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IMPACT OF LAND-USE PATTERNS ON PLANT DIVERSITY IN ECOLOGICAL ZONES OF KANO STATE

MAGAJI AB*[a] ● TELLA IO[b]

[a] Department of Forestry Technology, Audu Bako College of Agriculture, Dambatta. P.M.B. 3159, Kano State, Nigeria.
[b] Department of Forestry and Wildlife Management, Modibbo Adama University of Technology, Yola, P.M.B 2076, Adamawa State, Nigeria

*Corresponding Author: aminunbichi@yahoo.com, aminubichi01@gmail.com

ABSTRACT: The land-use pattern of a region is an outcome of its natural and socio-economic factors and their utilization by man in time and space. Land-use has become a central component in current strategies of managing natural resources and monitoring environmental changes. Urban expansion has increased the exploitation of natural resources and has changed land use and landscape patterns. Rapid urbanization, therefore, brings opportunities for new urban developments, however, it also has brought serious losses of arable land, forest land and water bodies. Plant diversity change is a major concern of global environmental changes. Remote sensing and Geographic Information system (GIS) provide fundamental tools used in the investigation of synoptic view and multi temporal Land use patterns of Kano state. The study was conducted to determine the impact of land use on plant diversity in the ecological zones of Kano state. Transects were laid in each of the sampling points to enumerate plant species, all from a quadrant size of 100 x 100m (10,000sqm). A total number of plant species enumerated for Sahel savanna were 46 species, 78 species for Sudan savanna and 94 species for the Northern Guinea savanna respectively. Land use of the state was determined through satellite imagery in a staggered form of ten years interval of 1973, 1983 1993, 2003 and 2013, respectively. The data obtained in percentages and square kilometers was analyzed using descriptive statistics, where the built up areas as at 1973 was found to be 1.32% out of the total land mass of the study area to a value increase of 5.6% in the year 2013, a clear significant difference of 4.28%. Identified increase in land use for infrastructural development has given rise to land and vegetation loss where Agriculture, Water body and Game reserves were affected by the anthropogenic activity of man in favor of built up areas.

Key words: Anthropogenic activity, Vegetation, Landscape, Savanna formations.

1. INTRODUCTION

Landuse changes have impacts on a wide range of environmental and landscape attributes including the quality of water, land and air resources, ecosystem processes and function, and the climate system itself through greenhouse gas fluxes and surface albedo effects (Lambin *et al*. 2000). For centuries, rapid population growth agricultural expansion, industrialization, mining and commercial activities have had major impacts on the natural ecosystems. Such impacts include the impoundment of many of the major rivers, the commissioning of many power stations, the rapid expansion of the timber industries as well as rural and urban settlements and other associated impacts. These have been increasing waste production, air, water, soil pollution, the fragmentation and destruction of natural habitats, which have become the albatross of ecosystem development (Maconachie 2007).

Landuse change has been a major driving forces in the current global environmental changes, affecting the quality of water, land resources, game reserves, soil quality and other environmental parameters, through deforestation, greenhouse gas fluxes and surface albedo effects (Lambin *et al.* 2001). Anthropogenic influence on ecosystem sustenance particularly on Fauna and Flora species has been enormous, continuing and mostly detrimental. The influence could be either through environmental destruction, modification, over extraction

or other forms of landuse. Such use creates an enormous amount of general concern over a threat to plant diversity about the range and composition of organisms, and implications of the increasing pace of species extinction (Munasinghe 1992). Landuse changes ensues from human decision making that occurs in the context of social institutions and is influenced by drivers that range from economic and cultural traditions to expected economic or ecological benefits. Land-use change alters the hydrological system, air movement, settlement spread, and trophic communities, primary productivity, land surface characteristics, and the overall ecological foot prints to become susceptible to catastrophic vulnerability such as air pollution, extreme geologic hazards and health risks (Murnaghan 2001).

Geographic Information Systems (GIS) and remote sensing are well – established information technologies, with widely recognized applications in land and natural resources management. They are, however, still essentially separate technologies and practitioners don't generally consider their primary involvement with one or the other (Qiming 1995).Current technologies such as geographic information system (GIS) and detection techniques based on multi – temporal and multi – spectral remotely sensed data, which have demonstrated a great potential as a means of understanding landscape dynamics, detection, identifying, mapping and monitoring differences in landuse and landcover patterns overtime, irrespective of the causal factors (Jensen 1996).

Markov process and Transition models are a class of probability models used to study this evolution of a system over time. The main objective of this study is to trace out the landuse pattern of Kano state ecological zones. The specific objectives are (1) to assess the changing landuse pattern of Kano state from 1973 to 2013 and (2) to assess the impact of landuse on the plant diversity in the ecological zones of Kano state.

2. MATERIALS AND METHODS

Kano State is located in North Western Nigeria, on latitude $12^0 3^{'}$N, longitude, 8^0 32'E; and altitude 476m (1562ft) above sea level. The state was created on May 27, 1967. The capital is Kano City. Kano state has forty-four Local Government Areas; a total land mass coverage of 20,620.01 square kilometers and is divided into three ecological zones, namely; of Northern Guinea savannah, Sudan savannah, and Sahel savannah. The eco-zones are delineated by the amount of rainfall and vegetation obtained within each of the areas (Olofin 1987). The data used for this presentation was obtained from the satellite imagery using coordinates of all the ecological units staggered in ten-year interval. The IDRISSI GIS Taiga version was used for analyzing the images.1973, 1983, 1993, 2003 and 2013, respectively. The vegetation survey was conducted through enumeration of the species using various quadrats from the 10,000 square meters taken as a representative sample from each Local Governments of the study area.

3. RESULTS

3.1 Landuse pattern in Kano State

There is no doubt that human activities have profoundly changed landscape during the last half centuries. Land is one of the most important natural resources. All agricultural, animal and forestry productions depend on the productivity of the land. The entire eco-system of the land, which comprises of soil, water and plant, meets the community demand for food, energy and other needs of livelihood. The land-use pattern of a region is an outcome of its natural and socio-economic factors and their utilization by man in time and space. Viewing the Earth from space is now crucial for the understanding of the influence of man's activities on his natural resource- base over time. In situations of rapid and often undocumented and unrecorded landuse change, observations of the earth from space provide objective information of human activities and utilization of the landscape.

Owing to the trend of values obtained in square kilometers over the five decades of this study, it could be noted that the built up areas and agriculture increased astronomically from 274.1km^2 in 1973 which is an equivalent of only 1.32% of the total land mass of the study area to an estimated value in square kilometers of 1156.25km^2 in the year 2013, which is equivalent to 5.6%, a clear increase in the land mass used for infrastructural development of 882.16km^2 or equivalent percentage of 4.28%. The land for agricultural development in 1973 was 18405.6km^2 or equivalence of 89.26% of the total land mass of the state. Within the period under review however, a conversion of 17,573.04km^{2}of agricultural land was observed to infrastructural development, an equivalence of 85.22% in 2013. Thus out of the 882.16 km^2 of land for agriculture in 1973, only 832.56km^{2}was left in 2013 i.e. an equivalence of 4.04% land was converted to build up areas. Water body in 1973 covered a land mass of 772.58km^2 an equivalence of 3.74% but dropped to 747.35km^{2}in the year 2013, an equivalence of 3.62%, clearly indicating a land conversion of 25.23km^{2}equivalent to 0.12%. Game reserves in the state, which were in 1973 occupying a land mass of 1,167.7km^2 equivalent to 5.66%, has been decimated to the land mass of 1,143.37km^2 in 2013 equivalent to 5.54%. This ultimately shows a difference of 24.37km^2

equivalent to 0.12% of the land used as a game reserve. By and large, as the land decreases following the land use so also the plant species.

Meanwhile, Figures 1,2,3, and 4 were the images obtained from the satellite showing different legends that characterized the different features of each ecological zone. Figure 1 is amap of Kano state showing the delineated ecological zones of Sahel, Sudan and Northern Guinea savannas respectively. Figure 2 is a representation of Northern Guinea savanna, while figure 3 is an imagery depicting the area covered by the Sudan savanna of the state and its features, whereas figure 4 is a map of the Sahel savanna with its legendary features. However, those legends like agriculture, built-up areas, water bodies, plantations, active farmland, uncultivated farm lands, and residential areas are features that surfaced in all the zones except for the game reserve which appeared only in the Sudan and Northern Guinea Zones respectively.

Table 1. Summary of Land Use Pattern in Kano State in Square Kilometers and Percentage

Years/	**1973**		**1983**		**1993**		**2003**		**2013**	
Layers	Km^2	%	Km^2	%	Km^2	%	Km^2	%	Km^2	%
Built-Up Area	274.1	1.32	303.48	1.47	647.28	3.13	846.41	4.1	1156.25	5.6
Water Body	772.58	3.74	770.08	3.73	764.83	3.70	760.70	3.68	747.35	3.62
Game Reserve	1167.74	5.66	1164.68	5.64	1160.86	5.62	1146.67	5.56	1143.37	5.54
Agriculture	18405.6	89.26	18381.77	89.14	18047.03	87.52	17866.23	86.64	17573.04	85.22

Source: Zonal Advanced Space Technology Application Laboratory, Bayero University Kano 2014.

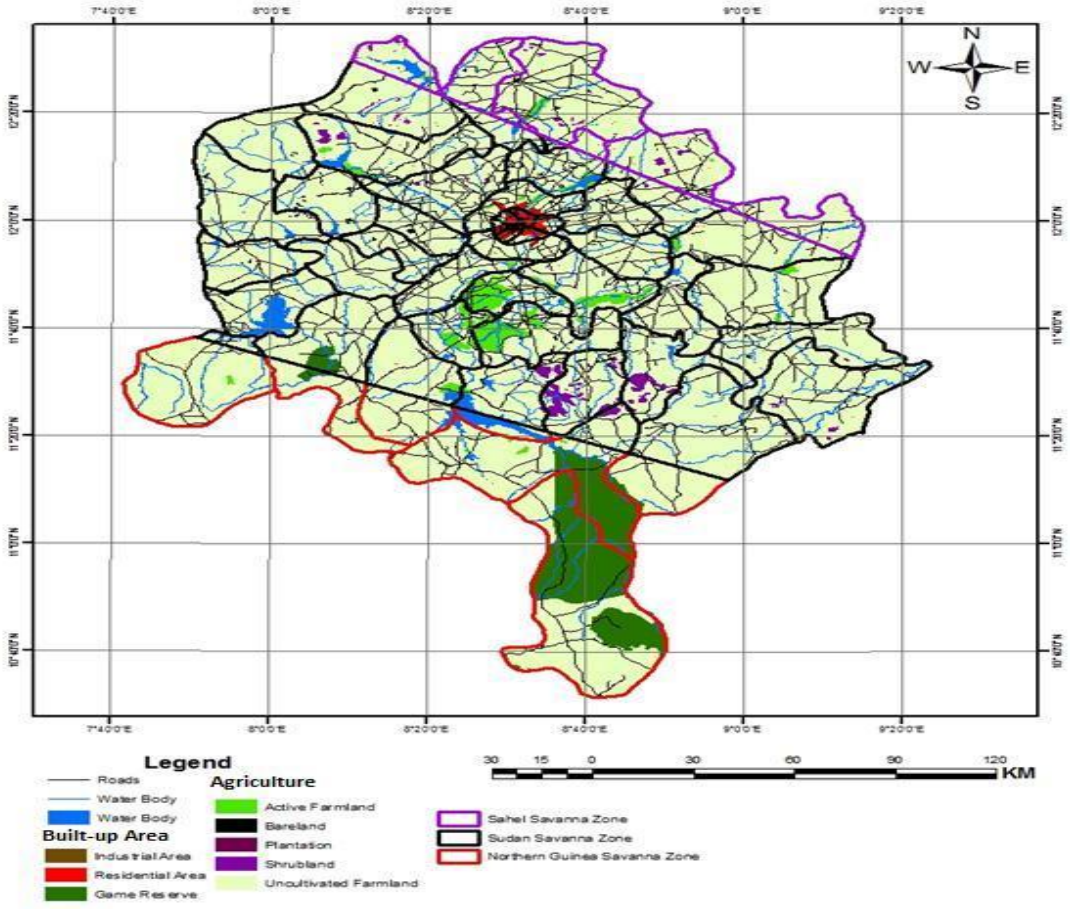

Figure 1**:** Map of Kano State Showing Different Ecological Zone
Source: Zonal Advanced Space Technology Application Laboratory Bayero University Kano, 2014.

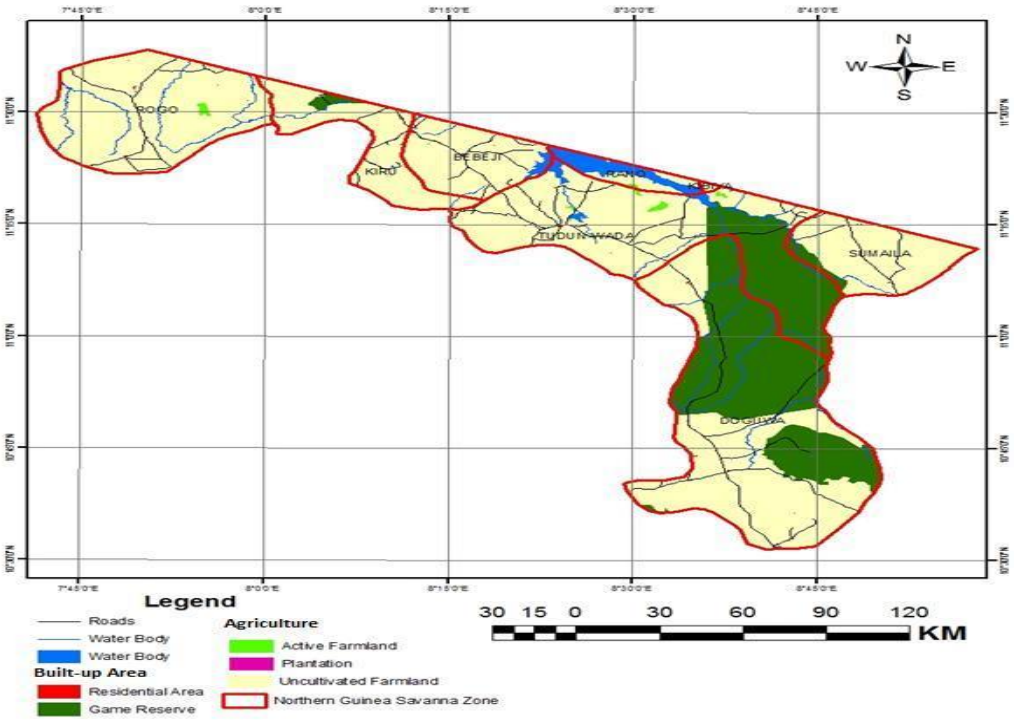

Figure 2: Map of Kano State Showing Northern Guinea Savanna Zone
Source: Zonal Advanced Space Technology Application Laboratory Bayero University Kano, 2014.

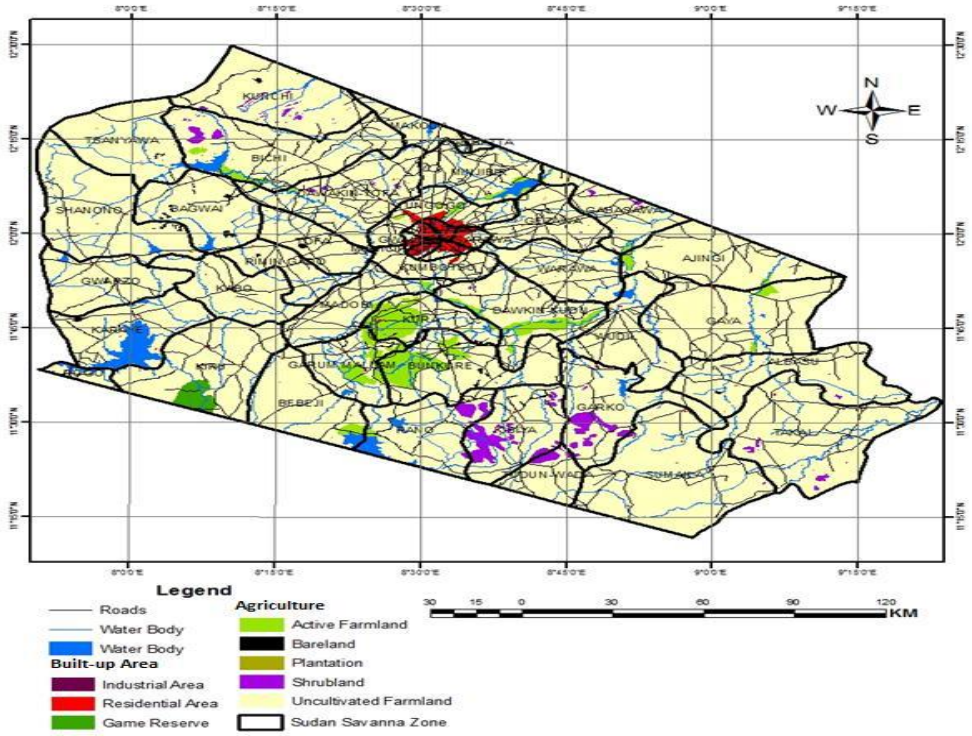

Figure 3: Map of Kano State Showing Sudan Savanna Zone
Source: Zonal Advanced Space Technology Application Laboratory Bayero University Kano, 2014.

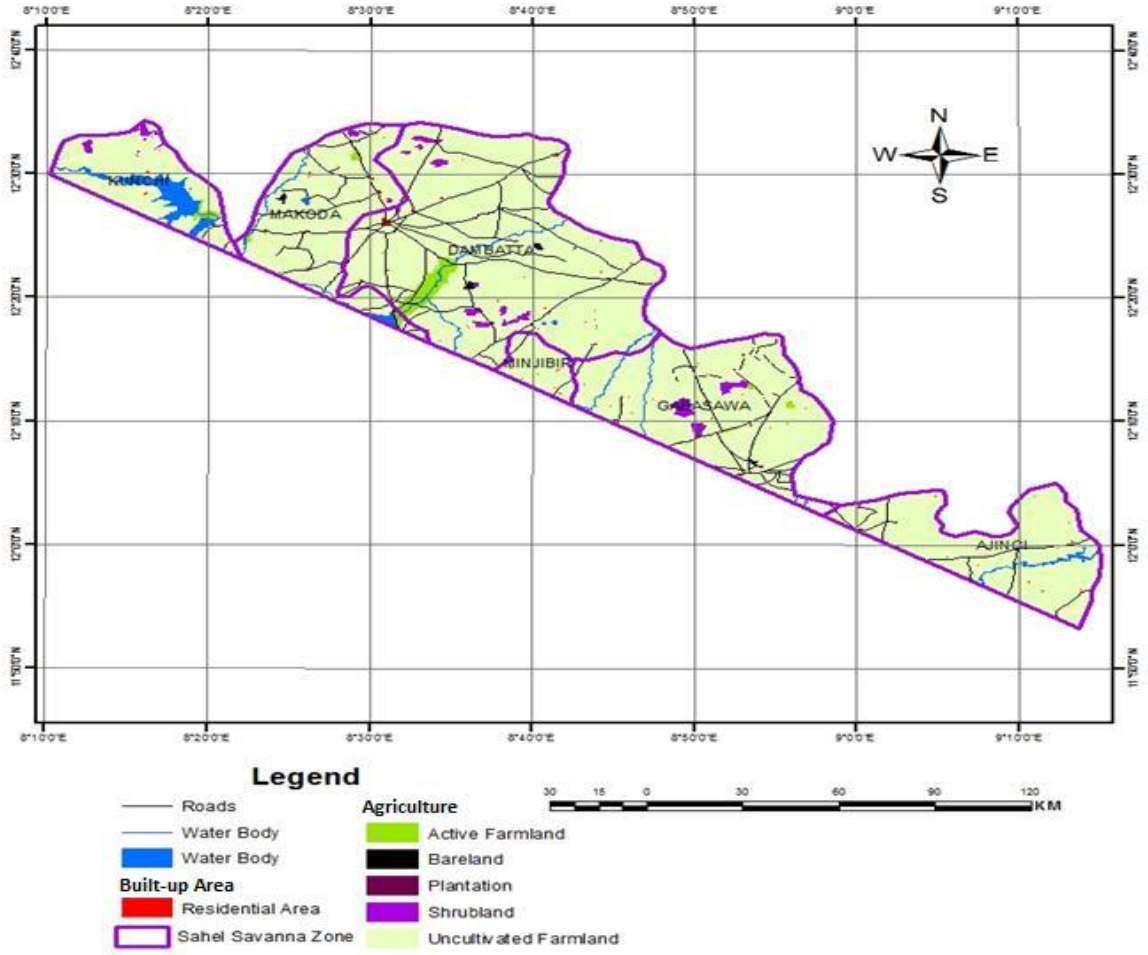

Figure 4: Map of Kano State Showing Sahel Savanna Zone
Source: Zonal Advanced Space Technology Application Laboratory Bayero University Kano, 2014.

Table 2 is a presentation of the number of woody species encountered in the course of the survey coducted in the ecological zones of Kano state, comprising of the Sahel, Sudan and Northern Guinea Savanna ecological zones respectively, The vegetation enumerated in the Sahel savanna zone had a total of 1,093 stands from (11) species encountered. In the Sudan savanna ecological zone (29) species were encountered with a total sum of 1,154 stands were recorded in the same square lengths of the same study units. More over, (34) species were recorded in the Northern Guinea savanna zone with a total sum of 1,269 stands of woody plants recorded per study units, invariably indicating variations according to ecological zones.

Table 3 is a presentation of non-woody plants encountered from the study units of the ecological zones where (35) species were enumerated totalling 10,389 stands in the Sahel savanna zone, whereas in the Sudan savanna zone (43) species were recorded with total species measuring 10,624 stands per study units. However, in the Northern Guinea savanna only (48) species were recorded with a total sum of 25,513 stands respectively.

Table 2: Species List and Estimated Number of Woody Plants Encountered in the Sampled Areas of Kano State Ecological Zone

Species scientific name	Sahel savanna	Sudan savanna	Northern guinea savanna
Adansonia digitate	(11)	(18)	(17)
Acacia ataxacantha		(09)	(03)
Acacia nilotica		(05)	(23)
Acacia Senegal		(08)	(15)
Aformosia laxiflora			(06)
Anacardium occidentale			(11)
Annona senegalensis	(42)		(023)
Anogeissus leiocarpus		(05)	(16)
Acacia siebrena			(10)
Azadirachta indica	(11)	(25)	(028)
Bauhinia rufesens		(20)	
Balsamidendron africanum			(022)
Borassus aethiopum			(021)
Cassia arereh		(38)	
Calotropis procera		(10)	
Catunaregan nilotica	(10)		
Citrus medicus			(019)
Combretum micranthum		(70)	
Piliostigma sp.	(332)	(30)	(43)
Combretum glutonism		(010)	
Commiphora Africana		(192)	(39)
Dichrostachys cinerea			(10)
Diospyros mespiliformis		(07)	(41)
Dalbergra saxatalis			(03)
Eucalyptus sp.		(02)	(10)
Euphorbia balsamifera		(30)	
Faidherbia albida	(14)	(016)	(122)
Ficus ingens			(06)
Ficus glumosa			(05)
Ficus platyphylla			(05)
Ficus sychomorus			(15)
Guierra senegalensis	(663)	(90)	(40)
Jatropha carcass	(171)	(303)	(156)
Khaya senegalensis		(016)	
Lawsonia inermis		(139)	(555)
Mangifera indica		(10)	(26)
Moringa oleifera		(37)	(22)
Melina aborrea			(07)
Parkia biglobosa	(04)	(29)	(17)
Phylantus reticulatum	(05)		
Ptendra species		(04)	
Prosofis africana			(08)
Scelorcarya birrea		(02)	
Sterculia setigera			(05)
Tamarindus indica		(13)	(13)
Terminalia species			(05)
Vitex doniana		(04)	
Vitellaria paradoxii	(01)	(10)	(08)
Zizziphus abyssinica		(04)	
Zizziphus spina christii		(02)	(06)

Source: Field Survey, 2014

Table 3: Species List and Estimated Number of Non-Woody Plants Encountered in the Sampled Areas of Kano State Ecological Zones

Species scientific name	Sahel	Sudan	Northern guinea savanna
Acanthospernum hispidium	(832)	(113)	(817)
Andropogon gayanus	(1,969)	(1,502)	(876)
Aneleima beniniense	(660)	(65)	
Anelemia acquinoctiale	(1,035)	(15)	(55)
Amaranthus spina	(231)	(147)	(173)
Aneleima lanceolatum			(37)
Aristolochia albida		(71)	(71)
Amaranthus caudate		(45)	(45)
Alysicarpus vaginalis		(35)	(35)
Borrerea stachydea			(49)
Cyperus rotundus	(3,843)	(1,132)	
Cenchrus biflorus	(494)	(1,919)	(152)
Cynodon dactylon	(245)	(160)	(95)
Commelina benghalensis	(633)	(140)	
Corchorus trilochularis	(75)	(15)	(15)
Commelina erecta	(897)	(25)	(15)
Citrus medica	(09)		
Cissus polnea		(40)	(71)
Cardiospermum grandiflorum		(30)	(20)
Digitaria debilis	(1,180)	(680)	(866)
Dactyloctenium aegyptium	(365)	(125)	(295)
Eragroslis astrosivens	(1,381)	(218)	(1,925)
Elusine indica	(397)	(167)	(59)
Echinochloa stagnina	(1,573)	(95)	
Euphorbia lateriflora		(25)	(27)
Evolvulus alsinoides		(46)	(46)
Hyperrania rufa	(1,240)	(150)	(403)
Hibiscus sabdarifa			(113)
Ipomea aquatic	(190)	(877)	(57)
Imperata cylindrical	(420)	(161)	(137)
Ipomea muricata			(43)
Kylinga squomulata	(173)	(15)	(48)
Kigelia Africana	(147)	(30)	
Ludwigia hyssopifolia	(109)	(13)	
Leucas martinicensis	(75)	(15)	(109)
Leptadenia hastate	(253)	(60)	(65)
Momordica balsamina	(203)	(20)	(27)
Mitracarpus hirtus		(118)	(170)
Mimosa asperata			(53)
Maytenus senegalensis		(25)	(19)
Oryza barhii	(210)	(25)	
Paspalum scrobiculanum	(1,415)	(175)	(1,301)
Penissetum pedicellatum	(1,415)	(175)	(1,301)
Portulaca olaracea			(88)
Striga haemonthica	(724)	(250)	
Senna obtussifolia	(273)	(643)	(154)
Schwenkia Americana	(550)	(250)	(119)
Salvadoara Persia	(45)	(350)	(35)
Securidata langepedunculata		(80)	
Tribulus terrestris	(67)	(85)	(99)
Thelepegon elegans			(18)
Urelytum giganteum		(84)	(90)
Waltheria indica	(2,185)	(213)	(213)

Source: Field Survey, 2014

4. DISCUSSION

Over the years it has been noted that there is an intensive demand for agricultural land and infrastructural development in Kano state. Moretimore *et al.* (1999) suggested that the driving forces of deforestation are the expansion of land for farming and infrastructural development. This phenomenon tallied with the idea of the United Nations Organization (UN Report 2007) that the role of population dynamics, stagnating economic, social and technological conditions coupled with a variety of land use practices employed around the world has affected land and plant sizes. Maiwada (2004) estimated that the total area of Kano metropolis increased from 122.7km^2 in 1996 to 154.6km^{2}in 1981, an increase of about 25% on the average, the expansion rate of about 2km^2 per annum. The same study also shows the decline in agricultural land use from 57.2% in 1962 to 38.8% in 1981, but residential land use increased from 22% to 44%, thus more than doubling. Inextricably linked to the concept of landuse, is the notion of vegetation loss. Yusuf (2001), stated that the land-use and landcover patterns of any region is an outcome of natural and socio economic factors and their utilization by man in time and space. Ahmed (2006) earlier noted that the natural vegetation of Kano state is largely degraded except for the Falgore Game Reserve, which is also suffering from encroachment. Tanko and Momale (2014) however, affirmed that the anthropogenic activity of man has transformed the vegetation over the years through the influence of fire, grazing, cultivation, urbanization and wood cutting, which has presently characterized the landscape of ecological zones of Kano state.

5. CONCLUSION

1. That the vegetation of the state was categorized based on location.
2. Demand for infrastructural development has systematically reduced the lands meant for agriculture, water bodies and game reserves in to build up areas.
3. That the plant diversity is a product of the land use formations in the state.
4. The classification achieved in this study produces information that fulfils the minimum accuracy threshold.
5. It is assumed that this application of the techniques of remote sensing and GIS as demonstrated in this study can open up new arena of comparative research so that a broad and full picture can ultimately be outspread to shed light over the pattern and processes of land use change in Kano state.

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