



(RESEARCH ARTICLE)



SPATIO-TEMPORAL DYNAMICS OF LAND USE AND LAND COVER IN A GRANITE QUARRYING AREA IN MANÉAH, GUINEA: A REMOTE SENSING AND GIS-BASED ANALYSIS FROM 1980 TO 2024

Sogbè KEITA ^{1,*}, Mamady Minata CONDÉ ², Ibrahima THIAM ², Lucien Solié ¹ and Alpha Issaga Pallé Diallo ¹

¹ Lecturer-Researcher at Gamal Abdel Nasser University of Conakry.

² Mory Kanté Higher Institute of Arts of Dubréka (ISAMK/D).

* Corresponding Author

GSC Advanced Research and Reviews, 2026, 28(03), 145–157

Publication history: Received on 28 July 2026; revised on 09 September 2026; accepted on 11 September 2026

Article DOI: <https://doi.org/10.30574/gscarr.2026.28.3.0222>

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

ABSTRACT

Quarrying is a major driver of transformation in peri-urban areas, particularly in spaces experiencing both rapid urbanization and increasing pressure on natural resources. This study analyzes the spatio-temporal dynamics of land cover in the urban commune of Manéah, Guinea, between 1980, 2020, and 2024, in order to characterize the territorial changes associated with the development of extractive activities and urban expansion. The methodological approach relies on the use of multi-temporal satellite imagery, its processing in a GIS environment, supervised classification of the main land cover classes, diachronic analysis of changes, construction of a transition matrix, and evaluation of the quality of the classifications using the Kappa index. The results highlight a profound transformation of the landscape. Between 1980 and 2024, the proportion of built-up areas increased from 7.22% to 32.67%, a rise of 25.45 percentage points, while quarries and construction sites, absent in 1980, represented 2.05% of the territory in 2024, after reaching 7.50% in 2020. Conversely, cultivated land and fallow land increased overall by 18.58 percentage points. In contrast, natural formations experienced a sharp decline: shrub savannas decreased from 40.50% to 1.73%, bodies of water from 31.46% to 11.30%, and mangroves from 8.85% to 0.84%. The Kappa values of 0.76, 0.79, and 0.82 indicate a satisfactory agreement between the classifications. These changes reflect the increasing human impact on the territory, resulting from the combined effects of urbanization, agriculture, and extractive activities. The change matrix also confirms a structural recomposition of the territory, with built-up areas increasing from 963.406 ha to 4,357.55 ha, while shrub savannas decreased from 5,401.819 ha to only 230.389 ha over the entire study period. The study thus highlights the need to further integrate remote sensing data and GIS tools into land-use planning, environmental monitoring, and the spatial management of quarries in Manéah.

Keywords: Remote Sensing; Land Use; Granite Mining; Anthropization; Manéah.

1 INTRODUCTION

Extractive activities occupy a strategic place in contemporary development dynamics, due to their contribution to the supply of raw materials, the construction of infrastructure, and the creation of economic activities. However, they also constitute significant drivers of territorial transformation, particularly when their development occurs in areas subject

to intense human pressures. The opening of extraction sites, soil stripping, crushing, the construction of access roads, and the transport of materials lead to changes in land use that can have a lasting impact on landscapes and ecosystems. Bridge (2004) thus emphasizes that mineral extraction must be understood as a process of territorial restructuring, while Sonter et al. (2014) show that mining activities can produce substantial changes in the configuration and functionality of landscapes. These transformations become particularly concerning when extractive expansion is accompanied by a simultaneous increase in built-up and agricultural areas.

This issue takes on a particular dimension in African urban peripheries, characterized by sustained population growth and spatial expansion that often outpaces institutional planning capacities. African urbanization is accompanied by an increasing conversion of land on the margins of cities and a reconfiguration of the relationships between residential, agricultural, natural, and productive spaces (Seto et al., 2012). According to Güneralp et al. (2018), projected urban expansion in Africa is likely to exert considerable pressure on ecosystems and agricultural land. In peri-urban areas, the challenge therefore lies not only in the increase in built-up areas, but also in the overlapping of several anthropogenic dynamics—urbanization, agriculture, infrastructure, and material extraction—which jointly contribute to the fragmentation and transformation of landscapes.

Analyzing such changes requires tools capable of capturing their spatial and temporal dimensions. Satellite remote sensing and geographic information systems (GIS) have gradually become the preferred instruments for analyzing changes in land cover and land use. They allow for the identification of landscape units, the measurement of their areas, diachronic comparisons, and the detection of major trajectories of territorial conversion (Lu et al., 2004). Satellite image series, in particular, offer the possibility of reconstructing transformations over several decades and producing spatially explicit information essential for environmental management. In extractive regions, these tools facilitate the detection of the expansion of exploited areas and the concomitant analysis of changes affecting vegetation, water resources, agricultural land, and urbanized areas (Sonter et al., 2014). The validation of classifications, particularly through the evaluation of their accuracy, remains essential to guarantee the robustness of the interpretation of observed changes (Congalton, 1991).

The urban commune of Manéah, in the Coyah prefecture of Guinea, is a particularly relevant study area in this regard. Located in a peri-urban space subject to urban sprawl and granite mining, it is experiencing a rapid transformation of its land use. Diachronic data from 1980, 2020, and 2024 show that built-up areas have increased from 7.22% to 32.67%, representing a rise of 25.45 percentage points. Conversely, shrub savannas have decreased from 40.50% to 1.73%, bodies of water from 31.46% to 11.30%, and mangroves from 8.85% to 0.84%. Quarries and construction sites, absent from the 1980 classification, subsequently appear as a new component of the territory's spatial organization. These trends demonstrate a transition from a landscape initially dominated by natural formations to a territory heavily influenced by human activity under the combined effect of urban, agricultural and extractive dynamics.

A central question thus arises: how has land use in Manéah been reshaped between 1980 and 2024 in a context marked by urbanization and the development of extractive activities? The objective of this study is to analyze and quantify this spatio-temporal dynamic using remote sensing and GIS, identifying the main classes of land use that are increasing or decreasing and trajectories of territorial change. Beyond cartographic characterization, the study aims to provide scientific data that can inform territorial planning, the spatial management of extractive activities, and the preservation of vulnerable ecosystems in a changing peri-urban context.

2 METHODOLOGY

2.1 Presentation of the study area

The study was conducted in the urban commune of Manéah, located in the prefecture of Coyah, in the Republic of Guinea. Its position within the peri-urban area of Conakry gives it a unique territorial dynamic, characterized by the coexistence of residential and agricultural spaces, natural vegetation, and areas dedicated to extractive activities. This configuration makes it a relevant territory for analyzing land-use changes associated with human activity.

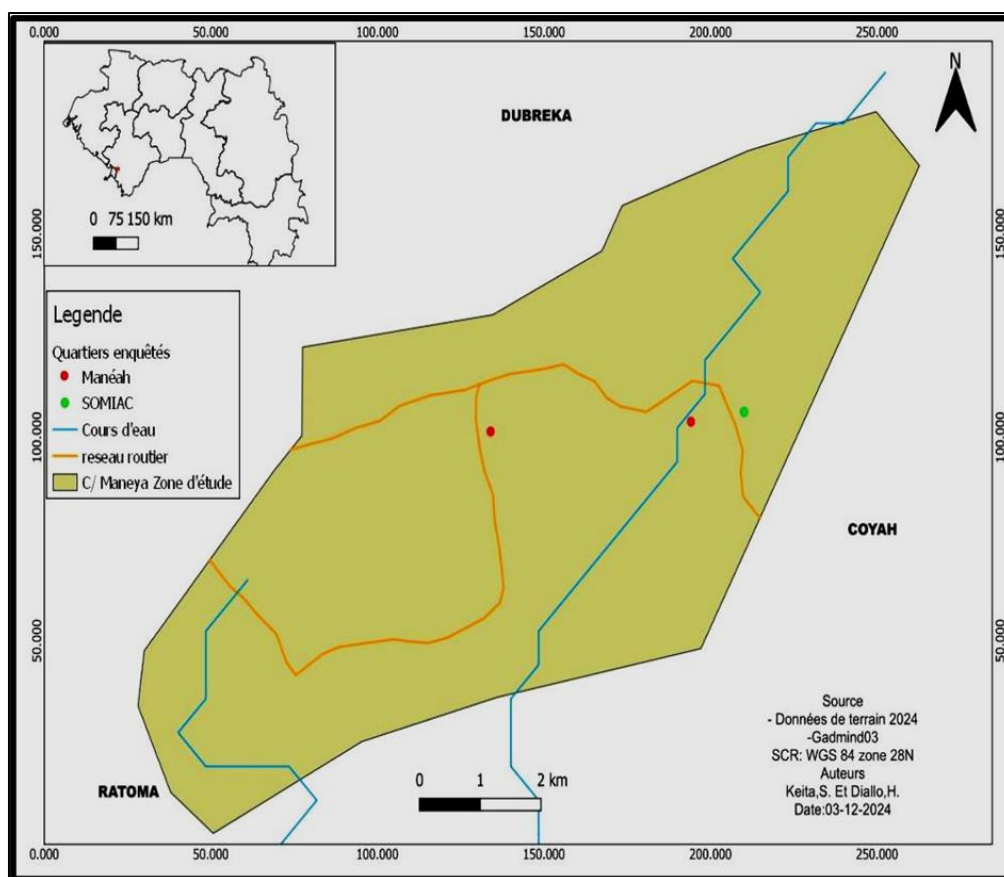


Figure 1: Map showing the location of the study area

The choice of Manéah is primarily justified by the significant territorial transformations observed over recent decades and the presence of granite quarrying activities. The study area includes the quarry operated by SOMIAG, around which various human activities are organized. Urbanization, agricultural activities, and mineral resource extraction are thus factors likely to interact in the reshaping of the landscape. The article identifies eight main land cover classes: built-up areas, cultivated land and fallow land, mangroves, grassy savannas, shrub savannas, quarries and construction sites, water bodies, and transitional shrub formations.

Analyzing this area allows us to study a territory where extractive activities are embedded in a broader dynamic of urban expansion and transformation of natural environments. This characteristic is essential to avoid systematically attributing all observed changes to granite mining and to consider jointly the various anthropogenic pressures that may explain these territorial transformations.

2.2 Satellite data and spatial analysis tools

The spatio-temporal analysis relies on the use of multi-temporal satellite data, supplemented by local mapping data and GPS surveys conducted in the field. This information was integrated into a Geographic Information System (GIS) environment to produce thematic land cover maps and quantify changes in the study area.

Data processing relied on a classification approach that allowed the observed areas to be divided into different land-use categories. The maps obtained for each date were then compared to identify changes in the spatial structure of the territory. This approach makes it possible, in particular, to locate areas affected by human activities, to assess the evolution of the footprint of quarries and construction sites, and to examine, in parallel, the expansion or contraction of built-up, agricultural, vegetated, and aquatic areas.

The reliability of the classifications was assessed using the Kappa index (KPA). The values obtained were 0.76 for 1980, 0.79 for 2020 and 0.82 for 2024, indicating an overall satisfactory and increasing agreement between the classifications used for the diachronic analysis.

2.3 Observation periods: 1980, 2020 and 2024

The diachronic analysis was structured around three reference dates: 1980, 2020, and 2024. The choice of these timeframes allows us to understand land-use changes according to two complementary scales. The 1980–2020

comparison reveals long-term territorial transformations, while the 2020–2024 period allows us to examine the most recent changes. The overall 1980–2024 comparison ultimately provides a synthetic overview of Manéah's territorial trajectory over forty-four years.

For each of the three dates, the areas and proportions occupied by the different classes were calculated. Changes were then determined by comparing the observed proportions between 1980–2020, 2020–2024, and 1980–2024. This approach makes it possible to identify classes that are expanding, those that are shrinking, and phenomena of spatial restructuring. In this respect, the change matrix is a key tool for quantitatively monitoring the evolution of buildings, crops and fallow land, quarries and construction sites, vegetation, mangroves, and bodies of water.

This multi-temporal approach thus makes it possible to move beyond a static snapshot of the territory to reconstruct its trajectory of human impact between 1980 and 2024, while distinguishing long-term transformations from more recent developments. It forms the methodological basis for the analysis of the interactions between urbanization, extractive activities, and ecosystem evolution in Manéah.

2.4 Image Preprocessing and Classification

The processing of satellite data relied on an approach aimed at transforming information from multi-temporal images into land cover classes comparable over time. In our methodology, spatial analysis is based on classifying images into different land cover categories, then comparing the maps obtained at different dates to identify changes that have occurred in the Manéah territory. The satellite data were supplemented by local mapping information and GPS surveys conducted in the field, particularly for locating the study areas and the various observation points.

The classification process allowed the observed spatial units to be assigned to different categories representative of the landscape structure of Manéah. The results of the article specify that the land cover statistics come from a supervised classification applied to images corresponding to the years 1980, 2020, and 2024. The maps thus produced formed the basis for quantifying the areas and relative proportions of each class.

The quality of the classifications was assessed using the Kappa index (KPA). The values obtained were 0.76 in 1980, 0.79 in 2020 and 0.82 in 2024, reflecting a satisfactory agreement between the classifications and providing an element of validation for the diachronic comparison.

2.5 Land use classes

The chosen classification is based on eight land cover classes, selected to represent the main natural and anthropogenic components of the Manéah landscape: water, built-up areas, mangroves, shrub savannas, grass savannas, quarries and construction sites, transitional shrubland, cultivated land, and fallow land. This typology makes it possible to distinguish directly human-modified areas from natural and semi-natural formations and, consequently, to assess the main trajectories of land transformation.

The building and quarry/construction site categories provide direct information on the artificialization of the land. Buildings primarily reflect the expansion of urbanized areas, while the latter category allows us to track the emergence and spatial evolution of spaces associated with extractive activities and construction work. Crops and fallow land, for their part, represent the agricultural component of human land use.

Conversely, the classes shrub savannas, grass savannas, mangroves, water, and transitional shrub formations allow us to understand the evolution of natural or semi-natural components. This distinction is particularly important as the analysis seeks to highlight the gradual shift from a landscape historically dominated by natural formations to a territory more marked by human activities.

The use of a common classification system for the three dates is a key methodological principle for the comparison. It allows us to calculate, for each class, its area and relative proportion, and then to determine its gains or losses over the different periods. The results indicate substantial changes between 1980 and 2024, particularly for built-up areas, shrub savannas, bodies of water, and mangroves.

2.6 GIS and diachronic land cover analysis

The classification results were integrated into a Geographic Information System (GIS) environment. We used QGIS software to create maps of the study area and land cover. The GIS allowed us to organize the spatial data, produce cartographic representations corresponding to different dates, and compare them.

The diachronic analysis was organized around three time periods: 1980–2020, 2020–2024, and 1980–2024. For each period, the proportions of the different classes were compared to identify their evolution. The change in a class can be expressed as the difference between its proportion at the end date and that recorded at the beginning date.

where represents the change in class i , its proportion at the initial date, and its proportion at the final date. A positive value indicates an increase in the class, while a negative value indicates a decrease.

This analysis was supplemented by a change matrix, allowing for a quantitative comparison of the areas occupied by each class at the three dates. The matrix notably highlights the evolution of built-up areas from 963.406 ha in 1980 to 4,028.124 ha in 2020 and then to 4,357.55 ha in 2024, while shrub savannas decreased from 5,401.819 ha to 1,017.212 ha and then to 230.389 ha. Quarries and construction sites, absent from the 1980 classification, represent 1,000.629 ha in 2020 and then 273.738 ha in 2024.

Combining cartographic information, surface areas, and relative variations allows us to identify the main trajectories of spatial recomposition in Manéah. This approach offers a quantitative and territorialized analysis of the human impact process and enables us to examine urban expansion, extractive and agricultural activities, as well as the regression or recomposition of natural formations.

2.7 Land cover change matrix

To quantitatively characterize the territorial transformations that have occurred in Manéah, the diachronic analysis was complemented by the development of a land-use change matrix. This approach allows for the comparison of the areas occupied by each class at different dates and the identification of the main trends of expansion, contraction, or spatial restructuring. It thus constitutes a complementary tool to the visual interpretation of maps, providing a quantitative measure of the extent of the transformations observed between 1980, 2020, and 2024.

The matrix takes into account the eight classes used in the classification: water, built-up areas, mangroves, shrub savannas, grass savannas, quarries and construction sites, transitional shrubland, crops, and fallow land. For each of these, the areas, expressed in hectares, were compared across the three dates. This approach makes it possible to distinguish between classes whose land area increased and those that contracted during the period studied. The matrix developed in the article shows, for example, that built-up areas increased from 963,406 ha in 1980 to 4,028,124 ha in 2020 and 4,357.55 ha in 2024. Conversely, shrub savannas decreased sharply, from 5,401,819 ha to 1,017,212 ha, and then to 230,389 ha. Quarries and construction sites, which were absent in 1980, occupy 1,000.629 ha in 2020 and 273.738 ha in 2024.

The analysis was also conducted in terms of proportions to measure the relative magnitude of changes between 1980–2020, 2020–2024, and 1980–2024. Over the entire period, the results show an increase in built-up areas of +25.45 percentage points and in cultivated land and fallow land of +18.58 points. Conversely, shrub savannas decreased by –38.77 points, water bodies by –20.16 points, and mangroves by –8.01 points.

The matrix thus constitutes the main quantitative tool for characterizing the spatial reorganization of Manéah. However, it only allows us to establish changes in land use and not, on its own, a causal relationship between these changes and granite mining. The interpretation of the observed transformations must therefore consider urbanization, agricultural and extractive activities, as well as other anthropogenic pressures exerted on the territory.

2.8 Evaluation of the classification by the Kappa index

The reliability of a diachronic analysis depends on the quality of the classifications from which land cover changes are calculated. In this study, the performance of the classifications corresponding to the years 1980, 2020, and 2024 was assessed using the Kappa index (KPA). This indicator measures the degree of agreement between the obtained classification and the reference data, taking into account the agreement that may result from chance. It is commonly used in remote sensing work to complement the evaluation of classification accuracy (Congalton, 1991).

In its general formulation, the Kappa coefficient can be represented by: where represents the proportion of observed agreement between the classified data and the reference data, while corresponds to the proportion of agreement theoretically attributable to chance. The value of tends towards 1 when the agreement is high; conversely, a value close to 0 indicates a low agreement beyond that expected by chance.

The classifications produced for this study have Kappa values of 0.76 in 1980, 0.79 in 2020, and 0.82 in 2024. These values indicate that the classifications used have a sufficiently high level of agreement to support the comparative analysis of land-use changes. They also show a progressive improvement in agreement between the three dates, with the 2024 classification exhibiting the highest Kappa value.

The integration of this indicator strengthens the methodological robustness of the study by providing a means of quality control for the cartographic data used in the diachronic analysis. Nevertheless, the interpretation of the Kappa index must remain linked to other available validation elements and the inherent limitations of multi-temporal satellite data. This precaution is particularly important when comparing images from distant time periods, as the characteristics of the available data and the observation conditions may differ.

In total, the articulation between supervised classification, GIS, diachronic analysis, change matrix and Kappa index constitutes the methodological framework enabling the identification, quantification and spatialization of the main transformations of land cover in Manéah between 1980 and 2024. This approach thus provides the analytical basis necessary for the presentation of the results relating to the expansion of buildings and anthropogenic activities as well as the regression of the main natural formations.

3 RESULTS

This section presents the results of the diachronic land-use analysis in the urban commune of Manéah at three selected dates: 1980, 2020, and 2024. The analysis focuses on eight classes: water, built-up areas, mangroves, shrub savannas, grass savannas, quarries and construction sites, transitional shrub formations, crops, and fallow land. It allows us to identify the landscape structure at each date and to highlight the main transformations that occurred during the period studied.

3.1 Diachronic analysis of the land use map in 1980

The cartographic representation of land use at different periods constitutes a fundamental tool for analyzing spatial dynamics and identifying major transformations that have occurred in the commune of Manéah.

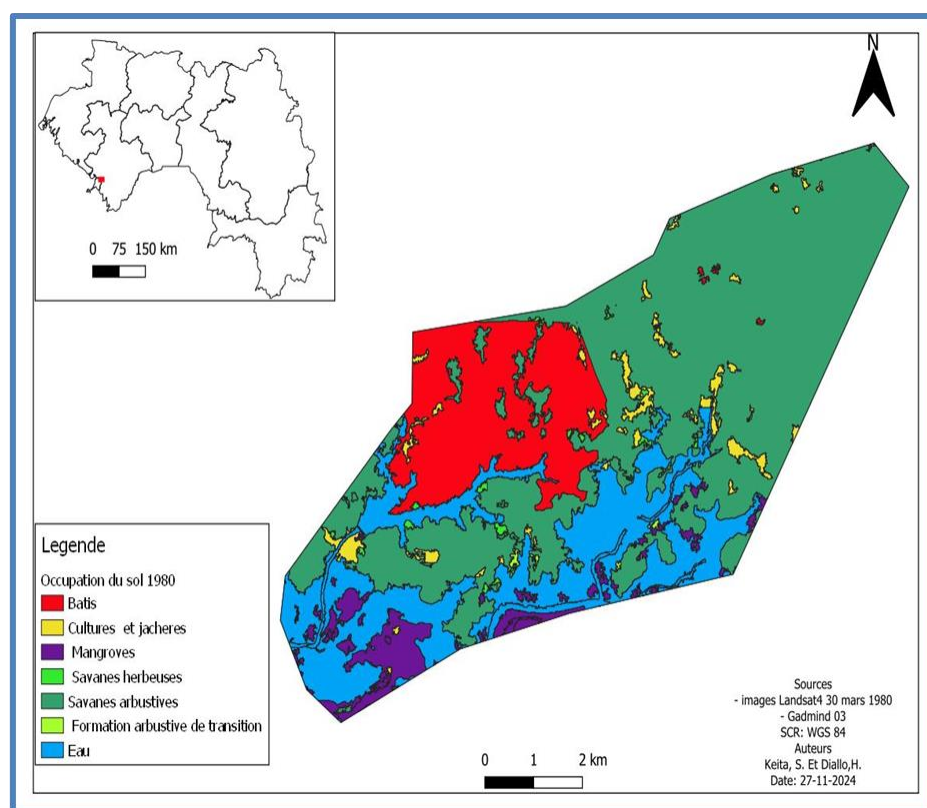


Figure 2: Land use map of Manéah, 1980

The year 1980 serves as the reference point for assessing the extent of subsequent transformations in the Manéah territory. At that time, the landscape was still largely dominated by natural formations. Shrub savannas constituted the largest land cover class, with 5,401.819 hectares, representing 40.50% of the studied area. These were followed by bodies of water, which covered 4,195.911 hectares, or 31.46% of the territory.

Other natural formations are also present in significant numbers. Mangroves cover 1,180.54 ha, or 8.85% of the territory, while grassy savannas represent 126.637 ha, or approximately 0.95%. Transitional shrubland formations cover 305.115 ha, corresponding to 2.29%.

Human-induced occupation remains comparatively limited. Crops and fallow land cover 1,163,872 hectares, or 8.73%, while buildings cover only 963,406 hectares, corresponding to 7.22% of the total area. Most importantly, no land is classified as "quarries and construction sites" in the 1980 classification.

Thus, the spatial configuration of 1980 reveals a territory that was still relatively undeveloped, in which shrubby savannas and bodies of water together constitute more than 70% of the studied area. This situation constitutes the historical reference point from which subsequent transformations are measured.

3.2 Land use in 2020

Forty years later, the land use pattern is profoundly different. In 2020, crops and fallow land became the dominant land use, covering 4,501,903 hectares, or 33.75% of the territory. This was followed by built-up areas, which reached 4,028,124 hectares, or 30.20%.

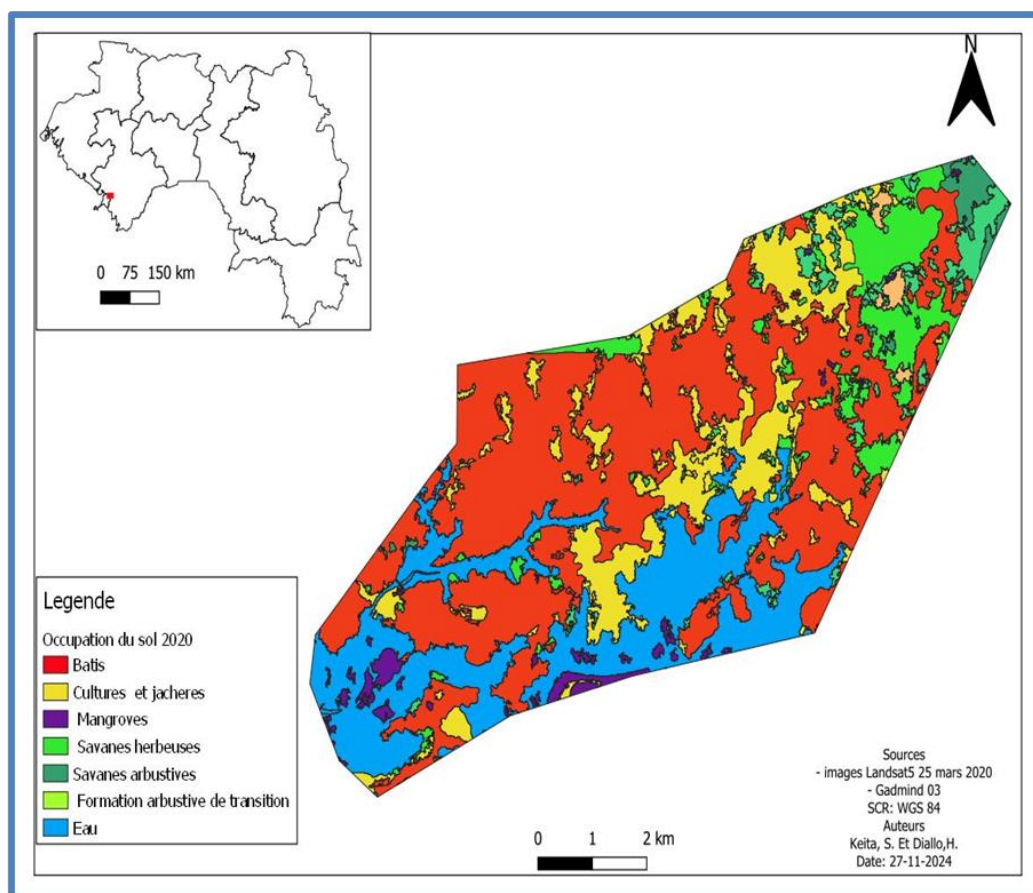


Figure 3: Land use map of Manéah in 2020

This increase in human occupation is accompanied by the emergence of the quarry and construction site class, which covers 1,000,629 hectares, or 7.50% of the studied area. At the same time, several natural formations have experienced a substantial decline. Shrub savannas now represent only 1,017,212 hectares, or 7.63%, compared to 40.50% in 1980. Mangroves have shrunk to 114,252 hectares, or 0.87%, while water bodies have decreased to 1,901,303 hectares, corresponding to 14.25% of the territory.

Between 1980 and 2020, cultivated land and fallow land increased by 25.02 percentage points, built-up areas by 22.98 points, and quarries and construction sites by 7.50 points. Conversely, shrub savannas decreased by 32.87 points, bodies of water by 17.21 points, and mangroves by 7.98 points.

Data analysis reveals particularly significant and structuring trends in the region's development. Indeed, the proportion of built-up areas has increased considerably, rising from 7.22% in 1980 to 32.67% in 2024, reflecting rapid and sustained urbanization. Simultaneously, the areas dedicated to crops and fallow land have also seen a notable increase, indicating an intensification of agricultural activities.

Conversely, natural formations, particularly shrub savannas, have undergone a very marked decline, falling from 40.50% to just 1.73%, indicating advanced degradation of terrestrial ecosystems. Similarly, the decrease in the areas

occupied by bodies of water and mangroves highlights the increasing disruption of wetland ecosystems, which are particularly sensitive to human pressures.

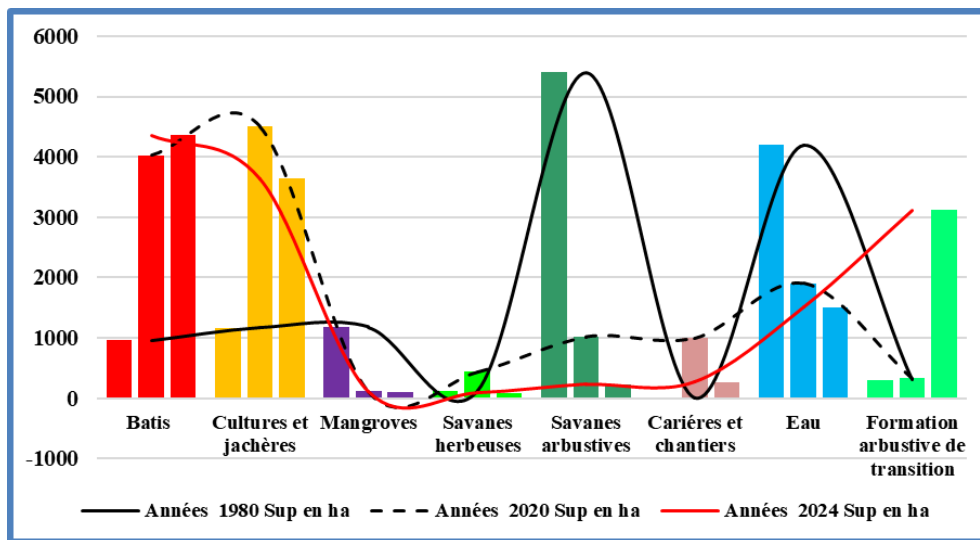


Figure 4: Spatiotemporal variation of occupation

Overall, these developments reflect an accelerated anthropization of the territory, closely linked to the expansion of human activities, particularly the exploitation of natural resources and urban development.

3.3 Land use in 2024

In 2024, the dynamics observed in previous decades continue, but with some internal changes. Built-up areas become the main land cover class, representing 32.67% of the territory, for an area of 4,357.55 ha. Crops and fallow land occupy 3,642.01 ha, or 27.31%, while transitional shrubland reaches 3,119.654 ha, representing 23.40% of the studied area.

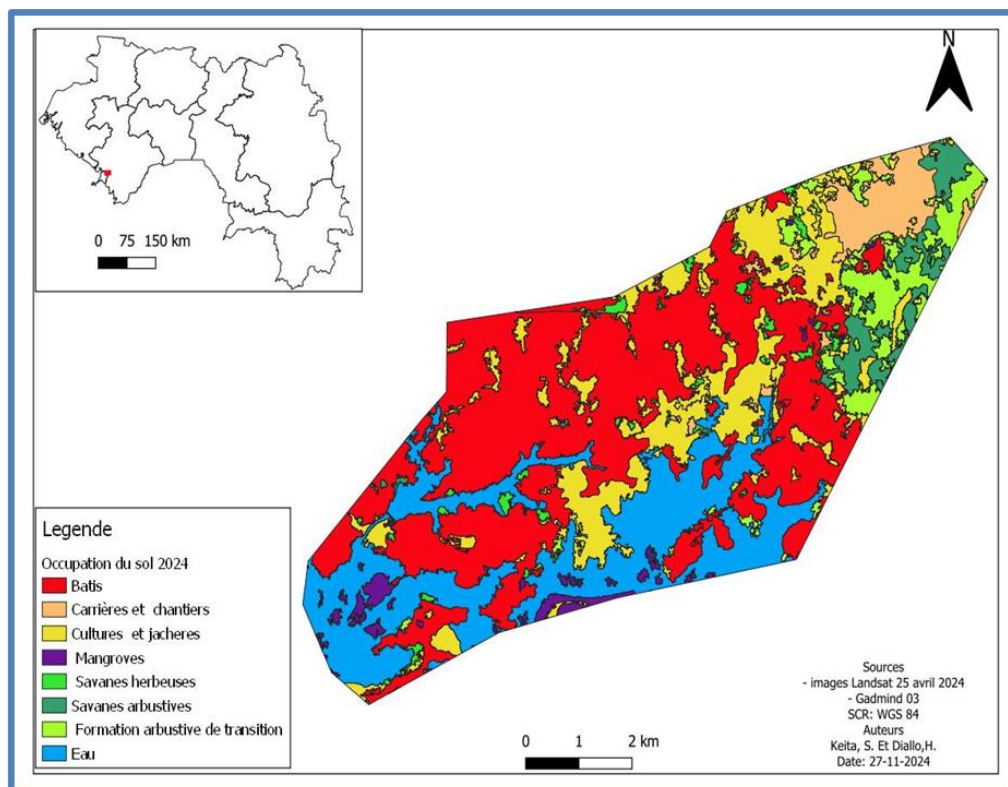


Figure 5: Land use map of Manéah in 2024

Water bodies now cover 1,506,639 hectares, or 11.30% of the territory. Shrub savannas now cover only 230,389 hectares, or 1.73%, while mangroves have shrunk to 112,247 hectares, or 0.84%. Grassland savannas represent 94,082 hectares, or 0.71%. Finally, quarries and construction sites occupy 273,738 hectares, representing 2.05% of the area studied.

The 2020–2024 comparison thus reveals a continued expansion of built-up areas (+2.47 points) and, above all, a significant increase in transitional shrubland (+20.92 points). Conversely, cultivated land and fallow land decreased by 6.44 points, quarries and construction sites by 5.45 points, and shrub savannas by 5.90 points.

3.4 Matrix of change and spatial recomposition

Analysis of the change matrix allows us to characterize the distribution of the different land cover classes and their evolution relative to the different observation dates (1980, 2020, and 2024). Table 25 below presents the spatial structure of these units and highlights the major transformations that have occurred in the study area.

Table 1: Change matrix.

Classes	Years	Years	Years
	1980	2020	2024
	Sup en ha	Sup en ha	Sup en ha
Buildings	963,406	4028,124	4357.55
Crops and fallow land	1163,872	4501,903	3642.01
Mangroves	1180.54	114,252	112,247
Grassy savannas	126,637	442,575	94,082
Shrubby savannas	5401,819	1017,212	230,389
Quarries and construction sites	0	1000,629	273,738
Water	4195,911	1901,303	1506,639
transitional shrub formation	305,115	330,308	3119,654
Total	13337.3	13336,306	13336,309
KPA Index	0.76	0.79	0.82

Source: Author, 2024 survey

Data analysis reveals that in 1980, the landscape of Manéah was largely dominated by natural formations, particularly shrub savannas (40.50%) and bodies of water (31.46%), reflecting an environment still relatively untouched by human activity. However, from 2020 onwards, a gradual shift towards human occupation has occurred, with a significant expansion of cultivated land and fallow areas (33.75%) and built-up areas (30.20%), accompanied by the emergence of quarries and construction sites. This trend continues in 2024, with built-up areas becoming the dominant land use (32.67%), followed by cultivated land (27.31%) and transitional shrub formations (23.40%), while natural ecosystems, such as shrub savannas, mangroves, and water resources, have experienced a marked decline. These results reflect a structural transformation of the territory, characterized by increasing human impact and a progressive degradation of natural environments.

3.5 Detection and analysis of change dynamics

The analysis of land-use dynamics reveals contrasting trends, marked by significant increases and decreases in the different environmental classes over the study period. Table 26 below summarizes the variations observed between the periods 1980–2020, 2020–2024 and 1980–2024.

An examination of the results reveals that between 1980 and 2020, the Manéah area underwent a major transformation characterized by a significant expansion of built-up areas (+22.98%), cultivated land and fallow land (+25.02%), as well as the emergence of quarries and construction sites (+7.50%), while natural environments, particularly shrub savannas (-32.87%), bodies of water (-17.21%), and mangroves (-7.98%), declined sharply. In the recent period of 2020–2024, this trend continued with a consolidation of built-up areas (+2.47%) and a notable increase in transitional shrub formations (+20.92%), reflecting ecological restructuring, although some categories, such as cultivated land (-6.44%) and quarries (-5.45%), experienced a relative decline. Finally, over the entire period 1980–2024, the trends confirm a structural change in the territory, dominated by urbanization (+25.45%), the expansion of human activities and the

progressive degradation of natural ecosystems, in particular shrub savannas (-38.77%), water resources (-20.16%) and mangroves (-8.01%).

Table 2: Percentages of land cover classes in the Manéah area

Class	1980-2020			2020-2024			1980-2024		
	Proportion (%)	Proportion (%)	Gap 1 (%)	Proportion (%)	Proportion (%)	Gap 2 (%)	Proportion (%)	Proportion (%)	Gap 3 (%)
Water	31.46	14.25	-7.21	14.25	11.30	+2.95	31.46	11.30	-20.16
Buildings	7.22	30.20	+22.98	30.20	32.67	+2.47	7.22	32.67	+25.45
Mangroves	8.85	0.87	-7.98	0.87	0.84	-0.03	8.85	0.84	-8.01
Shrubby savannas	40.50	7.63	-32.87	7.63	1.73	-5.90	40.50	1.73	-38.77
Grassy savannas	0.95	3.32	+2.37	3.32	0.71	-2.61	0.95	0.71	-0.24
Quarries and Construction Sites	0	7.50	+7.50	7.50	2.05	-5.45	0	2.05	+2.05
transitional shrub formation	2.29	2.48	+0.19	2.48	23.40	+20.92	2.29	23.40	+21.11
Crops and fallow land	8.73	33.75	+25.02	33.75	27.31	-6.44	8.73	27.31	+18.58

Source: Author, 2024 survey

4 DISCUSSION

4.1 Anthropization and progressive recomposition of the territory of Manéah

The results highlight a structural transformation of the Manéah landscape over the forty-four years studied. In 1980, shrub savannas and bodies of water represented 40.50% and 31.46% of the territory, respectively, while built-up areas occupied only 7.22%. By 2024, this configuration had been profoundly reversed: built-up areas had reached 32.67%, while shrub savannas represented only 1.73% and bodies of water 11.30%. This trajectory reflects the shift from a predominantly natural landscape to a territorial organization dominated by human activities.

This dynamic aligns with observations already made at the scale of Conakry. The work of Mansaray et al. (2018) highlighted a significant increase in urban areas alongside a decrease in vegetation, and emphasized the role of population growth and migration in the transformation of land use. Previous work on the spatial determinants of Conakry's growth also shows that proximity to major roads and topographical features contribute to the organization of urban expansion (Mansaray et al., 2017).

The results obtained in Manéah thus extend this metropolitan dynamic to peripheral areas. However, they show that peri-urban human impact cannot be equated solely with urbanization. Rather, it results from a combination of built-up expansion, agricultural development, infrastructure, and extractive activities. Between 1980 and 2024, cultivated land and fallow land increased by 18.58 percentage points, in parallel with a 25.45 percentage point increase in built-up areas. This multiplicity of factors confirms that territorial transformations should be interpreted as the product of concurrent human pressures rather than as the consequence of a single factor.

4.2 Extractive activities and land-use changes

The emergence of the "quarries and construction sites" class is one of the significant transformations observed. Absent from the 1980 classification, this class reached 1,000,629 ha in 2020, representing 7.50% of the territory, before falling back to 273,738 ha in 2024, or 2.05%. This trajectory confirms the progressive integration of extractive activities into the spatial structure of Manéah, but suggests avoiding overly simplistic causal interpretations.

Recent literature confirms that mining areas generally undergo significant land-use changes. In South Africa, the use of geospatial indices and satellite imagery has demonstrated the value of long-term monitoring for identifying environmental transformations in mining regions (Mhangara et al., 2021). In Zimbabwe, Mathe et al. (2025), using

multi-temporal imagery spanning thirty years, also observed changes in landscapes and riparian ecosystems associated with the expansion of artisanal mining activities.

The comparison is even more interesting with Ouagadougou, where a recent study specifically focused on quarries used Landsat data from 1990 to 2022. It shows that the main disturbances to vegetation coincide with the opening of new quarries and with urban expansion, particularly between 2005 and 2019. It also highlights instances of plant regeneration in approximately 23% of abandoned quarries. This finding offers an important avenue for interpretation for Manéah: the decrease in areas classified as "quarries and construction sites" between 2020 and 2024 does not necessarily reflect a proportional reduction in extractive activity. It could also result from changes in land use, plant recolonization, reallocation of land, or differences in classification.

This caution is essential because the data in the article provides information on the classified spatial extent of the quarries, but not on the annual volumes of granite extracted. It would therefore be scientifically unsound to attribute all the observed environmental degradation to granite quarrying.

4.3 Regression of natural formations and vulnerability of ecosystems

The decline in natural formations is one of the most concerning findings. Between 1980 and 2024, shrub savannas decreased from 5,401,819 to 230,389 hectares, a drop of 38.77 percentage points. Mangroves shrank from 8.85% to 0.84%, while water bodies declined from 31.46% to 11.30%. These changes indicate that human impact is not simply a matter of spatial redistribution of land use, but is accompanied by a significant contraction of several ecological components.

Similar trends are observed in various African mining regions. In Ghana, studies using participatory spatial tools show that communities perceive a gradual conversion of agricultural and natural lands to mining areas and human settlements (Boafo et al., 2021). More recently, a study conducted in a Ghanaian mining district between 2015 and 2025 reports a decrease in vegetation cover from 56.1% to 34.4%, coinciding with the expansion of degraded and mining areas, with measurable consequences for the value of ecosystem services.

A recent meta-analysis of 86 studies published between 2000 and 2025 also concludes that mining activities in sub-Saharan Africa are associated with significant land conversions, deforestation and degradation of ecosystem services, while highlighting the concomitant influence of agriculture and other anthropogenic uses (Peprah, 2025).

These findings reinforce the interpretation of the results of Manéah: the sharp decline of savannas, mangroves and water resources is an indicator of increasing vulnerability of ecosystems, but must be understood within a territorial system where mineral exploitation, agriculture and urbanization interact.

4.4 Urban expansion and suburban pressure

The increase in built-up areas constitutes the most significant and consistent transformation observed. Their surface area increased from 963.406 ha in 1980 to 4,028.124 ha in 2020 and then to 4,357.55 ha in 2024. Unlike quarries and agricultural land, which experienced a relative decline between 2020 and 2024, built-up areas continued to expand. This result suggests that urbanization is a structural and sustainable driver of the territorial transformation of Manéah.

This observation is consistent with studies conducted in Conakry, which show a continuous growth of urbanized areas and a concomitant reduction of vegetation. It also aligns with observations made in other African mining regions, where urban expansion and extractive activity frequently interact. A recent study conducted in a Moroccan mining town using images spanning 1984–2021 highlights transformations jointly associated with mining activities, urban expansion, water stress, and socio-economic changes.

Globally, Maus et al. (2022) identified 44,929 mining polygons covering over 101,000 km², demonstrating the growing importance of satellite mapping for identifying extractive areas and their interactions with other forms of land use. In peri-urban areas like Manéah, this interaction warrants particular attention, as the demand for construction materials can itself be stimulated by urbanization, potentially creating a functional relationship between urban growth and quarrying.

5 CONCLUSION

This study highlights a profound transformation of land use in Manéah between 1980 and 2024, characterized by the gradual shift from a territory largely dominated by natural formations to a heavily human-modified area. Diachronic analysis using remote sensing and GIS shows that built-up areas increased from 7.22% to 32.67%, while quarries and

construction sites, absent in 1980, represent 2.05% of the territory in 2024, after having reached 7.50% in 2020. Concurrently, shrub savannas have declined sharply, from 40.50% to 1.73%, as have bodies of water and mangroves.

These transformations reflect the combined effect of urban expansion, agricultural activities, and the development of extractive activities on the territorial organization of Manéah. Above all, they highlight the increasing vulnerability of natural ecosystems to human pressures.

From this perspective, the results argue for integrated territorial planning, combining urbanization regulations, spatial planning for quarries, restoration of degraded areas, and protection of sensitive natural environments. The regular use of remote sensing and GIS appears essential to establish a permanent system for monitoring land-use changes and to support territorial governance that reconciles economic development, resource exploitation, and environmental preservation.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Acknowledgments

The authors sincerely thank the local authorities and the communities of Bangouyah for their valuable cooperation during the field survey.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Verbal informed consent was obtained from all participants prior to their participation in the study. The objectives of the research, the voluntary nature of participation, confidentiality, and the right to withdraw at any time were explained before each interview.

REFERENCES

- [1] Aggrey, J. J., Ros-Tonen, M. A. F., & Asubonteng, K. O. (2021). Using participatory spatial tools to unravel community perceptions of land-use dynamics in a mine-expanding landscape in Ghana. *Environmental Management*, 68(5), 720–737. <https://doi.org/10.1007/s00267-021-01494-7>
- [2] Bridge, G. (2004). Contested terrain: Mining and the environment. *Annual Review of Environment and Resources*, 29, 205–259. <https://doi.org/10.1146/annurev.energy.28.011503.163434>
- [3] Congalton, R. G. (1991). A review of assessing the accuracy of classifications of remotely sensed data. *Remote Sensing of Environment*, 37(1), 35–46. [https://doi.org/10.1016/0034-4257\(91\)90048-B](https://doi.org/10.1016/0034-4257(91)90048-B)
- [4] Güneralp, B., Lwasa, S., Masundire, H., Parnell, S., & Seto, K. C. (2018). Urbanization in Africa: Challenges and opportunities for conservation. *Environmental Research Letters*, 13(1), 015002. <https://doi.org/10.1088/1748-9326/aa94fe>
- [5] Himmy, O., Nguyen, T. T., Hemmler, K. S., Loulad, S., Rhinane, H., & Buerkert, A. (2024). Leveraging machine learning and Landsat time series for high-resolution mapping of mining-induced vegetation changes in Ouagadougou, Burkina Faso. *Environmental Challenges*, 17, 101026. <https://doi.org/10.1016/j.envc.2024.101026>
- [6] Loukili, I., Laamrani, A., El Ghorfi, M., El Moutak, S., & Ghafiri, A. (2025). Monitoring land changes at an open mine site using remote sensing and multi-spectral indices. *Heliyon*, 11(2), e41845. <https://doi.org/10.1016/j.heliyon.2025.e41845>
- [7] Lu, D., Mausel, P., Brondízio, E., & Moran, E. (2004). Change detection techniques. *International Journal of Remote Sensing*, 25(12), 2365–2401. <https://doi.org/10.1080/0143116031000139863>
- [8] Mathe, T., Ncube, M., Moyo, F., & Ncube, V. (2025). Unravelling artisanal mining land use-land cover-change nexus through remote sensing in mining areas of Filabusi, Zimbabwe. *African Journal of Public Administration and Environmental Studies*, 4(1), 181–203. <https://doi.org/10.31920/2753-3182/2025/v4n1a9>
- [9] Maus, V., Giljum, S., da Silva, D. M., Gutschlhofer, J., da Rosa, R. P., Luckeneder, S., Gass, S. L. B., Lieber, M., & McCallum, I. (2022). An update on global mining land use. *Scientific Data*, 9, 433. <https://doi.org/10.1038/s41597-022-01547-4>

- [10] Mhangara, P., Tsoeleng, L. T., & Mapurisa, W. (2020). Monitoring the development of artisanal mines in South Africa. *Journal of the Southern African Institute of Mining and Metallurgy*, 120(4), 299–306. <https://doi.org/10.17159/2411-9717/938/2020>
- [11] Peprah, M. S. (2025). The impact of mining activities on land use/land cover (LULC) and ecosystem services in Sub-Saharan Africa: A case of the Republic of Ghana using systematic review and meta-analysis. *International Journal of Earth Sciences Knowledge and Applications*, 7(2), 255–277.
- [12] Seto, K. C., Güneralp, B., & Hutya, L. R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences of the United States of America*, 109(40), 16083–16088. <https://doi.org/10.1073/pnas.1211658109>
- [13] Sonter, L. J., Moran, C. J., Barrett, D. J., & Soares-Filho, B. S. (2014). Processes of land use change in mining regions. *Journal of Cleaner Production*, 84, 494–501. <https://doi.org/10.1016/j.jclepro.2014.03.084>
- [14] Traore, A., Mawenda, J., & Komba, A. W. (2018). Land-cover change analysis and simulation in Conakry (Guinea), using hybrid cellular-automata and Markov model. *Urban Science*, 2(2), 39. <https://doi.org/10.3390/urbansci2020039>
- [15] Traore, A., & Watanabe, T. (2017). Modeling determinants of urban growth in Conakry, Guinea: A spatial logistic approach. *Urban Science*, 1(2), 12. <https://doi.org/10.3390/urbansci1020012>