

ANALYSIS OF LAND USE LAND COVER CHANGE IN ABRAKA, DELTA STATE, NIGERIA USING GEOSPATIAL TECHNIQUES

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Abstract
This study examined the land use and land cover changes (LULC) in Abraka Town in Delta State using Geographic Information System (GIS) and Remote Sensing (RS). Imageries of Abraka town for 1990 and 2022 were sourced from Landsat Thematic Mapper TM and Operational Land Imager respectively. ArcGIS 10.8 reclassification operation aided in mapping all separated areas of change for which magnitude was later calculated. It was used for displaying, processing and enhancing images. ERDAS was used to create LULC classes, using Anderson classification scheme. The maximum likelihood classifier algorithm was used for supervised classification and six classes of land use namely: bare surface, water body, cultivation, built-up, vegetation and thick vegetation were generated. Overlay operation, limited to the built-up area, was performed in order to identify the actual locations and magnitude of change. The accuracy of the classification was assessed using four parameters: overall accuracy, user's accuracy, producer's accuracy and the Kappa index of agreement calculated using the Kappa statistics formula as modified by Janness and Wynne. The Kappa coefficient accuracy was 89.58% for 1990 and 89.84% for 2022. Based on the findings, percentage area of bare surface increased from 0.22% in 1990 to 0.88% in 2022, built-up area increased from 16.59% in 1990 to 30.49% in 2022 while thick vegetation and vegetation declined from 20.24% and 39.42% in 1990 to 15.28% and 28.86% in 2022 respectively. Cultivation increased from 21.71% as at 1990 to 22.66% in 2022. Water body remained the same. The LULC in the 23 years have expanded beyond the limits of the boundaries of the area to engulf the contiguous environments with no serious planning guidelines to control the expansion. This trend has led to serious environmental challenges. If it continues unabated or without proper land use planning to quell the unplanned expansion, it is projected that in the next 12 years the expansion will rise to 96 percent built-up area of the entire landscape. The study recommends that to forestall the impending unplanned development in Abraka town, Delta State Government should, as a matter of urgency, prepare a masterplan for the town, encourage vertical building development and adopt Remote Sensing and GIS for the planning, management and control of developing areas.

Keywords: GIS, Land, land cover, land use, Remote sensing.

1.0 Introduction
Global human population growth has expanded massively since the industrial era, and this is raising concern about the sustainability of the environment. The history of humanity is largely shaped by the dependence of individuals on land for food production and economic development. This continually alters the global landscape, thereby increasing the stress on land resources (Foley et al., 2011; Weinzettel et al., 2013). Taking these factors into account, anthropogenic activities and land use land cover changes (LULC) are among the most pressing issues of the 21st century, contributing to the global environmental degradation (Stabile, 2012). These LULC changes have a wide range of impacts on the natural environment, including climate change, deforestation, land degradation, loss of biodiversity, altering the hydrological circle and amplifying surface erosion (Turner et, al., 2007;



Berihun, et, al., 2019). Urbanisation process in developing countries has gone through three periods of rapid urbanization: pre-colonial, colonial, and postcolonial. As a result, each stage has produced its own special type of urban land use pattern (Ikhuoria, 1987; Farrel, 2018).

Over the past five decades, Nigeria has witnessed significant urbanization. The urban population was less than 7% of the entire population in 1931, but it rose from 10% and 19.2% in 1952 and 1963 respectively. Reliable estimates put the urban population at 33% and 42% in 1984 and 1991 respectively (Morenikeji, 2018). Similarly, the number of urban centres have increased. In 1921, Nigerian population was estimated to be 18.6 million, and about 1.5 million people were living in 29 cities with population of 20,000 and above. In 1952, the national census showed that 3.3 million people were living in cities across the country, and there were 329 urban centres with population exceeding 5,000 people (Avis, 2019).

In Nigeria, population growth and related human activities are increasing the use of land for agriculture, forestry, pasture, and most remarkably for urban and industrial purposes (Food and Agriculture Organization, 2020). The major dynamic component of this rapid urban growth is the attendant spatial manifestation of intensive economic activities. The urban area represents a complex association of population concentration, intensive economic activities and diverse life-styles. The centripetal nature of the urban areas creates intense pressure on the economic and spatial structure of urban services and facilities like educational institutions, housing, transport, telecommunication systems and energy supply. Of the burgeoning urban activities, the most prominent are housing, residential, transportation, commercial, industrial and institutional (Adie et al., 2019). Due to these changes, several issues relating to land are affecting Nigeria, including deforestation, crude oil pollution, soil erosion, biodiversity loss, urban congestion and desertification. Over the past decades, urbanization process has affected about 400,000 hectares of vegetation (Etim & Dukiya, 2013).

Human populations and their use of land have transformed most of the terrestrial biosphere into anthropogenic biomes. Such transformation has caused changes in ecological patterns and processes to emerge (Ellis & Pontius Jr, 2006), due to pressure from population growth, demand for increased production of commodities, expansion of settlements, establishment of more infrastructural facilities like roads, airports and industries (Balasubramanian, 2015). These land use activities have serious adverse effects on the local, regional and global environment (Longgao et al., 2019).

The above situations have triggered several researches on LULC change to aid planners in producing plans that can guarantee sustainable urban development. Innovative tools including GIS and remote sensing have also been developed for use in LULC assessment and prediction across urban areas and regions. El Bastawesy, et al. (2021) applied GIS to track land use land cover changes for 31 years in Aswan Kom Ombo in Egypt. Tekle, et al. (2017) used Landsat data and ArcGIS in a study of Ethiopia's LULC for 30 years and observed decline in wetlands and forests, and increase in settlement and agricultural land. GIS aids detection of spatial patterns of change, prediction of growth and identification of sensitive areas needing land



management intervention. Mishra & Rai (2016) studied urban landuse change in Mumbai using RS and GIS techniques. Forkuo & Frimpong (2020) in the study of urban growth effects on vegetation and water bodies in Accra, Ghana, used RS and GIS to observe environmental risks caused by unchecked urban development, proving GIS as a veritable tool for sustainable urban planning. Akpovwovwo (2020) stressed the need for a clear understanding of a city's growth and land use changes over time using real time, accurate and relevant data obtained from GIS and satellite technologies.

Other studies on LULC detection are available globally but there is limited research work on LULC change detection using geospatial techniques in rapidly growing towns in Nigeria. Abraka is a university town in Delta State and an emerging urban centre with fast growing land use and economic activities, and there is need for reliable data and information for consistent monitoring and proper planning of the town. This study therefore, examined the spatial analysis of land use/land cover change in Abraka between 1990 and 2022.

2.0 Literature Review

Abraka is an urban area in Ethiope Local Government Area of Delta State in Nigeria. The town lies approximately between latitude 5·75˚N and 5·79˚N of the equator, and longitude 6 .10˚E and 6.13 ˚E of the Meridian, at the eastern bank of River Ethiope, covering an area of about 5.5 square kilometres (Google Map, 2021). Abraka lies within the tropical rainforest region with a fluctuating climate. It has an annual mean temperature of 30.6^0C and mean monthly temperature stretching from 30^0C in September to 31.1^0C in June and July, giving a range of 1.1^0C. The mean annual rainfall is 3,098mm. It is drained by two rivers namely, River Ethiope and River Ovwuvwe in the north and south respectively. River Ethiope has its source at the outskirts of Umuaja community, where it flows through porous materials of holes, creating trickles that form several springs. The river flows down south and south-west towards Abraka town at which point it swings west and northwest with meanders towards Sapele where it meets River Jamieson to form the main trunk of the Benin River (Otuagoma et al., 2016).

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

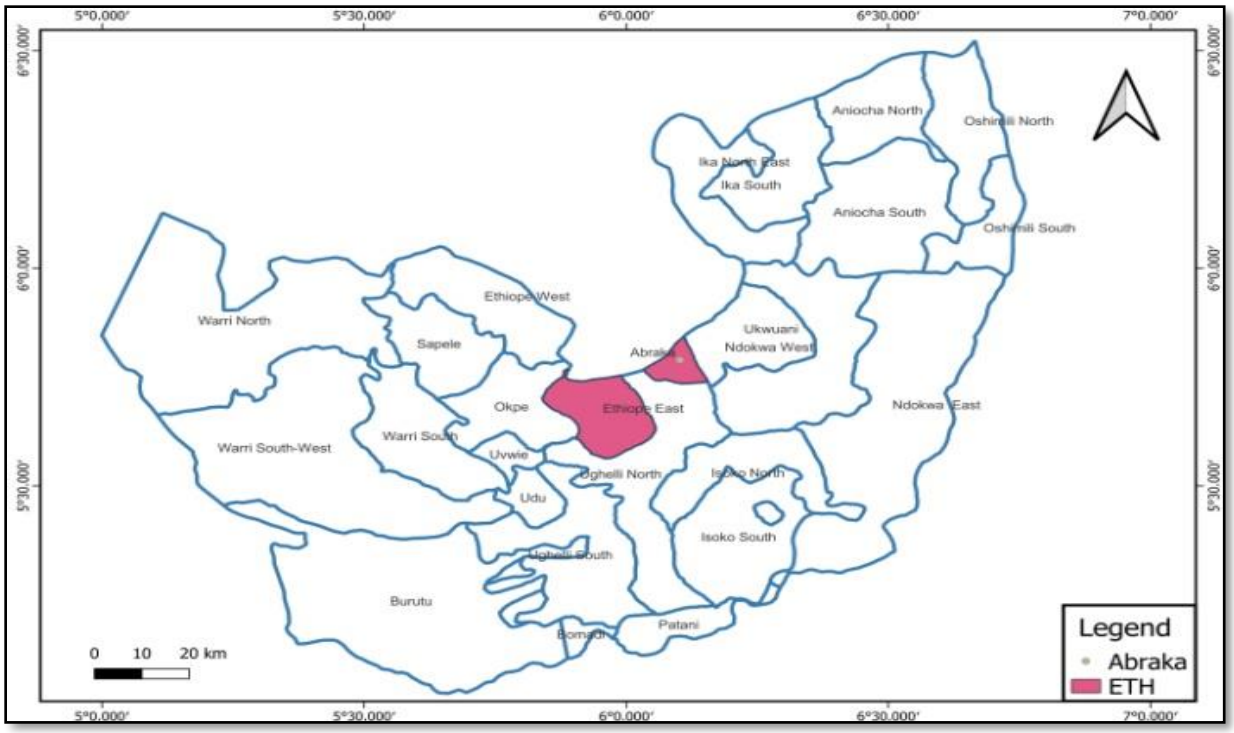


Figure 1: Map of Delta State showing Ethiope East (ETH) Local Government Area
Source: Digitized in ArcGIS 10.8 (2022).

Abraka is within a region with a relatively flat terrain on an elevation of 26.48m and it sloped down to a lower elevation of about 19.00m towards the Ethiope River (Efe & Okadikwe, 2006). The upper course of River Ethiope is marked by steeping incised valley, grouped under the interior coastal lowlands of Western Nigeria. Its boundary is distinct in the north by the edge of the basement complex of the quaternary deposits of the coastal margin. Its geology consists mainly of sedimentary rock formations deposited in three cycles. Secondary and tertiary sedimentary rocks dip gently southward showing dissected north facing low scarps. A notable feature of the formation is the presence of tropical hydromorphic white sands (quartz). Its exposure as a white sand bed at the bottom of the Ethiope River channel makes it possible to see through the river making it seemingly clean and appear safe. This quality makes the river a choice location for tourists resort. The sand and gravel beds support sand mining industry in Abraka. The vegetation is mostly covered with broad leaved evergreen and semi-deciduous forest with three layers of canopy namely: the upper layer (50m tall), middle layer (40m in height) and lower layer (30m in height), that are almost fading away due to agriculture and urban development resulting from increased urbanization (Ejemeyovwi, 2006).

The 2006 census put the population of Abraka at 79,963 made up of 39,560 males and 40,403 females, with population density estimated at 6.977 per km. sq. The estimated population for the year 2020 was given at 90,097 (city-facts) and for 2022 was given at 95,955. The town is



characterized by nucleated and linear settlement patterns. Abraka emerged as a nucleated settled in its stages of development. The linear settlement emerged following settlement expansion in recent years especially due to the sitting of a college of education, later converted to a university. The construction of a link road from Agbor through Abraka to Sapele in 1991 increased the population and commercial activities in the town. The land use classification of Abraka from field survey depicts nine categories namely: residential, commercial, industrial, institutional, communication/utilities, recreation and open space, light vegetation, thick vegetation and water bodies.

Land is a natural resource that is utilised for a number of purposes (Balasurbramanian, 2015). It is a scarce resource, with the supply that is fixed for all practical purposes at the same time (Mangalagowri & Nagara 2017). As a scarce resource, land is increasingly threatened by a competition of mutually exclusive uses and the increase in demand for this scarce resource is rapidly rising due to increase in human population (Wehrmann et al., 2011). Bongdab (2020) defined land use as the total of arrangements, activities and inputs that people undertake in a certain land cover type. Ganasri et al. (2013) noted the numerous benefits it has for human and associated land cover with the variety of features present on the earth surface which includes vegetation, water, desert, ice, soil and topography.

A common occurrence in many landscapes and a dominant factor affecting the biodiversity and functioning of terrestrial ecosystems is land use change. Its study is imperative for many planning and management oriented activities (Ganasri et al., 2013; Gibson et al., 2018; Tsegaye, 2021). The term "land use/land cover change" (LULCC) refers to the alteration of the earth's terrestrial surface caused by human activities (Hassan et al., 2016). People have been altering land for thousands of years in order to secure livelihoods and other necessities, and the severity and pace of LULCC are significantly increasing in recent times (Ganasri, et al., 2013; Hassan, et al., 2016). Unequaled changes in ecosystems and environmental processes at all levels are occurring as being fueled by these shifts (Longgao et al., 2019).

Land cover changes are cumulatively a major driver of global environmental change (Turner et al., 2007). In extent, the most important form of land conversion was expansion of crop and pastoral land in natural ecosystems. During the 1980–2000 period, more than half of agricultural land across the tropics came at the expense of intact forests. Today the direction of expansion is towards urbanization. In the last three decades, urban developments in many global cities such as Shanghai, Singapore and Jakarta are marked by proliferation of high-rise buildings due to urbanization (Cervero & Murakami, 2009) and in other cities on space that tends to increase due to expansion of urban suburbs caused by pressure from population and migration. In-depth understanding of the changes in land use and land cover, and their determinants and drivers have become crucial for a number of reasons, for forecasting future land cover trends and managing natural resources sustainably (Weng, 2001; Tsegaye, 2021). Recent studies developed scientific tools to analyze land use change and its drivers have crop up as new global initiatives, and they have received significant momentum (Hassan, et al., 2016). The efforts have stimulated



the interest of researchers to apply various techniques to detect and further model environmental dynamics at different levels. GIS and RS are successful and popular technologies for identifying, measuring, mapping, and monitoring changes in LULC patterns, largely due to their precise geo-referencing approach, digital formatting that can be processed, and their continuous data replication (Tagore & Shah, 2013; Hassan et al., 2016; Meyfroidt et al., 2018).

Deng et al., (2023) tracked changes in land cover and land use in a rapidly urbanized region of China using RS and GIS technologies. They determined also the causes of the modifications with the aid of these technologies. The digital process has been widely used to identify and ascertain uncharacteristic alterations between two or more years. The integration of these technologies enhances the understanding of spatial processes and supports evidence-based decision-making in environmental planning and management. El Bastawesy, et al. (2021) in a study in Aswan Kom Ombo in Egypt showed how Landsat images of 1990-2020 were processed using GIS and supervised classification to track land use land cover changes. They observed significant urban expansion driven by population growth and land reclamation programs for the 31 years, leading to reduction in agricultural land and increase in built-up area. Tekle, et al. (2017) applied Landsat data and ArcGIS, using supervised classification (Maximum Likelihood Algorithm) to study Ethiopia's LULC images of 1985, 2000 and 2015. They observed decline in wetlands and forests, and increase in settlement and agricultural land.

Mishra & Rai (2016) studied urban landuse change in Mumbai in India using Landsat TM and ETM+ with ENVI and ArcGIS (Remote Sensing and GIS techniques) to detect LULC changes from 1990 to 2010. They observed urban sprawl concentrated along road networks and commercial corridors, emphasizing the need for planning. Forkuo & Frimpong (2020) researched urban growth's effects on vegetation and water bodies using geospatial tools (RS and GIS) in Accra, Ghana. The study observed the environmental risks caused by unchecked urban development. Osemeobo & Okonofua (2021) assessed the LULC changes in Warri and environs using Landsat imageries of 1986, 2000 and 2016. They identified the extent of urban expansion, agricultural loss and deforestation. These studies and many others showed the use of RS and GIS in various areas of study relevant to urban and regional environment. The data on these changes are crucial for providing vital information to decision-making on ecological sustainability, thus LULC alterations are significant in the evaluation of current global and local environmental changes (Fan et al., 2007)

3.0 Methodology

The data for the study were collected from primary and secondary sources. Secondary data were gathered from journal articles, unpublished literature, conference papers and seminars on land use and land cover change. The primary sources were mainly field observations and profiling of the various landuses and their pattern in the study area. Satellite imageries of the study area were collected and analysed. Landsat satellite images of Abraka for two periods were acquired, using Landsat Thematic Mapper (TM) for years 1990 and Operational Land Imager (OLI) for year 2022. The Landsat imagery dataset was obtained from the United States Geological Surveys' Earth Explorer platform (USGS). Table

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

1 summarizes the sources and image properties of the dataset.

Table 1: Sources of Satellite Imagery Datasets

Data type	Resolution	Source
Landsat TM+ imagery - Feb. 1990	30m	USGS Explorer
Landsat 8 OLI imagery - Mar. 2022	30m	USGS Explorer

Source: United States Geological Survey (2022)

A topographic map of the area was used to extract the study area for image processing. The land cover changes were measured using a time series of remotely sensed data (Landsat TM, and OLI). Training samples were selected for each of the predetermined LULC type, by delineating polygons around representative sites. Spectral signatures for the respective LULC types derived from the satellite imagery were recorded by using the pixels enclosed by these polygons. A satisfactory spectral signature is the one ensuring that there is 'minimal confusion' among the land covers to be mapped (Butt, et al., 2015). Maximum likelihood classifier algorithm with decision rule was used for supervised classification by taking 100 training sites for five major land use land cover classes. The Maximum Likelihood Classification is the most widely used per-pixel method by taking into account spectral information of land cover classes (Myint et al., 2011). The delineated LULC classes are built-up areas, water bodies, thick vegetation, light vegetation, bare surface and cultivation as described in table 2. Based on the priori knowledge of the study area for over 30 years and a brief reconnaissance survey with additional information from previous researches, a classification scheme was developed for the study area based on Anderson et al. (1976) classification.

This study adopted the Error matrix approach (ERRMAT in ArcGIS) to assess the accuracy of the classification. The error matrix assesses accuracy using four parameters which were overall accuracy, user's accuracy, producer's accuracy and the Kappa Index of Agreement (KIA). The overall accuracy specifies the total pixels correctly classified and is derived by dividing the total number of pixels correctly classified by the total number of pixels in the error matrix. The producer's accuracy defines the probability of a reference pixel being correctly classified; it represents the error of omission. The number of samples correctly classified for a given column is divided by the total for that column.

Table 2: Land Cover Classification

Code	Land Cover Description
1. Bare surface	Excavation sites, open space and bare soils.
2. Water body	Areas persistently covered by water typically lakes, dams and rivers.
3. Cultivation	Agricultural land, and farming area
4. Light vegetation	Environment dominated by grasses and herbaceous plants typically, spear grass and elephant grass
5. Thick vegetation	High density of trees with little or no undergrowth, dominated by tropical trees

Source: Anderson (1976)

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

The user's accuracy on the other hand defines the probability that a pixel classified on a map actually represents that category on the ground. User's accuracy represents error of commission. This can be calculated by dividing the number of samples correctly classified for a given row by the total of the rows (Sarmento, 2015; Jande et al., 2019). The Kappa index measures the agreement between classification map and reference data (Congalton & Green 1999). All accuracy parameters have index values between 0 and 1, where 0 symbolizes poor classification accuracy/agreement and 1 symbolizes strong accuracy.

The Kappa statistics formula as modified by Jenness and Wynne in 2007 was adopted for calculating Kappa statistic. It has the advantage of correcting for chance agreements between the observed and predicted values (Jande et al., 2019).

Kappa Formula $\mathbf{K} = \frac{N_\rho - \delta}{N_2 - \delta}$ .....equation 1

Where N is the total number of points, $\boldsymbol{\rho}$ is the sum of correctly mapped points, $\boldsymbol{\delta}$ is the sum of the products between row and column for each class. Kappa value changes from -1 to +1 and the interpretation of the values can be determined according to the values in table 3:

Table 3: Kappa Index of Agreement

Interpretation of Kappa Statistic	
Kappa	Agreement
< 0.20	Poor
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Good
0.81-100	Very Good

Source: Borana, & Yadav, (2017)

Four main methods of data analysis were adopted in image analysis, namely:

1. Calculation of the area in hectares of the resulting land use/land cover types for each study year and subsequently comparison of the results.
2. Overlay operations
3. Image thinning
4. Maximum likelihood classification

To identify changes in land use types, the first two methods described were used. Land use and land cover statistics were compared to determine the percentage change, trend, and rate of change between 1990 and 2022. The first step was to create a table that displayed the area in hectares and the percentage change for each year (1990 and 2022) measured against each type of land use land cover. The observed change can then be divided by the sum of changes multiplied by 100 to calculate the trend of change.

(Trend) percentage change $= \frac{\text{Observed change}}{\text{Sum of changes}} * 100$.....equation 2

To calculate the annual rate of change, the percentage change was divided by 100 and multiplied by the number of study years 1990-2022 (32years). Overlay operations were carried out in order to identify the actual location and magnitude of change, but this was limited to built-up land. Boolean logic was applied to the result using ArcGIS 10.8, reclassification operation which aided in mapping out separately areas of change for which the magnitude was later calculated.

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

4.0 Result and Discussion

The classification accuracy for the two years under investigation, 1990 and 2022, showed overall accuracies of 89.58% and 89.84% respectively (table 4). These are acceptable overall accuracies for the subsequent analysis and change detection. The user's accuracy of different classes were from 0 to 100%, while the producer's accuracy ranged between 0 and 100% and between 4.74% and 100% for the investigating periods respectively. The overall Kappa index agreement was calculated for each classified map to determine the accuracy of the results.

The land use land cover for the base year (1990) as derived from the satellite imagery is presented in figure 3 and 4. The results revealed that light vegetation had the largest land cover with 3,082.18ha constituting 39.42% of the land cover, followed by cultivation occupying 1,696.95ha (21.7%) and thick vegetation covering 1,582.92ha (20.24%). Built-up area occupied 1,297.31ha (16.59%), water body covered 140.94ha (1.80%) and bare surface covered 17.42ha (0.22%).

Table 4: Classification Accuracy Assessment

	1990 Classification Accuracy		2022 Classification Accuracy	
LULC Type	Producer (%)	User (%)	Producer (%)	User (%)
Bare surface	0	0	11.11	100
Water body	100	100	96.40	91.45
Cultivation	100	80.77	81.25	92.86
Built-up	0	0	4.74	81.82
Vegetation	60	100	100	91.38
Thick vegetation	90	100	100	83.33
Overall Accuracy	89.58	89.58	89.84	89.84
Overall Kappa Statistics	0.8461	0.8461	0.8596	0.8596

Source: Researcher (2022)

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Vol 31, No 1 (2026)

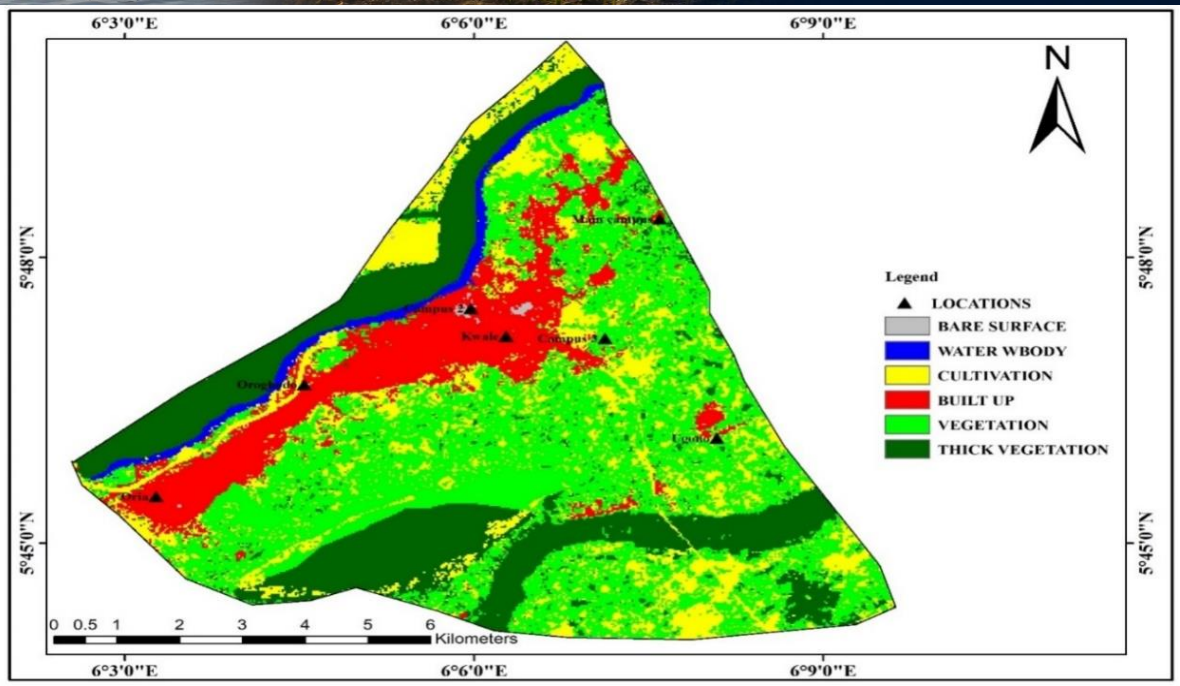


Figure 3: Land Use and Land Cover Map of Abraka in 1990
***Source*: Analysed in ArcGIS 10.8 (2022)**

The LULC distribution for the two years (1990 and 2022) as derived from the images are presented in table 5. The data shows also the extent of change in land use land cover for the area for the periods under investigation. The Kappa coefficient for the two periods ranges from good agreement to very good agreement on the Kappa scale, an indication that it can be used. The data represents the static area of each land use land cover category for each study year. The results revealed that in 1990, light vegetation covered 3,082.18ha (39.42%), thick vegetation covered 1,582.92ha (20.24%), built-up areas occupied 1,297.31ha (16.59%), bare surface was 17.42ha (0.22%) and water bodies covered 140.94ha (1.80%).

Table 5: Statistics of the land use land cover distribution in 1990 and 2022

	Land cover categories	Area covered in 1990		Area covered in 2022	
		Hectares	%	Hectares	%
1	Bare surface	17.42	0.22	68.94	0.88
2	Built-up area	1,297.31	16.59	2,383.92	30.49
3	Thick vegetation	1,582.92	20.24	1,195.13	15.28
4	Light vegetation	3,082.18	39.42	2,256.84	28.86
5	Cultivation	1,696.95	21.71	1,771.99	22.66
6	Water body	140.94	1.80	140.94	1.80
	Total	7,817.72	99.98	7,817.76	99.97

Source: ArcGIS Images (2022)

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

Results from the analysis show that light vegetation cover reduced from 3,082.18ha (39.42%) in 1990 to 2,256.84ha (28.86%) in 2022. This trend can be attributed to conversion of land covered by light vegetation to farmlands and built-up area through clearing of land for farming and settlement. The decline between these years is also attributable to expansion of urban and rural settlements. There was also a decline in thick vegetation cover over the period, from 1,582.92ha (20.24%) in 1990 to 1,195.13ha (15.28%) in 2022. This can be attributed to deforestation for agricultural purposes, as the original rainforest vegetation is cleared through lumbering and for farming. The built-up areas increased from 1,297.31 ha (16.59%) in 1990 to 2,383,92ha (30.49%) in 2022. This is a clear indication of increase in population and infrastructure development in the area. Bare surface recorded some reasonable and steady positive change over the year under study, from 17.42 ha (0.22%) in 1990 to 68.94ha 0.88% in 2022. This can be attributed to human activities, which includes over-grazing, indiscriminate bush burning and other factors. Water bodies seems not to have recorded any changes during the period. Water bodies cover stands at 140.94ha (1.80%) for the entire period.

The analysis as presented in table 6 and figure 5 showed that light vegetation lost the largest proportion of land, measuring 825.34ha between 1990 and 2022, indicating 26.78% negative change in the vegetation. This is followed by thick vegetation with a loss of 387.79ha (24.50%). This may be connected to increase in economic activities in the area and also attributed to the development of Delta State University in Abraka. The University has attracted rapid physical development to its host community as well as increase in the population and economy. Subsequently, bare surface increased by 295.75% (51.52ha), and built-up land increased by 83.76% (1086.61ha). These indicate that large expanse of land were converted from other uses particularly the forests to urban landuses. The land converted to farms also increased but just by 4.42% and the area occupied by water body remained unchanged.

Table 6: Land Use Land Cover Change (Area and Percentages) in 1990-2022

LULC Categories	Level of change	
	Area (Ha.)	Percentage of Change
Bare surface	51.52	295.75
Built-up	1086.61	83.76
Thick vegetation	-387.79	24.50
Light vegetation	-825.34	26.78
Cultivation	75.04	4.42
Water Body	0	0

Source: Authors' analysis (2022)

The spatial change as presented in figure 6 shows that there has been a drastic encroachment into the light vegetation and cultivated areas by urban expansion particularly in the northeast and southeast parts of the region. Many urban development projects emerged after the conversion of the State College of Education to Delta State University, and this attracted many people, both students and investors to the area thus contributing to the physical expansion of the city as evident in the increased built-up areas and reduction in thick forest and light vegetation. The siting of the main campus of the university in the

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

northeast attracted many facilities and houses to the surrounding areas. There were also some changes noticed in the area, including deforestation around the bank of River Ethiope, for lumbering, agriculture and housing development.

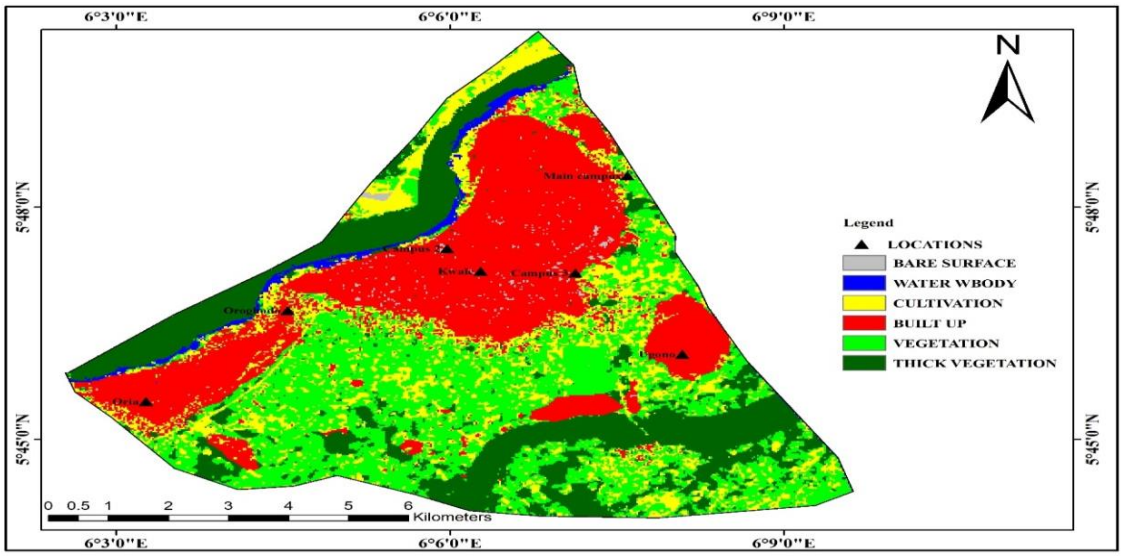


Figure 4: Land use and Land Cover of Abraka in 2022
Source: Analysed in ArcGIS 10.8 (2022)

An overlay of the built-up areas was carried out to show the extent of change (see figure 5). The imagery for built up urban area in 2022 was super-imposed on that of 1990 to show the spatial pattern and distribution of urban expansion. The largest urban expansion was recorded in the northeast with encroachment into the light vegetation and agricultural landuse. Some small settlements in the southeast also expanded drastically while new settlements emerged in the south-east region. These settlements are agricultural communities that deforested the forests in the area and opened new farming zones.

In addition to the outward expansion of the built-up area, there were some internal changes within the period. Some open spaces existing within the urban area were built up with structures thereby increasing the urban density. The residential pattern of Abraka appears in three zones, namely low, medium and high-density zones. The major areas of commercial activities are the main market, along the major road (New Sapele-Agbor road) and its surroundings. The zone is expanding into the surrounding residential area. There are few industries located in Abraka, which are mostly small scale factories and workshops. They include cassava mills, oil mills, table water factories, sawmills, polythene bag factories and fish feed production industry. The pattern is that most of the industries are located in available spaces between residential plots.

JOURNAL OF THE NIGERIAN INSTITUTE OF TOWN PLANNERS
Vol 31, No 1 (2026)

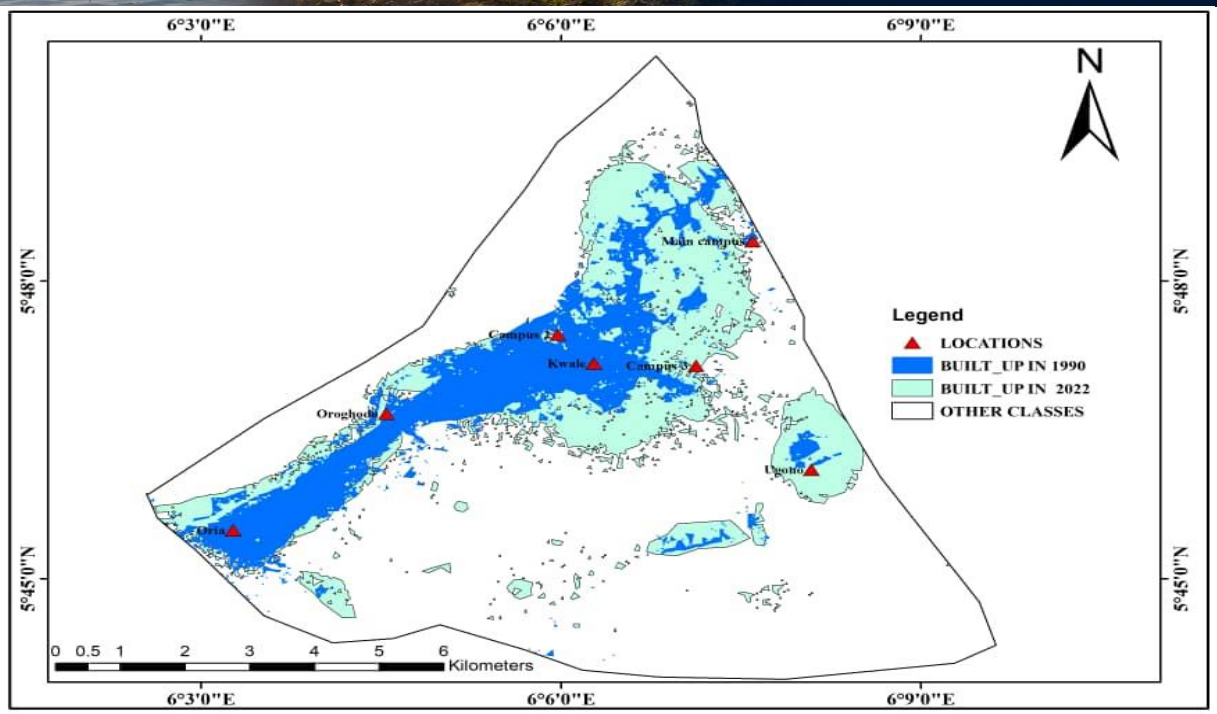


Figure 5: Overlay of Built up Land to Show the location of change in 1990/2022
Source: Analysed in ArcGIS 10.8 (2022)

The institutional land use includes land for government agencies such as schools, hospital, police station, post office and court, as well as private establishments such as banks, clinics and churches. These forms of landuses are increasing in number and land occupation. The major road connections that passes through Abraka has opened up communication network in the area, thus facilitating the urban expansion. The recreational land and open spaces are devoted to sports, football fields, hotels and relaxation bars. These places include Abraka River Motel, Mudi Beach, Labrix eateries/game lounge, and Campus Gym. The light vegetation comprises of agricultural plantation and cultivated farmlands supply farm produce, ensuring food security in the area. The thick vegetation land use is the uncultivated rainforest area and it is undergoing serious threat from lumbering, agriculture and urban expansion.

5.0 Conclusion

The analysis of land use land cover of Abraka between 1990 and 2022 revealed six categories namely; bare surface, water body, cultivation, built up area, vegetation, and thick vegetation. Within the 32 years, the area has undergone considerable change in land use land cover with increase in built-up and bare lands, and cultivated areas, and reduction in the areas with green cover. The pattern of land use change shows high encroachment of built up area into the other land uses particularly the massive light vegetation and primary rainforests. A number of factors were observed to drive this change and they include population increase, housing demand and establishment of urban institutions and



infrastructure (Li, et. al., 2025). This situation has implications on level of greenhouse gas emission, urban heat island and local climate change (Junk, et. al., 2025).

The land use land cover changes that have taken place in the last 32 years have expanded beyond the limits boundaries to engulf the contiguous environment with no serious planning guidelines to control the expansion. This current trend has led to numerous problems such as soil degradation, environmental and management challenges. If this trend continues without proper land use planning to quell the unplanned expansion, it is envisaged that in the next few years the changes will alter the entire landscape, as indicated by the percentage increase of built-up area and removal of primary forests in the area from 1990 to 2022. Not only will urban decay occur in the built up area leading to slums, the removal of vegetative land cover will intensify local effects of climate change. Oyalowo (2022) observed that in cities of developing countries, urban expansion is shaped by demand for space, but often without respect for administrative boundaries.

As derived from this data-driven analysis, it is recommended that the public should be properly enlightened on the importance of a planned urban environment. To forestall any impending slum development in Abraka, it is strongly recommended that the Government of Delta State should as a matter of urgency prepare master plan for physical development of the area, to guide all landuses and human activities in the area. State government agencies responsible for urban planning and development control, such as the Ministry of Physical Planning and Urban Renewal and Delta State Urban and Regional Planning Board should ensure that proper planning standards are developed and procedures are duly followed for any activity embarked upon for land uses. The agencies of the Delta State Government should adopt the approach of Remote Sensing and GIS for the planning, management, and control of newly developing areas to protect the vegetative resources and improve the livelihood and health standards of the people. The green infrastructures including the forests and other sensitive vegetative zones should protected to reduce biodiversity loss, and cushion the effects of climate change.

References

Adie, D. B., Olatunji, S. A., Asani, M. A., Oke, I. A., Otun, J. A., Lukman, S., & Odetola, A. (2019). *An overview on land use in Nigeria*. Nova Science Publishers.

Akpovwovwo, U. E. (2020). An urban growth analysis of Warri and environs, Delta State, Nigeria: A remote sensing approach. *FUW Trends in Science & Technology Journal, 5*(2), 533–537.

Anderson, J. R. (1976). *A land use and land cover classification system for use with remote sensor data* (U.S. Geological Survey Professional Paper 964). U.S. Government Printing Office.

Avis, W. (2019). *Urban expansion in Nigeria* (K4D Helpdesk Report 692). Institute of Development Studies.

Balasubramanian, A. (2015). *Categories of land use* [Paper presentation]. Country-Wide Classroom Educational TV Programme—Gyan Darshan, EMRC-Mysore. https://doi.org/10.13140/RG.2.2.22403.09763

Berihun, M. L., Tsunekawa, A., Haregeweyn, N., Meshesha, D. T., Adgo, E., Tsubo, M., Masunaga, T., Fenta, A. A., Sultan, D., & Yibeltal, M. (2019). Exploring land use/land cover changes, drivers and their implications in contrasting agro-ecological environments of Ethiopia. *Land Use Policy, 87*, 104052.



https://doi.org/10.1016/j.landusepol.2019.104052

Bongdap, N. N. (2020). *Land use: Definition and different types of land uses*. JotScroll. https://www.jotscroll.com/forums/3/post/204/land-use-definition-6-types-of-land-use.html

Borana, L., & Yadav, K. (2017). Comparison of model validation techniques for land cover dynamics in Jodhpur. *International Journal of Emerging Trends and Technology in Computer Science, 6*(5), 215–219.

Butt, A., Shabbir, R., Ahmad, S. S., & Aziz, N. (2015). Land use change mapping and analysis using remote sensing and GIS: A case study of Simly Watershed, Islamabad, Pakistan. *The Egyptian Journal of Remote Sensing and Space Science, 18*(2), 251–259.

Cervero, R., & Murakami, J. (2009). Rail and property development in Hong Kong: Experiences and extensions. *Urban Studies, 46*(10), 2019–2043.

Congalton, R. G., & Green, K. (1999). *Assessing the accuracy of remotely sensed data: Principles and practices* (1st ed.). CRC Press.

Efe, S. I., & Okadikwe, L. (2006). Relief and drainage system of Abraka. In A. Akinbode & B. Ugbomeh (Eds.), *Abraka region* (pp. 6–15). Central Books.

Ejemeyovwi, D. O. (2006). Physio-chemical characteristics, classification and mapping of soils in Abraka. In A. Akinbode & B. Ugbomeh (Eds.), *Abraka region* (pp. 44–67). Central Books.

El Bastawesy, M., Nasr, A. H., & Rayan, A. M. (2021). Monitoring land use/land cover changes using remote sensing and GIS techniques: A case study of Aswan and Kom Ombo in Egypt. *The Egyptian Journal of Remote Sensing and Space Sciences, 24*(1), 63–70.

Ellis, E., & Pontius, R., Jr. (2006). Land-use and land-cover change. In *Encyclopedia of Earth and environmental protection*. [Publication details incomplete in the supplied reference.]

Fan, F., Weng, Q., & Wang, Y. (2007). Land use and land cover change in Guangzhou, China, from 1998 to 2003, based on Landsat TM/ETM+ imagery. *Sensors, 7*(7), 1323–1342. https://doi.org/10.3390/s7071323

Farrel, K. (2018). An inquiry into the nature and causes of Nigeria's rapid urban transition. *Urban Forum, 29*, 277–298. https://doi.org/10.1007/s12132-018-9335-6

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., Mueller, N. D., O'Connell, C., Ray, D. K., West, P. C., Balzer, C., Bennett, E. M., Carpenter, S. R., Hill, J., Monfreda, C., Polasky, S., Rockström, J., Sheehan, J., Siebert, S., Tilman, D., & Zaks, D. P. M. (2011). Solutions for a cultivated planet. *Nature, 478*, 337–342.

Food and Agriculture Organization of the United Nations. (2020). *Framework for integrated land use planning: An innovative approach, Republic of Turkey*. https://www.fao.org/3/cb1170en/cb1170en.pdf

Forkuo, E. K., & Frimpong, A. (2020). Assessment of urban expansion and land use/land cover change using remote sensing and GIS: A case study of Accra, Ghana. *International Journal of Remote Sensing, 41*(20), 7866–7889. https://doi.org/10.1080/01431161.2020.1791966

Ganasri, B. P., Raju, A., & Dwarakish, G. S. (2013). Different approaches for land use land cover change detection: A review. *Research Reviews: Journal of Engineering and Technology, 2*(3), 44–48.

Gibson, L., Munch, Z., Palmer, A., & Mantel, S. (2018). Future land cover change scenarios in South African grassland: Implications of altered biophysical drivers on land management. *Heliyon*. [Publication details incomplete in the supplied reference.]

Hassan, Z., Shabbir, R., Ahmad, S., Malik, A., Aziz, N., Butt, A., & Erum, S. (2016). Dynamics of land use and land cover change (LULCC) using geospatial techniques: A case study of Islamabad, Pakistan. *SpringerPlus, 5*, 812. https://doi.org/10.1186/s40064-016-2414-z

Jande, J. A., Nsofor, G. N., & Abdulkadir, A. (2019). Assessment of land use and land cover changes and urban expansion using remote sensing and GIS in Gboko, Benue State,



Nigeria. *Journal of Research in Forestry, Wildlife and Environment, 11*(3), 201–204.

Jenness, J., & Wynne, J. J. (2007). *Kappa analysis (kappa_stats.avx) extension for ArcView 3.x*. Jenness Enterprises. http://www.jennessent.com/arcview/kappa_stats.htm

Junk, J., Lett, C., Trebs, I., Hipler, E., Torres-Matallana, J., Lichti, R., & Matzarakis, A. (2025). Quantifying the effects of climate change on the urban heat island intensity in Luxembourg: Sustainable adaptation and mitigation strategies through urban design. *Atmosphere, 16*(4), 462. https://doi.org/10.3390/atmos16040462

Li, M., Cao, Y., Dai, J., Song, J., & Liang, M. (2025). A comprehensive review of urban expansion and its driving factors. *Land, 14*(8), 1534. https://doi.org/10.3390/land14081534

Longgao, S., Yujie, L., Xiubin, L., Yuxin, C., & Qing, H. (2019). Spatio-temporal land use transition and its effects on water quality in the Erhai Lake Basin, China. *Land Use Policy, 81*, 247–260. https://doi.org/10.1016/j.landusepol.2018.10.045

Mishra, V. N., & Rai, P. K. (2016). Land use/land cover change detection using remote sensing and GIS: A case study of Mumbai, India. *Procedia Computer Science, 85*, 703–710.

Morenikeji, W. (2018). One hundred years of urbanisation in Nigeria: A panoramic view. In Y. A. Sanusi, A. M. Junaid, O. O. Morenikeji, S. N. Zubairu, R. A. Jimoh, & O. F. Adedayo (Eds.), *100 years of urbanisation in Nigeria*. Federal University of Technology, Minna.

Myint, S. W., Gober, P., Brazel, A., Grossman-Clarke, S., & Weng, Q. (2011). Per-pixel vs. object-based classification of urban land cover extraction using high spatial resolution imagery. *Remote Sensing of Environment, 115*(5), 1145–1161.

Osemeobo, G., & Okonofua, H. (2021). Assessment of land use and land cover changes in parts of Delta State using remote sensing and GIS techniques. *Nigerian Journal of Environmental Sciences and Technology, 5*(1), 97–110.

Otuagoma, S. O., Ogujo, E. A., & Kuale, P. A. (2016). Evaluation of the small hydropower potential of River Ethiope using the RETScreen software. *International Journal of Engineering Research, 5*(1), 1–5.

Oyalowo, B. (2022). Implications of urban expansion: Land, planning and housing in Lagos. *Buildings & Cities, 3*, 692–708. https://doi.org/10.5334/bc.243

Sarmento, P. A. R. (2015). *Error and uncertainty in the accuracy assessment of land cover maps* [Unpublished master's thesis]. NOVA Information Management School.

Tekle, K., Gessesse, B., & Melaku, D. (2017). GIS and remote sensing-based land use and land cover change detection in Ethiopia. *Remote Sensing Applications: Society and Environment, 6*, 1–9.

Tsegaye, N. (2021). Land use and land cover change analysis using GIS and remote sensing in the Kersa District, Jimma Zone, Oromia Region, Ethiopia. *International Research Journal of Agricultural Science and Soil Science, 10*(5), 1–9.

Turner, B. L., Lambin, E. F., & Reenberg, A. (2007). The emergence of land change science for global environmental change and sustainability. *Proceedings of the National Academy of Sciences, 104*(52), 20666–20671. https://doi.org/10.1073/pnas.0704119104

Wehrmann, M. L. (2011). Coupled organic and inorganic carbon cycling in the deep sub-sea floor sediment of the north-eastern Bering Sea slope. *Chemical Geology, 284*, 251–261.

Weinzettel, J., Fertsch, E., Peters, G., Steen-Olsen, K., & Galli, A. (2013). Affluence drives the global displacement of land use. *Global Environmental Change, 23*(2), 433–438.

Weng, Q. (2001). A remote sensing–GIS evaluation of urban expansion and its impact on surface temperature in the Zhujiang Delta, southern China. *International Journal of Remote Sensing, 22*, 1999–2014.