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COMPARATIVE DYNAMICS OF LAND USE/LAND COVER UNDER AN ANTHROPOGENIC PRESSURE GRADIENT IN MARITIME GUINEA: A FOUR-SITE CASE STUDY (1986-2024)

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Abstract

Introduction: Maritime Guinea is undergoing rapid land-cover transformation driven by urbanization, agricultural expansion, mining activity, and land degradation. Site-specific diachronic assessments are needed to characterize how these pressures diverge across contrasting land-use contexts. **Objective:** To analyze and compare land use/land cover (LULC) dynamics between 1986 and 2024 across four sites subject to contrasting anthropogenic pressure regimes: Damakhania (mixed reference pressure), Koba (coastal mangrove area), Missira (agricultural pressure), and Sangarédi (bauxite mining pressure). **Methods**: Diachronic analysis was performed using Landsat imagery (TM, ETM+, OLI) subjected to supervised classification (maximum likelihood). Classification accuracy was assessed via confusion matrices and the Kappa coefficient. **Results**: Forest and savanna formations declined across all four sites, with relative losses ranging from -22.7% (Missira) to -51.8% (Sangarédi). This decline was accompanied by site-specific expansion of anthropogenic land-cover classes: urbanization in Damakhania (+17.8 percentage points), agriculture in Missira (+7.3 points), mining in Sangarédi (+5.8 points), and mangrove cover in Koba (+2.8 points). Koba showed a distinct coastal dynamic, with forest decline (-14.7 points) coexisting with mangrove expansion (+2.8 points). **Conclusion**: These findings reveal a regional gradient of anthropogenic pressure, from a reference situation (Damakhania) to severe environmental crisis (Sangarédi), with intermediate profiles of moderate agricultural pressure (Missira) and coastal degradation (Koba). This quantitative evidence base can inform sustainable land management policy in Maritime Guinea and underscores the need for integrated planning that accounts for the diversity of anthropogenic pressures across sites.
***Keywords**: land use/land cover, remote sensing, spatio-temporal dynamics, anthropogenic pressure, Maritime Guinea, pressure gradient.*

1. INTRODUCTION

Coastal and sub-coastal areas of West Africa are undergoing increasingly rapid land use/land cover dynamics under the combined effects of population growth, urbanization, agricultural expansion, and mining activities. In Maritime Guinea, these pressures are resulting in a profound reorganization of natural landscapes—savannas, open forests, mangroves—in favor of anthropogenic land cover types. Land use and land cover change currently represent one of the main drivers of environmental transformations at the global scale. They directly influence ecosystem functioning, biogeochemical cycles, biodiversity, water resources, and climate (Foley et al., 2005; IPCC, 2021; Lambin & Geist, 2006). Recent reports from the Intergovernmental Panel on Climate Change (IPCC) emphasize that land use changes constitute an essential component of climate change mitigation and adaptation strategies (IPCC, 2021). Sub-Saharan Africa ranks among the world's regions where landscape transformations are most rapid. Population growth, increasing food demand, infrastructure expansion, urbanization, and exploitation of mineral resources are accelerating the conversion of natural ecosystems to anthropogenic uses (Curtis et al., 2018; FAO, 2022; Afuye et al. (2024)). These transformations result in reduced forest cover, habitat fragmentation, biodiversity loss, and progressive degradation of ecosystem services.

Mining currently constitutes one of the main drivers of deforestation in several African countries rich in mineral resources. Beyond the areas directly exploited, mining activities promote the opening of new roads, population settlement, expansion of agricultural areas, and infrastructure development, thereby generating indirect effects that are sometimes more significant than the direct impacts of mines (Sonter et al., 2018; Maus et al., 2022). In response to these dynamics, satellite remote sensing and geographic information systems (GIS) have become essential tools for monitoring land use/land cover changes. Landsat time series, available for over forty years, enable long-term analysis of landscape trajectories, quantification of conversions between land cover classes, and identification of the main drivers of observed changes (Wulder et al., 2019; Zhu, 2017; White et al., 2016). Recent advances in image classification and machine learning are significantly improving the accuracy of the maps produced. However, most studies available for Guinea remain focused on single sites, limiting the comparative scope of results and the ability to identify robust regional

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trends. The present study proposes a comparative analysis of land use/land cover dynamics between 1986 and 2024 across four sites in Maritime Guinea selected to represent a contrasting gradient of anthropogenic pressure: Damakhania, Koba, Missira, and Sangarédi. The objectives are (i) to quantify the evolution of land cover classes specific to each site, (ii) to compare the intensity and nature of these changes between sites, and (iii) to discuss the underlying pressure factors in light of an anthropogenic gradient ranging from reference conditions to mining pressures.

2. MATERIALS AND METHODS

2.1. Study area

The study sites of Damakhania, Koba, Missira, and Sangarédi are located in Maritime Guinea, within the administrative regions of Kindia and Boké. These four sub-prefectures belong respectively to the prefectures of Kindia, Boffa, Télimélé, and Boké. The four sites represent contrasting ecological and socio-economic contexts: a rapidly expanding peri-urban area (Damakhania), a coastal landscape dominated by mangroves (Koba), an agricultural basin (Missira), and a major bauxite mining district (Sangarédi). They are located between approximately 9°20′ and 11°10′ North latitude and 13°05′ and 14°20′ West longitude. The four sites are subject to a humid tropical climate characterized by a rainy season from May to October and a dry season from November to April. Annual precipitation generally ranges between 2,000 and 4,000 mm, with mean temperatures between 25 and 28 °C. The topography is generally gently undulating, alternating coastal plains, lowlands, lateritic plateaus, and low hills. Vegetation is composed of dense and open forests, wooded and shrubby savannas, mangroves, and agricultural lands, reflecting high ecological diversity. Socio-economically, the populations derive their livelihoods primarily from agriculture, artisanal fishing, livestock farming, forestry, and mining activities. Over recent decades, urbanization, expansion of agricultural areas, infrastructure development, and bauxite mining have profoundly transformed land cover in these territories. This diversity of contexts makes these four sites particularly suitable natural laboratories for comparative analysis of landscape dynamics and their environmental impacts in Maritime Guinea.

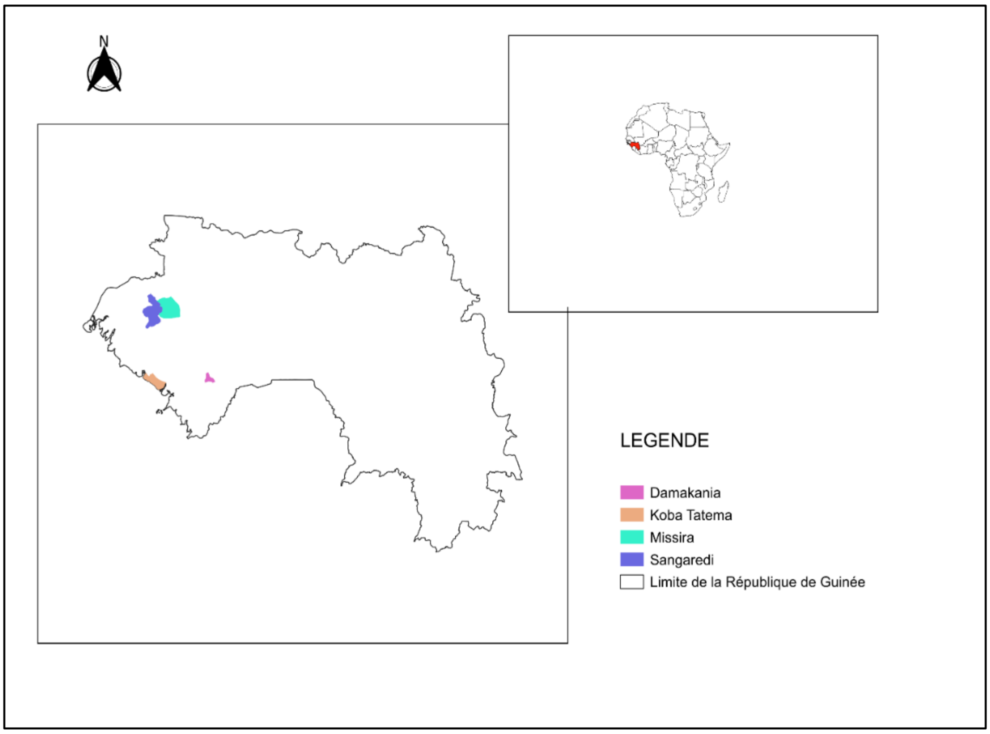


Figure 1: Location of the four (4) sample zones.

2.2. Satellite data and preprocessing

The study is based on Landsat TM, ETM+, and OLI satellite images acquired in March 1986, 2002, and 2024, from the USGS Collection 2 Level 2. These images, already geometrically and atmospherically corrected, have a spatial resolution of 30 m, ensuring consistent temporal comparison. Preliminary processing, including color compositing, image clipping according to study site boundaries, and data preparation for classification, was carried out using QGIS, ENVI, and the R language.

2.3. Land cover classification

Land cover mapping was performed using a combination of unsupervised and supervised classification, the latter using the Maximum Likelihood algorithm. Six land cover classes were defined for each of the four sites, with a nomenclature adapted to their ecological and socio-economic characteristics. Thus, certain classes are specific to particular sites, such as mangroves in Koba or mines and quarries in Sangarédi and Missira. Classification accuracy was assessed using a confusion matrix, overall accuracy, and the Kappa coefficient, in accordance with remote sensing recommendations. The area of each class, expressed in hectares and as a percentage of total area, was calculated for the years 1986, 2002, and 2024, along with their annual rates of change.

2.4. Inter-site comparative analysis

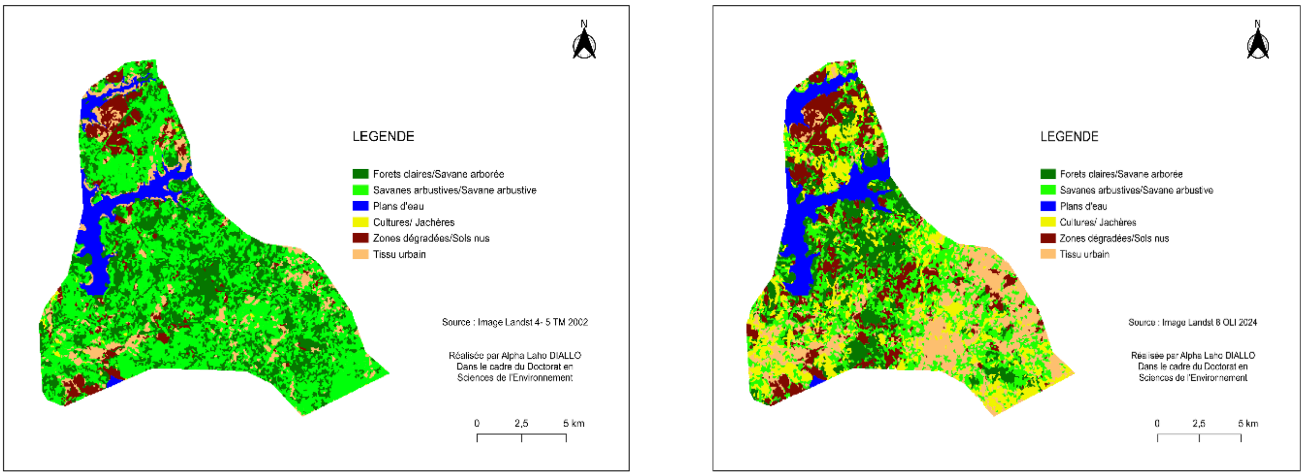
Land cover dynamics were analyzed using transition matrices to identify conversions between different classes during the periods 1986-2002 and 2002-2024. Changes were quantified as absolute variation (percentage points), relative variation (%), and annual rate of change. Gain and loss maps, as well as deforestation hotspots, were produced to locate the areas most affected by landscape transformations. A comparative analysis was then conducted between the four sites to highlight differences in landscape trajectories according to: (i) the magnitude of regression of natural formations (forests, savannas, and mangroves), (ii) the classes that experienced the greatest expansion (agriculture, urbanization, mining, or land degradation), and (iii) the main anthropogenic factors responsible for observed changes. All statistical analyses, indicator calculations, and production of tables, graphs, and maps were performed using R. This integrated approach enables characterization of the spatio-temporal dynamics of land cover and identification of the main drivers of landscape transformation across the four study sites.

3. RESULTS AND DISCUSSION

3.1. Land cover dynamics by site (1986-2024)

3.1.1. Urbanization at the expense of savannas and forests in Damakhania

The land cover classification maps for Damakhania (Figure 2) reveal a profound landscape transformation between 2002 and 2024. In 2002, the territory was largely dominated by natural formations, with 36.3% wooded/shrubby savanna and 31.3% open forest, representing a total of 67.6% natural vegetation cover. Anthropogenic areas (urban, agricultural, degraded zones) accounted for only 23.2% of the area. By 2024, this ratio had reversed: natural formations fell to 36.1%, while anthropogenic surfaces reached 54.8%. The regression of wooded/shrubby savanna is particularly marked, declining from 36.3% to 19.1% (-17.2 percentage points, -47.4%), while open forest declined from 31.3% to 17.0% (-14.3 points, -45.7%). This concurrent decline of the two main natural classes reflects sustained anthropogenic pressure, comparable to trends observed in other peri-urban areas of West Africa (Traore et al., 2018; Obateru, 2026). Urban expansion is spectacular, rising from 8.7% to 26.5% (+17.8 points, +203.4%), reflecting rapid urbanization dynamics characteristic of the peripheries of Guinean cities. Degraded areas/bare soils also increased substantially (+10.9 points, +189.7%), indicating erosion and land degradation processes associated with urban expansion and intensive agricultural practices (Sy et al., 2017). Crops/fallow lands experienced moderate increase (+2.9 points, +33.5%), suggesting a less pronounced agricultural transition than in Missira, but nonetheless significant.



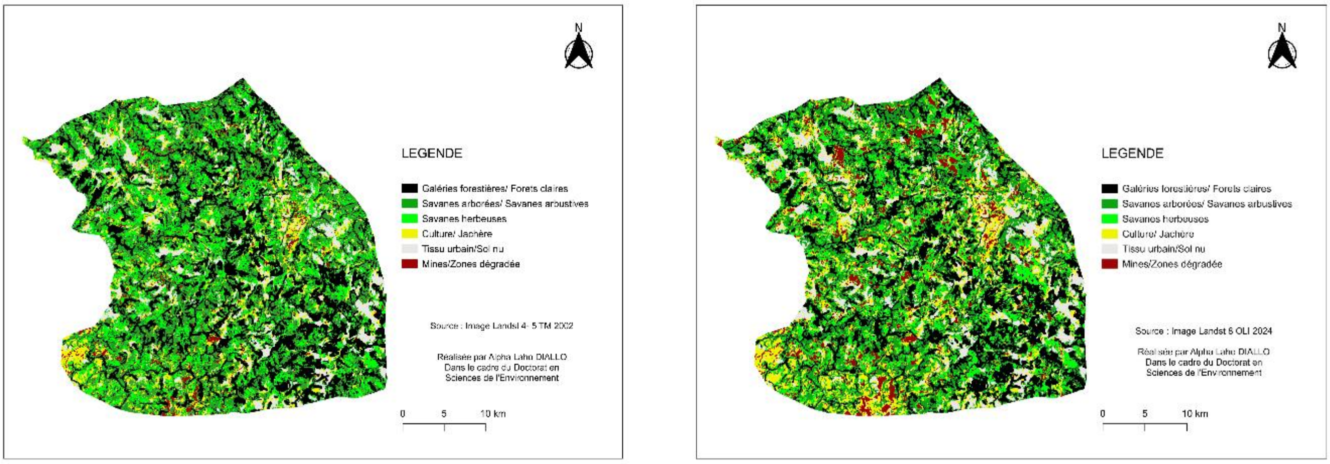
2002 2024

Figure 2 : Dynamique spatio-temporelle de l'occupation des terres dans la zone d'étude entre 2002 et 2024.

3.1.2. Agricultural expansion as a driver of change in Missira

In Missira, land cover dynamics are dominated by agricultural expansion (Figure 3). Open forest/gallery forest declined from 24.5% to 18.9% (-5.6 points, -22.7%), while wooded/shrubby savanna decreased from 24.5% to 19.0% (-5.5 points, -22.5%). Herbaceous savanna, a class characteristic of ecological transition zones, lost 1.4 points, falling from

18.1% to 16.7%. In contrast, crops/fallow lands recorded the strongest increase (+7.3 points, +54.4%), confirming the role of agriculture as the main driver of change, consistent with observations by Curtis et al. (2018) on deforestation factors in sub-Saharan Africa. Urban/bare soil areas increased slightly (+0.5 points), while mines/degraded zones increased by 4.7 points (+99.8%). This increase in mining and degraded surfaces, although less spectacular than in Sangarédi, indicates the emergence of extractive pressure that could intensify in coming years (Kolie et al., 2025). Missira's profile illustrates the consequences of agricultural intensification on natural ecosystems, where conversion of forests and savannas to cropland occurs at the expense of biodiversity and ecosystem services (Foley et al., 2005; FAO, 2022).

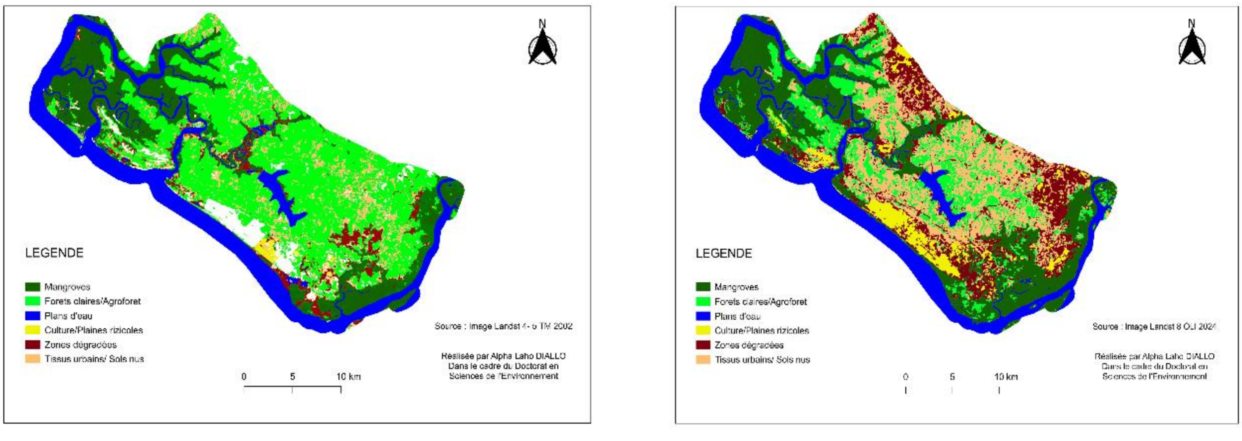


2002 2024

Figure 3 : Dynamique de l'occupation des terres entre 2002 et 2024.

3.1.3. Forest decline and mangrove expansion in Koba

Koba presents a distinctive land cover dynamic (Figure 4), marked by a decline in open forest/agroforest from 33.6% to 18.9% (-14.7 points, -43.9%), comparable to forest losses observed in Sangarédi. However, this forest regression is accompanied by mangrove expansion (+2.8 points, +11.9%), a distinctive phenomenon not observed at other sites. This mangrove progression, also observed in other coastal areas of West Africa (Lemenkova, 2024; Lombard & Andrieu, 2021)), suggests a specific coastal dynamic potentially linked to sedimentation processes, sea-level variations, or coastal ecosystem protection policies. Rice paddies/crops increased moderately (+0.8 points), while degraded areas increased from 5.8% to 14.7% (+8.9 points, +156.0%), indicating degradation of agricultural and forest lands. Urban/bare soils nearly doubled (+2.5 points, +64.5%). Koba's singularity lies in the coexistence of significant forest degradation and mangrove expansion, suggesting mechanisms of partial ecological compensation. This observation underscores the importance of coastal zones as biodiversity reservoirs and buffer zones against anthropogenic pressures, justifying special attention in conservation policies (Karbon-X Corp., 2025).



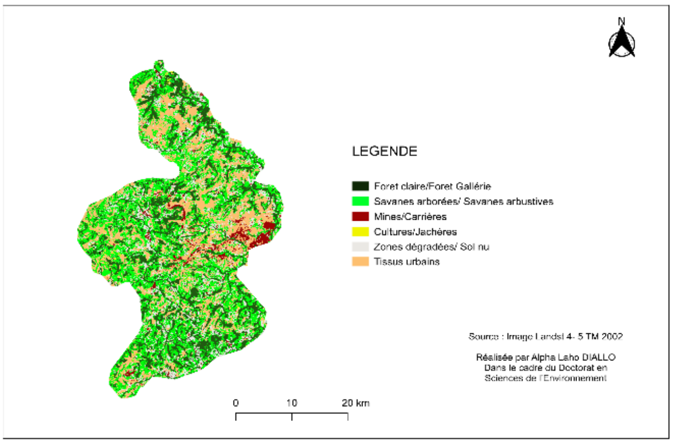
2002 2024

Figure 4 : Dynamique de l'occupation du sol entre 2002 et 2024.

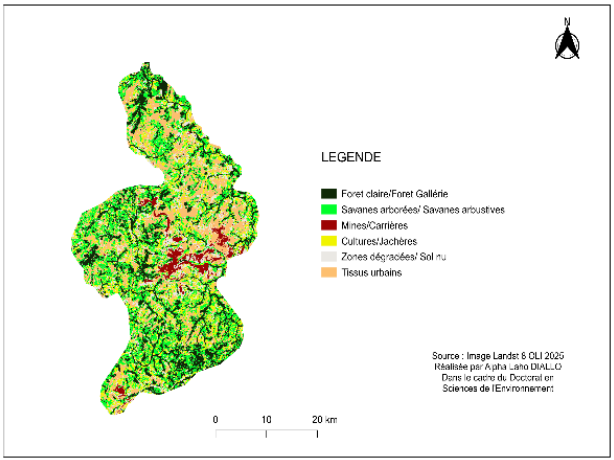
3.1.4. Mining as a driver of massive deforestation in Sangarédi

Sangarédi is undergoing the most radical transformations (Figure 5), with a decline in open forest/gallery forest from 35.5% to 17.1% (-18.4 points, -51.8%), the highest forest loss among the four sites. Wooded/shrubby savanna regressed from 25.1% to 19.9% (-5.1 points, -20.6%). This massive deforestation is directly attributable to the expansion of mines/quarries, which increased from 13.3% to 19.1% (+5.8 points, +43.4%), and urban areas from 13.2% to 21.7% (+8.4 points, +63.5%). Crops/fallow lands also experienced strong growth (+9.4 points, +96.0%). These results are consistent with the work of Sonter et al. (2018) and Maus et al. (2022), showing that mining in West Africa generates significant indirect effects on land cover, notably through road opening, population settlement, and agricultural expansion.

The Sangarédi case perfectly illustrates these mechanisms: the increase in crops (+9.4 points) is comparable to that of mines (+5.8 points), confirming the indirect effects of extractive activity. Camara et al. (2024) furthermore highlight the land-use conflicts and social tensions generated by mining expansion in the Boké region, while Erusani et *al.* (2025) insist on the need to manage post-mining environmental impacts. The persistence of bare soils and degraded areas, symptomatic of irreversible land degradation, places Sangarédi in a situation of critical environmental emergency.



2002



2024

Figure 45 : Évolution de l'occupation du sol entre 2002 et 2024.

3.2. Quantitative evolution of areas by class (2002-2024)

Table 1 synthesizes quantitative changes by class across all sites. Three major trends emerge from this comparative analysis. Across all sites, forest and savanna classes recorded significant decreases, with relative losses ranging from -7.8% (herbaceous savanna, Missira) to -51.8% (open forest/gallery forest, Sangarédi). This trend confirms observations by Afuye et *al.* (2024) on the acceleration of land cover changes in sub-Saharan Africa, where natural ecosystems are progressively converted to anthropogenic surfaces under the combined effects of population growth, agricultural expansion, and extractive activities. Deforestation rates observed at Sangarédi (-18.4 points in 22 years) and Damakhania (-14.3 points) are comparable to those reported by Curtis et al. (2018) for deforestation hotspots in West Africa.

Each site is characterized by a rapidly expanding anthropogenic class, reflecting the specific nature of the dominant pressure: urbanization in Damakhania (+17.8 points), agriculture in Missira (+7.3 points), mangrove in Koba (+2.8 points), and mining activities in Sangarédi (+5.8 points). This diversification of change trajectories underscores the importance of a comparative approach for understanding local factors of landscape transformation, as recommended by Lambin & Geist (2006).

Water bodies remained remarkably stable across all sites, with variations between -0.1 and -0.3 points. This stability, also observed by Traore et al. (2018) in Guinea, suggests lower sensitivity of this class to the anthropogenic pressures considered, although complementary studies are needed to assess qualitative impacts (water quality, sedimentation) of these land cover changes.

Table 1: Comparative evolution of land cover by class and by site (2002–2024).

LAND-COVER CLASS	2002 (%)	2024 (%)	Change (pts)	Relative change (%)	Trend
DAMAKHANIA: REFERENCE SITE / MIXED PRESSURE (URBANIZATION + DEGRADATION)					
WATER BODY	9.20%	9.10%	−0.10 pts	−1.1%	Stable
WOODED/SHRUB SAVANNA	36.32%	19.10%	−17.22 pts	−47.4%	Sharp decrease
OPEN FOREST/WOODED SAVANNA	31.25%	16.97%	−14.28 pts	−45.7%	Sharp decrease
URBAN FABRIC	8.74%	26.52%	+17.78 pts	+203.4%	Sharp increase
DEGRADED AREAS/BARE SOIL	5.74%	16.63%	+10.89 pts	+189.7%	Sharp increase
CROPLAND/FALLOW LAND	8.75%	11.68%	+2.93 pts	+33.5%	Sharp increase
KOBA: COASTAL ZONE: FOREST DECLINE / MANGROVE EXPANSION					
LAND-COVER CLASS	**2002 (%)**	**2024 (%)**	**Change (pts)**	**Relative change (%)**	**Trend**
WATER BODY	18.55%	18.23%	−0.32 pts	−1.7%	Stable
MANGROVE	23.22%	25.98%	+2.76 pts	+11.9%	Sharp increase
RICE FIELDS/CROPLAND	14.97%	15.78%	+0.81 pts	+5.4%	Increase
OPEN FOREST/AGROFOREST	33.60%	18.86%	−14.74 pts	−43.9%	Sharp decrease
DEGRADED AREAS	5.75%	14.72%	+8.97 pts	+156.0%	Sharp increase
URBAN FABRIC/BARE SOIL	3.91%	6.43%	+2.52 pts	+64.5%	Sharp increase
MISSIRA: DOMINANT AGRICULTURAL PRESSURE					
LAND-COVER CLASS	**2002 (%)**	**2024 (%)**	**Change (pts)**	**Relative change (%)**	**Trend**
OPEN FOREST/GALLERY FOREST	24.50%	18.93%	−5.57 pts	−22.7%	Sharp decrease
WOODED/SHRUB SAVANNA	24.53%	19.00%	−5.53 pts	−22.5%	Sharp decrease
GRASS SAVANNA	18.12%	16.71%	−1.41 pts	−7.8%	Decrease
CROPLAND/FALLOW LAND	13.46%	20.78%	+7.32 pts	+54.4%	Sharp increase
URBAN FABRIC/BARE SOIL	14.70%	15.21%	+0.51 pts	+3.5%	Increase
MINES/DEGRADED AREAS	4.69%	9.37%	+4.68 pts	+99.8%	Sharp increase
SANGARÉDI: DOMINANT MINING (BAUXITE) PRESSURE					
LAND-COVER CLASS	**2002 (%)**	**2024 (%)**	**Change (pts)**	**Relative change (%)**	**Trend**
WOODED/SHRUB SAVANNA	25.06%	19.91%	−5.15 pts	−20.6%	Sharp decrease
OPEN FOREST/GALLERY FOREST	35.47%	17.08%	−18.39 pts	−51.8%	Sharp decrease
CROPLAND/FALLOW LAND	9.81%	19.23%	+9.42 pts	+96.0%	Sharp increase
MINES/QUARRIES	13.34%	19.13%	+5.79 pts	+43.4%	Sharp increase
URBAN FABRIC	13.24%	21.65%	+8.41 pts	+63.5%	Sharp increase
WATER BODY	3.08%	3.00%	−0.08 pts	−2.6%	Stable

3.3. Land cover transitions by site

Dense forest retains between 43% (Sangarédi) and 60% (Damakhania) of its initial area, while savanna shows stability rates between 55% (Sangarédi) and 65% (Damakhania). These high persistence rates suggest that, despite anthropogenic pressures, a significant portion of natural ecosystems remains. However, increasing fragmentation of vegetation cover, not quantified in this study, may mask significant qualitative degradation of forest and savanna formations. Conversion of forests and savannas to cropland is the dominant flow in Missira (6-7% of natural class area converted) and Damakhania (5-7%). In Sangarédi, conversion to mines and urban areas is predominant, while in Koba, flow toward degradation (bare soils) is most significant. These results confirm the hypothesis of diversification of change drivers according to local socio-economic context. Cropland shows relatively low stability rates (55-65%), indicating plot rotation or abandonment, leading to fallow and degraded areas. Degraded areas, in particular, show high persistence (>70%), suggesting difficulty in restoring these spaces. This finding underscores the importance of land degradation as a potentially irreversible process in contexts of intense anthropogenic pressure.

Figure 6: Land cover transitions across sites (Sankey diagram).

3.4. Anthropogenic pressure gradient and regional trajectories

Comparative analysis of the four sites allows identification of an anthropogenic pressure gradient, ranging from a reference situation (Damakhania) to a severe environmental crisis (Sangarédi), with intermediate situations of moderate agricultural pressure (Missira) and coastal degradation (Koba). Table 2 synthesises change profiles by site. Damakhania constitutes the reference site, with rapid urbanisation but partial maintenance of natural formations (overall stability 67%). This profile corresponds to that of many West African urban peripheries, where land pressure is high but natural spaces remain, playing a role as cool islands and biodiversity reservoirs (Traore et al., 2018). Missira is characterized by dominant agricultural pressure, with cropland expansion and moderate regression of natural formations. This profile is typical of Guinean agricultural basins, where intensification of farming practices is accompanied by progressive soil degradation and biodiversity loss (Voulemo Djeuhala et al., 2025). Koba stands out with an original coastal dynamic, where forest decline coexists with mangrove expansion. This singular profile illustrates the importance of coastal ecosystems in change trajectories and underscores the need for a specific approach to their sustainable management. The apparent resilience of mangrove to anthropogenic pressures merits particular attention in conservation policies (Lemenkova, 2024). Sangarédi presents the most critical situation, with massive deforestation and irreversible land degradation linked to mining. This profile is emblematic of West African mining territories, where extractive activities generate rapid and often irreversible transformations of landscapes and ecosystems (Camara et al., 2024; Kolie et al., 2025). The work of Erusani et *al.* (2025) underscores the urgency of developing sustainable management strategies for post-mining impacts, notably through ecological restoration and diversification of economic activities.

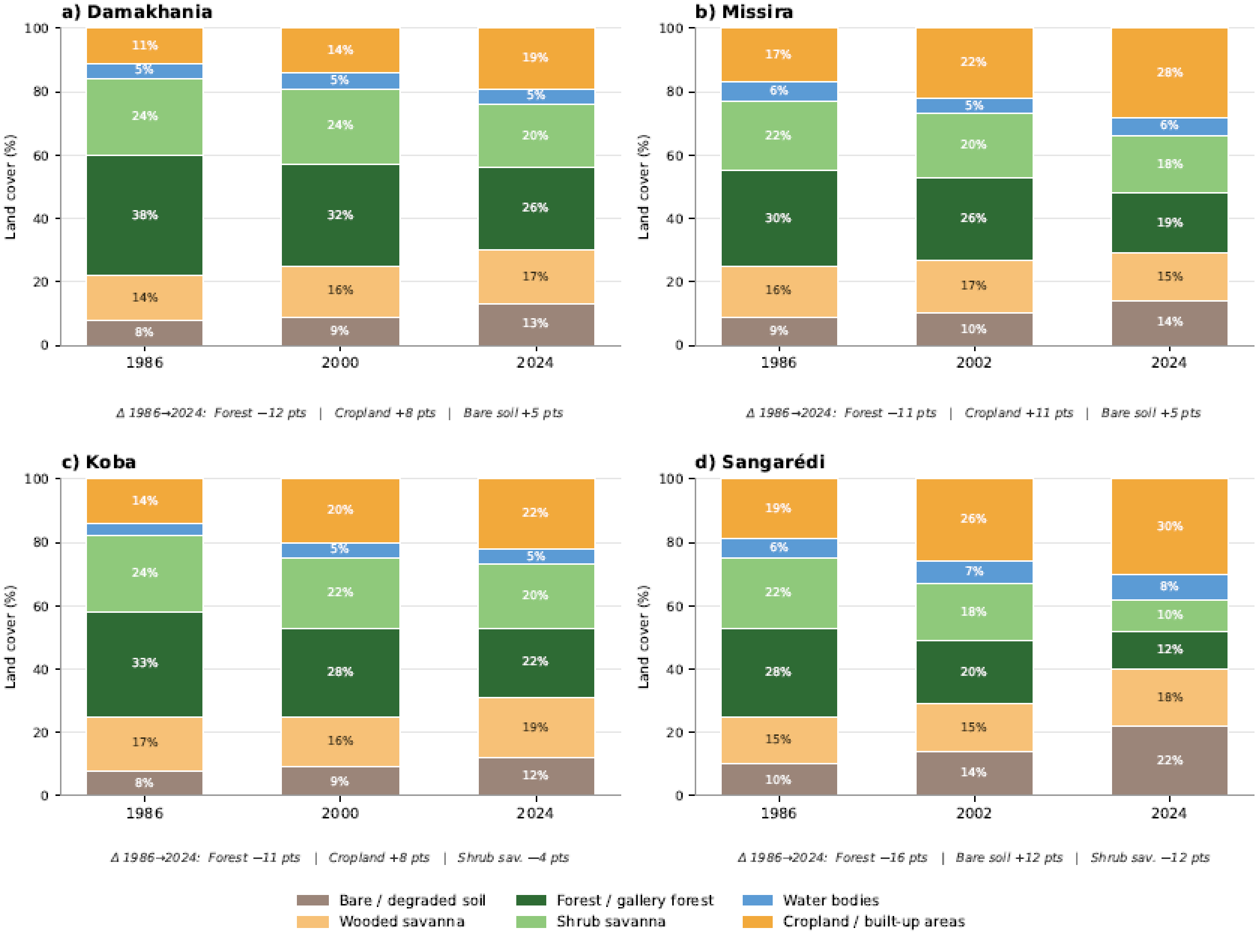


Figure 7: Comparative analysis of the four sites in terms of anthropogenic pressure gradient

Table 2: Comparative summary of the 4 sites.

Indicator	Damakhania	Missira	Koba	Sangarédi
Stability	67%	58%	62%	52%
Total change	33%	42%	38%	48%
Forest loss	7%	12%	10%	16%
Agricultural expansion	3%	10%	7%	9%
Degradation	+5.6%	8%	8%	12%
Urgency level	Low	Moderate	High	Critical

3.5. Comparative synthesis and regional implications

The results of this study highlight a regional gradient of anthropogenic pressure in Maritime Guinea, ranging from peripheral urbanization (Damakhania) to agricultural pressure (Missira), through a specific coastal dynamic (Koba) and culminating in a mining crisis (Sangarédi). This gradient, although non-linear, enables understanding of the diversity of change trajectories and identification of the local factors that structure them. Population growth, demand for agricultural land, urbanization, and mining are all drivers that act in synergy to modify land cover. In accordance with the analytical framework of Lambin & Geist (2006), these proximate factors interact with underlying factors (political, economic, institutional) to generate change trajectories specific to each site. The generalized decline of natural formations across all sites confirms the regional trend documented by Afuye et al. (2024), while the diversification of expanding classes underscores the importance of local specificities. The results of this study call for differentiated interventions according to local contexts. In Damakhania, the challenge is to control urban sprawl and preserve residual natural spaces to maintain cool islands and ecological corridors. In Missira, emphasis should be placed on sustainable agriculture to limit soil degradation and preserve land fertility. In Koba, mangrove conservation and integrated coastal zone management are priorities. In Sangarédi, finally, ecological restoration actions and strict regulation of extractive activities are essential, in accordance with recommendations of Erusani et *al.* (2025) and Kolie et *al.* (2025). All these interventions should be part of an integrated territorial planning framework, involving local stakeholders, authorities, and economic operators.

Table 3: Comparative summary of land-use change profiles by site.

Site	Dominant profile	Sharpest increase	Sharpest decrease
Damakhania	Reference / urbanization + degradation	Urban fabric (+17.8 pts; +203%)	Wooded savanna (-17.2 pts; -47%)
Koba	Coastal zone: forest/mangrove retreat	Mangrove (+2.8 pts; +12%)	Open forest/Agroforest (-14.7 pts; -44%)
Missira	Dominant agricultural pressure	Crops/Fallow land (+7.3 pts; +54%)	Open forest/Gallery forest (-5.6 pts; -23%)
Sangarédi	Dominant mining pressure (bauxite)	Crops/Fallow land (+9.4 pts; +96%)	Open forest/Gallery forest (-18.4 pts; -52%)

4. CONCLUSION

This four-site diachronic analysis (1986–2024) provides robust quantitative evidence of a regional gradient of anthropogenic pressure across Maritime Guinea, extending from a reference peri-urban trajectory (Damakhania) to a critical mining-driven crisis (Sangarédi), with intermediate profiles shaped by agricultural intensification (Missira) and coastal mangrove dynamics (Koba). Across all four sites, forest and savanna formations declined consistently, with relative losses ranging from -22.7% to -51.8%, confirming that natural land cover in Maritime Guinea is under sustained and accelerating anthropogenic pressure. However, the nature of the dominant replacement class diverged markedly across sites, urbanisation, agriculture, mining, and mangrove expansion, demonstrating that landscape trajectories in this region are not homogeneous but are structured by local socio-economic drivers superimposed on a shared regional trend of natural-cover regression. The persistence of stable water-body extents across sites, contrasted with the high variability of anthropogenic classes, further underscores the selective sensitivity of terrestrial land-cover types to human pressure.

These findings offer a quantitative, site-differentiated evidence base to inform land-use planning and environmental governance in Maritime Guinea. They support the need for spatially differentiated management strategies: containment of urban sprawl and preservation of ecological corridors in peri-urban zones; promotion of sustainable agricultural intensification in farming basins; integrated coastal zone management with a focus on mangrove conservation; and strict regulation coupled with ecological restoration in mining districts. Given the reliance on 30 m Landsat imagery and a six-class classification scheme, finer-scale fragmentation processes and qualitative degradation may be underestimated; future work should incorporate higher-resolution or radar-based sensors, extend the site network to strengthen regional representativeness, and integrate hydrological and socio-economic data to refine the drivers underlying each observed trajectory. Overall, this comparative approach demonstrates the value of multi-site diachronic remote sensing for capturing the diversity of land-use change pathways and for guiding integrated, context-specific territorial planning in West African coastal and sub-coastal landscapes.

Recommendations :

- Strengthen environmental monitoring of sites subject to intense mining or agricultural pressure (Sangarédi, Missira).
- Extend the comparative analysis to other sites in Maritime Guinea to consolidate the regional representativeness of the identified pressure gradient.
- Deepen the study of the singular case of Koba (coastal and mangrove dynamics) through complementary data (hydrology, sedimentology).
- Develop regional land-use planning schemes (SRAT) that integrate all sectors (agriculture, mining, urban planning, conservation) to avoid land-use conflicts and cumulative impacts.
- Ensure consultation between technical services (environment, mines, agriculture, urban planning) for coherent territorial governance.
- Train technical staff of ministries and local authorities in remote sensing, GIS, and integrated territorial planning.
- Strengthen the capacities of local communities to participate in sustainable natural resource management (training, technical support).
- Support applied research on land cover dynamics, impacts of extractive activities, and ecological restoration solutions.
- Develop partnerships with universities and research centers to improve knowledge and practices.

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