

Land Use/Land Change Dynamics Of Katsina State, Nigeria.

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Abstract: The land use and land cover mapping and change dynamics study using satellite remote sensing and GIS techniques has helped in understanding the different forms of changes in our environment and the effect of the changes on the land cover/land use pattern. The aim of this study is to access the quantitative understanding of the land use/land change dynamics in Katsina state from 2006 to 2016. Two satellite images; Nigeria Sat-1 acquired in 2006 and LandSat-8 acquired in 2016 were used for the study. Point samples were taken during fieldwork in Katsina state to help in classification and accuracy assessment. The satellite images were classified into six classes: water body, shrubs/farmland, vegetation, settlement, rock outcrop and bare surface. Land change modeler in Idrisi Selva was used for the change detection analysis to compare the change in Land classes during the period of review for the study. The change matrix result shows loss and gains by different land cover classes and relationship between different classes. As observed during field investigation and analysis, the frontline local government areas, such as Baure, Zango, Mai'adua, Mashi, Kaita, Jibia, Daura and Safana have suffered from deforestation and land degradation, which has resulted in desert encroachment. Climatic and social economic factors are the main drivers of the observed changes. Proper monitoring of the land use will help monitor land degradation which leads to desertification and help in proper planning, usage and management of natural resources that support human life and ecosystem stability.

Keywords: Change dynamics, Desertification, Environment, Land use.

1. INTRODUCTION

The study of the land use and land change dynamics of environment is important in understanding and backing up the examination of the sources and implication of land use and the changes that occurs. This will enhance the understanding of how the land use system, planning and policy function together. LULC mapping and recognition of alterations in it using remote sensing and GIS procedures is of immense relevance to the society and those involved in the affairs i.e planners, geographers, environmentalists and policy makers. Human alteration of the natural environment which is Land cover into different forms including all forms of Settlement, Urbanization, Industrialization and every human activity that changes the natural state of the environment including agricultural practices made up the Land use of that area. The different use in which Land is put into by human with major emphasis on the economic aspect can be referred to as land use. Of all-natural resources available to mankind, land is the most important because it comprises of plant, animal, soil and water in which each living organism gave out there niche and makes up the ecosystem (Ganasri and Dwaraiash 2015). The land use classes that were considered in this study are Settlement, Farmland/Shrubs, Vegetation, Water body, Rock outcrop and Bare surface. The change in global environment as a lot to do with the land use and land cover change, the increase in population, urbanization, land scarcity, industrialization etc are among the drivers of Land use in this modern world and environment that we found ourselves. The dynamics of Land use are at high rate and of high significant which processes leading to changes are human actions and also brings about changes that affect human activities which also affect the availability of other important natural resources like water, soil, vegetation etc. Eshetu Yirsaw et al. (2017) in their study on Land use/land cover change modelling and prediction of subsequent changes on ecosystem in the Su-Xi-Chang Region of China, found the ecosystem values were diminished due to farmland, wetland, waterbodies percentage

decrease compared to percentage increase in constructed land use. This implies that constructed land expansion is at the expense of those other land use. Conversion of grassland, savannah, temperate deciduous forest and tropical forest biome into agricultural land by human all over the world has contributed greatly to changes in different land use. The growing pressure on land and other resources are due several factors including Increase in population, land degradation, Industrialization and urbanisation, all these are of human activities which will affect overall climate of the environment. A research on causes and implications of Desertification in Northern Nigeria on national food security was carried out by Mohammed Ngozi Thelma (2015), She discussed the visibility of desertification in eleven states in Northern Nigeria which pattern shows a southwards direction from the northern part of the states and the state are agricultural dominated states. The Nigerian government introduced programs and policies that will help in adverting the spread of desertification and help increase food security and nation development. Some of these policies include: Arid Zone Afforestation Project (AZAP) in 1977; River Basin Development Authorities (RBDA) in 1987, Federal Environmental Protection Agency (FEPA) in 1988 which later facilitated the establishment of the State Environmental Protection Agency (SEPA in March, 7 2017) and the Great Green Wall project, (2002) The consequences of desertification in Nigeria was also discussed which include Conflict, security threat, poverty, corruption, policy inconsistency, technology, food security. Desertification effects on the Northern state in Nigeria will impact negatively on food security because it has a direct correlation with the water body which are dammed and other sources of waterbody used for irrigation for agricultural purposes. There will be need for urgent measure to be put in place to help check land degradation and desertification and its negative effect on food security and sustainable development of the nation. The Rapid population growth affects environmental resources base through increased demand for food, fodder,

water and arable land (Federal department of Forestry, 2001). The high and continuous demand on food, water and arable land by increasing population have effects on environmental resources and vegetation cover are the most affected through man-made activities which affect the valuation of the land and the availability, this then leads to change in Land use. Also the advert effect of Anthropogenic activities on the dynamics of Land use and land cover is of great importance and need to be closely monitored by relevant authorities at all levels (Yadav et al 2019). The introduction of satellite remote sensing and geospatial techniques provides reliable source of data for assessing and monitoring spatial and temporal changes. Satellite remote sensing data are important in analysing land use/land change phenomenon; it has helped in the quantification land use/land change dynamics and control with time their different changes (Dewan and Yamaguchi 2009), The combination of both can be invaluable in addressing a wide variety of resource management problems, and were employed in analysing the land use/land change dynamic of Katsina State. The present study analysed the dynamics of Land use in Katsina State over a period of 10 years (2006 and 2016). The aim of this study is to understand the different land use and the dynamics of land change of Katsina state over the period of interest and point out the changes as it results in land degradation which leads to desertification. The objective includes carrying out Land use/Land cover assessment of Katsina state, the different land use classes in the study area, the dynamics of Land change and the change detection of Katsina. The satellite image data of the study for different years from the same geographical area were obtained, the imagery will be processed, and analysed using the Erdas imagine version 2014, ArcGIS 10.3 and Idrisi Selva for the image classification, vector analysis and change detection analysis.

2. STUDY AREA

Katsina state is one of the State in the North Western part of Nigeria. Katsina geographically lies between latitude $11^{\circ} 07' 49''$ and $13^{\circ} 22' 57''$ North and longitude $6^{\circ} 52' 03''$ and $9^{\circ} 09' 02''$ East. The Hausas and Fulanis are the dominant local tribe in the Katsina and it is made up of Thirty six local governments Areas. Katsina state shares boundary with four states, namely Zamfara, Kaduna, Kano and Jigawa states and also with the Republic of Niger to the frontline Northern part. Katsina state has an estimated population of 5,792,578 (NPC 2006) and covers an area of about 23,938 Square Kilometres. The state covers three agro-ecological zones; the Sahel, the Sudan and the Northern Guinea Savanna zones, Rainfall pattern in Katsina state ranges between 350 and to 1000mm and annual temperature between 29°C to 31°C (Ogungbile et al., 1999). Katsina State has high agricultural production potential and agricultural practices including farming and rearing of animal dominant the primary means of livelihood for the high percentage of the population of the state and this can either be of convectional which is rain fed or through Irrigation practices including forest practices and livestock farming. The state is also blessed with some natural resources most especially solid minerals which includes Marble, Lead, Granite, Precious stone etc but despite all these, government still remain the highest employer of Labour. (Adam 2015).

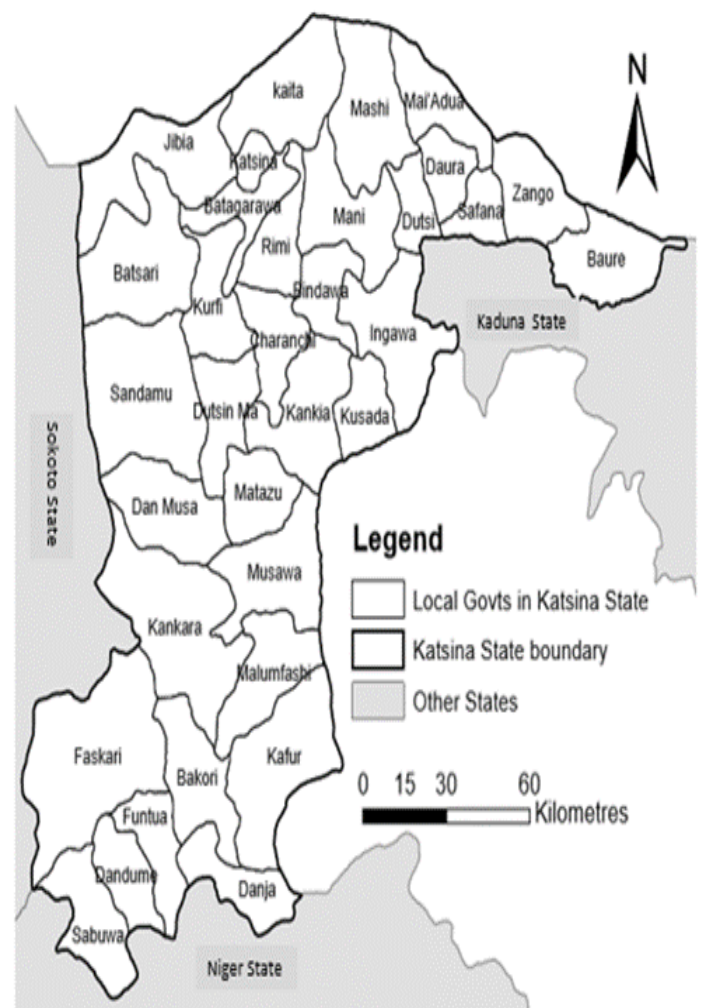


Figure 1: Study Area Map

3. MATERIAL AND METHOD

The data and information for this research were of different sources, which include:

- Satellite images: This research work was carried using the remotely sensed data of Nigeria-Sat 1image acquired in 2006 and Landsat-8 image acquired in 2016.
- Field Survey: The field investigation includes ground validation for information to help in Land use/cover classes, collection of reference points using a GPS in classification and accuracy assessment.
- Interview: Interviews were conducted on both scholars and residents of the areas visited during field survey.

The flow chart for the Methodology adopted for this study is shown below:

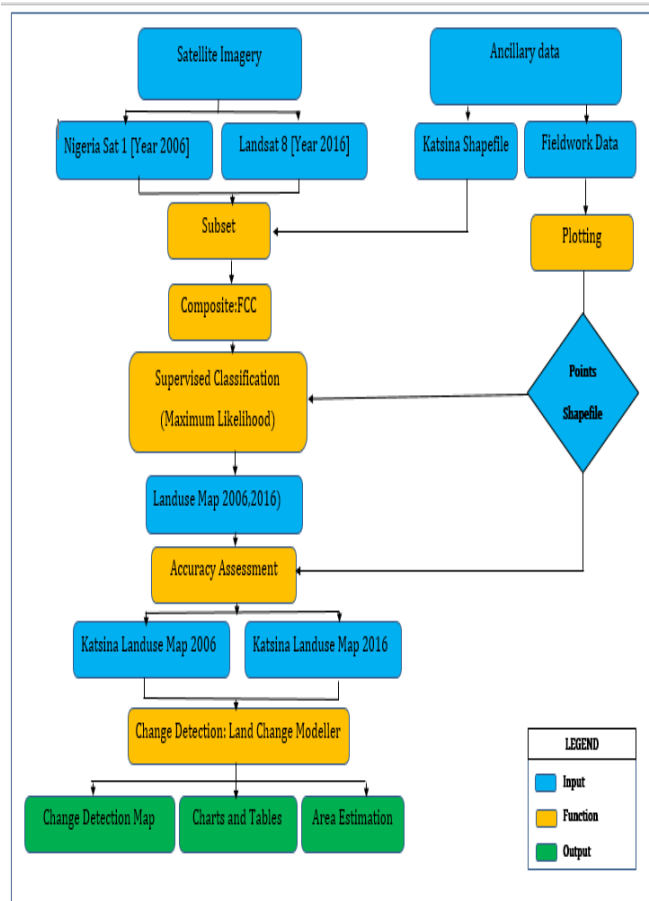


Figure 2: Flow Chart of the Methodology

4. FIELD TRIP REPORT

All thirty-four local government areas in Katsina State were surveyed during the field investigation between 22nd to 28th October 2016. The field survey was carried with the aid of:

- Handheld GPS
- Digital Camera
- Questionnaires
- Printed maps
- Voice recorders
- Writing materials

This field survey was carried out:

- To obtain correct location point data.
- To analyse current land-use pattern of Katsina state.
- To obtain first-hand information about the land use and ways of people's culture as it relates to the study through questionnaire and interviews.
- For pictorial information and documentation.

During the field work, Scholars and Head of Rural water and sanitation Agency (RUWASA) were interviewed to ask of their view on Land use, Land degradation and desertification as far as Katsina State is concerned.

5. SATELLITE DATA

5.1 Satellite image pre-processing and Image classification

Satellite preprocessing is carried to help correct some errors and other operations like band combination to ease visualisation and interpretation, it aims at building a connection between the satellite data and that of the actual.

The ERDAS imagine software 2014 was used in the pre-processing, corrections and subsequent operations and bands combination was carried out to improve the appearance of the image for better visualization in order to carry out classification. The subset image was then classified by assigning different spectral signatures from the satellite datasets to each identified land cover. One of the objectives of carrying out image classification is to group pixels in an image into landuse/land cover classes according to their spectral signature in order to draw out suitable thematic information. Before going on field trip, the pre-processing of the satellite image was done and unsupervised classification was carried out on the satellite image. The system makes use of information from the bands to identify pixels that have similar characteristics. These pixels were grouped into thirty classes and the classes were further merged into six: bare surface, farmland, rock outcrop, settlement, vegetation and waterbody. Referenced points of interest were also generated on the classified image maps to be used during ground validation. Pictures, notes, interview and questionnaires were taken and used during the field work to help gather information in carrying out supervised classification of the image after the field exercise. Supervised classification and accuracy assessment were carried out on the satellite image after the field investigation. The different colour composite was also supported by points from the ground truthing to help in classification of the image. With the aid of the visible spectral signature, training site was designated to form polygon around the typical site that have the same distinctive signature and this were later recorded by using pixels enclosed in the selected polygons using the Erdas Imagine 2014 software. The classification algorithm employed for the satellite image classification is the maximum likelihood, this algorithm based its decision on membership of a pixel of the information or selected class. This algorithm depends on the second-order statistics of the Gaussian probability density function model for each class (Ganasri and Dwarakish 2015) and affluence of identifying and variability level dictates the number of training site for each land use. The delineated classes were Settlement, Farmland/Shrubs, Vegetation, Bare surface, Rock outcrop, Water body. The GPS points and other information acquired on the field makes it easier, and aimed at accurate classification.

5.2 Accuracy Assessment:

The understanding and estimation of changes accurately in LULC after classification has to do with accuracy assessment which evaluate the level of correspondence of what's on ground and the actual classification result. It's very good to obtain a high degree of accuracy in order to validate the individual classification and for it to be essential in the study of the change detection. The correctness valuation was carried out for each classified image before carrying out the change detection analysis. The acceptance of a classified LULC result for change valuation depend on the accuracy valuation that was carried out for each class member of the classification.

5.3 Change detection:

To determine and examine the LULC variations and its dynamics, a change matrix was carried out with Idrisi Selva software, the Quantitative data of LULC deviations as well as different land-use class gains together with each class

losses data were generated based on the classified images of 2006 and 2016 respectively.

6. RESULT AND DISCUSSION

The conversion of Vegetation, farmland and other land use into other land uses in the Northern part of Nigeria through deforestation, land deletion, industrialization, Urbanization etc prompt the investigation of land degradation leading to desertification and this is one of the main focus of carrying out this study in Katsina State. The supervised classification for both 2006 and 2016 were carried out for the study area, using six land use classes they are: Bare surface, Farmland/shrubs, Settlement, Vegetation, Rock outcrop, Waterbody. The overall classification accuracy is 75% for 2016 and 85% for 2006. Figures 3 and 4 shows the result of classification for both Katsina state 2006 and 2016 images.

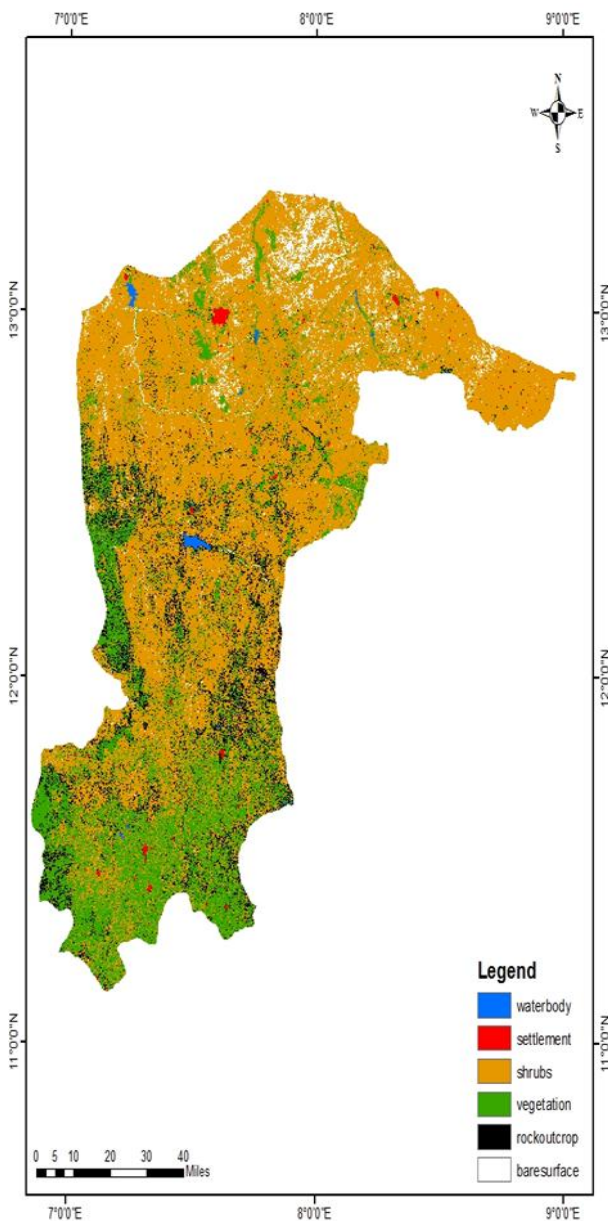


Figure 3: Classified Image of Katsina State 2006

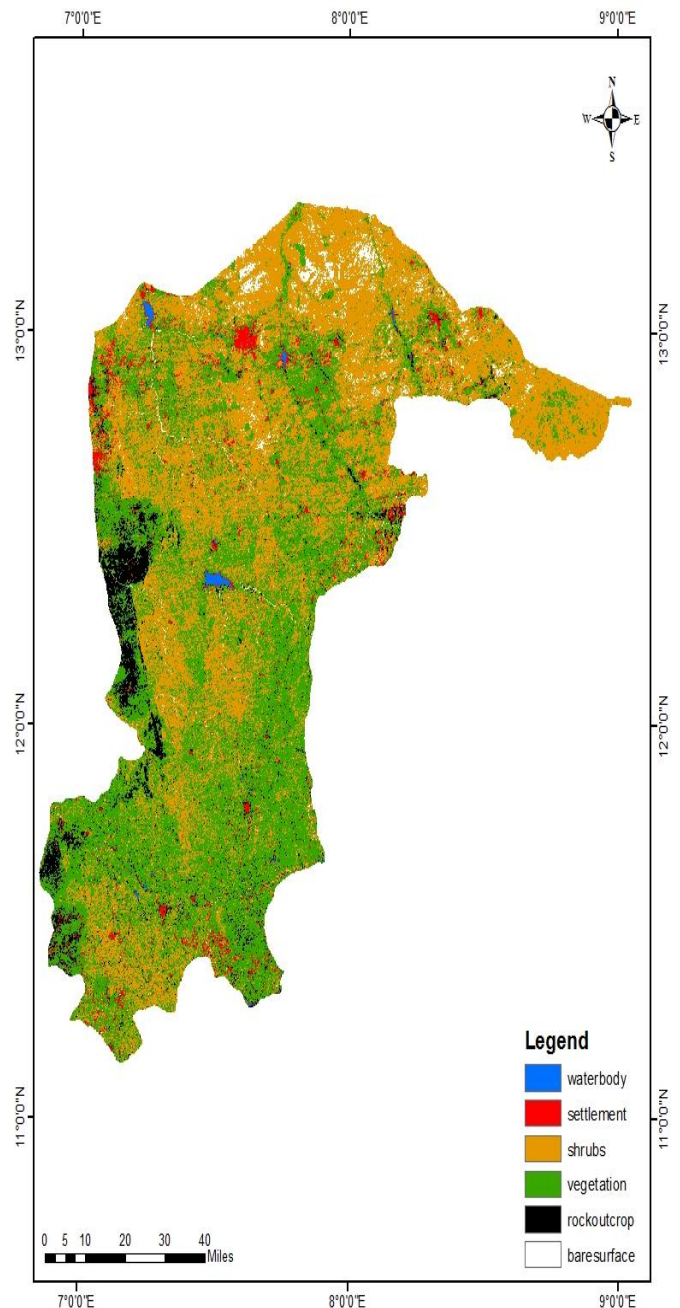


Figure 4: Classified Image of Katsina State 2016.

7. CHANGE ANALYSIS FOR YEAR 2006-2016.

In the previous classification result of Katsina state for 2006 and 2016 shown in figure three and four shows an increase in Farmland/Shrub and Settlement and decrease Bare surface, Waterbody, Vegetation and Rock outcrop which were also computed in hectares and percentage shown in Table 1 and 2 below. Table 3 also shows computed land use loss and gains and the net changes between different classes in between the two epochs of 2006 and 2016. According to the change detection analysis carried out on Idrisi Selva using both classified images of 2006 and 2016, the results shows an increase in settlement and vegetation with corresponding decrease in other land use classes. The loss in one land use will be gained by another land use over the years. The overall Kappa for the change detection is 0.6685. The extent occupied by each land use in hectares and percentage are shown in table 1 and table 2:

Table 1: 2006 LANDUSE HACTARES AND PPERCENTAGE

Land use	Hectares	Percentage
Waterbody	7912.17	0.35%
Settlement	13120.92	0.5%
Shrubs/Farmland	1553588	64%
Vegetation	524462.9	21%
Rock Outcrop	209195.8	8.7%
Bare Surface	87350.12	3.6%

Table 2: 2016 LANDUSE HACTARES AND PPERCENTAGE

Land Use	Hectares	Percentage
Waterbody	6916.5	0.29%
Settlement	88010.01	3.6%
Shrubs/Farmland	1071651	44.7%
Vegetation	1070072	44.7%
Rock Outcrop	109174.6	4.6%
Bare Surface	49815.27	2.1%

Table 3: LANDUSE LOSS, GAINS AND NET CHANGE

Land Use	Loss	Gains	Net change
Waterbody	-17.95	7.99	-9.96
Settlement	-33.82	782.71	748.89
Shrubs	6884.84	2065.47	-4819.37
Vegetation	1917.77	7373.87	5456.1
Rock outcrop	1788.76	788.55	-1000.21
Bare surface	-678.05	302.61	-375.45

Table 4: CHANGE DETECTION FOR ALL LAND USE

Land use Change	Area (Hectares)
Settlement to waterbody	12.51
Shrubs to waterbody	323.82
Vegetation to waterbody	262.08
Rock outcrop to waterbody	134.01
Bare surface to waterbody	66.78
Waterbody to settlement	958.14
Shrubs to settlement	51552.72
Vegetation to settlement	12057.21
Rock outcrop to settlement	13068.54
Bare surface to settlement	634.5
Waterbody to shrubs	201.96
Settlement to shrubs	542.52
Vegetation to shrubs	118867.14
Rock outcrop to shrubs	23800.14
Bare surface to shrubs	63135.63
Waterbody to vegetation	269.91
Settlement to vegetation	2133.09
Shrubs to vegetation	589331.97
Rock outcrop to vegetation	141742.44
Bare surface to vegetation	3909.33
Waterbody to rock outcrop	334.53
Settlement to rock outcrop	681.93
Shrubs to rock outcrop	17595.27
Vegetation to rock outcrop	60183.72
Bare surface to rock outcrop	59.67
Waterbody to bare surface	30.33
Settlement to bare surface	11.97
Shrubs to bare surface	29680.56
Vegetation to bare surface	406.98
Rock outcrop to bare surface	131.22

CLASS	1	2	3	4	5	6	Total
Waterbody	67970	139	3598	2912	1489	742	76850
Settlement	10646	108210	572808	133969	145206	7050	977889
Shrubs	2244	6028	9612262	1320746	264446	701507	11907233
Vegetation	2999	23701	6548133	3696508	1574916	43437	11886994
Rockoutcrop	3717	7577	1995503	668708	336883	663	121305
Baresurface	337	133	329784	4522	1458	217269	553503
Total	87913	145788	17262088	5827365	2324398	970668	26618220

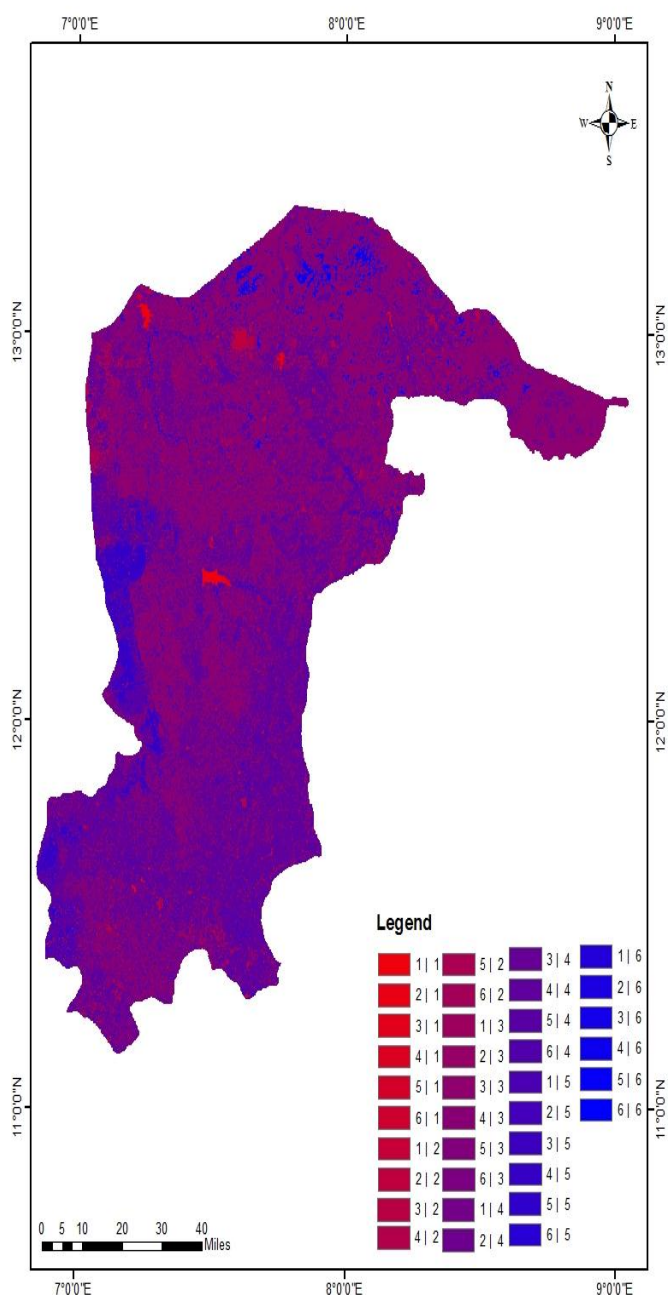


Figure 5: Map showing cross tabulation between 2006 and 2016.

8. CONCLUSION

In conclusion the climatic variation and human activities which include deforestation, farming practices, urbanization and industrialisation together with government policy has played a vital part in the changes in landuse of the study area Katsina State. Climatic variation between the northern and southern part which are evidence in a greener southern Katsina with more agricultural practices than the northern part as seen in (James G.K et al 2018). Desertification encroachment are more pronounced in the Northern part with high percentage of land degradation which result in loss of more agricultural land that is shrubs/farmland in the Northern part and there is gain vegetation which is due to intervention by Government and Non-governmental organisation.

Summary of some local governments, towns, and settlement visited during the field Survey.

LOCAL GOVT.	SETTLEMENTS	OBSERVATIONS
Kafur LG	Marabarava Banja Mahangi village Masu-gundi Suburakisa Kafur town	-Linear settlement with mud houses -Farmland covering most land use -Vegetation are also seen along road -Kafur is the biggest settlement of the LG with population and has a wind mill -Both dry and flowing water bodies were seen. -Dominant crops are Cereals, vegetables and Tomatoes.
Malumfashi	-Malumfashi -Yam mama town -Gabon village -Dayi village -Dannanma village -Mugawa village	-Malumfashi town is the 4th biggest settlement in the state and the local government headquarter. -Settlement are of linear pattern with mud houses in most rural settlements. -Sparse vegetation along the road -Farmlands dominate the land use -Scattered shrubs mixed with bare surface -Forestry project of the local government -Tree plantations were visible along the main road.
Rimi	-Kayaoki village -Markurda village -Dagabagwa -Din-din -Karfawa -Nudum -Sheme -FadiGurue -Manchi town -Sabon-Gari -Garu village	-Rimi local government shares boundary with Katsina city -Settlements are of modern houses and mud houses dominate the rural settlements -Sparse and vegetation are visible along the road. -Shrubs mixed with Bare surface are also present and are visible from the main road Dogged Earth material pit were first noticed by the travelling team in this local government. -Dried water bodies were noticed due to the time of the year (Dry season)
Dutsi	-Zakaliya -Tashar -Sharikkale -Sarika -Giginya	-Shelter belt project stretched like two kilometers along the road around Tashar village -Great green wall project was seen along the road in Zakaliya village -At Shariale town, we saw a working Wind mill water proect along the road. -Settlement are of Linear pattern with mud houses and few modern structures -Scattered shrubs -Dominant land use in this locality is farmland
Daura	-Dan Nakola -TambuGari -Ganda village -Daura town -Kongolom -Maturmi	-Daura is the third largest city in the state with many commercial activities. -Farming is the maor occupation of the people in this town -Bare surface were missed with Shrubs -Dry waterbody -Kongolom is a border town

		between Nigeria and Niger.
Mai'adua	-Mai'adua town -Yan-Vanshe -Sabu town	-Mai'adua town is the biggest local government in this area. -At the centre of the town is the big Mai'adua market with plenty to buy and sell. -The team was also at Sabu dam to view how the dam is used for irrigation. -Farmland dominated the land use -Sparse vegetation and Shrubs mixed with it.
Mashi	-Tansha -Bagiwa -Samaru	-Settlements are of Linear pattern with mud houses surrounded by farmland -Farmland dominated the land use and cows are seen used for ploughing on farms. -Scattered shrubs were observed with Sparse vegetation and bare surfaces.
Mani	-Mani town -Tokarlim -Sha'iskwa -Faru village -Eka village	-Population dominated by farmers and over 70% of their lands are cultivated -Settlement are characterized by mud houses with little percentage of modern houses except for Mani town. -Dry water bodies -Scattered shrubs were observed along the road -Earth material dogged pits were seen very close to the settlements.
Sandamu	-Sandamu town	-Settlement are of linear pattern -Sandamu town is the largest in the local and is the commercial capital for the local community around it -Dry water bodies were observed.
Zango	-Zango town	-Zango local government is one of the boarder local government with Niger Republic -it is characterized by sparse vegetation -Seedling Nursery by international NGOS were seen -Settlement are of linear and 90% of the population are farmers.
Baure	-Baure town	-Baure is of similar character with Zango and Sandamu local government.
Mashi	-Randa village -Tasha-Zana -Marke village -Kaki-Marke -Tashar-Usman -Wale-Wale -Kilago village -Kasanki -Binin-Kuka -Majikri -Dandogan -Makau	-Settlement are of linear pattern in most of the villages and well developed settlement are in Benin-Kuka border town with presence of border market -Farmland cover most of the land use -Scattered shrubs around the settlement -Forstry program of the local government were also captured -Depleted vegetation were also visible
Kaita	-Godi village -Dankama -Inwala -Yar-Fadama -Moda -Unguwar -Dantaba -Tsauri -Ido Sama -Kaita Town -Fanfon-Lula -Kwanmar village	-Rock outcrop at length was seen around Kwanmar and extended to Yandaki village -Kaita, Danakama and Shinkafi town are both big settlement while others are villages. -Land use are dominated by farmland -Settlements are of linear pattern surrounded by farmland -Shrubs mixed up with Bare surface are seen along the way.

	-Yandaki -Mangwarori -Shinkafi -Natisnata -Miltskwas -Dadaara -Makeera	
Jibia	-Dan masari -Mangomajibiya -Jibia town -GubiaMagariye -Kwari -Mallamana -Garingado -Garinyara -Yagamiji -Garininu -Ruma village -TasharRanda -Gobiriwa	-Along the road connecting Kaita LG to Jibia LG, we observed prone evidence of desertification which includes: Open Shrubs, Bare surface, Absence of vegetation, small size sand formations. -Forest reserve around Jibia town -Big water body and dried water channels were observed -Rock outcrop was seen in Garininu village
Batsari	-Biya -Kasalle -Batsari town -Baori- Sabo -Manina village -Gimi village -Runka village	-Farmland is these are big and are present on both sides of the road. -Trees mixed with vegetation are seen along the way -Depleted forest reserve was seen around Manina -Massive rock outcrop in Gimi village -Dried water body channels were seen.
-Safana	-Runka village -SabuwarSabana -Safana town	-Big settlement Safana town has a lot of modern houses and commercial activities -Massive farmland -Scattered Shrubs missed with vegetation -Small sixe rock outcrop -Dry water body where seen along the way.
Dustin-ma	-Dubuwa village -Dustin-ma town	-Settlement are of linear pattern -Farmland dominated the land use in this area -Dustin-ma town is the biggest settlement here with villages maing up the local government -Dustin-ma town has a dam in it -Shrubs mixed with vegetation and bare surface
Kurfi	-Birchi village -Sabon layi -Kurfi town -Tsanmi town	-Settlement are of linear pattern with mostly mud houses except for Kurfi town which happens to be a big settlement with population -Farmland dominates land use -Shrubs are seen along the way -Presence of forest reserve in Tsanmi.
Batagarawa	-Yargmu village -Batagarawa town -State University -State Polytechnic	-This local government house both the state university and polytechnic -Farmland is seen all along the way -Developed settlement which is Batagarawa -Sparse vegetation mixed with shrubs are seen along the way
Dan Musa	-Dan musa town -Yantumaki -Marabar -Kyanmar -Wawari-Kaza	-Forest reserve area was seen along Dan-Musa -Farmland dominate land use follow by Shrubs in the settlement visited -Large area of shrubs was seen after Dan-Musa junction Settlement are of linear pattern and are of small size except for Dan-Musa.
Kankara	-Mabayi village -Kakumi -RuwanGodiya	-Rock outcrop at length are seen in Mabayi settlement -Evidence of Soil erosion are

	Kwakware Sheme town Yankara Ungwarbarau	visible along the road. -Dried waterbody is visible -Large area of farmland with evidence of soil erosion around the farmland -Sheme is the biggest settlement in this local government and Rail line passed through the town			which happens to be the biggest settlement in the local government.
Faskari	-Faskari town -Fankama village -Sabon layi -Maigora -Ungwali	-Most settlement are of linear pattern with mud houses except for Fasari which is a town and of high population -Visible long stretched length of Rock outcrop at Faskari town -Farmland dominates most part of the land area and as at the time of visit, guinea corn was been harvested. -Afforestation program are also seen in this local government	Musawa	-MarabaMusawa -Jikamshi -Kira village -YarKanja -Sabon Gari -Yar'Gajam -Dan Kwari	-Visible large area vegetation cover around Sabon Gari village -Most land are covered with farmland -Scattered shrubs mixed u with bare surface -Earth material dugged out pit were seen around the villages -dry water body channels were also seen.
Sabuwa	-Magora -Dungun Muazu -MarabarMaigora -Machika village -Kewonw -Damani -Ganji -UngwaSanni -Yarkata -Tasha Nadaya -Sabuwa town	-Mixed up of farmland with shrubs and vegetation was noticed around Megora and Dungun but overall farmland dominates most part of the land area Afforestation program for the local government was seen around Dungun Muazu -Irrigation water project was seen around Ganji village for domestic and agricultural purpose since most are farmers. -large area of shrubs underlain by Laterite was seen around Ganji -Rock outcrop was visible around UngwaSanni village with farmland surrounding it -Sabuwa Dam located in Sabuwa town	Kusada	-Gudamuntumda -Yashi -Kusada town -Kakai village -Doduuni -Ganjuwa -Kandawa	-Settlement patterns are of linear form except for Kusada town which happens to be the biggest settlement in the local government with modern houses -Presence of tree fencing was observed around Dodunni village -Farmland with lots of trees and shrubs -Little visible vegetation.
Dandume	-Nasarawa Dandume -Ilalla -Kadawa -Gyazuma -UngawarMakkada	-Large scale farming is going on in this local government -Linear settlement pattern -Scattered shrubs -Dried water body -Much vegetation.	Ingawa	-Ingawa town -Daya village -Zangotama -Tama	-Harvested farmland -Farmland occupies most land use -Dry waterbody channels were seen -Vegetation and shrubs were more pronounced
Funtua	-Funtua town	-Visibe rock outcrop as we approached Funtua town from the southern part -Farmland dominated most Land use as you approach Funtua town -Funtua is the second largest city in Katsina State with many commercial activities, developed settlement with large population -Dried waterbody channels were also seen	Kankia	-Fanga village -Yariyaji -Sha'Iskwa -Kada kano -Kankia town	-Farmland occupies most land use in area -Except for Kankia which town which is relatively big, other settlements are of rural setting and characterized by mud houses and of linear pattern. -Bare surface are seen mixed shrubs
Bakori	-Bakori town -Tazarma village -Marabar -Mosoya -LayinKuka -Gangaren -Makurdi -Dagon market -LayinManista -Tashar Fulani	-In Bakori, we saw the construction site sign of Jare Earth Dam -Most common pattern for this settlement is linear -Farmland dominated most part of their land use -Vegetation was visible mixed with scattered shrubs and bare land in some areas			
Malumfashi	-Malumfashi town -Karfi village -MarabaKankara -Yan mama -Gora village -Dayi village -Danjaku -Yarmala village	-Forest reserve was seen around Gora village -Farmland mixed with vegetation and bare surface was noticed around Dayi village Rock outcrop was visible in Dayi village -Most settlement are of linear pattern except for Malumfashi			

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