Journal of Environmental Impact and Management Policy
Vol: 06, No. 01, Jan-June 2026
ISSN: 2799-113X, DOI: 10.55529/jeimp.61.12.26

Research Paper

Integrating remote sensing and ecosystem valuation to quantify the impacts of land use change in a mining-affected district of ghana

Priscilla Badaweh Coffie[1*], Dr. Kwadwo Gyasi Santo[2], Michael Asigbaase[3], Ophelia Ayambae[4], Jeff Dacosta Osei[5]

[1*]Department of Land Management, University of Energy and Natural Resources, Sunyani, Ghana.
[2]Department of Agroforestry, University of Energy and Natural Resources, Sunyani, Ghana.
[3]Department of Horticulture and Crop Production, University of Energy and Natural Resources, Sunyani, Ghana.
[4]Department of Sustainable Minerals and Resource Development, University of Energy and Natural Resources, Sunyani, Ghana.
[5]Department of Urban Forestry, Environment and Natural Resources, Southern University and A&M College, Baton Rouge, USA.

Article Info

Article History:
Received: 27 September 2025
Revised: 07 December 2025
Accepted: 13 December 2025
Published: 30 January 2026

Keywords:
Land Use and Land Cover
Ecosystem Services
Land Degradation
Remote Sensing
Ghana

ABSTRACT

This study assessed land use and land cover (LULC) changes, ecosystem service values (ESVs), and their interactions in the Atwima Nwabiagya South District of Ghana between 2015 and 2025. Satellite image classification identified five LULC classes: vegetation, bare land, built-up areas, mined sites, and waterbodies. Over the decade, vegetation cover declined sharply from 56.1% to 34.4%, while bare land expanded from 32.6% to 48.3% and mined areas increased from 0.3% to 3.2%. Using a benefit transfer approach, total ecosystem service value decreased from about USD 765.4 million in 2015 to USD 551.2 million in 2025, largely due to the conversion of high-value vegetation and waterbodies into degraded land. The findings link land degradation primarily to rapid urban expansion and intensified mineral extraction. The study highlights the need for sustainable land management, ecosystem restoration, and district-level monitoring systems to support land-use planning, community-led stewardship, and Ghana's Land Degradation Neutrality objectives.

Corresponding Author:
Priscilla Badaweh Coffie
Department of Land Management, University of Energy and Natural Resources, Sunyani, Ghana.
Email: priscilla.coffie.stu@uenr.edu.gh

Journal of Environmental Impact and Management Policy (JEIMP)

1. INTRODUCTION

Land degradation, driven by human activities and natural processes, remains a major global environmental challenge, particularly in developing countries where livelihoods depend heavily on natural ecosystems. Worldwide, more than 25% of land on Earth is degraded and the combination of the factors such as growth of population, urban areas extending, cutting down trees and non-environmental friendly agricultural practices has a major contribution to the degradation of earth surface [1], [2].

Ghana is one of the countries that is facing such issues, as more than 65% of its land that is economically productive is degraded due to poor land governance, overexploitation of resources and non-environment-friendly land practices [3]. Protected areas are gradually invaded by legal and illegal mining, charcoal production and agriculture, what is slowing down land monitoring and land administration through poor technology [4].

Atwima Nwabiagya South District, is Ghana's high-forest transition zone, and it demonstrates the above-mentioned difficulties. This district contains important water catchments that furnish Kumasi city with water and it happens to be a cross road for agriculture where land degradation is causing food crisis, water pollution and extinction of species [5]. Increased artisanal and illegal mining has led to an increase in deforestation, soil disturbance and water contamination, including the forest reserves nearby have also been polluted with heavy metals [6]. Such trends correspond to the fast land change that was happening at the Kumasi metropolitan fringe [7]. To know about the changes in land it is not only important for monitoring but also for land management and restoration planning purpose in the district that is ecological, hydrological, and economically important.

With the help of remote sensing and GIS technologies, the monitoring of land cover dynamics can be accomplished easily, while at the same time degradation is detected and spatial planning is supported [8]. In this research, land degradation trends of the past will be scrutinized with the help of these tools, the values of ecosystem services will be roughly measured and the major shifts in the land cover that have had a positive or negative impact on the value of these services in a district within Ghana which has been affected by mining will be revealed.

2. RELATED WORK

Land degradation has been thoroughly reported as a primary environmental issue worldwide having effects on the diversity of life, the production of crops, the quality of water, and the wellbeing of humans [2]. In the case of developing countries, the degradation's causes are often related to economic and social tensions, for instance, rapid growth of population, large-scale agriculture, and poorly managed land [1]. Across Africa, degradation is intensified by unsustainable land practices and limited institutional capacity [3].

In Ghana, degradation is commonly driven by illegal mining, agricultural expansion, settlement growth, and encroachment into protected reserves [9]. Weak land administration and limited digital land information systems remain barriers to sustainable land regulation [4]. Research done in the Atwima Nwabiagya District and like peri-urban regions indicates that the landscape has change greatly and this has been connected with the intensification of agriculture, expansion of settlements, and increase in small-scale mining activities [10].

Mining has emerged as a major driver of ecological disturbance. Research has documented mining-induced deforestation, soil degradation, and water contamination, including heavy metal pollution in forest reserves [6]. These changes undermine essential ecosystem services such as carbon storage, water filtration, and soil fertility. According to [5], the combination of ecosystem service valuation and LULC analysis is essential in order to show the hidden environmental costs of land degradation completely.

Remote sensing and GIS-based studies are the main ways to comprehend the degradation' spatial patterns and the human impacts, like deforestation and landscape fragmentation [11]. Urbanization or agricultural development are the main subjects of most LULC studies in Ghana, while, only a few are dealing with the combined effects of mining, settlement growth, and ecosystem service loss at the district scale. This research takes these insights further by combining remote sensing and ecosystem valuation methods to measure the effects of land use change on ecosystem services in a quickly-shifting area of Ghana.

3. METHODOLOGY

Study Area

Atwima Nwabiagya South Municipal is located in the western part of the Ashanti Region of Ghana, with Nkawie as the administrative capital Figure 1. The municipality covers approximately 289–295 km² and recorded a population of 161,893 in the 2021 Ghana Population and Housing Census, resulting in a density of about 560 persons per square kilometre.

The region is located in the wet semi-equatorial climatic zone that experiences double rainfall and has high relative humidity as its basic characteristics. The average yearly rainwater is in the range of 170 cm to 185 cm which contributes greatly to a mainly semi-deciduous forest ecosystem. Moreover, the municipality is home to significant ecological treasures like the Owabi Water Works Forest Reserve and the nearby forest blocks that together play an important role in providing the area with hydrological and biodiversity resources [12].

The soil fertility and favorable climatic conditions are the main factors leading to the dominance of agriculture as the economic activity of the area. The variety of food crops that can be grown includes maize, rice, cassava, plantain, and vegetables while the main tree crops are citrus, cocoa, oil palm, and ginger. Also, small- and medium-scale agro-processing, wood-based industries, ceramics, and local manufacturing are all industries that are contributing to the municipal economy [12]. According to the Ghana Statistical Service, the municipality exhibits notable socioeconomic diversity, with livelihoods strongly tied to land productivity and natural resource conditions [13].

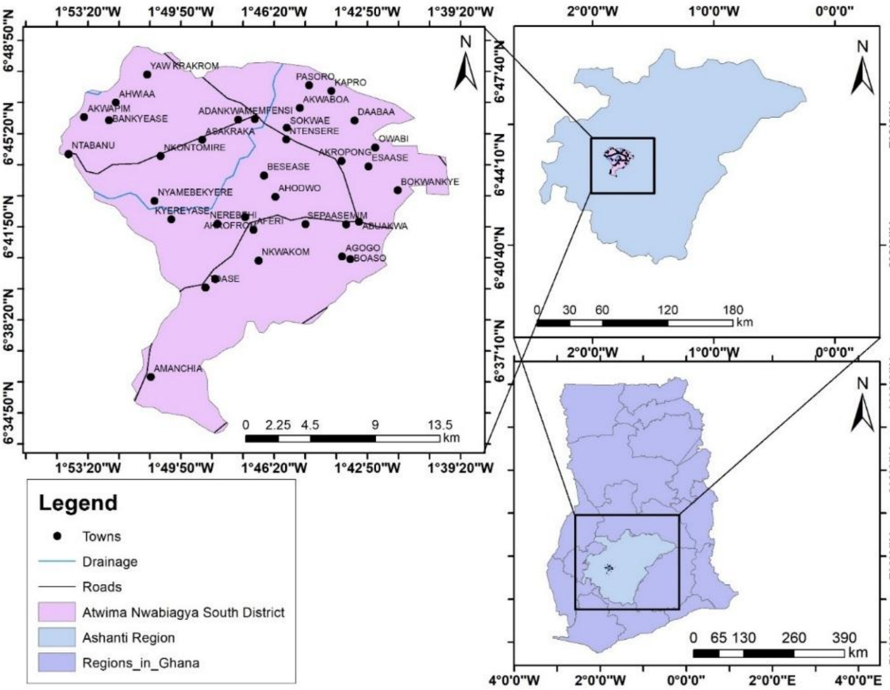

Figure 1. A Map of the Study Area

Given its rapid peri-urban expansion, increasing artisanal mining activity, and intensive agricultural land use, Atwima Nwabiagya South has become a hotspot for land cover transformation and land degradation, highlighting the need for LULC monitoring and ecosystem service assessment to support environmental sustainability.

Materials and Data Used

This study used Sentinel-2 satellite imagery (10 m spatial resolution), accessed via the Copernicus Data Space Ecosystem and processed in Google Earth Engine (GEE), to monitor land degradation over time Table 1. Image selection was guided by data availability, spatial resolution, and minimal cloud cover. Three temporal snapshots were analysed: 2015 (baseline prior to intensified mining and urban development), 2020 (midpoint assessment), and 2025 (a projected scenario derived from classified trends and model outputs). A five-year interval was adopted because land degradation associated with mining and rapid land-use change often occurs over short periods, enabling effective detection of emerging patterns [14].

Cloud masking performed with the QA60 band was used on all imagery pre-processed with Sentinel-2 surface reflectance products. Training samples for five LULC classes forest, bare land, built-up areas, water bodies, and mining areas were generated through visual interpretation of GEE imagery, Google Earth historical images (2015 and 2020), and field-collected GPS data. The sample dataset was split into 70% for model training and 30% for validation to support classification and accuracy assessment.

Table 1. Sentinel Data Used for the Study

Sentinel Products	Acquisition Date	Tile ID	Spatial Resolution	Source
2015	2015-02-12	T30NXN	10	Copernicus Data Space Ecosystem
2020	2020-01-27			
2025	2025-01-20			

Methods

Land Use Land Cover Classification

LULC classification was conducted using the Random Forest (RF) algorithm in GEE. Ground-truth points were created by way of expert interpretation of high-resolution imagery using a stratified sampling strategy to ensure the proper representation of all six LULC categories. The classification framework was in line [15], [16] prescribed methodologies, and the corresponding class descriptions can be found in Table 2.

Table 2. Land Cover Types Considered in the Study

Land use Type	Description
Mined sites	Areas dominated by exposed soil and mining pits, showing high reflectance in the visible spectrum and low reflectance in the near-infrared (NIR).
Built-Up areas	Urban and infrastructural regions are identified by high reflectance in the shortwave infrared (SWIR) bands.
Vegetation	Natural vegetation, including forests, shrubs, and herbaceous (rangelands)
Barelands	Exposed soil or barren areas, with high reflectance in visible bands.

Accuracy Assessment

Classification accuracy was evaluated using an independent reference dataset derived from field observations and very high-resolution satellite imagery. A confusion matrix was constructed to compute Overall Accuracy (OA), User's Accuracy (UA), Producer's Accuracy (PA) and the Kappa Coefficient (κ) (Equations 1-4) following the methods of Congalton and Green [17]. All classified maps achieved greater than 85% accuracy, confirming their suitability for reliable land change analysis.

Producer's Accuracy (PA):

$$PA = \frac{\text{Correctly classified pixels in a class}}{\text{Total reference pixels for that class}} \times 100 \quad ....1$$

User's Accuracy (UA):

$$UA = \frac{\text{Correctly classified pixels in a class}}{\text{Total pixels classified in that class}} \times 100 \quad ....2$$

Overall Accuracy (OA):

$$OA = \frac{\text{Total number of correctly classified pixels}}{\text{Total number of reference pixels}} \times 100 \quad ....3$$

Kappa Coefficient (κ):

$$\kappa = \frac{P_0 - P_e}{1 - P_e} \quad ....4$$

Where:
Po = observed agreement (overall accuracy),
Pe = expected agreement by random chance.

Change Detection and Land Degradation Assessment

Change detection was performed through comparative analysis of classified maps for 2015–2020 and 2020–2025. The conversion from vegetated to non-vegetated classes was seen as a sign of land degradation, especially the transitions such as Vegetation → Bare land, Bare land → Mining, and Vegetation → Mining or Built-up. The degree and speed of land cover changes were measured to assess the area's degradation and trend in the district. For each type of transition, the area (in hectares) and the percentage of the change were assessed to spot the area and the time trend of degradation in the district. The study only looked at the patterns and sizes of changes; it did not take into account the economic, political, or social factors that might have caused the changes directly. Interpretations of possible contributing factors are therefore addressed separately in the discussion, based on established literature.

Ecosystem Service Valuation

Ecosystem service values (ESVs) were calculated through application of the value transfer method by assigning monetary coefficients to each LULC category for the years 2015, 2020, and 2025. Production of classified maps was done in GEE and then the maps were further processed in QGIS 3.28. Each land cover category was provided a value coefficient (VC) in USD/ha/year, which was extracted from Ghanaian and West African peer-reviewed studies, and the summarized information is given in Table 3.

Table 3. Ecosystem Service Value (ESV) Coefficient for Different Land Cover Types

LULC Type	VC (USD/ha/year)
Vegetation	3800
Built-up	0.00
Bare land	100
Mined site	0.38
Waterbodies	6552.97

The value transfer method was selected because it is widely used where primary valuation data are limited and enables integration of empirical evidence into spatially explicit ESV estimation [18]. Built-up areas were assigned an ESV of zero because impervious surfaces provide no meaningful provisioning, regulating, or supporting ecosystem services, while bare land received a low but non-zero value due to residual soil-based processes such as infiltration and nutrient cycling [19].
Ecosystem service values for each land cover type were then computed using Equation 5

$$ESV = \sum (Ai \times Vci) ....5$$

Where ESV is the total ecosystem service value (USD/year), A_i is the area (ha) of LULC class i, and VC_i is the corresponding value coefficient [20]. The class-specific ESVs were summed to obtain the total ESV for each reference year, with results presented in Table 7 under the Results section.

To identify temporal changes in the provisioning of ecosystem services, ESV change was calculated by comparing the totals of ESV across three survey years. Change is expressed both absolutely and as a percentage using Equations 6 and 7:

Absolute Change:

$$\Delta \text{ESV} = ESV_{year1} - ESV_{year^4} \ldots\ldots 6$$

Percentage Change:

$$\%\Delta \text{ESV} = \frac{ESV_{year^4} - ESV_{year1}}{ESV_{year1}} X\ 100 \ldots\ldots 7$$

These indicators enabled an assessment of the gains or losses in ecosystem service provisioning resulting from land degradation, urbanisation or vegetational regeneration. An important application of this result is that it offers a valuable rough guide on the environmental costs of bad land use practices, particularly in regions which are affected by small-scale mining or deforestation.

Work Flow

The complete workflow Figure 2 includes data acquisition and preprocessing, Random Forest model training and classification, accuracy assessment, change detection of land cover types associated with human activities such as urban expansion and unsustainable agriculture, and predictive analysis to evaluate degradation trends and implications.

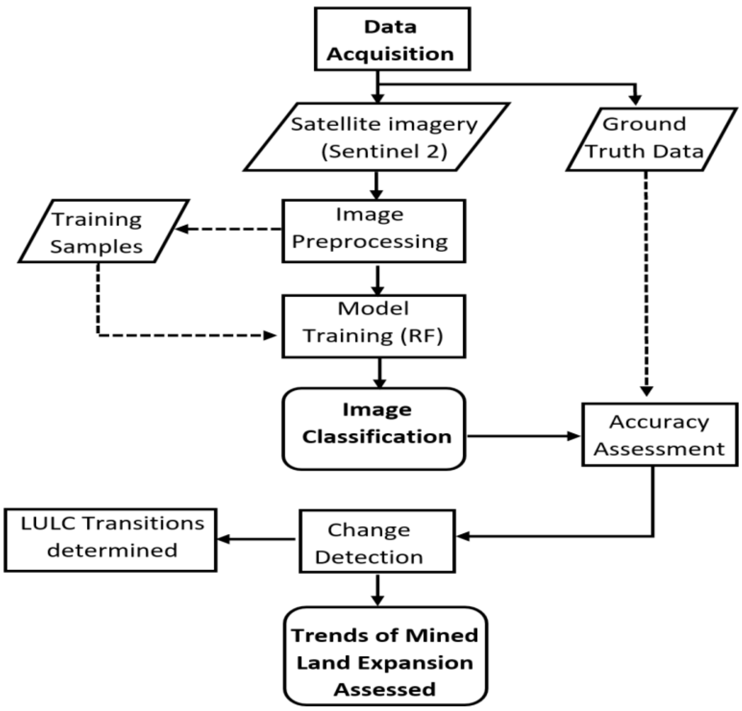

Figure 2. Flow Chart of Activities

4. RESULTS AND DISCUSSION

Land Use Land Cover Dynamics (2015-2025)

The district spans approximately 36,815 ha and has undergone significant land cover transformations over the ten-year period. The spatial distribution and evolution of land use and land cover classes in 2015, 2020 and 2025. Vegetation cover declined sharply from 20,666 ha in 2015 to 12,648 ha in 2025, representing a net loss of 8,018 ha Table 4. This downward trend is consistent with documented patterns of vegetation depletion across Ghana, where agricultural expansion, settlement growth and increasing land degradation have contributed to sustained forest loss [21]. Similar trajectories of vegetation loss linked to anthropogenic pressure have been documented by [22].

On the contrary, bare land expanded from 11,995 ha to 17,774 ha over the same period. Similar increases in bare surfaces have been reported in peri-urban and mining-affected Ghanaian districts, where soil exposure and degradation result from vegetation removal and intensive land disturbance.

Built-up areas increased from 3,969 ha in 2015 to 5,178 ha in 2025, reflecting ongoing urban expansion trends observed throughout the Ashanti Region, particularly in districts influenced by the outward growth of the Greater Kumasi metropolitan area [23]. As in other rapidly urbanising landscapes, settlement growth tends to coincide with reductions in surrounding vegetation and increases in exposed surfaces.

Mining sites recorded the most substantial proportional increase, rising from 116 ha to 1,178 ha between 2015 and 2025. This pattern mirrors the broader national rise in small-scale and illegal mining ("galamsey"), which has been identified as a major contributor to forest clearance, soil disturbance and hydrological alteration in forested districts [24]. Studies across Ghana have consistently identified mining as a major contributor to forest loss, soil disturbance, hydrological alteration and long-term environmental degradation.

The total area of water bodies showed that it was about 37 ha which is almost the same as previous years; however, the very slight cuts in water bodies' area are in accordance with the hydrological impacts of vegetation loss and mining activities which have been reported in the similar watersheds of Ghana. The overall LULC results represent a gradual transformation of the vegetated and biologically functional area into the degraded, mining and urban zones. This transformation represented in Figure 3, Figure 4, is consistent with a range of regional research depicting the synergistic effect of the development of cities, land degradation and resource extraction in modifying the landscapes across the Ghanaian forest belt [19], [21].

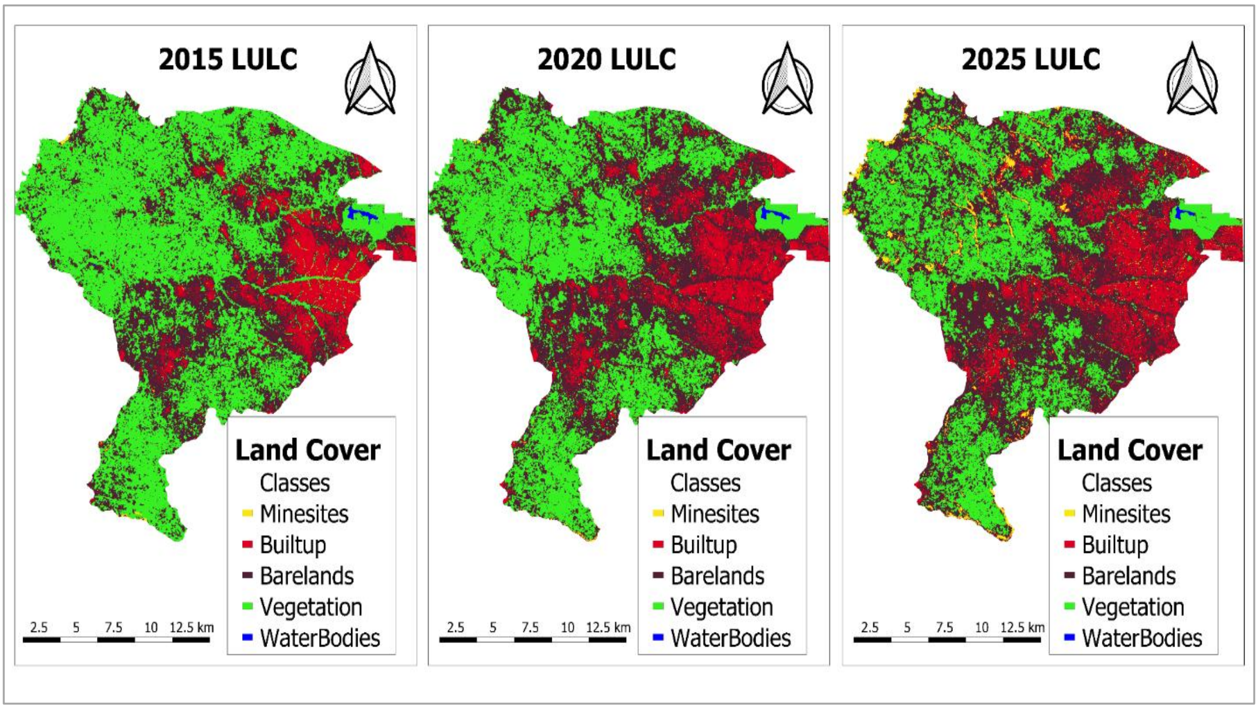

Figure 3. Trends of Land Use and Land Cover Maps for Atwima Nwabiagya South District in 2015, 2020, and 2025

Table 4. Area and LULC Proportions in Atwima Nwabiagya South District (2015–2025) in Hectares and Percentages

Lulc Type	2015 (Ha)	2020 (Ha)	2025 (Ha)	2015 (%)	2020 (%)	2025 (%)
Minesites	116	193	1,178	0.3	0.5	3.2
Built-up	3,969	4,668	5,178	10.8	12.7	14.1
Barelands	11,995	15,304	17,774	32.6	41.6	48.3
Vegetation	20,666	16,593	12,648	56.1	45.1	34.4
Water bodies	69	58	37	0.2	0.2	0.1
Total Area	36,815	36,815	36,815	100	100	100

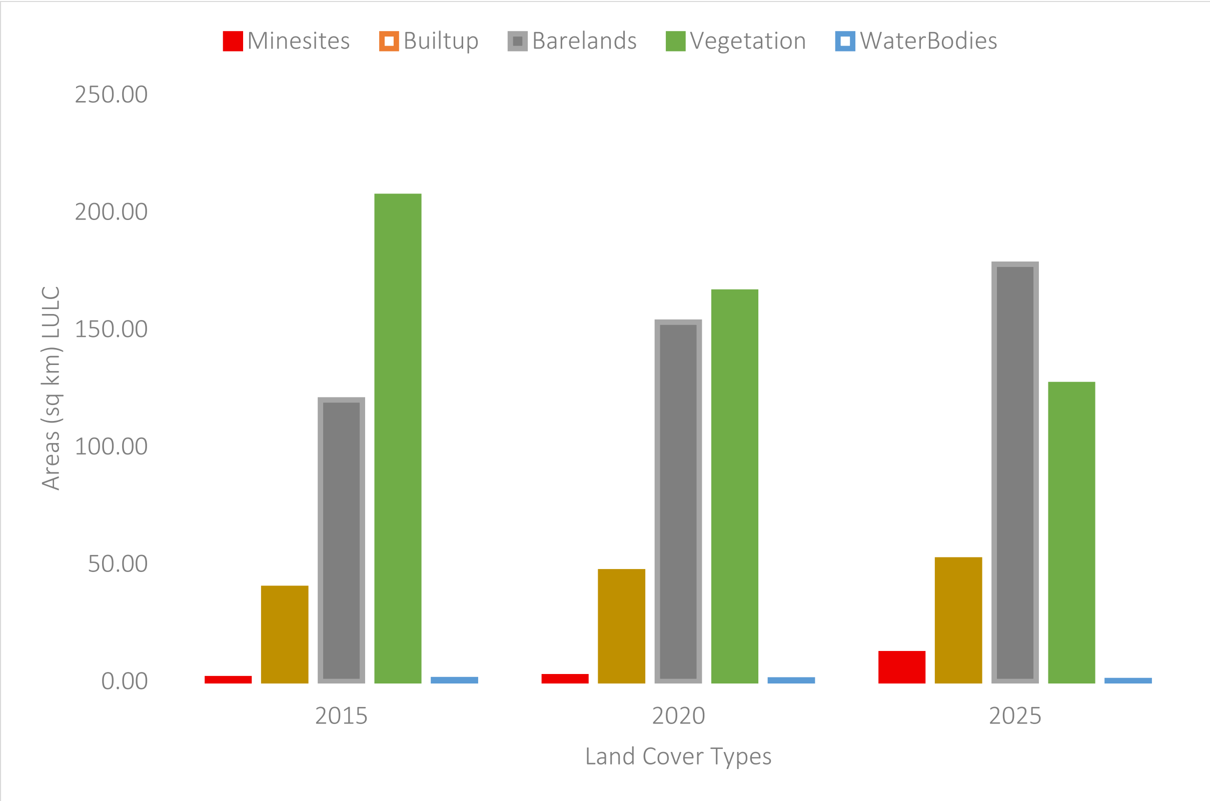

Figure 4. Areas (Sq Km) LULC for 2015, 2020 and 2025

Transitional Analysis of LULC Classes in the Atwima Nwabiagya South District

To understand the dynamics of land cover shifts, an analysis of gains and losses was conducted over three intervals: 2015–2020, 2020–2025, and cumulatively from 2015–2025. Table 5 summarizes the LULC class-wise gains and losses, whereas Figure 5, Figure 6 show the transition map and Net change in LULC, respectively. The transition analysis revealed that vegetation was primarily converted into barelands and built-up areas, while barelands were increasingly transformed into minesites. This indicates a sequential degradation pathway: forest → bareland → mining or urban expansion. Similar patterns have emerged in other parts of Ghana where forests are exhausted, the land is gradually stripped of its soil, and mining becomes economically feasible [25]. Urbanisation was also a big factor. Built-up areas increased by over 1200 ha during the study period. This trend reflects Amoako and Boamah's [26] observation that peri-urban settlements proliferate rapidly outside of Kumasi. Building on these results with remote-sensing data, it has now been found that population burden and extraction activities drive land deterioration in this district.

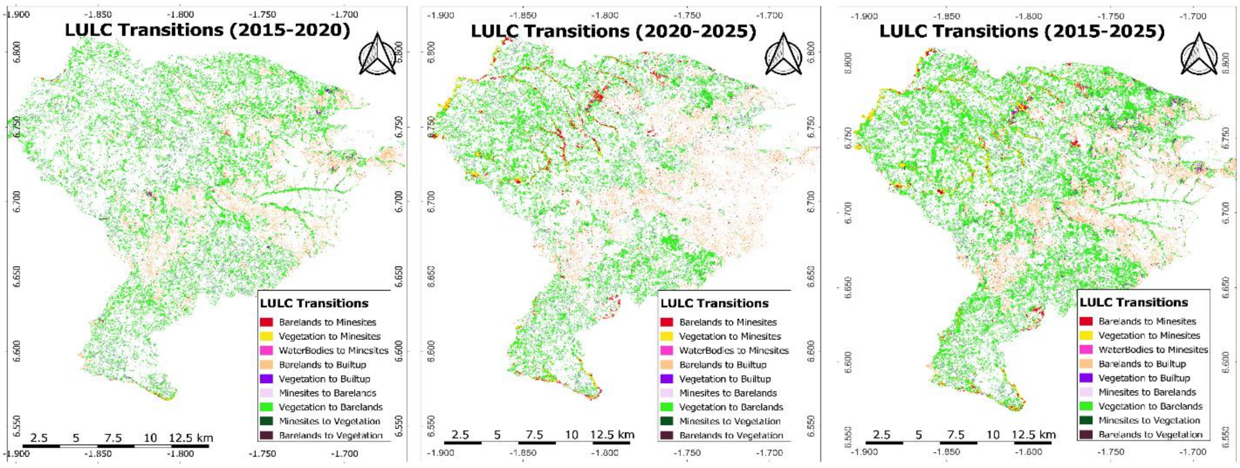

Figure 5. Transition Flows between Major LULC Classes during the Study Period

Table 5. Gains, Losses, and Net Changes in LULC (2015–2025) in Hectares

Period	LULC Type	Losses (ha)	Gains (ha)	Net Change (ha)
2015–2020	Minesites	-103	180	77
	Built-up	-772	1,465	693
	Barelands	-3,285	6,566	3,281
	Vegetation	-5,941	1,902	-4,039
	Water	-14	2	-12
2020–2025	Minesites	-133	1,110	977
	Built-up	-1,077	1,583	506
	Barelands	-3,761	6,211	2,450
	Vegetation	-5,754	1,841	-3,913
	Water	-21	1	-20
2015–2025	Minesites	-79	1,133	1,054
	Built-up	-1,005	2,205	1,200
	Barelands	-3,840	9,572	5,732
	Vegetation	-9,607	1,655	-7,952
	Water	-33	1	-32

Figure 6. Net Change in LULC, 2015 to 2025

Classification Accuracy and Reliability of Results

The classification accuracy assessment produced overall accuracies above 90% for 2015, 2020, and 2025, confirming the robustness of the remote sensing approach adopted Table 6. Vegetation and waterbody classes achieved consistently high producers' and users' accuracies, indicating strong classification performance. The lower accuracy observed for minesites in 2020 reflects spectral similarity between newly degraded lands and bare surfaces, which is a common classification challenge in transitional landscapes [18]. Despite this, the consistently high overall accuracies validate the reliability of the LULC trends reported.

Table 6. Classification Accuracy Metrics for the Atwima Nwabiagya South District (2015–2025)

Year	Overall Accuracy (%)	LULC Type	Producer's Accuracy (PA, %)	User's Accuracy (UA, %)
2015	92.0	Minesites	100.0	83.3
		Built-up	91.9	91.9
		Barelands	85.3	93.5
		Vegetation	95.8	95.8
		Water	100.0	100.0
2020	93.0	Minesites	80.0	92.3
		Built-up	90.9	88.2
		Barelands	94.6	94.6
		Vegetation	100.0	96.3
		Water	100.0	100.0
2025	94.1	Minesites	93.5	96.7
		Built-up	94.9	92.5
		Barelands	94.7	85.7
		Vegetation	92.6	100.0
		Water	100.0	100.0

Ecosystem Service Valuation in 2025

Using value coefficients from relevant literature [26], the total ecosystem service value (ESV) of the district in 2025 was estimated at USD 48.54 million per year. Vegetation accounted for more than 99% of the total ESV thus indicating that it was the primary agent in maintaining the ecological and economic functions. The presence of water bodies besides 37 ha exerted a considerable impact on ESV due to their higher valuation coefficient implying that hydrological regulation role is very important. Conversely, the area of barelands and minesites was bigger, but their contributions to the total ESV were minor. This shows how degraded land directly results in a loss of ecological and economic benefits to the district, and not just a loss of land area.

Impact of LULC Changes on Ecosystem Services (2015-2025)

From 2015 to 2025, the district lost 38.2% of its total ESV. This resulted in an annual loss of ESV of USD 30.04 million Table 7 and Figure 7. This loss was primarily due to the loss of vegetation, as global evidence shows that the loss of vegetation is the primary driver of the loss of ecosystem services [27]. In the ecosystem service hierarchy, the shift from vegetation to barelands and minesites represents a movement from high to low land use. This directly contributes to the loss of ecosystem resilience. Such scenarios are also reported in West Africa, where land degradation impacts the ecosystem's productivity and climate regulation [28]. The reduction in water bodies aggravates the situation by cutting off the water-related services for living, irrigation, and domestic water supply that are coming from the water bodies. It is reported that mining-induced water loss leads to reduced ecosystem benefits in the River Basins.

Table 7. Changes in Ecosystem Service Values (Esvs) by LULC Class (2015-2025) in the Atwima Nwabiagya South District

LULC Type	Area 2015 (ha)	ESV 2015 (USD/year)	Area 2020 (ha)	ESV 2020 (USD/year)	Area 2025 (ha)	ESV 2025 (USD/year)	Net Change 2015–2025 (USD/year)
Vegetation	20,666	78,530,800	16,593	63,053,400	12,648	48,062,400	-30,468,400
Built-up	3,969	0	4,668	0	5,178	0	0
Bareland	11,995	1,199,500	15,304	1,530,400	17,774	1,777,400	+577,900
Mined site	116	44.08	193	73.34	1,178	447.64	+403.56
Waterbodies	69	452,154.93	58	380,072.26	37	242,460.00	-209,694.93
Total	36,815	78,582,499	36,815	64,963,945	36,815	48,543,707	-30,038,792

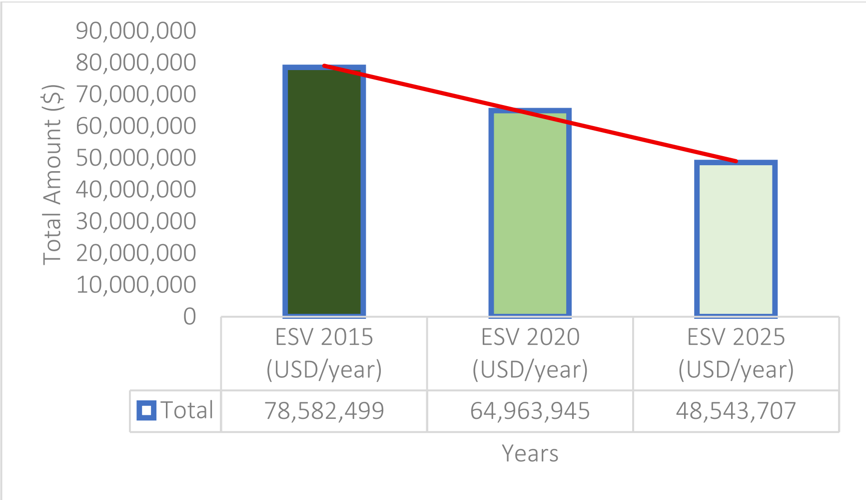

Figure 7. Trends in Total Ecosystem Service Value from 2015 to 2025 in the Atwima Nwabiagya South District

Implication for Sustainable Land Management

The region is confronted with the problem of finding a way to sustain the land affected by LULC dynamics and the declining ESV. Failing to take action will lead to a progressive decline in ecosystem services which in turn will adversely affect the local livelihoods, degrade agricultural productivity, and reduce climate resilience. It is a matter of extreme urgency that the measures like sustainable agriculture, afforestation, and reclamation of mining land be taken to reverse the trend. Besides these actions, it is also very important to make land use regulations stricter so as to prevent illegal mining and control urban sprawl. Further, local authorities could integrate ecosystem valuation into land-use planning to grasp the hidden economic implications of ecosystem degradation and restoration and to prioritize restoration financing. This is consistent with Land Degradation Neutrality principles promoted by the UN Convention to Combat Desertification and sustainable development prospects for the district.

5. CONCLUSION

The years 2020 to 2025 saw the district going through a significant transformation in land cover and a decline in ecological integrity. Water bodies shrank by 21 ha (36%), while the areas covered by bare soil, construction, and mining activities increased by 2,470 ha, 510 ha, and 985 ha, respectively. Such patterns show a transition from lands with ecological functions to those with degraded and extractive uses mainly due to mining and urban sprawl. As a result of loss of vegetation, there was an estimated annual reduction of USD 30.04 million in the values of ecosystem services of which vegetation provided over 99% of total ESV. The accuracy of classification being above 90% attests to the reliability of the analysis done.

To turn the tide will require massive forest restoration, reclamation of mined lands, strengthened land-use governance, integration of LULC data into planning, and alignment with Ghana's Land Degradation Neutrality targets under the UNCCD.

Acknowledgment

The authors acknowledge the GEO Land Degradation Neutrality (GEO-LDN) Secretariat for funding and institutional support, with additional collaboration from United Nations Convention to Combat Desertification (UNCCD) and the German Agency for International Cooperation (GIZ) for their collaborative support to the GEO-LDN Secretariat and facilitating this research. Appreciation is also extended to the GEO-LDN Secretariat at the University of Energy and Natural Resources, as well as Prof. Richard Amankwah Kuffour and Ambrose Derzu, for their guidance and support throughout the study.

Funding Information

This research was funded by the Group on Earth Observation flagship Land Degradation Neutrality Secretariat hosted under the German International Cooperation for Development (GIZ), Bonn, Germany.

Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Priscilla Badaweh Coffie	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Dr. Kwadwo Gyasi Santo	✓						✓			✓		✓		
Michael Asigbaase	✓	✓		✓	✓					✓	✓	✓		
Ophelia Ayambae	✓	✓			✓			✓		✓		✓		
Jeff Dacosta Osei	✓	✓	✓		✓	✓		✓	✓	✓	✓			

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed Consent

There was no informed consent needed for this study.

Ethical Approval

There was no ethical approval needed for this study.

Data Availability

The datasets used and/or analysed in the current study are included in the article.

REFERENCES

[1] F. S. K. Agyemang, E. Silva, and M. Poku-Boansi, 'Understanding the urban spatial structure of Sub-Saharan African cities using the case of urban development patterns of a Ghanaian city-region', Habitat Int., vol. 85, pp. 21-33, Mar. 2019. doi.org/10.1016/j.habitatint.2019.02.001

[2] J. N. Atieku and S. K. Segbefia, 'Land degradation: A global challenge and its effects on humankind and the environment, with a special focus on Ghana', 2024.
[3] A. Hossain et al., 'Agricultural land degradation: Processes and problems undermining future food security', in Environment, Climate, Plant and Vegetation Growth, Cham: Springer International Publishing, 2020, pp. 17-61. doi.org/10.1007/978-3-030-49732-3_2
[4] P. B. Coffie, J. D. Osei, E. O. Boamah, T. Abindaw, and T. L. Jiru, 'Building an efficient Land Information System in Ghana: Insights from land governance', April-May 2024, no. 43, pp. 37-50, May 2024. doi.org/10.55529/jeet.43.37.50
[5] A. Koranteng, B. F. Frimpong, I. Adu-Poku, J. N. Asamoah, and T. Zawiła-Niedźwiecki, 'Assessment of past and future land use/land cover dynamics of the old Kumasi metropolitan assembly and atwima nwabiagya municipal area, Ghana', J. Geosci. Environ. Prot., vol. 11, no. 03, pp. 44-69, 2023. doi.org/10.4236/gep.2023.113004
[6] J. D. Osei et al., 'Poisoned for gold: Assessing the spatial extent of heavy metal contamination within the Tutua-Bura-Angoben Shelter Belt Forest Reserve in Ghana', Watershed Ecology and the Environment, vol. 6, pp. 146-154, 2024. doi.org/10.1016/j.wsee.2024.08.001
[7] G. F. Arfasa, E. Owusu-Sekyere, and D. A. Doke, 'Spatio-temporal analysis of land use/land cover change and the implications on sustainable development goals in the Vea catchment of Ghana', Rangeland Ecol. Manage., vol. 94, pp. 83-94, May 2024. doi.org/10.1016/j.rama.2024.02.005
[8] D. O. Appiah, F. Asante, and B. Nketiah, 'Perspectives on agricultural land use conversion and food security in rural Ghana', Sci, vol. 1, no. 1, p. 14, Mar. 2019. doi.org/10.3390/sci1010014.v1
[9] A. Y. Emmanuel, C. S. Jerry, and D. A. Dzigbodi, 'Review of environmental and health impacts of mining in Ghana', J. Health Pollut., vol. 8, no. 17, pp. 43-52, Mar. 2018. doi.org/10.5696/2156-9614-8.17.43
[10] K. Abass et al., 'Urban sprawl and green space depletion: Implications for flood incidence in Kumasi, Ghana', Int. J. Disaster Risk Reduct., vol. 51, no. 101915, p. 101915, Dec. 2020. doi.org/10.1016/j.ijdrr.2020.101915
[11] X. Zhang et al., 'Land use and land cover mapping using RapidEye imagery based on a novel band attention deep learning method in the Three Gorges Reservoir Area', Remote Sens. (Basel), vol. 13, no. 6, p. 1225, Mar. 2021. doi.org/10.3390/rs13061225
[12] R. M. Abdul, E. Arhin, and A. A. Arhin Jnr, 'Mineralogy and geochemistry of geophagic materials at Mfensi-Adankwame in the Ashanti region of Ghana and possible health implications', Geol. Ecol. Landscapes, vol. 7, no. 4, pp. 281-292, Oct. 2023. doi.org/10.1080/24749508.2021.1952775
[13] E. D. Kullo, E. K. Forkuo, E. Biney, E. Harris, and J. A. Quaye-Ballard, 'The impact of land use and land cover changes on socioeconomic factors and livelihood in the Atwima Nwabiagya district of the Ashanti region, Ghana', Environ. Chall. (Amst.), vol. 5, no. 100226, p. 100226, Dec. 2021. doi.org/10.1016/j.envc.2021.100226
[14] H. Xu et al., 'A systematic review and comprehensive analysis on ecological restoration of mining areas in the arid region of China: Challenge, capability and reconsideration', Ecol. Indic., vol. 154, no. 110630, p. 110630, Oct. 2023. doi.org/10.1016/j.ecolind.2023.110630
[15] J. R. Anderson, E. E. Hardy, J. T. Roach, and R. E. Witmer, 'A land use and land cover classification system for use with remote sensor data', Professional Paper. US Geological Survey, 1976. doi.org/10.3133/pp964
[16] M. C. Hansen et al., 'High-resolution global maps of 21st-century forest cover change', Science, vol. 342, no. 6160, pp. 850-853, Nov. 2013. doi.org/10.1126/science.1244693
[17] R. G. Congalton and K. Green, Assessing the accuracy of remotely sensed data, 2nd edn. Boca Raton, FL: CRC Press, 2008. doi.org/10.1201/9781420055139
[18] R. Costanza et al., 'Changes in the global value of ecosystem services', Glob. Environ. Change, vol. 26, pp. 152-158, May 2014. doi.org/10.1016/j.gloenvcha.2014.04.002
[19] R. Baidoo and K. Obeng, 'Evaluating the impact of land use and land cover changes on forest ecosystem service values using landsat dataset in the Atwima Nwabiagya North, Ghana', Heliyon, vol. 9, no. 11, p. e21736, Nov. 2023. doi.org/10.1016/j.heliyon.2023.e21736

[20] M. Biedemariam, E. Birhane, B. Demissie, T. Tadesse, G. Gebresamuel, and S. Habtu, 'Ecosystem service values as related to Land Use and Land Cover changes in Ethiopia: A review', Land (Basel), vol. 11, no. 12, p. 2212, Dec. 2022. doi.org/10.3390/land11122212
[21] G. A. B. Yiran, J. M. Kusimi, and S. K. Kufogbe, 'A synthesis of remote sensing and local knowledge approaches in land degradation assessment in the Bawku East District, Ghana', Int. J. Appl. Earth Obs. Geoinf., vol. 14, no. 1, pp. 204-213, Feb. 2012. doi.org/10.1016/j.jag.2011.09.016
[22] J. Aduko, M. A. Yakubu, and K. Anokye, 'Assessing the environmental impacts of urban sprawl on vegetation cover and ecosystem integrity in Wa municipality, Ghana', World Dev. Sustain., vol. 6, no. 100225, p. 100225, June 2025. doi.org/10.1016/j.wds.2025.100225
[23] G. Issahaku and A. Abdulai, 'Household welfare implications of sustainable land management practices among smallholder farmers in Ghana', Land Use Policy, vol. 94, no. 104502, p. 104502, May 2020. doi.org/10.1016/j.landusepol.2020.104502
[24] V. R. Wingate, F. O. Akinyemi, C. J. Iheaturu, and C. Ifejika Speranza, 'A remote sensing-based inventory of West Africa tropical forest patches: A basis for enhancing their conservation and sustainable use', Remote Sens. (Basel), vol. 14, no. 24, p. 6251, Dec. 2022. doi.org/10.3390/rs14246251
[25] C. Amoako and E. Frimpong Boamah, 'The three-dimensional causes of flooding in Accra, Ghana', Int. J. Urban Sustain. Dev., vol. 7, no. 1, pp. 109-129, Jan. 2015. doi.org/10.1080/19463138.2014.984720
[26] G. M. Foody, 'Status of land cover classification accuracy assessment', Remote Sens. Environ., vol. 80, no. 1, pp. 185-201, Apr. 2002. doi.org/10.1016/S0034-4257(01)00295-4
[27] C. Werema, 'Does the use of exotic and native tree species in rehabilitation attract birds equally? The case of Golden Pride Gold Mine, Tanzania', Afr. J. Ecol., vol. 59, no. 3, pp. 641-654, Sept. 2021. doi.org/10.1111/aje.12871
[28] M. Gastauer et al., 'Mine land rehabilitation: Modern ecological approaches for more sustainable mining', J. Clean. Prod., vol. 172, pp. 1409-1422, Jan. 2018. doi.org/10.1016/j.jclepro.2017.10.223

How to Cite: Priscilla Badaweh Coffie, Dr. Kwadwo Gyasi Santo, Michael Asigbaase, Ophelia Ayambae, Jeff Dacosta Osei. (2026). Integrating remote sensing and ecosystem valuation to quantify the impacts of land use change in a mining-affected district of ghana. Journal of Environmental Impact and Management Policy (JEIMP), 6(1), 12-26. https://doi.org/10.55529/jeimp.61.12.26

BIOGRAPHIES OF AUTHORS

	**Priscilla Badaweh Coffie**, is an environmental planner and a researcher with expertise in sustainable land management, ecosystem restoration, and climate resislience. Her work focuses on land degradation monitoring, phytoremediation, and the reclamation of degraded and post-mining landscapes. She has contributed to community-based green city initiatives, composting research, and Environmental Impact Assessment projects in Ghana. In the current study, she contributed to data collection, developing the research methodology, and manuscript preparation. Email: priscilla.coffie.stu@uenr.edu.gh
	**Dr. Kwadwo Gyasi Santo**, is a Senior Lecturer at the University of Energy and Natural Resources (UENR), Sunyani, Ghana, specializing in agronomy and sustainable crop production. His research focuses on soil fertility, nutrient-use efficiency, and crop performance under different agronomic systems. He has supervised numerous students and published widely on maize, cassava, and intercropping systems. Dr. Santo also contributes to agritech innovation, linking research with practical

	agricultural solutions in Ghana. In the current study, he provided guidance, reviewed the findings, and contributed to the discussion of results. Email: kwadwo.santo@uenr.edu.gh
	**Michael Asigbaase**, is a Senior Lecturer in the Department of Horticulture and Crop Production at the University of Energy and Natural Resources (UENR). He holds a PhD in Environmental Science from the University of Nottingham and MSc and BSc degrees in Natural Resources Management from KNUST. His research focuses on forestry, climate change, biodiversity conservation, agroforestry, plant–soil interactions, and sustainable land management, and he supports postgraduate training at UENR. He contributed to this publication through manuscript review and guidance. Email. Michael.asigbaase@uenr.edu.gh
	**Ophelia Ayambae**, is a Lecturer in the Department of Sustainable Mineral Resources Development at UENR. She holds a PhD in Environmental Sciences (University of Ghana), an MBA in International Resource and Environmental Management, a Postgraduate Diploma in Occupational Safety and Environmental Management, and a BSc in Mining Engineering. She is a registered engineer with professional and research experience in sustainable mining, environmental management, climate adaptation, and ecosystem valuation. In the current study, she provided guidance and reviewed the manuscript. Email: ophelia.ayamba@uenr.edu.gh
	**Jeff Dacosta Osei**, is a researcher at the Department of Urban Forestry, Environment, and Natural Resources at Southern University and A&M College, Baton Rouge, LA, USA. Jeff holds a background in environmental science and geospatial analysis, with a focus on urban forestry, remote sensing applications, and hydrological modelling. His research interests include land use and land cover change, flood risk assessment, and the impact of urbanization on soil and water resources. In the current study, he contributed to data collection, developing the research methodology and manuscript review. Email: jeffdacosta.osei@subr.edu