611,795.70 | 30,740.81 |
| **Total LC Area** | **74,176,989.84** | **84,454.48** | **3,512,417.19** | **376,009.27** | **773,697.66** | **63,091.14** | **23,253.64** | **0.44** | **1.05** | **4,611,795.70** | **74,176,989.84** | **9,444,720.57** | **9,444,720.57** | **(0.00)** |

## 8.8 Change matrix for 2020 to 2021

| Land Cover | Opening stock, area(ha) 2020 | Water | Trees | Flooded Vegetation | Crops | Built Area | Bare Grounds | Snow/Ice | Clouds | Rangeland | Closing stock, area (ha) 2021 | Total loss (2020 to 2021) | Total gain (2020 to 2021) | Net change (2020 to 2021) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | 1,386,025.39 | | 7,058.98 | 18,082.13 | 316.06 | 152.66 | 3,489.56 | 0.10 | - | 31,344.31 | 1,384,530.44 | 60,443.80 | 58,948.85 | (1,494.95) |
| Trees | 38,899,290.28 | 4,730.23 | | 22,725.12 | 56,936.66 | 1,778.22 | 819.60 | 0.02 | 0.01 | 3,108,604.55 | 39,723,590.76 | 3,195,594.41 | 4,019,894.89 | 824,300.48 |
| Flooded Vegetation | 800,643.46 | 16,665.56 | 28,684.07 | | 955.19 | 928.91 | 202.22 | 0.06 | - | 151,267.30 | 988,751.23 | 198,703.31 | 386,811.08 | 188,107.77 |
| Crops | 2,971,463.34 | 1,382.18 | 58,288.79 | 38,240.90 | | 12,298.93 | 700.41 | - | 0.01 | 802,116.20 | 2,809,215.78 | 913,027.42 | 750,779.86 | (162,247.56) |
| Built Area | 378,909.78 | 366.12 | 2,254.13 | 922.30 | 8,373.28 | | 433.21 | 0.01 | - | 30,873.88 | 405,259.58 | 43,222.93 | 69,572.73 | 26,349.80 |
| Bare Grounds | 49,589.22 | 2,962.94 | 257.35 | 1,366.26 | 611.23 | 242.27 | | - | - | 16,866.44 | 42,655.75 | 22,306.49 | 15,373.02 | (6,933.47) |
| Snow/Ice | 0.68 | 0.13 | - | 0.17 | - | 0.02 | 0.14 | | - | 0.12 | 0.29 | 0.58 | 0.19 | (0.39) |
| Clouds | 1.08 | - | 0.72 | - | 0.02 | 0.01 | - | - | | 0.33 | 0.02 | 1.08 | 0.02 | (1.06) |
| Rangeland | 29,691,066.61 | 32,841.69 | 3,923,350.85 | 305,474.20 | 683,587.42 | 54,171.71 | 9,727.88 | - | - | | 28,822,985.99 | 5,009,153.75 | 4,141,073.13 | (868,080.62) |
| **Total LC Area** | **74,176,989.84** | **58,948.85** | **4,019,894.89** | **386,811.08** | **750,779.86** | **69,572.73** | **15,373.02** | **0.19** | **0.02** | **4,141,073.13** | **74,176,989.84** | **9,442,453.77** | **9,442,453.77** | **-** |

# NOTES

# NOTES