

LAND-USE PATTERNS AND PLANT COMMUNITY STRUCTURE IN THE PERI-URBAN ENVIRONS OF LOKOJA, KOGI STATE, NIGERIA: AN INTEGRATED FIELD AND NDVI ASSESSMENT, 2015 TO 2025

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Abstract

Rapid urbanisation is transforming natural vegetation on the fringes of medium sized Nigerian cities, yet the flora of these zones is rarely documented. This study assessed plant community structure in relation to land use in the peri-urban fringe of Lokoja, Kogi State, by combining field surveys at three sites, namely Zango, Ganaja and Banda, with a dry season Landsat 8 NDVI record spanning 2015 to 2025. Along one transect of 2 km at each site, trees and shrubs were counted in twenty plots of 10 m by 10 m and herbs and grasses were recorded with a point intercept frame of 1 m by 1 m on six visits, in April to June and October to December 2025. Shannon diversity and Pielou evenness were calculated, area normalised densities of each growth form were compared among sites by one way analysis of variance with the Duncan test, differences in composition were tested by permutational multivariate analysis of variance on Bray-Curtis dissimilarities, and NDVI trends were tested with the Mann-Kendall test and the Sen slope estimator. Seventy four taxa were recorded, comprising 13 trees, 8 shrubs, 14 grasses and sedges and 39 herbs, in 31 families. Woody plants averaged 187 stems per hectare, and two introduced trees, *Cassia fistula* and *Azadirachta indica*, made up 71 percent of tree stems, while the herb layer was dominated by ruderal species such as *Hyptis suaveolens* and *Cynodon dactylon*. Ganaja was the richest and most even site, with 44 taxa, a Shannon index of 3.19 and an evenness of 0.84; Banda had the fewest taxa at 24 and Zango the lowest evenness at 0.71. Tree and herb densities differed among sites, at $p = 0.004$ and $p < 0.001$ respectively, whereas shrub and grass densities did not. Composition differed clearly among sites, with a pseudo F of 7.19, an R^2 of 0.49 and $p = 0.001$. Across the eleven year record, moderate vegetation condition covered between 69.1 and 87.6 percent of the land area in every year and no monotonic trend in dry season NDVI was detected. The findings indicate a flora already reshaped by disturbance, in which the dominant woody component is introduced and the herb layer is ruderal, and in which compositional difference between neighbouring sites is large.

Keywords: peri-urban vegetation; plant diversity; growth forms; land-use change; NDVI; Lokoja; beta diversity

1. Introduction

Plants are central to terrestrial ecosystems. As primary producers they form the base of food chains, stabilise soils, regulate water flows and draw down atmospheric carbon, and they provide the structural matrix within which animal communities are organised. Plant diversity is also associated with higher and more stable primary production, so that the composition of a flora bears on the functioning of the system and not merely on its inventory (Ebeling et al., 2025).

Terrestrial plant diversity now faces multiple pressures, including agricultural and urban expansion, deforestation and the development of transport and other infrastructure. These act most intensely at the margins of growing cities, where land is converted rapidly and where the boundary between cultivated, built and semi natural vegetation is continually redrawn (Sedeq, Khan and Khan, 2022; Sexton, 2025). The peri-urban fringe is consequently the zone in which floristic change is fastest and, paradoxically, the zone least often surveyed.

Studies of the expansion of Lokoja have concentrated on the built environment. Ukoje (2016) analysed land use change and the spatial pattern of growth on the urban fringe, and Olufayokemi and Ojodale (2025) examined vegetation health response to urbanisation using geospatial methods. What is missing is a ground based floristic account: remote sensing establishes how much greenness is present but cannot identify which species compose it, and a canopy that appears stable in an index may nonetheless have changed entirely in composition.

This study addresses that gap by combining ground survey with remote sensing to describe the current plant diversity of peri-urban Lokoja. The specific objectives were to analyse the floristic composition and growth form structure of the vegetation at three peri-urban sites, to compare diversity and density among those sites, to characterise compositional turnover between them, and to establish whether dry season vegetation condition across the wider analysis window changed monotonically between 2015 and 2025.

2. Materials and Methods

2.1 Study Area

The study was carried out at three peri-urban localities around Lokoja, the capital of Kogi State in north central Nigeria: Zango, Ganaja and Banda (Figure 1). Each lies in the transitional zone between the built up core and the surrounding countryside. The climate is tropical savanna, with a rainy season from April to October and a dry season from November to March. Mean annual rainfall is between 1,200 and 1,500 mm, peaking in July and August.

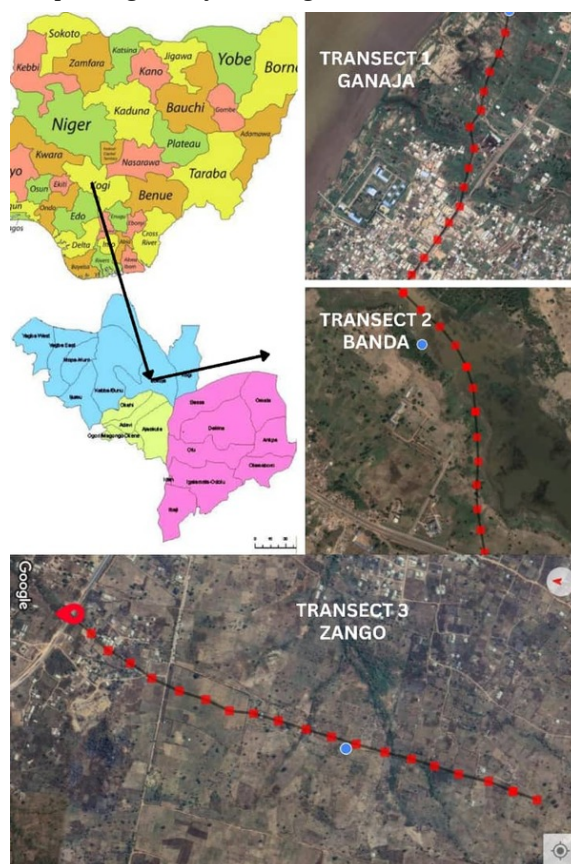


Figure 1: Location of the study area in Kogi State, Nigeria, and of the three sampling transects on the outskirts of Lokoja: transect 1 at Ganaja, transect 2 at Banda and transect 3 at Zango.

2.2 Study Design and Sampling

Field surveys were made once a month in April, May and June 2025, covering the early to mid rainy season, and in October, November and December 2025, covering the late rainy to early dry season, giving six visits in total. Following Tanko, Ezealor and Bako (2013), one linear transect of 2 km was laid out at each locality and sampling points were placed every 100 m, giving 20 points per transect. At each point trees and shrubs were counted in a plot of 10 m by 10 m, and herbs and grasses were recorded with a point intercept frame of 1 m by 1 m.

Voucher specimens were pressed, dried, mounted and identified using the Flora of West Tropical Africa (Hutchinson and Dalziel, 1972) and the regional compendia of Burkill (1985, 2000), following standard herbarium practice (Sullivan and Nazaire, 2022; Fortier, Heberling and Feeley, 2024). Vouchers are deposited at the Federal University Lokoja Herbarium and are listed in Table 6.

2.3 Long Term Change in Vegetation Condition

Vegetation condition between 2015 and 2025 was assessed in Google Earth Engine (Gorelick et al., 2017) from Landsat 8 OLI Collection 2 Level 2 surface reflectance imagery at 30 m resolution (Crawford et al., 2023). Analysis was restricted to the dry season window of December to February in order to limit the confounding influence of phenology and rainfall on the index. Permanent water was masked using the global surface water dataset of Pekel et al. (2016).

The Normalised Difference Vegetation Index was computed in the standard form

$$NDVI = (\rho_{NIR} - \rho_{Red}) / (\rho_{NIR} + \rho_{Red}) \quad (1)$$

where ρ_{NIR} and ρ_{Red} are surface reflectance in the near infrared and red bands. Composite values were grouped into three vegetation condition classes following Essaadia et al. (2022): low, where $-0.1 \leq NDVI < 0.2$, corresponding to bare ground, built up surfaces and sparse vegetation; moderate, where $0.2 \leq NDVI < 0.5$; and high, where $NDVI \geq 0.5$.

Monotonic trends in annual mean NDVI and in the percentage of land in each class over the eleven years were tested with the Mann-Kendall test (Mann, 1945; Kendall, 1975) and their magnitude estimated with the Sen slope (Sen, 1968). Because interannual variation in a greenness index can arise from rainfall as well as from land cover change (Wessels et al., 2007), mean NDVI was also regressed against wet season rainfall derived from the CHIRPS record (Funk et al., 2015) and the residuals tested for trend.

2.4 Data Analysis

Field records were analysed in Python using the pandas, SciPy and scikit-bio libraries. Species richness S , the Shannon diversity index and the Pielou evenness index were calculated for each site from records pooled over all visits:

$$H' = -\sum_{i=1}^S p_i \ln p_i, \quad J = H' / \ln S \quad (2)$$

in which p_i is the proportional abundance of taxon i . Densities of each growth form were area normalised and compared among sites by one way analysis of variance on $\log_{10}(x + 1)$ transformed point means, with the Duncan multiple range test for post hoc comparison (Duncan, 1955).

For the community analyses the records of each site and month were combined into 18 samples, being three sites by six months, standardised to 20 sampled points. Compositional dissimilarity between samples was quantified by the Bray-Curtis coefficient

$$BC_{jk} = \sum_i |x_{ij} - x_{ik}| / \sum_i (x_{ij} + x_{ik}) \quad (3)$$

and differences in composition among sites were tested by permutational multivariate analysis of variance (Anderson, 2001; Anderson and Walsh, 2013). The species contributing most to between site dissimilarity were identified by similarity percentage analysis (Clarke, 1993). Similarity in species occurrence was additionally summarised by the Jaccard index.

3. Results

3.1 Vegetation Condition, 2015 to 2025

A total of 93 Landsat 8 scenes met the selection criteria, between 7 and 11 per year. After masking permanent water, moderate vegetation condition was the dominant class in every year, covering between 69.1 and 87.6 percent of the land area. Annual mean NDVI ranged from 0.302 in 2022 to 0.424 in 2025, and stood at 0.419 in 2015 against 0.424 in 2025 (Figure 2a). The Mann-Kendall test did not detect a monotonic trend in mean NDVI across the eleven years.

Two checks were made on this result. Mean NDVI was not related to wet season rainfall, which ranged from 1,147 to 1,379 mm, with a Spearman correlation of 0.24 at $p = 0.484$, and the rainfall adjusted residuals likewise showed no trend. Mean NDVI was, however, related to the mean acquisition date of the annual composite (Figure 2b), later composites returning lower values, which is the expected signature of progressive dry season senescence and indicates that acquisition timing rather than land cover accounts for part of the interannual scatter.

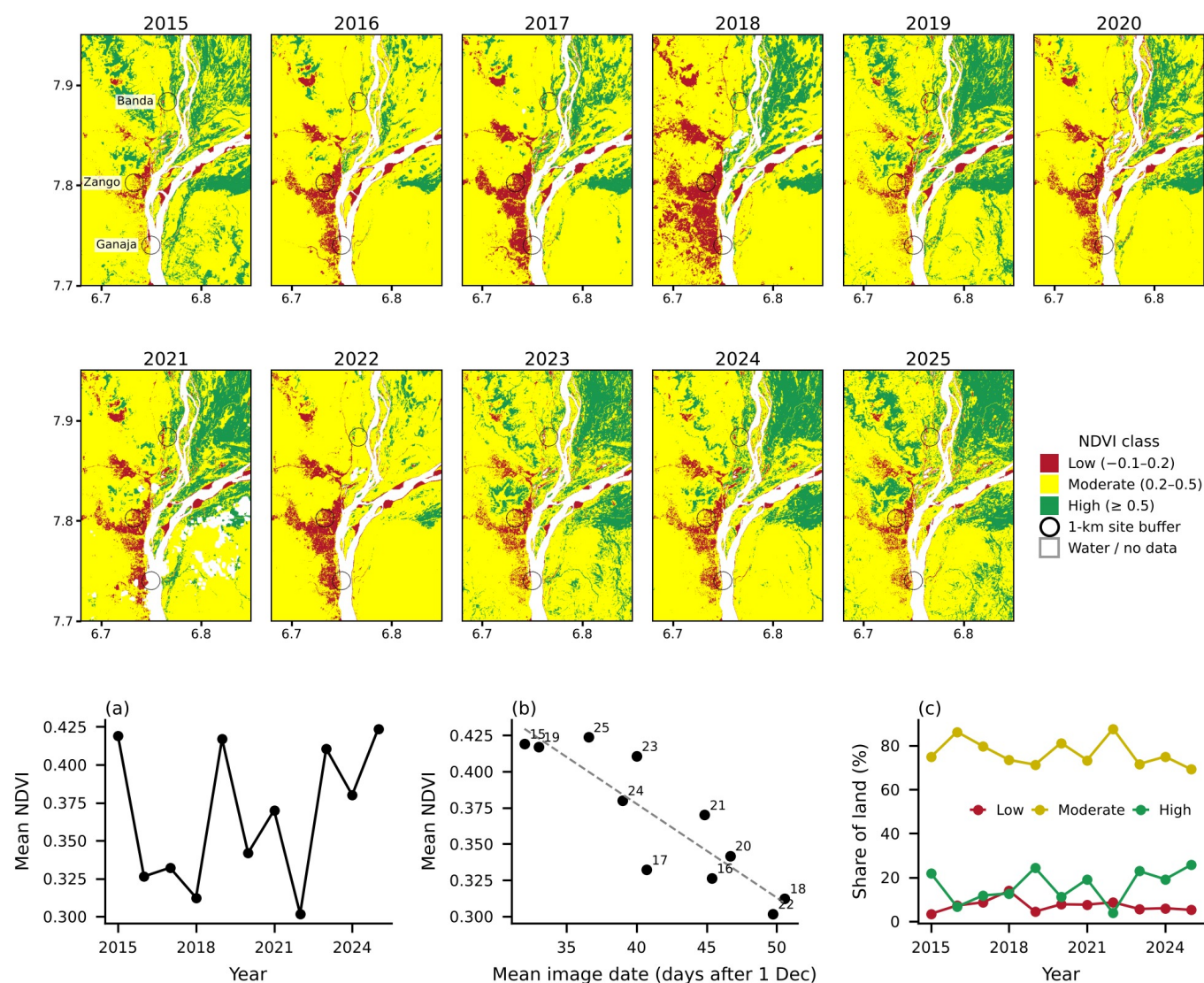


Figure 2: Dry season vegetation condition in the Lokoja analysis window, 2015 to 2025. Upper panels show annual Landsat 8 median NDVI composites classified as low, moderate and high, with the three site buffers marked. Lower panels show (a) annual mean NDVI, (b) mean NDVI against mean composite acquisition date, and (c) the share of land in each condition class.

3.2 Floristic Composition by Growth Form

In total, 74 taxa belonging to 31 families and 16 orders were recorded in the sampling plots (Table 5): 13 trees, 8 shrubs, 14 grasses and sedges and 39 herbs. Poaceae, with 12 taxa, and Fabaceae were the richest families.

A few species dominated each growth form. Two introduced trees, *Cassia fistula* at 43 percent of tree stems and *Azadirachta indica* at 28 percent, accounted together for 71 percent of all tree stems. The herb layer was dominated by ruderal species, principally *Hyptis suaveolens*, *Cynodon dactylon* and *Paspalum dilatatum*. The concentration of the woody component in two introduced species is the single most striking compositional feature of the dataset and is taken up in Section 4.2.

3.3 Diversity at Site Level

Ganaja recorded the most taxa at 44, the highest Shannon diversity at 3.19 and the highest evenness at 0.84 (Table 1). Zango held an intermediate number of taxa at 35 and the largest number of records at 1,870, but the lowest evenness at 0.71, indicating a community in which a few taxa account for a disproportionate share of records. Banda recorded the fewest taxa at 24 and the fewest records at 1,022.

Table 1: Records, richness by growth form and diversity indices of the plant communities at the three sites, with the six visits pooled

Site	Records	Taxa (S)	Trees	Shrubs	Grasses	Herbs	H'	J
Banda	1,022	24	5	3	4	12	2.414	0.760
Ganaja	1,545	44	4	3	10	27	3.193	0.844
Zango	1,870	35	8	3	7	17	2.538	0.714

Note. Records are stem counts for trees and shrubs plus pin contacts for herbs and grasses, summed over the six visits. Because pin contacts far outnumber stems, *H'* and *J* mainly reflect the herb layer.

3.4 Growth Form Composition and Density

Within the woody layer, trees outnumbered shrubs at Banda, at 87 percent of woody stems, and at Zango, at 90 percent, whereas shrubs, mainly *Chromolaena odorata*, slightly outnumbered trees at Ganaja, at 57 percent (Figure 3a). Tree density differed significantly among sites, $F(2, 57) = 6.19$, $p = 0.004$ (Table 2). Trees occurred at 14 of the 20 points at Zango but at only 5 points at Ganaja. Herb density also differed among sites, $F(2, 57) = 11.97$, $p < 0.001$, whereas shrub and grass densities did not.

Table 2: Density of each growth form at the three sites, with one way analysis of variance results

Growth form	Ganaja	Banda	Zango	<i>F</i>	<i>p</i>
Tree (stems ha ⁻¹)	63.3 ± 40.7 ^a	195.8 ± 110.9 ^a	165.8 ± 33.6 ^b	6.19	0.004
Shrub (stems ha ⁻¹)	82.5 ± 50.7	28.3 ± 17.9	19.2 ± 9.8	0.06	0.939
Grass (contacts m ⁻²)	1.00 ± 0.21	0.82 ± 0.16	1.18 ± 0.17	1.18	0.316
Herb (contacts m ⁻²)	1.28 ± 0.19 ^b	0.45 ± 0.07 ^a	1.57 ± 0.23 ^b	11.97	< 0.001

Note. Values are mean ± standard error with $n = 20$ sampling points per site; degrees of freedom are 2 and 57. Analysis of variance was performed on $\log_{10}(x + 1)$ transformed point means, and superscript letters denote Duncan groupings on that scale. For trees the Duncan test compares typical, that is geometric mean, densities of 2.5 at Ganaja, 2.8 at Banda and 40.5 stems per hectare at Zango; the higher arithmetic mean at Banda reflects a small number of dense forest points and is why the lettering does not follow the order of the arithmetic means.

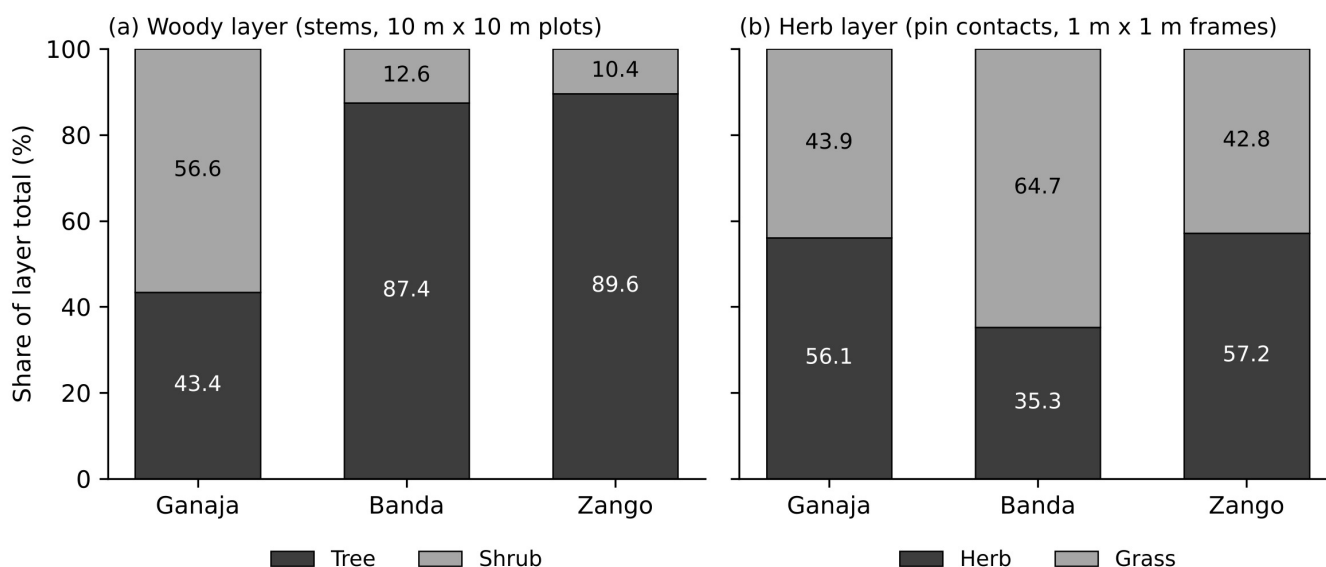


Figure 3: Composition of (a) the woody layer, as stem counts in plots of 10 m by 10 m, and (b) the herb layer, as pin contacts in frames of 1 m by 1 m, at each site.

3.5 Beta Diversity and Community Similarity

Bray-Curtis dissimilarity between the 18 month and site samples ranged from 0.04 to 0.87 (Figure 4). Samples from the same site were more similar, with a mean of 0.41, than samples from different sites. Permutational multivariate analysis of variance confirmed that composition differed among sites, with a pseudo F of 7.19, an R^2 of 0.49 and $p = 0.001$, so that site accounts for approximately half the variation in composition.

Similarity in species occurrence between sites was low, with Jaccard indices between 0.172 and 0.229, and only five taxa occurred at all three sites: *Cynodon dactylon*, *Paspalum dilatatum*, *Hyptis suaveolens*, *Passiflora foetida* and *Azadirachta indica*. Eight species accounted for just over half of the average dissimilarity between sites (Table 3).

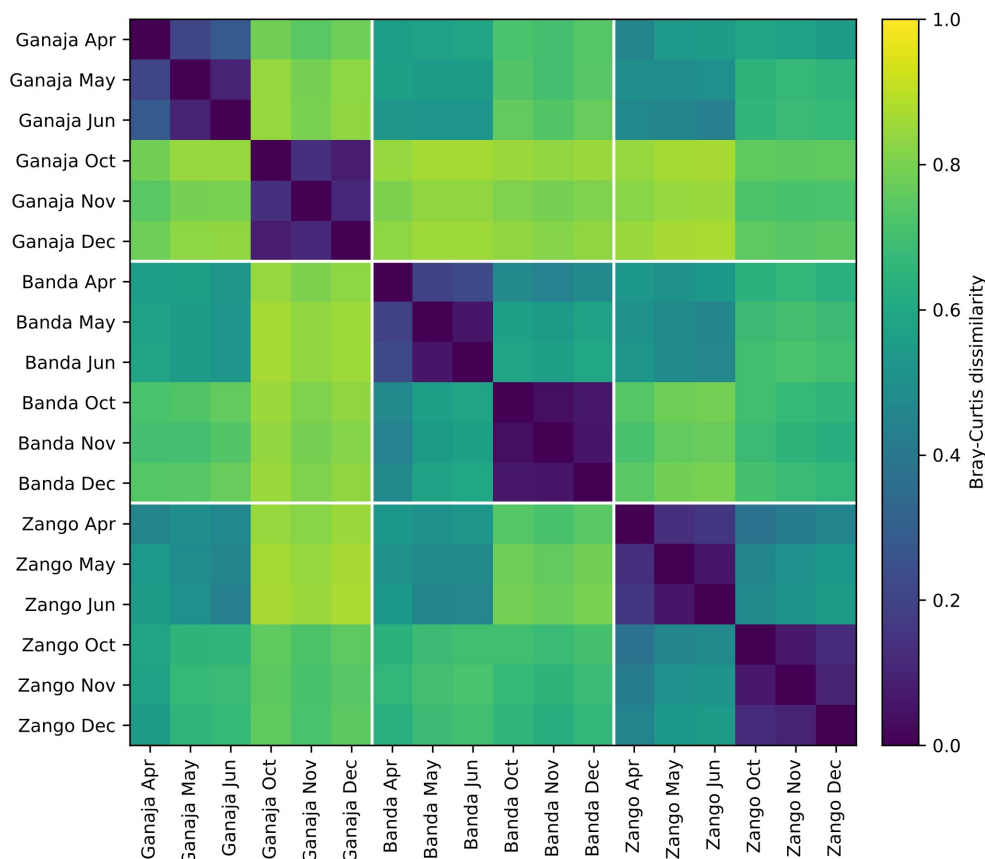


Figure 4: Bray-Curtis dissimilarity between the 18 month and site samples, where 0 denotes identical composition and 1 no shared taxa. White lines separate the three sites; within each site, samples run in month order.

Table 3: Species contributing most to the average Bray-Curtis dissimilarity between sites

Species	Growth form	Ganaja–Banda	Ganaja–Zango	Banda–Zango	Mean
<i>Hyptis suaveolens</i>	Herb	4.6	12.5	19.2	12.1
<i>Cynodon dactylon</i>	Grass	11.5	10.6	10.1	10.7
<i>Paspalum dilatatum</i>	Grass	12.1	7.2	11.3	10.2
<i>Passiflora foetida</i>	Herb	5.9	3.0	9.0	5.9
<i>Cassia fistula</i>	Tree	4.6	5.9	2.6	4.4
<i>Sida acuta</i>	Herb	0.4	4.9	5.6	3.6
<i>Euphorbia hirta</i>	Herb	5.4	4.5	0.7	3.5
<i>Chromolaena odorata</i>	Shrub	4.2	3.5	0.4	2.7
Total of the eight species		48.8	52.2	58.8	53.2
Average dissimilarity		0.738	0.678	0.654	–

Note. Values are percentage contributions to each pairwise dissimilarity, obtained by similarity percentage analysis; species are ranked by their mean contribution.

4. Discussion

4.1 Two Lines of Evidence, One Conclusion

Two independent lines of evidence describe the peri-urban vegetation of Lokoja, and they point in the same direction while measuring different things. On the ground, the flora is dominated by a ruderal herb layer led by *Hyptis suaveolens*, *Cynodon dactylon* and *Paspalum dilatatum*, and by a woody component in which two introduced species account for seventy one percent of stems. From orbit, dry season vegetation condition shows no monotonic trend across eleven years, with moderate condition covering the great majority of the analysis window in every year.

The apparent tension between a disturbed flora and a stable greenness record is instructive rather than contradictory, and resolving it is the main interpretive contribution of this study. NDVI measures canopy greenness and photosynthetic activity. It does not distinguish between a stand of indigenous savanna trees and an equivalent cover of *Cassia fistula*, nor between native grassland and a sward of ruderal colonisers. A landscape can therefore retain a constant index while undergoing complete

compositional substitution. The stability reported in Section 3.1 should accordingly be read as the absence of net greenness loss, not as evidence that the vegetation is unchanged, and the ground data indicate that the composition behind that greenness is already heavily modified.

This is a general caution for the use of vegetation indices in peri-urban monitoring. Studies that rely on NDVI alone, including those conducted for Lokoja itself (Olufayokemi and Ojodale, 2025), can establish how much photosynthetic cover persists but cannot detect the replacement of a diverse indigenous flora by a depauperate introduced one. The two methods are complementary and neither substitutes for the other.

4.2 A Woody Flora Dominated by Introductions

That *Cassia fistula* and *Azadirachta indica* together constitute seventy one percent of tree stems is the most consequential floristic finding. Both are introduced, both are widely planted for shade and amenity, and both regenerate readily on disturbed ground. Their dominance indicates that the woody vegetation of the Lokoja fringe is substantially a planted and self propagating anthropogenic assemblage rather than a remnant of the Guinea savanna woodland that would otherwise occupy these sites.

The indigenous woody species that were recorded, among them *Parkia biglobosa*, *Vitellaria paradoxa*, *Daniellia oliveri* and *Piliostigma thonningii*, occurred at low stem counts and at single sites. These are economically and culturally important trees in the region, and their scarcity in the sampled plots suggests that the conversion of fringe land is removing precisely the species whose loss is least easily reversed, since all are slow growing and none is being planted at a rate comparable to the introductions.

4.3 Reading the Growth Form Results Against the Sampling Design

Herbs and grasses dominated the sampled flora, but this result must be read with the sampling design in mind. Woody stems were counted in plots of 100 m² while herb layer contacts were recorded in frames of 1 m², and pin contacts are a fundamentally different unit from stem counts. The two are not commensurable, and the preponderance of herb records in the pooled totals is partly an artefact of measurement rather than a pure reflection of abundance. The diversity indices in Table 1, which are computed on pooled records, therefore describe the herb layer more faithfully than the community as a whole, and this is stated in the table note so that the values are not over read.

The density comparisons in Table 2 avoid this problem because each growth form is compared only with itself across sites, on an area normalised basis. One feature of that table warrants comment. For trees, the Duncan lettering does not follow the order of the arithmetic means: Banda has the highest arithmetic mean yet shares a letter with Ganaja, while Zango carries a separate letter. The explanation is that the analysis was conducted on log transformed point means, and on that scale the typical density at Zango, at 40.5 stems per hectare, greatly exceeds that at Banda, at 2.8. Banda has a high arithmetic mean because four of its twenty points fall in dense forest while the remainder carry almost no trees. The transformed analysis is the appropriate one for such a distribution, and the apparent anomaly in the lettering is a correct consequence of it rather than an error.

4.4 Compositional Turnover Across Short Distances

The three sites occupy different positions along the land use gradient crossed by the transects, and the compositional consequences are substantial. Permutational analysis attributed approximately half the variation in composition to site, Jaccard similarities between sites lay between 0.172 and 0.229, and only five taxa of seventy four occurred at all three locations. For sites separated by a few kilometres within the same climatic zone this is a high degree of turnover.

Ganaja, whose transect runs through built up land, grassland and riparian vegetation, was the richest and most even site. That the most heterogeneous land use supported the highest diversity is consistent with the general finding that intermediate disturbance and habitat heterogeneity sustain species richness, but it carries a caution: richness accumulated across contrasting patches is not the same as the richness of an intact community, and a site may score well on diversity indices precisely because it has been fragmented into several partial habitats.

The eight species identified by similarity percentage analysis account for just over half the average dissimilarity between sites, and six of the eight are ruderal herbs or grasses. Turnover among these sites is therefore driven less by the replacement of one natural community by another than by differences in which disturbance adapted colonisers have established, which is itself a signature of a landscape in flux.

4.5 Limitations

Several limitations should be stated. Each site was represented by a single transect, so differences among sites are differences among transects and cannot be separated from other local factors such as soil, hydrology and management history; replicate transects per site would be required to attribute composition to land use with confidence. Sampling covered one year across six visits, so interannual variation in the herb layer is unobserved. The herb and woody layers were measured in different units on plots of different size, which limits direct comparison between growth forms as discussed in Section 4.3. The NDVI analysis covers a wider window than the three transects and is restricted to the dry season, so it characterises the landscape rather than

the sampled plots. Finally, the association between mean NDVI and composite acquisition date indicates residual phenological influence that the dry season restriction reduced but did not eliminate.

5. Conclusion and Recommendations

The peri-urban vegetation of Lokoja is dominated by a ruderal herb layer, seventy one percent of its tree stems belong to two introduced species, and its composition differs strongly among three sites only a few kilometres apart. Across the eleven years from 2015 to 2025, dry season vegetation condition showed no monotonic trend, with moderate condition covering between 69.1 and 87.6 percent of the analysis window in every year.

The central conclusion is that stability in a greenness index is compatible with substantial floristic change, and that the two must be measured separately. A monitoring programme that tracked only NDVI would have recorded an unremarkable decade for the Lokoja fringe; the ground survey shows a flora in which the dominant trees are introduced and the herb layer is composed largely of disturbance adapted colonisers. The following recommendations follow.

1. **Pair ground survey with remote sensing in municipal vegetation monitoring.** Greenness indices should not be used alone to assess vegetation status on the urban fringe, since they cannot detect compositional substitution.
2. **Protect and propagate the remaining indigenous trees.** *Parkia biglobosa*, *Vitellaria paradoxa* and *Daniellia oliveri* occurred at low densities and at single sites, and are not regenerating at a rate comparable to the introduced species.
3. **Diversify amenity planting.** Where trees are planted on the fringe, indigenous species should be included rather than relying on the two introductions that already dominate.
4. **Extend the design to replicate transects.** Two or more transects per land use class would allow composition to be attributed to land use rather than to transect identity.
5. **Establish the present survey as a floristic baseline.** The inventory of seventy four taxa with vouchers at the Federal University Lokoja Herbarium provides a reference against which future change can be measured directly rather than inferred from imagery.

Ethical Statement

This study did not involve human participants or animal subjects; ethical approval and informed consent were therefore not required.

Conflict of Interest

The authors declare that they have no conflict of interest.

Funding

This research received no external funding.

Data Availability

The datasets generated and analysed during this study are available from the corresponding author on reasonable request. The full floristic inventory and the voucher list are reproduced as Tables 5 and 6 of this article.

Authors Contributions

Baba Joshua Enenyo: conceptualisation, study design, fieldwork, data collection, data analysis and drafting of the manuscript. **Dauda Tanko:** conceptualisation, study design, interpretation of results, review and editing. **Sikirat Uhaitu Zubairu:** study design, fieldwork, data collection, interpretation of results, review and editing. All authors read and approved the final manuscript.

Appendix: Floristic Inventory and Voucher Specimens

Table 5: Plant taxa recorded in the sampling plots, comprising 74 taxa in 31 families and 16 orders, with family, order, growth form, record count and sites of occurrence

S/N	Common name	Scientific name	Family	Order	Growth form	Records	Sites
1	Baobab	<i>Adansonia digitata</i>	Malvaceae	Malvales	Tree	6	G
2	Neem	<i>Azadirachta indica</i>	Meliaceae	Sapindales	Tree	144	G, B, Z
3	Orchid tree	<i>Bauhinia variegata</i>	Fabaceae	Fabales	Tree	18	B
4	Golden shower tree	<i>Cassia fistula</i>	Fabaceae	Fabales	Tree	219	B, Z
5	African copaiba balsam	<i>Daniellia oliveri</i>	Fabaceae	Fabales	Tree	6	Z
6	White lead tree	<i>Leucaena leucocephala</i>	Fabaceae	Fabales	Tree	18	Z
7	Mango	<i>Mangifera indica</i>	Anacardiaceae	Sapindales	Tree	6	Z

S/N	Common name	Scientific name	Family	Order	Growth form	Records	Sites
8	African peach	<i>Nauclea latifolia</i>	Rubiaceae	Gentianales	Tree	6	Z
9	Locust bean	<i>Parkia biglobosa</i>	Fabaceae	Fabales	Tree	18	B
10	Camel's foot tree	<i>Piliostigma thonningii</i>	Fabaceae	Fabales	Tree	5	Z
11	Java plum	<i>Syzygium cumini</i>	Myrtaceae	Myrtales	Tree	48	B
12	Umbrella tree	<i>Terminalia mantaly</i>	Combretaceae	Myrtales	Tree	9	G
13	Shea butter tree	<i>Vitellaria paradoxa</i>	Sapotaceae	Ericales	Tree	7	G, Z
14	Sugar apple	<i>Annona squamosa</i>	Annonaceae	Magnoliales	Shrub	27	B
15	Sodom apple	<i>Calotropis procera</i>	Apocynaceae	Gentianales	Shrub	14	Z
16	Siam weed	<i>Chromolaena odorata</i>	Asteraceae	Asterales	Shrub	92	G, B
17	Croton	<i>Croton</i> sp.	Euphorbiaceae	Malpighiales	Shrub	10	G
18	Wild poinsettia	<i>Euphorbia heterophylla</i>	Euphorbiaceae	Malpighiales	Shrub	1	B
19	Hymenocardia	<i>Hymenocardia acida</i>	Phyllanthaceae	Malpighiales	Shrub	6	Z
20	Sweet acacia	<i>Vachellia farnesiana</i>	Fabaceae	Fabales	Shrub	3	G
21	Bitter leaf	<i>Vernonia amygdalina</i>	Asteraceae	Asterales	Shrub	3	Z
22	Carpet grass	<i>Axonopus compressus</i>	Poaceae	Poales	Grass	70	B, Z
23	Congo grass	<i>Brachiaria ruziziensis</i>	Poaceae	Poales	Grass	71	G
24	Buffel grass	<i>Cenchrus ciliaris</i>	Poaceae	Poales	Grass	12	G
25	Mission grass	<i>Cenchrus polystachios</i>	Poaceae	Poales	Grass	10	B
26	Elephant grass	<i>Cenchrus purpureus</i>	Poaceae	Poales	Grass	82	G, Z
27	Bermuda grass	<i>Cynodon dactylon</i>	Poaceae	Poales	Grass	725	G, B, Z
28	Tall flat sedge	<i>Cyperus digitatus</i>	Cyperaceae	Poales	Grass	72	Z
29	Nut grass	<i>Cyperus rotundus</i>	Cyperaceae	Poales	Grass	7	G
30	Love grass	<i>Eragrostis</i> sp.	Poaceae	Poales	Grass	53	G
31	Jaragua grass	<i>Hyparrhenia rufa</i>	Poaceae	Poales	Grass	12	Z
32	Guinea grass	<i>Megathyrsus maximus</i>	Poaceae	Poales	Grass	35	G, Z
33	Dallis grass	<i>Paspalum dilatatum</i>	Poaceae	Poales	Grass	558	G, B, Z
34	Stubborn grass	Poaceae (unidentified)	Poaceae	Poales	Grass	43	G
35	Bristly foxtail	<i>Setaria barbata</i>	Poaceae	Poales	Grass	37	G
36	Chicken spike	<i>Achyranthes aspera</i>	Amaranthaceae	Caryophyllales	Herb	8	G
37	Goat weed	<i>Ageratum conyzoides</i>	Asteraceae	Asterales	Herb	10	B
38	Arrasa contodo	<i>Alternanthera pungens</i>	Amaranthaceae	Caryophyllales	Herb	34	G, B
39	Washer woman	<i>Alternanthera sessilis</i>	Amaranthaceae	Caryophyllales	Herb	6	G
40	Spiny amaranth	<i>Amaranthus spinosus</i>	Amaranthaceae	Caryophyllales	Herb	14	G
41	Hogweed	<i>Boerhavia diffusa</i>	Nyctaginaceae	Caryophyllales	Herb	18	G
42	Calopo	<i>Calopogonium mucunoides</i>	Fabaceae	Fabales	Herb	5	Z
43	Crown flower	<i>Calotropis gigantea</i>	Apocynaceae	Gentianales	Herb	3	G
44	Spider plant	<i>Cleome gynandra</i>	Cleomaceae	Brassicales	Herb	13	Z
45	Asian spider flower	<i>Cleome viscosa</i>	Cleomaceae	Brassicales	Herb	16	G
46	Tropical spiderwort	<i>Commelina benghalensis</i>	Commelinaceae	Commelinales	Herb	28	G, Z
47	Three-flowered beggarweed	<i>Desmodium triflorum</i>	Fabaceae	Fabales	Herb	30	G, Z
48	Asthma weed	<i>Euphorbia hirta</i>	Euphorbiaceae	Malpighiales	Herb	121	G, B
49	Spurge	<i>Euphorbia</i> sp.	Euphorbiaceae	Malpighiales	Herb	5	G
50	Blue pubby leaf	<i>Evolvulus alsinoides</i>	Convolvulaceae	Solanales	Herb	34	G, Z
51	Turnsol	<i>Heliotropium indicum</i>	Boraginaceae	Boraginales	Herb	6	G
52	Roselle	<i>Hibiscus sabdariffa</i>	Malvaceae	Malvales	Herb	24	Z
53	Bush mint	<i>Hyptis suaveolens</i>	Lamiaceae	Lamiales	Herb	736	G, B, Z
54	Indigo plant	<i>Indigofera</i> sp.	Fabaceae	Fabales	Herb	6	B
55	Morning glory	<i>Ipomoea</i> sp.	Convolvulaceae	Solanales	Herb	42	G, B
56	Mexican primrose willow	<i>Ludwigia octovalvis</i>	Onagraceae	Myrtales	Herb	14	G
57	Water primrose	<i>Ludwigia</i> sp.	Onagraceae	Myrtales	Herb	25	B, Z
58	Spearmint	<i>Mentha spicata</i>	Lamiaceae	Lamiales	Herb	65	B, Z
59	Sensitive plant	<i>Mimosa pudica</i>	Fabaceae	Fabales	Herb	22	G, Z
60	Stinking passion flower	<i>Passiflora foetida</i>	Passifloraceae	Malpighiales	Herb	286	G, B, Z
61	Wild gooseberry	<i>Physalis angulata</i>	Solanaceae	Solanales	Herb	13	G
62	Curlytop knotweed	<i>Polygonum lapathifolium</i>	Polygonaceae	Caryophyllales	Herb	18	G
63	Water hyacinth	<i>Pontederia crassipes</i>	Pontederiaceae	Commelinales	Herb	47	G
64	Broom weed	<i>Scoparia dulcis</i>	Plantaginaceae	Lamiales	Herb	51	G, Z
65	Beniseed	<i>Sesamum indicum</i>	Pedaliaceae	Lamiales	Herb	8	G

S/N	Common name	Scientific name	Family	Order	Growth form	Records	Sites
66	Common wireweed	<i>Sida acuta</i>	Malvaceae	Malvales	Herb	123	B, Z
67	Arrowleaf sida	<i>Sida rhombifolia</i>	Malvaceae	Malvales	Herb	11	G
68	Tomato	<i>Solanum lycopersicum</i>	Solanaceae	Solanales	Herb	4	Z
69	Wormbush	<i>Spigelia anthelmia</i>	Loganiaceae	Gentianales	Herb	27	G, B
70	Mexican sunflower	<i>Tithonia diversifolia</i>	Asteraceae	Asterales	Herb	27	Z
71	Coat buttons	<i>Tridax procumbens</i>	Asteraceae	Asterales	Herb	15	B, Z
72	Cattail	<i>Typha</i> sp.	Typhaceae	Poales	Herb	30	G
73	Milk weed	Unidentified herb	–	–	Herb	27	G
74	Ironweed	<i>Vernonia</i> sp.	Asteraceae	Asterales	Herb	6	Z
75	Coffee senna	<i>Senna occidentalis</i>	Fabaceae	Fabales	Shrub	–	–
76	Rice flat sedge	<i>Cyperus iria</i>	Cyperaceae	Poales	Grass	–	–
77	Water spinach	<i>Ipomoea aquatica</i>	Convolvulaceae	Solanales	Herb	–	–
78	Haemorrhage plant	<i>Aspilia africana</i>	Asteraceae	Asterales	Herb	–	–
79	Stonebreaker	<i>Phyllanthus amarus</i>	Phyllanthaceae	Malpighiales	Herb	–	–

Note. Sites are G for Ganaja, B for Banda and Z for Zango. Records are stem counts for trees and shrubs and pin contacts for herbs and grasses, summed over the six visits.

Table 6: Voucher specimens deposited at the Federal University Lokoja Herbarium

S/N	Scientific name (with author)	Voucher no.	Growth form
1	<i>Euphorbia hirta</i> L.	FULH 0002	Herb
2	<i>Senna occidentalis</i> (L.) Link	FULH 0008	Shrub
3	<i>Phyllanthus amarus</i> Schumach. & Thonn.	FULH 0061	Herb
4	<i>Tridax procumbens</i> L.	FULH 0094	Herb
5	<i>Cyperus rotundus</i> L.	FULH 0021	Grass
6	<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	FULH 0117	Shrub
7	<i>Calopogonium mucunoides</i> Desv.	FULH 0112	Herb
8	<i>Aspilia africana</i> (Pers.) C.D.Adams	FULH 0118	Herb
9	<i>Hyptis suaveolens</i> (L.) Poit.	FULH 0120	Herb
10	<i>Setaria barbata</i> (Lam.) Kunth	FULH 0231	Grass
11	<i>Nauclea latifolia</i> Sm.	FULH 0067	Tree
12	<i>Ipomoea aquatica</i> Forssk.	FULH 0139	Herb
13	<i>Daniellia oliveri</i> (Rolfe) Hutch. & Dalziel	FULH 0188	Tree
14	<i>Cyperus iria</i> L.	FULH 0091	Grass
15	<i>Calotropis procera</i> (Aiton) W.T.Aiton	FULH 0131	Shrub
16	<i>Passiflora foetida</i> L.	FULH 0134	Herb
17	<i>Sida acuta</i> Burm.f.	FULH 0200	Herb
18	<i>Vitellaria paradoxa</i> C.F.Gaertn.	FULH 0029	Tree
19	<i>Piliostigma thonningii</i> (Schumach.) Milne-Redh.	FULH 0056	Tree
20	<i>Mimosa pudica</i> L.	FULH 0237	Herb

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