Re-Evaluation Of Succession And Invasion Of Land Use/Land Cover Changes In Dadin Kowa, Jos, Nigeria

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DOI: 10.29322/IJSRP.10.09.2020.p10592
http://dx.doi.org/10.29322/IJSRP.10.09.2020.p10592

Abstract- Succession and Invasion is fundamental of increase in land use and land cover (LULC) changes in the global environment. Despite its global importance, decisions on land use management have considered less attention to the impact of succession and invasion in LULC changes. This research is aimed to evaluate the impact of succession and invasion on LULC change in Dadin Kowa, Jos, Nigeria from 1962-2016 Aerial photographs of the study area (1962 (1: 9,000), 1971(1: 10,000), 1991(1: 6,000), were processed using photogrammetry technique, and the 0.6m resolution Quick Bird satellites imagery for the year 2015 and 2016 were processed using Remote Sensing technique and Geographical Information System techniques was used for the analyses. The results revealed that in between 1962-1971, 1971-91, 1991-2005 and 2005-2016 the built-up area, forest and water bodies invaded agricultural land use and increased gradually from a total of 29.609ha to 90.073ha and to 209.832ha. This increase led to an overwhelming decrease about 380.059ha of agricultural land by 2016. The Land Cover Changes revealed a rapid increase in residential use and a substantial decrease of agriculture and vegetation land use and rock outcrops. It was concluded that one of the biggest problems of LULC change and its management is the ability to reconcile conflicting goals and their uses, and secondly human activities over time modify the direction of succession and invasion resulting into several lasting effects as revealed in this study. Thus, recommending the use of Geospatial techniques for Land use Land cover change detection and analyses.

Index Terms- Land Use, Land Cover, Succession and Invasion, Remote Sensing and Geographical Information System Techniques

I. Introduction

Rapid urbanization and infrastructure development have modified landscape characteristics through changes in Land Use and Land Cover (LULC) types across the world (Puech et.al. 2015). Knowledge of Land Use (LU) and Land Cover (LC) is important for planning and management activities and considered as an essential element for modelling and understanding the earth as a system. LC maps have presently developed from local to national and global scales (Nagarajan and Poongothai, 2011). However, studies on LULC changes have been conducted mostly in developed countries since post-industrial age due to more governments' attention to ecological and environmental issues than those in the developing countries. Additionally, human activities affect landscape characteristics at a faster rate in prosperous developing countries than in developed countries. The environment sustains man and other living things around a man (Ogunlami, 1994). For example, urban growth and the concentration of people in cities are creating social problems such as flood, urban sprawl, deforestation, erosion worldwide. The environmental consequences of the rapidly increasing growth of cities in many parts of the world have attracted much research attention in both developed and developing countries. One of such effects which offer ample opportunities for study relates to the LC implication of the change as it affects the socio-economic lives of people (Zubair, 2006).

II. LULC Change Detection

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Singh. 1989; Lu et al., 2004). Change detection is used for diverse applications such as evaluation of Land Use (LU) change, monitoring of shifting cultivation, assessment of deforestation, the study of changes in vegetation phenology, damage assessment, disaster monitoring, day/night analysis of thermal characteristics and other environmental changes (Singh, 1989). The use of panchromatic, medium-scale aerial photographs to map LU changes has been an accepted practice since the 1940s. More recently, small-scale aerial photos and satellite images have been utilized for mapping LULC change detection. LC changes can be observed as one of the most sensitive indicators of land use interactions. Change detection on LC mainly focus on four aspects, (1) detecting if any change has occurred, (2) identifying the nature of the change, (3) measuring the areal extent of the change, and (4) assessing the spatial pattern of the modification. Since the spatial pattern of the LU changes is regarded as a good indicator of the impact of the other three aspects, its research has become quite active in change detection (Lu et al., 2004). Chiroma et al (2018), have used satellite imagery to study land use changes in Maiduguri, Nigeria. Many change detection methods have applied using remote sensing to monitor LC changes and identify the patterns of change and derive more understanding of the consequences of LULC modification to achieve more accurate model of the changing tendency of LULC (Achuenu and Ayuba, 2015; Aplin, and Curran, 1999; Asadi, et.al. (2012), Baldocchi,

2015; Keefe, 1977; Koladade, 1992; Lambin and Ehrlich, 1997; Marsland, 2009 and Meyer, 1995). In general, remote sensing change detection methods have two broad classes. They are bi-temporal change detection analysis and temporal trajectory analysis. The former was based on the comparison between two dates, and the latter analyzes the tendency of change in multiple periods or a continuous time scale (Lillesand et al., 2004).

Thus, this research is focused on the successive and invasive changes by conversion between LULC in Dadin Kowa area of Jos, Nigeria. The extent of alteration may vary with population numbers, stage of economic development, the age of culture and other factors. Some modifications have been introduced through the acts of industrialization, deforestation, mining, scarification, construction and agricultural activities. The above mentioned environmental parameters require continual information to enable proper monitoring, such information is called geographical information; information relating to a particular location on the earth (Radwan, 1991). Adequate information on LULC is essential to ensure proper planning and management of land uses in towns, cities and metropolitan areas. Adequate information on the historical trends of LULC changes be documented (www.gisdevelopment.net, 2013). This will form baseline data for analysis of the past and present, from which the future demand for each LU activity is projected, and subsequent planning for land-use zoning as designed.

III. Sociological Theory of Neighborhood Change:

The urban theory used in analyzing land use/land cover for this study is adapted from sociological theories of neighborhood's change. Weinstein (2007) studied land-use/ land-cover form from the sociologist point of view using the concepts of succession and invasion which describes two different but complementary processes of neighbourhood change in urban areas'. Weinstein (2007) further compared what he termed "Old urban sociology" of Park and Burgess (1925), which used the theory of Concentric Zone Model to explain patterns of growth and development, through invasion, succession, natural areas, urbanism, competition, transition zone and decentralization. Park and Burgess (1925) developed a theory of urban ecology which proposed that cities are environments like those found in nature, governed by many of the same forces of Darwinian evolution; which affects natural ecosystems. When a city grows, people and their activities cluster in a particular area (this is the process of "concentration"). Gradually, this central area becomes highly populated, so there is a scattering of people and their activities away from the central city to establish the suburbs (this is "dispersion"). This theory used human adaptation through invasion to change their physical environment. According to views by, these "New Urban Sociologists which emerged in the 1980s cities are viewed as "growth machines" with emphasis on how different parcel of Land is used and developed on social conflicts, capitalist economic forces combined with political decision-making processes according to Marxian Model of society. Where all development shares the same interest: are pro-growth mentality and a pro-business agenda, by the people and for the people.

Although. Park and Burgess (1925) original ideas of the concentric zone theory have not stood the test of time, his basic argument that cities have spatially distinct zones that interact via ecological mechanisms of the competition of invasion and succession has survived in a number of forms. Invasion is the process by which a new category of people or type of land use arrives in an area previously occupied by another group or type of LU; while succession is the process by which a new category of people or type of LU gradually predominates in an area formerly dominated by another group or type of land use (McKenzie, 1924). Succession mostly applied in ecological concepts in two forms; Primary and secondary succession. Primary succession is one of two types of the biological and ecological succession of plant life, occurring in an environment in which new substrate devoid of vegetation and other organisms usually lacking soil, such as a lava flow or area left from a retreated glacier, is deposited. In other words, it is the gradual growth of an ecosystem over a longer period (Walker and del Moral, 2015).

In contrast, secondary succession occurs on a substrate that previously supported vegetation before an ecological disturbance from smaller things like floods, hurricanes, tornadoes, and fires which destroyed the plant life. It is a process following severe disturbance or removal of a pre-existing community (Baldocchi, 2015). This process of regrowth called secondary succession is different from primary succession because there has already been a community of life in the area of the disturbance, and there is typically still some life present. This is unlike primary succession where you begin with bare rock - no life - even though the ecosystem in question may have been drastically altered. There is soil, which may be housing seeds, nutrients, and other vital components that will make the recolonizing by the growth of producers, typically plants, occur much more quickly. The stages of primary succession include pioneer plants (lichens and mosses), grassy stage, smaller shrubs, and trees. Animals begin to return when there is food there for them to eat. When it is a fully functioning ecosystem, it has reached the climax community stage (The U.S. Department of Agriculture, retrieved 2013-09-30). Secondary succession is much more commonly observed and studied than primary succession. Particularly common types of secondary succession include responses to natural disturbances such as fire, flood, and severe winds and response to human-induce disturbances such as logging and agriculture.

The concept of Ecological approach in primary and secondary succession and invasion can be used to study the pattern of urban land use and land cover (LULC) change. According to Cumming (2008), the concept is of benefit to LC studies because it provides a clearer description of the mechanism and framework to the study LC changes. He further states that Ecological approach to LC study has a much stronger approach at analyzing models based on simple and clearly defined theory-derived mechanisms and such theoretical sight can be adapted in analyzing land cover change that offers useful insights into ways of viewing and understanding LULC changes. Ecological approaches thus have considerable potential in the analysis of spatial resilience in landscapes from LC maps inclusive of some potential weaknesses. There are several challenges in bridging the gap between ecological approaches and LC analyses of which one of it, is to carefully look up the different processes used in the study of the same kind of LC types. Secondly when applying ecological approaches to the analysis of LC and spatial resilience lies in the differences in the mechanisms driving LU and LC as opposed to

those driving changes in plant and animal communities. This is because LC change in the twenty-first century is largely caused by anthropogenic and human activities, though some land cover change may arise out of the interaction between social and ecological systems that affect LC change. Another recent review demonstrates current models used to test ideas on LULCC even though the focus of most land use models has been to develop applications that facilitate decision making in a particular context and ignoring the potential for feedback mechanisms (Mattew, et.al, 2007). This kind of insight can help to quantify alternative scenarios for future land use changes and to explore how spatial and time variation influences influence by the complex system because just as cities occur within a particular landscape, it also occurs within a period of history.

The renowned sociologist Mckenzie (1924) was one of the first to propound the theory of "invasion and succession" in explaining how ethnic group replaces themselves. They suggested that, over time, the competition for land and other scarce urban resources leads to the division of the urban space into distinctive ecological niches, "natural areas" or zones in which people share similar social characteristics because they are subject to the same ecological pressures. As a zone becomes more prosperous and "desirable", property values and rents rise, and people and businesses migrate into that zone, usually moving outward from the city centre in a process called "succession" (a term borrowed from plant ecology), and new residents take their place.

Using two scenarios, McKenzie (1924) first compared this type of change to an environment change alongside change in its first sets of inhabitant's species of grasses and insects being overtaken by new species and animals which would also be replaced over time by the former. Secondly, he Likened invasion and succession to land use or economic activity of a community. Weinstein (2007) applied the concept of succession and renewal to Coney Island, a famous neighbourhood in New York City as the case study for the application of the general principles and model involving the change in urban areas.

IV. Materials and Methods

Materials used for this research are both hardware and software which includes:
Computer and its accessories,
ArcGIS is a Remote Sensing software,
ILWIS software was used to digitised the scanned image to softcopy and ,
Leica Photogrammetry Suite was used to processed the aerial photographs

V. The Study Area

Dadin Kowa neighbourhoods'is located in Jos South Local government of Plateau State, Nigeria. It is about 5 minutes' drive from Bukuru metropolis (Latitude: 9°48′00″N and Longitude: 8°52′00″E), the Headquarter of Jos South Local Government Area of Plateau State. It is bounded by four distant hills. It is initial settlers were the Berom tribe, an indigenous people of the Jos plateau. The community developed pre-1960 as a result of the mining and quarrying activities which experienced a lot of LULC changes over the years. Dadin Kowa is a good example, the secondary succession of LULC which occurred steadily since 1962 and more rapidly from 2001 to 2005 due to ethno-religious crises in Jos city. The crises led to the invasion and succession of the landscape by the continuous relocation of people and development of residential and commercial properties. The entire Dadin Kowa land area leaving only small unbuilt areas which consist mainly of trees, grasses and crops and others.

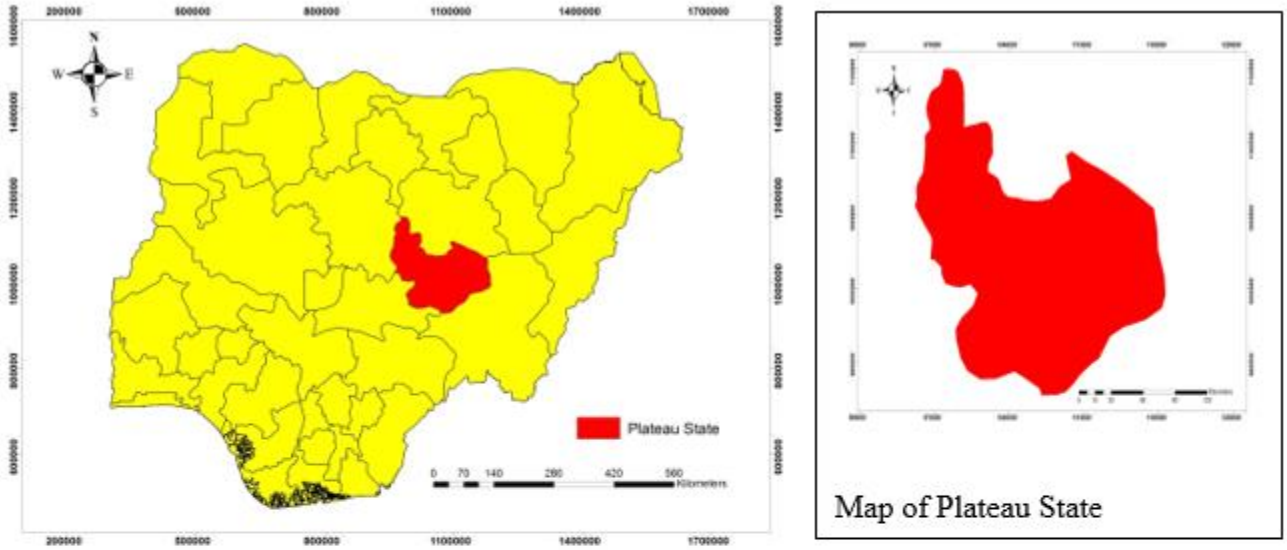

Figure 1: Map of Nigeria showing Plateau State

Satellite Imagery of Jos South Local Government
Source: (https://www.plateaustate.gov.ng/government/lgas/jos-south)

Data Sources and Establishment of Land Uses/Land Cover Classification

An area of 84000 m^2 was delineated on the Landsat scene covering Dadin Kowa the study area. Post-Classification change detection approach was employed due to its ability to bypass the problems and difficulties associated with the analysis of images acquired at different times of the year and sensors (Yuan et al., 1998). The study focuses mainly on seven independent land use/land cover classification and was achieved by supervised classification as follows: land cover changes; Built-up areas (developed areas) and agricultural land, forest areas, water bodies, rock outcrops, degraded areas and undeveloped areas respectively. The research was limited to the use of the aerial photograph of 1962, 1971, 1991, 2005 and 2016 satellite imagery alongside the use of topographic maps of Naraguta North East and a ground survey map of 2000 (update of 1976 maps) and field work to validate the change detection on the aerial photographs. That is because obtaining images at near image dates is considered important for change detection studies (Jensen and Im, 2007).

The images were corrected to rectify atmospheric effects and then geo-referenced using ground control points acquired by GPS. The images were re-sampled to 30m pixel size for all bands using the nearest neighbour method. The resultant root means squared error was found to be 0.53 pixels (about 16 m on the ground) between the 1962 and 1971 images, 0.51 pixel (about 15 m on the ground) for the 1991 and 2005 images. All the data were projected to a Universal Transverse Mercator (UTM) coordinate system, using three sets of sequential aerial photographs of Dadin Kowa for 1962 (1: 9,000), 1971(1: 10,000) and 1991 (1:6000), 2005 and 2016 satellite imagery of 0.6m Quick Bird resolution of the study area. Following the previously drown scheme and transfers plan, areas of doubtful preliminary interpretation were particularly verified since there was no functional land-cover survey, it was, therefore, necessary to produce one at a scale and quality compatible with the study.

Land-cover data was transferred from the interpreted overlays to a base map with the aid of a digitizer. 1962, 1971, 1991, 2005 and 2016 land-use maps on a unified scale of 1:500 base map were overlaid on each other to produce a land-cover change map between 1962-1971, 1971-1991, 1991-2005 and 1991-2016. The transferred data became the preliminary land-cover map for the study area and it formed the basis of quantitative measurement for the land-cover changes analysis. To compare the four sets of data, the resulting values were converted to percentages. Based on the ground truth data, modifications were effected and classes, as well as their boundaries, were redefined and digitized. In order to make the classification scheme clear for understanding, the classification system used in this project is based upon categories which are partially exhaustive (no omission of any phenomena) and naturally, exclusive (no overlap of any category) because of the scale provided by the aerial photographs and the satellite imagery utilized. The methodology and classification scheme employed in this study was appropriate and compatible with the area under investigation and the study objective. The analyses of the causes of land-use/land-cover succession are also classified into; Initial causes and continuing causes as follows:

Succession and Invasion of LULC change in Dadin Kowa from 1962-1971

As shown in Table 1 the areal extents are presented in hectares. Table 1 and Figure 1 shows the initial cause of succession between the pre-1962 bases year and 1972 showed that factors such as the indigenous/original traditional settlements, their agricultural, water bodies and the natural vegetation and forest existed long before the industrial tin mining activities began on the Jos plateau.

These factors have resulted in the primary succession of the land use/land cover of the area. Dadin Kowa town started developing from pre-1960 as a result of the mining and quarrying activities that took place and since then it has experienced a lot of changes in its development over the years. With the advent of industrial large-scale tin mining activities began the secondary successional and invasive change on the land cover and land use of the area. Lands categorized as agricultural lands are given way to development due to gradual human invasion process and activities. The 1962-71 base year showed that the areal extent of Agricultural land was 45.29ha but over the span of 10-years gradual land cover change caused mostly by several human developmental activities by 1971 a total of 29.609 ha had been developed into urban land uses.

VI. RESULTS AND FINDINGS

Table1. Trends in Invasion and Succession of Land-Use/Land-Cover (LULC) change for 1962-71, 1971-91, 1991-2005 & 2005-2016

	S/N	LCLU change detection	The areal extent of change detection in hectares (ha)							
			LCLU change distribution from 62-71 (ha)	Invasion and succession of LCLU from 62-71(ha)	LCLU change distribution from71-91(ha)	Invasion and succession of LCLU from 1971-91(ha)	LCLU change distribution from 1991-2005 (ha)	Invasion and succession of LCLU from 1991-2005 (ha)	LCLU change distribution from 2005-2016(ha)	Invasion and succession of LCLU for 2005-2016 (ha)
LCLU type		Agricultural(Ag)	676.00-630.71		630.71-460.52		460.52-252.82		252.82-592.761	
Invasion/ succession in LCLU	1	Ag-DA		4.367		161.360		140.892		360.183
	2	Ag-DL		12.378		9.880		14.684		0.000
	3	Ag-FO		8.016		1.246		8.343		0.000
	4	Ag-RO		5.042		6.130		45.600		0.000
	5	Ag-VL		0.000		11.040		0.000		0.000
	6	Ag-WB		0.072		0.417		0.313		0.000
Total change	06		45.29	29.609	170.19	190.073	207.18	209.832	380.059	360.183
LCLU type		Vacant lands(VL)	00.00-00.00	00.00	00.00-14.34	00.00	14.34-9.880	00.00	00.00-00.00	00.00
Total change	00		00.00	00.00	14.34	00.00	4.46	00.00	00.00	00.00
LCLU type		Developed areas(DA)	11.71-14.02		14.02-195.83		195.83-413.27		413.27-598.78	
Invasion/ succession in LCLU	7	DA-Ag		0.516		4.129		0.000		0.000
	8	DA-DL		0.021		0.000		1.079		0.086
	9	DA-FO		1.009		0.000		0.000		0.000
	10	DA-RO		0.000		0.127		1.364		1.237
	11	DA-VL		0.000		0.845		0.000		0.000
	12	DA-WB		0.000		0.000		0.015		0.028
Total change	06		2.31	1.546	181.81	5.101	217.44	2.458	185.51	1.351
LCLU type		Degraded Lands(DL)	36.80-49.89		49.89-47.82		47.82-69.78		69.78-0.164	
Invasion	13	DL-Ag		5.076		1.322		12.489		17.243
	14	DL-DA		0.000		1.313		8.683		50.843

/succession in LCLU	15	DL-FO		9.904		0.000		0.000		0.000
	16	DL-RO		0.000		0.932		1.044		3.112
	17	DL-WB		0.000		0.409		0.000		0.000
Total change	05		13.09	14.98	2.07	2.976	21.96	22.216	69.616	71.198
LCLU type		Forest(FO)	00.00-40.52		40.52-35.68		35.68-12.59		12.59-00.0	
Invasion /succession in LCLU	18	FO-Ag		0.000		0.803		0.000		0.000
	19	FO-DA		0.000		2.111		16.242		9.163
	20	FO-RO		0.000		0.449		0.000		0.000
	21	FO-VL		0.000		1.363		0.000		0.000
	22	FO-WB		0.000		1.106		3.397		3.411
Total change	05		40.52	00.0	4.84	5.832	23.09	19.639	12.59	12.574
LCLU type		Rock Outcrop(Ro)	108.02-106.33		106.33-83.86		83.86-86.13		86.13-4.76	
Invasion /succession in LCLU	23	RO-Ag		0.432		3.616		0.836		20.552
	24	RO-DA		0.690		10.941		1.275		8.334
	25	RO-DL		0.347		4.487		0.500		0.000
	26	RO-FO		0.296		1.094		0.000		0.000
	27	RO-VL		0.000		0.974		0.000		0.000
	28	RO-WB		0.000		0.707		0.000		0.000
Total change	06		1.69	1.765	22.47	21.818	2.27	2.611	81.37	28.886
LCLU type		Water bodies(WB)	04.15-03.90		03.90-05.79		05.79-05.32		05.32-3.439	
Invasion /succession in LCLU	29	WB -Ag		0.000		0.000		0.131		0.176
	30	WB -DA		0.000		0.000		0.391		1.263
	31	WB-VL		0.000		0.174		0.013		0.374
	32	WB-DL		0.140		0.036		0.017		0.078
	33	WB-FO		0.193		1.469		0.000		0.000
	34	WB-RO		0.000		0.000		0.015		0.111
Total change	06		0.25	0.333	1.89	1.679	0.47	0.557	1.881	2.002
TOTAL			103.75	48.233	397.61	227.487	472.41	257.313	731.026	476.194

Source: 1962, 1971 and 1991 Aerial photographs and 2005, 2016 Satellite imagery.

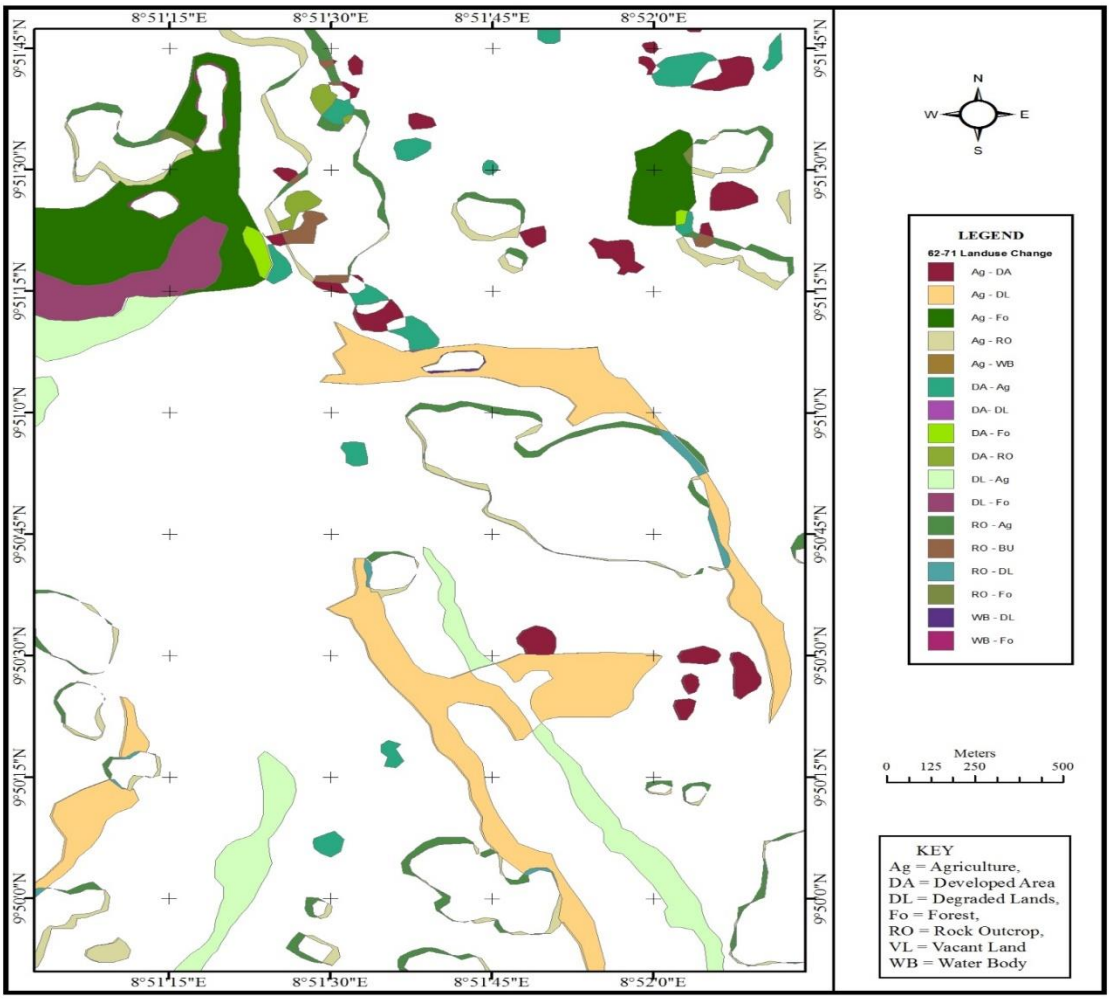

Figure 1: Trends in invasion/successions of land use/land cover change from 1962-1971.

The decrease indicated that Ag land use/cover has undergone invasion and succession with Ag-DL taking the lead with 12.378ha, reducing the areal extent of agricultural land area by 1971 (see Table 1). 8.016 ha indicated that between 1962-71 Agricultural land was converted to the forest (Ag-Fo) mostly Eucalyptus trees to aid in curbing degradation and wastelands, this situation altered the socio-economic status of the inhabitant of the study areas.

Succession and Invasion of Land use from 1971-1991

Between 1971-1991, the secondary succession became more eminent due to factors such as the conducive climate condition of the city of Jos, the gradual change of the physiographic configuration of the landscape due to the tin mining activities within the area. This has influenced erosion and gradual depletion of the forest area which results to land the degradation. From 1962-1971 to 19971-1991, the invasion areal extent from FO-WB was 0.0ha to106 ha. This resulted in the increase of the level of water bodies and mined ponds from 0.25ha to1.89ha within the area as shown in Table 1 and Figure 2. Between 62-71 and 71-91 there was the record of change from 14.34ha to 0.00 changes in vacant land areal extent due to the planting of tree gardens and orchard interpreted as forest. The continuing causes are major as a result of the following factors; the rural/urban migration to Dadin Kowa while most trees then were cut down for the purpose of construction work and residential use.

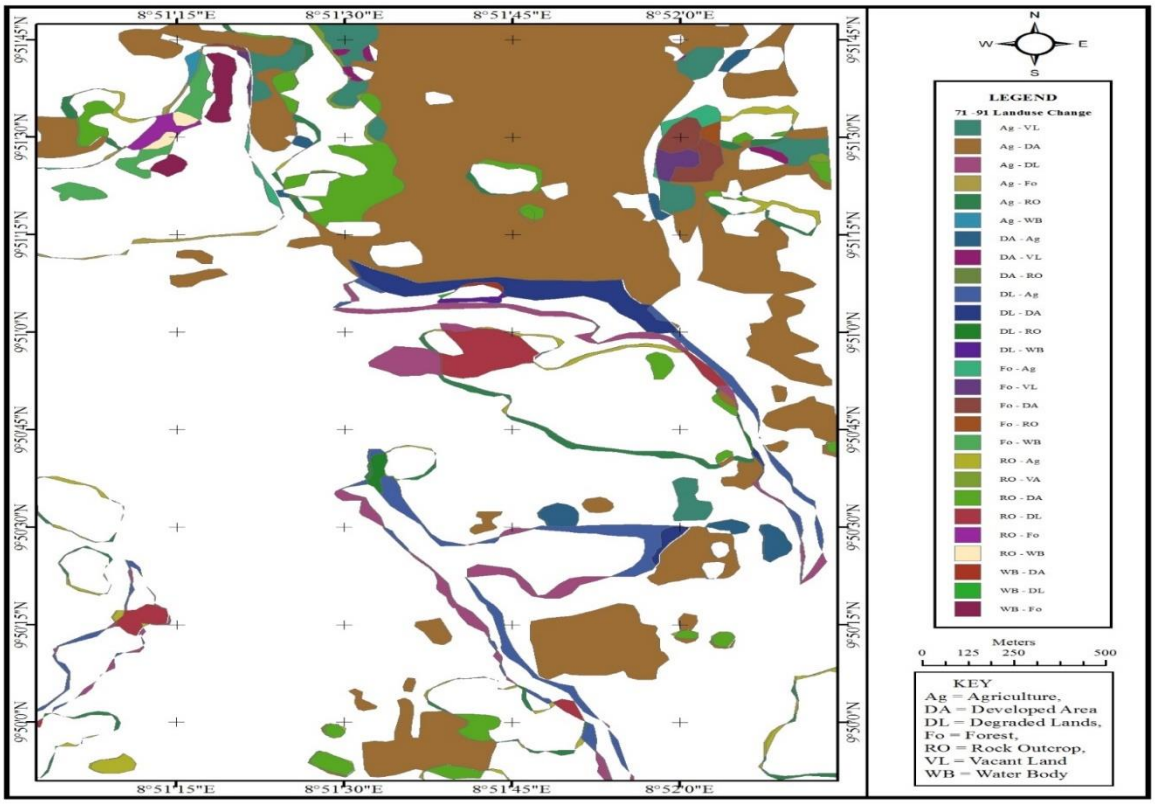

Figure 2: Trends detection in the evasion and succession of land uses/cover change from 1971-1991

Succession and Invasion of Land use from 1991-2005

The gradual inhabitation of Dadin Kowa from the 1990's to the year 2000, was boosted by the advent of security crises within Plateau state which resulted in the rapid relocation of people to Dadin Kowa for several reasons other than Tin mining. The period from 1991-2005 as shown in Figure 3 and Table 1, experienced rapid growth, development and mass movement of people and property development in Dadin Kowa area. The movement became more prominent in the year 2000 immediately after the Jos religious crises, which led to the establishment of different settlements and continuous growth of Dadin Kowa area.

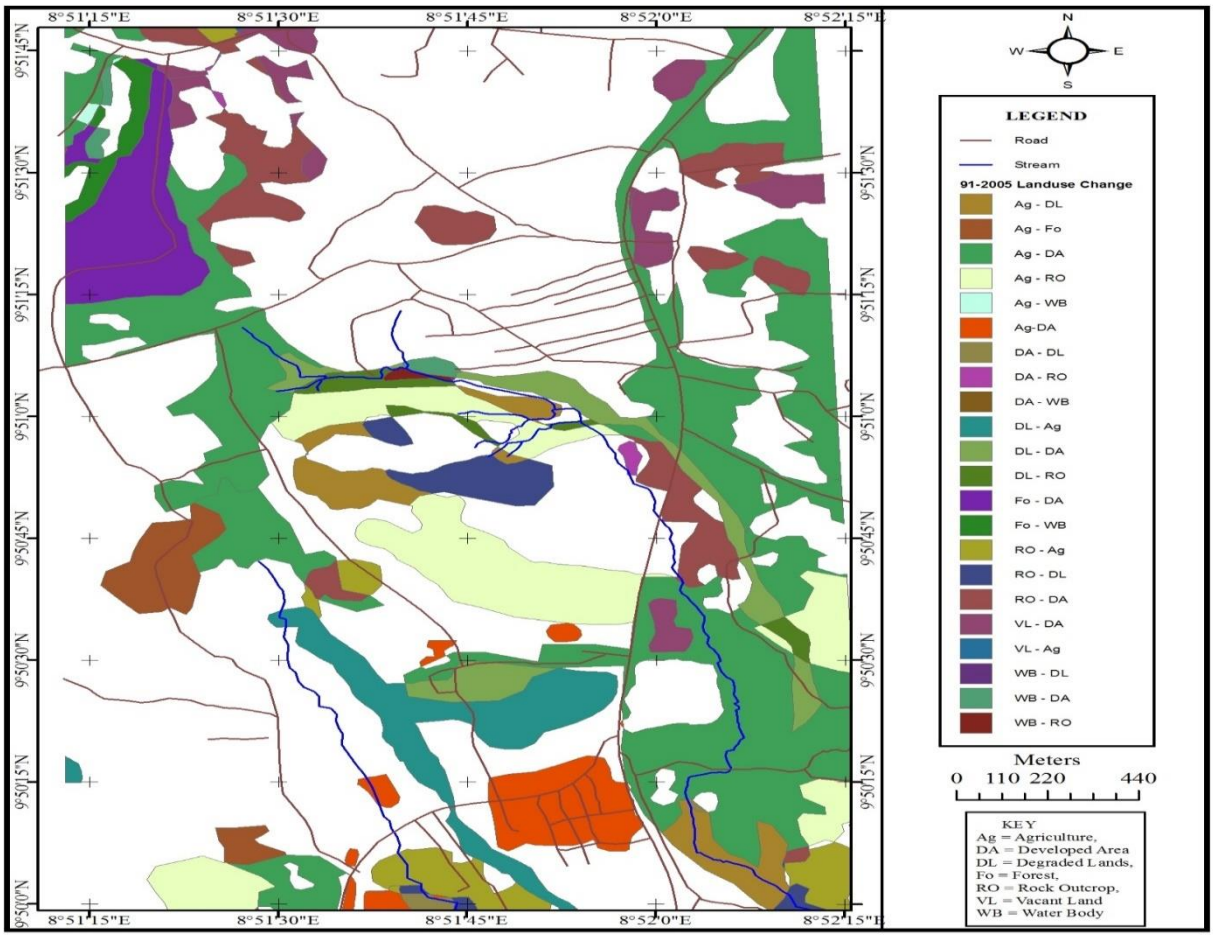

Figure 3: Trends in the evasion and succession of land uses/cover change detection from 1991-2005

The 2001-2005 ethnic-religious crises brought about a dramatic change to Dadin Kowa community in Jos both to its residential and agricultural, forest, rock outcrop and water body LULC. Before 91-2005 succession and invasion process pre-62-71 period had more residents in the mining camps and traditional occupants scattered around. The invasion was perhaps welcomed by the landowners, who benefited from the year-round rentals and sales of plots to the most dominant religious sects seeking succor and security mostly comprising of non- indigenous tribes from other states. The whole process has led to the establishment, spreading out and expansion of Dadin Kowa into new areas like Barkin Akawo, Zaramaganda and Kufang. At this continuing stage, several groupings and aggregation of settlements and residential building began to erupt everywhere. The settlers invade new areas gradually more migration has continued to take place. Thus in course of time, the immigrants scattered and invaded other land uses as a result of spreading out. Consequently, competition is especially more intense among the individuals for the resident in the process. It is interesting to note that due to this continuous movement of people between year 71-91 and 91-2005 there was an increase in the areal extent of invasion of Agricultural land from 170.19ha to 207.18ha, short of 36.99ha indicating a change to other land covers. Considering the analysis on land cover change of the study area, it is also noted that activities such as Tin mining and scarification led to increases in Vacant lands between 71-91 and 91-2005 from 0.00 to 14.34 but reduced to 9.880ha due to tree planting intervention was undertaken by the government in curbing further land degradation (see Figure.3). 91-2005 witness an increased change 19.639 ha of invasion from those of 00.0ha as at 62-71 showing that changes occurred because of the succession of increased demand on development and water bodies taking over forested areas on their own.

Succession and Invasion of Land use from 2005-2016

By 2005-2016, the environmental consequence of rapidly increasing growth in Dadin Kowa has attracted a great deal of attention to planners, city administrators and urban geographers. This increase has resulted from the rapidly increasing population and socio-economic activities. Many people have to be housed, and so this brings about the conversation of 360.183 ha of agricultural and 9.163 ha of forest lands into urban uses (see Figure 4 and table 1). Sprawling has resulted from the fact that residential landowners discovered that they could make quick returns from investing in urban uses than agriculture and forestry. The movement of old and new resident continued into the study area which spreads out into Kianga, New Abuja, Barkin Akawo. Over 69% of residents are non-indigenes the Ibos, Yoruba, Hausa, Edo, Delta, Benue and so on while 31% comprises of the indigene plateau tribes of Birom, Angas and other minorities. The increase in population brought about high demand for reservoirs and pound for domestic activities (see Table1).

The trends in LULC successions/invasion and their changes for the period of 54years went through 34 different variables of change, mainly as a result of pressure from the ever growing population and its associated problems such as the increasing demand for land and trees for firewood, poor institutional and socio-economic settings, unfavorable government policies such as lack of control of tenure system and poor infrastructural development.

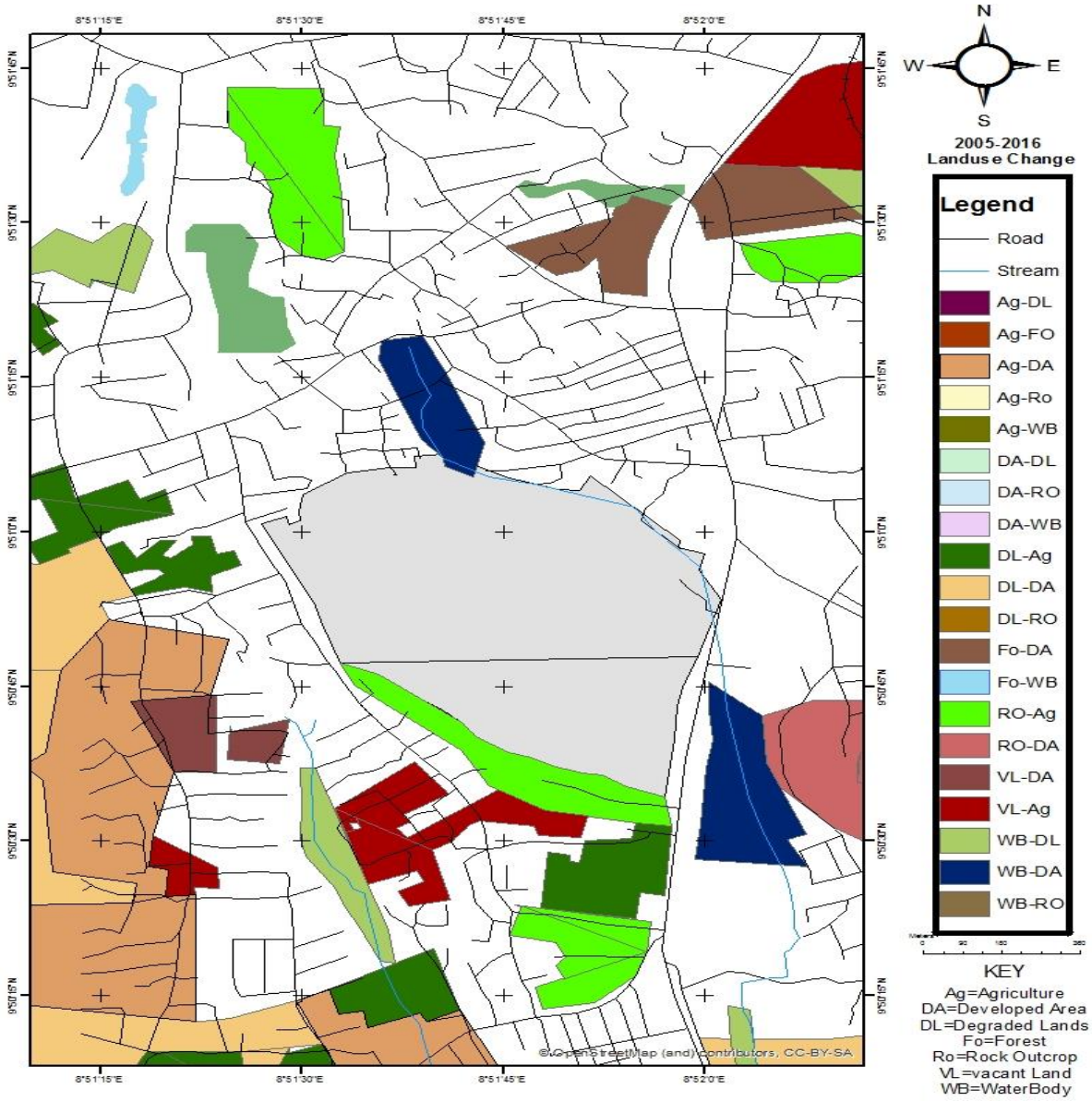

Figure 4: Trends of evasion and succession of land uses/cover change from 2005-2016.

It is observed that due to the improvement of infrastructures, the growth of Dadin Kowa moved from the North towards the North Southern part of the area shown in Figures 1, 2, 3 and 4. The southern part of Dadin Kowa is characterized by steep-sided slopes and a mountainous terrain which constrained the expansion of land use. Analysis of the LULC indicates urban growth expanded outwards into the rural-urban fringe around Barkin Akawo, Angwan Baki, Kangana and New Abuja. The results in Table 1, shows that between 1962 and 1971 (a total of 103.75ha of the LULC change was detected, with 48.233ha of succession and invasion. 18 of the 34 variable did not experience invasion and succession change., variables such as the changes from from Agriculture to Vacant land, Developed areas to Rock outcrop, Developed areas to Vacant Land, Developed areas to Waterbody and so on. The changes between 1971 and 1991 increased to a total of 397.61ha, with invasion/succession rate at 227.487ha. 8 variables did not experience change while 26 variables out of 34 variables experienced invasion/succession changes. For 1991 to 2005 the total LU changed increased with a difference of 74.8ha from those of 1971-91, making a total of 472.41ha with a total extent of 257.313 ha of succession and invasion. 12 variables did not change in their uses (see Table 1). It is reasonable to argue that there has been a relative change in the continuous and discontinuous fragmentation and spatial distributions of these LULC categories for the study area.

The result of change detection in LULC of the study area shows that for the period of 54 years, the LU dynamics for the degraded land has decreased from 14.98ha in 1962-71 to 2.976ha in 1971-91. The Built up (developed) areas change for 1962-1971 and 1971-1991 at an estimated increase from 13.07ha to 175.725ha as shown in Table 1 and Figures 1 and 2. The change in Agriculture between 1962-1971 and 1971-1991 indicates a decrease in the available cultivable land (Figure 1 and 2). Regarding the area distribution of other LU categories and their dynamics, it was found out that water bodies (Reservoirs, Ponds,

Stream) increase from 0.25ha in 1962-71 to1.89ha in 1971-91, it then decreased to 0.47ha in 1991-2005 and then increased to 1.881ha in 2005-16 in Table 1 and Figures 1, 2, 3 and 4. This may be attributed to the global climate change phenomena, as climate at Polar regions are experiencing high temperatures which bring about snow melting and rainfall which flows through the temperature region down the tropics of which Jos is a part. Forest land, Agricultural lands and Rock Outcrop experienced some levels of change in their sizes due to the population explosion. Considering the above LULC change detection of the study area, it is noted with keen interest that activities such as mining and scarification have led to an increase in wastelands. Lands categorized as agricultural lands are lost to development. This is to say that, the percentage change in the proportion of various LU for the five decades shows an increase in developed area, water bodies and the disappearance of Vacant areas and a decrease in an agricultural land, forest land and rock outcrop in their changes (see Table 1 and Figures 1, 2, 3 and 4).

VII. CONCLUSION

The Argument of Mckenzie (1924), and Weinstein (2007) application of the theory in the study of Coney Island and neighbourhood and its results and findings supports the arguments that invasion leads to changes in land value and that invasion does not necessarily lead to succession. And that one important condition that initiates invasions is the sudden demand for special real estate sites. McKenzie also noted that "resistance to invasion" depends on the "type of Invader" and the Solidarity of Present occupants" This also is true for Dadin Kowa community as observed in the rise in value of land for Built-up/developed areas because of sudden increase of population mobility in search of security for their life and property as seen in the increase rent-age and scale of plot size, with development sprawling into the suburbs and merging up with other neighbouring community but not showing any evidence of change within the type of development aside residential use. It is obvious that Dadin Kowa has sprawled considerably over the years.

VIII. RECOMMENDATIONS

The trend in land cover change derived from this study on Dadin Kowa has shed more light on its spatial structure which is of paramount importance to urban development effort. To facilitate for proper planning and motivation of change, the following recommendations are made:

For Planners and policymakers to achieve effective spatial planning and management in towns and cities data on LULC change must be adequately available. This can be done using Geospatial techniques as exhibited in this research. There should be restrictions of expansion of residential to unfertile uncultivable but suitable land so that fertile cultivable land could be conserved for agriculture. Depletion of natural resources disrupts natural processes in ways that often are irreversible over long periods of time. The loss of soil via erosion that occurs during agriculture and the loss of wetlands and their associated ecological processes and species are few examples. To prevent depletion; such resources at risk must first be determined. In most parts of the nation, large areas of natural habitats are becoming less common as they are fragmented into smaller habitat patches suitable for fewer species. A useful management approach generally favours protecting large areas and smaller areas that are well-connected to other habitats. Human uses of the land should avoid structures and uses that might have a negative impact on other systems; at the very least, ways to compensate for those anticipated effects should be determined.

It is useful to look for opportunities to design land use to benefit or enhance the ecological attributes of a region. For example, parts of golf courses in cities can be designed to serve as wildlife habitat, or traffic in rural areas can be concentrated on fewer and more strategically placed roads, resulting in decreased traffic volumes and lastly Implementing land-use and -management practices that are compatible with the natural potential of the area requires that land managers have an understanding of the site potential.

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