FUDMA Journal of Earth and Environmental Sciences (FUDJEES), Vol. 1, No. 1, 2024

ASSESSMENT OF THE IMPACT OF GURARA DAM ON LAND USE/LAND COVER IN THE SURROUNDING COMMUNITIES OF KACHIA LOCAL GOVERNMENT AREA OF KADUNA STATE, NIGERIA

[*1]Bulus Elisha Gimba, [2]Solomon Moses Kwallah, and [3]Masugari Danjuma Yakubu

[1,2,3]Geography Department, Kaduna State College of Education, Kafanchan

***Corresponding Author's Email:** gimbabulus@yahoo.com

https://doi.org/10.33003/jees.2024.0101/06

ABSTRACT

The study assessed the impact of Gurara Dam on land use/land cover changes (LULCC) in the Kachia Local Government Area of Kaduna State. The study made use of geospatial techniques to assess the impact of the dam on land use/land cover changes within the period of study. Landsat data from 2001, 2012 and 2022 were acquired and processed to produce the land use/land cover maps of the area. The identified land use/land cover in the area were Built-up areas, Water bodies, Vegetation, bare land, and Rock outcrops. The Annual rate in land use/landcover changes was analyzed and the result revealed that, during the period 2001-2012, and 2012-2022 water bodies increased at an annual rate of 242% and 97% but reduced at an annual rate of 0.9%between 2012 and 2022. The analysis revealed that all the land use/land cover types identified in the study area recorded a net gain except vegetation. Water bodies gained about 5480 ha from 2001 to 2022. The study concluded that the construction of the Dam has altered the land use land cover dynamics of the area and there is also evidence of deforestation in the study area. The study recommends the control of land use in the basin and uses it as a guide to help in prioritizing the management of the basin and the dam among others.

Keywords: Impact, Landuse/landcover, Dam, Environmental, Development.

INTRODUCTION

All forms of life on earth rely on the sustainable presence of water. However, this important resource is unevenly distributed over the world. In most cases, the uneven distribution of the water is restored by constructing dams along rivers. A reservoir is a natural or artificial lake where water is stored before it is taken to where it would be used. Reservoirs are built for agriculture, domestic, hydro-electric power generation, and recreation most dam provides substantial benefits to human and their economies (Richter and Thomas, 2007). The expansion of dam construction schemes in most countries of the world has gone a long way in assisting the achievement of water sufficiency and poverty reduction. The socioeconomic benefits of dams are immense, but there are undeniable safety issues posed by aging dams, especially for people living in downstream or the ''inundation zone'' (Federal Emergency Management Agency, 2013). Dams are barriers constructed across a river to obstruct the flow of river water (Ahmad, Sa'id, and Alhasan, 2019). Most dams aid economic development. Hydroelectric power is crucial for economic, social, and environmental development among the different forms of energy. The knowledge is proven and obtainable. According to Chunwate, Yahaya, Samaila, and Ja'afaru, (2019), apart from the high cost of construction and maintenance, the direction cost of a dam ranges from 50 – to 100 years, which makes it easier for the builders to get back their next profit on time (Yuksel, 2009). The cost of technology is moderately small and it is high in efficiency about other means of power generation. In terms of cost, the energy is affordable compared to other conventional sources of electricity. Most developing countries prefer it to other alternative sources because of its moderate cost (Yuksel, 2009).

Dams have long been acknowledged for providing electricity, and flood protection and for making water available for agriculture and human needs (Worako, 2016). Within recent decades, however, the environmental impacts of dams have been debated. While dams do perform important functions, their effects can be damaging to the environment. The damming of a river usually comes with dramatic consequences on the nature of the environment both upstream and downstream of the dam. The magnitude of the effects is usually directly related to the size of the dam. Dam causes inundation of large areas upstream of dams thereby destroying riverine valleys, grassland, and Madama areas as while as sites of historical importance. The construction of a dam also impacts human livelihoods through the reduction of fish and other aquatic resources. It tends to displace a large number of people. For example, about 40 – 80 million people worldwide were physically relocated by dams in 2000 (World Commission on Dams, 2000). Native inhabitants engaging in subsistence lifestyles are the most heavily impacted by the loss of natural resources from hydropower (Jimme, Gwamna, and Ikusemoran, 2015).

Studies in the past showed that related environmental effects of dams comprise degradation of the upstream changes in part of the watershed, sedimentation, and changes in water quality and quantity. Other environmental effects of dams are loss of forest wildlife habitats, loss of vegetation cover, loss of soil quality, and the emission of greenhouse gases (from decomposing vegetation). The combined use of Remote Sensing with a Geographic Information System (G I S) has proven useful for the timely assessment of land-use/cover changes (Rawat, and Kumar, 2015). Many studies have investigated land use dynamic association with dam construction and reservoir impoundment using Remote and G IS Technologies Research conducted in various regions of the world has indicated that man's attempts to re-engineer and manage the shrinking and uneven water resources distribution conflict with natural systems. For example, Alemu, Garedew, Eshet, and Kassa, (2015), conducted research on the impact of the Kiri dam (Adamawa state Nigeria) on the land cover along the lower reaches of the Gongola River, they revealed that in the post-dam period, the impact of Kiri dam has resulted in substantial changes in the land cover with losses in shrubs and woodland, water bodies and grassland by 14.96%, 15.11%, and 35.04% respectively. A similar study was carried out in Pathankot and Dharkalan Tensils, Punjab (India). Balasubramanian, (2016), shows that within 15 years, there were major land cover changes (natural forest has changed into cropped land and build-up areas) due to man's efforts. Iwuji Iheanyichuku, Njoku Okpiliya, Anyanwu, Amangabara and Ukaegbu (2007) assess the land use changes and impacts of dam construction on Mbaa River Ikeduru Nigeria, their result shows that Mbaa River which is a very vital surface water resources for adjoining communities has been modified by construction of a dam. These effects or conflicts include inundation of farmlands upstream, landslides, soil erosion, etc. Additionally, Maureen Weiguo, Fanuel, and Xiaodao. (2018), evaluate the land use and cover changes on the Nkula dam in the middle Shire River catchment in Malawi.

The research result indicated that there was severe siltation downstream in the Nkula dam. This appears to be strongly linked to an increase in soil erosion as a result of the dam construction and the following changes were observed: Forest declined from 739 hectares (12. 07%) to 679 hectares (11. 08%), shrubland declined from 2201 hectares (33. 44%). While cultivated land increased from 1367 hectares (22. 33%) to 1538 hectares (25. 12%) and artificial surfaces increased from 26 hectares (0. 43%) to 28 hectares (0. 45%). W C D (2009) pointed out that, dams have significantly contributed to human development and the benefits from such have been known. A study carried out by Bature (2017) on the socio-economic impact of Curare Dam on the surrounding communities shows the contribution of the dam in terms of social amenities employment opportunities, agricultural activities, etc. Musa, Audu, Abdul, Usman, and Adamu. (2015) in their research on the impact of the Gurara dam on land use and land cover change game a robust platform for understanding the nature of the environmental impact of gigantic projects as that of the Gurara. The expansion of water in the reservoir will eventually extend to areas that were not initially covered by water. This will consequently result in changes in various activities in the study area. This is what the study intends to address.

STUDY AREA

The Dam is situated on the Gurara River between Lat 9°30'N-, 9°80''N and Long. 7'40''-7'50'' (Figure 1. 2). The Gurara River extends to about 570 km from the highland at over 700 m, 530 m through Jere, and into the Niger confluence at a height of 40 m. The River flows northeast to southwest and then turns southwards as it flows through FCT to its confluence with the river Niger. The study area is bounded to the South by Niger state, to the North by Kachia Local Government Area, and to the East and West by Kagarko Local Government Area respectively (Ishaya, 2014) as indicated in Figure 1.

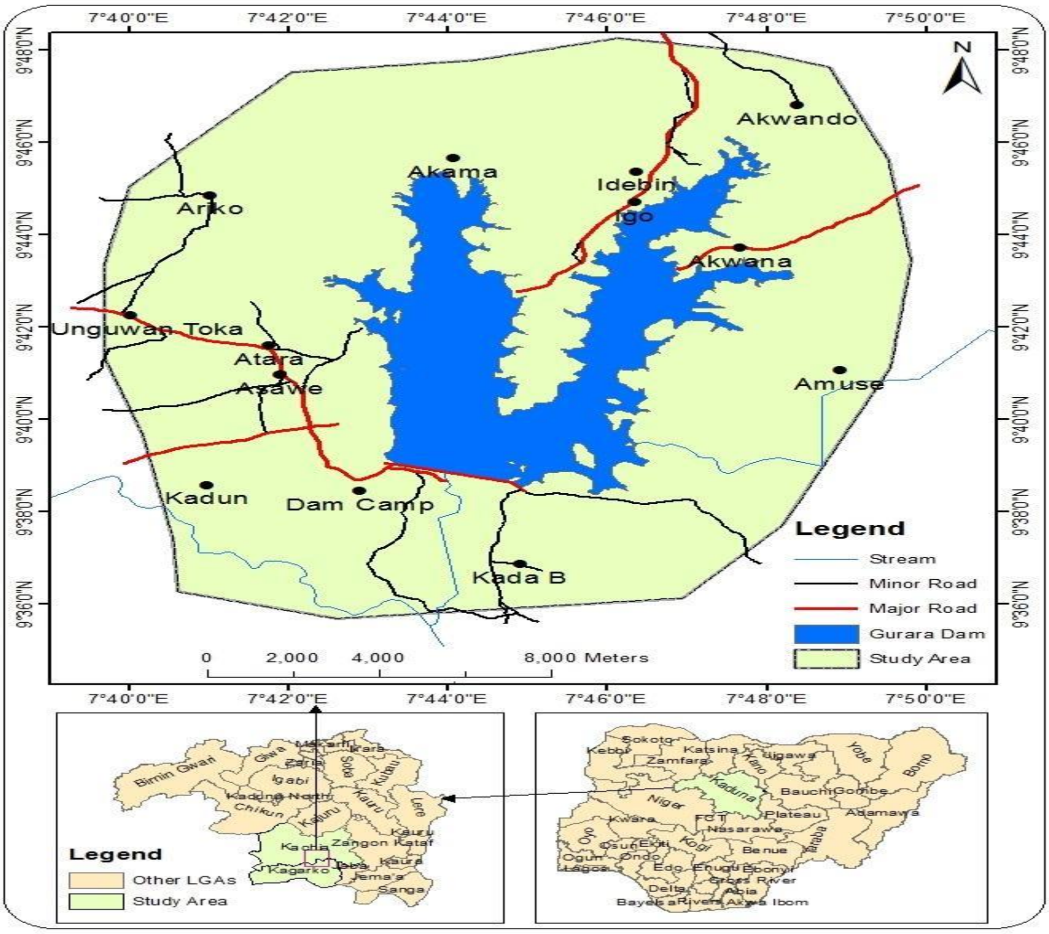

Fig. 1: Study area

Source: Modified from the Google map of the study area, 2022

MATERIALS AND METHODS

The study commenced with several reconnaissance surveys which were made to familiarise with the area and to acquire first-hand information. Hand-held Global Positioning System (GPS) was used to take readings of the coordinates for geo-referencing. Observations of interest that were relevant to the study were documented.

The research made use of qualitative methods to collect field data. This involves processing satellite imagery of the study area obtained for different periods (2001, 2012, and 2022) using ArcGIS 10.1 and ERDAS Imagine 9.0 software to produce land use land cover maps. The secondary data includes information from Institutions and Governmental Organizations relevant to the study and journal publications. A review of existing literature from published materials such as journals, textbooks, conference papers, unpublished thesis, selected reports, and other relevant articles from the internet.

Processing and Analysing of Satellite Imagery was done using:

a) Database Digital Change Creation**:** The hardcopy of the topographical map covering the study area was first converted into a digital database, using ArcGIS 10.1 and ERDAS Imagine 9.0 software. The process involves scanning the maps, followed by geo-referencing and raster-vector conversion. The final result was a vectorized land use/land cover map.

b) Rasterisation and Cross operation: The output from step 1 was rasterized to obtain the required data for the calculation of areas with ArcGIS version 10.1. In addition, computation (cross operation) was performed on the land use land cover maps for the periods (1990, 2000, 2005, and 2015) to measure the rate of changes over time.

c) Land use Land cover Area Calculation**:** Using the raster database generated the area coverage of each land use land cover class for the periods was calculated and presented in kilometer square. The attribute Table obtained from database shows the number of pixels for each Land use Land cover category and the area for each class in square metre. By applying the column operation function, the area coverage in the respective Land use Land cover classes was computed.

d) Geometric Correction: This was conducted to amend distortions due to earth curvature, atmospheric refraction, and relief displacement.

e) Appraisal of False Colour Composite (FCC): Three bands of color composite (Red, Green, and Blue) were assigned to one of the basic colors. These include Natural Colour Composite (NCC) and False Colour Composite (FCC) respectively.

To determine the spatial extent of the various land use land cover classes between 2001 and 2022 in the study area; the static LULC distribution of the resultant classification for each study year (2001, 2012, and 2022) was calculated in hectares within ArcGIS 10.6 software interface and tabulated

The annual rate of change of the various classes was calculated in Microsoft Excel using the following formula:

$$r\ (Ha) = \left(\frac{1}{t_2 - t_1}\right) * (S_2 - S_1) = \left(\frac{1}{t_2 - t_1}\right) * (S_2 - S_1)$$

$$r\ (\%) = \left(\frac{S_2 - S_1}{S_1}\right) * \left(\frac{1}{t_2 - t_1}\right) * 100\% = \left(\frac{S_2 - S_1}{S_1}\right) * \left(\frac{1}{t_2 - t_1}\right) * 100\%$$

Where r (Ha) and r (%) are the annual rates of change in hectares and percent respectively while S_1 and S_2 are areas of each LULC class at base year t_1 and reference year t_2 respectively.

LULC change analysis was conducted using a post-classification comparison (PCC) technique, and this resulted in a cross-tabulation (transition) matrix. The Land Use Land Cover Change (LULCC) transition matrix was computed using the overlay procedure in ArcGIS 10.6 to quantify the area converted from a particular LULC class to another LULC category during the study period. 'Combinatorial and Tabulate Area tools in the spatial Analyst extension of ArcGIS 10.6 were used to generate the change matrix.

RESULTS AND DISCUSSION

Land Use Land Cover (LULC) Classification

The land use land cover classification maps for the study area in 2001, 2012 and 2022 were generated and presented in Figures 1,.2, and 3. Table 1 shows the summary of the total land area for each land use land cover and the corresponding percentage of the total.

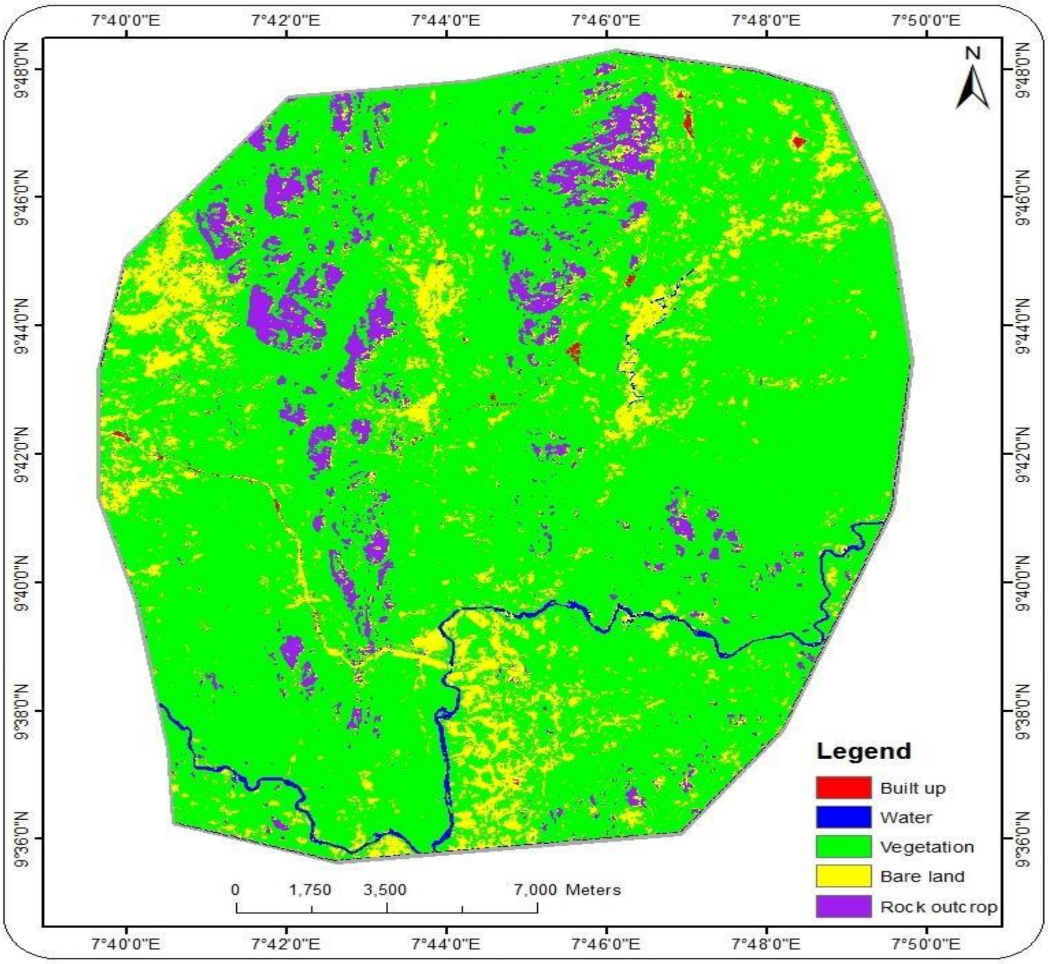

Figure 2: Land use land cover Classification in 2001
Source: Author's Analysis, 2022

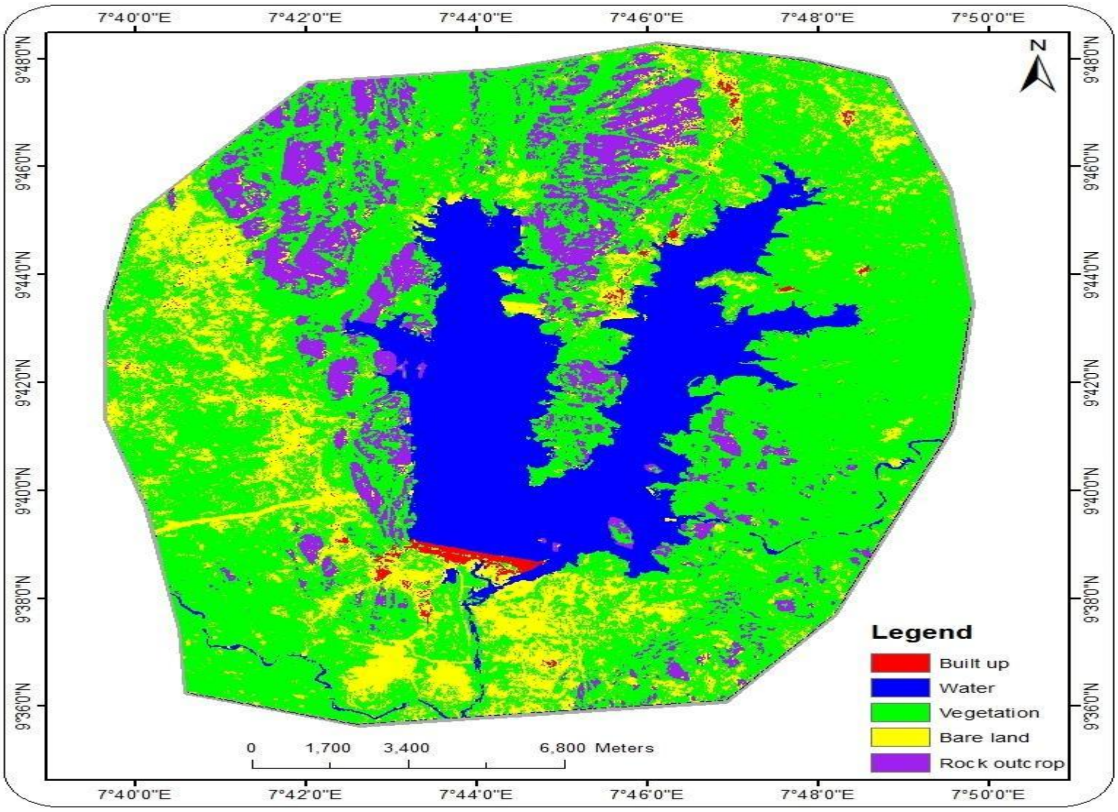

Figure 3: Land use land cover Classification in 2012
Source: Author's Analysis, 2020

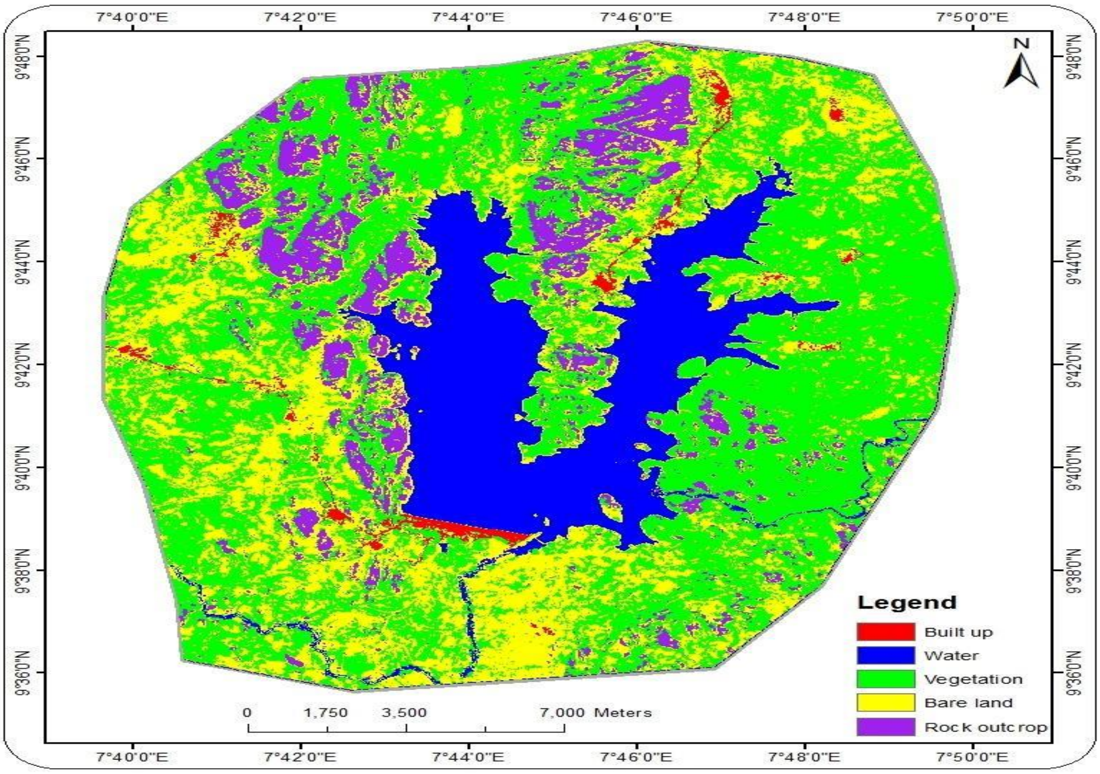

Figure 4: Land use land cover Classification in 2022
Source: Author's Analysis, 2022

Table 1: Extent in (Ha) of land use/landcover change for respective periods

	2001		2012		2022		Extend for change (2001-2022)
Class name	Ha	%	Ha	%	Ha	%	Ha
Built up	68.6	0.2	232.1	0.7	423.5	1.2	354.9
Water	308.3	0.9	6277.3	17.9	5691.4	16.2	5383.1
Vegetation	28568.7	81.5	19826.6	56.6	15974.8	45.6	-12593.9
Bare land	4066.3	11.6	5210.9	14.9	9734.5	27.8	5668.2
Rock outcrop	2033.9	5.8	3498.8	10.0	3221.5	9.2	1187.6
Total	35045.7	100	35045.7	100	35045.7	100	35045.7

Source: Author's Analysis

Table 1 shows that in 2001, Vegetation dominated the landscape with a proportion of 81.5% of the total land area. This is followed by bare land which occupied 11.6%. Built-up, water, and rock outcrop accounted for 0.2%, 0.9%, and 5.8% of the total area respectively. In 2012, Vegetation witnessed a significant decrease to 56.6% but still occupied the largest proportion of the study area. On the contrary, bare land, Water, Rock outcrop, and Built increased to 14.9%, 17.9%, 10%, and 0.7% respectively. The year 2012 also recorded a decrease in Vegetation, Rock outcrop, and Water to 45.6%, 9.2%, and 16.2% respectively. Bare land recorded a significant increase in proportion to 27.8% while built-up increased slightly to 1.2%. The increase in Built and Water land use land cover in the study area is a result of population growth and the construction of the Gurara Dam. Chunwate, Yahaya, Samaila, and Ja'afaru (2019) researched to analyze the changes in urban land use in the land cover of Lafia and the result revealed an increase in built-up areas from 1.56% to 15% between 1986 and 2014 while vegetation cover decreased from 25% in 1986 to 12% in 2014. This is not surprising because the increase in human population leads to urban development. Other human activities such as farming, grazing, and land excavation especially for road construction might be responsible for the increase in Bare land and reduction in Vegetation (Khan, Agarwal, 2015, Dalil, 2007).

Vegetation has shown a significant change in area extent of 12593.9Ha because most of the vegetation was converted to other land use/landcover followed by Ireland 5668.2Ha as the water retreat into the dam during the dry season's areas that were initially under water are exposed and converted to bare land, built-up areas shown little change in the area extend of 354.9Ha for the period under consideration.

Rate of Change in Land Use Land Cover

The annual change (magnitude) and rate of land use land cover were calculated in Microsoft Excel as shown in Table 2.

Table 2: Annual Rate of LULC Changes

Class Name	2001-2012		2001-2022		2012-2022	
	Change (Ha)	Rate (%)	Change (Ha)	Rate (%)	Change (Ha)	Rate (%)
Built up	20.44	29.81	19.72	28.75	19.14	8.25
Water	746.13	242.05	299.07	97.02	-58.59	-0.93
Vegetation	-1092.76	-3.83	-699.66	-2.45	-385.18	-1.94
Bare land	143.08	3.52	314.90	7.74	452.36	8.68
Rock outcrop	183.11	9.00	65.98	3.24	-27.73	-0.79

Source: Author's Analysis, 2022

According to Table 2, from 2001 to 2012 land, Rock outcrop, built-up, and Water increased by 3.5%, 9%, 29.8%, and 242.1% respectively, while Vegetation decreased by 3.8%. The increase in Water land use land cover during this period was as a result of the construction of the Gurara dam. Between 2012 and 2022, Vegetation, Water, and Rock outcrop slightly decreased by 1.9%, 0.9%, and 0.8% respectively but the Built and Bare land increased by 8.3% and 8.7% respectively. In general, between 2012 and 2022 Rock outcrop, Bare land, built, and Water increased by 3.2%, 7.7%, 28.8%, and 97% respectively while Vegetation decreased by 2.5% with the greatest reduction (3.8%) occurring from 2001 to 2012. This is in line with the discovery of Morenikeji, Umaru, Liman, and Ajagbe (2015) who monitored the land use land cover dynamics of Minna and found that natural vegetated area coverage decreased from 43.79% in 1986 to 0.20% in 1996 and extended to 24.32% in 2006, and later decreased to 5.77% in 2011 while the rate of growth of Built-up area between 1986, 1996, 2006 and 2011 were 0.81%, 2.93%, and 4.06% respectively.

Land Use Land Cover Change Analysis of Gurara Dam Area between 2001 and 2022

A conversion matrix was analyzed for the 2001 and 2022 periods to show the source and destination of the major LULCCs in the study area. Using the following steps

Data Preparation: The land use/land cover data for periods under consideration were gathered and each period was represented as a raster or a matrix where each cell corresponds to a specific land use/ land/cover category.

Create Transition Matrices: The study area was divided into distinct categories (e.g., waterbody, agriculture, built-up, bareland, etc) and created a transition matrix for each pair of periods. A transition matrix shows how land cover changes from one class to another over time. Rows and columns in the matrix represent the land cover classes, and the values in each cell indicate the number of pixels or areas transitioning from one class to another.

Normalize the Matrices: The transitional matrices were normalized to ensure that the values are proportional and can be compared across different matrices. This is typically done by dividing each cell value by the total number of cells in the corresponding row.

Correlation Calculation: Spearman rank correlation method was used to quantify the similarity or dissimilarity between the normalized matrices. The correlation coefficient for each pair of matrices was calculated. A positive correlation indicates similar patterns of land cover change, while a negative correlation suggests dissimilar changes.

Visualization: The results were visualized using maps, graphs, or other graphical representations. This can help in interpreting the spatial patterns and trends in land cover changes.

Consider Spatial Autocorrelation: Spatial autocorrelation was done to show the degree of similarity between neighbouring locations or land use/land cover changes. Consider analyzing spatial autocorrelation to account for the spatial dependence of land cover changes. In addition, the net gain and loss of each land cover category during the study periods were calculated while diagonal numbers in bold show the unchanged pixels

Table 3: LULCC Matrix of Gurara Area between 2001 to 2022 in Hectares and Percentage

	Built up	Water	Vegetation	Bare land	Rock outcrop	Total	Loss
Built up	**34.38**	8.19	4.68	20.43	0.90	68.58	34.20
Water	1.71	**211.50**	31.50	52.38	11.16	308.25	96.75
Vegetation	228.69	4425.39	**15206.58**	7696.71	1011.33	28568.70	13362.12
Bare land	148.68	1029.06	719.46	**1881.81**	287.28	4066.29	2184.48
Rock outcrop	10.08	17.28	12.60	83.16	**1910.79**	2033.91	123.12
Total	423.54	5691.42	15974.82	9734.49	3221.46		
Gain	389.16	5479.92	768.24	7852.68	1310.67		
Net	354.96	5383.17	-12593.88	5668.20	1187.55		

Source: Author's Analysis, 2022

Table 3 reveals that 34.4Ha of Built in 2001 remained unchanged and 34.2Ha was converted to other LULC types by 2012. Most of the Built in 2001 was converted to bare land (20.4Ha) and Water (11.9Ha) because it was the period of the construction of the reservoir and the inhabitants of the area were relocated to create room for the reservoir and avoid possible destruction of life and properties as a result of the construction of the reservoir. By 2012, land use and land cover witnessed a net gain of about 355 ha from other LULC types. This may be due to the construction of the Gurara dam which led to the influx of people to the area for employment opportunities. Lasisi, Popoola, Adediji, Adedeji and Babalola (2017) conducted similar research in eight peri-urban areas and the result revealed that built-up had increased from 6.6% in 1986 to 20.11% in 2014 at the expense of a vegetative cover. About 211.5Ha of Water in 2001 remained unchanged in 2012 but 52.4Ha and 31.5Ha were converted to bare land and Vegetation. Water recorded a gain of 5480Ha mainly from Vegetation and Bare land. The increase in the area extent of water land use land cover in the area is due to the construction of the Dam. Vegetation gained 768.2Ha but recorded a net loss of about 12593.9Ha to others and was mainly converted to bare land (7696.7Ha) and water (4425.4Ha). Bare land experienced a net gain of 5668.2Ha and most of the gains were from Water (1029.1Ha) and vegetation (719.5Ha). Rock outcrop lost about 123Ha and gained about 1187.6Ha from others. Generally, land use and land cover change can result in soil degradation, the removal of topsoil, to loss of soil fertility, and the depletion of biodiversity, which in turn leads to the irreversible deterioration of natural resources.

CONCLUSION AND RECOMMENDATIONS

This assessed the impact of the Gurara dam on land use and land cover changes in Kachia Kaduna State using the geospatial technique. This study has provided information on land use and land cover changes in the surrounding area of Gurara Dam from 2001 to 2022. Based on the results of this study it can be concluded that the construction of the dam has altered the land use land cover dynamics of the area. There is also evidence of deforestation in the study area.

The nature of land use in the basin must be controlled and used as a guide to help prioritize the management of the basin and the dam. Increasing bare surfaces or loss of vegetation cover may spell doom due to rapid erosion, sediment transport, and sedimentation of the dam.

REFERENCES

Alemu, B., Garedew, E., Eshetu, Z. and Kassa, H. (2015). Land Use and Land Cover Changes and Associated Driving Forces in North Western Lowlands of Ethiopia. *International Research Journal of Agricultural Science and Soil Science,* 5(1): 28-44.

Balasubramanian., (2016). Supervised/Unsupervised Classification of LULC using Remotely Sensed Data for Coimbatore City, India. *International Journal of Computer Applications, 2* (No.7), pp. 26 – 30.

Chunwate, B.T., Yahaya, S., Samaila, I.K. and Ja'afaru, S.W. (2019). Analysis of Urban Land Use and Land Cover Change for Sustainable Development: A Case of Lafia, Nasarawa State, Nigeria. Journal of Geographic Information System, 11, 347-358. https://doi.org/10.4236/jgis.2019.113021.

Dalil M (2007). Assessment of land use and land cover along the lower reaches of Gongala River as a result of the impact of Kiri Dam. Unpublished PhD thesis summated to Federal University of Technology, Minna Nigeria.

FEMA (2013) Living with dams: know your risk. rep Fema P-956, 25pp google scholar. FEMA federal emergency Management agency.

Ishaya S. (2014) Analysis of The Ginger, Maize, and Soybeans Marketing in Kachia Local Government Area Kaduna State, Nigeria

Iwuji, M.C., Iheanyichukwu, C.M., Njoku J.D., Okpiliya F.I Anyanwu S.O Amangabara G.T and Nkaegbu K.O.E (2017). Assessment of the land use changes and impact of dam construction on the Mbaa River, Ikeduru, Nigeria. Journal of Geography, environment, and earth science International. Department of Environment Technology, Federal University of Technology, Owerri Nigeria.

Iwuji, M.C., Iheanyichukwu, C.M., Njoku J.D., Okpiliya F.I Anyanwu S.O Amangabara G.T and Nkaegbu K.O.E (2017). Assessment of the land use changes and impact of dam construction on the Mbaa River, Ikeduru, Nigeria. Journal of Geography, environment, and earth science International. Department of Environment Technology, Federal University of Technology, Owerri Nigeria.

Jimme, M.A., Gwamna, A.I. and Ikusemoran, M. (2015). Land use and Land cover Change Detection in Kuje Area Council of the Federal Capital Territory (FCT), Abuja, Nigeria. IOSR *Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*, Volume 9, Issue 10 Ver. I, PP 01-11.

Khan, Y., Agarwal, K., (2015). Supervised/Unsupervised Classification of LULC using Remotely Sensed Data for Coimbatore City, India. *International Journal of Computer Applications, 2* (No.7), pp. 26 – 30.

Lasisi, M., Popoola, A., Adediji, A., Adedeji, O. and Babalola, K. (2017). City Expansion and Agricultural Land Loss within the Peri-Urban Area of Osun State, Nigeria.

Maureen K.M Weiguo Z, Manuel K and Xiaodao W (2018). The impact of land use and land cover change on the Nkula sam in the Middle Shire River catchment. Geospatial analysis of earth observation data, Antonio Pepe and Qing Zhao, intech open, doi: 105772. Google scholer.

McCully, P. (2001). *Silenced Rivers: The ecology and politics of large dams*. London: Zed Books.

Morenikeji, G., Umaru, E.T., Liman, S.H. and Ajagbe, M.A. (2015). Application of Remote Sensing and Geographic Information System in Monitoring the Dynamics of Land Use in Minna, Nigeria. *International Journal of Academic Research in Business and Social Sciences*, Vol. 5, No. 6. DOI: 10.6007/IJARBSS/v5-i6/1682.

Musa, D. Audu P.M Abdul H, Usman MB Adamu A (2015). Assessment of the impact of Gurara Dam on land cover in the surrounding communities A journal of Environmental and Earth Science, Department.

Rawat, J.S. and Kumar, M. (2015). Monitoring land use/cover change using remote sensing and GIS techniques: A case study of Hawalbagh block, district Almora, Uttarakhand, India. The *Egyptian Journal of Remote Sensing and Space Sciences*, 18, 77–84.

Richter B.D and G.A Thamas(2007). Restoring environmental flows by modifying dam operations Eco/soc 12,12 Google Scholar.

Worako, A.W. (2016). Land Use Land Cover Change Detection by Using Remote Sensing Data in Akaki River Basin. *International Journal of Environment*, *Agriculture and Biotechnology (IJEAB)*, Volume 1, Issue 1, pp. 1-10.

World Commission on Dams (WCD) (2000). Dams and Development A. new framework for decision-marking. London and steering Va: earth scan Compaigns world –commission –on –dams.

Yuksel (2009) of Urban and Regional planning federal university of Technology, Minna, Niger, Nigeria.