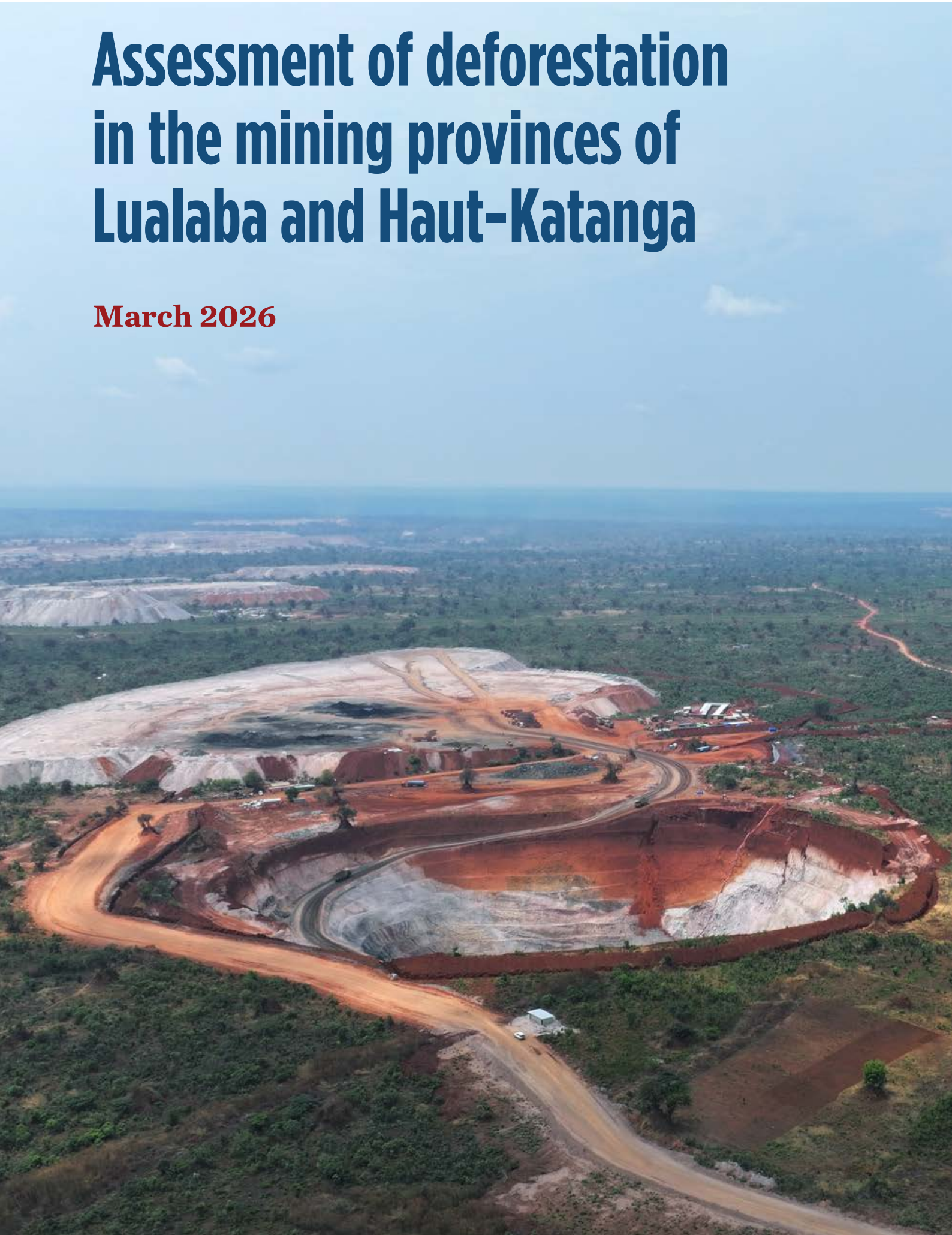
AFREWATCH
African Resources Watch
Observatoire Africain des Ressources Naturelles

Assessment of deforestation in the mining provinces of Lualaba and Haut-Katanga

March 2026



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ACRONYMS AND ABBREVIATIONS

ACK	Katanga Copper Belt
C	Carbon
°C	Degrees Celsius
CO2	Carbon dioxide
DRC	Democratic Republic of Congo
EA	Environmental Authority to operate
EU	European Union
g/mol	grammes per mole
GEE	Google Earth Engine
GPS	Global Positioning System
ha	Hectare
km²	Square kilometre
OLI-TIRS	Operational Land Imager – Thermal Infrared Sensor
PE	Exploitation Permit
REDD+	Reduced Emissions from Deforestation and Degradation
t	Ton
TDA	Total Deforestation Annual
TDP	Total Deforestation Period
TM	Thematic Mapper
USA	United States of America

Miombo forests in brief

Miombo woodlands make up the largest dry forest area in the world. They cover an estimated area of 2.4 million square kilometres (km²),[1] representing approximately 10% of the total forest area in Africa (FAO, 2023). This forest, the main vegetation formation in the Zambezi region, spans countries in Central and Southern Africa (Botswana, DRC, Malawi, Mozambique, Namibia, South Africa, Zambia, and Zimbabwe) and also covers parts of Angola, Burundi, and Tanzania, and constitutes an ecoregion which is dominated by species of the genus Brachystegia, Julbernardia and Isoberlinia, of the Fabaceae family (Frederique, 2021).

In the Democratic Republic of Congo (DRC), the open Miombo forest, located in the south-eastern part of the country, covers approximately 58% of the former province of Katanga (formerly Shaba)[2] and provides several ecosystem services. They play a vital role in the food security of local communities by providing various non-timber forest products, including fruit, honey, mushrooms and medicines, and remain a source of space for rural activities.

They also constitute a cultural and traditional setting par excellence, acting as a sacred space for worship, initiation rites and ancestral cemeteries, thus strengthening the spiritual and social ties between communities and nature while being a symbol of customary power.

Ecologically, the Miombo is a reservoir of exceptional biodiversity with several endemic animal and plant species. As a key component of the environment in these two provinces, it regulates the climate by influencing the carbon and water cycles, thereby affecting rainfall and temperature patterns.

1 FAO. (2023). Evaluation finale du projet « Gestion Communautaire des Forêts Miombo dans le Sud-Est du Katanga ».
2 Montfort, Fréderique. 2021. "Dynamics of forest landscapes in Mozambique: Study of Miombo ecology to contribute to strategies for restoring degraded land Frederique Montfort". Doctoral thesis, AgroParisTech University.

Between 2000 and 2024, forest loss in the Katanga Copper Belt and the Lobito Corridor corresponded to 83 times the area of Paris, or approximately 3.5 times the area of Paris per year. Image by Didier Makal: Destroyed forest and fragment of forest next to the Mutanda mining concession

EXECUTIVE SUMMARY

For more than 25 years, the open Miombo forests of the Democratic Republic of Congo (DRC) have been experiencing severe deforestation and forest degradation, particularly linked to intense mining activities. This trend is part of the liberalisation of the mining sector, which was formerly under the exclusive control of public companies such as Gécamines.

This study is based on the analysis of Landsat satellite images, coupled with geographic information system (GIS) and remote sensing tools, to analyse forest cover dynamics between 2000 and 2024.

An initial analysis focused on forest cover in the copper belt area, extending to the Lobito Corridor, with the aim of understanding deforestation dynamics. The study was then expanded to consider deforestation patterns within the 12 largest mining exploitation permits in this area to maximise the robustness, accuracy and interpretability of the results. The samples chosen enable detailed and systematic cross-referencing of high-resolution satellite data and field observations, which is essential for analysing deforestation dynamics over time and space.

The scale of the study makes it possible to trace the evolution of the deforestation front and thus establish a direct causal link between the expansion of extractive infrastructure and the loss of Miombo forests.

The study shows that in 2000, the forest areas covered by these 12 companies' operating areas represented 117,481 hectares (ha), which had shrunk to 49,764 by 2024, representing a loss of more than half (58%). Conversely, over the same period, the land area occupied by these infrastructures, mainly mining, increased from 10,628 ha to 78,798 ha – a 741% increase. The loss of forest cover observed in the sampled area would have resulted in estimated emissions of eight megatonnes of carbon dioxide equivalent (CO_2e) (equivalent to 8 million flights from London to New York).

Extrapolating this out, it can be estimated that between 2000 and 2024, **873,926 hectares of Miombo forest disappeared, resulting in total emissions of around 108 megatonnes of CO_2e (equivalent to Bangladesh's annual emissions).**

We can therefore see that the frantic race for minerals is not only increasing pressure on forest ecosystems, it is also worsening the climate crisis and exacerbating the socio-economic vulnerability of communities living in this area.

This is being driven by intensified geopolitical competition for access to critical minerals, marked by China's dominant position and the United States of America's (USA) efforts to strengthen supply chains. The European Union's (EU) also aims to secure supply chains by diversifying supply through strategic partnerships and investing in robust industrial and agricultural projects (its "Global Gateway" approach).

This race for strategic minerals, key elements in the energy and digital transition, exacerbated by the resurgence of military spending, has led to the signing of several international agreements, including 2023's Lobito Corridor project, which includes major investments in infrastructure, energy and agribusiness, increasing the risk of accelerated deforestation.

The Lobito Corridor project is a major railway infrastructure project designed to connect the port of Lobito in Angola to the landlocked, mineral-rich regions of the DRC and Zambia. It aims to reduce mineral transit times from 45 days to 45 hours. Image by Indra Van Gisbergen/ Fern: The existing Lobito Corridor railway in Lualaba was built in the 1920s and is undergoing renovation.

I. CONTEXT

The DRC is an important part of global efforts to protect forests and the climate, due to the extent of its forest cover and the diversity of its ecosystems (67% of its national territory is covered by tropical forests, representing 60% of the forests in the Congo Basin).[3] These forests consist of different types of forest ecosystems, including the dry Miombo forests.

For a long time, local pressures were considered the main cause of DRC's deforestation. Threats to forest ecosystems were mainly attributed to subsistence agriculture and charcoal production, while the impacts of large-scale development projects, such as mining, were largely underestimated or even ignored.[4]

3 DRC. (2018) Forest reference emission levels for reducing emissions from deforestation in the Democratic Republic of Congo https://redd.unfccc.int/files/2018_frel_submission_drc.pdf

4 Roads to destruction: emerging impacts of infrastructure development in the forests of the Congo Basin https://rainforestfoundationuk.org/wp-content/uploads/2021/10/media.ashx_infrastructure-report-fr.pdf

Currently, like many other forest ecosystems, the Miombo is increasingly exposed to pressures from mining activities.[5] This is partly because a significant part of this forest is in the Katanga copper belt, which stretches between the DRC and Zambia and contains 34% of the world's cobalt reserves and more than 10% of its copper reserves.

The former province of Katanga, (divided into Tanganyika, Haut-Lomami, Lualaba and Haut-Katanga since 2015), has estimated reserves of 70 million tonnes of copper and 5 million tonnes of cobalt.[6] Since the mining sector was liberalised in 2002, this area has seen rapid intensification of mining activities, with a particularly severe impact on Miombo forests.

The significant copper and cobalt deposits, which are essential to the energy transition and abound in this area, are coveted by China, which has had a monopoly on them for more than two decades thanks to its "minerals for infrastructure" agreement with the DRC.[7] The USA and the EU have also recently signed agreements with DRC government to secure these minerals.

Such geopolitical movements are rapidly transforming the territories into areas of heavy infrastructure. In return for securing supply chains, the USA and EU are committing to constructing related infrastructure (such as roads, railways, power stations and ports), the large-scale deployment of which is likely to exacerbate the negative impacts on Miombo forests. There is therefore a clear tension between global climate objectives and the environmental impacts generated by strategic mineral supply models.

The Lobito Corridor project, which stems from agreements signed in 2023 between the DRC, the USA, the EU, Angola and Zambia, is a major rail infrastructure project designed to link the port of Lobito in Angola to the DRC's rich mining regions and Zambia. It aims to reduce transit times for minerals such as copper from 45 days to 45 hours, while stimulating trade and regional economic development.

5 AFREWATCH. (2024) Report on the state of deforestation in the mining provinces of Haut-Katanga and Lualaba in the DRC: the case of mining areas located in the Katanga copper belt https://afrewatch.org/state-of-play-of-deforestation-in-the-mining-provinces-of-lualaba-and-haut-katanga-case-of-mining-areas-located-in-the-katanga-copper-belt

6 https://documents1.worldbank.org/curated/en/211201468202139747/pdf/779440WP0Frenc0t0FRENCH0FINAL0may13.pdf

7 https://mines.cd/accord-minerais-contre-securite-les-usa-souvrent-a-la-rdc

The Lobito Corridor

Initially commissioned in 1928, then interrupted due to the civil war in Angola, the Lobito Corridor is now a strategic axis linking the port of Lobito to the landlocked mining regions of the DRC and Zambia, partly to aid the export of critical minerals.

Against a backdrop of geopolitical competition marked by Chinese dominance via the Belt and Road Initiative (BRI), the USA and the EU are supporting the Corridor to secure supply chains for cobalt, copper and lithium, notably through two specific investment approaches: the Partnership for Global Infrastructure and Investment for the USA and the Global Gateway for the EU,[8] which includes plans to invest up to €300 billion by 2027, including €150 billion in Africa.[9]

Rail operations are provided by Lobito Atlantic Railway, a consortium comprising Trafigura, Mota-Engil and Vecturis, with a transport target of 240,000 tonnes per direction in 2026, rising to 1.5 million tonnes in 2027, including 750,000 tonnes for both export and import.[10]

Although presented as a lever for development, the Lobito Corridor is primarily a mining supply chain. The associated model, combining infrastructure, agribusiness and energy, is likely to increase deforestation in the Miombo woodlands, exacerbate the climate crisis and reinforce land tenure insecurity, with increased risks to livelihoods, food security, social cohesion and the cultural identity of local communities.

Despite growing recognition of Forests' central role in climate regulation, and strengthened commitments to combat deforestation and tropical forest degradation, conserve and sustainably manage forests, and enhance forest carbon sequestration,[11] the rapid expansion of mining to supply the energy, digital and defence transition poses a direct threat to the climate, the integrity of Miombo forests and the livelihoods of local communities.[12]

This contradiction is striking given that the DRC has committed, as part of its National Reduced Emissions from Deforestation and Degradation (REDD+) Framework Strategy, to stabilising its forest cover at 63.5%, down from 67% in 2000.

AFREWATCH undertook this study to build on initial work[13] highlighting the tension between climate, forests and energy transition in the DRC. With financial and technical support from Fern, they extended their initial analysis to the Lobito Corridor area as part of analysis aimed at documenting the environmental impacts of mining expansion along the Lobito Corridor. It aims to identify the risks to Miombo forests and local communities and recommend ways to ensure that resource exploitation is compatible with stakeholders' environmental, social and climate commitments.

8 Idem
9 Global Gateway, the EU's response to China – DW – 26/11/2025
10 https://miningandbusiness.com/2025/09/19/copper-lobito-atlantic-railway-to-transport-240000-tons-from-kolwezi-to-lobito--starting-2026/#:~:text="120,000 tonnes of bulk will,750,000 in each direction)."
11 https://www.forestcarbonpartnership.org/sites/fcp/files/fcp-docs/2013/Deforestation%20in%20Congo%20Basin_full%20report-FR_feb13.pdf
12 https://www.fern.org/fr/publications-insight/driving-change-not-deforestation
13 https://afrewatch.org/wp-content/uploads/2024/12/Rapport-AFREWATCH-Decembre-2024.pdf

Land use in the region covering the Katanga copper belt and the Lobito Corridor has shown a decline in Miombo woodland and an increase in savannah and built-up areas, particularly mining areas. Image by Didier Makal: Village near Mutanda mining

II. OBJECTIVES OF THE STUDY

II.1 GENERAL OBJECTIVE

The research aims to assess mining's impacts on DRC's Miombo forest between 2000 and 2024, and to produce baseline data on the Lobito Corridor area to inform future monitoring of potential social and environmental impacts related to the development of infrastructure and extraction projects resulting from agreements between the DRC and the EU.

II.2 SPECIFIC OBJECTIVES

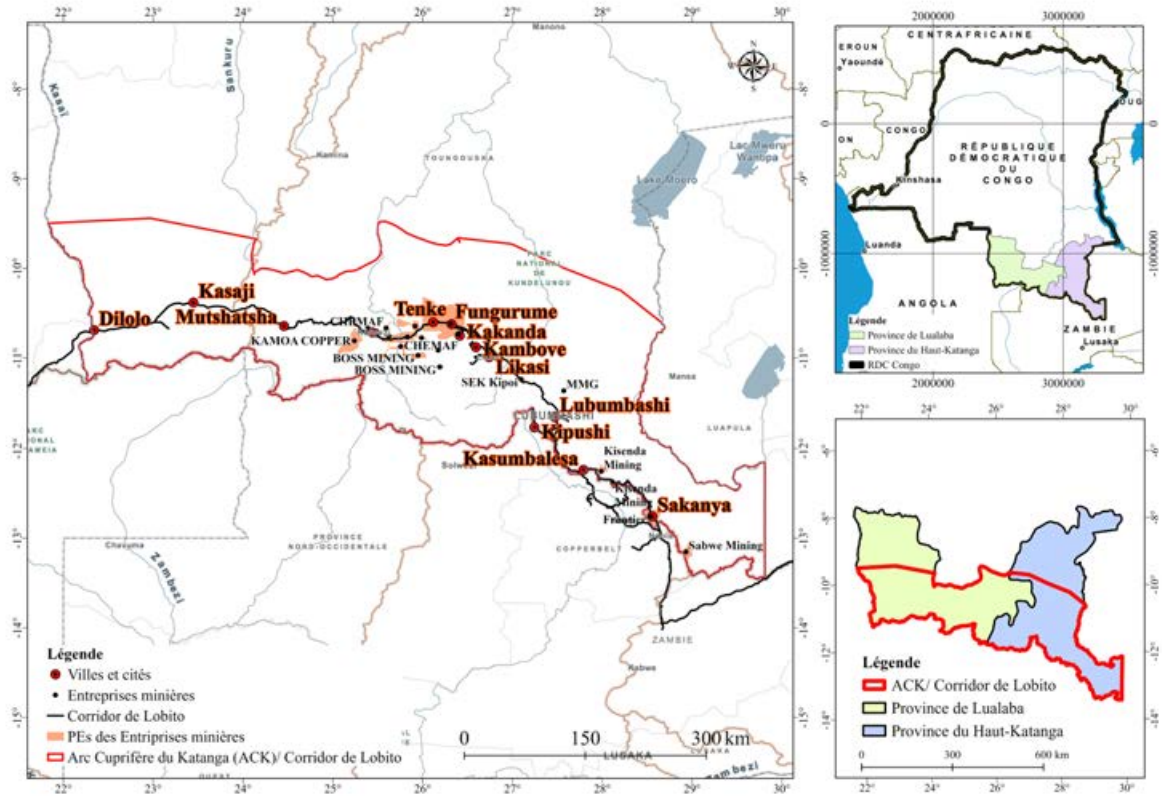
The specific objectives of this research are to:

- Quantify CO_2 emissions associated with deforestation-linked mining activities and analyse their potential implications for the region;
- Characterise the global ecological uniqueness of DRC's Miombo forests and analyse their vulnerability to deforestation and forest degradation due to growing demand for strategic raw materials;
- Analyse the impacts of mining expansion on forests and local populations;
- Contribute to the discussion on alternative approaches and policy frameworks that could protect forests.

III. METHODOLOGY

III.1. THE STUDY AREA

Figure 1: **Study area comprising the Katanga copper belt and the Lobito Corridor area**



The study covers the mining provinces of Lualaba and Haut-Katanga, with a particular focus on the Katanga copper belt, which covers an area of more than 48,358 km². The Lobito Corridor was included to obtain reference data on forest cover before planned infrastructure is built. It extends from the territory of Sakania to the territory of Dilolo, passing through the cities of Lubumbashi, Likasi and Kolwezi, as well as the territory of Mutshatsha (geographic coordinates: 9°02′S-13°33′S, 24°41′S-28°50′S). This research should allow us to assess the direct and indirect impacts of the Lobito Corridor project on forests.

The area is characterised by a high concentration of mining companies linked to the intensive exploitation of mineral resources, as well as the presence of large urban areas such as Lubumbashi, Likasi and Kolwezi.

Only 29% of forest cover in the Katanga Copper Belt and the Lobito Corridor in 2000 remained in 2024; 16% was converted to savannah and around 1% to agricultural areas, urbanisation and mining infrastructure. Image by Didier Makal: Expansion of villages around Mutanda mining.

III.2 DATA COLLECTION

Satellite data was collected pre-processed, classified and validated.

III.2.1 LITERATURE REVIEW

The literature review included analysing books, scientific articles and reports about the mining activities' impact on Miombo forests. It was during this stage that the mining companies operating in this area were identified.

III.2.2 SELECTED COMPANIES

To accurately assess the impact of mining activities on forests in the study area, twelve mining companies were selected so as to analyse changes to forest cover within their operating permits. These companies combined production accounts for most national cobalt production: In 2022, this sample represented 55% of the 115,371 tonnes of cobalt produced by the DRC with the exception of four companies that did not produce during this financial year).

Table 1: **Companies in the sample and the area covered by their mining licences**

No.	No.	Name
1	BOSS MINING	41,720
2	CHEMAF	42660
3	COMIDE	20840
4	FRONTIER S.A.	29040
5	KAMOA COPPER	39320
6	KISANFU MINING	3209
7	KISENDA MINING	12,860
8	MMG	2095
9	MUTANDA MINING	17380
10	SABWE MINING	13,410
11	SEK KIPOI	5615
12	TFM	157,900
	Total	386,049
	Katangane Copper Belt (ACK)	4,832,000
	%	7.9

III.2.3 FIELD DATA COLLECTION

Field missions were organised to survey geographical points using a Global Positioning System (GPS), with a minimum of five points per company. These points were used as supplementary data to improve the accuracy of satellite image processing.

III.2.4 DATA ANALYSIS AND PROCESSING

III.2.4.1 CHOICE OF SATELLITE DATA

The study used spatial mapping to assess changes in forest cover within the permits of selected mining companies and in the area along the Lobito Corridor. Satellite images showed land use between 2000 and 2024 and were used to analyse the cumulative impact of mining activities on forest ecosystems since the permits were granted.

Landsat satellite images were acquired between June and August (the dry season) via Google Earth Engine (GEE), a platform dedicated to the analysis, visualisation and storage of large-scale geospatial data (Gorelick et al., 2017). Two types of sensors were used: TM (Thematic Mapper) for the period 2000 to 2008, and OLI-TIRS (Operational Land Imager – Thermal Infrared Sensor), including OLI-TIRS I for 2016 and OLI-TIRS II for 2024. The spatial resolution was 30 metres.

The years selected correspond to strategic periods: 2000 (before the liberalisation of the mining sector), 2008 (global economic crisis), 2016 (break-up of the provinces) and 2024 (the recent situation).

III.2.4.2 PRE-PROCESSING, CLASSIFICATION AND VALIDATION OF CLASSIFICATIONS

To analyse each year, the study used the median images from between June and August to generate a representative colour composite, cropped and mosaicked to ensure continuous coverage. This mosaicking was performed using the spectral bands of the mid-infrared, near-infrared, red and green, with specific parameters (minimum and maximum thresholds of 0 and 0.3, and gamma correction of 2). These bands were selected for their ability to effectively discriminate vegetation from other land cover classes, thanks to their distinctive reflectance properties (Dutra et al., 2022). The images obtained were then reprojected into the WGS 84 / UTM zone 35S coordinate system (EPSG: 32735).

Homogeneous training areas corresponding to the different land cover classes were defined by visual interpretation of false-colour composites, supported by aerial photographs available on GEE, and ground truth points collected using GPS between August and September 2025.

Six land cover and land use classes were selected, namely Miombo woodland, savannah, agricultural areas, built-up areas, bare soil, mining infrastructure and water. These represent the most dominant land cover classes in the region (Useni et al., 2020; Khoji et al., 2023). For supervised classification, training areas were used to train the Random Forest algorithm, known for its robustness in dealing with complex and heterogeneous data, including non-linear relationships between variables (Phan et al., 2020).

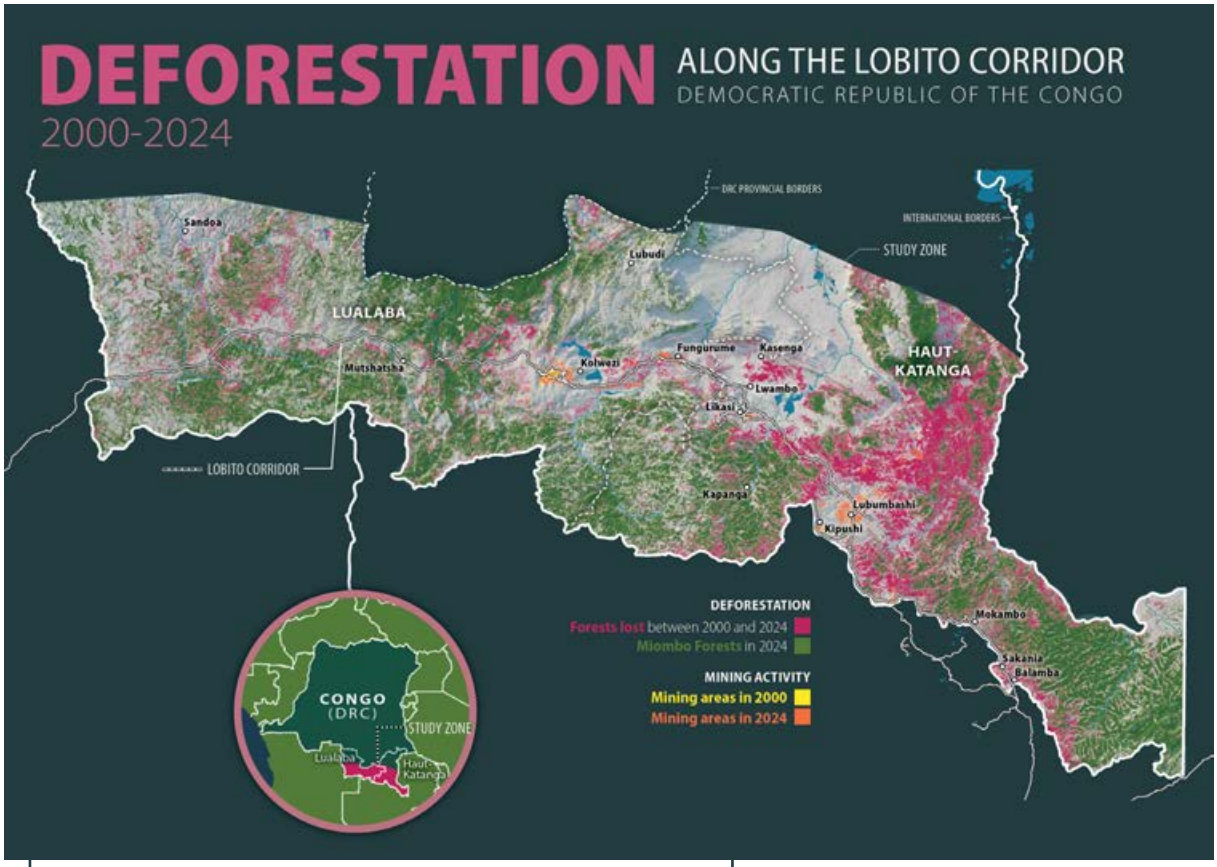
The classifications were validated for each year using a confusion matrix, comparing the classified data with reference data collected in the field. The indicators calculated on GEE include overall accuracy, producer accuracy, and user accuracy. Only classifications with an overall accuracy greater than 70% were retained, as this threshold is considered acceptable or near perfect according to the literature (Więckowska et al., 2022).

The results for 2000 (pre-liberalisation reference for the mining sector) and 2024 (recent situation) are presented in the following section to provide an overview of trends, while details for the intervening years are provided in the appendix.

IV. PRESENTATION OF RESULTS

IV.1 GENERAL SITUATION OF LAND COVER BETWEEN 2000 AND 2024

Figure 2: **Map of deforestation along the Lobito Corridor between 2000 and 2024**



Analysis of the spatio-temporal dynamics of land use in the region covering the Katanga copper belt and the Lobito Corridor has shown a decline in Miombo woodland and a remarkable increase in savannah, also in built-up areas, particularly mining areas.

This decline in forest cover has been more pronounced around towns and mining cities, as shown in the maps.

Figure 3: Variation in land use class proportions in the Katanga copper belt associated with the Lobito Corridor area

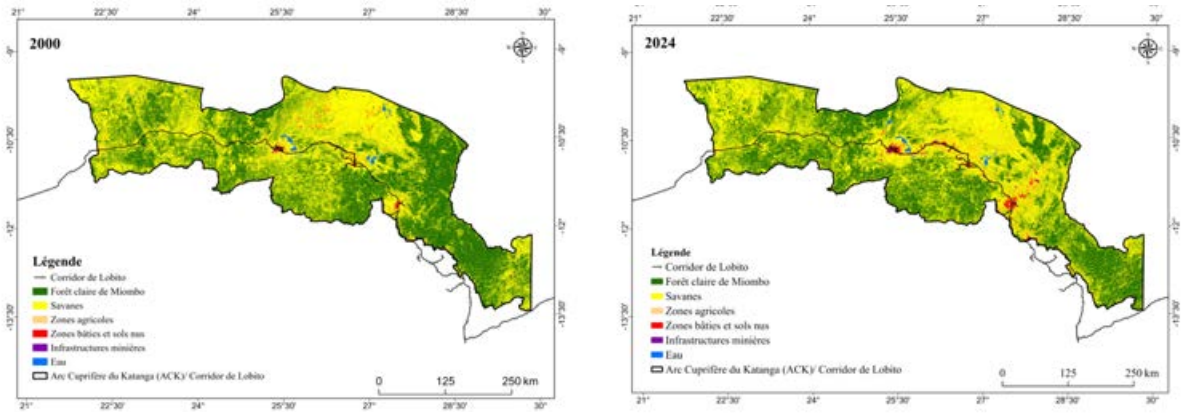
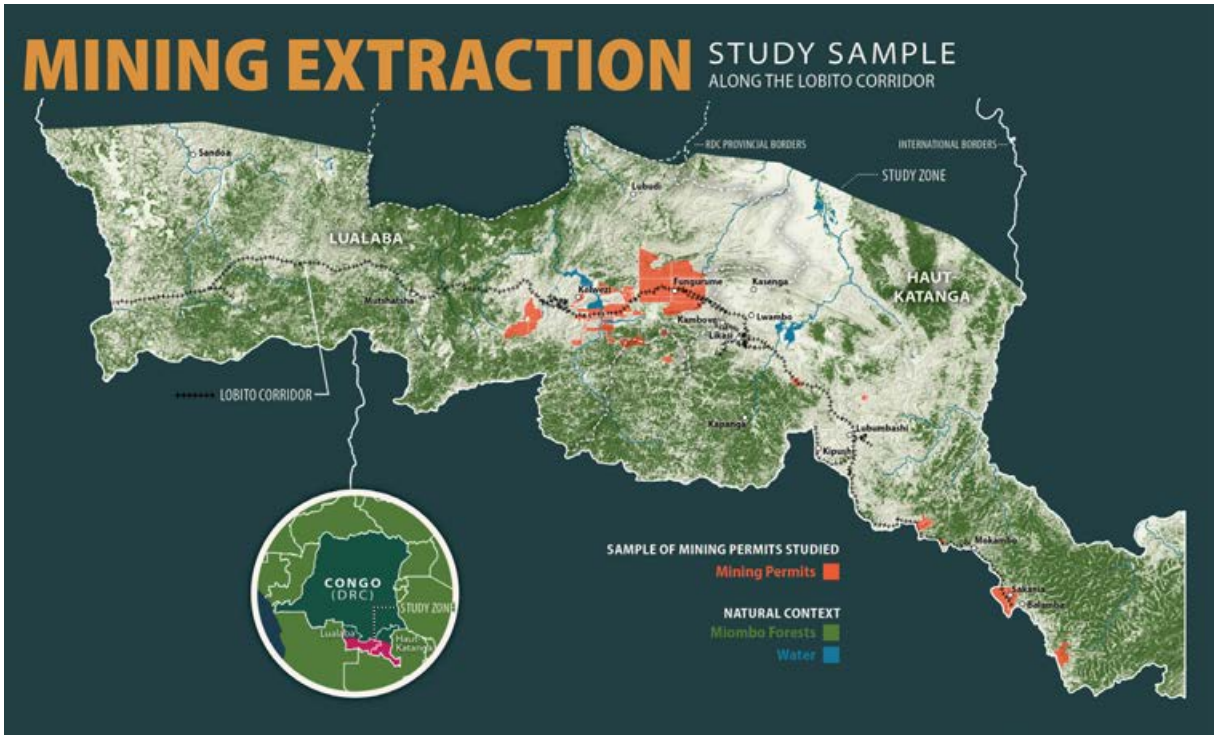


Figure 4: Map of mining operations in the study sample along the Lobito Corridor



DYNAMICS OF LAND COVER CLASS CONVERSION IN THE AREA COVERING THE KATANGA COPPER BELT AND THE LOBITO CORRIDOR

Figure 5: Evolution of land cover and land use in the area covering the Katanga copper belt and the Lobito Corridor between 2000 and 2024

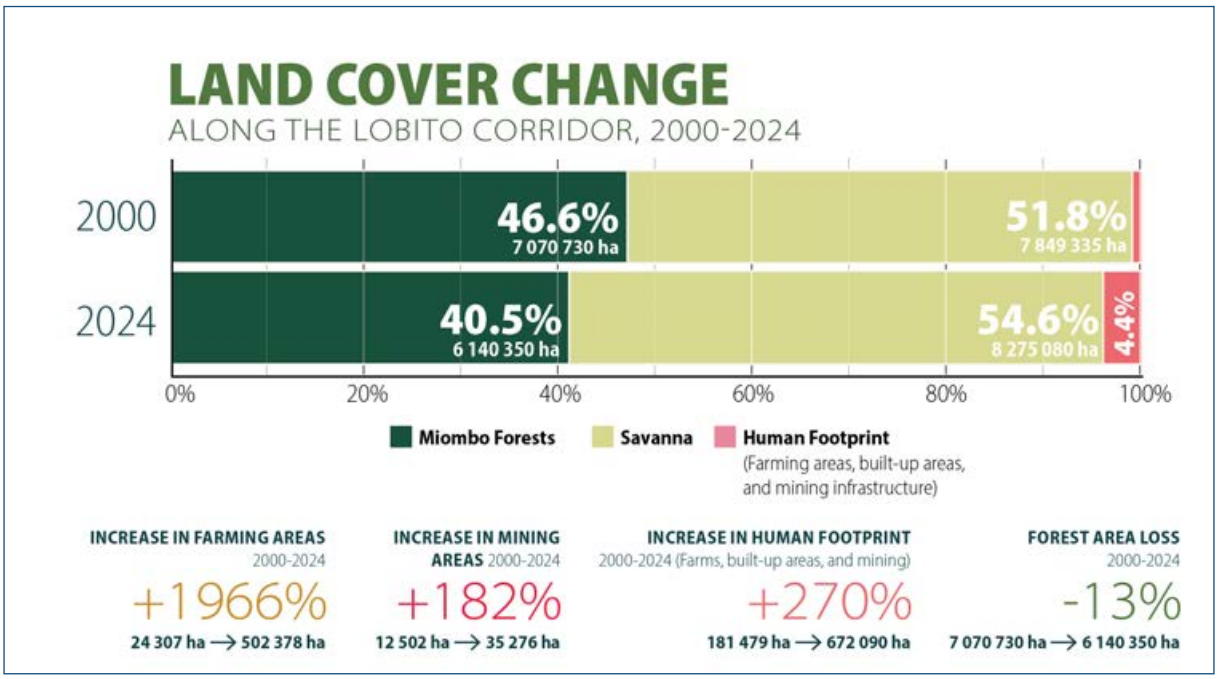


Figure 6: Dynamics of land cover conversion in the area covering the copper belt and the Lobito Corridor

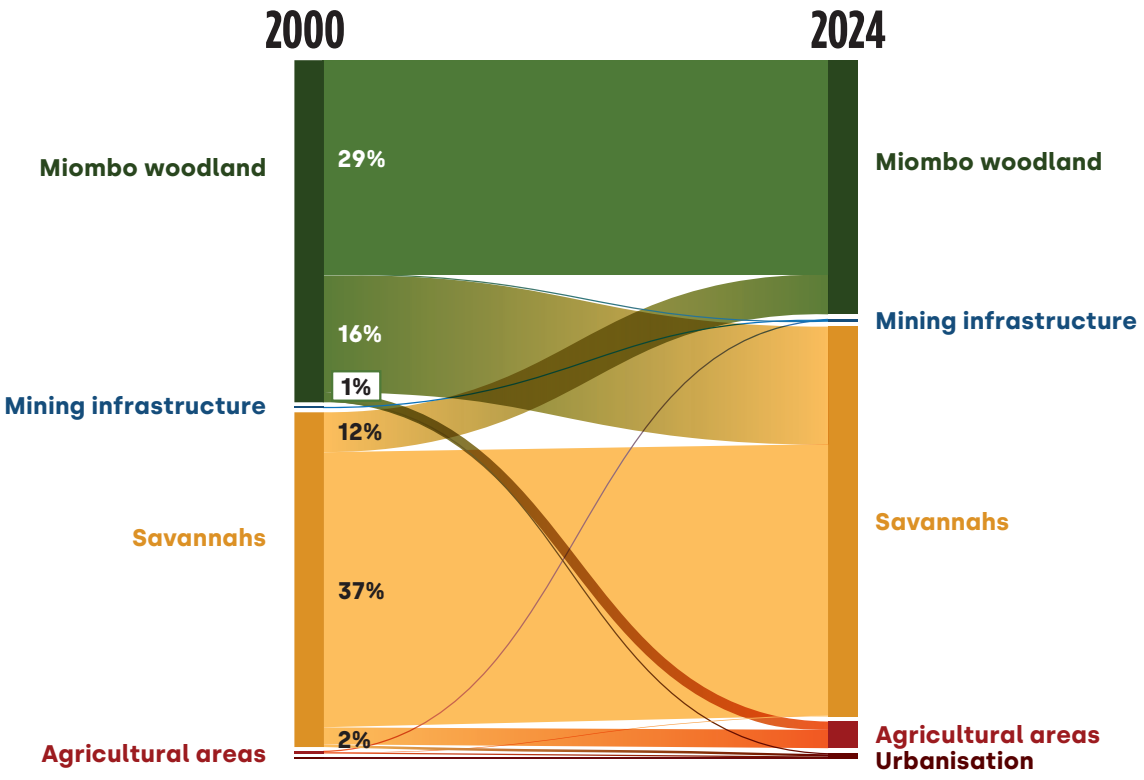


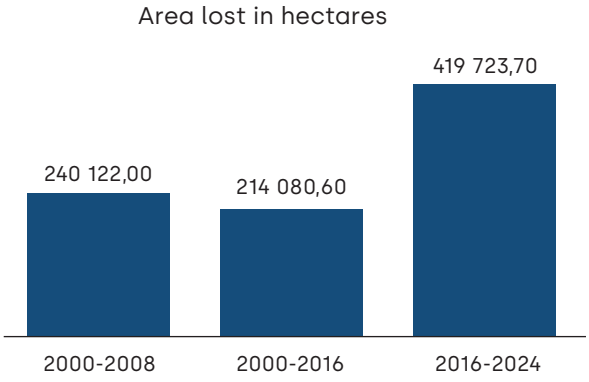
Figure 6 illustrates the main conversion dynamics that have characterised the evolution of land cover and land use classes. It shows that only 29% of 2000's forest cover remained in 2024, 16% was converted to savannah and around 1% to agricultural areas, urbanisation and mining infrastructure.

Despite this worrying trend, regeneration has also been observed - around 12% of savannahs were converted into wooded savannah between 2000 and 2024. This change corresponds to areas that were formerly forested but were cleared and then abandoned. After a phase of open savannah, these areas have gradually been recolonised by vegetation, marked by the natural regrowth of trees. Although positive, this trend towards regeneration remains marginal given the scale of deforestation and only concerns wooded savannahs of lesser ecological quality than the original Miombo woodlands.

Table 2: Area lost over three periods

Period	Area lost in hectares
2000-2008	240,122
2008-2016	214,080
2016-2024	419,723
Total	**873,926**

Figure 7: Forest area lost between: 2000-2008, 2008-2016 and 2016-2024



Between 2000 and 2024, the region recorded a total forest loss of 873,926 ha.

To better visualise the scale, this loss is equivalent to approximately 12 times the area of Lubumbashi (estimated at 74,700 ha), or on average half the area of the city lost each year. The region has lost the equivalent of 83 times the size of Paris, France (approximately 10,500 ha), or about 3.5 Parises per year.

The forest loss corresponds to approximately 1,248,466 standard 0.7 ha football pitches in 24 years, or nearly 52,019 pitches per year.

The main directly and indirect causes of this deforestation are mining activities, one of the key pillars of the DRC economy. The direct causes stem from the proliferation of mining sites since the sector was opened to multinationals, where mining infrastructure has been developed, namely open-pit mines, processing industries, roads, offices and workers' camps.

According to the Extractive Industries Transparency Initiative report 2020-2021, Haut-Katanga and Lualaba currently have 337 and 467 mining companies respectively.[14]

The impact of mining is not limited to mining areas, but also leads to indirect deforestation,[15] as the increase in mining operators is leading to a massive influx of people. These new populations increase pressure on the forest, particularly due to agricultural activities and charcoal production. This pressure is exacerbated by migration linked to illegal artisanal mining, where artisanal miners encroach on companies' mining permits. Makeshift camps form around these sites, with multiple activities contributing to tree felling, mainly agriculture and charcoal production.

Road infrastructure developed by mining companies encourages other actors to enter territories, negotiate with traditional authorities and exploit forest resources for charcoal which is then transported to urban areas such as Lubumbashi, Kolwezi, Likasi and Fungurume, where households face a severe shortage of electricity. Indeed, with the current electricity supply rate at only 21% for the province of Lualaba and 28% for Haut-Katanga,[16] charcoal remains the main source of domestic energy, particularly for cooking.

14 https://eiti.org/sites/default/files/2023-03/RAPPORT%20ITIE-RDC%202020-2021%20Adopté%20par%20le%20CE_23022023_V_Publiée%20%281%29.pdf
15 https://www.canopee.ong/faq/la-deforestation/pourquoi-lexploitation-miniere-est-elle-cause-de-deforestation
16 https://magazinelaguardia.info/2024/08/14/haut-katanga-28-de-desserte-en-electricite-oearse/

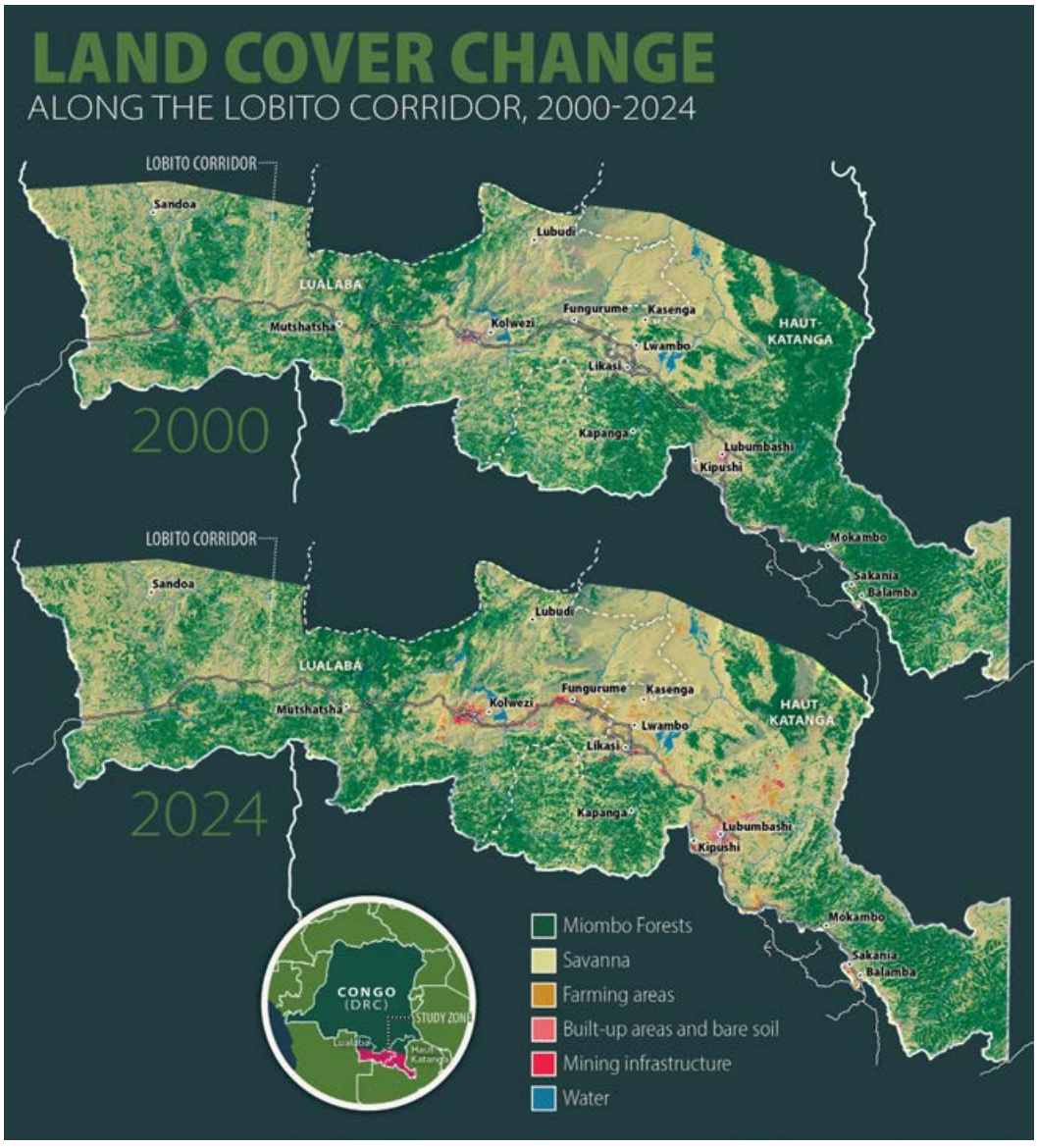
IV.3 COMPARISON OF CHANGES IN FOREST, SAVANNAH AND INFRASTRUCTURE CLASSES WITHIN THE OPERATING PERMITS OF THE COMPANIES IN THE SAMPLE

Table 3: **Dynamics of forest, savannah and infrastructure classes between 2000 and 2024**

Years	Forests	Savannah	Infrastructure
2000	117,481.396	254,561.678	10,628.64308
2024	49,764.3877	249,168.822	78,798.989

The study showed a decline in forest cover within the operating permits of the sampled companies (see Appendix 1), which in 2000, before the mining sector was opened to private companies, was 117,481 ha. Twenty-four years later, in 2024, this area is 49,764 ha, representing a loss of 67,717 ha, or 58% of vegetation cover. During the same period, infrastructure increased from 10,628 ha to 78,798 ha, an increase of 68,170 ha, equivalent to 741% growth in infrastructure.

Figure 8: **Overall change in land use between 2000 and 2024**



The rapid expansion of mining poses a direct threat to the climate, the integrity of Miombo forests and the livelihoods of local communities. Image by Didier Makal: Residents are exposed to dust kicked up by trucks carrying raw ore, west of Kisanfu.

V. CLIMATIC IMPACT OF DEFORESTATION IN THE REGION COVERING THE KATANGA COPPER BELT

Scientific literature on Miombo forests reports varying values for estimating CO_2 emissions from deforestation, depending on the region, age, rainfall and land use history. For the purposes of this study, the scientific reference of Gumbo et al., 2018 was used.

According to this reference, the average value of carbon stored in the above-ground biomass of an old-growth Miombo forest is approximately 33.9 tonnes of carbon/ha.

Based on this value, CO_2 emissions associated with deforestation were calculated by applying the standard carbon-to-CO_2 conversion factor of 3.6667 (1 tonne of carbon is equivalent to 3.6667 tonnes of CO_2), obtained from the ratio between the molar mass of carbon (12 grammes/mole (g/mol)) and that of CO_2 (44 g/mol). The average emissions per ha is thus estimated at 124.3 tonnes of CO_2 for an old-growth Miombo woodland forest.

On this basis, the estimated loss of 873,926 ha of forest between 2000 and 2024 corresponds to total emissions of 108,629,039 tonnes of CO_2e, or approximately 108.6 megatonnes. For the mining companies selected in the study sample alone, the loss of 67,717 hectares of forest translates into estimated emissions of 8,417,112 tonnes of CO_2e, or approximately 8 megatonnes.

At the local and regional level, Miombo is a key component in determining the climatic conditions of these two provinces. Through photosynthesis, it acts on the carbon cycle, removing carbon from the atmosphere and storing it in its biomass (trees and undergrowth), thereby mitigating climate change by reducing CO_2 concentrations and limiting its accumulation in the atmosphere, while also limiting warming in the region it covers.

These extra CO_2 emissions caused by direct and indirect deforestation due to mining activities, contribute to the climate change observed in the Katanga copper belt area.

CONCLUSION

This study highlights the dynamics of the regression of the Miombo woodland forest in the area covering the Katanga copper belt and the Lobito Corridor zone between 2002 and 2024, a period corresponding to the liberalisation of the mining sector in the DRC. Using Landsat satellite images, combined with GIS and remote sensing tools, the study reveals that the Miombo lost 873,926 ha of forest during this period, equivalent to approximately 12 times the city of Lubumbashi or 83 times the city of Paris.

The combined loss of Miombo woodland and the increase in infrastructure in the study area has resulted in total CO_2 emissions estimated at 108.6 megatonnes CO_2e, and 8 megatonnes CO_2e for the operating permits of the 12 mining companies studied.

In parallel, the study also demonstrates sustained growth in infrastructure, mostly mining developments, within the operating permits of the selected companies. This evolution reflects the intensification and scale of mining activities.

It also shows the tension created by this mining infrastructure and competition for land as changes are triggering an increase in charcoal production (a source of quick income) and agriculture (long-term food security), illustrating the dilemmas faced by communities in a context of energy and land insecurity.

This contradiction between global climate objectives and local impacts highlights the need for a truly equitable approach to the energy and digital transition, which ensures that ecosystems are preserved and community rights are respected.

APPENDICES

APPENDIX 1 SUMMARY OF DATA ON DEFORESTATION BY MINING COMPANIES I N THE KATANGA COPPER BELT

Companies	2000	2008	2016	2024	TDA (%)	CO_2 released (tonnes)
BOSS MINING	20089	19,576.8	18,099.6	13,271.1	-0.931	847,784.5
CHEMAF	8,137.52	7,605.71	7,427.21	5,006.19	-1.6033	389,298
COMIDE	9,637.58	8,603.22	6,496.85	3,924.76	-2.4699	710,466
FRONTIER S.A.	15,216.8	8,950.59	5,987.5	4,257.43	-3.0009	1,362,774
KAMOA COPPER	6,906.05	6,251.49	4,917.2	3,934.16	-1,793	369,080
KISANFU MINING	972,706	876,793	654,718	272,826	-2,998	87,064
KISENDA MINING	7,983.56	4,902.92	5,154.93	3,715.53	-2.2275	530,537
MMG	1,886.66	1147.63	182.016	47.6387	-4.0615	228,731
MUTANDA MINING	4,624.82	3,480.89	1,725.01	291.693	-3.9039	538,798
SABWE MINING	11,025	8,854.87	7,263.31	4,638.84	-2.4135	793,809
SEK KIPOI	4,983.1	4,351.05	2,817.99	1484.7	-2.9252	434,820
TFM	26,017.9	24,438.8	20,939.3	8,919.52	-2.7382	2,123,951

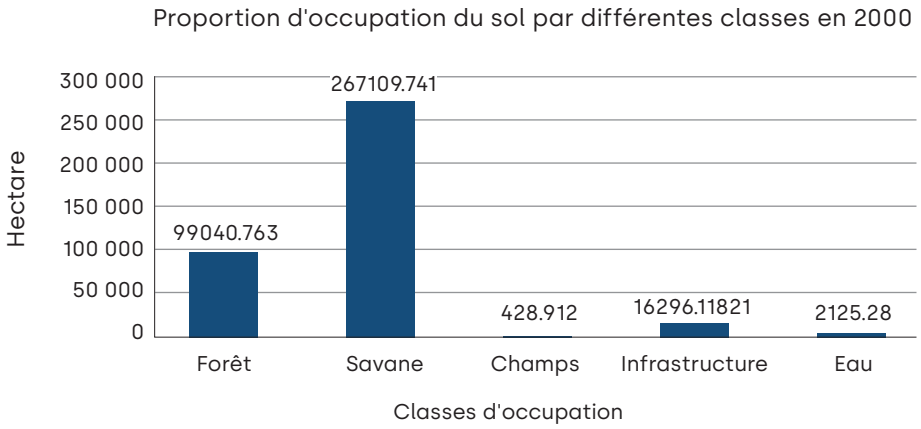
APPENDIX 2 OVERVIEW OF DEFORESTATION BY MINING COMPANIES BETWEEN 2000 AND 2024

OVERVIEW OF DEFORESTATION AT COMPANY LEVEL IN 2000

Table 2.A: **Overview of land use classes within the operating permits of companies in the sample in 2000 in ha**

Company	Forests/ha	Savannah/ha	Fields/ha	Infrastructure/ha	Water
Boss Mining	20,089.7	20,613.2		1014.46	
Chemaf	8,137.52	30,516.8		1,856.68	2,147.67
Comidé	9,637.58	11,121.5		78.1524	
Frontier S.A.	15,216.8	12,473.9		699.2381572	
Kamoa Copper	6,906.05	31,310.9	57.7636	1036.55	4.62
Kinsafu Mining	972.706	2,225.32		10.74	
Kinsenda Mining	7,983.56	3,889.03		610.5122998	
MMG	1886.66	203.867		4.20832	
Mutanda Mining	4,624.82	12,505.3		143,917	114.446
Sabwe Mining	11,025	2,368.35		15.3849	
SEK Kipoï	4,983.1	626.511		5.85	
TFM	26,017.9	126,707		5,152.95	
Total	**117,481.396**	**254,561.678**	**57.7636**	**10,628.64308**	**2,266.736**

Figure 2.A: Area occupied by each soil class in hectares within the operating permits of the companies in the sample in 2000

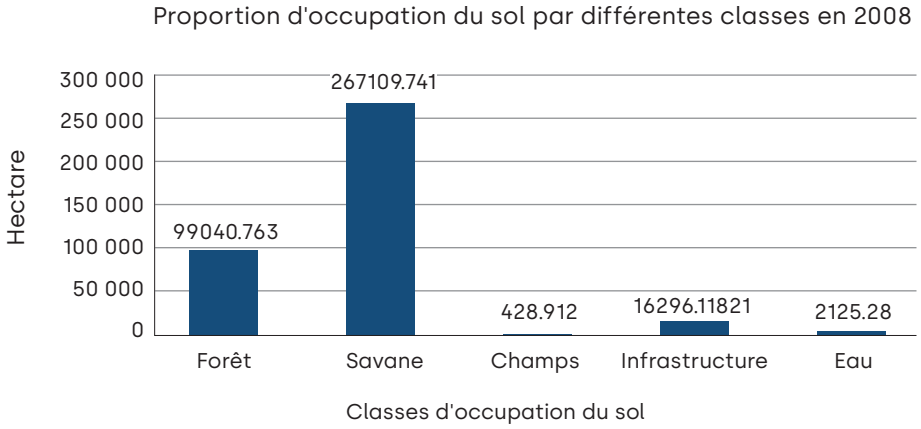


STATUS OF DEFORESTATION AT COMPANY LEVEL IN 2008

Table 2.B: Status of land use classes within the operating permits of the companies in the sample in 2008 in ha

Company	Forests/ha	Savannah/ha	Fields/ha	Infrastructure/ ha	Water
Boss Mining	19,576.8	20,569.2		1,571.19	
Chemaf	7,605.71	31,692.5		1,337.84	2022.68
Comidé	8,603.22	12,064.5		169.356	
Frontier S.A.	8,950.59	17,329.6		2,109.797461	
Kamoa Copper	6,251.49	32,556.3	428.912	79.5675	3.3
Kinsafu Mining	876,793	2,312.63		19.2904	
Kinsenda Mining	4,902.92	6,909.25		671.506349	
MMG	1,147.63	554.301		392.702	
Mutanda Mining	3,480.89	13,579.5		229.02	99.3
Sabwe Mining	8,854.87	3,903.81		650.232	
SEK Kipoï	4,351.05	1189.15		75.3565	
TFM	24,438.8	124,449		8,990.26	
Total	**99,040.763**	**267,109.741**	**428,912**	**16,296.11821**	**2125.28**

Figure 2.B: Area occupied by each soil class in hectares within the operating permits of the companies in the sample in 2008

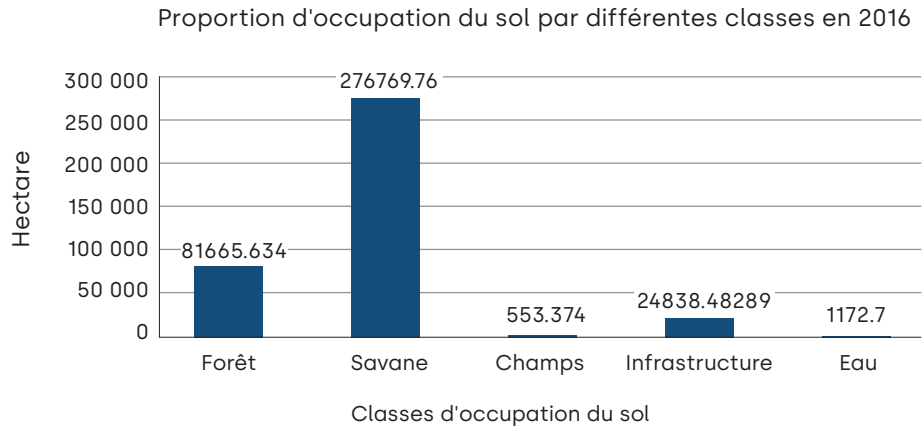


STATUS OF DEFORESTATION AT COMPANY LEVEL IN 2016

Table 2.C: Status of land cover classes within the operating permits of the companies in the sample in 2016 in ha

Company	Forests/ha	Savannah/ha	Fields	Infrastructure/ha	Water
Boss Mining	18,099.6	20,979.7		2,638.05	
Chemaf	7,427.21	32,091.9		2,069.14	1070.22
Comidé	6,496.85	13,631.8		708.466	
Frontier S.A.	5,987.5	20,606.2		1,795.93842	
Kamoa Copper	4,917.2	33,546.7	553.374	301.025	2.52
Kinsafu Mining	654,718	2,549.62		4.32226	
Kinsenda Mining	5,154.93	6,166.85		1,160.936208	
MMG	182.016	1,276.64		636.042	
Mutanda Mining	1,725.01	14,140.5		1423.3	100,024
Sabwe Mining	7,263.31	5,773.6		371.795	
SEK Kipoï	2817.99	2,454.25		343,268	
TFM	20,939.3	123,552		13,386.2	
Total	**81,665.634**	**276,769.76**	**553,374**	**24,838.48289**	**1,172.764**

Figure 2.C: Area occupied by each soil class in hectares within the operating permits of the companies in the sample in 2016

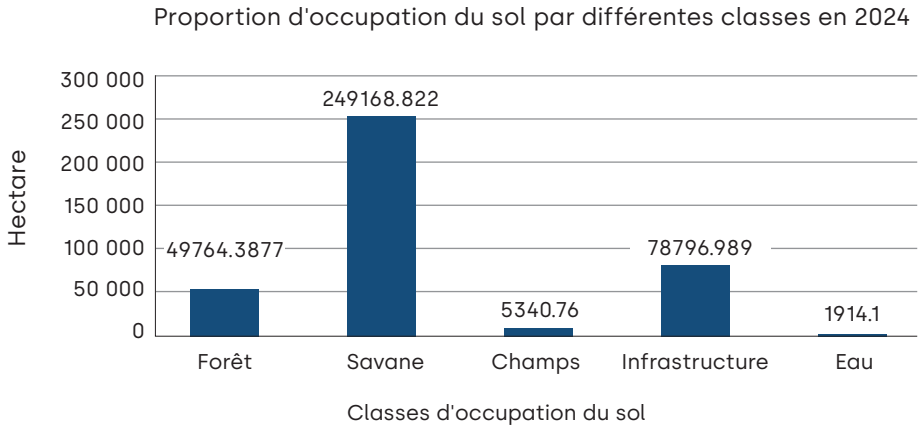


STATUS OF DEFORESTATION AT COMPANY LEVEL IN 2024

Table 2.D: Status of land use classes within the operating permits of the companies in the sample in 2024 in ha

Company	Forests/ha	Savannah/ha	Fields	Infrastructure/ha	Water
Boss Mining	13,271.1	22,914.8		5,531.47	
Chemaf	5,006.19	26,911.1		8,951.49	1,789.63
Comidé	3,924.76	12,664.8		4,247.88	
Frontier S.A.	4,257.43	18,156.7		5,975.550799	
Kamoa Copper	3,934.16	27,612.1	5,350.76	2,417.16	3.27
Kinsafu Mining	272.826	1,377.34		1558.6	
Kinsenda Mining	3,715.53	6,740.34		2026.678203	
MMG	47.6387	846.932		1,200.17	
Mutanda Mining	291.693	11,875.3		5,100.47	121.2
Sabwe Mining	4,638.84	7,443.41		1,326.33	
SEK Kipoï	1484.7	2831		1299.89	
TFM	8919.52	109,795		39,163.3	
Total	**49,764.3877**	**249,168.822**	**5,340.76**	**78,798.989**	**1914.1**

Figure 2.D: Area occupied by each soil class in hectares within the operating permits of the companies in the sample in 2024



APPENDIX 3 SUMMARY OF LAND USE CLASS DYNAMICS IN EACH COMPANY IN THE SAMPLE

Figure 3.A: Comparison of the dynamics of forest, savannah and infrastructure classes between 2000 and 2024 in ha within the companies in the sample

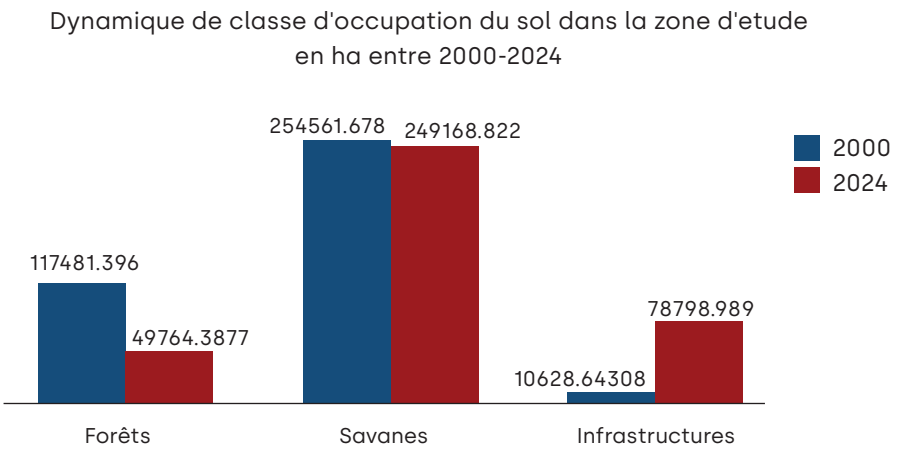


Figure 3.B: Regression of the forest class within the companies in the sample between 2000 and 2024

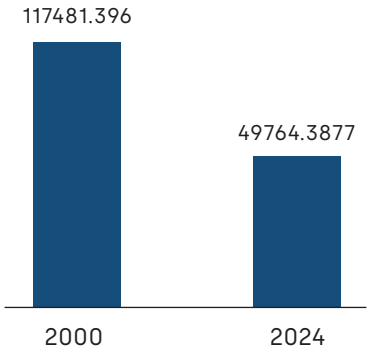
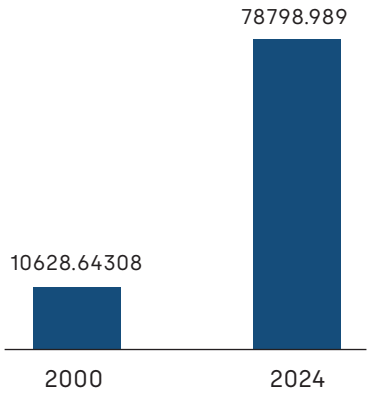


Figure 3.C: Growth of infrastructure within the operating permits of the companies in the sample



APPENDIX 4 DYNAMICS OF LAND USE CLASSES IN EACH COMPANY IN THE SAMPLE

BOSS MINING

Figure 4.A: Map showing changes in Miombo woodland in Boss Mining's Permis d'Exploitation (Exploitation Permit (PE))

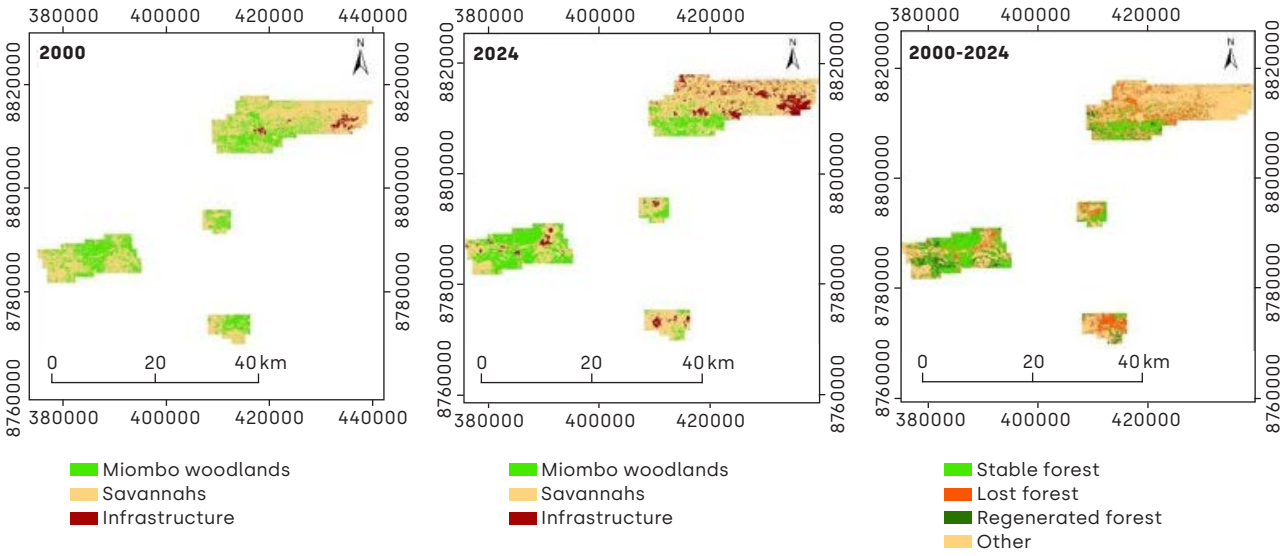
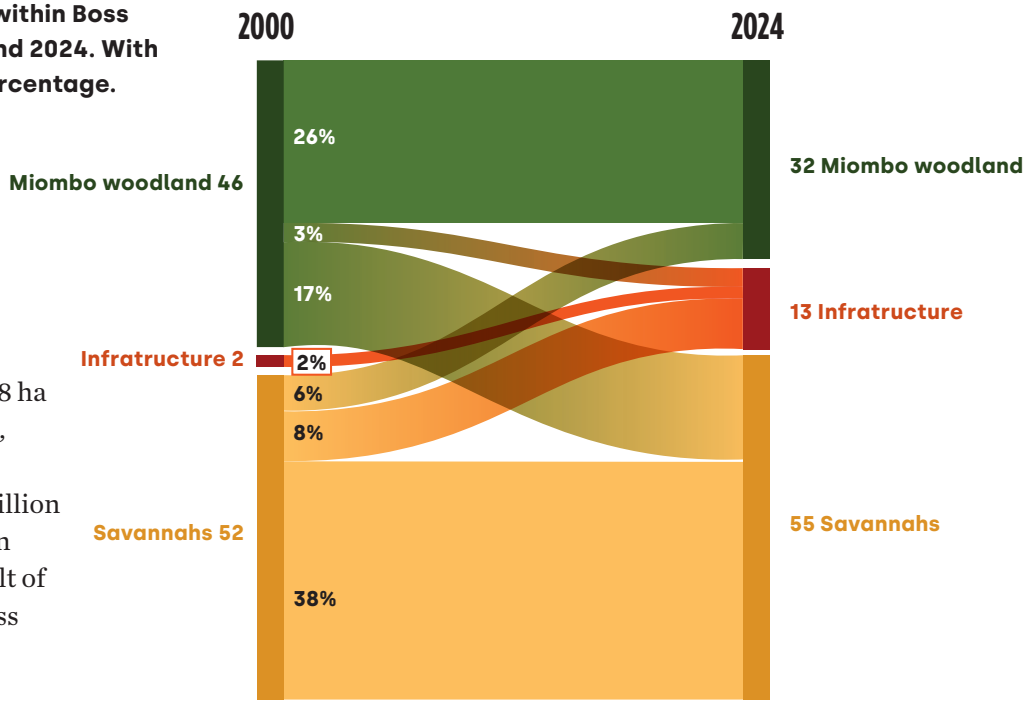


Table 4.A: Map showing changes in the area (ha) of Miombo woodland in the mining permits of the BOSS MINING company. Where Total Deforestation Period (TDP) is the periodic deforestation rate (between 2000 and 2024) and Total Deforestation Annual (TDA) is the annual deforestation rate

	Forest	Savannah	Infrastructure
2000	2008	20613.2	1014.46
2008	19,576.8	20,569.2	1,571.19
2016	18,099.6	20,979.7	2,638.05
2024	13,271.1	22,914.8	5,531.47
TDP	-22.344%		
TDA	-0.931%		

Figure 4.B: Conversion dynamics of the Miombo woodland within Boss Mining between 2000 and 2024. With conversion values in percentage.



With an area loss of 6,818 ha between 2000 and 2024, 847,784 tonnes of CO_2 (approximately 0.848 million tonnes) emitted between 2000 and 2024 as a result of deforestation within Boss Mining.

CHEMAF

Figure 4.C: Map showing changes in the Miombo woodland in CHEMAF's PE.

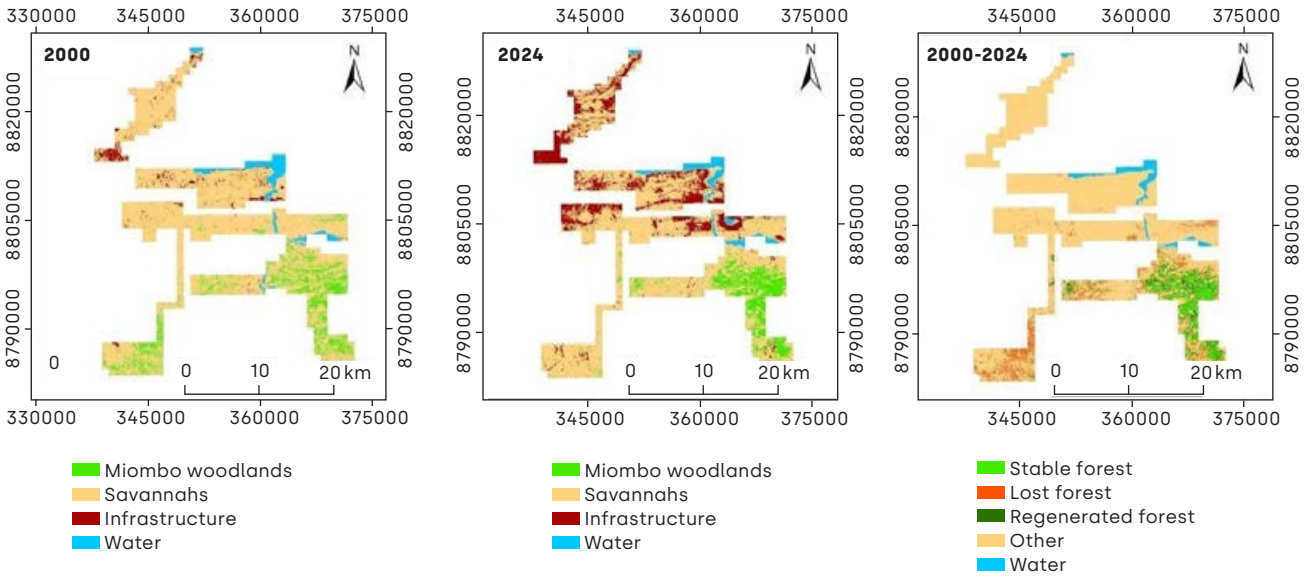
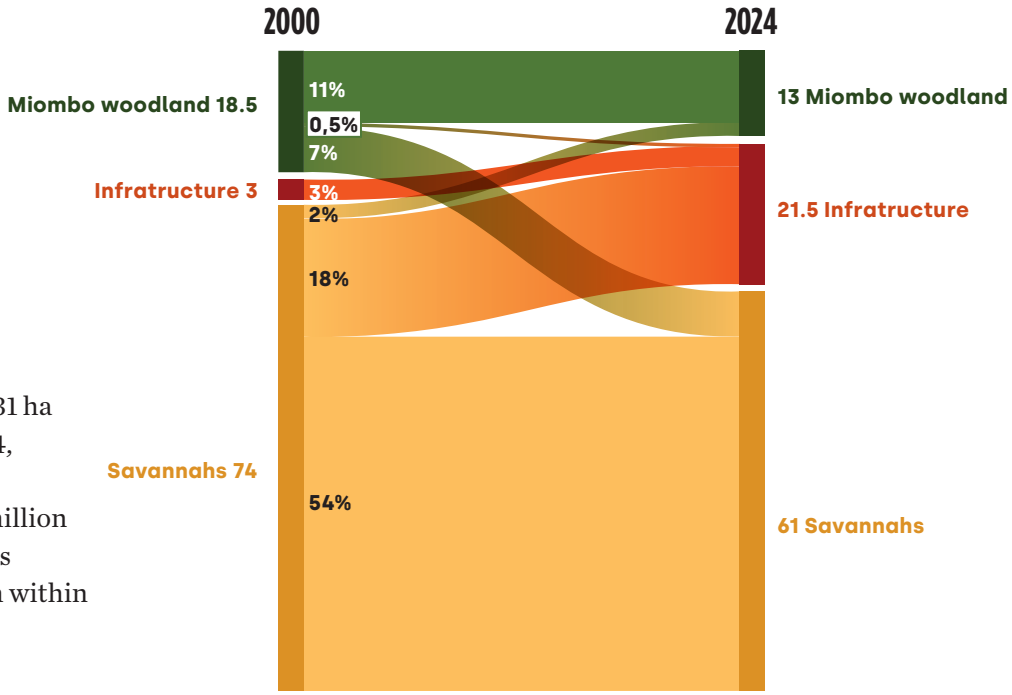


Table 4.B: Map showing changes in the area (ha) of Miombo woodland in CHEMAF's PEs. Where TDP is the periodic deforestation rate (between 2000 and 2024) and TDA is the annual deforestation rate.

	Forest	Savannah	Infrastructure	Water
2000	8,137.52	30,516.8	1,856.68	2147.67
2008	7,605.71	31,692.5	1,337.84	2022.68
2016	7,427.21	32,091.9	2069.14	1,070.22
2024	5,006.19	26,911.1	8,951.49	1,789.63
TDP	-38.48			
TDA	-1.6033			

Figure 4.D: Conversion dynamics of the Miombo woodland within CHEMAF between 2000 and 2024. With conversion values in percentage.



With a forest loss of 3,131 ha between 2000 and 2024, 389,298 tonnes of CO_2 (approximately 0.389 million tonnes) were released as a result of deforestation within CHEMAF.

COMIDE

Figure 4.E: Map showing changes in the area (ha) of Miombo woodland in COMIDE's PEs.

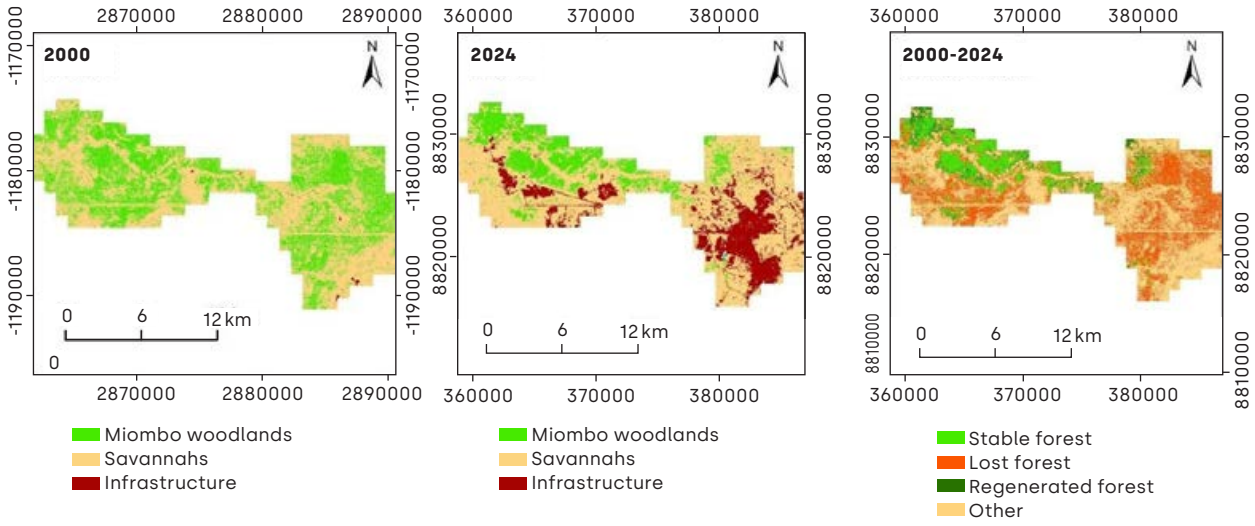
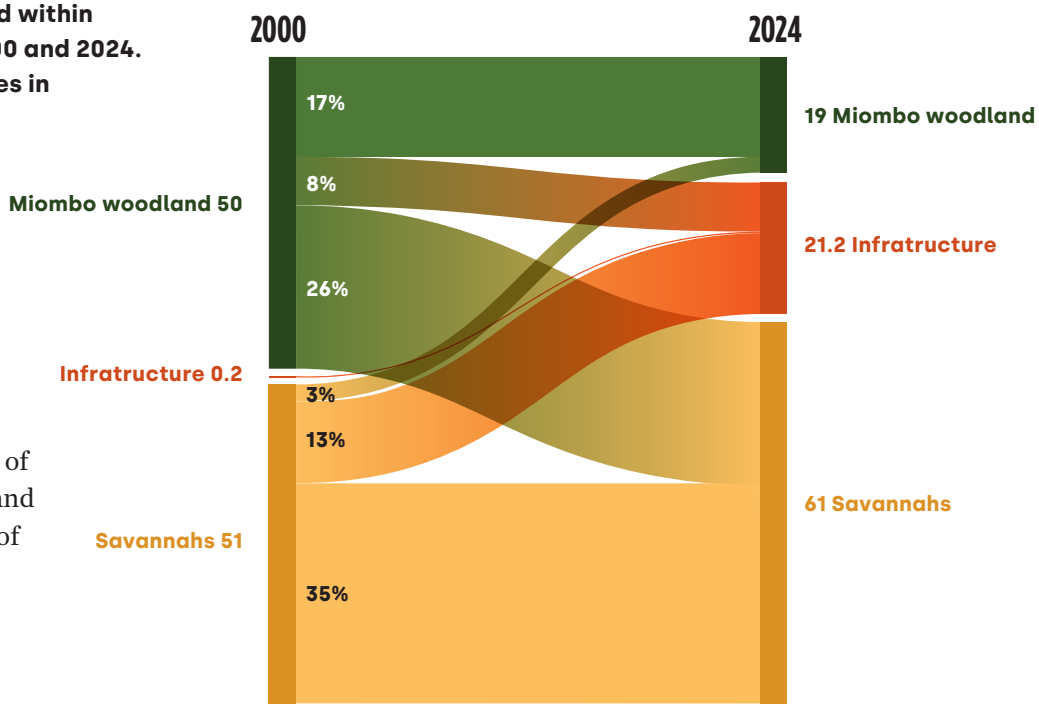


Table 4.C: Map showing changes in the area (ha) of Miombo woodland in COMIDE's PEs. Where TDP is the periodic deforestation rate (between 2000 and 2024) and TDA is the annual deforestation rate

	Forest	Savannah	Infrastructure
2000	9637.58	11,121.5	78.1524
2008	8,603.22	12,064.5	169.356
2016	6,496.85	13,631.8	708,466
2024	3,924.76	12,664.8	4,247.88
TDP	-59.277		
TDA	-2.4699		

Figure 4.F: Conversion dynamics of the Miombo woodland within COMIDE between 2000 and 2024. With conversion values in percentage.



With a loss of 5,712 ha of forest between 2000 and 2024, 710,466 tonnes of CO_2 (approximately 0.71 million tonnes) emitted as a result of deforestation within COMIDE.

FRONTIER S.A.

Figure 4.G: Map showing changes in the Miombo woodland forest in the PEs of the FRONTIER S.A. company.

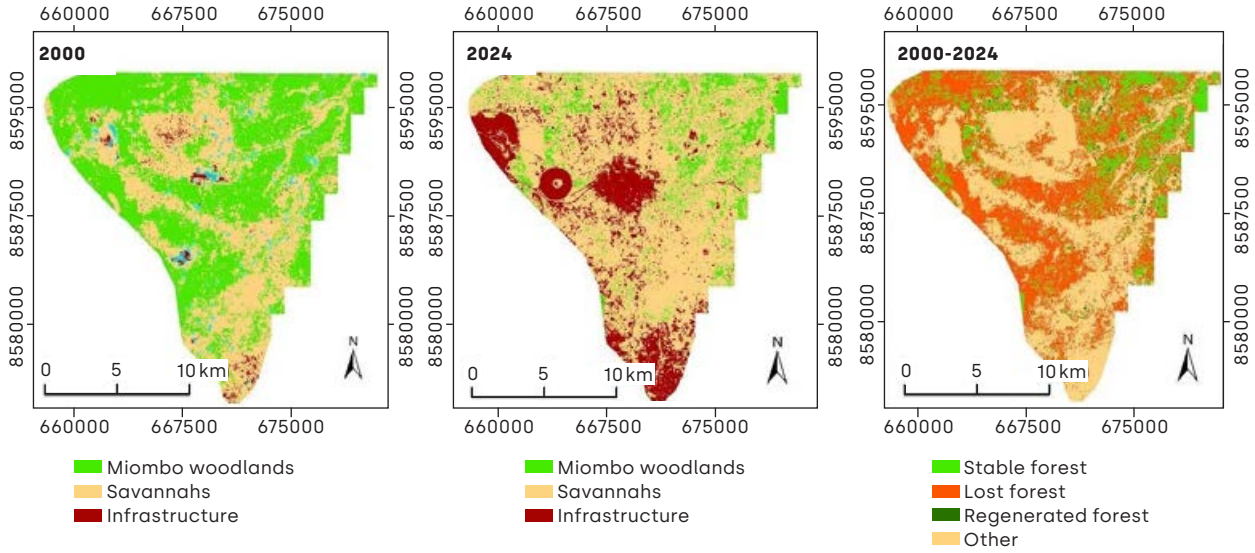
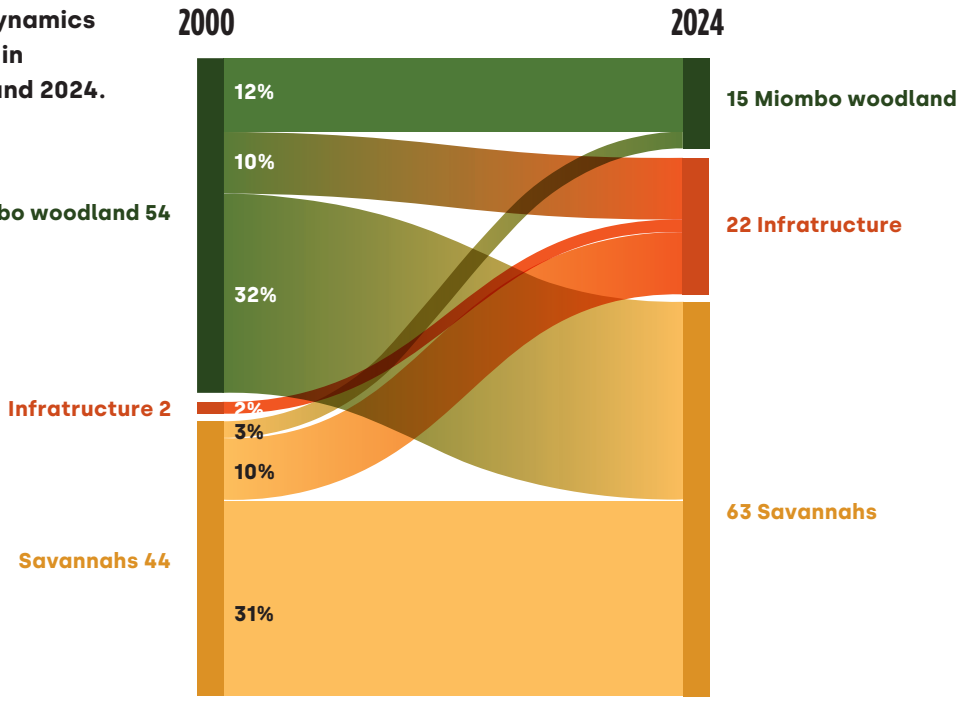


Table 4.D: Map showing changes in the area (ha) of Miombo woodland in the PEs of the FRONTIER company.

Classes	Forest	Savannah	Infrastructure
2000	15,216.8	12,473.9	699.2381572
2008	8,950.59	17,329.6	2,109.797461
2016	5,987.5	20,606.2	1,795.93842
2024	4,257.43	18,156.7	5,975.550799
TDP	-72.021		
TDA	-3.0009		

Figure 4.H: Conversion dynamics of Miombo woodland within FRONTIER between 2000 and 2024. With conversion values in percentage.



With a loss of 10,959 ha of forest between 2000 and 2024, 1,362,774 tonnes of CO_2 (approximately 1.36 million tonnes) released as a result of deforestation within FRONTIER S.A.

KAMOA COPPER

Figure 4.I: Map showing changes in the Miombo woodland forest in the PEs of the KAMOA COPPER company.

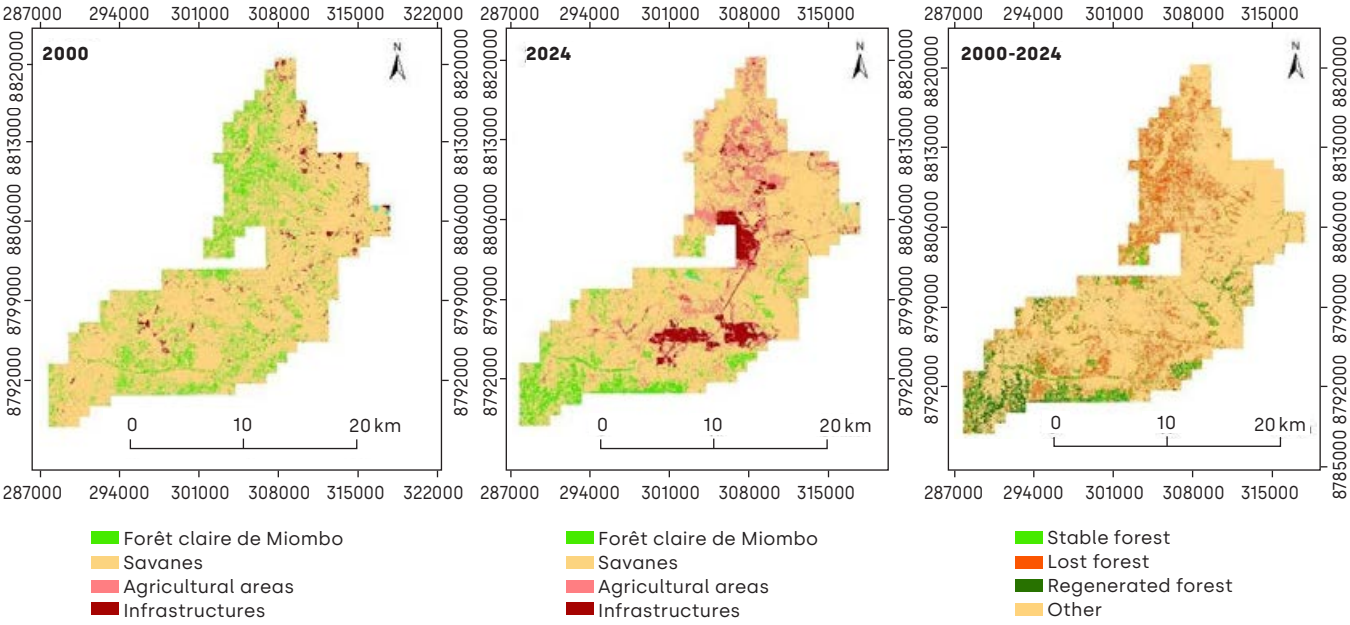
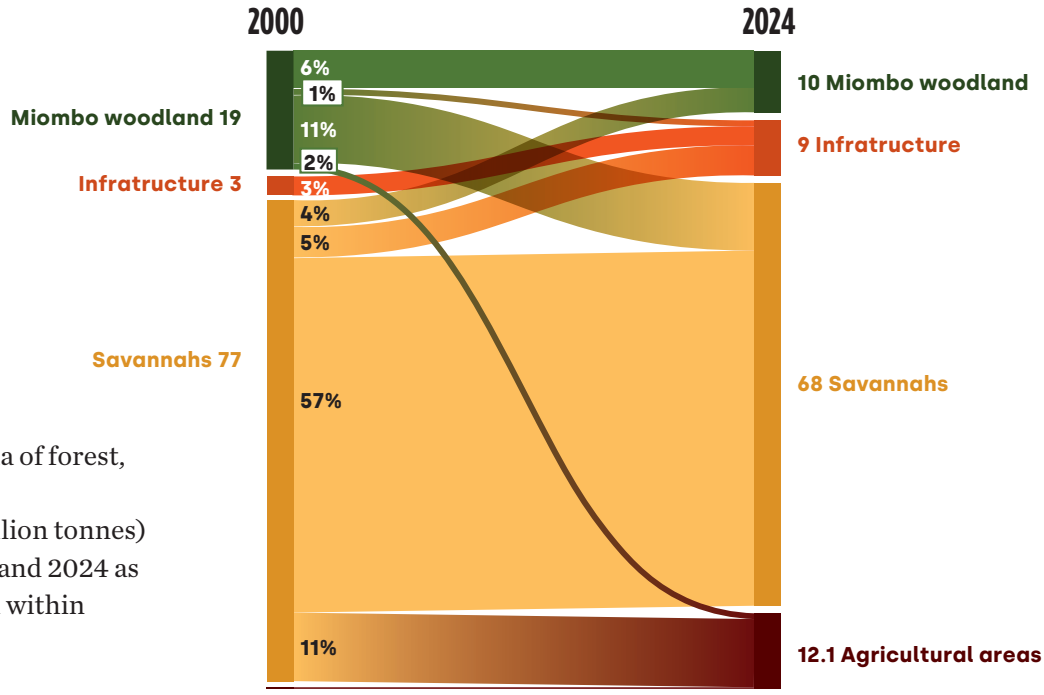


Table 4.E: Map showing changes in the area (ha) of miombo woodland in the PEs of the KAMOA COPPER company.

Classes	Forest	Savannah	Fields	Infrastructure	Water
2000	6,906.05	31,310.9	57.7636	1036.55	4.62
2008	6,251.49	32,556.3	428.912	79.5675	3.3
2016	4,917.2	33,546.7	553.374	301.025	2.52
2024	3,934.16	27,612.1	5,350.76	2,417.16	3.27
TDP	-43.033				
TDA	-1.793				

Figure 4.J: Conversion dynamics of the Miombo woodland within KAMOA COPPER between 2000 and 2024. With conversion values in percentage.



With a loss of 2,971.89 ha of forest, 369,080 tonnes of CO_2 (approximately 0.37 million tonnes) released between 2000 and 2024 as a result of deforestation within KAMOA COPPER.

KISANFU MINING

Figure 4.K: Map showing changes in the Miombo woodland forest in the PEs of the KISANFU MINING company.

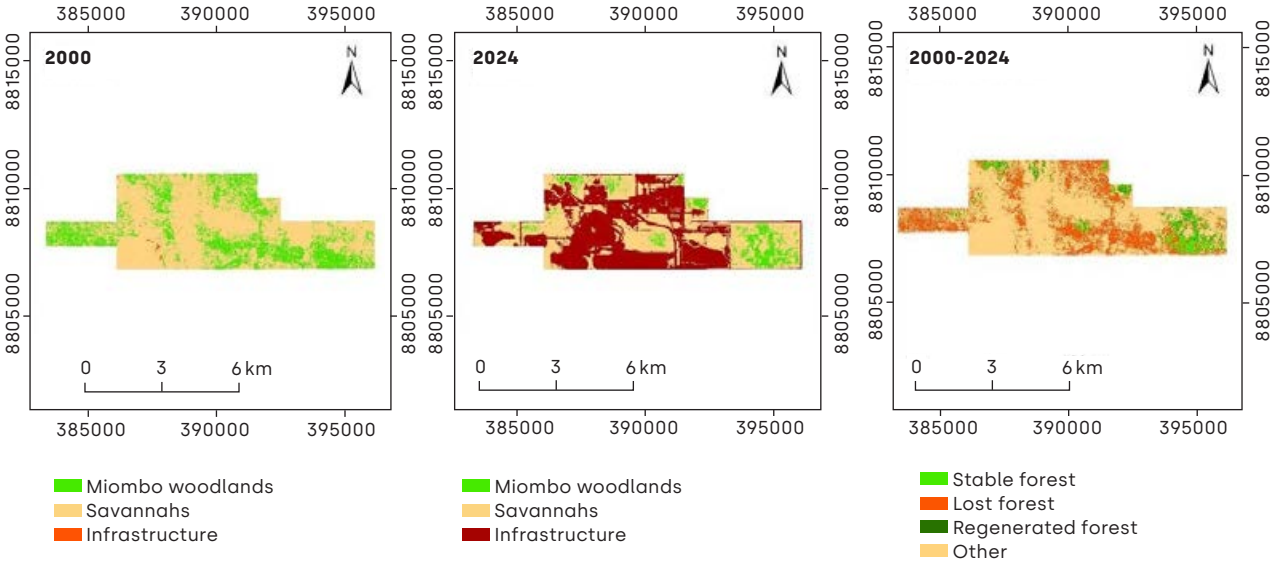
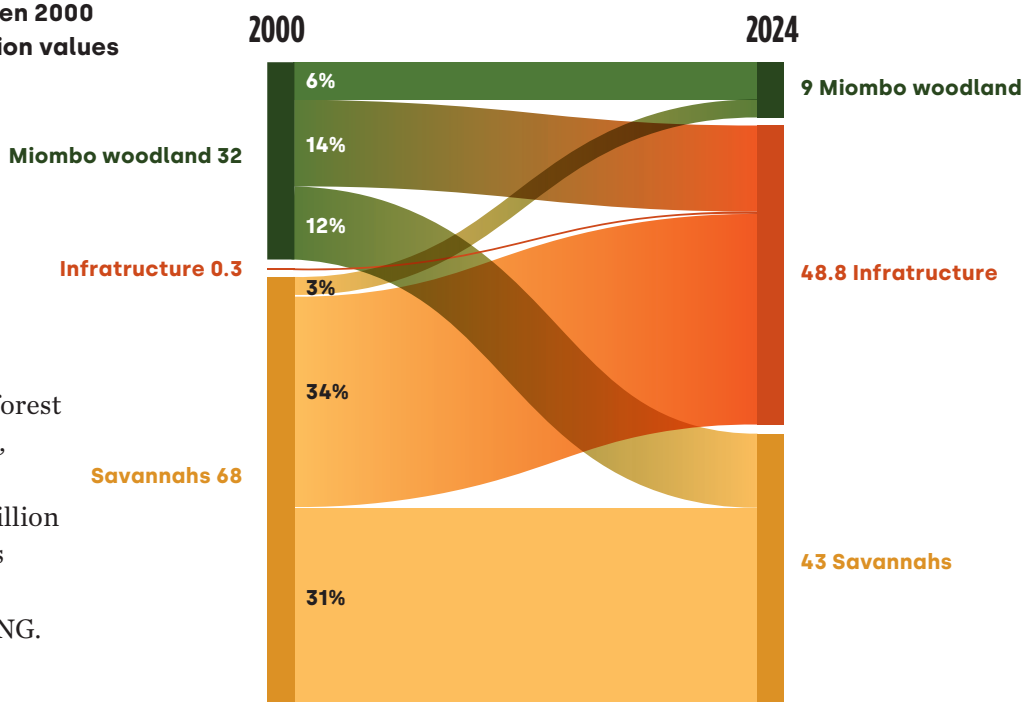


Table 4.F: Map showing changes in the area (ha) of Miombo woodland in the PEs of the KISANFU MINING company.

Classes	Forest	Savannah	Infrastructure
2000	972,706	2225,32	10,74
2008	876,793	2312,63	19,2904
2016	654,718	2549,62	4,32226
2024	272,826	1377,34	1558,6
TDP	-71,952		
TDA	-2,998		

Figure 4.L: Conversion dynamics of the Miombo woodland within KISANFU MINING between 2000 and 2024. With conversion values in percentage.



With a loss of 699 ha of forest between 2000 and 2024, 87,064 tonnes of CO_2 (approximately 0.087 million tonnes) were released as a result of deforestation within KISANFU MINING.

KISENDA MINING

Figure 4.M: **Map showing changes in the Miombo woodland forest in the PEs of the KISENDA MINING company.**

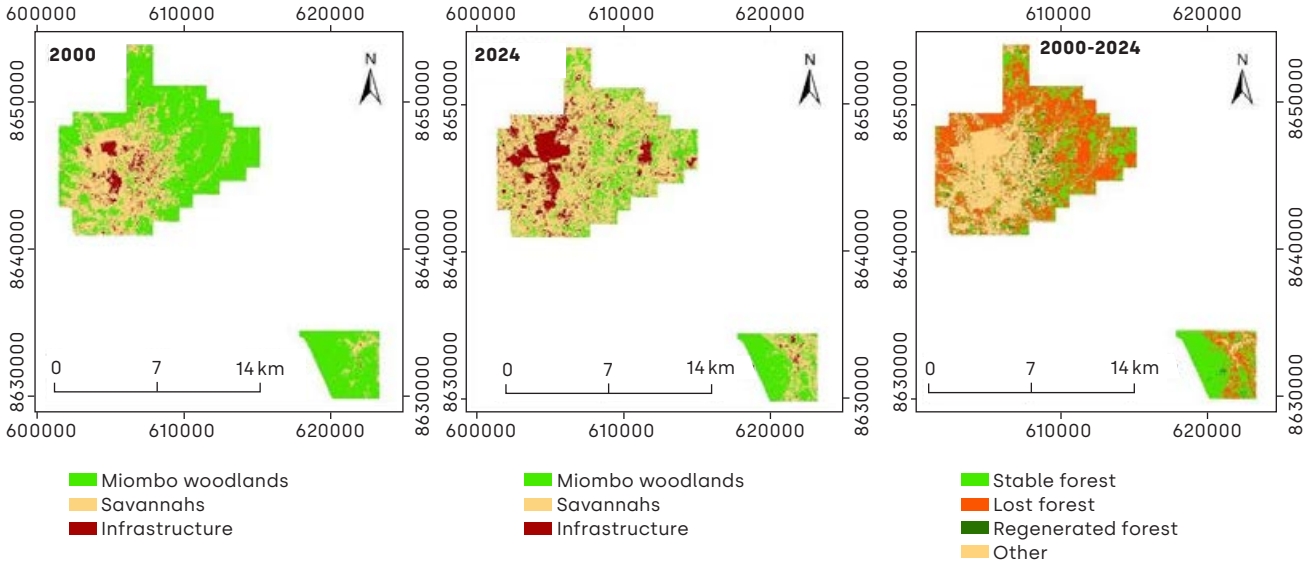
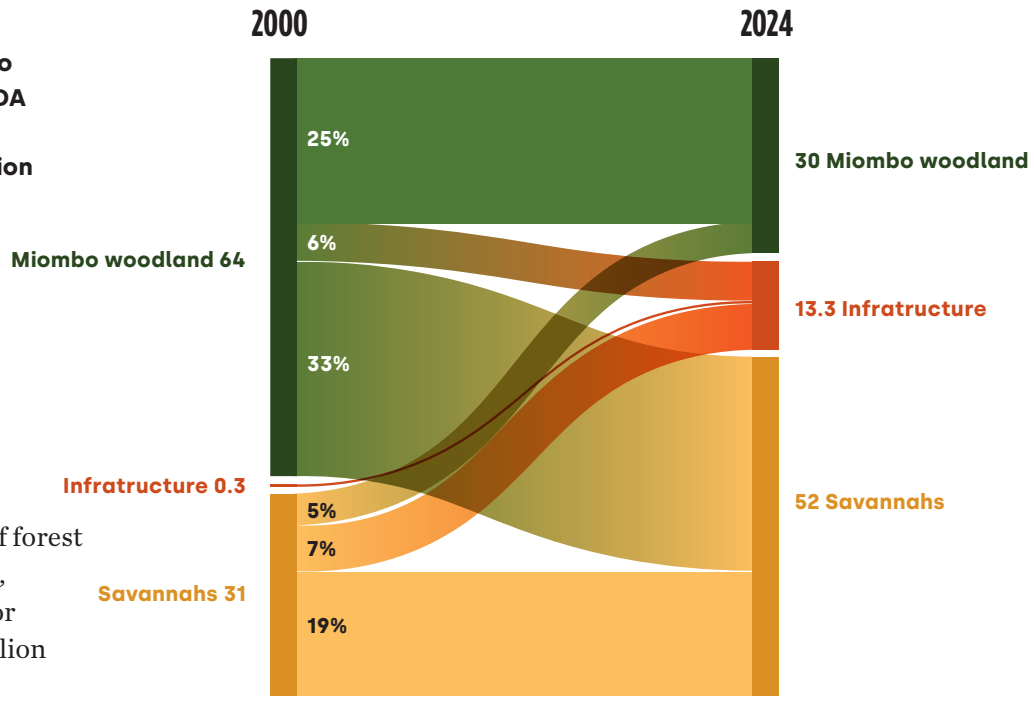


Table 4.G: **Map showing changes in the area (ha) of Miombo woodland in the PEs of the KISENDA MINING company.**

Classes	Forest	Savannah	Infrastructure
2000	7,983.56	3,889.03	610.5122998
2008	4,902.92	6,909.25	671.506349
2016	5,154.93	6,166.85	1,160.936208
2024	3,715.53	6,740.34	2026.678203
TDP	-53.46		
TDA	-2.2275		

Figure 4.N: **Conversion dynamics of the Miombo woodland within KISENDA MINING between 2000 and 2024. With conversion values in percentage.**



With a loss of 4,268 ha of forest between 2000 and 2024, 530,537 tonnes of CO_2, or approximately 0.531 million tonnes, were released as a result of deforestation at KISENDA MINING.

MMG

Figure 4.O: Map showing changes in the open Miombo forest in MMG's PEs.

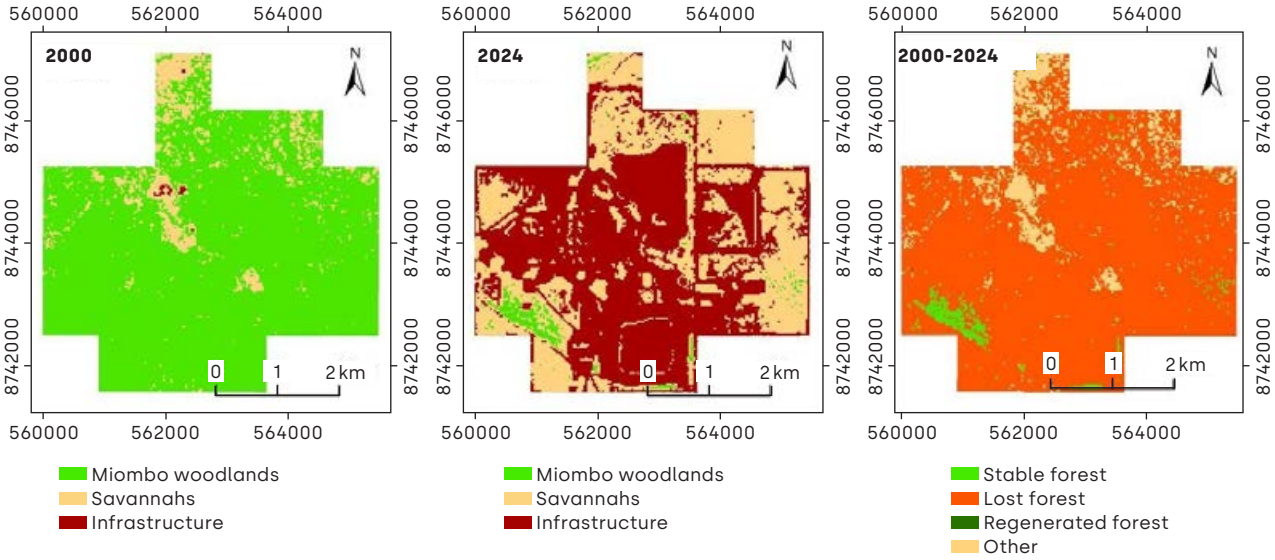
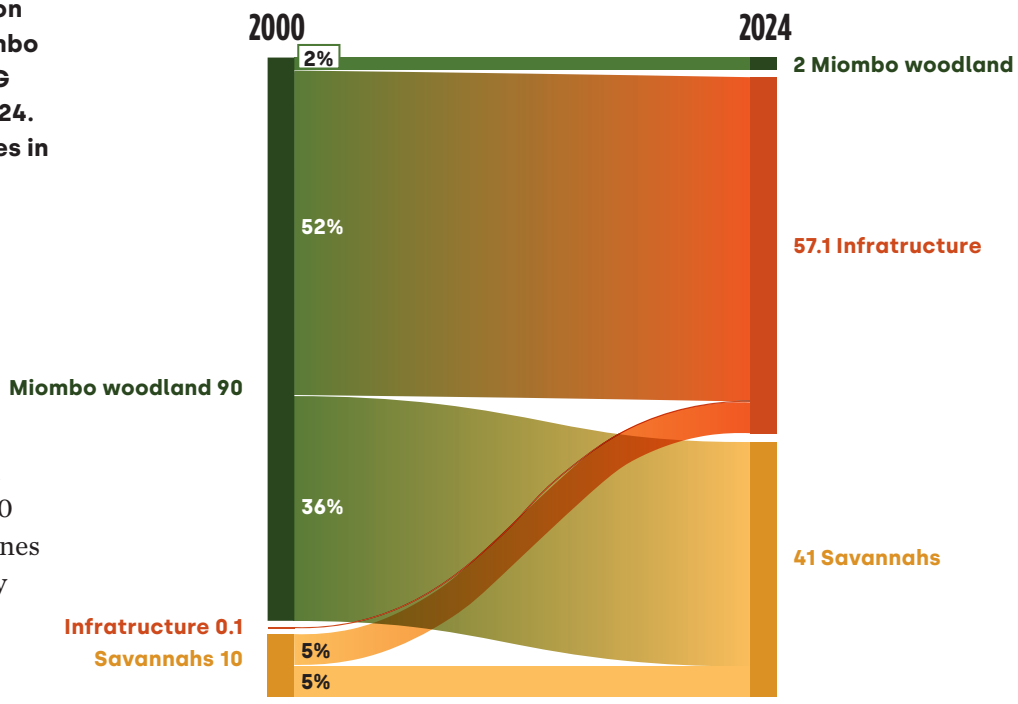


Table 4.H: Map showing changes in the area (ha) of Miombo woodland in MMG's PEs.

Classes	Forest	Savannah	Infrastructure
2000	1886.66	203.867	4.20832
2008	1,147.63	554,301	392,702
2016	182,016	1,276.64	636,042
2024	47.6387	846.932	1,200.17
TDP	-97.475		
TDA	-4.0615		

Figure 4.P: Conversion dynamics of the Miombo woodland within MMG between 2000 and 2024. With conversion values in percentage.



With a loss of 1,839 ha of forest between 2000 and 2024, 228,731 tonnes of CO_2 (approximately 0.229 million tonnes) released as a result of deforestation within MMG.

MUTANDA MINING

Figure 4.Q: Map showing changes in the Miombo woodland forest in the PEs of the MUTANDA MINING company.

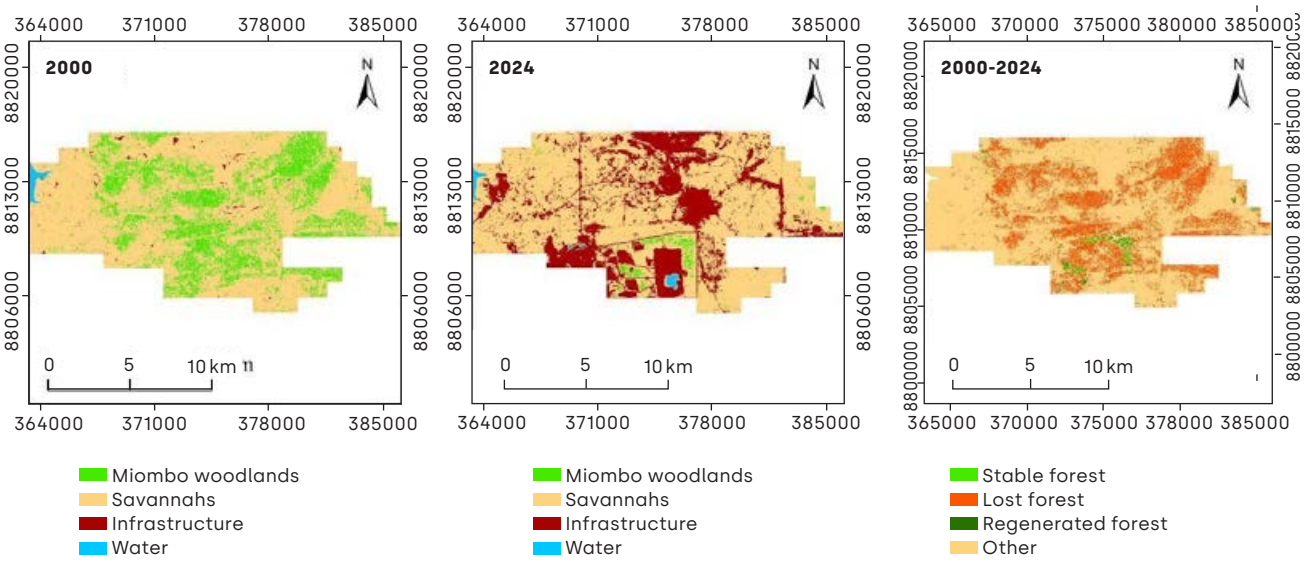
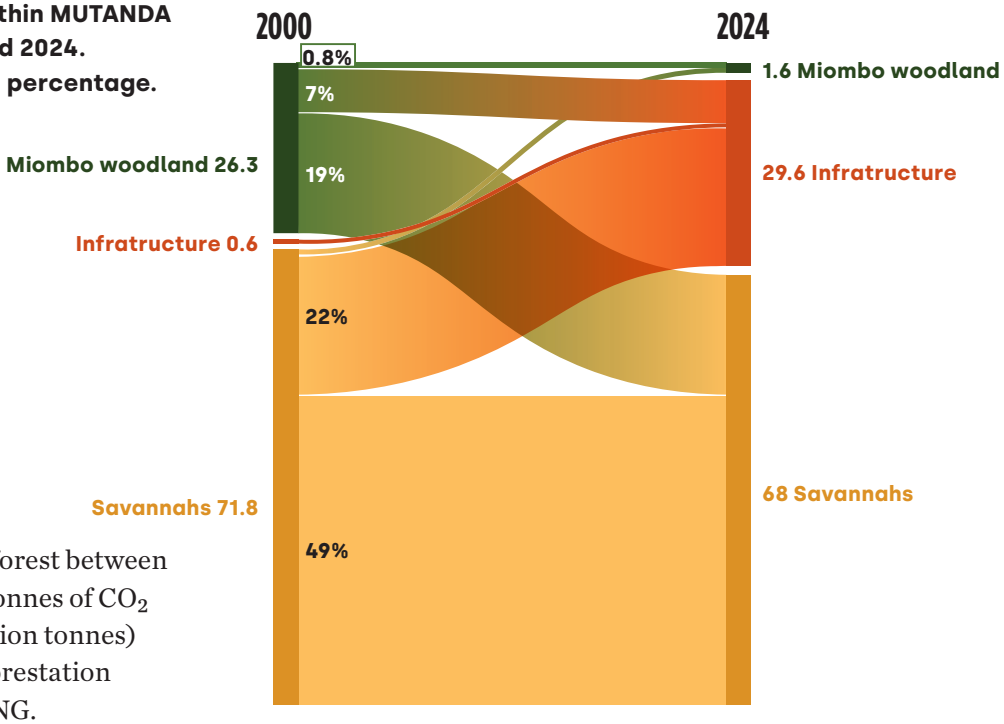


Table 4.I: Map showing changes in the area (ha) of Miombo woodland in the PEs of the MUTANDA MINING company.

Classes	Forest	Savannah	Infrastructure	Water
2000	4624.82	12,505.3	143,917	114,446
2008	3,480.89	13,579.5	229.02	99.3
2016	1,725.01	14,140.5	1,423.3	100.024
2024	291.693	11,875.3	5,100.47	121.2
TDP	-93.693			
TDA	-3.9039			

Figure 4.R: Conversion dynamics of the Miombo woodland within MUTANDA MINING between 2000 and 2024. With conversion values in percentage.



With a loss of 4,333 ha of forest between 2000 and 2024, 538,798 tonnes of CO_2 (approximately 0.539 million tonnes) released as a result of deforestation within MUTANDA MINING.

SABWE MINING

Figure 4.S: Map showing changes in the area (ha) of Miombo woodland in the PEs of the SABWE MINING company.

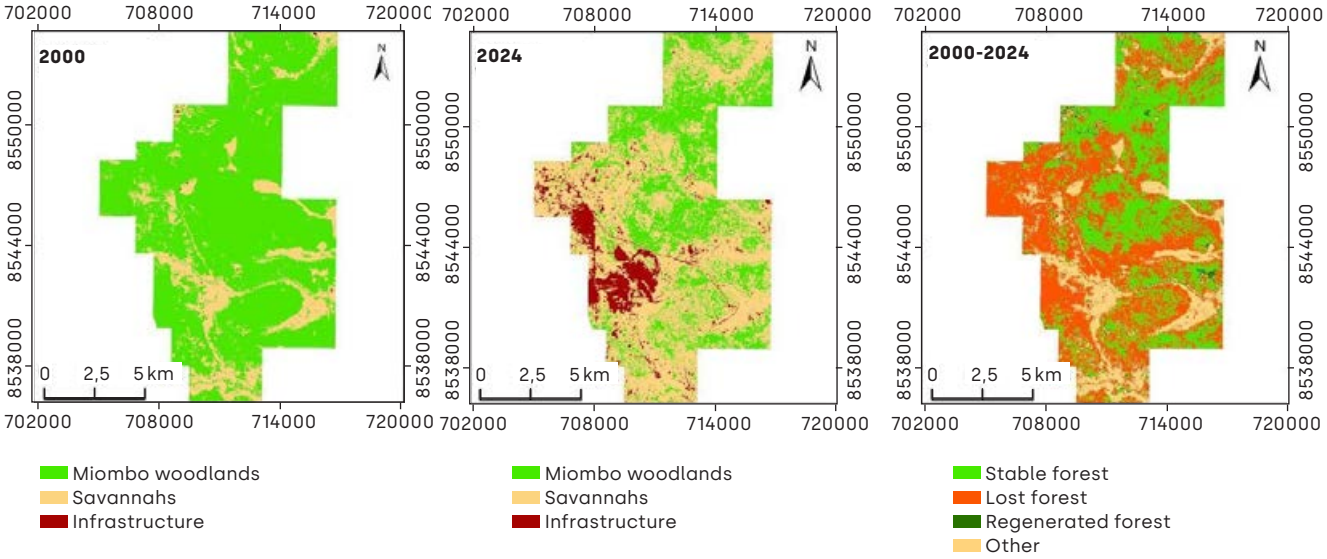
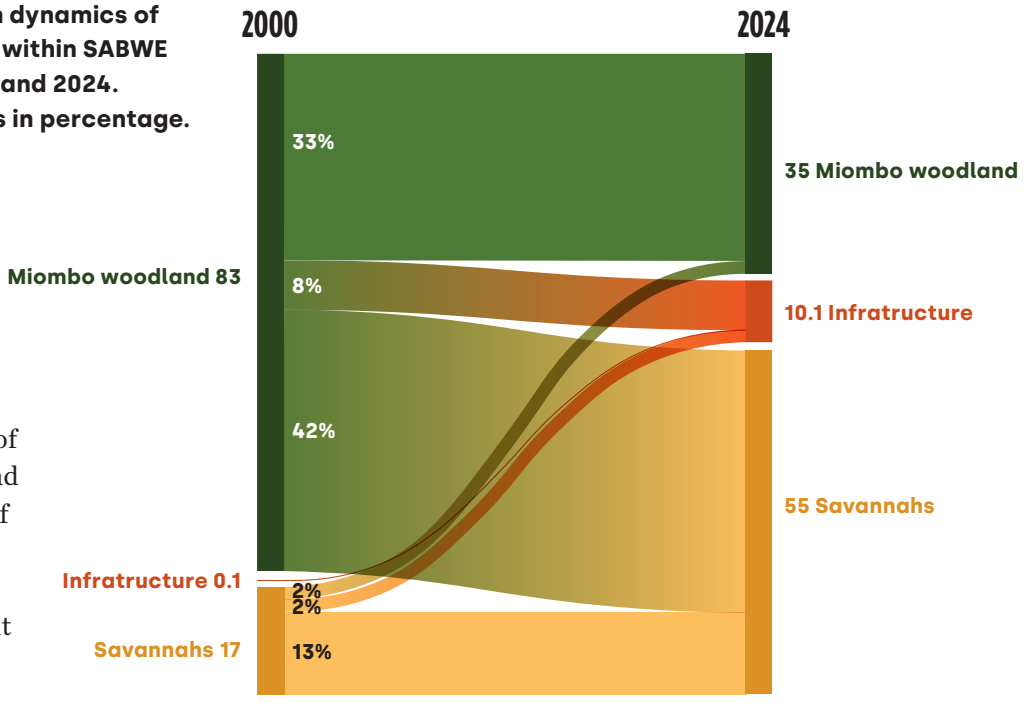


Table 4.J: Map showing changes in the area (ha) of Miombo woodland in the PEs of the SABWE MINING company.

Classes	Forest	Savannah	Infrastructure
2000	11,025	2368.35	15.3849
2008	8,854.87	3,903.81	650.232
2016	7,263.31	5,773.6	371,795
2024	4638.84	7,443.41	1,326.33
TDP	-57.924		
TDA	-2.4135		

Figure 4.T: Conversion dynamics of the Miombo woodland within SABWE MINING between 2000 and 2024. With conversion values in percentage.



With a loss of 6,386 ha of forest between 2000 and 2024, 793,809 tonnes of CO_2 (approximately 0.794 million tonnes) were released as a result of deforestation within SABWE MINING.

SEK KIPOI

Figure 4.U: Map showing changes in the Miombo woodland in the PEs of the SEK KIPOI company.

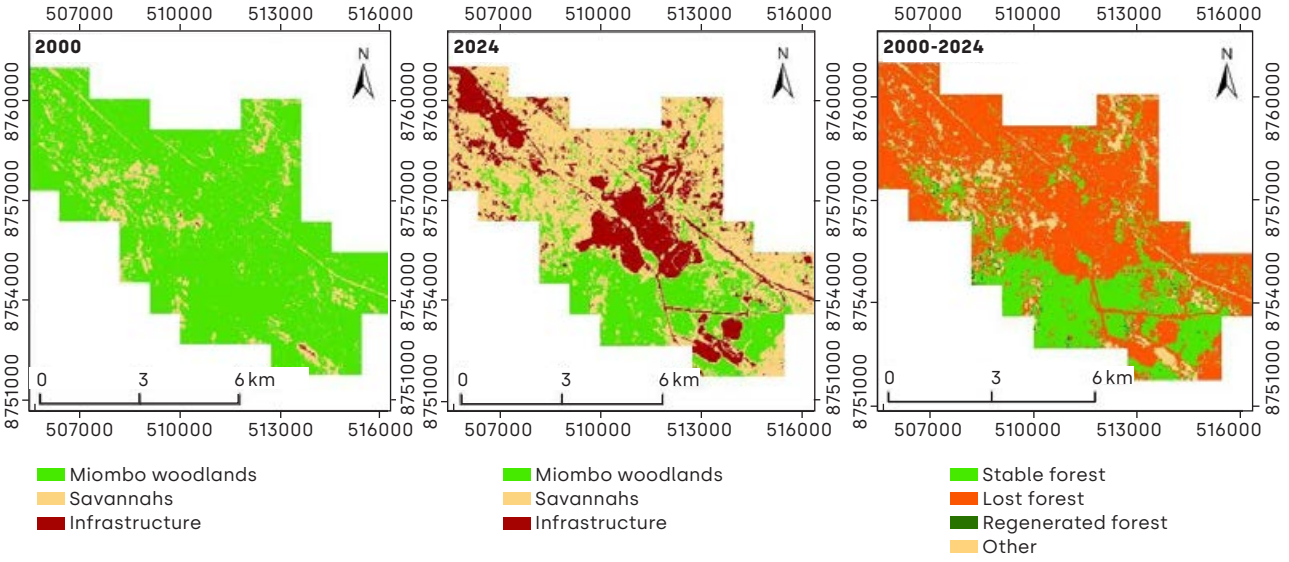
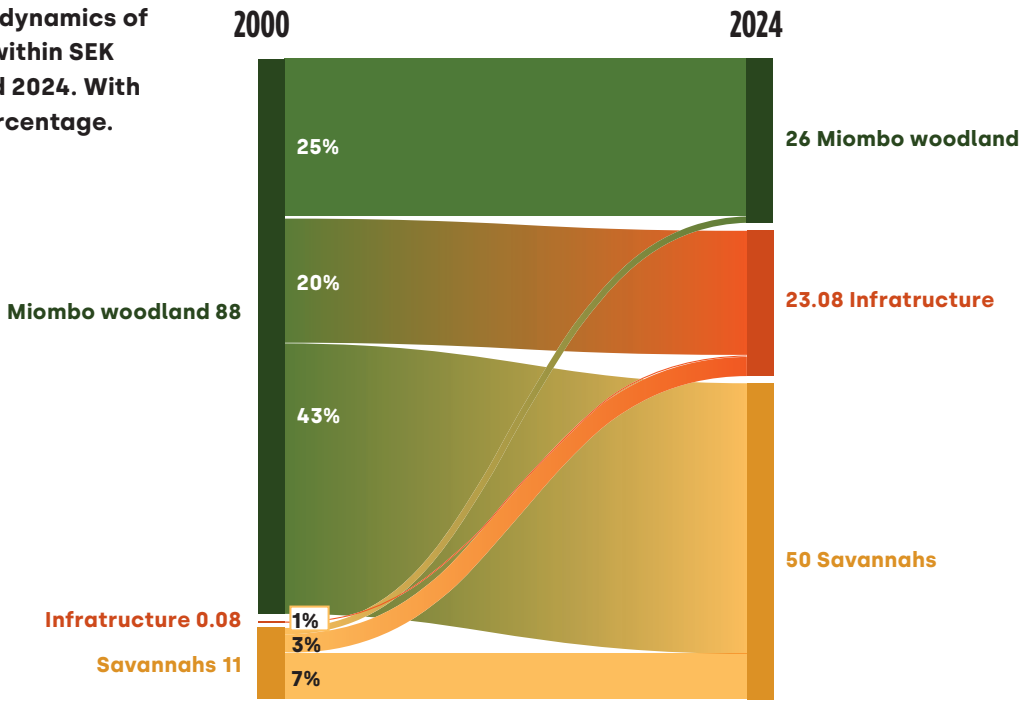


Table 4.K: Map showing changes in the area (ha) of Miombo woodland in the PEs of the SEK KIPOI company.

Classes	Forest	Savannah	Infrastructure
2000	4,983.1	626.511	5.85
2008	4,351.05	1,189.15	75.3565
2016	2,817.99	2,454.25	343.268
2024	1,484.7	2831	1299.89
TDP	-70.205		
TDA	-2.9252		

Figure 4.V: Conversion dynamics of the Miombo woodland within SEK KIPOI between 2000 and 2024. With conversion values in percentage.



With a loss of 3,498 ha of forest, 434,820 tonnes of CO_2 (approximately 0.435 million tonnes) were released as a result of deforestation within SEK KIPOI.

TFM

Figure 4.X: Map showing changes in the Miombo woodland forest in TFM's PEs.

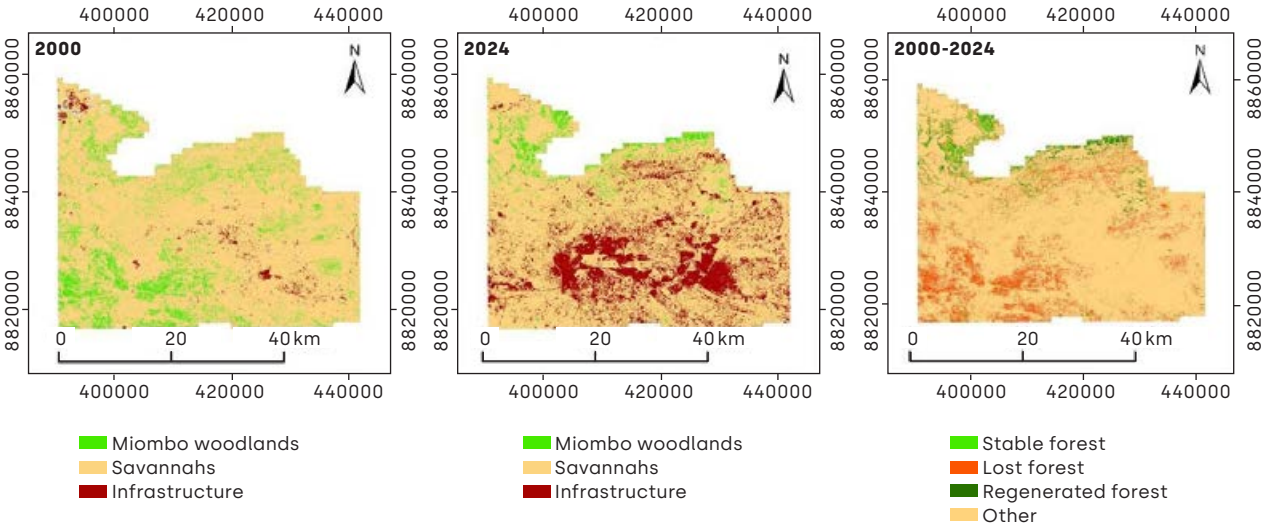
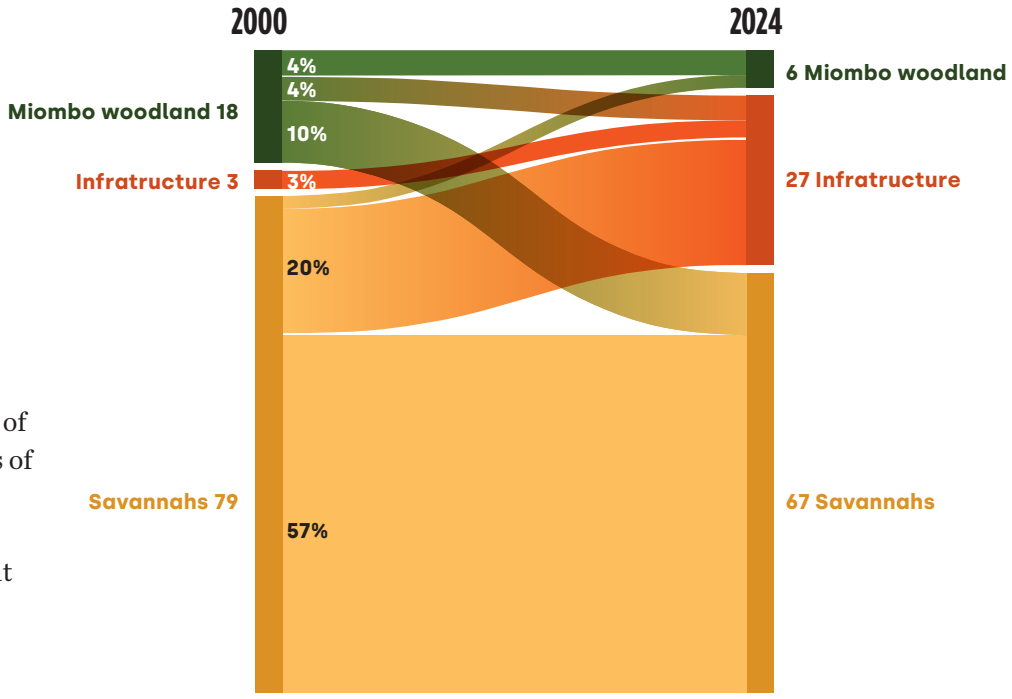


Table 4.L: Map showing changes in the area (ha) of Miombo woodland in TFM's PEs.

Classes	Forest	Savannah	Infrastructure
2000	26,017.9	126,707	5152.95
2008	24,438.8	124,449	8,990.26
2016	20,939.3	123,552	13,386.2
2024	8,919.52	109,795	39,163.3
TDP	-65.718		
TDA	-2.7382		

Figure 4.Y: Conversion dynamics of the Miombo woodland within TFM between 2000 and 2024. With conversion values in percentage.



With a loss of 17,098 ha of forest, 2,123,951 tonnes of CO_2 (approximately 2.124 million tonnes) were released as a result of deforestation within TFM.

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