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"Effect of Shagari Earth Dam on Farming Activities within it's Immediate Environment"

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Abstract:*This study used geospatial techniques based on multi-source imageries to investigate the effects of Shagari earth dam on its immediate environment in Shagari LGA of Sokoto State. The remotely sensed datasets used include Landsat TM 1994, Landsat ETM+ 2005 and Landsat OLI/TIRS 2014 which covered a period of 20 years. A supervised classification using maximum likelihood was also done on the images in other to delineate and identify the different land/use land/cover classes. The result of the land use land cover classification revealed an increase with waterbody Landsat TM 2005 having 0.98% and farmland 15.40%, Landsat ETM+ 2005 with waterbody 1.67% and farmland 37% and Landsat OLI 2014 with waterbody 7.79% and farmland 50% respectively over the years. In the change detection results, bareground decreased from 292.9581km^2 in 1994 to 65.8458km^2 in 2005 and 78.9786km^2 in 2014. Vegetation also recorded an increase from 43.2126km^2 in 1994 to 193.1958km^2 in 2005, while in 2014 it experienced a decrease to 85.9104km^2. Waterbody showed a continuous increased throughout the study, it increased from 4.1886km^2 in 1994 to 7.1748km^2 in 2005 and 33.4476km^2 in 2014. Farmland has been identified to be the dominant land/use with a significant continuous increase over the years. It increased from 66.1266km^2 in 1994 to 159.0939km^2 in 2005 and 215.5941km^2 in 2014.*

Keywords: *Change Detection, Landsat OLI/TIRS, Remote Sensing, Shagari earth dam, Vegetation,*

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I. Introduction

Scholars have found that earth observation data along with advancing geospatial technologies have supported the inventory, assessment and monitoring of natural resources system including dams worldwide (Davidson and Finlayson, 2007). Human activities are considered as one of the most important components of the terrestrial environment system (Lin *et al*., 2009). Deviations in the pattern of landuse/landcover give a reflection of the impacts and effects of human activities on the environment. On a global scale, these changes have been known to have impacts on continental and global atmospheric circulation leading to even larger impacts on regional and continental climate (Lambin and Geist, 2006). Numerous studies have investigated the complex relationships which exists between land surface and other components of the climate at the local to global scales, detailing the differences in magnitude of land surface changes in different geographic localities over the Earth (Betts *et al*.1996; Pielke, 2002).

As a result of these researches, there is profound evidence indicating that large-scale landuse/landcover changes, particularly in the tropics, induce remote climatic effects of global extent far from where the surface has been directly affected by land-cover changes (Franchito and Rao, 1992; McGuffie *et al*. 1995; Pielke, 2002; Zhang *et al*., 1996). Dams are one of the most important tools or mechanisms used in the utilization of the hydrological resources. They have been in existence dating to hundreds of years before gaining present information about hydrology and hydromechanics. These are not ordinary engineering constructions. Dam projects, which are useful in meeting the need for water in desired times and in regulating stream regimes, have played an important role in the development of civilization.

Over the years, dam have been developed, designed and constructed in order to prevent floods, to supply drinking and domestic purposes, to generate hydroelectric energy and for irrigation practices since the old-times.However, dams have a great potential for both positive and negative effects on the environment asides their benefits like controlling stream regimes, consequently preventing floods, obtaining domestic and irrigation water from reservoir and maintaining optimum leverage for generating energy. Dams have a high potential for considerable damage to living organisms as well as the environment as a whole in addition to their advantages such as meeting basic requirements of the society and increasing living standards. During the course of the construction and completion of these dams, it was observed that there was something missing and detrimental. Although the effects of water on human life and the development of civilizations are well-known all over the world, it is claimed that the economic benefits expected from the projects designed to utilize water resources could not be gained and also necessary precautions to decrease the environmental, economic and social losses were not taken.

In any case, the ecological effects/results of a dam on the environment is the same, no matter the location. The environmental impacts of dams can be classified according to different criterions as long term and short term impacts, the impacts on the close area and the impacts on the regions where the dam services, social and unsocial impacts, beneficial and harmful impacts. These effects may be ordered in an intensive and complicated manner like climatic, hydraulic, biological, social and cultural. Shagari earth dam resources is currently being threatened by various anthropogenic activities and natural factors. Notable among the human factors are population pressure, rapid rate of urbanization, over tilling of land for crop production, over-grazing, logging of wood, unprecedented land reclamation and the construction of the dam itself. Climatic factors which could have over time affected the life of the earth dam include drought and desertification which is attributed to dryness and also flooding that occurs as a result of heavy rainfall among others.

Nevertheless, the construction of Shagari dam is overwhelming whether one talks of economic, biological reserve, culture and ecology. The demand for irrigation and agricultural developmental purpose leads to its construction in the 20th century. This has often resulted in higher frequency of near flooding. The use of remote sensing data in recent times has been of immense help in monitoring the changing pattern of different land cover types. Change detection, as defined by Hoffer (1978) is the temporal effects as variation in spectral response that involve situations where the spectral characteristics of the vegetation or other land cover type in a given location change over time. Singh (1989) described change detection as a process that observes the differences of an object or phenomenon at different times.

Study Area

The place,Shagari (2001; p.5) described it`s origin in his book titled "Beckoned to Serve". He mentioned that Dan Fodio reportedly said "you can remain and sha (enjoy) your gari (millet flour)"; it isa valley located in Shagari Local Government Area, Nigeria. The dam falls between latitudes 12^{0}37'44"N and 12^{0}39'N, Longitudes 4^{0}59'E and 5^{0}14'31"E. It is located south east of Sokoto city. Shagari falls into the typically tropical climate which has distinct wet and dry season. The study area itself is situated in the arid and Semi-arid areas of Northern Nigeria (Yelwa, 2012)(fig.1.1).

The climate of the study area is tropical continental and is dominated by two opposing air masses, the dry tropical continental blowing from the Sahara Desert and moist Tropical maritime blowing from the North Easterly direction, the later comes from South-Westerly direction (Davis, 1982). These two major air masses result in two major seasons, the wet and dry season. While the rainy season commences from mid-April and lasts to the end of September, the dry season extends from early October to May.

The Harmattan period is characterized by a dry, cold and dusty wind experienced in the state between November and February. During this period, the weather is usually cold at night and in the morning with temperature often dropping to less than 20^{0}C in some cases (Davis, 1982). Temperatures are highest from late March to May, ranging from 35^{0}C to 45^{0}C. Mean annual rainfall is about 600mm with most of it falling in July and August. Over the last fifty years, the rainy season has been characterized by late arrivals of rains, long spells of aridity of up to 21 days and early cessations, this is a suggestive of climate change (Iliya, 2013).

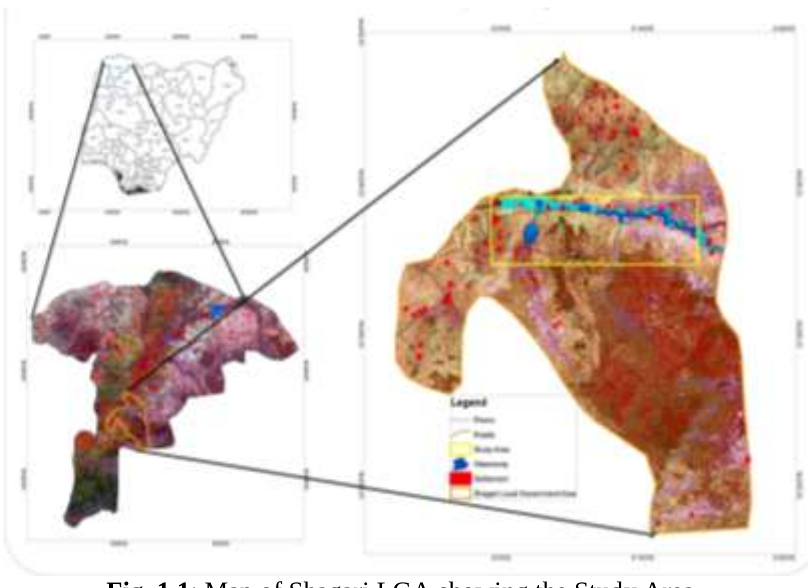

Fig. 1.1: Map of Shagari LGA showing the Study Area.
(***Source: National Space Research and Development Agency, 2015***)

II. Literature Review

Throughout the course of the past millennium, human beings have played an increasingly large role in the modification of the environment on a global scale. With increasing numbers and developing technologies, man has emerged as the major, most powerful, and universal instrument of environmental change in the biosphere today. Globally, land cover today is altered primarily by direct human use. Any conception of global change must include the pervasive influence of human action on land surface conditions and processes (Yang, 2001).

Lambin and Strahler (1994) listed five categories of causes that influenced land-cover change: a) long-term natural changes in climate conditions, b) geomorphological and ecological processes such as soil erosion and vegetation succession, c) human-induced alterations of vegetation cover and landscapes such as deforestation and land degradation, d) inter-annual climate variability and e) the greenhouse effect caused by human activities. According to Ringrose *et al.* (1997) LULC change in Africa is currently accelerating and causing widespread environmental problems and thus needs to be mapped. This is important because the changing pattern of LULC reflect changing economic and social conditions.

III. Materials andMethod

Remote Sensing, Geographic Information System as well as other relevant techniques have been used in the acquisition, processing, interpretation, analysis and presentation of the results and findings of this research work. Satellite Remote Sensing has been proven to be a useful tool in the assessment of the landuse/landcover patterns for the purpose of development, monitoring and management. This has made it possible through the use of satellite imagery in the implementation of various applications as well as the aim of this research. Remote Sensing generally, has a high efficiency and accuracy which cannot be doubted given the fact that the acquired data is precise and credible.

3.1 Data Acquisition

For the purpose of this study three satellite imageries of different time periods: - Landsat TM 1994, Landsat ETM 2005, and Landsat 8 year 2014 have been used in the detection on farmlands in the study area. For the purpose of feature extraction, a SPOT 5 (2005) 5m resolution satellite image was also used. All the satellite images were obtained from the Global Land Cover Facility (GLCF) an Earth Science Data Interface, with the exception of the Spot 5 satellite image which was acquired from National Space Research and Development Agency in Abuja (NASRDA). The study area was clipped out of the local government area as well as the topographic map which was also acquired from the NASRDA. These were then projected in the World Geodetic Survey (WGS) 1984 coordinate system. The materials used for the purpose of this study are listed in Table 1.

Table 1: Data and Materials for the Research

S/N	Data type	Date Acquired	Scale	Source
1.	Landsat image	2001	30m	GLCF
2.	Landsat image	2005	28.5m	GLCF
3.	Landsat image	2014	5m	GLCF
4.	SPOT 5	2005	30m	NASRDA
5	Shuttle Radar Topographic Mission	2010		NASRDA
5	Admin and LGA Map of Sokoto.	2005	Variable	NASRDA

3.2. Software Used

Basically, five software were used for this project viz;

a. ArcGIS 10.1 – this was used for displaying and subsequent processing and enhancement of the image. It was also used for the carving out of the study area from the larger image of Sokoto state using both the administrative and local government maps.

b. ENVI -This was used for the development of land use land cover classes and subsequently for change detection analysis of the study area.

c. Microsoft word – was used basically for the presentation of the research.

d. Microsoft Excel- was used in producing the bar graph and other charts for data presentation.

3.3 Image Processing

Raster operations such as filtering and stretching of individual bands of the images were carried out to enhance the radiometric resolutions and visual interpretation of the satellite's imageries. Colour composite operation was carried out in band 4, 3, 2 of the Landsat images were illuminated by Red, Green and Blue lights. This gave rise to a false colour composite image which shows the study area in different varieties of blue colour and vegetation in the usual reddish variations.

3.4 Land Cover Classification

Image classification is performed to identify and assign real world thematic classes to the image pixels. In this study, image classification was done in two stages, by performing an unsupervised classification to assist in collecting additional training samples for supervised classification; and the use of maximum likelihood classification algorithm was selected because it has the ability to incorporate the statistics of the training samples before assigning the land covers to each pixel. The Landsat image bands used for the classification were the visible, near-infrared, middle and far-infrared.

After image classification the land cover maps will be filter generated with the majority of the filters are to remove the “salt-and-pepper appearance” (Lillesand and Kiefer, 2000) and to enhance the cartographic presentation. The land cover classes when generated will indicate built-up, vegetation, water body and bare surface/ground and farmlands. See Table 3.3 for the display of the nomenclature use for the land covers.

The Maximum Likelihood classification assumes that spectral values of training pixels will be statistically distributed according to a 'multi-variate normal (Gaussian) probability density function'. For each set of spectral input values, the distance towards each of the classes will be calculated. The class name with the shortest distance will be assigned to determine whether the distance is smaller than the user-defined threshold value, otherwise the undefined pixel value will be assigned at random. The different images however, will be classified based on the above mentioned classification characteristics.

IV. Results andDiscussion

4.1 Results/Land Use Classes

The presentation of results is carried out on the basis of a sequential order according to how they were interpreted. Figure 4 shows the result of classified Landsat TM of 1994 image. The land use/land cover was classified into five (5) different classes namely; bareground, farmland, waterbody, built-up area and vegetation. The bareground class for the year 1994 covers 68.21%, farmland covers 15.40%, waterbody covers 0.98%, built-up area covers 5.3%, while vegetation covers 10.06% of the total land area respectively as shown in Fig 4.1, as represented in Fig 4.1 and Table 2. The total land coverage area in square kilometres of the land use/landcover classes is also indicated in table 2.

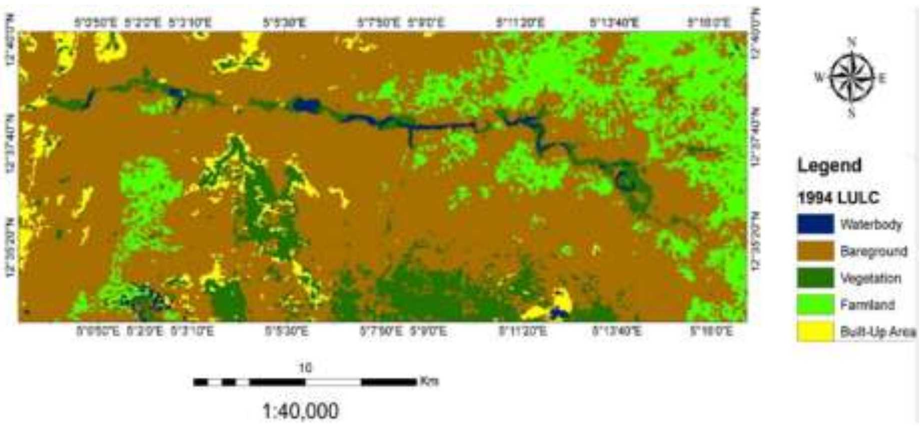

Fig. 4: classified Landsat TM for 1994

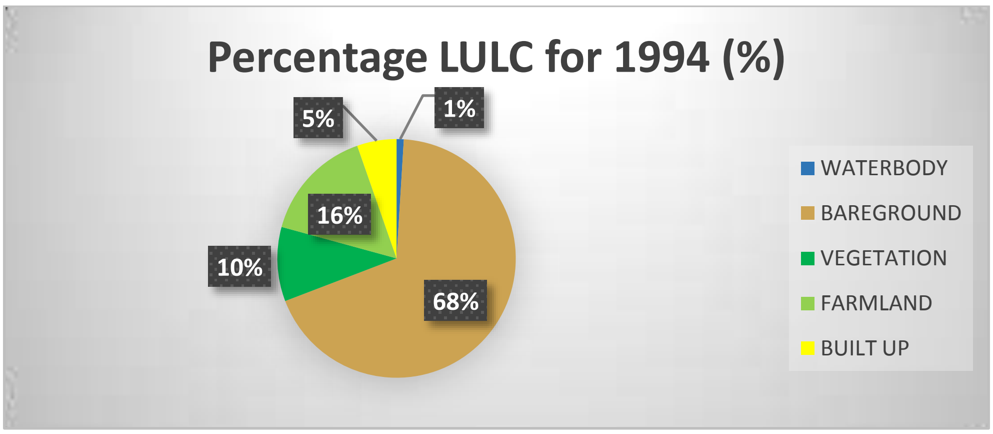

Fig. 4.1: pie chart showing percentage of LULC for 1994

Table 2: LULC Total Area and Percentage for 1994

CLASS	AREA(Km^2)	PERCENT
Waterbody	4.1886	0.98%
Bareground	292.9581	68.21%
Vegetation	43.2126	10.06%
Farmland	66.1266	15.40%
Built up	22.9878	5.35%
Total	429.4737	100.00%
Overall Accuracy		(483/678) 71.2389%
Kappa Coefficient		0.6034

Source: Author 2015

Fig 4.2, shows the result of the classified Landsat ETM+ of 2005 and also displayed in graphical representation in Fig 4.3. Table 3, shows the percentage coverage of the landuse/landcover classes. Bareground covers 15.33%, farmland covers 37.04%, waterbody covers 1.67%, built-up area covers 0.97%, while vegetation covers 44.985 of the total land area as shown in table 3. The total land coverage area of the landuse/ landcover classes in square kilometres is also indicated in table 3.

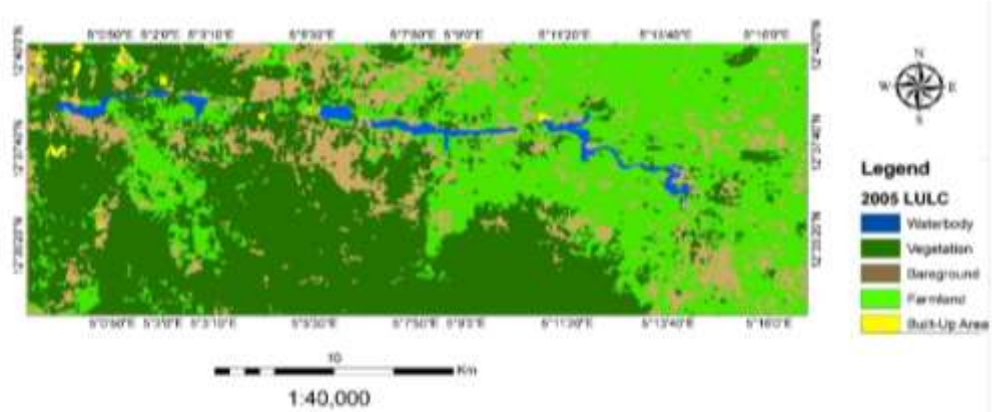

Fig. 4.2: Classified Landsat ETM+ for 2005

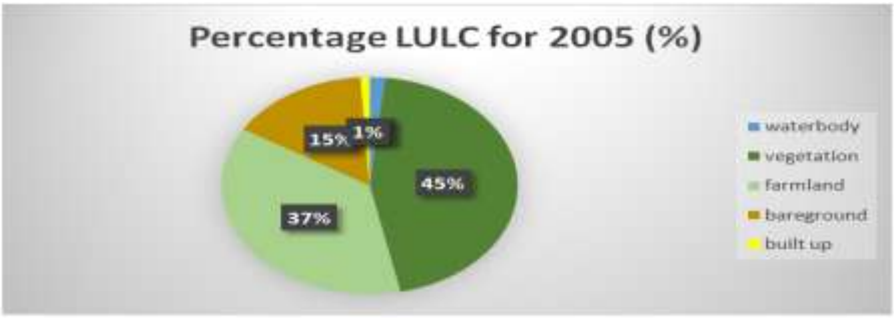

Fig. 4.3: Pie chart showing percentage of LULC for 2005

(Source: Author's work 2015)

Table 3: LULC Total Area and Percentage for 2005

CLASS	AREA(sqkm)	PERCENT
waterbody	7.1748	1.67%
vegetation	193.1958	44.98%
farmland	159.0939	37.04%
bareground	65.8458	15.33%
built up	4.1634	0.97%
Total	429.4737	100.00%
Overall Accuracy		(1862/2018) 92.2696%
Kappa Coefficient		0.8933

Source: Author 2015

Fig 4.4, shows the result of the classified Landsat 8 image and also displayed in graphical representation in Figure 4.5. Table 4, shows the percentage coverage of the landuse/landcover classes. Bareground covers 18.39%, farmland covers 50.20%, waterbody covers 7.97%, built-up area covers 0.97%, while vegetation covers 20% respectively. Table 4 also shows the total land coverage area of the landuse/landcover classes in square kilometres. The accuracy assessment and kappa coefficient of the classified images are also represented in tables 4.

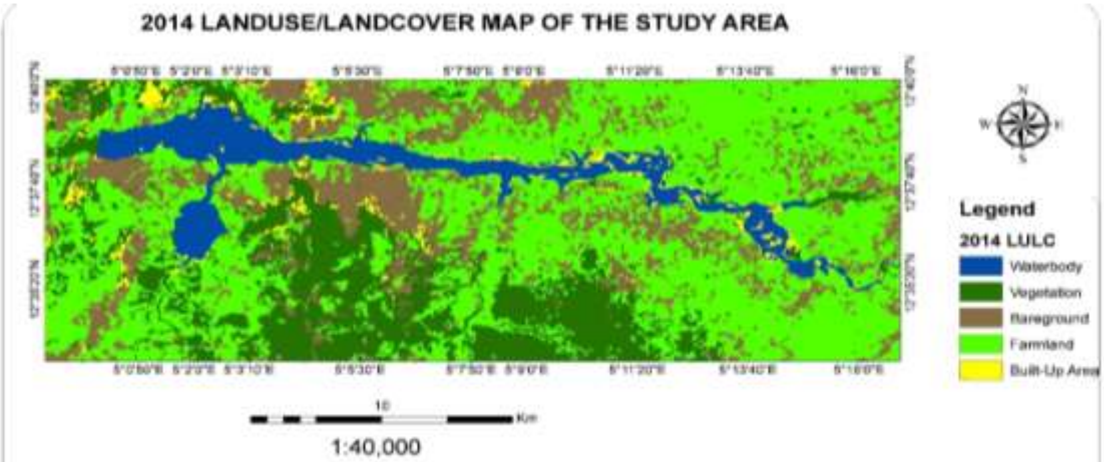

Fig. 4.4: Classified Landsat 8 for 2014

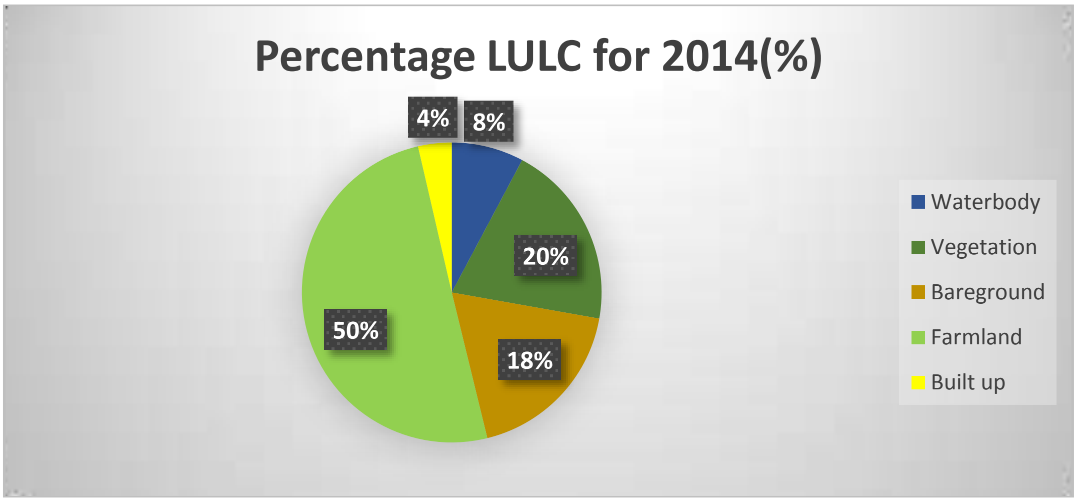

Fig. 4.5: Pie chart showing percentage of LULC for 2005

(Source: Author's work 2015)

Table 4: LULC Total Area and Percentage for 2014

CLASS	AREA(Km^2)	PERCENT
Waterbody	33.4476	7.79%
Vegetation	85.9104	20.00%
Bareground	78.9786	18.39%
Farmland	215.5941	50.20%
Built up	15.543	3.62%
Total	429.4737	100.00%
Overall Accuracy		(2063/2327) 88.6549%
Kappa Coefficient		0.8537

Source: Author 2015

4.2 Discussions of Findings

The classified image of 1994 in figure 2, shows that bare ground covers the largest area292.9581km^2, followed by farmlands 66.1266Km^2, waterbody covers 4.1886Km^2, vegetation covers 43.2126Km^2, and built up area has an area of 22.9878Km^2. From the result of the landuse/landcover done, it can be seen that over 50% of the study area was covered by bareground, the class with the least total area coverage is the waterbody. It can be seen that due to the low coverage of the waterbody, vegetation and farmlands were not much, compared to the bareground and there were little anthropogenic activities.

The classified image for the year 2005 shows that farmland has increased from 66.1266Km^2in1994 to 159.0939Km^2in 2005. The increment could be attributed to the increase in waterbody from 4.886Km^2 in 1994 to 7.1748Km^2 in 2005. The areal coverage of bareground reduced drastically from 292.9581Km^2 in 1994 to 65.8458Km^2 in the year 2005. In the year 2005, the classified image also showed an increase in the vegetation cover from 43.2126Km^2 in 1994 to 193.1958Km^2. The built-up area also suffered a decrease as compared to its previous coverage of 22.9878Km^2 in 1994 to 4.1634Km^2 in 2005, most of the built up area lost was around the water body and as such the loss in area cover can be attributed to the increase in water body.

In the 2014 image of the area, the results of the classification showed that farmland increased greatly from66.1266Km^2 in 1994, to 159.0939Km^2 in the year 2005 and 215.5941Km^2 in 2014, vegetation recorded a decrease in areal coverage, from193.1958Km^2 in 2005 to85.9104Km^2 in 2014, built up area also built up area and bareground were also among the classes which showed a positive increase in areal coverage; with built up increasing from 4.1634Km^2 in 2005 to 15.543Km^2 in 2014. Bare ground increased from65.8458Km^2 in the year 2005 to 78.9786Km^2 in 2014.

4.3 Change Detection

From the results of the interpreted satellite imagery for the different years, various changes have occurred on each of the classes defined while carrying out the classification; these were discussed individually and a side by side comparison was also carried out between classes in the images of different years.

4.3.1 Built-Up Areas:

The interpreted satellite imagery of the three different periods has revealed a sharp decrease and also an increase in the built-up areas over a period of 20 years. There is a remarkable decrease between 1994 and 2005; with a recovery between 2005 and 2014 as displayed in the bar chart of Figure 4.6. Thus, this can be related to expansion of settlements and other socio-economic activities which has taken place with increase in the population over the period. In 1994, the built up areas covered 22.9878Km^{2}about 5.35% of the land use/land cover of the area. However, it experienced a sharp decrease in the year 2005 from 22.9878Km^2 to 4.1634 about 0.97%, by 2014 the built up areas increased up to 15.543Km^{2}about 3.62% of the land use/land cover of the area as shown in Figure 4.6. The change in area between 1994 and 2005 is 18.8244Km^2 while the change between 2005 and 2014 is 11.3796Km^2. Figure4.7, also shows the map of built up area changes over a period of 20years.

Fig. 4.6: Bar chart for built up areas

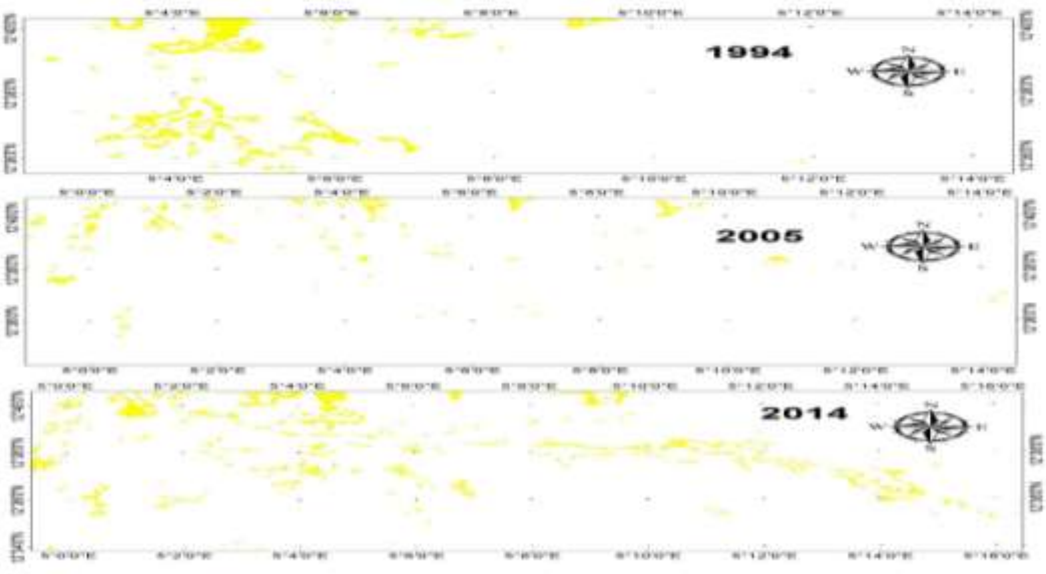

Fig. 4.7: Built-up Area Maps

4.3.2 Farmland

The results of the analysis carried out on the three satellite image for the different time frames showed that farm has been on the positive increase from 1994 to 2014; which is an indication of the socio-economic effects of the actions of the people on the living environment of the area. In 1994, farmlands covered an area of about 66.1266Km^2 which represents 15.40% of the area. By the year 2001, it experienced an increase to 159.0939Km^2 and 215.5941Km^2 by 2014; which is 37.04% and 50.20% respectively as shown in Figure 4.8. Figure 4.9 also shows farmland maps over a period of 20years.

The increase in farm land over the years has shown effects on other land uses, which are vegetation, bare ground etc. The implications of this expansion resulting from farming activities are multifaceted. The continued expansion of farming may lead to depletion in the vegetation cover due to demand for more agricultural land. The change in the area between 1994 and 2005 is 92.9673Km^2 while the change between 2005 and 2014 is 56.5002Km^2.

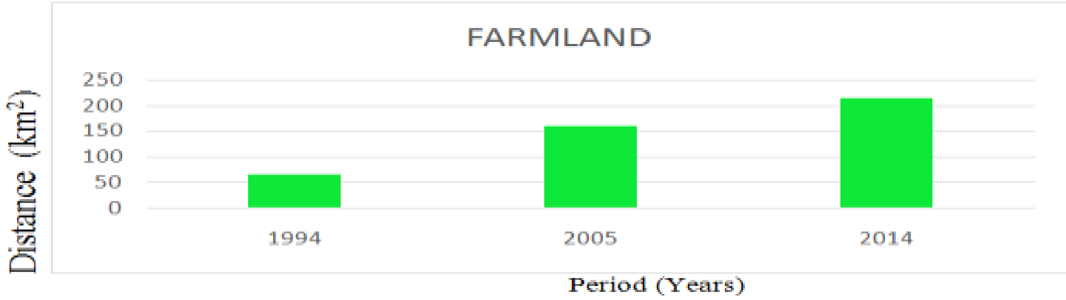

Fig. 4.8: Bar chart for Farmland

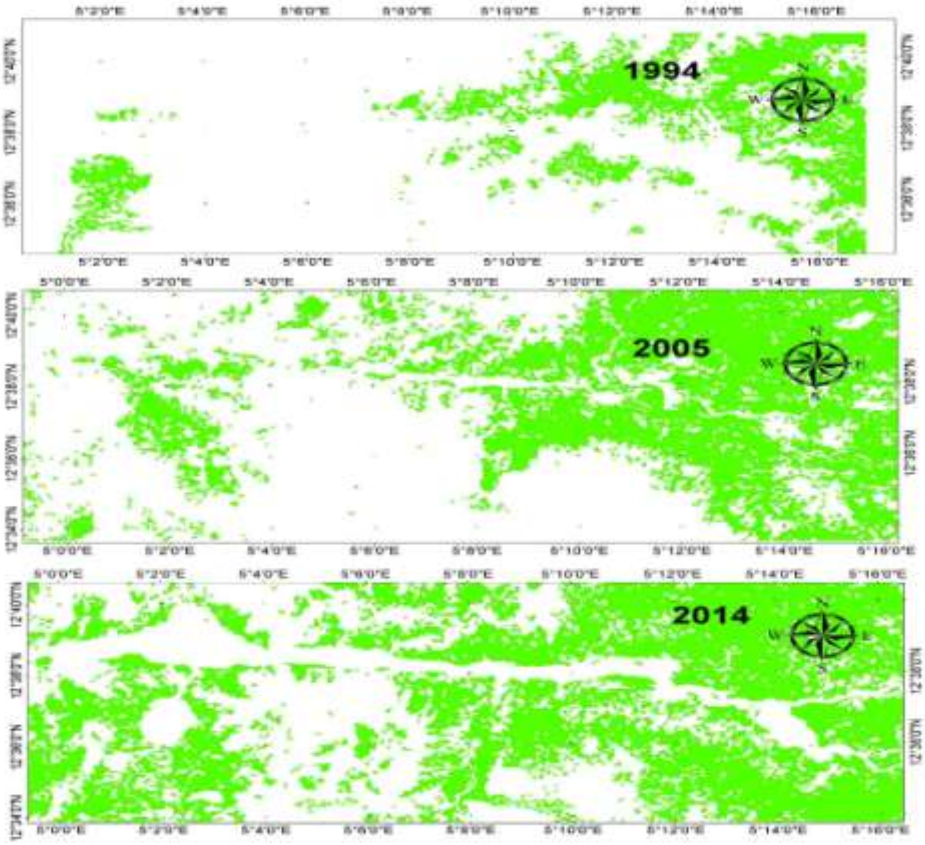

Fig. 4.9: Farmland

4.3.3 Water body:

Results of the analysis shows the water body to be on a steady increase from 1994 to 2005 which is 4.1886Km^2 (0.98%) to 7.1748Km^2 (1.67%) respectively. But from the year 2005 to 2014, there was a sharp increase in the area covered by the water body; from 7.1748Km^2 (1.67%) in 2005 to 33.4476Km^2 (7.79%) in 2014 as displayed in graphical representation in Figure 4.10 and in Figure 4.11. The sharp increase might be attributed to the dam overflow and from River Sokoto. As such, intensified anthropogenic activities in the study area are capable of revealing water bodies that were hitherto not noticed as a result of vegetation cover.

The change in the area between 1994 and 2005 is 2.9862Km^2 while the change between 2005 and 2014 is 26.2728Km^2.

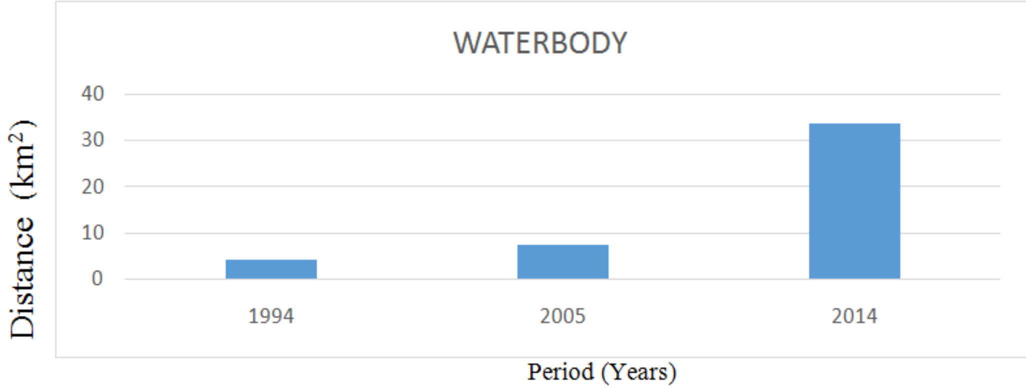

Fig. 4.10: Bar chart for water body

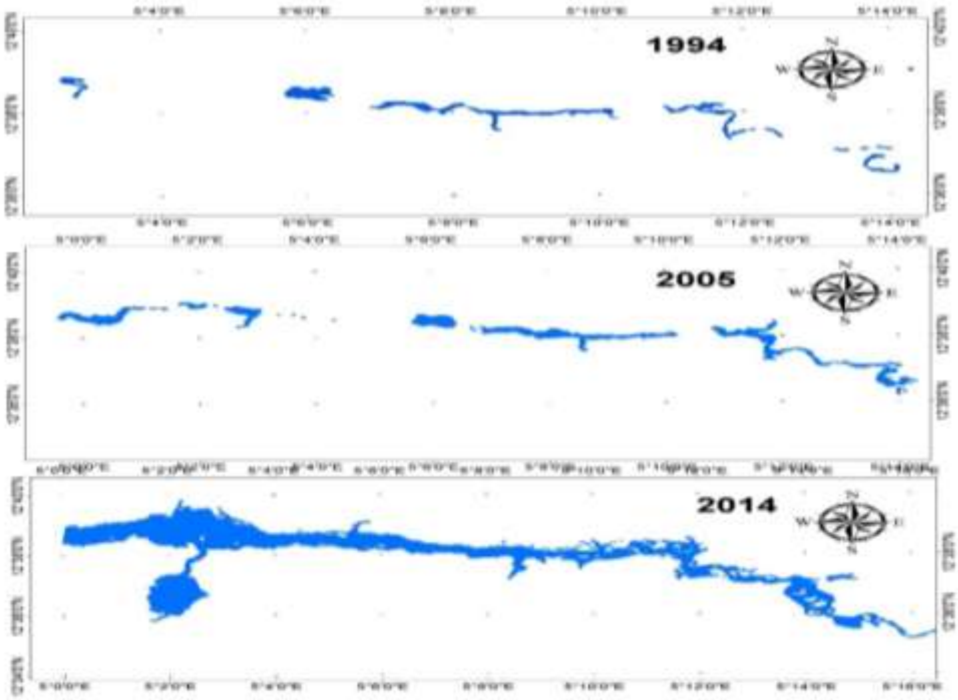

Fig. 4.11: Waterbody

4.3.4 Bare ground

This class showed a decrease between 1994 and 2005 there was a change from 292.9581Km^2 to 65.8458Km^2 respectively; while from 2005 to 2014 there was a slight increase from 65.8458Km^2 to 78.9786Km^2 respectively as shown in Figure 4.12. The decrease in the area can be attributed to increased demand for agricultural land for food production, given the fact that the major occupation of the inhabitants of the area is farming (both seasonal and irrigation farming). Between 1994 and 2005 the change in the area covered by the bare ground was therefore 227.1123Km^2 while the change between 2005 and 2014 is 13.1328Km^2. Figure 4.13, also shows the map of bare ground over a period of 20years.

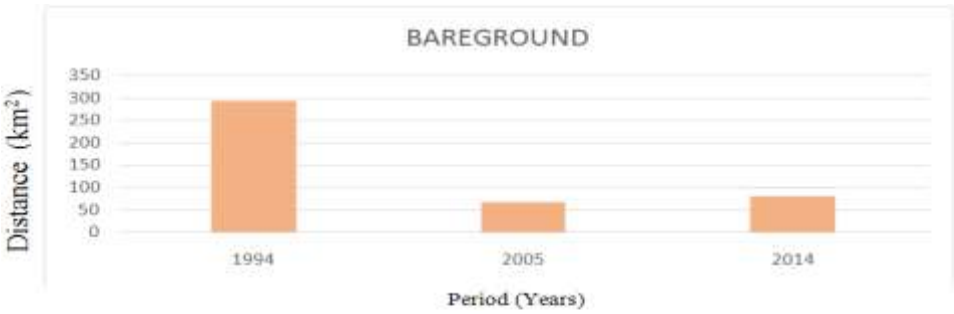

Fig 4.12: Bar chart for bare ground

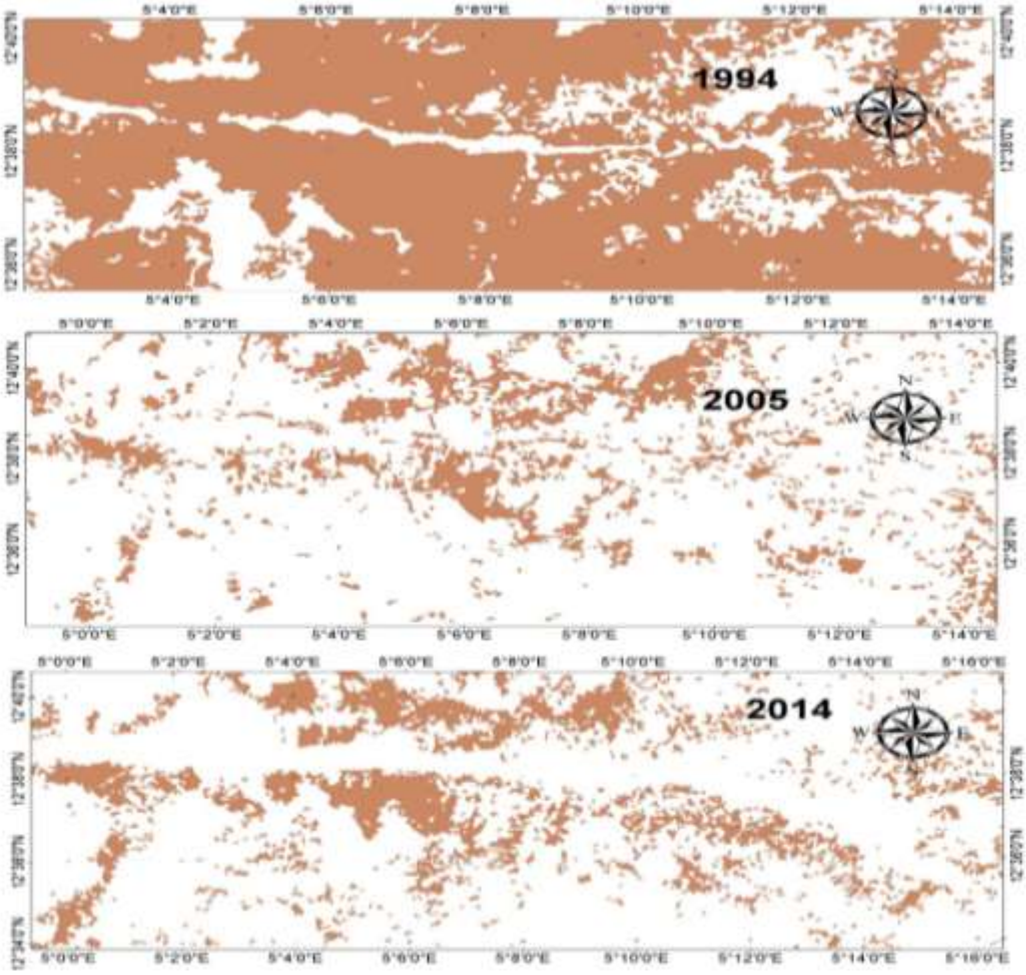

Fig 4.13: Bareground

4.3.5 Vegetation

From the results of the classified images for the three (3) different years, it could be seen that from the year 1994 to 2005 there has been a significant increase in vegetation cover from 43.2126Km^2 (10.06%) to 193.1958Km^2 (44.98%) respectively. While from 2005 to 2014 there was a decrease in the area covered by vegetation; from193.1958Km^2 85.9104Km^2 (20.00%) respectively as shown in Figure 4.14 and as evidence in Figure 4.15. The increase in vegetation cover from the 1994 to 2005 might be as a result of the decrease in bareground cover, while the decrease which occurred between 2005 and 2014 can be attributed to the increased demand for agricultural land which lead to the clearing and cutting down of natural and undisturbed vegetation. Between 1994 and 2005 the change in the area covered by vegetation was 149.9832Km^2 while the change between 2005 and 2014 is 107.2854 Km^2 as shown in the chart below:

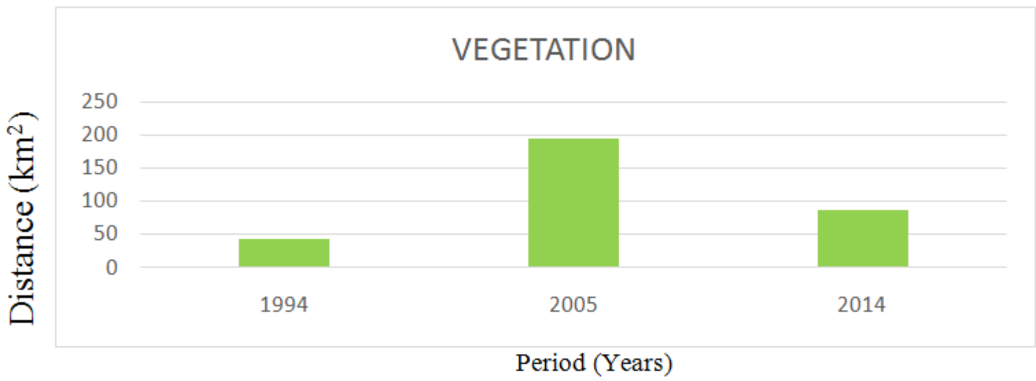

Fig. 4.14: Bar chart for vegetation

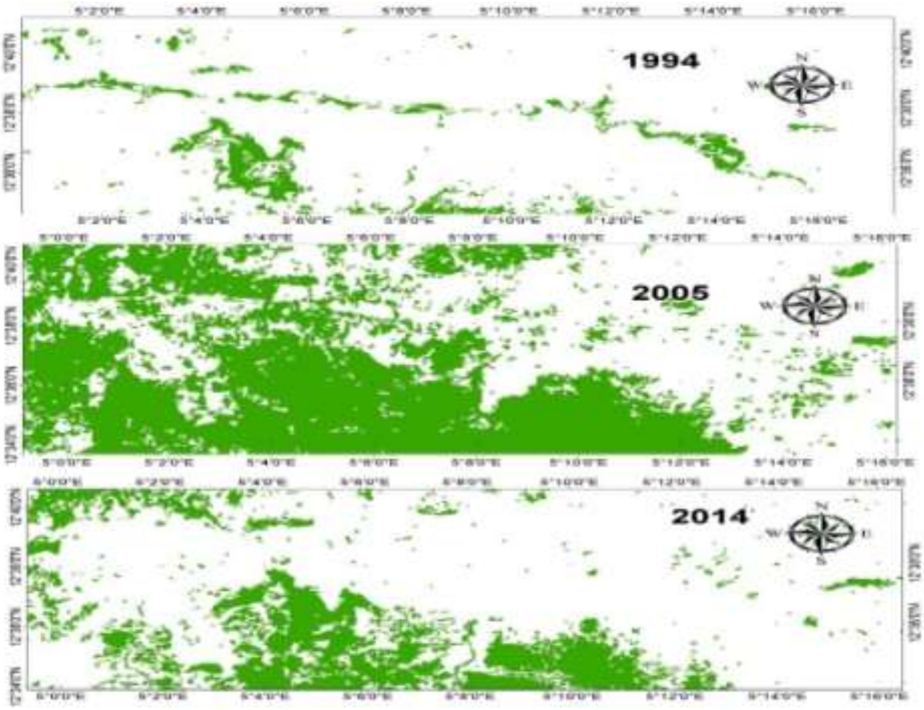

Fig. 4.15: Vegetation

4.4 Effect of Shagari Dam on its immediate environment

During the course of this research work, it has been observed from the results and analysis of the satellite imagery that certain classes have shown a positive increase (notably in the classes' water body and farmland). The increase in area coverage of the farmland can be attributed to the increasing water levels in the water body class. This increase has led to a growth in agricultural activities as the demand for food supply increases. The dam has also experienced overflow which has led to the flooding of its banks, as such most settlements and built up areas located close to the water body were lost, as seen in the classified image of 2005. This built up areas showed a significant reduction in the area covered. Farmlands situated close to the banks were also lost but it has impacted greatly in boosting the scale of irrigation farming activities.

Bare ground has experienced a decline too, from 1994 to 2014. Which is as a result of the high demand for land that is used for farming practices; as such areas that used to be bare were either converted to farmlands or covered by vegetation. Farmlands and vegetation thrive well in the area due to the presence of the dam itself which is key to the survival and development of plant crops and other vegetation types.

4.5 Driving forces behind the change

In the analysis carried out, it could be seen that various land cover classes have undergone changes from 1994 to 2014. Some of these classes underwent positive changes, while some were affected negatively. The major class identified here which is responsible for these changes, is the water body; this class has greatly influenced and supported the growth of farming activities all year round. As such, the demand for expansion of the farmlands has led to the encroachment on other classes especially bareground and vegetation. This could have both positive and negative impacts on the environment as a whole. In the positive aspect, it helps in maintaining a balance in the ecosystem, it can also serve to protect the ground surface from harsh environmental conditions which usually persists. The negative aspects of increased demand of land for farming activities may lead to environmental degradation such as drought, erosion etc.

V. Summary andConclusion

5.1 Summary

The writer was centred on the effects of Shagari earth dam on farming activities within its immediate environments in Shagari local government area, Sokoto State Nigeria using remote sensing and GIS. Three Landsat satellite images were used in the course of the study Thematic Mapper of 1994, ETM of 2005 and Landsat 8 of 2014. These images were classified to identify the various land use/land cover types and also to determine the changes in the land use/land cover identified. The spatiotemporal extent of change was determined through change detection analysis. The result revealed that two classes (water body and farmland) have undergone major positive change over the years.

The degradation and loss of the bare ground and vegetation due to human induced activities has also been observed in the study area. These human-induced activities include farming, expansion of agricultural land. These practices have resulted in the significant loss of the bare ground and reduction in the natural vegetation cover which may lead to the loss of valuable soil nutrients erosion and general environmental degradation. The major driver behind the change was identified to be water body, over the years it has been on the increase which lead to the growth and support of agricultural practices all year round. Thus, this has resulted in the expansion of these agricultural land and encroachment on other land use types; in order to accommodate the growing demand for food supply.

5.2 Conclusion

It can be concluded that remote sensing and GIS has been proven to be a powerful tool in assessing the effects of Shagari dam on its immediate environment. The results of the classification revealed that farmland and water body is increasing rapidly over the years, while bare ground and vegetation are decreasing. This is a clear indication that the dam has an effect on the land use patterns as its support the growth and development of farming practices in the area. The change detection analysis result indicated the different rates of change for each of the individual classes in the study area over the years. The classes with the highest change include the farmland, water body and bare ground. The change detection revealed that as some classes experienced a positive increase in area coverage, others suffered a decrease in terms of area covered. The water body which has been on the increase over the years, has been identified to be the key driver of change in the area. It has resulted in the continuous and rapid increase in the areal coverage of farmlands; this has led to the encroachment of other landuse/landcover in the study area. Bareground as seen from the study has been the major class being affected by this encroachment, closely followed by the vegetation cover.

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