Current Journal of Applied Science and Technology

41(14): 33-48, 2022; Article no.CJAST.86082
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

An Assessment of Land Use and Cover Changes in the Kainji Lake Basin, Niger State, Nigeria

B. M. Gwari [a*], D. Dantata [b], O. R. Jeminiwa [c], E. S. Owolabi [a], J. B. Ewosuyi [d] and U. J. Mubarak [a]

[a] Environmental Studies Division, National Institute for Freshwater Fisheries Research, P.M.B. 6006, New Bussa, Niger State, Nigeria.
[b] Department of Geography, Federal University of Kashere, Gombe State, Nigeria.
[c] Forestry Research Institute of Nigeria, P.M.B. 5054, Jericho, Ibadan, Nigeria.
[d] Department of Geography, Federal University of Technology Minna, Niger State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2022/v41i1431716

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/86082

Original Research Article

Received 15 February 2022
Accepted 23 April 2022
Published 21 May 2022

ABSTRACT

This paper assesses the land-use and land-cover changes within the Kainji Lake basin between 1975 and 2018 – a period of 38 years, using remotely sensed data and geographic information systems (GIS). Since 1968 when the River Niger was impounded and Kainji Lake created, various anthropogenic activities such as agriculture, irrigation deforestation, fishing, and tion environmental degradation and the damage of the ecosystem of the lake basin. Landsat MSS image of 1975, Landsat TM of 1987 and Landsat ETM+ images of 1999 and 2005 and Landsat Operational Land Imager OLI of 2018 were acquired, classified and analysed between 1975 and 2018. Area calculations of the arc GIS 10.2.2 software were used to derive the trends, rates and magnitudes of changes, while map overlay was employed for assessing the nature and location where the changes have taken place. The study reveals that the rate of deforestation and erosion in the study area is linked to population increase that lead to expansion of agricultural lands. Uncontrolled human settlement and demand for fuel wood were some other issues to contend with. If this issue of land degradation is not appropriately dealt wiith, power supply and fisheries production will further reduced and this is detrimental to the development od Nigeria as a whole.. Finally, it is

**Corresponding author: E-mail: bitrusgwari54@gmail.com;*

hoped that the findings from the study will provide useful insight into the current state of the environment, and the recommendations proposed in this paper would equally be helpful to mitigate, control and to improve the management of the basin. The federal government should take the lead in implimenting the management options for the benefits of fisherfolks and farmers in the Lake Basin in general.

Keywords: Geographic information system; land use; Kainji Lake Basin; defostation.

1. INTRODUCTION

Kainji Lake Basin and its catchment support millions of people. It provides food (fish), transport and communication, tourism, water for domestic use, agricultural and recreation. The largest hydro-electricity station in the country is also situated in the basin and has also supported the Kainji National park. It is a known fact that whenever a dam is constructed along a river channel, riparian communities around such locations are often affected directly and indirectly [1]. This is because over the years inhabitants living within the Kainji Lake Basin experienced heavy flooding due to the construction of the dam on the River Niger. Disturbances created to the human settlememts around the river channels are as a result of the backward effects of the lake water.

The counstruction of the Kainji Lake reservoir on River Niger has led to the creation of lake ecosystem, which also changed the land cover around the lake. The forest arond the lake has also changed overtime, which could be linked to the temporal displacement of people livingin the area thereafter. In addition, more institutions, government agencies and schools have been created to take care of the rising population of the inhabitants. The small villages in the Kainji Lake Basin have grown to become major towns. This has led to more lands are cleared for farming activities and constructions of houses to accomomdates the growing population, thereby completely changing the land use and land cover of the entire basin.

The growth of a society totally depends on its social and economical development. Knowledge about land-use and land-cover is very critical and increasingly important to every nation so as to reduce the problems of loss of productive ecosystems, biodiversity, deterioration of environmental quality, loss of agricultural lands, destruction of wetlands, and loss of fish and wildlife, pollution and food and energy security for inreasing population. Land-use data analysis is a very important and useful source for planners in land use studies. It helps to examine environmental processes, identifies environmental problems as well as provides information on changing proportions of agricultural and recreational areas for better and effective planning for regional development.

Researchers world wide have applied the use of Remote sensing and GIS in Land use and Land cover studies. Remote sensing and GIS have covered wide range of applications in the fields of agriculture, water resources, and integrated eco-environment assessment. [2] used LANDSAT satellite imagery of 1987 to 2015 in order to assess the changes in the volume of water in Dadinkowa reservoir, Gombe state, Nigeria and found out that water level increased and decreased from 2000 to 2015 due to climate change condition and the high rate consummation of water due to population growth of the area. “The report also showed that Dadin Kowa reservoir may completely dry up by the year 2029 if the climatic condition remains the same. [3] used GIS and physical soil resources inventory techniques to assessed land use land cover change in Igwuruta in the Niger Delta area of Nigeria. Their results shows urban development and industrialization took over most of the suitable lands for agriculture. [4] used Spot HRV imagery of 1986 and aerial photographs of 1974 to examine the environmental impact of Burumburum/Tiga dam in Kano State, Nigeria. The construction of the dam was revealed to have led to the depletion of vegetation cover that could have minimized desertification.

Therefore, due to the central roles of providing of electricity, fisheries production and the conservation of flora and founa in the Kainji Lake basin, proper monitoring of the Lake Basin and its environs becomes necessary for sustainable utilization and management of water resources. The objectives of the study are as follows:

i. To create land-use/land-cover maps of the Kainji Lake Basin using GIS technique and remote sensing data for

assessing the trends, magnitudes, nature and locations of the land use and vegetation cover changes of the lake within the study period.

ii. To assess the actual land areas which have been lost or, gained by the principal features around the lake

iii. To evaluate the environmental implications of the land-use and land-cover changes in the lake basin.

2. MATERIALS AND METHODS

2.1 The Study Area

Due to the growth of industries and rapid urbanization in Nigeria, increasing demand for electricity became eminent and couple withe the fact that that supply of electricity could be cheaper through the utilization of hydro began the and the exploitation of water resources of River Niger upstream of Jebba started immediately by the former Electricity Corporation of Nigeria (ECN) [5], According to [6] Kainji was the best site for the Lake because of the fact that, rock foundation which was tested and was found to be capable of holding the enormous height of the dam. Similarly, Kainji was the point where the river valley is narow and the physical features of upstream of the dam valley also allows for a large reservoir [6]. Agboarumi [7] observed that the Kainji dam is today a pride of nature, providing cheap and abundant means of electricity for the continuously growing population and industries, sources of revenue, fishing, irrigation, cattle crossing, tourism, employment, international recognition, man-power training and many more.

The lake is located between latitudes 9° 50″ to 10° 42″N and longitudes 4° 20″ to 4° 42″E (Fig. 1) [8]. The construction of the Kainji dam began in March 1964 to December, 1968 and was officially commissioned on 15th February, 1969. The lake covers an area of 1250 km^2 with a maximum depth of 54.9 m and extends to about 136.8 km upstream of Jebba beyond Yelwa in the North [5]. The lake gets its water from two sources: the river Niger with its headwater in Guinea, and local Rivers around the lake basin which flow directly into the lake or into River Niger before entering into the lake [9].

The soil depth of the area increases with slope and a gentle undulating topography for the area with red to brown well drained soils differing in texture from sandy loam to clay loam [6]. Most of the basin area have dry season of five months starting from early November to middle of March. Rainfall increases from the month of April, reaching the peak in August and starts declining in September. Rainfall decreases with decrease in latitudes within the basin and also increases with increasing altitude [8].

2.2 Sources of Data

The first four data sets (Table 1) which cover a total period of 38 years (1975-2018) were the main images that were acquired for the assessment of the lake basin. The first two and last two data sets have large gap of at least ten years while the middle two have close gaps of five years. It was done to reflect the impact of the dam in the past years of low population and the recent years when the population of the country was increased tremendously. All four images were acquired between June and September, which is the peaking periods of the wet season where climatic conditions during this period is the same all over the lake basin, hence the vegetation cover and land-use types appear the same on the images regardless of the year they were obtained. This methods was adopted from the early work of [10].

2.3 Image Classification

In classifying the images into various themes, the supervised approach to classification was adopted using Arc GIS 10.2.2 software. The images were classified into three major classes: water body; agricultural, built-up and other land-uses and; floodplain and waterweed as seen on Table 2. Maximum likelihood classification method was adopted from [11] and [12].

Three features of major concern were selected for this purpose: the lake reservoir, the flood plains and the agriculture/settlement areas. The result was to produce the following:

1. Areas that were not Lake Reservoir in 1975 but have changed to Lake Reservoir in 2018 so as to know whether the lake is expanding or not as has been the fear of Nigerians.
2. Areas that were dense forest in 1975 but have changed to other land-use types in 2018. This was done to determine the land areas of the forest lost within the study periods to other land use types.
3. Areas that were not intensive agriculture/ settlement in 1975 but have changed to

intensive agriculture in 2018 so as to assess the rate of land captured by intensive agriculture/settlement within the study periods

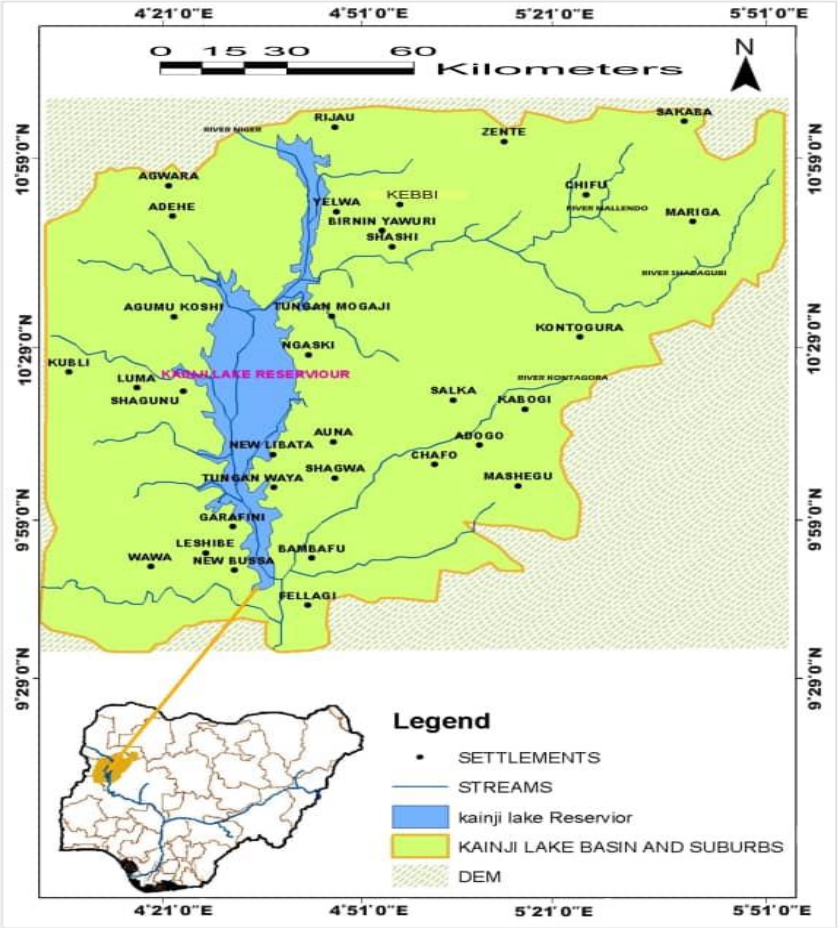

Fig. 1. Kainji Lake Basin

Table 1. Data type source

S/N	Data Type	Date	Spatial Resolution
1.	Landsat Thematic mapper (TM)	1th July, 1987	30 meters
2.	Landsat Enhanced Thematic mapper (ETM)	6th Feb., 1999	30 meters
3.	Landsat Enhanced Thematic mapper (ETM)	5th July, 2005	30 meters
4.	Landsat Operational Land Imager (OLI)	5th Feb., 2018	30 meters

Source: Adapted and modified from [12]
Sources: Global Land Cover Facility, 2014

Table 2. Land-use and land cover classification scheme

1.	Water body	Lake water
2.	Build up areas	Land containing buildings
3.	Agricultural	Agriculture lands
4.	Dense vegetation	Game reserves
5.	Others	Streams, rock out crops

2.4 Change Detection Techniques

Three main change detection methods which have been previously applied by [13] were employed in this paper, they are:

2.4.1 Change detection by area calculation

1. The first step is the calculation of the magnitude of change, which is derived by subtracting observed change of each period of years from the previous period of years.
2. The second step was the calculation of the trends, that is, the percentage change of each of the land-use, by subtracting the percentage of the previous land-use from the recent land- use divided by the total land-use and multiplied by 100 (BA/ Tx100).
3. The last is the calculation of the annual rate of change by dividing the percentage change by 100 and multiplied by the number of the study years, that is 38 years (1975-2018).

3. RESULTS AND DISCUSSION

3.1 Trends, Magnitudes, Percentage Change and Annual Rate of Changes

Table 3 shows summary of trends in terms of the area coverage and the percentage of each class of the basin area from 1975 to 2018. It was revealed that the lake reservoir which covered 1566.49 km^2 in 1975 has reduced to 1179.12 km^2 in 2018 which means it lost a total area of 387.3 km^2. Agricultural lands for crop production and grazing of livestock which covered 2144.22 km^2 in 1975 has reduced to 1550.67km^2 in 2018 (a reduction of 593.55 km^2). Scanty settlements found in the basin have dramatically increased from 4 percent, equivalent coverage of 715.06km^2 in 1975 to 20.38 percent (3330.5 km^2) in 2018. This is as result of population increase as also noted by [10].

Table 3b shows that bare surface that was originally 585.65 km^2 in 1975 increased to 1340.95 km^2 in 1987 recorded positive change (see Fig. 2). This could be attributed to the 1983/194 drought which affected the whole country and falls within this period in addition to increased in agricultural activities and other constructions. Build up area or settlements which covers 715.06km^2 in 1975 sprang up to 1597.28km^2 in 1987 recorded positive change, this is due to migration of the people to the Lake basin whereby more settlements were formed. Dense vegetation cover that covers 4973.17km2 in 1975 had decreased to 2976.57km^2 in 1987 also recorded negative change and could be attributed to increased deforestation in the area where by forest were cleared to pave way for constructions of settlements, road networks and agricultural lands. Extensive grazing/Agricultural lands that covers only 2144.22km^2 in 1975 expanded to 4143.12km^2 and recorded positive change. This could be attributed to the increase in population of the people who engaged in agriculture as well as the increase in the number of herders that migrated from other part of the North. Table 5a further showed that Grasslands/ light vegetation that covers 4184.22km^2 in 1975 and decreased significantly to 2563.98km^2 recording a negative change. Again, this reduction could be atributed to increase in the human activities such as grazing, farming and increase in the number of settlements in the lake basin. Lake coverage stood at 1566.49 km^2 in 1975 and reduced to 1069.66km^2 in 1987 and recorded negative change. This could also be attributed to 1983/1984 drought that ravage the country within this period.

Table 3c revealed that bare surface reduced from 1340.95km^2 in 1987 to 1111,70 km^2 in 1999 and also recorded negetive change (see Fig. 3). This could be due to continuous usage of land for agriculture may lead to agricultural land been converted to open, non-cultivated type such as open grassland or sandy bare surfaces as noted in the Table. Land exposure and desiccation are noted for increasing the local rainfall run-off and reducing infiltration. “This factor affects the total water balance of a drainage basin, reduce soil matter by exposure to agents of erosion and consequently hamper land cultivation [14] Consequently, over 90% of the natural vegetation in Nigeria had been deforested and over 350,000 ha of forest and natural vegetation are lost annually [10].

Table 3c also revealed that build up area or settlement which covered 1597.28km^2 in 1997 increased to 2027,08 km^2 in 1999 with a positive change record. This could be attributed expansion of settlements and the building of more houses in Newbussa and its surrounding villages. Dense vegetation that covered an area of 2976.57 km^2 in 1987 and reduced to 1961.30 km^2 with a negetive change record. This could be attributed to increased deforestation in the area where by forest were cleared to pave way for more constructions of settlements, road networks and agricultural lands. Extensive grazing/ Agricultural lands that covers 4143.12km^2 in 1997 reduced to 4019.17 km^2 in 1999 with a negetive record of change. This could be

attribued to the increase in population of the people who engaged in agriculture as well as the increase in the number of herders that migrated to the basin.

Table 3c further showed that Grasslands/ light vegetation that covers 2563.98km^2 1997 and increased significantly to 2936.87km^2 recording a positive change. Again, this could be attributed to increase in the human activities such deforestation agricultural and logging which are common in this period in the basin. Lake water covered 1069.66km ^{2} in 1987 and increased to 1215.09km^2 in1999 recording a positive change, this would not be unconnected to the control measures implored by the Freshwater Institute, where by mechanical, biological and manual were used to remove the water hyacinth on the lake [15]. Through this methods 45% of the estimated coverage by the weeds has been effectively removed.

Table 3d revealed that bare surface covered 111.70km^2 in 1999 and increased to 588.94km^2 in 2005 with a positive record of change, this could be traced to increase in population and agricultural activities where forests are cut down for farming and settlement purposes. The table also revealed that Built up areas or settlements covered 2027.08km^2 in 1999 and inceased to 2823.86 km^2 in 2005 with also a positive change This could be attributed continous expansion of settlements and the building of more houses in Newbussa and its surrounding villages due to increase in population. Similarly, dense vegetation, covered 1961.30 km^2 in 1999 and increased significantly to 2770.78 km^2 in 2005 with also a positive record of change and could be attributed to increased deforestation in the area where by forest were cleared to pave way for more constructions of settlements, road networks and agricultural lands.

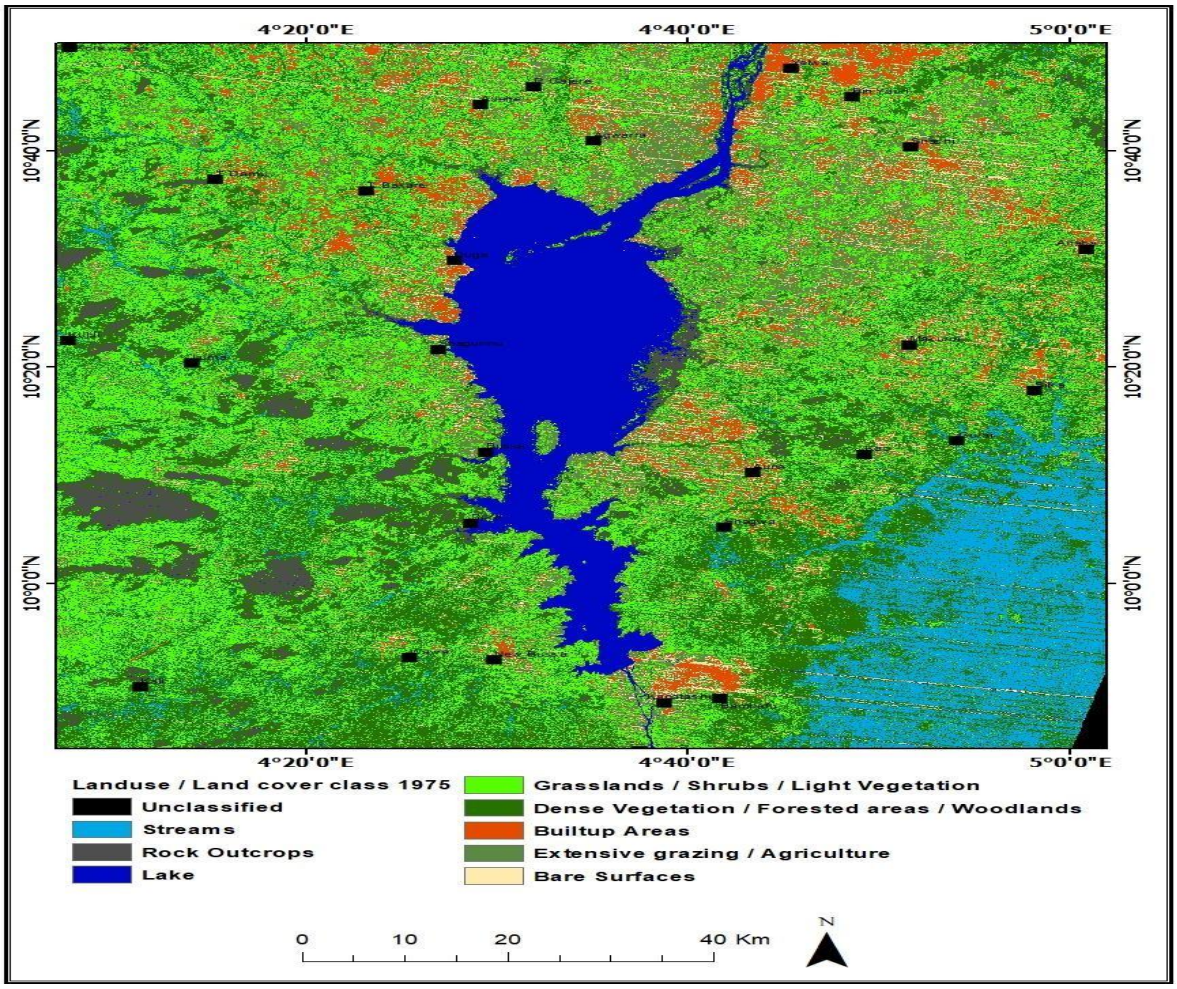

Fig. 2. Spatial distribution of land use and land cover in 1975

Table 3a. Trends of the land use and land cover of Kainji Lake basin (1975-2018)

Land use Land cover classification	1975		1987		1999		2005		2018	
	Area (km_sq)	%	Area (km_sq)	%	Area (km_sq)	%	Area (km_sq)	%	Area (km_sq)	%
Bare Surfaces	585.65	3.58	1,340.95	8.20	1,111.70	6.80	588.97	3.60	1,102.91	6.75
Builtup Areas	715.06	4.38	1,597.28	9.77	2,027.08	12.40	2,823.86	17.28	3,330.50	20.38
Dense Vegetation	4,973.17	30.43	2,976.57	18.21	1,961.30	12.00	2,770.78	16.95	1,976.83	12.10
Extensive grazing / Agriculture	2,144.22	13.12	4,143.12	25.35	4,019.17	24.59	2,783.36	17.03	1,550.67	9.49
Grasslands / Light Vegetation	4,184.22	25.60	2,563.98	15.69	2,936.82	17.97	4,268.93	26.12	3,330.74	20.38
Lake	1,566.49	9.58	1,069.66	6.54	1,215.09	7.43	1,185.94	7.26	1,179.12	7.21
Rock Outcrops	503.28	3.08	2,051.62	12.55	2,565.12	15.69	817.51	5.00	2,273.26	13.91
Streams	1,398.11	8.55	428.81	2.62	507.39	3.10	1,104.21	6.76	714.29	4.37
Unclassified	273.47	1.67	171.67	1.05			0.10	0.00	885.34	5.42
	16,343.66	100.00	16,343.66	100.00	16,343.66	100.00	16,343.66	100.00	16,343.66	100.00

Table 3b. The magnitude percentage and annual rate of changes of the lake basin (1975 – 1987)

LULC Classification	1975	1987	Magnitude of change	% change	Annual rate of change	Remark
Bare surface	585.65	1340.95	755.3	128.92	+55.46	Increase
Build up area	715.06	1597.28	882.22	123.38	+53.05	Increase
Dense vegetation	4973.17	2976.57	1996.6	-40.15	- 17.26	Decrease
Extensive grazing/ agriculture	2144.22	4143.12	1998.9	93.22	40.08	Increase
Grass lands/light vegetation	4184.22	2563.98	1620.24	- 38.72	- 16.65	Decrease
Lake	1566.49	1069.66	496.8	- 31.72	- 13.64	Decrease
Rock out crops	503.28	2051.62	1548.34	307.64	132.29	Increase
Streams	1398.11	428.81	969.3	- 69.30	- 29.80	Decrease
Un-classification	273.47	171.67	101.8	- 32.22	- 14.28	Decrease

Source: Authors Computation, 2018

Table 3c. The Magnitude percentage and annual rate of change of the lake basin (1987 – 1999)

LULC Classification	1987	1999	Magnitude of Change	% Change	Annual Rate of Change	Remark
Bare surface	1340.95	1111.70	229.25	- 17.10	- 7.35	Decrease
Build up area	1597.28	2027.08	429.8	26.91	+11.57	Increase
Dense vegetation	2976.57	1961.30	1015	- 34.11	- 14.67	Decrease
Extensive grazing/ agriculture	4143.12	4019.17	123.95	- 2.99	- 1.29	Decrease
Grass lands/light vegetation	2563.98	2936.82	372.84	14.54	+6.25	Increase
Lake	1069.66	1215.09	145.13	13.60	+5.85	Increase
Rock out crops	2051.62	2565.12	513.5	25.03	+10.76	Increase
Streams	428.81	507.39	78.58	18.33	+7.88	Increase
Un-classification	171.67	231.71	59.44	34.97	+15.04	Increase

Source: Authors computation, 2018

Table 3d. The Magnitude percentage and annual rate of change of the lake basin (1999 – 2005)

LULC Classification	1999	2005	Magnitude of Change	% Change	Annual Rate of Change	Remark
Bare surface	111.70	588.94	522.73	- 47.02	- 20.22	Decrease
Build up area	2027.08	2823.86	796.78	39.31	+16.90	Increase
Dense vegetation	1961.30	2770.78	809.48	41.27	+17.75	Increase
Extensive grazing/ agriculture	4019.17	2783.36	1235.81	30.74	+13.22	Increase
Grass lands/light vegetation	2936.82	4268.93	1332.11	45.36	+19.50	Increase
Lake	1215.09	1185.94	29.15	- 2.39	-1.03	Decrease
Rock out crops	2565.12	817.5	- 1747.61	- 68.13	+29.30	Increase
Streams	507.39	1104.21	596.82	117.63	+50.58	Increase
Un-classification	231.71	0.10	-	-	-	

Table 3e. The Magnitude percentage and annual rate of change of the lake basin (2005 – 2018)

LULC Classification	2005	2018	Magnitude of Change	% Change	Annual Rate of Change	Remark
Bare surface	588.97	1102.91	513.94	87.26	+37.52	Increase
Build up area	2823.86	3330.50	506.64	17.94	+7071	Increase
Dense vegetation	2770.78	1976.83	793.95	-28.65	-12.32	Decrease
Extensive grazing/ agriculture	2783.36	1550.67	1232.69	-0.44	-0.19	Decrease
Grass lands/light vegetation	4268.93	3330.74	-938.19	-0.22	-0.95	Decrease
Lake	1185.94	1179.12	6.82	-0.58	-0.25	Decrease
Rock out crops	817.51	2273.26	1455.75	178.07	+76.57	Increase
Streams	1104.21	714.29	389.92	-35.31	-15.18	Decrease
Un-classification	0.10	-	0.00	0.00		Increase

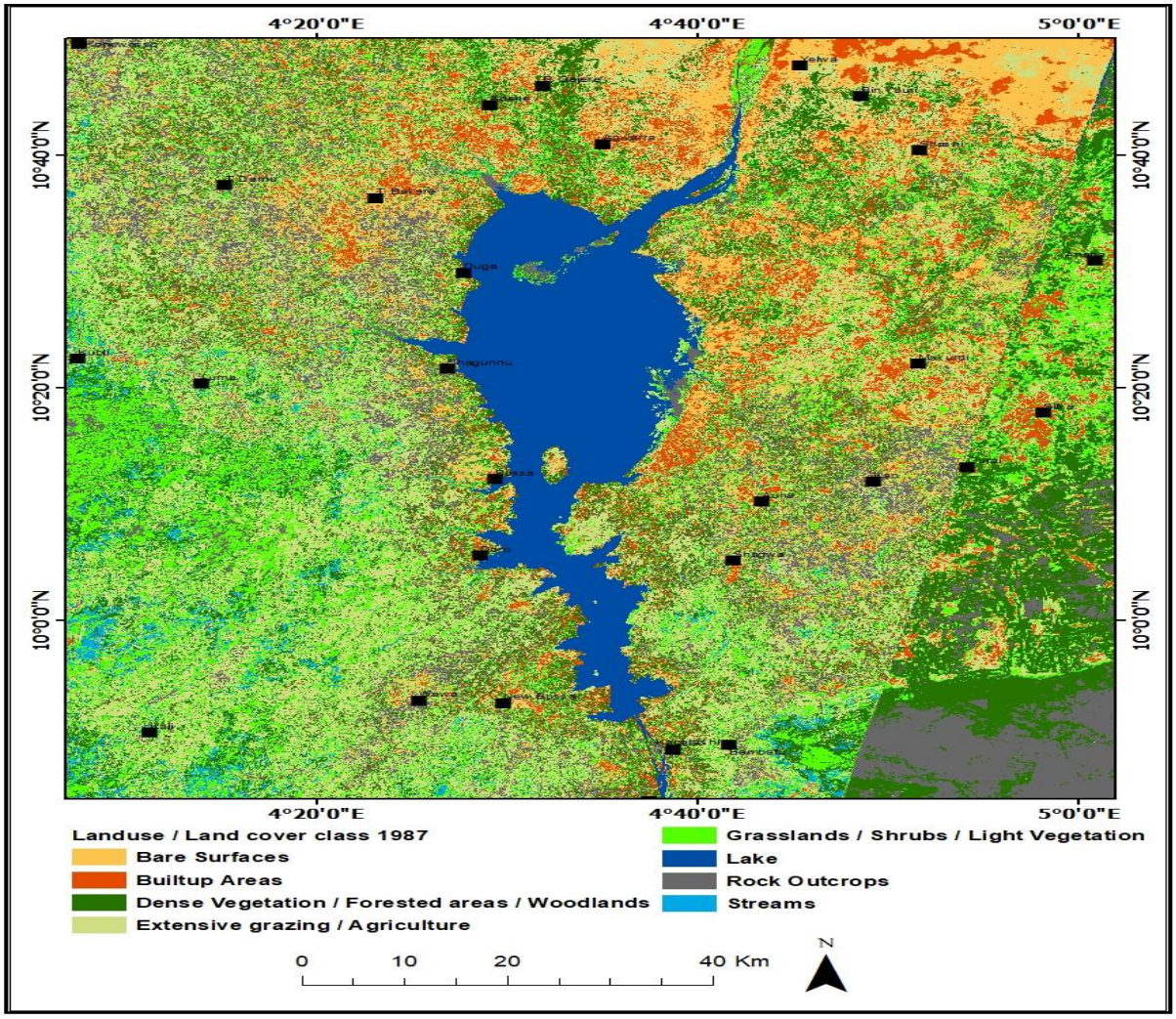

Fig. 3. Spatial distribution of Land Use/land cover in 1987

Extensive grazing/Agricultural lands that covers 4019.17km^2 in 1999 and increased to 2783.36km^2 in 2005 with a negetive record of change. This could also attribued to the increase in population of the people who engaged in agriculture as well as the increase in the number of herders that migrated to the basin. [16] also of the view that increased human and cattle population is continuously putting more pressure on the Kainji Lake Area. Table 3d further showed that Grasslands/ light vegetation that covers 2936..82km^2 1999 and increased significantly to 4268.93 km^2 recording a positive change. Again, this could be atributed to increase in the human activities such deforestation agricultural and logging which are common in this period in the basin. Kainji Lake water covered 1215.09km^2 in 1999 and reduced 1185.94km^2 in 2005 recording a positive record of change (see Fig. 4). The above mentioned activities help in no small measure in aiding erosions in the basin which in turn, reduce the water body.

Table 3e present the state of land use change in Kainji lake basin. It shows that bare surface covered 588.97km^2 in 2005 and increased significantly to 1102.91km^2 in 2018 with a positive record of change (see Fig. 5). This couuld be attributed to further increase in population and agricultural activities where forests are cut down for farming and settlement purposes.

The table also revealed that Bulit up areas or settlements covered 2823.86 km^2 in 2005 and expanded to 3330.50km^2 in the year 2018 with also a positive record of change This could also be attributed to continuous expansion of

settlements and the building of more houses in Newbussa and its surrounding villages due to increase in population. This conform with the report by [12] who reported that land use and landscape structure facing serious challenges such as rapid population growth, and pressure on land use, agricultural expansion and climate change. The report also indicated that Nigeria agricultural lands covered only 184,754 km^2 in 1975 and expanded to 380,000km^2 in 2013, 40 percent of the total land mass and that forest land decreased by 45 percent in 2013.

Table futher showed that streams in the Lake Basin reduced to only total 714. 24 km^2 of total area coverage in 2018 but covered an area of 1104.25 km^2 in 2005. This could be due the effects of climate change whereby rivers and lakes are drying up as corraborated by the finding of [17] who revealed that open water of Lake Chad Basin had reduced to just 1350 km^2 in 2007 against 23,000km^2 in 1963. The spacial location changes as presented in Fig. 6 showed the tremendous changes in land use and land cover during the study perod from 1975 to 2018.

3.2 Implications of the Land-use Changes on the Lake Basin

1. Dam safety concerns: reduction in lake area from 1566.49 km^2 to 1179.12 km^2 since the construction of the dam in 1969 raises a lot of potential concerns, considering the fact that Nigeria economy depends on electricity generated from the dam. On the one hand, the silting up of the dam could lead to inevitable reduction in the capacity of the dam to generate enough electricity [18]. On the other hand, fish production could be affected as spawning ground for fish will be reduced [19]. All these, if unchecked could directly affect both electricity generation and fish production.

2. Increase in deforestation: With the alarming rate of settlement and land clearing for agriculture has increase significantly between 1975 and 2018. Forest land meant for National Game Reserves (Kainji Game Reserve) is gradually disappearing (4973.17km^2 to 2976.57km^2). This is an indication of population increase where more land was needed for agriculture and settlement purposes. [20] cornfirmed that incroachment by farmers had reduced the park land and adviced that if deforestation is not checked the farmous Kainji National Park will become a history and that many animals, plants and other micro organisms in the basin may become extinct.

3. Reduction in fish catch: degradation of the lake area through deforestation which leads to incresed erosion, excessive water (floods), weed encroachment and sitltation, no doubt have collectively affected the annual fish catch in the lake area as [21] reported the reduction of estimated total fish catch from 38,346 mt to 13, 361 mt between year 1996 to 2001.

4. Land exposure/desiccation: Continuous cultivaton of crops on a peace of land may lead to land been converted to non-cultivated type such as open grassland or sandy bare surfaces as noted in Table 3c-e where bare surface that was absent in the basin in 1975 but appearing gradually since 1987. Land exposure and desiccation are factors for increasing the local rainfall runoff and reducing infiltration. Both affects the total water balance of a drainage basin, by increasing rate of erosion and consequently hamper cultivation of crops [14]. This ascertion was also supported by [22] and [23].

5. Flooding: The expansion of the lake water has resulted into serious flooding especially at the western bank and the downstream is the most affected area [1]. Ihe first 3 km from the reservoirs including the river channels and surface water body lying between 69 and 162 m above sea level, while the lowest is at 15 km away from the reservoir and greater than 193 m above sea level was dicovered to be the highest susceptibility areeas of flood in the Kainji Lake [4]. The devastative flood at the downstream had caused displacement of settlements and huge destructions of farmlands, fish ponds during the 2012 floods running in millions on Naira [24].

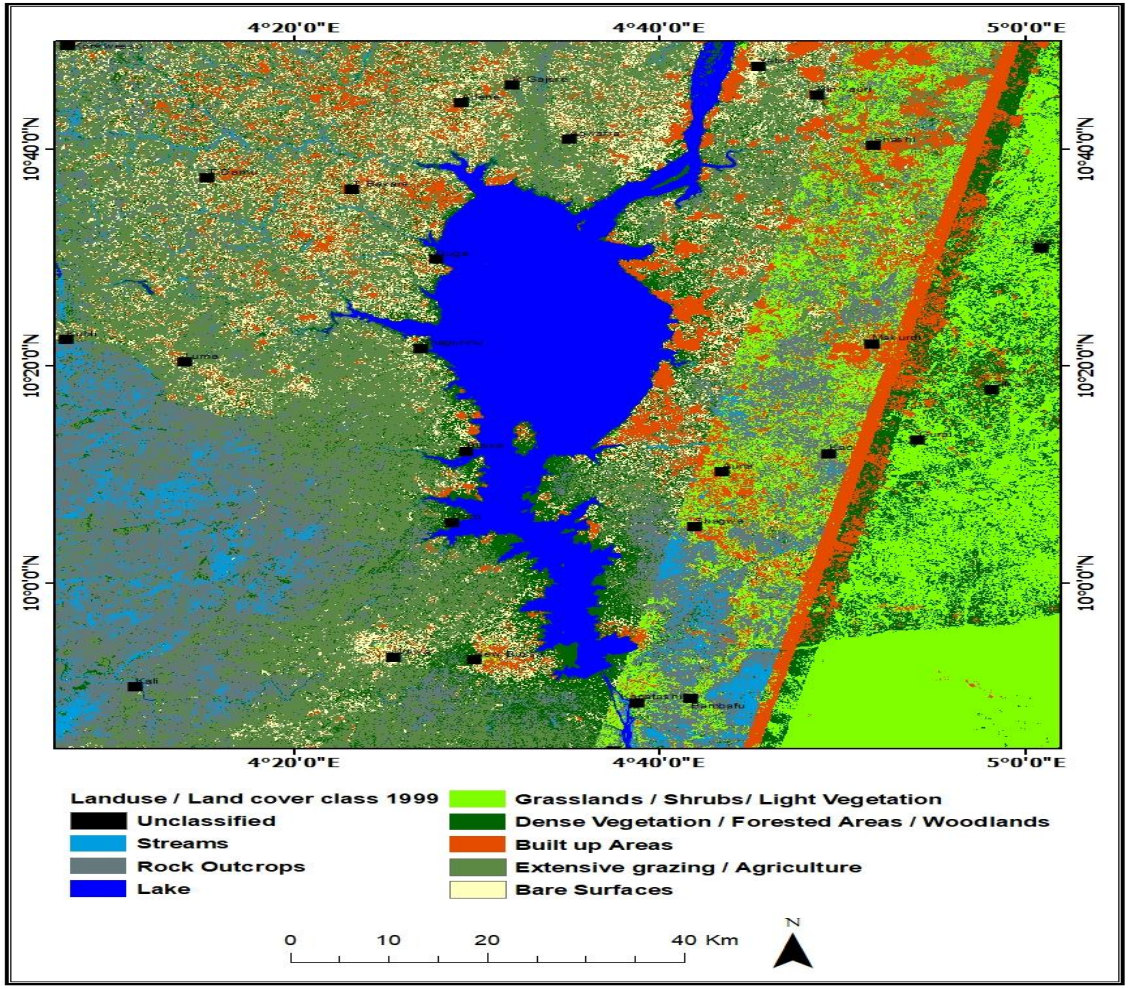

Fig. 4. Spatial Distribution of Land Use/land cover in 1999

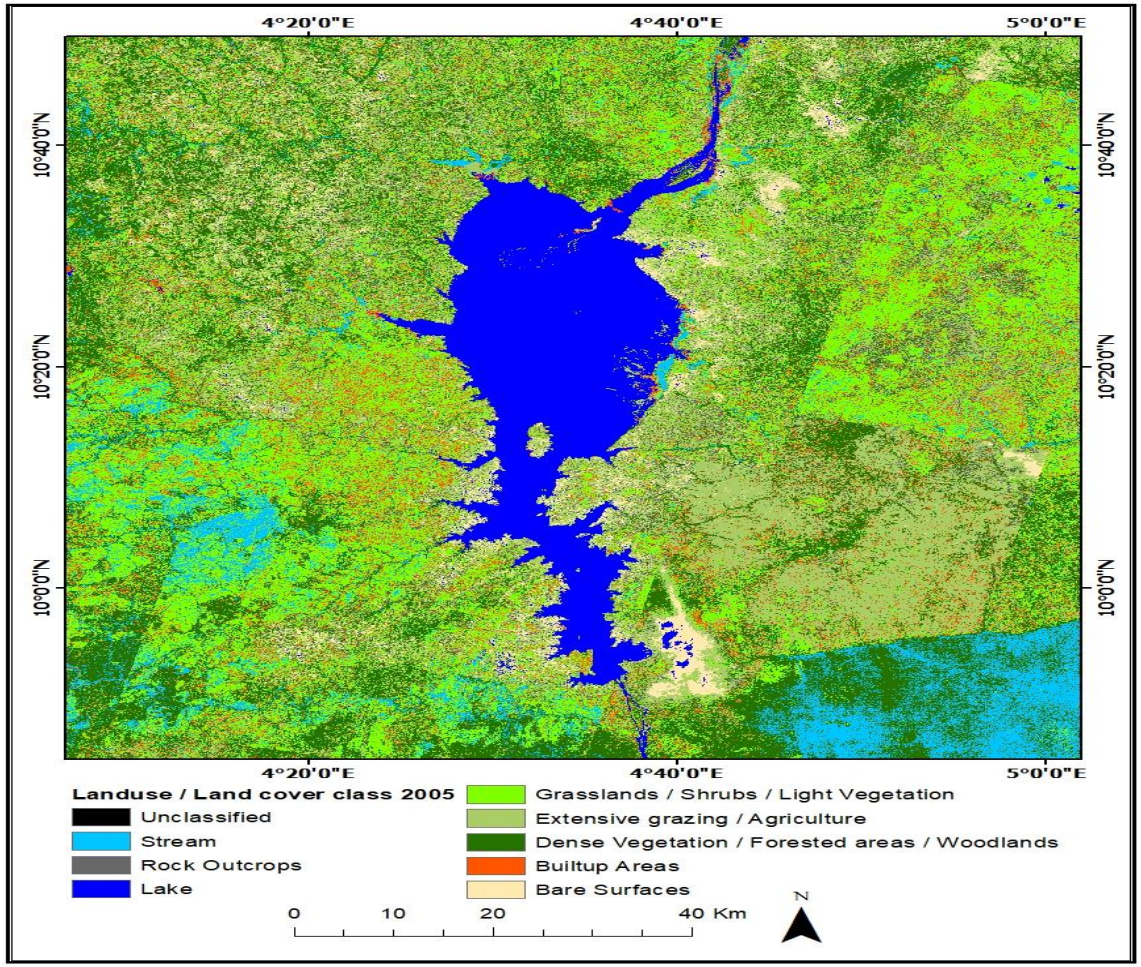

Fig. 5. Spatial Distribution of Land Use/land cover in 2005

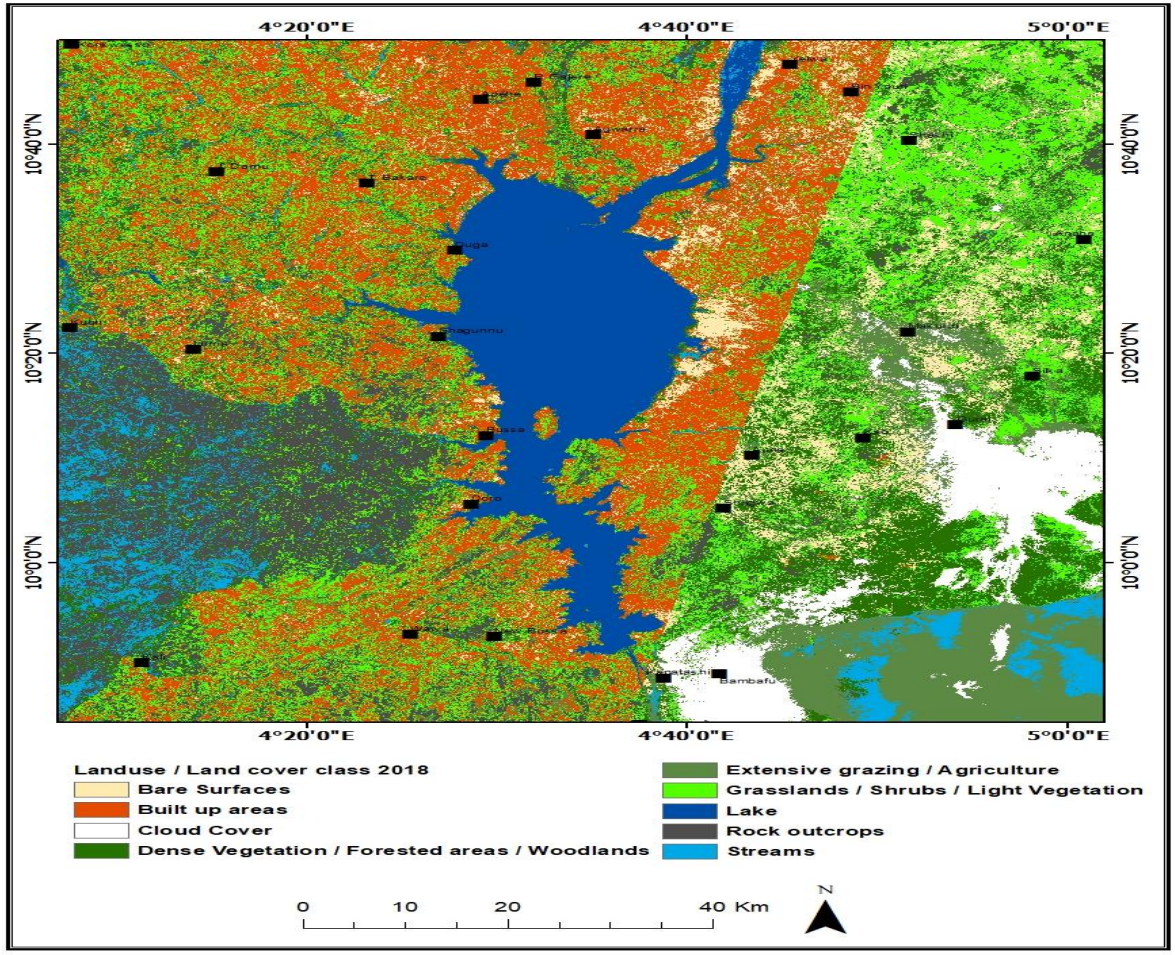

Fig. 6. Spatial Distribution of Land Use and land cover in 2018

4. CONCLUSIONS AND RECOMMENDATIONS

This paper found out that human activities are responsible for the degradation of the Kaiji Lake Basin. If this issue of land degradation is not appropriately dealt wiith, power supply and fisheries production will further reduced and this is detrimental to the development od Nigeria as a whole. Its important to point out here that, responsible authorities, government and the host communities can work harmonously to tackle the major environmental problems facing the fragile environment of the dams.

Finally, it is hoped that the findings from the study area will provide useful insight into the state of the environment, and the recommendations proposed in this paper would equally be helpful to mitigate, control and to improve the management of the dams.

The following recommendation were made:

i. The author strongly suggests that the main solution to deforestation has to start from local action. In other words a bottom-up approach between the responsible authorities and local people to work together in partnership to check deforestation is highly recommended.
ii. Tree planting and protection of existing vegetation from fire and land clearing should be also encouraged, as the restoration of degraded lands.
iii. Remote Sensing and GIS techniques are recommended for use in environmental monitoring and management of our already fragile environment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Abiodun AA. Waters of Lake Kainji - Hydrological Predictions and Perfomance. Hydrol. Sci. J. 2009;18:(3):321-327.
2. Jessy, EE, Igbokwe J.I, Etido E, Yakubu LS. Assessment of Water Level in Dadin Kowa Dam Reservoir in Gombe State Nigeria Using Geospatial Techniques. International Journal of Environment and Geoinformatics. 2019; 6(1):115-130.
3. Kamalu OJ, Wokocha CC. Assessment of Land Use Patterns and Land Cover Change in Igwuruta Area of Rivers State, Nigeria. IIARD International Journal of Geography and Environmental Management. 2019;5(1). ISSN: 2505 8821.
4. Okhimanhe AO. Assessment of Environmental Impact of Dam Construction in Nigeria: A Case Study of Tiga Dam, Kano State. An Unpublished M.Tech Disertation in Remote Sensing, Department of Geography, Federal University of Technology, Minna, Nigeria; 1993.
5. NEPA Diary. National Electric Power Authority, Federal Ministry of Power, Nigeria; 1995.
   Ogunwusi AA. The Forest Products Industry in Nigeria. African Research Review. Afr. J. Online. 2012;6(4):191-205.
6. Nedeco C, Balfour B. River Studies and Reformation on Improvement of River Niger and Benue. North Holland Publishing Company, Amsterdam; 1961.
7. Agboarumi B. Borgu: Past, Present and Future. Matanmi Press, Ilorin, Nigeria; 1997.
8. Olokor JO. The Climate of Kainji Lake Area.Annual Report of the Federal Ministry of Agriculture, Water Resources and Rural Development. National Institute for Freshwater Fisheries Research; 1995.
9. Mbagwu IG, Ladu BMB, Amadi AO. Contributions of the Seasonal and Long Term Flood Patterns of River Niger to the Development and Control of Water Hyacinth in Kainji Lake Nigeria.Annual Report of the Federal Ministry of Agriculture, Water Resources and Rural Development. National Institute for Freshwater Fisheries Research; 2002.
10. Ikusemoran M, Olokor JO. Monitoring the land-use and vegetation cover changes in the Kainji Lake Basin, Nigeria. Africa Journal of Environmental Science and Technology. 2014;8(2):129-142.
11. Anderson JR, Hardy EE, Roach JT, Witmer RE. A Land use and Land covers Classification System for use with Remotely Sensed Data. Geological Survey Professional Paper 964, Washington. D.C; 1976.
12. Eugene R. Agricultural and Landuse changes in West Africa: Drivers, impacts and strategies for sustainable agricultural intensification presented at the 13th

Conference of Parties to the UN Convention to Conservation of Migratory Species (CMS} at Mahatma Mandir in Gandhinagar; 17-18 Febraury, 2020.
13. Jijingi HE, Yuguda TK, Dauda PA. An Assessment of Changes in Land-Use and Land-Cover within the Kiri Lake, Nigeria (1976-2014). International Journal of Engineering Research. 2016;5(7):606-609.
14. Adeniyi PO, Omojola AS. Landuse and Landcover Changes in Sokoto-Rima Basin of North-West Nigeria, Based on Archival Remote Sensing and GIS Techiques. An African Association of Remote Sensing of the Environment (AARSE) on Geo-information Technology Applications for Resource and Environmental Management of Africa; 1999.
15. Daddy F, Pitan F, Aina E, Abubakar A. Establishment of NeochetinaEichomiaeand N. BruchiPopulatios for Water Hyacinth Control on Lake Chad. Annual report of the federal ministry of agriculture, water resources and rural development: National Institute for Freshwater Fisheries Research. Forestry Monitoring and Evaluation Unit (FOMECU), Federal Ministry of Environment, Abuja, Nigeria; 1995.
16. Henry MI, Augustine UO, Damilola O. Analysis of Poaching Activities in the Kainji Lake National Park, Nigeria. Environ. Nat. Resour. Res. 2013;3(1):51-61.
17. De young, C, Sinéad S, Sandy D, Antonia H. Climate change implications for fishing communities in the Lake Chad Basin. What have we learned and what can we do better? FAO/Lake Chad Basin Commission Workshop 18–20 November 2011. N'Djamena, Chad; 2012.
18. Mohammad AS, Syed S, Muhammad U, Amir W, Muhammad F, Abdur RK. The Impact of Suspended Sediment Load on Reservoir Siltation and Energy Production: a Case Study of the Indus River and Its Tributaries. Pol. J. Environ. Stud. 2012; 22(1):219-225.
19. Carolyne Lwenya, Ernest Yongo. Human aspects of siltation of Lake Baringo: Causes, impacts and interventions, Aquatic Ecosystem Health & Management. 2010;13(4):437-441.
20. Amusa TO, Aridanzi P, Haruna M. Ethnobotany and Conservation of Plant Resources in the Kainji Lake National Park. Ethnobotany Res. Appl. 2010;8:181-194.
21. Omojowo FS, Olowosegun T, Omojowo TM. Fish Consumption Pattern in Kainji Lake Areas. World Rural Observation. 2010;2(1):75-79.
22. Ogunwusi AA. The Forest Products Industry in Nigeria. African Research Review. Afr. J. Online. 2012;6(4):191-205.
23. Akintoye OA, Bisong FE, Utang PB, Andrew-Essien E. Impact of Logging on Non-Logged Species in the Moist Forest Region of South Eastern Nigeria. Journal of Environment and Earth Science. 2013; 3(3).
24. Nzeribe GE, Nwokoye E, Uwajumogu NR, Ezenekwe U. What Implications Does 2012 Flood Disaster Have on the Nigerian Economy? (March 8, 2014). Nigerian Journal of Energy and Environmental Economics. 2014;6(1):15-28.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/86082