INTERNATIONAL JOURNAL OF: SOCIAL SCIENCE RESEARCH AND ANTHROPOLOGY

TIMBOU-AFRICA ACADEMIC PUBLICATIONS
INTERNATIONAL JOURNAL, FEBRUARY, 2023 EDITIONS
VOL. 12 NO. 6 ISSN: 2977-5745

APPLICATION OF GEOSPATIAL TECHNIQUES IN ASSESSING THE EFFECTS OF ARTISANAL AND SMALL - SCALE MINING ON LAND USE AND LAND COVER OUTLOOK IN KEANA LOCAL GOVERNMENT AREA, NASARAWA STATE, NIGERIA.

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ABSTRACT

Human socio-economic activities, the connection between human population growth and mineral resource exploitation have caused significant variations and jeopardized the land use/cover change (LUCC) sustainability of the city area. Land cover is the natural or basic elements of the environment that link and impacts many parts of the local, regional and global levels of the environment. This paper assessed the effects of artisanal and small - scale mining on the Land Use and Land Cover (LULC) in Keana, Nasarawa State. Specifically, the objective of the study entailed a time series analysis of LULC between 1986, 1996,

Introduction

A variety of mining activity is carried out in Nigeria by diverse group of people and mining companies. Most mining activities in Nigeria and Nasarawa State by extension is done by Artisanal and Small Scale miners using simple and basic technology. Artisanal and Small-Scale mining (ASM) refers to informal mining activities carried out using low technology or with minimal machinery. Artisanal and Small Scale mining is an important source of income for millions of poor people around the world. The past decade has seen increasing numbers of individuals and households turn to ASM, and this trend is likely to grow in the face of high mineral prices, population growth, poverty and climate change. Because ASM activities contribute to poverty reduction in remote rural areas, efforts to simply eradicate the activity tend to fail (Idris-Nda *et.al.,* 2018).

Mining is a major economic activity in many developing countries. Throughout the world, mining is carried out basically in resource endowed areas. Mining is an activity which has to pass through a lot of processes before the final product is arrived at. These mining activities have attracted a lot of attention in the world over as many people are involved and several economies are affected. The 1990s saw significant shifts in global investment flows in mining, an effect of changes in national regulatory frameworks in over 90 countries

2006 and 2016 using LandSat 4 TM, 7 ETM+ and 8 (OLI) to quantify the various land use categories, percentage change. Major land use classes used to determine changes in land use/cover area built-up area, vegetation, farmlands, mining pits and water bodies. These were classified using the maximum likelihood classifier. Results obtained are summarized using descriptive statistics and presented in tables and charts. The results show that major changes were observed in built-up area, mining area and farmland land use and land over categories. Findings shows an upward trend in built up areas from 96.24km^2 (9.07%) in 1986 to 242.82km^2 (22.89%), mining areas increased from 1.07km^2 (0.10%) in 1986 to 22.08km^2 (2.08%) in 2016. However, farmlands declined from 506.16km^2 (47.71%) in 1986 to 484.55km^2 (45.68%) in 2016. It is concluded that land use and land cover changes as well as uncontrolled mining activities contribute to the existing environmental deterioration in the study area. sensitization should be initiated by MMSD, NGOs and Town Planning agency to educate mine stakeholders and the communities on the dangers of environmental degradation. Therefore, there is need to implement and enforce sustainable mining methods, effective monitoring of mining activities through strict adherence to the country's EIA standards and proper management of land resources.

KEYWORDS: Artisanal, Land Use and Land Cover, Remote Sensing, Geographic Information System, Landsat image, Artisanal, Small –Scale, resources

worldwide (Bridge, 2004; Dougherty, 2011). One of the many consequences of these changes has been that an increasing share of investment has flowed through South America down to Africa. People enter the mining industry and leave as and when a resource in question permits through its demand. However, mining is seen with two spectacles; a blessing or a curse. This depends on how an area, group, community or country is positively or negatively impacted by these activities and processes of exploitation of the resource in question (Kitula, 2006).

An estimated 13-20 million men, women, and children from over 50 developing countries are directly engaged in the artisanal mining sector (Hilson, 2002). The conservation of forests is also a great concern as many artisanal mining operations take place in and around forests that are home to vast amounts of biodiversity. One assessment indicates that almost three-quarters of active mining and exploratory sites overlap with areas of high conservation value and high watershed stress. (Ford *et al.,* 2010) It has also been reported that some mining operations also work within environmental protected areas. The Impact of Artisanal and Small-Scale Mining (ASM) in parts of Nasarawa state was assessed. The study assessed the Impact of Artisanal and Small-Scale Mining activities in Awe local government area.

THE STUDY AREA

The geographical entity known as Nasarawa State came into existence in October 1996 (Binbol and Marcus, 2010). It has a central location in the middle belt region of Nigeria. The state lies between latitude 7° 45' and 9° 25' N of the Equator and between 7° 29' and 9° 37' E of the Greenwich meridian. It shares boundary with Kaduna State in the North, Plateau State in the East, Taraba and Benue

States in the South while Kogi and Federal Capital territory flanks in the West. The state has a total land of 27,138.8 km2s and a population estimate with a density of about 67 persons per km2s (Mamman *et al.,* 2000). Nasarawa State is divided into 13 local government areas out of which three (3) LGAs was selected for study as shown in Figure 1. The town is 90 km north of Lafia the capital of Nasarawa State. It is situated on longitude $08^{\circ} 30^{0}$ east and latitude 08° 320 north. The area is accessible through the major road from Abuja - Keffi - Akwanga - Lafia to Keana. **Keana** is a Local Government Area in Nasarawa State, Nigeria. Its headquarters are in the town of Keana. It has an area of 1,048.1 km^2 and a population of about 80,000 (according to the 2006 census). It is home to Federal Government Girls College, Keana.

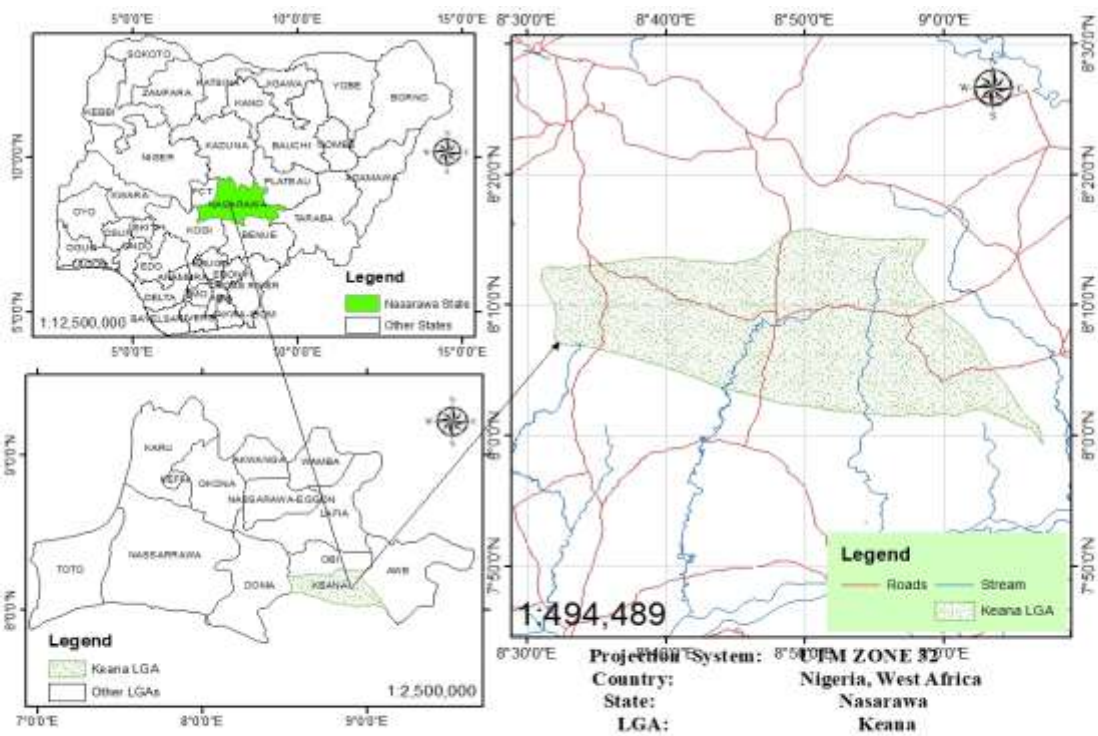


Fig. 1: The Study Area (Awe LGAs, Nasarawa State, Nigeria).
Source: Nigeria Geological Survey Agency (NGSA), 2019

Materials and Methods

The primary data used for the study is fieldwork and includes Photographs from the field, *in situ* observation, focus group discussions, GPS for picking geographic coordinates, key informant interviews.

The secondary data were sourced from the Geological Map of the study area from the Nigeria Geological Survey Agency (NGSA), The Geo-referencing properties of 1986, 1996, 2006 and 2016 made up of universal Transverse Mercator (UTM) projection, and datum WGS 84, zone 32, IDRISI Terrset was used for the development of land use and land cover maps for the study areas. ArcGIS 10.3 was used in developing, displaying and processing of the location maps as well as identify the mining points.

Analyzing the trend of land use and land cover of the study area.

The vectors of the study areas were imported into GIS environment for the development of geo-references using geo-spatial techniques and the Landsat satellite imageries of 1986, 1996, 2006, 2016 through the use of Maximum likelihood classification scheme with five (5) land use and land cover classes (mining site, water body, built-up areas, farmland and vegetation).

Using questionnaires and Key informant interviews, data were sourced for the description of mining location and mineral type. Other mining related features such as pits, degraded lands (e. g. erosion), destruction of vegetation, impacts of physical activities on streams (water bodies) were identified and mapped. Photographs of the features and activities observed in the mining sites were taken using digital camera.

The spectral resolution of landsat TM, ETM+ and OLI (30m) data makes it very useful for land use and land cover classification and general mapping. The dataset includes a notable period of four epochs which are 1986, 1996, 2006 and 2016.

RESULTS AND DISCUSSION

Analysis of land use and land cover classification for Keana imagery

The map of land use and land cover in Figure 2 give account of the spatial distribution and arial degree of the several groups of land cover and use of the area under study. Figure 4.21 represents the map of land cover and use in the area under study in 1986. The map describes five (5) classes of land uses and land covers (built-up areas, vegetation, farmland areas, mining pit and water body). The areal level of land use and cover categorized reveal the dominant classes of land use in study area is farm land covers 506.1591Km^2 (47.71%) followed by vegetation cover 446.9679 Km^2 (42.13%), built up 96.237 Km^2 (9.07%) while mining pit 1.0701 Km^2 (0.10%) and water body cover 10.5255 Km^2 representing (0.99%) of the total study area are the less predominant groups. The baseline conditions used for detection of change over the period of study

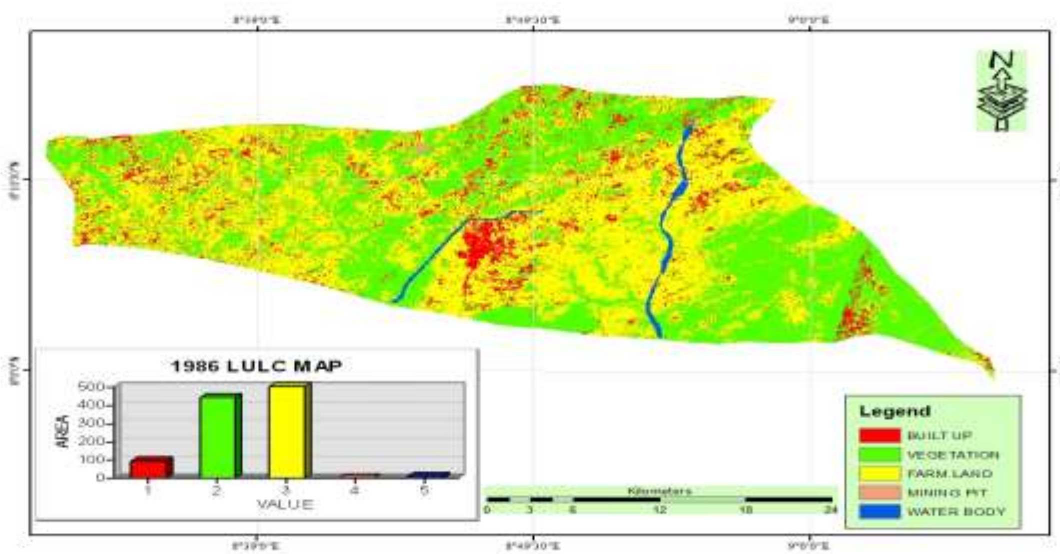


Figure 2: Keana 1986 LULC Distribution from LandSat 4 TM
Source: Author's Fieldwork, 2019.

TIJSSRA
ISSN: 2977-5745

Figure 3 is the land use and land cover classification for Keana 1996.

The result in Figure 3 illustrates the map of land use and cover of the area under study for the year 1996. Farm land covers 564.2451 Km^2 (53.18%) followed by vegetation covers 332.4321 Km^2 (31.33%), farm land has the largest area cover in 1996 covering 564.2451 Km^2 (53.18%) when compared to 506.1591Km^2 (47.71%) in 1986. An increase of 58.086 Km^2 (5.7%) in areal degree in contrast to its coverage in 1986 while Built-up cover 151.7355 Km^2 (14.29%). Also, mining pit cover 2.1924 Km^2 (0.21%) and water body cover 10.4904 Km^2 (0.99%) covers the smallest area. However, when it was compared with that of 1986 land use and land cover, the study area has undergone significant changes with about 31.33%, 14.29%, 0.99 % and 0.21 of vegetation, built up and mining changes witnessed on water body and mining pit changing to other land use and land cover classes.

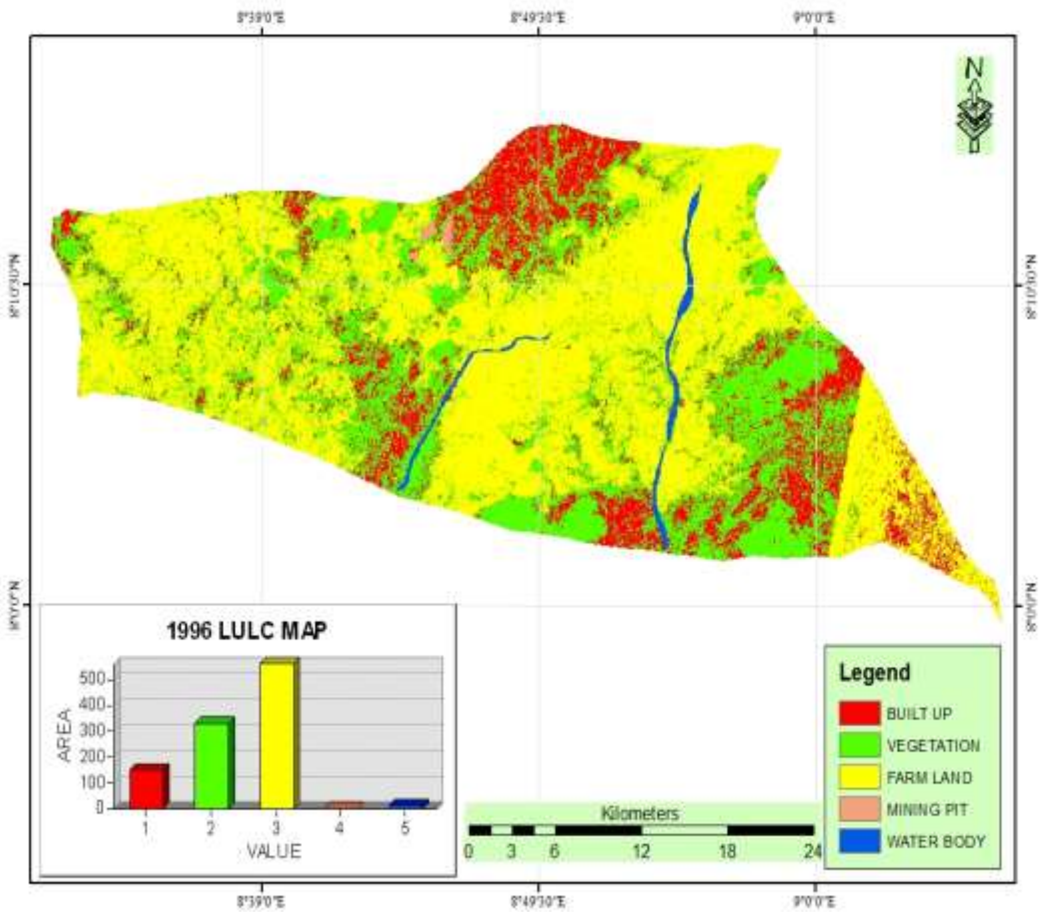


Figure 3: Classified 1996 LULC Distribution Map of Keana from LandSat4
Source: Author's Analysis, 2019.

Satellite image classification and analysis of land use and cover of Keana in 2006

The result in Figure 4 shows the map of the land use and cover map of the area under study for the year 2006. Farmland covered 520.8093 Km^2 (48.08%) followed by vegetation cover covering

369.4095 Km² (34.81%), Built-up covered 159.3576 Km² (15.02%) whereas water bodies covered 10.485 Km² (0.99%), and mining pits cover was the least area of about 1.071 Km² which represents 0.11% of the total study area. The change during the second period of study (1996-2006) shown that built-up, farmland and water bodies have increased by 10.73%, 4.1%, and 0.85 % respectively while vegetation and has decreased by 10.58% and mining pit remains relatively stable 0.09% implying that large area of land were cultivated during the timeframe as seen on figure 4.25 suggesting increased human activities.

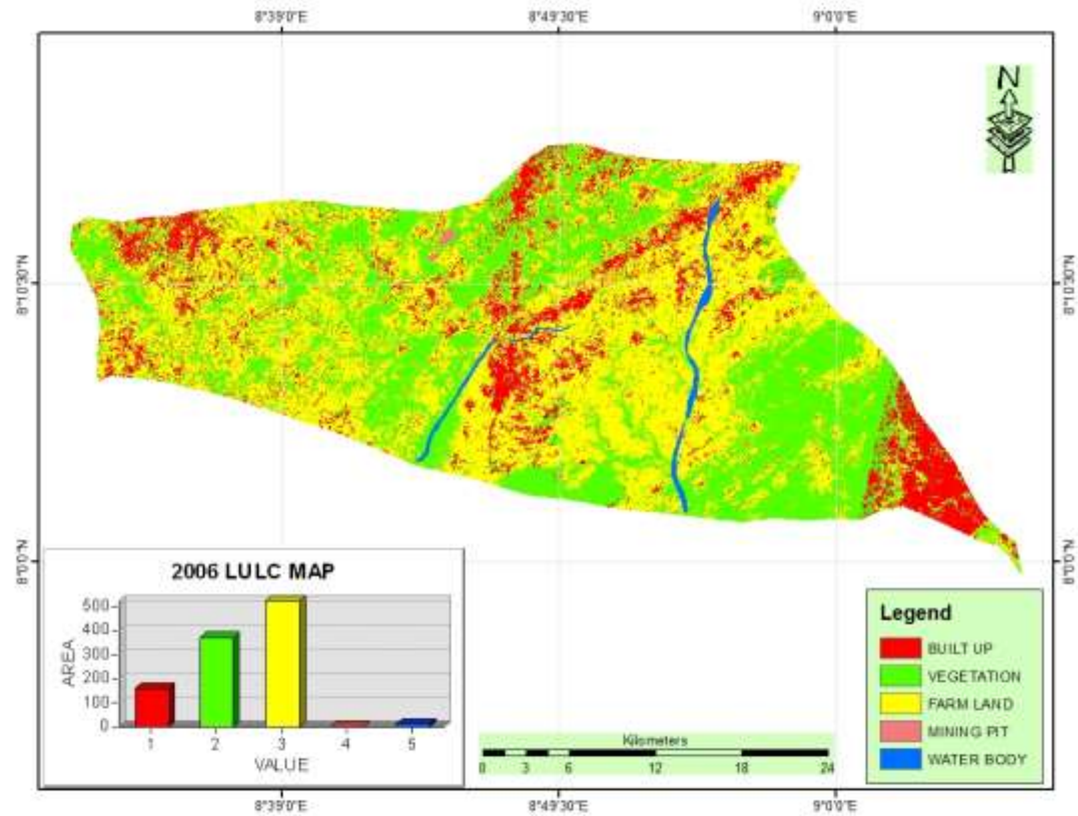


Figure 4: Classified 2006 LULC distribution of Keana from Landsat 7
Source: Author's Field Analysis, 2019.

Satellite image classification and analysis of land use and cover of Keana in 2016

Furthermore, the land use and cover categorization for 2016 shows there was drastic change that have occur among the different land use and cover types. It revealed that areas that built-up have continued to increase at the detriment of other land use category due to influx of people into that area. It increased from 159.3576 Km² (15.02%) in 2006 to 245.3697 (23.13%) and vegetation covers reduces from 369.4095 Km² (34.81%), to 301.5603 Km² (28.43%) in 2016 due to deforestation activities in the area. while Farmland covers reduces from 520.8093 Km² (48.08%) in 2006 to 497.2662 Km² (46.88%) of the total area whereas water bodies cover 10.5624 Km² (0.99%), and finally mining pit 6.0552 Km² (0.57%) of the total area as presented in figure 5

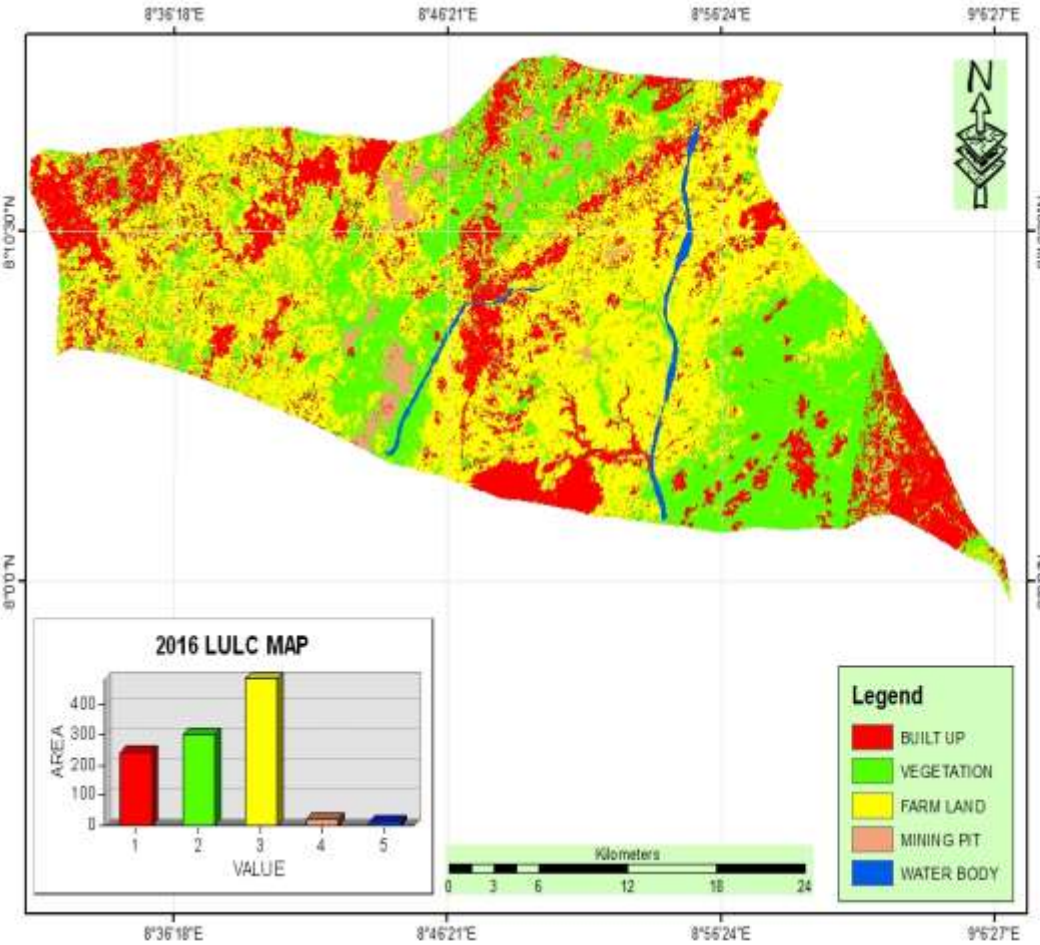


Figure 5: 2016 LULC Distribution of Keana from LandSat8 (OLI) in 2016
Source: Author's Analysis.

Table 1: LULC Distribution of Keana (1986, 1996, 2006 and 2016)

LULC	1986		1996		2006		2016	
Land Cover Category	Area (Sqkm)	Area covered (%)	Area (Sqkm)	Area covered (%)	Area (Sqkm)	Area covered (%)	Area (Sqkm)	Area covered (%)
Build-up	96.237	9.07	151.7355	14.29	159.3576	15.02	242.8218	22.89
Vegetation	446.9679	42.13	332.4321	31.33	369.4095	34.81	300.627	28.34
Farmland	506.1591	47.71	564.2451	53.18	520.8093	49.08	484.5438	45.68
Mining pit	1.0701	0.10	2.1924	0.26	1.071	0.11	22.0824	2.08
Water body	10.5255	0.99	10.4904	0.98	10.485	0.98	10.5768	0.99
Total	1060.9596	100	1060.9596	100	1060.9596	100	1060.9596	100

Source: Author's Field Analysis, 2019.

Similarly, the result in Figure 6 shows some of the degraded land at the various mining site at Keana LGA of Nasarawa state. Some of the mining site in Keana are Kuduku mine (Lead and Zinc), Otume mining pit (Baryte) Otume mining pit abandoned (Baryte), Pinega mine pit (Lead and Zinc) Pinega abandoned, Akiana (salt mine) and Virgin field (lead, Zinc, Copper and iron).

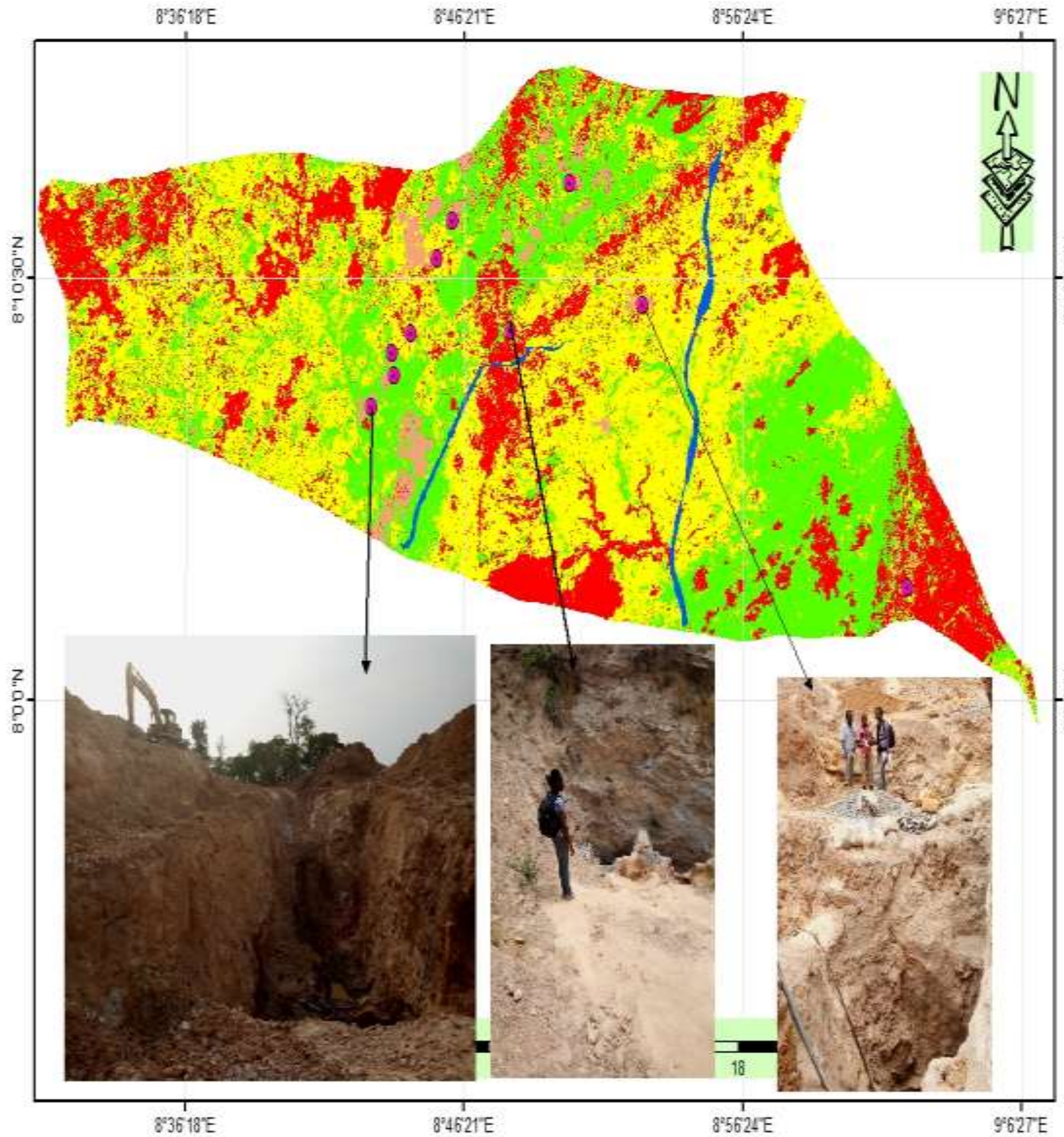
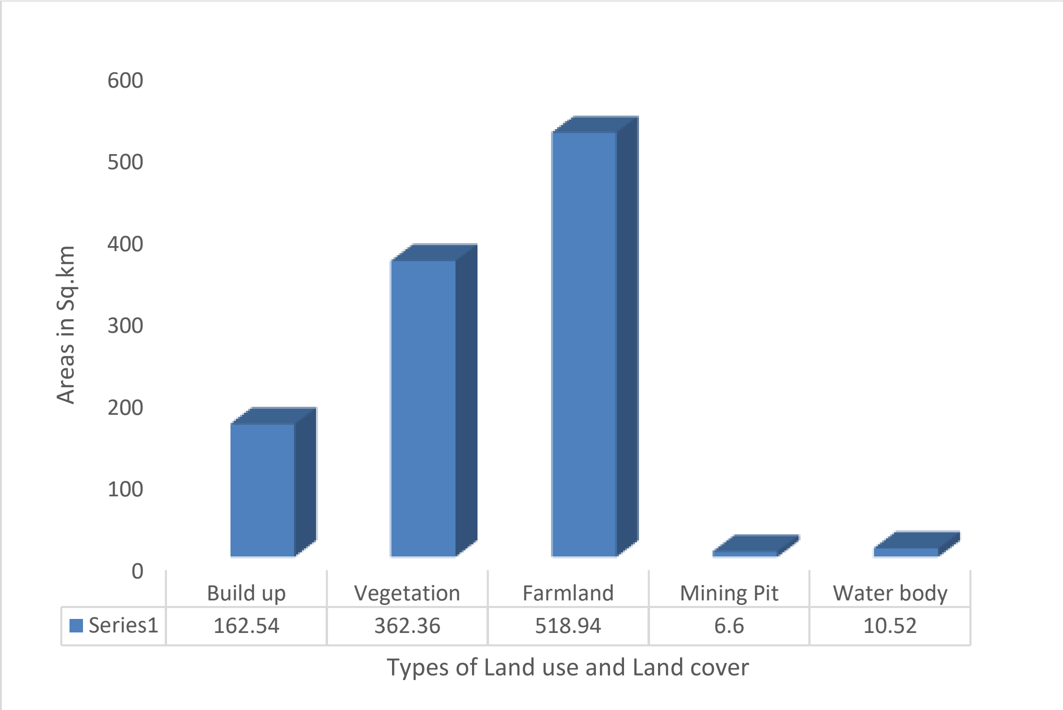


Figure 6: Geo-Tagged Degraded Land
Source: Author's Field Analysis, 2019.



4.7: Mean Land Use and Land Cover Distribution of Keana

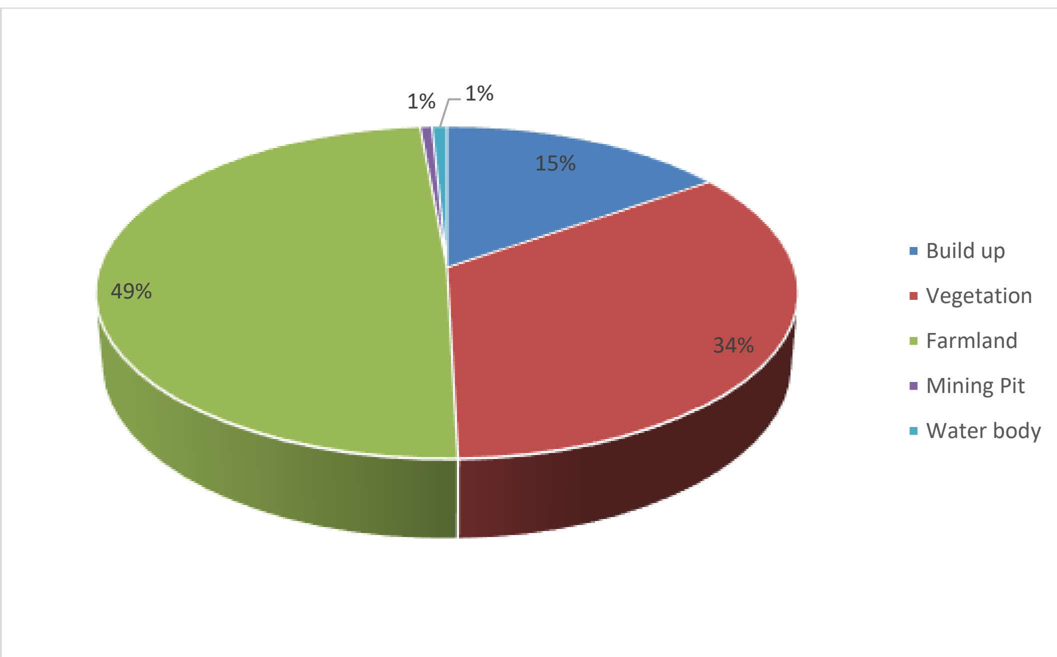


Figure 4.8: Mean (%) Land Use and Land Cover Distribution of Keana

Conclusion

The study revealed that: Mean land use and land cover change for the study locations keep changing at an alarming rate of 41% for Awe within the four epoch of the year 1986-2016. Socioeconomic study revealed that activities increased as the population and mining activity increases. However, if the current trend of degradation of the environment continues without putting measures to curb the situation at hand, there could be an imbalance in the ecosystem.

The practice of backfilling of mining pit would have a strong positive impact on the mining sites. The practice of reclamation and reseeding of backfilled mine pits will help return the degraded land to close-to its original form prior to mining. Proper chemical control respectively will have a strong positive impact on environmental management and activities.

Adoption of soil retention practice through planting of ornamental plants for water quality and air quality in the mining sites will reduce deforestation and major landscape changes. Evidence abound that much has not been studied and documented on thorough impact and associated health risks of artisanal and small-scale mining activities in Nasarawa State, Nigeria. ASM activities are on the increase and are carried out without recourse to mining standards making these activities unsafe and unsustainable, adoption of these environmental management plan for miners, operators and workers will reduce the rate of ASM degradation in the study area and Nigeria.

It is therefore recommendations that

A review of the methods of mining and ore processing in terms of skill needs, safety and environmental protection be undertaken.

Comprehensive and collaborative grassroot sensitization should be initiated by Ministry of Mines and Steel Development (MMSD), Non- Governmental Organizations (NGOs) and Town Planning agency to conscientize mine stakeholders and the communities on the dangers of environmental degradation, and Miners in the state should move to restore, backfill and reclaim the abandoned mining pits for other economic activities, and

The use of the rivers by the mine workers should be discouraged. Government should provide appropriate number of water collectors/reservoirs to extract water from filled mines to serve as alternatives.

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