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RESEARCH ARTICLE

LANDUSE/LAND COVER CHANGE DETECTION OF KATERIGI ARTISANAL GOLD MINE IN NIGER STATE NIGERIA

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ABSTRACT

Mining activities in Niger State has attracted people from all over the Nigeria in search of gold and other solid minerals. The issue of insecurity and economic hardship has triggered the exploitation living behind serious human and environmental impact. The land use and cover classification was conducted using recent technology of GIS software (Arcgis). this was done in other to trace the change detection that have occurred over the years in the mines the result were found out that the artisanal mining have brought rapid urbanization and high health impact of due the mining process. The magnitude of change of forest area in 30 years between 1990 to 2020 shows that forest decreased further by -30.82Sq. km representing a change (18.01%) of the total change for the period in the Mining zones.

KEYWORDS

Gold Mining, Exploitation, Health, Impact, Urbanization

1. INTRODUCTION

Artisanal mining (AM) has been defined differently around the world due to its diverse nature (Keita, 2001). Artisanal mining may be defined as the exploitation of minerals by poor people with the help of primitive tools such as diggers and shovels (spades) usually on a small scale. However in recent times, the AM industry in many countries has experienced constant growth which has resulted in the use of sophisticated equipment. Mining is the extraction of mineral deposits from the surface of the earth or from beneath the surface (Ige and Ojulari, 2019). The common mining sectors in Niger State are the formal small scale miners and the informal small scale or artisanal small scale miners.

The later involves unskilled small scale, informal and usually illegal miners who employ rudimentary methods and processes to extract mineral resources and who most times, have little or no knowledge of environmental issues (Jaiye, 2013). The uncontrolled mining in the study area has exposed the environment to serious hazards like the generation and uncontrolled discharge of enormous amount of toxic wastes which impact adversely on the human health and the ecosystem (Hilson, 2002). In March 2010, Medecins Sans Frontieres (MSF) discovered an epidemic of lead poisoning in Zamfara state, North-Western Nigeria. This led to the death of hundreds of people (UNEP/OCHA, 2010). The source of the outbreak was associated with artisanal Aluminum ore processing that occurs in the mining communities (Anene et al., 2018).

The pathways through which people were affected include drinking water, food, inhalation of contaminated dust, oral ingestion of particles especially by children and breast feeding babies. Lead is a confirmed toxic metal with no known beneficial effect on the human body. It damages the liver, kidneys, brain, central nervous and reproductive systems of man (DesRoches et al., 2008). Mercury occurs in the metallic, inorganic and organic forms in the environment. The most common organic form is methyl mercury which is produced by microscopic organisms in the soil and water. Human exposure to abnormal levels of mercury damages the brain, kidneys and developing foetus leading to irritability, tremors, impaired vision, memory problems, lung damage, nausea, skin rashes etc (UNEP/OCHA, 2010).

2. METHODOLOGY

2.1 Study Area

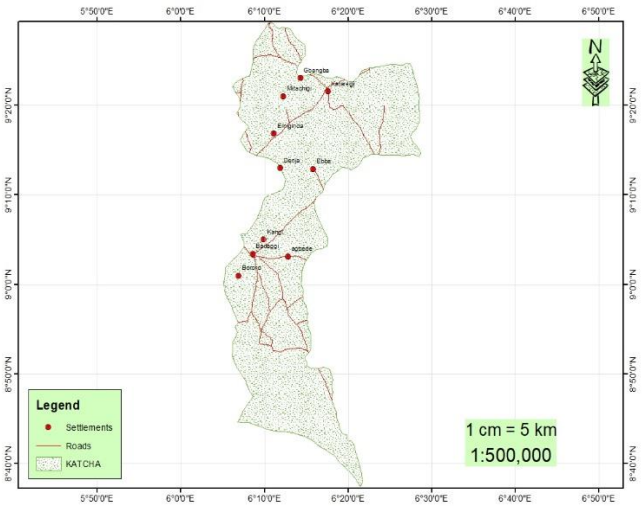

Figure 1: Map of Katcha Local Government Area Showing Kataeregi and other communities Area

Niger State experiences two distinct seasons the dry and wet seasons. The annual rainfall varies from about 1,600mm in the south to 1,200mm in the north. The duration of the rainy season ranges from 150-210 days or more between April and September from the north to the south. Mean maximum temperature remains high throughout the year, hovering about 32°F,

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particularly in March and June. However, the lowest minimum temperatures occur usually between December and January when most parts of the state come under the influence of the tropical continental air mass which blows from the north. Dry season in Niger State commences in October.

2.2 Idrisi Terrset

This is an integrated software system used for the analysis and display of spatial data, it includes tools for GIS analysis, image processing, surface analysis, Vertical applications for land change analysis, earth trend modeler, climate change and adaptation modeler, ecosystem services and more. The software includes a comprehensive suit of image processing tools, making it an excellent choice for land cover mapping application with remotely –sensed data which is an important aspect of this study. Tools are also provided for image restoration, enhancement, classification and transformation, the software also provides a host of machine learning tools, among them are artificial neural network classifiers, Maximum likelihood classification and land change and time series analysis most of which were utilized for this study.

2.3 Arc Map 10.3

was used in producing National, State and Local government boundary map of the study area as well as used to extract the study area from each satellite scene and thereafter exported to Idrisi for further image analysis. ArcGIS is both a vector and raster-based software designed by ESRI.it provides a scalable framework for implementing GIS (Geographic Information System) for users. ArcGIS is an integrated family of GIS software products for building a complete GIS. More specifically, modules such as Arc-Map, Arc-Catalogue and spatial analysis were used for the study

3. Result and Discussion

3.1 Analysis of Land Use/Land Cover Classification in the Study Area

3.1.1 1990 Satellite Imagery LULC Classification for Kateregi

The land use/ land cover map gives an account of the spatial distribution and areal extent of various categories of land use/land cover over the study area. Figure 3.1 presents the classified land use/land cover map of the study area for the year 1990. The map portrays six (6) categories of land use/land covers; built-ups, grassland, bare surface, cultivated land, water bodies and forest cover. The areal extent of these classes reveal that the dominant class is cultivated land which covers 748.37 km² (43.40%), this is followed by grassland with 528.40 km² (30.57%), built up areas covers 146.24 km² (8.46 %). This is seen more at the Centre, bare surface on the other hand occupies an area of 113.06 km² (6.54 %), forest cover also covers 171.13 km² (9.90%) and water bodies with 21.04 km² representing (1.22 %) of the total area as the less dominant land use and land cover class.

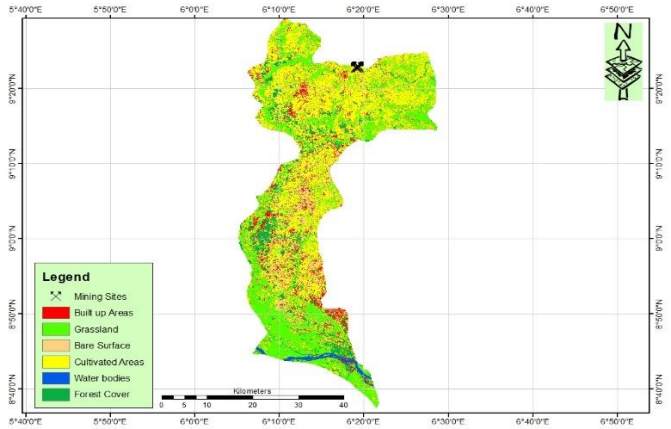

Figure 2: Kateregi 1990 LULC distribution map generated from LandSat 4 TM (Source: Author's Analysis, 2021).

3.1.2 Analysis of Land use/Land Cover Classification of 2010 Satellite Imagery for Kateregi

The land use and cover map of Kateregi for 2010 (Figure 3), reveals that there was a drastic increase in built up areas. Result shows that built up area increase from 146.24 km² (8.46%) in 1990 to 156.91 km² (9.08%) in 2010. The built up expands towards the center due to continuous influx of people.

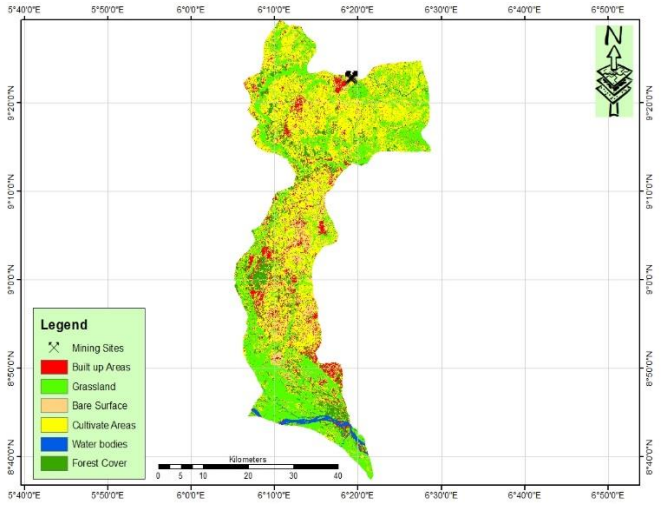

Figure 3: Kateregi 2010 LULC distribution map generated from LandSat 4 TM (Source: Author's Analysis, 2021).

This sharp increase can be attributed to continuous influx of people as a result of the mark of a new era of democracy and the quest for people to get better job opportunities so as to improve their standard of living and improved socio-economic development in the area. This is followed by grassland area; findings reveal that forest cover reduces from 171.13 km² (161.07 %) in 1990 to 161.07 km² (9.32 %) in 2010. The large proportion of cultivated land area indicates that most of the marginal dry and wetlands have been converted to agricultural land. However, there is an increase in bare surface area as findings indicate that bare surface areas increase from 113.06 km² (6.54 %) in 1990 to 115.29 km² (6.67%) in 2010. Similarly, grassland also witnesses an increase from 528.40 km² (30.57 %) in 1990 to 535.91 km² (31.02 %) in 2010. water body remains relatively stable with 21.37 km² (1.24 %) respectively.

3.1.3 Analysis of Land use/land cover Classification of 2020 Satellite Imagery for Kateregi

Figure 4 shows the land use and cover map of Kateregi for 2020, findings reveal that cultivated land is the most dominant land use and cover type and continues to increase across the study area, an indication of increased urbanization. Result also shows that built up area increase from 156.91 km² (9.08 %) in 2010 to 317.37 km² (18.36 %) in 2020. The built up expands towards the Central section which serves as the local government headquarters as well as the western, southern, north west and south western section of the study area as more people to influx the area.

This is followed by grass land areas as findings reveal that there was an increase in cultivated land but still occupies more land area than other land use category. Findings shows that bare surface increases from 115.29 km² (6.67 %) in 2010 to 242.17 km² (14.01 %) in 2020. Similarly, there was a decrease in forest land area as findings indicate that forest areas decreased from 161.07 km² (9.32 %) in 2010 to 140.31 km² (8.12 %) in 2020. This decrease in grassland may be attributed to conversion to build up areas, agricultural and other land use and land cover categories. Similarly, in addition, water body remains relatively stable 21.58 km² (1.25 %) respectively.

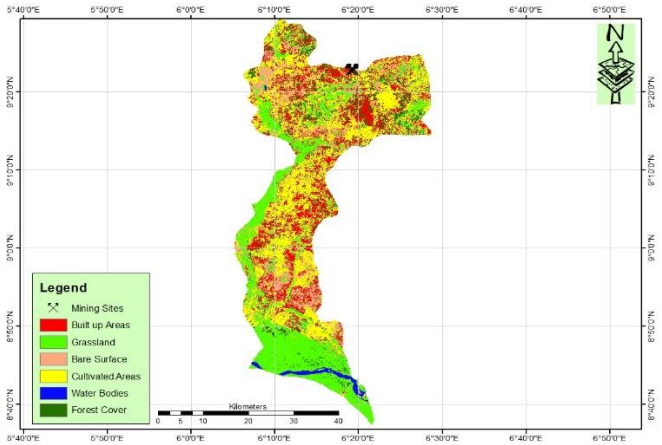

Figure 4: Kateregi 2020 LULC distribution map generated from LandSat 8 OLI (Source: Author's Analysis, 2021).

In addition, Figure 5 and Table 1 indicates the trend in the change of the various land use and land cover across the study area, it shows that grassland, cultivated land and forest cover are on the decrease while built up areas and bare surface (mining areas) are on the increase.

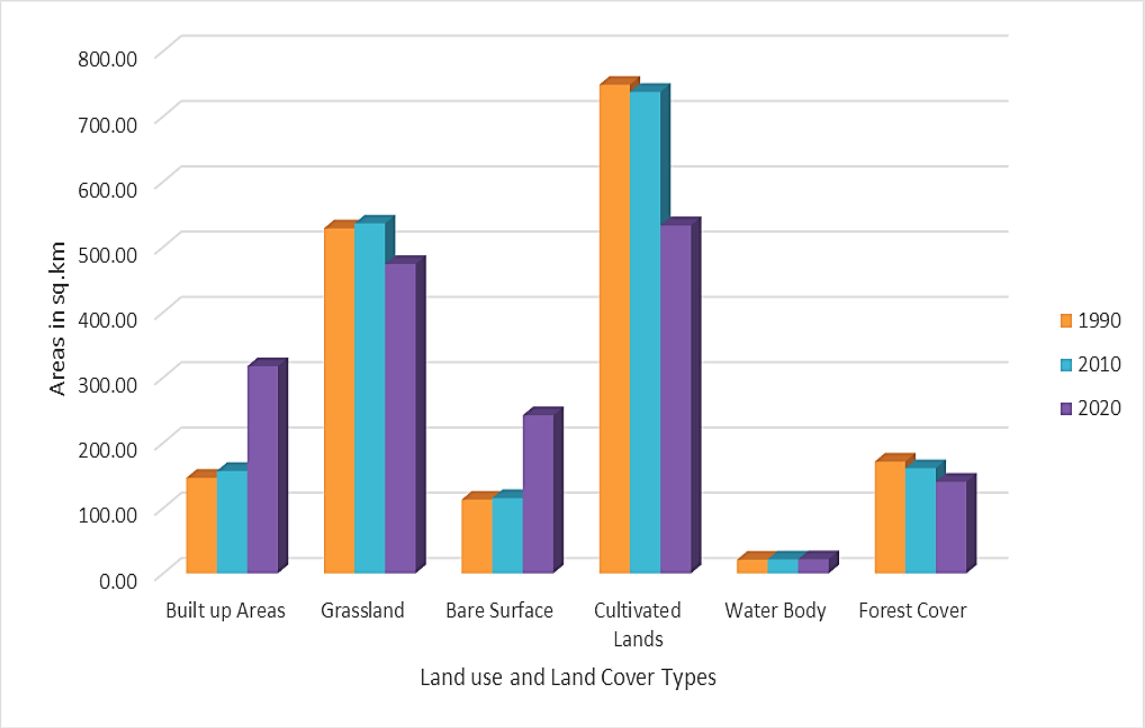

Figure 5: Land use and Land Cover Trend chart

Table 1: Land use and Land Cover Distribution of Kateregi (1990, 2010 and 2020)						
LULC	1990		2010		2020	
Land Cover Category	Area (Sqkm)	Area covered (%)	Area (Sqkm)	Area covered (%)	Area (Sqkm)	Area covered (%)
Build up	146.24	8.46	156.91	9.08	317.37	18.36
Grassland	528.40	30.57	535.91	31.02	473.83	27.42
Bare surface	113.06	6.54	115.29	6.67	242.17	14.01
Cultivated land	748.37	43.30	737.36	42.67	532.96	30.84
Water bodies	21.04	1.22	21.37	1.24	21.58	1.25
Forest cover	171.13	9.90	161.07	9.32	140.31	8.12
Total	1728.25	100	1727.91	100	1728.22	100

Source: Author's Analysis, 2020

3.2 Magnitude and Percentage of Change in Land Use/Landover between 1990 and 2010

The magnitude of change of forest area for 20 years between1990 to 2010 showed that forest decreased by 10.06 Sq. km representing a change (7.30%) of the total change for the period as shown on Table 2 with annual rate of change of 1.46%. Forest has one of the highest annual rates of change of -1.18 % while cultivated land had the least annual rate of change of -0.29 %. The period also witnessed an increase in Grassland area. The grassland decreased by 7.51 Sq. km representing 1.42 % of the total change, while cultivated land decreased by -11.01 Sq. km (-1.47 %). These changes could be attributed to the intensification of urbanization.

Table 2: Magnitude and Percentage of Change in Land Use/Landcover between 1990 and 2010					
LULC Class	1990 Extent(Sq. km)	2010 Extent(Sq. km)	Magnitude ofChange (Sq. km)	Percentageof Change	Annual Rateof Change %
Built up areas	146.24	156.91	10.67	7.30	1.46
Grassland	528.4	535.91	7.51	1.42	0.28
Bare surface	113.06	115.29	2.23	1.97	0.39
Cultivated lands	748.37	737.36	-11.01	-1.47	-0.29
Water body	21.04	21.37	0.33	1.57	0.31
Forest cover	171.13	161.07	-10.06	-5.88	-1.18
Total	1728.25	1727.91	41.81	19.6	1.37

3.3 Magnitude and Percentage of Change in Land Use/Landover between 2010 and 2020

The magnitude of change of forest area for 10 years between 2010 to 2020 shows that forest decreased further by -20.76Sq. km representing a change (-12.89 %) of the total change for the period as shown on Table 3.3 Forest had an annual rate of change of -1.29 % while water had the least annual rate of change 0.10 %. The period witnessed further increase in Built up and farmland area. The built-up land increased by 160.46 Sq. km representing 102.26 % of the total change with annual growth rate of 10.23%, while Bare surface increased by 126.88 sq. km (110.05 %) at an annual growth rate of 11.01%. These changes are attributable to the increase agricultural activities, built up encroachment, fuel wood and among others use.

Table 3: Magnitude and Percentage of Change in Land Use/Landover between 2010 and 2020					
LULC Class	2010 Extent (Sq. km)	2020 Extent (Sq. km)	Magnitude of Change (Sq. km)	Percentage of Change	Annual Rate of Change %
Built up areas	156.91	317.37	160.46	102.26	10.23
Grassland	535.91	473.83	-62.08	-11.58	-1.16
Bare surface	115.29	242.17	126.88	110.05	11.01
Cultivated lands	737.36	532.96	-204.4	-27.72	-2.77
Water body	21.37	21.58	0.21	0.98	0.10
Forest cover	161.07	140.31	-20.76	-12.89	-1.29
Total	1727.91	1727.91	574.79	265.48	

3.4 Magnitude and Percentage of Change in Land Use/Landover between 1990 and 2020

The magnitude of change of forest area in 30 years between 1990 to 2020 shows that forest decreased further by -30.82Sq. km representing a change (18.01%) of the total change for the period as shown on Table 3.4 Forest had an annual rate of change of -5.40% within the study years while water had the least annual rate of change of 0.77% (Table 4). The period witnessed more increase in Built up and Bare surface area. The built-up land increased by 171.13 Sq. km representing 117.02% of the total change with an annual growth rate of 35.11%, while Bare surface increased by 129.11 sq. km (114.09 %) at an annual growth rate of 34.26%. These changes are attributable to the increased developmental activities.

Table 4: Magnitude and Percentage of Change in Land Use/Landover between 1990 and 2020					
LULC Class	1990 Extent(Sq. km)	2020 Extent(Sq. km)	Magnitude ofChange (Sq. km)	Percentage of Change	Annual Rateof Change %
Built up areas	146.24	317.37	171.13	117.02	35.11
Grassland	528.4	473.83	-54.57	-10.33	-3.10
Bare surface	113.06	242.17	129.11	114.20	34.26
Cultivated lands	748.37	532.96	-215.41	-28.78	-8.64
Water body	21.04	21.58	0.54	2.57	0.77
Forest cover	171.13	140.31	-30.82	-18.01	-5.40
Total	1728.25	1728.22	601.89	290.96	

4. Conclusion

Generally, from the results, forest, grassland, cultivate lands and water bodies were decreasing as the built- up areas increased. The increased depletion rate of the general land cover indicated that, human population and mining activities were immensely destroying the vegetation cover. However, the mining activity is the main reason for the tremendous changes in the study area. This is because, these activities are linked to both direct and indirect changes of the land cover especially in areas where the operations are being carried out. These have substantial effects on the land cover land use of which the forest is the greatest victim because these mineral resources are embedded within the soils in which they are found.

The loss of the forest cover was due to the random and rampant clearing of the forest for mining activities (surface mining) especially those mostly found on the areas. This indirectly has affected the water bodies as most of them highly polluted and in most case leading to their drying up as these vegetation covers are cleared. Built-up areas were increasing because of increase in population and also immigrants from far and near have come to settle at the location of the mining operation for work and trade purposes. Though, mining activities boosts a country's economy, it leaves a negative impact on land cover because it is a function of time that results in direct and indirect effects on different land use and land covers. This however, confirms the studies conducted by (Keita, 2001), (Hartman & Mutmansky, 2002) who concluded that, increase in populations and mining activities and the changes in the land use/land cover were mutually related to each other.

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