ASSESSMENT OF FOREST RESOURCE EXPLORATION AND ITS ENVIRONMENTAL IMPACTS IN ARAKANGA FOREST RESERVE, ABEOKUTA, OGUN STATE, NIGERIA

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ABSTRACT

Forests' crucial role in maintaining socio-economic development and ecological balance through carbon sequestration, biodiversity conservation, and providing livelihoods makes them an invaluable resource for humankind. However, the unsustainable exploitation of forest resources in Nigeria continues to threaten the integrity of its forests. The study assesses the spatiotemporal dynamics of the Arakanga Forest Reserve from 1984 to 2023. The study integrates remote sensing with a social survey of 110 residents from surrounding communities to determine land-use/land-cover changes and local perceptions of reserve administration and exploitation. The findings revealed a significant decline in forest cover, from over 41% in 1984 to 26% in 2023, alongside a corresponding increase in the built-up area, from 8% to 37% during the same period, indicating rapid anthropogenic encroachment and land conversion. This significantly contradicts the perception of the locals, who believe that 85% of the reserve is underexploited due to the effective implementation of restrictions by the reserve management. The study identifies a significant weakness in the collaboration between the community and management in implementing enforcement mechanisms. The study recommends participatory management of the reserve, a stronger regulatory framework, and increased community awareness to promote sustainable management of the Arakanga Forest Reserve.

Keywords: Anthropogenic Impact, Arakanga Forest Reserve, Deforestation, Land Use Change, Local Perception

INTRODUCTION

Forests play a critical dual role in maintaining socio-economic development and ecological balance. They achieve this through carbon sequestration, climate regulation, water purification, and the mitigation of natural disasters, while also providing livelihoods for humanity, making them an invaluable resource. The forest is a valuable resource for humankind due to its numerous social, economic, and environmental benefits. From an ecological perspective, forests absorb carbon dioxide, store and purify water, mitigate the effects of natural calamities such as floods and droughts, and regulate the climate. In addition to providing a wide range of items and serving as a source of food, forests also provide cultural and medicinal qualities (Dantani et al., 2020).

Nigeria is blessed with an abundance of forest resources that span different ecological zones, ranging from the tropical rainforest and swampy forests in the south to the forest savannah of the middle belt region. Nigeria's forests cover approximately 110,890 km^2, which represents about 12% of the country's total land mass (Mfon et al., 2014). However, these forest resources have been subjected to extensive degradation and deforestation due to anthropogenic pressures, including logging, agricultural expansion, and urbanisation. Since the 1950s, the country has experienced significant forest fragmentation and loss (Chubb, 1961; Petrides, 1965; Dore, 1986), reflecting the growing tension between economic development and forest sustainability.

Poor land use management and unregulated anthropogenic expansion have disrupted the natural balance of the forest ecosystems, resulting in various ecological issues, including soil erosion, loss of biodiversity and declining ecological resilience (Nyadar et al., 2021). Osemeobo (1988) also attributed the forest degradation to inefficient land use systems and weak management, destabilising forest systems across the country. Read and Lam (2002) identified deforestation and land use change as extremely prevalent in tropical regions, where population pressure and economic demand for forest resources continue to increase. Despite these challenges, the assessment of forest resource loss and the understanding of its drivers in Nigeria remain inconsistent and under-researched (Enaruvbe and Atafo, 2016).

The management of forest reserves in Nigeria, especially those in peri-urban areas, presents unique challenges. Peri-urban forests are forests located at the interface between urban and rural areas. They are under increasing threat from rapid population growth, urban expansion and the resultant need for land resources. Carrilho and Trindade (2022) describe peri-urban forest areas as zones of transition, where land use changes rapidly from rural to urban and within a short travel time to the city centres. The Arakanga Forest Reserve, situated in Abeokuta, Ogun State, exemplifies such a setting, primarily due to its proximity to the River Ogun and the Abeokuta metropolis. The reserve plays a vital ecological role in managing the microclimate, protecting watersheds, and conserving biodiversity. However, its proximity to urban areas also highlights the anthropogenic pressure of encroachment, illegal logging and agricultural expansion (Soaga et al., 2012; Salami et al., 2021).

In the last six decades, weak and inadequate policy implementation and enforcement have significantly limited the conservation objectives of forest reserves across Nigeria. The Arakanga Forest Reserve was primarily established as a buffer for the Ogun River Basin. However, it has faced significant levels of anthropogenically related degradation, particularly due to the unsupervised exploitation of forest resources for firewood, timber, and medicine, as well as illegal hunting, which have contributed to the depletion of the ecosystem and habitat loss (Soaga et al., 2012; Fasona et al., 2018).

The role played by the local community in forest conservation cannot be overemphasised. The attitude and perception of locals around forest reserves often influence the effectiveness of conservation and resilience of the forests (Ntuli et al., 2019). The community's understanding of the significance of the forest ecosystem, compliance with forest conservation regulations and their involvement in the management mechanism are crucial to ensuring the resilience and sustainability of the forest reserves. Thus, integrating local knowledge and perceptions into the management of the reserves, as per Allendorf et al. (2018), would foster a sense of ownership, thereby ensuring communal protection of the reserves. Unfortunately, many forest management policy frameworks in Nigeria remain top-down, limiting communal awareness and engagement, and thereby reducing their long-term goal of forest conservation and resilience.

Against this backdrop, the study provides a holistic assessment of the dynamics and extent of forest reserve exploration and its environmental impacts in the Arakanga Forests Reserve, Abeokuta, Ogun State, between 1984 and 2023. The study integrates remote sensing and GIS techniques with a social survey to provide a comprehensive analysis of land-use and land-cover changes, as well as local perceptions regarding forest management and exploitation. By doing so, the study bridges the gap between scientific evaluation and local perception, providing critical insights for policymakers, stakeholders, and researchers on the conservation, sustainability, and management of peri-urban forests in Nigeria.

THE STUDY AREA

The research area is the Arakanga Forest Reserve, situated in Abeokuta, Ogun State, within the Odeda Local Government Area. The area is located between latitudes 7°11'45" and 7°13′30" N and Longitudes 3°18′30" E and 3°20′10"E (Figure 1). It is located approximately five kilometres from the centre of Abeokuta, the capital city of Ogun State, and closer to Akomoje, the headquarters of Abeokuta North Local Government Area. It is one of Ogun State's nine (9) forest reserves. The Arakanga Forest Reserve covers approximately 2.3 km² and is classified as a peri-urban forest. Two distinct seasons describe the area's climate. The two distinct seasons are the longer rainy season, which spans from March to October, and the shorter dry season, which occurs between November and February, accompanied by harmattan winds (Fasona et al., 2019a). Crop cultivation, including the production of cassava, maize, vegetables, and palm products, is the primary source of income for the residents (Salami et al., 2021).

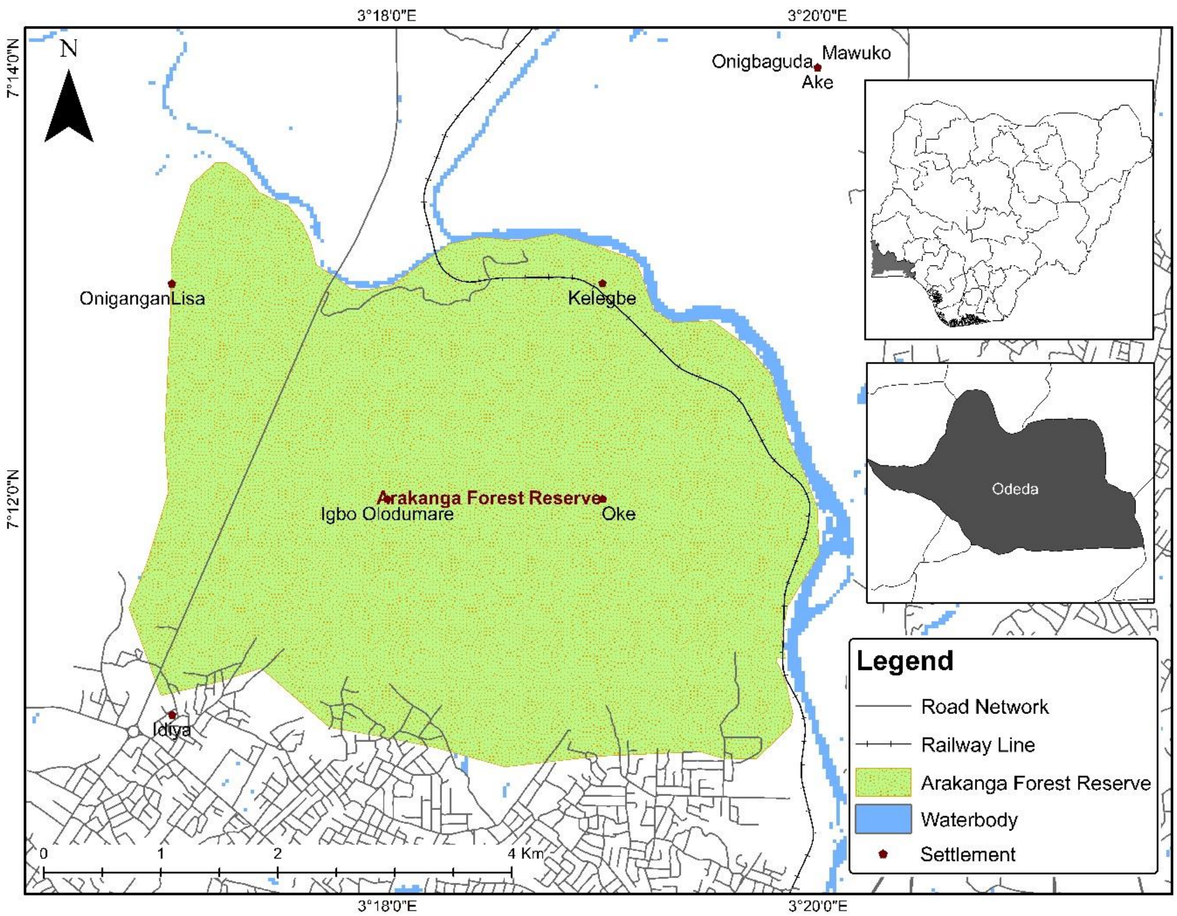

Figure 1: Arakanga Forest Reserve

MATERIALS AND METHODS

Study Design

The study integrates Remote Sensing (RS) and Geographic Information System (GIS) techniques with a social survey to provide a comprehensive assessment of changes in forest reserve land use, exploration, and local perception of the management of Arakanga Forest Reserve, Abeokuta, Ogun State. The RS and GIS components quantified the extent and pattern of land use and land cover changes over the past four decades (1984-2023), while the social component evaluated local perceptions, awareness, and attitudes towards forest resource management and exploitation.

Population and Sampling Technique

The study's scope encompasses communities surrounding the Arakanga Forests Reserve, including Ajegunle, Akomoje, Ile Pupa (Quarry), and Mawuko. These nearby communities primarily depend on the forest ecosystem services for their livelihood and sustenance. A probability sampling technique, considered more representative of the target population and providing all households an equal chance of selection (Shorten and Moorley, 2014; Elfil and Negida, 2017), was used to select respondents within these communities. Participants in the research must be over the age of eighteen, live in one of the previously specified locations, and have worked or resided in the area for a minimum of one year. Face-to-face interviews were chosen for the study over conventional methods, such as internet surveys, because they provide a significantly higher response rate and enable persuading respondents who may be sceptical (Ongena and Dijkstra, 2021). A total of 110 questionnaires were administered for the study, and were determined using a combination of Yamane's (1967) sampling formula and research practicality for field-based environmental studies.

The Yamane formula is expressed as: $n = \frac{N}{1+N(e)^2}$

Where: n = required sample size, N = estimated population of the study (approx. 1,500 households), and e = level of precision (0.09).

Adapted from Oluigbo et al. (2024).

Substituting these values:

$$n = \frac{1500}{1 + 1500(0.09)^2} \approx 110$$

Hence, 110 respondents provide a statistically valid and representative sample size for capturing the local perspectives with a 0.09 precision. This number aligns with similar environmental perception studies conducted in communities near forests, where sample sizes of 100 to 150 respondents were deemed valid (Soaga et al., 2012).

Remote Sensing and GIS Data Procedure

Multi-temporal Landsat TM and OLI imageries for 1984, 2013, and 2023 were downloaded from the US Geological Survey (http://glovis.usgs.gov/index.shtml) for Path 191 and Row 055, corresponding to Landsat 5 and 8, respectively. They were used for the land-use and land-cover analysis of the study. The SCP plug-in in QGIS 3.24, an open-source (GIS) software, was used to execute the LU/LC analysis. First, a 7 km² region that included the Arakanga Forest Reserve and its surroundings was clipped out. Band compositing (Land/Water Composite) was applied to the Landsat picture in the Near Infrared (NIR), Short-wave Infrared (SWIR), and Red bands, specifically 543 (2013 and 2023) and 432 (1984).

Following the steps suggested by Fasona et al. (2018), two different categorisation algorithms were used in the study to address the area's complex and varied land cover. Supervised classification, which uses the Maximum Likelihood (MAXLIKE) algorithm to classify all of the image's pixels, was applied after the Unsupervised classification (IsoData) produced eight classes that were verified through field surveys and reference maps (Zaitunah et al., 2018). Spectra signatures are used to define training areas in supervised classification. According to Fasona et al. (2014), MAXLIKE is a hard classifier that compares the posterior probability of each examined signature to determine which class a pixel belongs to. This allows it to be assigned to the most similar class. To provide classification outputs of the five (5) landcover classes, which are stated in Table 1, that are more condensed and refined, additional refinement and modification of the classes (training area) were accomplished.

Table 1: The Land-use/landcover classification scheme

S/n	LULC/Class	Description
1	Built-Up	Urban, road, and other surfaces with extensive anthropogenic alteration
2	Waterbody	Ocean, Lakes, Rivers, Creeks, and Streams
3	Forest	Areas covered with broadleaved evergreen and deciduous forest between have witnessed minimal disturbance.
4	Disturbed forest	Forest areas that have suffered heavy alteration due to anthropogenic activities
5	Agricultural land	Areas covered by activities that involve tilling of the soil, as well as heavily disturbed and altered vegetation

Source: Adapted from Campbell and Wynne (2011)

Data Analysis

Social survey

IBM SPSS Statistics 23 and Microsoft Excel were used to analyse the questionnaire results. The study supports the SPSS software package due to its simplicity, reliability in scientific research, adaptability in analysis, and data interpretation capabilities. The SPSS software program was selected for this study over other options due to its broad support of statistics, ranging from basic descriptive statistics to complex multivariate matrix analysis. It is acceptable to integrate data, modify existing variables, and create new ones (Arkkelin, 2014). The SPSS program also performs comparison and correlational statistical tests in the context of univariate, bivariate, and multivariate analysis using both parametric and non-parametric statistical methodologies (Ong and Puteh, 2017).

Remote sensing analysis

The change detection analysis for the study was conducted between classified maps from 1984, 2013, and 2023. The percentage change for the various land use classes was computed using:

$$Percentage\ Change = \frac{(A_2 - A_1)}{A_1} \times 100$$

Where: A_1 and A_2 represent the area of each land use class at the initial and end time intervals.

RESULTS AND DISCUSSION

Land-use/Landcover Change in Arakanga Forest Reserve Area

Table 2 and Figure 2 illustrate the historical dimensions of vegetation and other land-use changes for 1984, 2013, and 2023. The analysis indicates that in 1984, approximately 88% of the Arakanga reserve area, which spans over 7 km², was forested, or over 6 km². This is based on the five classes of land use that were previously shown in Table 1.

Table 2: Land-use/Landcover Dimension of Arakanga Forest Reserve Area

Class	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%
	1984		2013		2023	
Built-up	0.59	8.41	2.05	29.27	2.59	36.97
Forest	2.90	41.35	0.76	10.88	1.83	26.19
Waterbody	0.11	1.56	0.16	2.23	0.28	3.99
Disturbed Forest	3.24	46.33	3.70	52.83	2.06	29.39
Agric	0.17	2.36	0.33	4.78	0.24	3.46
Total	**7.00**	**100.00**	**7.00**	**100.00**	**7.00**	**100.00**

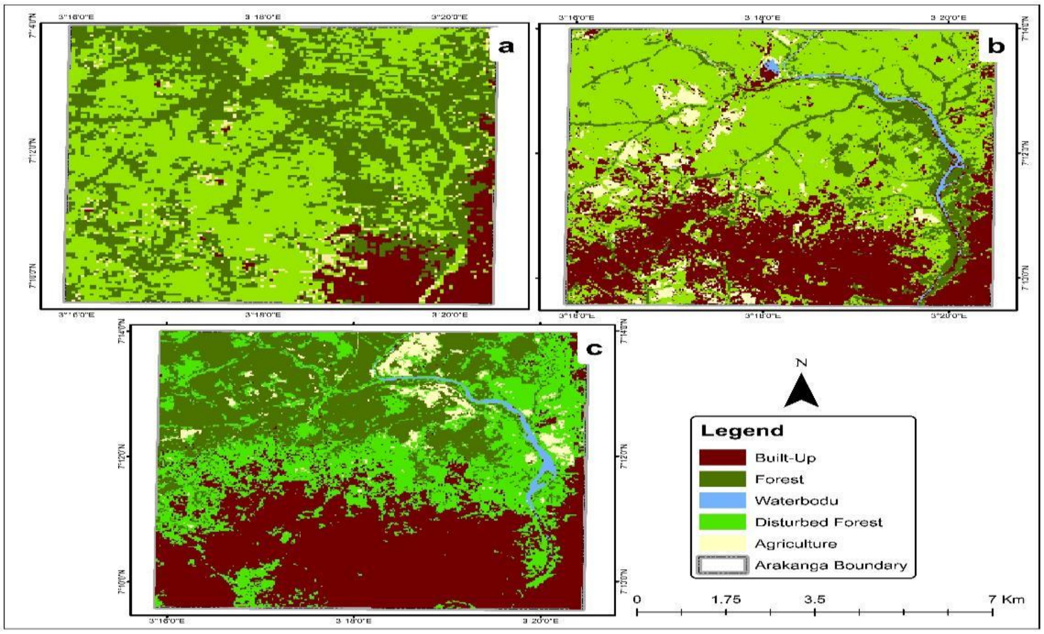

Figure 2: LU/LC dimension of Arakanga Forest Reserve area (a: 1984; b: 2013, and c: 2023)

More specifically, forests cover an area of more than 41%, and disturbed forests cover an area of 46%. Over 7% (8.4 km^2) of the area was made up of built-up areas, whilst 1.6% and 2.4% of the land was made up of water bodies and agricultural activities. By 2013, the area's forest resources had been significantly diminished, with over 52.8% (3.7 Km^2) of its land covered by disturbed forest. Anthropogenic activities had also left their footprint, with the Built-Up area rising significantly from 8% to over 29% (2.1 Km^2) of the land. Moreover, the area devoted to agricultural activity increased to 4.8% (2.4 Km^2) of the total. The region's forest resources have been drastically reduced, from their original 41% to 10.9% (0.8 Km^2) of the total area. The built-up area rose to 37% (2.6 Km^2), agricultural operations to 3.5% (0.2 Km^2), and disturbed forest to 29% (2.1 Km^2) by 2023, reflecting the ongoing development of human activities in the region. By 2023, there has also been a notable decline in the Forest class, from 41% in 1984 to 26.2% (1.8 Km^2). This indicates a rapid deforestation driven by significant exploration and resource extraction, consistent with trends reported for other forest reserves around Akure (Fabiyi and Fajilade, 2024), as well as other Forest Reserves in Southwest Nigeria 9Fasona et al., 2018) and Nigeria (Tang et al., 2023).

Local Residents' Awareness of the Purpose of Arakanga Forest Reserve

Table 3 indicates that all residents in the vicinity of the Arakanga Forest Reserve are aware of it. The fact that nearly 62% (69) of the inhabitants stated they did not understand why the Arakanga forest reserve was established is also a worrying issue. Additionally, according to 23% (25) and 12% (13) of the locals, the reserve was established to preserve the environment and save endangered tree species. While these viewpoints are valid, the Principal Forester in charge of the designated forest custodians states that the primary objectives of establishing the forest reserve were to minimise evapotranspiration, shield and conserve the Ogun River's tremendous flow, and protect it from contamination. This particular attribute might explain the strategic positioning of the Ogun State Water Corporation near the forest's terminus, aligning with the point where the river water emerges from its wooded sanctuary.

Table 3: Residents' Awareness of the Arakanga Forest Reserve

	Ajegunle	Akomoje	Ile Pupa (Quarry)	Mawuko	Total
Awareness of the Arakanga Forest Reserve					
	30	26	29	25	110 (100%)
Purpose of Arakanga Forest Reserve					
Ecological conservation	6	5	8	6	25 (22.7%)
Protection against floods and erosion	0	0	1	0	1 (0.9%)
Not sure	17	18	19	15	69 (62.7%)
Shed the Ogun River and prevent it from drying out	1	0	0	0	1 (0.9%)
Protect Tree species from being endangered	6	2	1	4	13 (11.8%)
To conserve the ecosystem	0	1	0	0	1 (0.9%)
Total	**30**	**26**	**29**	**25**	**110 (100.0%)**

Perception of the Protection of the Arakanga Forest Reserve

Regarding the locals' perception of the effectiveness of protective measures for the forest reserve, Figure 3 shows that 84 (76%) agree that the forest reserve is adequately protected. In comparison, another 15 (14%) respondents strongly believe that these measures are effective.

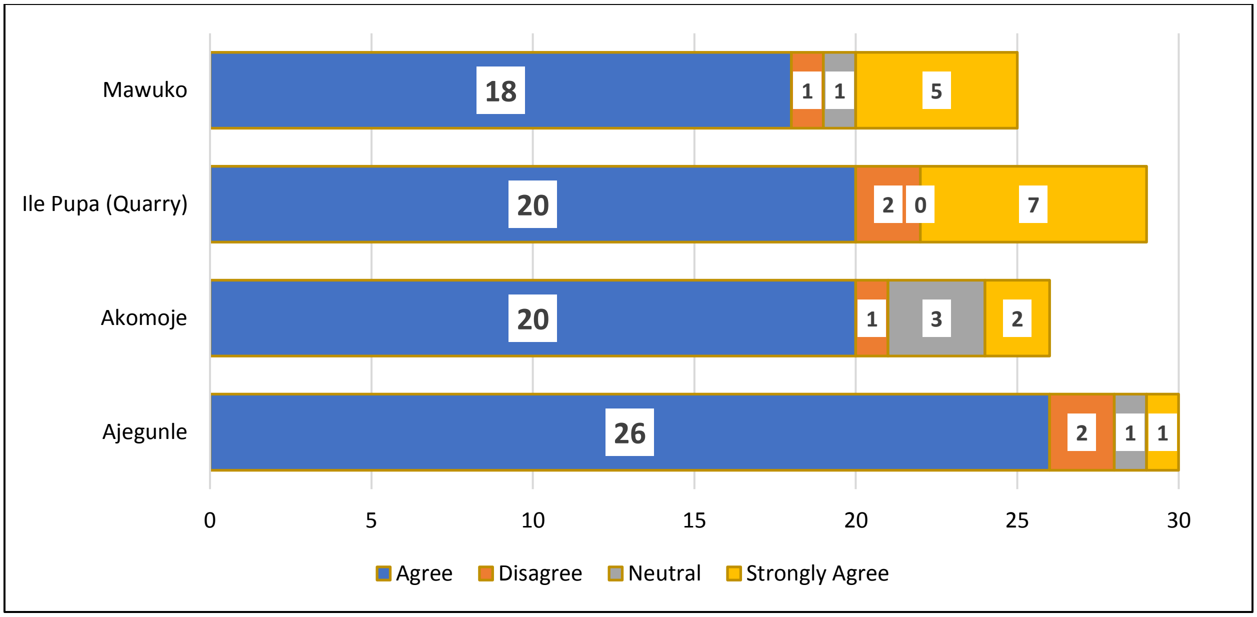

Figure 3: Perception of the Protection of the Arakanga Forest Reserve

Forest Exploration by Local Residents around the Arakanga Forest Reserve

Due to severe prohibitions and seldom permission from management and guards to visit the forest reserve to gather fallen branches and trees, the majority of residents (86%) are not directly engaged in the exploitation of forest resources, as shown in Table 4. They argued that the majority of the region's commercial and communal logging occurs in Opeji village, which is approximately six kilometres from the forest reserve. This area is sometimes mistaken for the Arakanga reserve. Overall, the majority of residents opined that the government successfully regulates the exploration of forest resources in the Arakanga forest reserve.

A notable finding of the variation between the remotely sensed evidence of significant forest loss and residents' perception of logging intensity. While the land-use and land-cover analysis clearly reveals widespread canopy reduction and degraded forest along access corridors and proximate areas to settlements, most locals reported minimal or no active logging in the reserve. This observation can be attributed to selective or small-scale logging that escapes the notice of locals, or perceptual normalisation where gradual exploration over decades makes deforestation to appear less severe (Asner et al., 2009; Mon et al., 2012). The issue is further compounded by institutional weakness, where unwillingness or inadequate management among agencies encourages informal settlements and unregulated logging as observed in other reserves in Nigeria (Ahmed and Oruonye, 2017). The absence of local participation in forest governance and management means that they have little incentive to protect the forest or report illegal logging.

Table 4: Local Residence Exploration of Arakanga Forest Resources

	Ajegunle	Akomoje	Ile Pupa (Quarry)	Mawuko	Total
Perception of community engagement in forest resource exploration					
No	22	25	26	22	85 (86.4%)
Yes	8	1	3	3	15 (13.6%)
Total	**30**	**26**	**29**	**25**	**110 (100%)**
Categories of forest resources exploited					
Leaves	1	0	0	0	1 (0.9%)
N/A	22	24	25	22	93 (84.5%)
Wood	7	2	3	3	15 (13.6%)
Wood/Leaves	0	0	1	0	1 (0.9%)
Total	**30**	**24**	**29**	**25**	**110 (100%)**
Assessment of government regulation at the reserve					
No	3	0	0	0	3 (2.7%)
Yes	27	26	29	25	107 (97.3%)
Total	**30**	**26**	**29**	**25**	**110 (100%)**
Level of compliance with the forest regulation					
Very High	23	21	20	19	83 (75.5%)
High	5	4	7	5	21 (19.1%)
Average	2	0	1	1	4 (3.6%)
Low	0	1	1	0	2 (1.8%)
Very Low	0	0	0	0	0 (%)
Total	**30**	**26**	**29**	**25**	**110 (100%)**

Overall, the combination of remote sensing and local perception study underscores that the primary drivers of forest loss in Arakanga forest Reserves are socio-economic rather than large-scale industrial deforestation. This mirrors broader national patterns where urbanisation, livelihood dependence, and policy failures remain the dominant forces of land cover change (Fasona et al., 2018). Addressing these challenges will require the integration of GIS-based monitoring, institutional collaboration strengthened by local participation and involvement in management strategy development, as suggested by Salimi et al. (2025)

CONCLUSION

The study conclusively highlighted that the Arakanga Forest Reserve has undergone significant degradation between 1984 and 2023, with forest land use declining from 41% to 26%, primarily due to urban expansion and agricultural encroachment. The study observed that deforestation is most intense along settlement corridors and access roads, confirming the negative influence of peri-urban expansion on the natural vegetation. Despite locals' perception of minimal logging, remote sensing evidence reveals widespread canopy loss, indicating that decades of small-scale and unregulated exploration have significantly transformed the forest landscape. The observed forest loss in Arakanga Forest Reserves mirrors that observed in other forest reserves in the Southwest, where socioeconomic pressures and weak enforcement of forest protection laws have accelerated forest depletion. The study thus reinforces the argument that forest loss in southwest Nigeria is driven less by large-scale timber extraction and more by the cumulative impacts of everyday local interventions, logging practices, and unregulated urban development. Until these structural deficiencies are addressed, the Arakanga Forest Reserves will continue to degrade, threatening the ecosystem services, local climate regulation, and other biodiversity conservation and sustainability aims it was aimed to address.

REFERENCES

Ahmed, Y. M., & Oruonye, E. D. (2017). Challenges of Enforcing Forestry Legislation in Taraba State, Nigeria. *International Journal of Geography and Geology*, *6*(3), 48–57. https://doi.org/10.18488/journal.10/2017.6.3/10.3.48.57

Allendorf T., Swe K., Aung M., & Thorsen A. (2018). Community use and perceptions of a biodiversity corridor in Myanmar's threatened southern forests, *Global Ecology and Conservation,* 15: e00409, https://doi.org/10.1016/j.gecco.2018.e00409

Arkkelin D (2014). Using SPSS to understand research and data analysis, *Psychology Curricular Materials. 1.* https://scholar.valpo.edu/psych_oer/1

Asner, G. P., Keller, M., Lentini, M., Merry, F., & Carlos, S. J. (2009). Selective logging and its relation to deforestation. *Amazonia and global change. Geophysical Monograph Series. Vol. 186. Washington, DC: American Geophysical Union. p. 25–42.*, https://doi.org/10.1029/2008GM000723

Campbell, J.B. and Wynne, R.H. (2011*). Introduction to Remote Sensing, Fifth Edition*. The Guilford Press, New York.

Carrilho, J., & Trindade, J. (2022). Sustainability in peri-urban informal settlements: a review. *Sustainability*, *14*(13), 7591. https://doi.org/10.3390/su14137591

Chubb, I. (1961). *Ibo Land Tenure 2nd ed*. Ibadan University Press, Ibadan, Nigeria: vii 115

Dantani A., Mukhtar R., Sani M., Gupa M., & Abubakar B. (2020). Evaluation of farmers' perception on deforestation and its impact on agricultural production, Gaya Local Government Area, Kano state, Nigeria, *South Asian Research Journal of Agriculture and Fisheries, 2*(2), 31–37, https://doi.org/10.36346/sarjaf.2020.v02i02.003

Dore M. (1986). Extinction is forever: Historical past and factors responsible. Paper presented at a workshop on Enforcement of Endangered Species Control of International Trade and Traffic, Decree No. 11, 25-27 March 1985, Federal Department of Forestry, Lagos, Nigeria.

Elfil, M., & Negida, A. (2014) Sampling methods in Clinical Research; an Educational Review, *Emergency*, *5*(1): e52

Enaruvbe, G., & Atafo, O. (2016). Analysis of deforestation pattern in the Niger Delta region of Nigeria, *Journal of Land Use Science, 11*(1), 113–130, https://doi.org/10.1080/1747423X.2014.965279

Fabiyi, O. O., & Fajilade, O. (2024). Characterisation of the impact of urban development on deforestation and forest degradation in Akure, Environ, Ondo State, Nigeria. *Osun Geographical Review*, *6*(1).

Fasona, M., Adedoyin, B., & Sobanke, I. (2020). Status and drivers of spatial change of forest reserves and protected areas in selected states of Southeast Nigeria: A case study of Ogun, Osun and Oyo States, Nigeria, *Osun Geographical Review*, 3: 54-69

Fasona M., Akintuyi A., Udofia S., Akoso T., Ariori A., Adeonopekun P., Agboola O., Ogunsanwo G., Ogundipe O., Soneye A., & Omojola A. (2018). Deforestation and landcover changes in the forest reserves of Southwest Nigeria, *Lagos Journal of Geo-Information Sciences,* 5: 67-87

Fasona M., Muyiolu S., Soneye A., Ogundipe O., Otusanya O., Adekanmbi O., Adeonipekun P. & Onuminya T. (2019a). Temporal analysis of the present and future climate of the Lagos Coastal Environment. U*nilag Journal of Medicine, Science and Technology (UJMST), 7*(1), 113-128

Fasona M., Soneye A., Ogunkunle O., Adeaga O., Fashae O., & Abbas I. (2014). Simulating Land-Cover and Land-Use Change in the Savanna Under Present Day and Future Climate Scenarios- A GIS-Based Approach. *Earth Science* Research, *3*(1), 25-40

Fasona, M., Adeonipekun, P. A., Agboola, O., Akintuyi, A., Bello, A., Ogundipe, O., ... & Omojola, A. (2019b). Incentives for collaborative governance of natural resources: A case study of forest management in southwest Nigeria. *Environmental development*, 30: 76–88.

Laakkonen, A., Hujala, T., & Pykäläinen, J. (2019). Integrating intangible resources enables creating new types of forest services-developing forest leasing value network in Finland. *Forest Policy and Economics*, 99: 157-168. https://doi.org/10.1016/j.forpol.2018.07.003

Mfon, P., Akintoye, O.A., Mfon, G, Olorundami, T., Ukata, U., & Akintoye, T. A. (2014). Challenges of Deforestation in Nigeria and the Millennium Development Goals. *International Journal of Environment and Bioenergy*, *9*(2), 76-94.

Mon, M. S., Mizoue, N., Htun, N. Z., Kajisa, T., & Yoshida, S. (2012). Factors affecting deforestation and forest degradation in selectively logged production forest: A case study in Myanmar. *Forest Ecology and Management*, 267: 190-198.

Ntuli, H., Jagers, S., Linell, A., Sjöstedt, M., & Muchapondwa, E. (2019). Factors influencing local communities' perceptions towards conservation of transboundary wildlife resources: the case of the Great Limpopo Trans-Frontier Conservation Area. *Biodiversity and Conservation, 28*. https://doi.org/10.1007/s10531-019-01809-5.

Nyadar B., Sambo G., Arhyel M., & Ntiajuka N. (2021). Assessment of deforestation in Dambia Local Government Area of Borno State, *Journal of Research in Environmental and Earth Sciences, 7*(9), 01-14

Oluigbo, C. U., Ngozi, E. C., & Ohaegbu, P. M. N. I. (2024). Determination of sample sizes in research using Taro Yamane formula: an overview. In the *76th Proceedings of the 1st Annual Faculty of Science International Conference, Niger Delta University*.

Ong, M. H. A., & Puteh, F. (2017). Quantitative data analysis: Choosing between SPSS, PLS, and AMOS in social science research. *International Interdisciplinary Journal of Scientific Research*, *3*(1), 14–25.

Ongena, Y. P., & Dijkstra, W. (2021). Advances in research on survey interview interaction. *International Journal of Social Research Methodology, 24*(2), 177-179. https://doi.org/10.1080/13645579.2020.1824625

Osemeobo G. (1988). The human causes of forest depletion in Nigeria, Environmental Conservation, *Spring*, *15*(1), 17-28

Petrides G. (1965). *Advisory report on wildlife and natural parks in Nigeria, 1962,* American Committee for International Wildlife Protection, Bronx, New York.

Read, J., and Lam, N (2002). Spatial methods for characterising land cover and detecting land cover changes for the tropics. *International Journal of Remote Sensing,* 23, 2457–2474. doi:10.1080/01431160110106140

Salami K., Agbo-Adediran A., and Kankomi D. (2021). Development of tree height-diameter models for Arakanga forest reserve, Abeokuta, Ogun state, *Journal of Research, Wildlife and Environment, 31*(1): 163-171

Salimi, H., Bahramjerdi, S. F. N., & Tootoonchi, R. (2025). The role of geographic information systems (GIS) in participatory conservation of heritage areas. *European Journal of Geography*, *16*(1), s1-s11. https://doi.org/10.48088/ejg.si.spat.hum.h.sal.1.11

Shorten, A., & Moorley, C. (2014). Selecting the sample. *Evid. Based. Nurs.* 17 eb–2014–101747–. https://doi.org/10.1136/eb-2014-101747

Soaga, J., Shotuyo, A. A., & Oduntan, O. (2012). Multiple Land Use Benefits of Peri-urban Forest (Arakanga Forest Reserve, Ogun State, Nigeria): Perception of Resource Users and its Implication. *International Journal of Molecular Ecology and Conservation.*

Tang, X. L., Adesina, J. A., & Ren, Y. (2023). Monitoring West Africa Sanctuary Encroachment and Degradation through Remote Sensing: A Focus on National Parks in Nigeria. https://doi.org/10.20944/preprints202309.1381.v1

Zaitunah, A., Samsuri, Ahmas A., & Safitri R. (2018). Normalised difference vegetation index (NDVI) analysis for land cover types using Landsat 8 OLI in Besitang watershed, Indonesia. *IOP Conf. Series: Earth and Environmental Science*, *126*(1), 012112