



RESEARCH ARTICLE

DYNAMICS OF THE FOREST LANDSCAPE IN THE MIKEMBO SANCTUARY: 20 YEARS AFTER ITS CREATION AS A FLORA AND FAUNA CONSERVATION RESERVE, UPPER-KATANGA, DR CONGO

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ARTICLE DETAILS

Article History:

Received 19 March 2023
Revised 05 May 2023
Accepted 25 May 2023
Available online 20 July 2023

ABSTRACT

Remote sensing is very important for conservation and biodiversity research and applications. For instance, it can be used for monitoring changes in ecosystems. **Objective:** The objective of this paper was to analyze the change in the forest landscape of Mikembo Sanctuary between 2002 and 2022 using satellite imagery. **Method:** Supervised classification by maximum likelihood algorithm was performed and helped to differentiate 3 land use classes. **Results:** The cartographic and statistical analysis show that land use dynamics of the study area are dominated by an increase in forest and a reduction in bare soil. The forest increases with 0.78 km² (18.04% of the study area) and therefore had a rate of change of more than 32.25%. **Conclusion:** It has been demonstrated that the Miombo woodland, specially Mikembo Sanctuary is capable of regenerating naturally or by assisted means. Encouraging people for using alternative solutions is necessary to ensure the sustainable forest management and utilization.

KEYWORDS

Ecological restoration, Regeneration, Remote sensing, Land use change, Miombo woodland

1. INTRODUCTION

Most of the Southeastern part of the Democratic Republic of Congo (DRC) is covered by a vast expanse of Miombo woodland under the Zambezi region of the greater Sudano-zambezi region (Duvigneaud, 1958). This ecosystem plays an important role in providing a wide range of ecosystem services among others non-timber forest products, charcoal and fuelwood, agriculture, local climate regulation and carbon sequestration for the local population and throughout the sub-region (Ryan et al., 2016; Gumbo, 2018).

In the miombo, the intense production of charcoal, wood and mining activities are identified today as major activities of deforestation, degradation, and disappearance of the forest cover (Bebroux et al., 2007; Munyemba et al., 2014; Khoji et al., 2022). Moreover, Useni et al., (2017), show that the Miombo is threatened by human activities in general. In this study on the deforestation radius around the city of Lubumbashi (Haut-Katanga, DRC), the authors show that there are four main causes of the regression of the miombo cover, and which would be supported by the accelerated population growth, namely agricultural development, charcoal production, city expansion and mining activities. Additionally, the miombo woodland is completely removed around the city of Lubumbashi within a radius of 100 km² and that intensity of deforestation would be -19.85 km² per year. Moreover, Khoji et al., (2022) show that the natural cover that dominated the landscape in 1979 has lost more than 60 % of its surface in 41 years (1979-2020) around four agglomerations in Southeastern Katanga (Lubumbashi, Likasi, Fungurume and Kolwezi) to agricultural and energy production.

These changes in land use and land cover, also known as land-use change, have severe consequences at several levels, notably on the capacity of forest ecosystems to adequately provide ecosystem services (Gillet, 2016, Ahononga et al., 2020). For instance, most of the non-timber forest products (NTFPs), such as honey, edible mushrooms, edible caterpillars, and wild edible fruits are gradually disappearing due to selective cutting of host plants (Gillet, 2016; Ahononga et al., 2020). This degradation also leads to a significant reduction in wildlife (Gillet, 2016) and decreased rainfall in some parts of the region (Ndehedehe and Agutu et al., 2022).

At the northeast of Lubumbashi, there is a private reserve "Mikembo" whose vocation is the conservation of biodiversity. This ecosystem also serves as a tourist site, as well as an educational support for schoolchildren from surrounding villages and for scientists from universities and research centres. For over ten years, several studies in the field of ecology have been conducted there (Kizila, 2012; Mushagalusa, 2012; Mushagalusa et al., 2014; Muledi et al., 2016; Bauman et al., 2016; Muledi et al., 2017, 2018; Muledi et al., 2020; Mushagalusa et al., 2020; Godlee et al., 2020; Kyalamakasha et al., 2021; Kasongo et al., 2021; Kaumbu et al., 2023). In addition, in remote sensing, Thibaut (2019) has attempted to explain the structure of the miombo open forest in the sanctuary using satellite imagery and photogrammetry; however, studies related to the spatial dynamics of vegetation within this reserve have not yet been conducted (Thibaut, 2019).

This study analyzes the dynamics of the forest landscape within the Mikembo Sanctuary, based on diachronic analyses of the forest cover between 2002 and 2022 using satellite imagery in order to clearly show the importance of sustainable forest conservation.

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DOI:
10.26480/ees.02.2023.54.60

4. DISCUSSION

4.1 Land Use Dynamics Between 2002 and 2022

The evolution of land use within the Mikembo Sanctuary was visualized and analyzed respectively through Figure 3 and Table 3 from 2002 to 2022. It appears that during the two decades, the Forest class increased by 0.78 km² (18.04% of the study area), for a rate of change of 32.25%. However, a new class that did not previously exist has appeared in the study area. This is the Water class estimated at 0.09Km². Only the Bare Soil class has decreased, with a conversion of 0.88 km² or 20.19% of surface occupied by the study area, to other land use classes. Its high regression rate returns to 45.82% in 20 years.

Indeed, the positive evolution of the area occupied by forests attracted our attention because it is exceptional, compared to studies conducted by our predecessors where the land cover dynamics reveal in most cases a loss of forest cover over time (Munyemba et al., 2014; Useni et al., 2020; Mukenza et al., 2022; Khoji al., 2022).

In 2002, the Mikembo sanctuary was characterized by high anthropization. However, as shown in Figure 3, the sanctuary has undergone considerable restoration in 2022. Due to protective measures (fencing of the entire perimeter) and rigorous monitoring since the acquisition of this space, the vegetation is in full natural regeneration. In support of the results of this study, according to Muledi (2017) and Kyalamakasa et al., (2021), the growth dynamics of trees in Mikembo are explained by several factors. First, the growth of some species in the plot is influenced by edaphic factors of the environment, while some by local conditions, including competition between trees, assessed through the slenderness factor (Height/Diameter). Secondly, the annual mortality rate in the system is low, while the recruitment rate is higher than in most tropical forests. Finally, the authors conclude that the changes in demographic evolution place Mikembo Forest among the most dynamic stands, characterized by a good rate of diametral growth, low mortality, and high recruitment (Muledi et al., 2020).

In the same province where our study was conducted, there has been a rapid expansion of the built-up area, that has led to a regression of the vegetation (Munyemba et al., 2014; Useni et al., 2020). The liberalization of the mining sector in 2002 has led to a considerable loss of forest cover in mining sites and peripheries for more than two decades (Useni et al., 2020; Khoji et al., 2022; Cabala et al., 2022). In the western part of the province, in the Lufira Biosphere Reserve (LBR), a decrease in the Miombo woodland area is reported. The forested area has decreased from 85.3 km² in 1979 to 11.2 km² in 2018. The annual deforestation rate between 1979 and 2018 was 1.8%; nearly eight times the rate recorded at the country level (Useni et al., 2020).

At a time when forest areas are increasingly threatened and are declining in area and connectivity (Salomon et al., 2021). The Mikembo Sanctuary can constitute a conservation model to be followed, and popularized throughout the sub-region, because its policy is in line with contributing to the preservation of natural resources, the reconstitution of the vegetation cover, the improvement of soil fertility, the protection of land against erosion and the growth of wood and non-wood products.

5. CONCLUSION

This study analyzed the change observed in the forest landscape of Mikembo Sanctuary over the two decades since its acquisition. The combination of GIS tools, remote sensing and field observations shows the dynamics that have taken place in this reserve. Previous work in Upper Katanga and around Lubumbashi shows a drastic reduction in forest cover in the face of building and mining activities. However, the results found in this study show a significant progression of Miombo woodland in the Mikembo sanctuary between 2002 and 2022. The encouraging results of this research prove the effectiveness of the management model imposed on this reserve and demonstrate the pursuit of one of the objectives of the Mikembo ASBL, which is to protect the environment, which they call "priceless heritage" in southeastern Democratic Republic of the Congo. However, future studies should assess canopy dynamics in combination with dendrometric parameters to predict the Miombo woodland forest how many years more accurately is capable of regenerating. Then, same studies are very important in the local concession community forestry across the whole former Katanga province to assess the efforts made by indigenous people to contribute to the sustainable forest reconstitution and management.

ACKNOWLEDGEMENTS

The authors thank the leaders of the ASBL MIKEMBO for having welcomed us and offered us the doors of the sanctuary for the realization of our fieldwork.

AUTHORS' CONTRIBUTIONS

Conceptualization: Kalambulwa N.A; Data collection: Kalambulwa N.A and Mumba T.U Data processing and analysis: Kalambulwa N.A; Kakule M.S; Lobho L.J; Manuscript writing: Kalambulwa N.A; Kakule M.S, Mumba T.U and Lobho L.J; Review: All authors.

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