GSC Advanced Research and Reviews

eISSN: 2582-4597 CODEN (USA): GARRC2

Cross Ref DOI: 10.30574/gscarr

Journal homepage: https://gsconlinepress.com/journals/gscarr/

(Research Article)

Check for updates

# Spatio-Temporal Land Use Dynamics and Environmental Impacts of Gold Mining: An Integrated Remote Sensing Analysis in the Siguiri Prefecture, Guinea (1992–2022)

Lucien SOLIE [1], Thierno Boubacar BAH [1,*], Fatoumata Binta Sombily DIALLO [1], Sogbè KEITA [2] and Alpha Issaga Pallé DIALLO [2]

[1] *Institute for Environmental Research of Guinea (IREG), Conakry, Guinea.*

[2] *Maritime and Coastal Research Center (CEREMAC), Conakry, Guinea.*

GSC Advanced Research and Reviews, 2026, 26(02), 079-091

Publication history: Received on 02 February 2025; revised on 21 March 2025; accepted on 29 March 2025

Article DOI: https://doi.org/10.30574/gscarr.2026.26.2.0038

## Abstract

Extractive activities are generating major environmental transformations. This study analyzes the spatio-temporal dynamics of land use and their impacts on natural resources between 1992 and 2022.

An integrated approach combining remote sensing (Landsat 5–8 imagery, supervised classification) and socio-economic surveys (288 respondents, 50 households) was implemented. The diachronic analysis quantifies land-use changes across five classes: dense vegetation, agricultural land, settlements, bare soils/mining areas, and water bodies.

The observed transformations reveal critical environmental degradation within the AngloGold Ashanti mining area in Siguiri, characterized by a 16.27% decline in vegetation cover (2,356 $km^2$) and a drastic 28.75% increase in degraded surfaces. Exceptional demographic growth (53.7% over 40 years) has intensified anthropogenic pressures and reshaped the rural economy: 75% of households are now engaged in artisanal gold mining. Both industrial mining (AngloGold Ashanti) and artisanal operations generate severe cumulative impacts, notably the systematic abandonment of non-rehabilitated sites.

These findings highlight the urgent need for sustainable mining governance in West Africa. The remote sensing-based methodology (accuracy >87%) demonstrates strong effectiveness for continuous environmental monitoring. The study advocates the integration of ecological restoration practices, stricter regulation of extractive activities, and local economic diversification.

**Keywords:** Remote sensing; Land-use change; Gold mining; Environmental sustainability; Guinea; Ecosystem ecology

## 1. Introduction

The Landscape transformation under anthropogenic pressure represents one of the major environmental challenges of our time. Land-use and land-cover changes, defined as modifications in the biophysical characteristics of the Earth's surface resulting from human activities, constitute key drivers of environmental degradation.

In West Africa, land-use dynamics are particularly alarming in mining regions, where recent acceleration of extractive investments coincides with severe natural-resource degradation (Nziguheba et al., 2023). Although land rehabilitation practices, sustainable mining approaches, and low-emission energy use offer pathways to improve environmental sustainability, their implementation remains limited. The Republic of Guinea illustrates this paradox: its vast Birimian gold deposits attract massive investments while exerting intense pressure on local ecosystems.

* Corresponding author: Alain GBILIMOU

Copyright © 2026 Author(s) retain the copyright of this article. This article is published under the terms of the Creative Commons Attribution License 4.0.

Recent studies highlight the magnitude of landscape transformations in Guinea. Between 2005 and 2015, national land distribution comprised 82% natural and semi-natural terrestrial ecosystems, 15% agricultural land, 1.5% wetlands, and only 1% artificial surfaces (AFD et al., 2019). However, these national averages mask strong regional disparities, particularly in intensive mining zones where ecosystem conversion rates reach critical levels.

Indirect impacts—often underestimated—include habitat fragmentation, intensified pressure on peripheral natural resources, and accelerated land degradation processes (Sonter et al., 2017). Approximately 11.74% of vegetation cover in the study area was converted into bare soil and mined land between 2019 and 2023, largely linked to abandoned mining sites where vegetation has been destroyed.

In Cameroon, Voundi et al. (2019) demonstrated that semi-mechanized gold mining caused massive vegetation destruction and accelerated savannization processes. Deforestation increased by 9% between 2005 and 2017, while savanna cover expanded from 36% in 1976 to 55% in 2017. Dense forests and forest-savanna mosaics declined respectively from 31% and 28% to 22% and 18%. The authors attributed 90% of land-use changes to mining activities, compared to only 10% to agriculture, illustrating the dominant pressure of extractive industries on tropical forest ecosystems.

Socio-economic consequences are equally severe. In Cameroon, 38.7% of local populations were forced to change livelihoods due to farmland loss from mining, becoming artisanal miners (82.13%), migrating to new agricultural zones (11.87%), or shifting to petty trade (7.23%) (Voundi et al., 2019).

Natural-resource conflicts constitute another critical indicator of socio-environmental degradation in mining regions. In Guinea, Pakoun (2015) documented more than 90 conflicts across 17 localities, particularly concentrated in active mining projects (70%). The Siguiri Prefecture records the highest concentration, fueled by declining arable land, massive youth migration toward mining opportunities, and inequitable benefit distribution (Maud & Alfred, 2016).

The rapid expansion of Guinea's mining sector further illustrates mounting ecosystem pressures. Between 2004 and 2014, 380 mining titles were granted—274 within just four years (2010–2014). Such proliferation generates cumulative environmental impacts whose assessment and management remain insufficient.

In this context, integrating remote sensing and Geographic Information Systems (GIS) offers powerful tools for monitoring and understanding spatio-temporal land-use dynamics in mining regions (Johansen et al., 2007). These technologies enable objective landscape-change assessment, vegetation-loss quantification, and priority-area identification for ecological restoration.

This study therefore aims to analyze land-use dynamics and their impacts on natural resources in the Siguiri Prefecture over the period 1992–2022. Specifically, it seeks to quantify spatio-temporal land-use changes, assess their environmental consequences, and identify the key drivers of these transformations, contributing to sustainable natural-resource management strategies in intensive mining contexts in West Africa.

## 2. Material and methods

### 2.1. Study Area

The Siguiri Prefecture constitutes the geographical area of this research. Located in the Kankan administrative region in northeastern Republic of Guinea, it lies approximately 850 km from the capital city, Conakry.

The study area extends between 11°25′20″ North latitude and 9°10′11″ West longitude, with an average altitude of 971.9 m, and covers a total surface area of 15,500 km$^2$ (Figure 1). It is bordered to the north and east by the Republic of Mali, to the south by the prefectures of Kankan and Mandiana, and to the west by the prefectures of Dinguiraye and Kouroussa (National Institute of Statistics of Guinea, 2022).

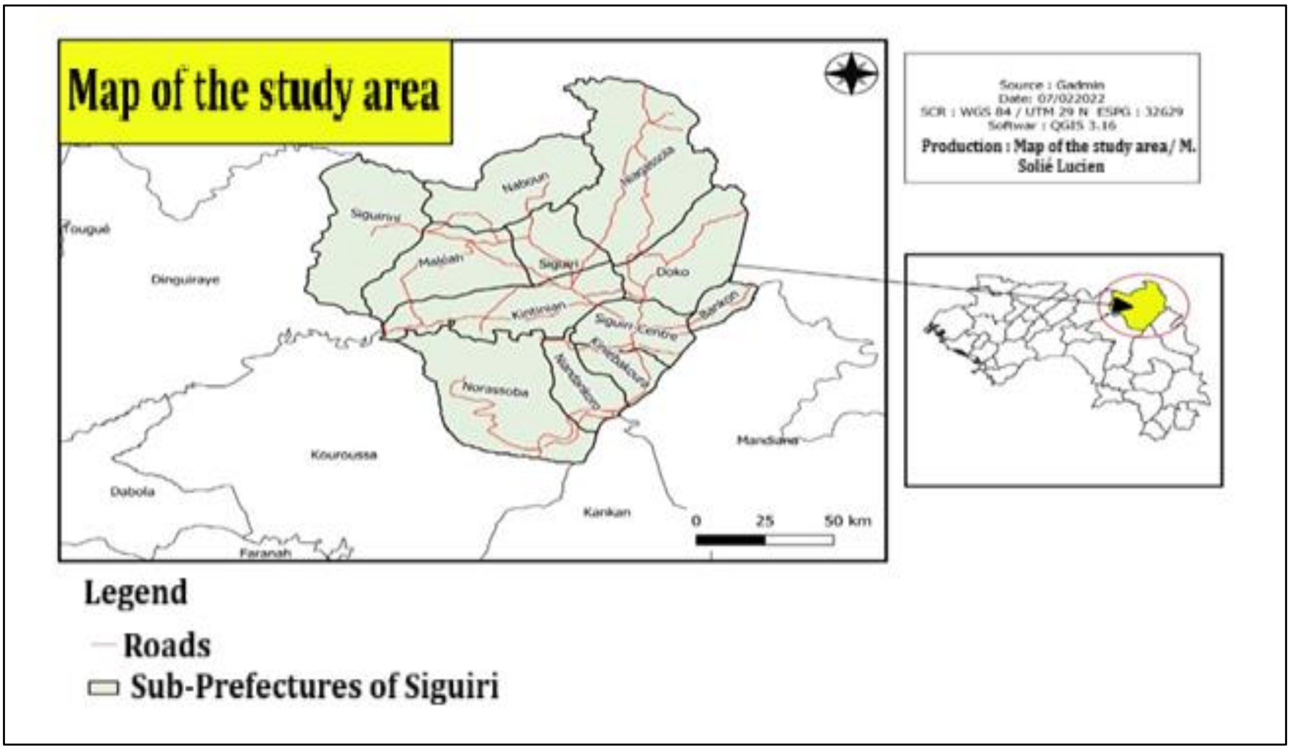


**Figure 1** Geographic location of the Siguiri Prefecture in the Republic of Guinea

The prefecture presents major geological significance due to its substantial gold reserves located within the Birimian Basin. These reserves, estimated at more than 700 tonnes of high-grade gold (850–980‰, equivalent to 20–23.5 carats), occur in both secondary deposits (alluvial placers) and primary deposits (quartz veins) (Ministry of Mines and Geology, 2020).

As of December 2019, total proven and probable reserves were estimated at 72.33 Mt at 0.76 g/t, containing 1.76 Moz of gold, while total mineral resources were estimated at 185.6 Mt at 0.95 g/t, containing 5.7 Moz of gold (AngloGold Ashanti, 2020).

The administrative territory has been subdivided into twenty (20) sub-prefectures since 2022, compared to fourteen (14) in 2018, reflecting demographic growth and the expansion of economic activities, particularly mining (Presidential Decree D/2022/089/PRG/SGG).

The Bouré mining area, where the activities of the AngloGold Ashanti Guinea Company (SAG) are located, covers a surface area of 1,728 km$^2$ and hosts a population of 124,847 inhabitants distributed across twelve (12) villages: Kintinian, Boukaria, Balato, Fatoya, Kofilani, Samany, Kourouni, Kamatiguiya, Setiguiya, Kourouda, Lenkekoe, and Fenserekolen, all situated within the Kintinian sub-prefecture.

Population density in this zone is estimated at 72.25 inhabitants/km$^2$, with an annual demographic growth rate of 9.5% between 1996 and 2014 (RGPH, 2014).

The Société Aurifère de Guinée (SAG), a subsidiary of AngloGold Ashanti, produces approximately 350,000 ounces of gold per year. The company's shareholding structure is composed of 85% AngloGold Ashanti and 15% Government of Guinea.

*2.1.1. Research Design*

This study adopts a mixed-methods approach combining quantitative analyses based on spatial remote sensing and qualitative assessment through socio-economic surveys (Creswell & Plano Clark, 2017). This integrated methodology enables a multidimensional analysis of the interactions between anthropogenic activities and environmental dynamics over a three-decade period (1992–2022).

*2.1.2. Demographic Data Collection*

The demographic data cover a 39-year period (1992–2022) and are derived from the General Population and Housing Censuses (RGPH 1983, 1996, 2014) as well as projections from the National Institute of Statistics of Guinea.

Population density, a key indicator of anthropogenic pressure, is calculated using the following formula:

$$d = \frac{P_t}{S}$$

Where:

d = population density (inhabitants/km$^2$)

$P_t$ = total population

S = total surface area of the zone where SAG is established (1,728 km$^2$)

**Table 1** Demographic Evolution of Siguiri Prefecture (1992–2022)

| Year | Population | Data Type | Growth Rate (%) |
|---|---|---|---|
| 1992 | 271,224 | RGPH 1996 Census | 4.5 |
| 2022 | 855,494 | INS Projection | 2.74 |

### 2.2. Enquêtes socio-économiques

*2.2.1. Échantillonnage*

Un échantillonnage stratifié proportionnel a été mobilisé afin de sélectionner les participants, conformément aux critères de détermination de la taille d'échantillon proposés par Yamane (1967) pour les populations finies. Cette approche garantit la représentativité des différentes strates de la population étudiée.

L'échantillon est constitué de **288 répondants**, répartis au sein de **50 ménages** localisés dans les zones d'influence directe et indirecte des activités de la Société Aurifère de Guinée (SAG).

La structuration par genre met en évidence **186 hommes (64,58 %)** et **102 femmes (35,42 %)**, avec des âges compris entre **18 et 75 ans**.

**Table 2** Socio-Demographic Characteristics of the Survey Sample

| Education Level | Frequency | % |
|---|---|---|
| Primary education | 68 | 23.61% |
| Middle school (Lower secondary) | 58 | 20.13% |
| High school (Upper secondary) | 40 | 13.88% |
| Vocational training | 36 | 12.53% |
| Higher education (Tertiary) | 16 | 5.55% |
| No formal schooling | 70 | 24.30% |
| Total | 288 | 100.00% |

The educational attainment of respondents is distributed as follows: primary education (23.61%), middle school/lower secondary (20.13%), high school/upper secondary (13.88%), vocational training (12.53%), higher education (5.55%), and no formal schooling (24.30%).

## 3. Socio-Economic Surveys

### 3.1. Sampling

Proportionate stratified sampling was employed to select participants in accordance with the sample size determination criteria proposed by Yamane (1967) for a finite population. This method ensures adequate representation of the different population strata within the study area.

The sample consists of **288 respondents** drawn from **50 households** located within both the direct and indirect zones of influence of the activities of the *Société Aurifère de Guinée (SAG)*.

Gender distribution shows **186 men (64.58%)** and **102 women (35.42%)**, with respondents' ages ranging from **18 to 75 years**.

**Table 3** Socio-Demographic Characteristics of the Survey Sample

| **Education Level** | **Frequency** | **%** |
|---|---|---|
| Primary education | 68 | 23.61% |
| Middle school (Lower secondary) | 58 | 20.13% |
| High school (Upper secondary) | 40 | 13.88% |
| Vocational training | 36 | 12.53% |
| Higher education (Tertiary) | 16 | 5.55% |
| No formal schooling | 70 | 24.30% |
| Total | 288 | 100.00% |

Respondents' educational attainment is distributed as follows: primary education (23.61%), middle school/lower secondary (20.13%), high school/upper secondary (13.88%), vocational training (12.53%), higher education (5.55%), and no formal schooling (24.30%).

### 3.2. Exploitation of Forest and Energy Resources

The analysis of resource extraction activities reveals considerable pressure on woody resources, primarily exerted by women and children. Fuelwood accounts for **44%** of total extraction, followed by charcoal production (**25%**), reflecting households' strong dependence on wood-based energy sources.

**Figure 2** Artisanal Gold Mining Site at Kintinian

This intensive exploitation, combined with deforestation driven by the expansion of mining sites, is accelerating the degradation of regional forest cover. This trend is consistent with patterns observed across Sub-Saharan Africa, where natural vegetation has declined by approximately **21% over a 25-year period**, with nearly **5 million hectares of forest and natural vegetation lost annually**.

## 4. Environmental Impacts of Mining Activities

### 4.1. Soil Degradation and Abandonment of Mining Sites

Direct field observations of mining sites reveal severe environmental impacts characterized by the destruction of soil structure and the systematic abandonment of depleted sites. Both industrial and artisanal extraction practices generate profound disturbances to edaphic balance, including crater formation, destabilization of soil profiles, and alteration of the physico-chemical properties of soils (Bridge, 2004).

The abandonment of former mining pits without rehabilitation constitutes a defining feature of extractive activities in Siguiri. These abandoned sites, lacking vegetative cover and exposed to intense water and wind erosion, become sources of diffuse contamination and permanent landscape degradation. Such conditions are widely documented in mining environments, where soil degradation and geomorphological disturbances are common consequences of extractive operations.

This issue echoes recent observations indicating that 11.74% of the vegetation cover within the study areas was converted into bare soil and mined land between 2019 and 2023, alongside a marked increase in exposed soils associated with the proliferation of abandoned sites.

The images below illustrate the degradation of soil structure resulting from mining activities.

**Figure 3** Unrehabilitated Abandoned Mining Sites Operated by SAG in Kintinian Rural Municipality

## 5. Results

### 5.1. Introduction of Semi-Mechanized Technologies

The technological evolution of artisanal gold mining toward semi-mechanized practices has considerably intensified environmental impacts. The introduction of motor pumps, mobile crushers, and chemical processing equipment has increased extraction efficiency while proportionally expanding the areas affected and the volumes of waste generated.

This progressive mechanization, documented in other African contexts (Hilson, 2016), is transforming traditional artisanal mining into a quasi-industrial activity with environmental impacts comparable to those of formal mining operations.

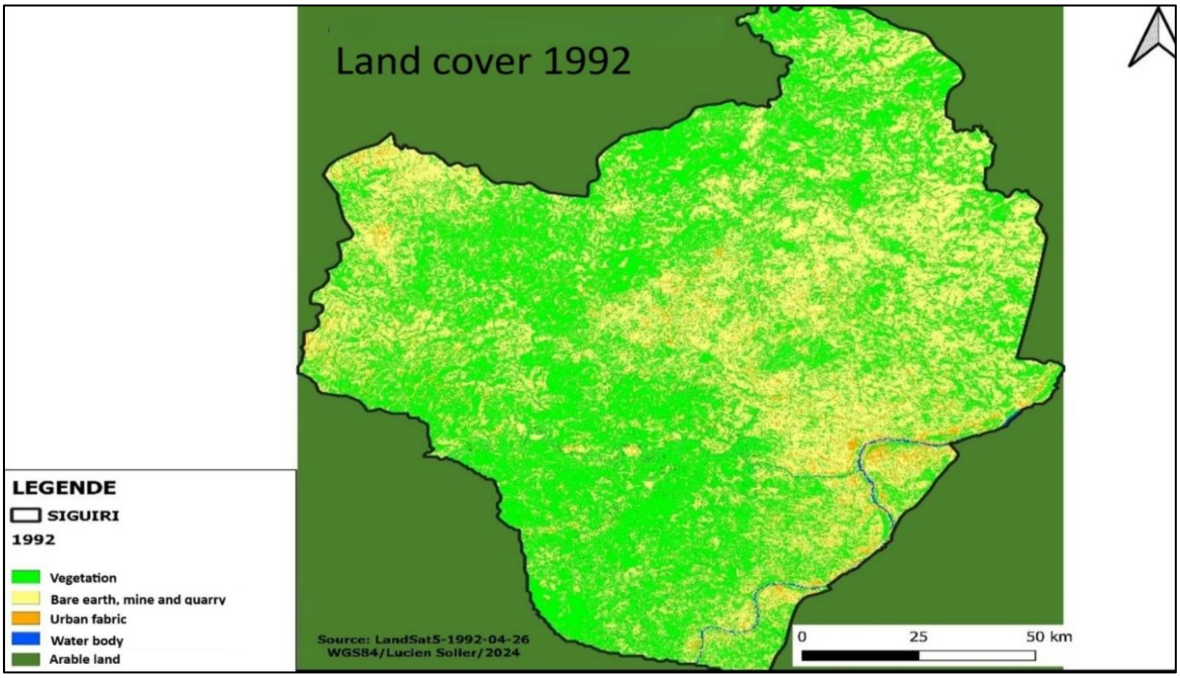


**Figure 4** Land Use and Land Cover (LULC) Map of Siguiri Prefecture, 1992

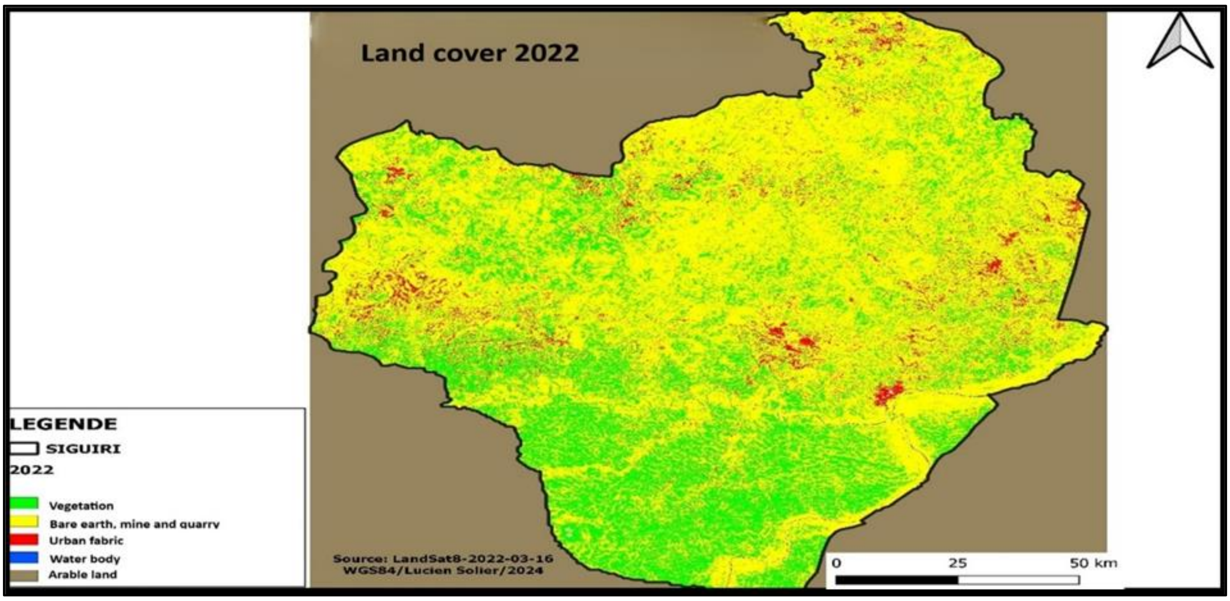


**Figure 5** Land-Use Map of Siguiri Prefecture in 2022

### 5.2. Spatio-Temporal Dynamics of Land Use (1992–2022)

*5.2.1. Evolution of Land-Use Classes*

The diachronic remote sensing analysis reveals major transformations in land use over the 1992–2022 period, characterized by opposing trends between natural and anthropogenic classes. Land-use maps illustrate an accelerated dynamic of conversion from natural ecosystems to anthropogenic uses, particularly pronounced within the zones of influence of mining activities.

### *5.2.2. Quantification des changements par classe d'occupation*

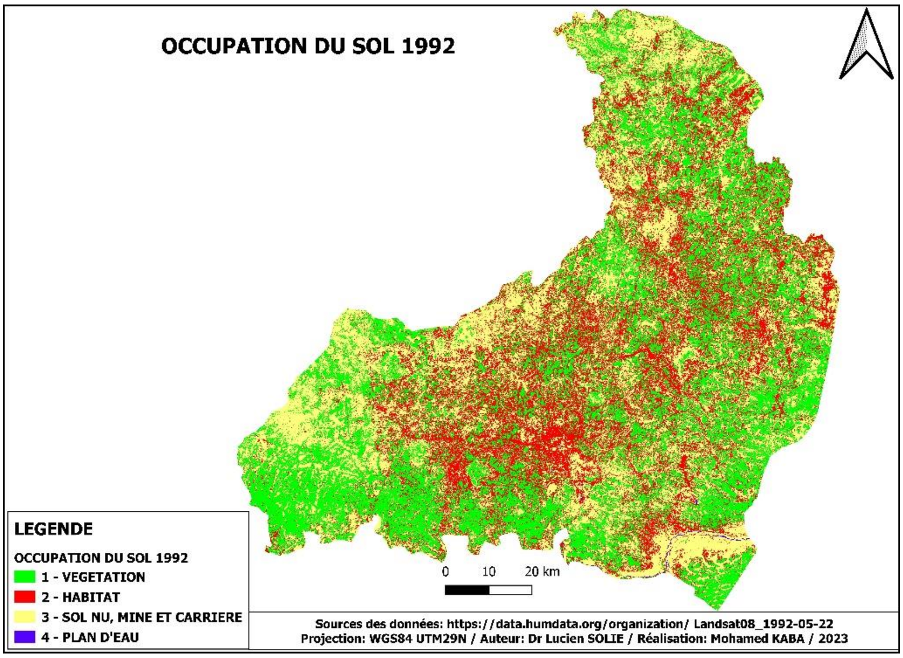


**Figure 6** Quantitative Evolution of Land-Use Classes (1992)

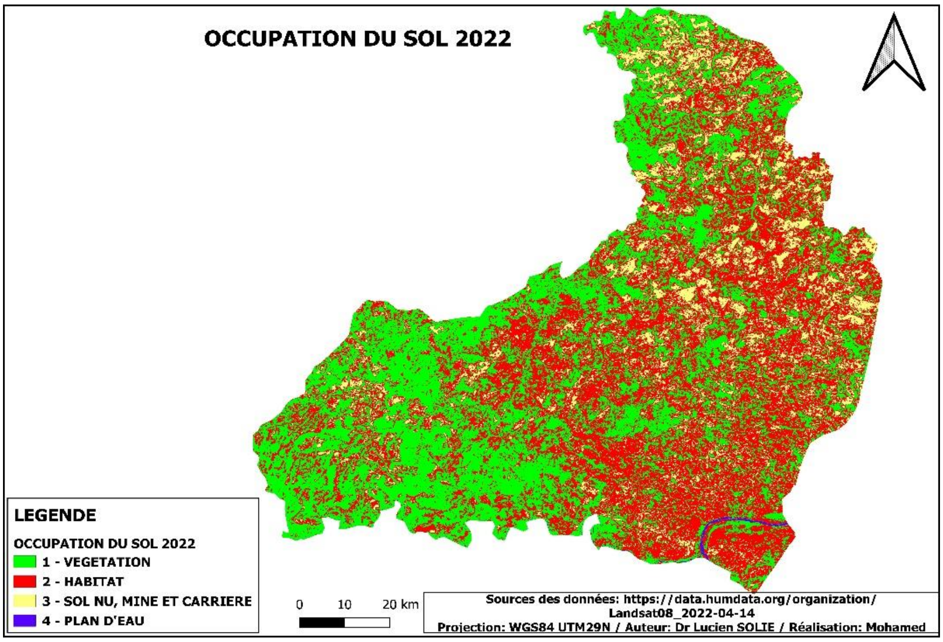


**Figure 7** Land-Use Map of the AngloGold Ashanti Mining Concession in Siguiri Prefecture, 2022

Agricultural land shows moderate growth (**+8.7%**), reflecting the expansion of cultivated areas to meet the food needs of a growing population. Although this agricultural expansion is necessary for local development, it contributes to increasing pressure on the remaining natural ecosystems.

Bare soils, mining areas, and quarries recorded the most dramatic increase, with their surface area rising by **287.5%**, from **156 km² in 1992** to **604 km² in 2022**. This surge in degraded land—corresponding to an annual growth rate of **9.6%**—illustrates the magnitude of the spatial impact of extractive activities across the prefectural territory.

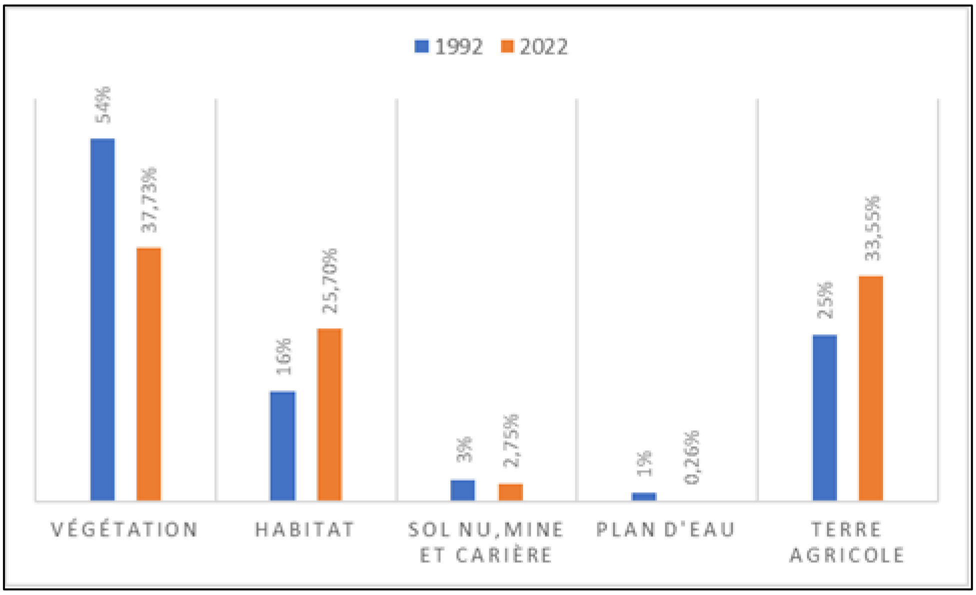


**Figure 8** Comparative Evolution of Surface Areas by Land-Use Class (1992–2022)

The quantitative analysis of land-use changes reveals contrasting trends across the different land-use classes (Figures 8, 9, and 10). Natural vegetation exhibits the most severe decline, with a **16.27% reduction in surface area** over the study period, corresponding to an average annual regression rate of **0.51%**.

This loss—estimated at approximately **2,356 km²**—represents an area larger than that of many national protected areas, highlighting the scale of ecosystem degradation within the study region.

## 6. Discussions

This study provides significant insights into the spatio-temporal dynamics of land use in a context of intensive mining exploitation in West Africa, revealing environmental transformations of exceptional magnitude. The results obtained in Siguiri Prefecture illustrate the critical environmental sustainability challenges faced by African mining regions within the context of the contemporary extractive boom.

The exponential demographic growth observed in Siguiri (+537% between 1983 and 2022) constitutes a major driver of anthropogenic pressure on natural resources, confirming the findings of Diallo et al. (2021) regarding the links between demographic dynamics and environmental degradation in Guinea. This population surge, peaking at 61 inhabitants/km$^2$ in 2018, far exceeds the critical thresholds identified in the literature for Sudanian tropical ecosystems (Lambin et al., 2003).

The economic attractiveness of gold mining opportunities generates massive migration flows that exponentially amplify pressure on local resources, creating a vicious cycle of environmental degradation and socio-economic vulnerability.

### 6.1. Transition Matrix Analysis

The transition matrix analysis reveals the dominant processes of conversion between land-use classes. The vegetation-to-bare soil/mining conversion constitutes the most significant process, accounting for 68% of total observed changes. This direct conversion reflects the predominant impact of extractive activities on deforestation and the degradation of natural ecosystems.

Vegetation-to-agriculture conversion represents 22% of total changes, illustrating agricultural pressure on natural formations. Conversely, reverse conversions (agriculture-to-vegetation, bare soil-to-vegetation) remain marginal (**<5%**), highlighting the largely irreversible nature of most transformations observed within the local context.

### 6.2. Validation of the Remote Sensing Analysis

Accuracy assessment of the classifications indicates satisfactory reliability levels for diachronic analysis. Overall accuracy ranges from 87.3% (1992) to 91.6% (2022), with corresponding Kappa coefficients of 0.84 and 0.89, confirming the robustness of the results obtained (Table 3).

These performance levels, consistent with quality standards established by Foody (2002) for land-use change studies, validate the reliability of the identified trends. The "vegetation" and "bare soil/mining" classes exhibit the highest individual accuracies (>90%), whereas the "agriculture" and "settlement" classes show slightly lower accuracies (85–88%) due to local spectral confusion between cultivated areas and natural herbaceous formations.

### 6.3. Structural Transformation of the Rural Economy

The economic specialization toward artisanal gold mining (75% of households) reflects a profound structural transformation of the Guinean rural economy, diverging from the traditional agriculture-based model. This large-scale shift toward extractive activities, driven by the search for immediate income, corroborates observations by Voundi et al. (2019) in Cameroon, where 82.13% of populations who lost agricultural land reconverted to artisanal mining.

Paradoxically, the low rate of formal employment within the industrial mining company (1%) highlights the socio-economic integration challenges faced by local communities in large-scale mining projects, consistent with findings by Hilson & Banchirigah (2009) regarding the mismatch between mining development and local employment opportunities.

### 6.4. Magnitude and Intensity of Environmental Transformations

Quantitative analysis reveals environmental transformations of remarkable intensity, with a **287.5% increase** in degraded land surfaces (bare soils, mines, and quarries) between 1992 and 2022. This expansion—equivalent to an annual growth rate of **9.6%**—significantly exceeds deforestation rates observed in other African mining contexts. In central Tanzania, for example, gold mining activities generated a **121.45% increase** in degraded land, a markedly lower impact than that documented in Siguiri.

The **15.2% regression of natural vegetation cover**, representing **2,356 km² lost**, is equivalent to the destruction of an area larger than the Upper Niger National Park (2,200 km²). This massive biodiversity loss aligns with alarming regional trends, where mining activities have resulted in the depletion of more than **577.15 km² of forest** within the West African Sahelian zone.

The apparent irreversibility of these transformations—illustrated by low natural reconversion rates (<5%)—underscores the urgency of systematic ecological restoration interventions.

### 6.5. Environmental and Energy Pressures

The findings highlight the considerable challenges of reconciling economic development with environmental conservation in African mining regions. Mining activities generate severe negative environmental impacts, including water contamination, air pollution, land degradation, and biodiversity loss, corroborating field observations from this study.

The intensification of fuelwood extraction (**69% of gathering activities**), combined with forest cover destruction driven by extractive operations, is accelerating regional desertification and undermining the ecological resilience of local ecosystems. This dual pressure—simultaneously exerted by domestic energy needs and mining expansion—illustrates the complex interactions between energy poverty and environmental degradation in rural African contexts (Atidegla et al., 2017).

### 6.6. Technological Intensification and Regulatory Gaps

The technological shift toward semi-mechanized artisanal mining is significantly intensifying the environmental footprint of informal extractive activities. The introduction of motor pumps, mobile crushers, and chemical processing equipment is transforming low-impact traditional mining into quasi-industrial operations with environmental consequences comparable to formal mining, but without associated mitigation measures.

The systematic abandonment of depleted mining sites without rehabilitation reveals critical shortcomings in Guinea's regulatory framework regarding environmental restoration. This issue, also documented by Maud & Alfred (2016), generates recurrent conflicts among local communities, artisanal miners, and industrial companies, fueled by the scarcity of cultivable land and unequal access to mining benefits.

### 6.7. Socio-Environmental Conflicts and Governance Challenges

The exceptional concentration of conflicts in Siguiri Prefecture (**>90 documented conflicts**) illustrates the socio-environmental tensions generated by competition over resource access in a context of accelerated degradation. These conflicts—more frequent during exploitation phases (**70%**) than exploration phases (**30%**)—underscore the critical importance of planning and community dialogue in preventing socio-environmental tensions.

### 6.8. Toward Sustainable Mining Pathways

The transformations documented call for a fundamental reassessment of mining development approaches in West Africa. Advanced land rehabilitation techniques, adoption of sustainable mining practices, and the use of low-emission energy resources present opportunities to enhance the environmental sustainability of the African mining sector.

The integration of remote sensing-based environmental monitoring technologies—demonstrated as effective in this study (accuracy >87%)—offers promising prospects for real-time tracking of landscape transformations and early warning of critical degradation thresholds. Such an approach could serve as an essential decision-support tool for regulatory authorities and mining companies in the continuous assessment of cumulative environmental impacts.

### 6.9. Integrated Resource Management Imperative

The need for an integrated natural resource management approach—combining active ecological restoration, economic diversification, and strengthening of local institutional capacities—emerges as a prerequisite for the long-term sustainability of Guinean mining regions.

The Siguiri case demonstrates that, without rapid corrective intervention, current trajectories of environmental degradation risk irreversibly compromising natural ecosystems and the socio-economic viability of local communities.

## 7. Conclusion

The spatio-temporal analysis of Siguiri Prefecture (1992–2022) highlights major environmental degradation, characterized by a 16.27% decline in vegetation cover and an 8.55% increase in degraded land, representing 2,356 $km^2$ of transformed ecosystems.

This dynamic, amplified by 53.7% demographic growth, illustrates the critical pressures associated with West African mining exploitation. The rural economy is undergoing a profound transformation, with 75% of households engaged in artisanal gold mining.

The expansion of semi-mechanized technologies is further intensifying environmental impacts—now comparable to those of industrial mining—yet without corresponding mitigation measures, thereby fueling more than 90 documented land-related conflicts.

The integrated methodology, combining remote sensing (accuracy >87%) and socio-economic surveys, confirms the effectiveness of spatial monitoring for assessing cumulative impacts and guiding restoration priorities.

The findings propose regionally relevant solutions, including site rehabilitation, stricter regulatory enforcement, economic diversification, and community infrastructure development, advocating for sustainable and resilient mining governance across Africa.

## Compliance with ethical standards

*Acknowledgments*

The authors thank the municipal authorities, market managers, and all participants for their collaboration during the field surveys.

*Disclosure of conflict of interest*

The authors declare that there is no conflict of interest.

*Statement of informed consent*

Informed consent was obtained from all participants included in the study.

## Références


[1] Aldwaik, S. Z., & Pontius, R. G. Jr. (2012). Intensity analysis to unify measurements of size and stationarity of land changes by interval, category, and transition. Landscape and Urban Planning, 106(1), 103–114. https://doi.org/10.1016/j.landurbplan.2012.02.010

[2] Agence Française de Développement (AFD), et al. (2019). Zones agroécologiques de la Guinée : Dépliant de la cartographie de l'occupation du sol et du suivi de la dynamique du territoire sur les quatre régions naturelles de la République de Guinée (12 p.). AFD.

[3] Atidegla, S. C., & Hounmenou, C. (2018). Adaptation des producteurs à la variabilité climatique au sud-Bénin : Cas de la plaine inondable de Gbessou Houékèkomè. Annales des Sciences Agronomiques, 22, 93–110.

[4] Bossard, M., Feranec, J., & Otahel, J. (2000). CORINE land cover technical guide – Addendum 2000 (Technical Report No. 40). European Environment Agency (EEA).

[5] Bridge, G. (2004). Contested terrain: Mining and the environment. Annual Review of Environment and Resources, 29, 205–259.

[6] Congalton, R. G., & Green, K. (2019). Assessing the accuracy of remotely sensed data: Principles and practices (3rd ed.). CRC Press.

[7] Coppin, P., Jonckheere, I., Nackaerts, K., Muys, B., & Lambin, E. (2004). Digital change detection methods in ecosystem monitoring. International Journal of Remote Sensing, 25(9), 1565–1596.

[8] Core Team, R. (2023). R: A language and environment for statistical computing. R Foundation for Statistical Computing.

[9] Creswell, J. W., & Plano Clark, V. L. (2017). Designing and conducting mixed methods research (3rd ed.). Sage Publications.

[10] Coulibaly, M. (2019). Exploitation industrielle des substances de carrières et communautés locales au Burkina Faso : Les leçons des sites de granite d'Afric Carrières (97 p.).

[11] Diallo, A. I., & Palle, S. (2021). Évaluation et hiérarchisation des menaces pesant sur la biodiversité aux niveaux national et local afin d'identifier deux secteurs prioritaires pour le projet BIODEV2030. Centre d'Étude et de Recherche en Environnement (CERE), Université Gamal Abdel Nasser de Conakry.

[12] Fortin, M.-F., & Gagnon, J. (2016). Fondements et étapes du processus de recherche : Méthodes quantitatives et qualitatives (3e éd.). Chenelière Éducation.

[13] Foody, G. M. (2002). Status of land cover classification accuracy assessment. Remote Sensing of Environment, 80(1), 185–201.

[14] Hilson, G., & Banchirigah, S. M. (2009). Are alternative livelihood projects alleviating poverty in mining communities? *Journal of Development Studies, 45*(2), 172–196.

[15] Institut des Sciences de l'Environnement (ISE), UCAD. (2020). *Évaluation de l'état de la biodiversité et de ses différentes menaces au Sénégal* (Rapport provisoire, 63 p.).

[16] Lambin, E. F., Geist, H. J., & Lepers, E. (2003). Dynamics of land-use and land-cover change in tropical regions. Annual Review of Environment and Resources, 28, 205–241.

[17] Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote sensing and image interpretation (7th ed.). Wiley.

[18] Maud, B., & Alfred, A. (2016). Analyse des conflits miniers en Haute Guinée. Search for Common Ground.

[19] Nziguheba, G., Merckx, R., Vanlauwe, B., & Zingore, S. (2023). Integrated soil fertility management in Sub-Saharan Africa: Progress, challenges, and future research needs. Soil Security, 11, 100094. https://doi.org/10.1016/j.soisec.2023.100094

[20] Pakoun, L. (2015). Analyse des conflits miniers en Guinée.

[21] Sonter, L. J., Ali, S. H., & Watson, J. E. M. (2017). Mining and biodiversity: Key issues and research needs. Conservation Letters, 11(2).

[22] Soro, T. D., Soro, G. E., Kouadio, B. H., & Oga, M. S. (2014). Apport de la télédétection à la cartographie de l'évolution spatio-temporelle de l'occupation du sol dans la région des Lacs (Centre de la Côte d'Ivoire). Télédétection, 13(2), 115–129.

[23] Voundi, E., et al. (2019). Analyse des mutations socio-environnementales induites par l'exploitation minière à Bétaré-Oya, Est-Cameroun. VertigO, 19(1). https://id.erudit.org/iderudit/1065409ar