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TEMPORAL ANALYSIS OF VEGETATION COVER CHANGES IN NORTHEASTERN PART OF NIGERIA'S SUDAN SAVANNAH

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ABSTRACT

Survival of teeming population in sub-Saharan Africa necessitates conversion of natural vegetation to farmland in an unsustainable manner leading to environmental degradation and subsequently, the threat to food security. The study aims at analyzing of vegetation cover changes in Nigeria's Sudan savannah agroecological zone. Landsat images of Yamaltu-Deba town with periodic interval of 10 years between 1990-2020 were acquired at 30 m spatial resolution and 16 bit of radiometric resolution was analyzed using Arc GIS. Image processing and data analysis was used to determine the trend pattern of vegetation cover changes. While NDVI was used to classify the vegetation into high, low, moderate, no vegetation and water body, overlay analysis was used to produce vegetation cover change map. The study discovered reduction in high vegetation at the rate of -9.32% in 1990 to -29.81% in 2020 while low vegetation cover changes increased from 4.09% in 2000 to 50.01% in 2020. In conclusion both high and moderate vegetation cover have been reducing at alarming rate resulting to increase in low vegetation cover. Therefore the study hereby recommended the need for incorporation of spatial integration of soil nutrient improve tree into the farming system and legislation against all form of deforestation.

Key words: *Landuse, change, temporal, trend, pattern, vegetation.*

INTRODUCTION

The nature of vegetation in any ecological zone is directly under the influence of soil, climate as well as anthropogenic interference. Directly or indirectly, human activities lead to the damage of vegetation as a result of deterioration of the ecological environment and global environmental changes, such as the proportion of soil erosion, atmospheric carbon dioxide content increased global warming (Jianfeng *et al.*, 2017). Vegetation is an important bond for the interaction of the atmosphere, soil, and water, and it is also an important and available part of the terrestrial ecosystem. World vegetation type is broadly arranged in a latitudinal pattern with increase plants species richness toward the equator (Mutke and Barthott, 2005).

The Food Agricultural Organization (2007) reported that 75% of 2 billion people worldwide who depend on fuel wood for cooking and heating are being harsh on forest resources. This condition is worst in drier region of tropics (FAO, 2007). In some part of West Africa, availability of fuel wood is an essential element of community welfare (Nwoboshi, 2002). At least 90% of the trees cut in Africa were burn as fuel (FAO, 2007). Cline-cole (1994) observed that the fuel wood human needs relation does delay forest conservation, and gradually alter the composition of the vegetation. Apart from domestic fuel demand in Africa, (Fairhead and Leach, 1997) indicated that the highest causes of forest and trees depletion in the region, is timber export to western countries. About 7895 plant species have been identified in Nigeria with almost 128 endemic, only few hundred are encountered in the savannah areas.

Forest vegetation is often believed to be unchanging because of the trees long life span; undergo changes ecosystem on which plants and animal's population depend on. According to Winjin and Schroeder (1994), the change of vegetation composition of world forest could threaten the existence of large number of species. Forest vegetation stores about two-third (2/3) of the terrestrial organic carbon and cover half carbon presence in soil otherwise known as Soil Organic Carbon. Change in vegetation composition could therefore be grave as few trees on the landscape will contribute little carbon to terrestrial stock (MacDonald, 1993).

However savannah region of Nigeria is not exceptional in the aforementioned scenario. In Nigeria, vegetation distribution pattern and density diminish northwards from the south, the condition attributed to the spatial distribution of rainfall. In Northern part of Nigeria, as one advances north-wards the region is characterized with low rainfall and drought-like conditions (Xue and Shukla, 1993). Despite the predominant harsh weather conditions of the region, many plant species in association with savannah still exist but in sparse pattern.

Urban development together with human activities such as unsustainable agricultural practices and unplanned urbanization subsequently lead to loss of vegetation in any geographical location. The conversion of the forest to crop and pasture lands remains a prevalent form of vegetation change in the world. In the last three centuries, 20% of existing forests and the woodland have disappeared (Richards, 1990). Most current deforestation occurred in tropical and subtropical regions and approximately 100,000km^2 of the forest in tropical Africa, America and Asia are cleared annually (FAO, 1995). In many tropical savannahs, woody species are also declining (Hoffmann and Jackson, 2000). Degradation of vegetation contributes significantly to global climate change because vegetation is one of the major components of environmental system. It also plays an important role in climate change, as it is shown by studies assessing the impact of land use changes on general circulation models (Cogne, 2004). Degradation of vegetation resources is the gateway to environmental management faced in developing countries, especially in Africa (UN, 2005; UNEP, 2008).

The effect of land use change is prominent in savannah belt of the world. The Northeastern part of Nigeria falls within the Savannah and Sahelian region which is experiencing unprecedented environmental changes in vegetation cover and quality (Lambin *et al*., 2003; Foley *et al*., 2003). The changes originate from the methods people manage their land resources leading to ecological disaster such as drought, desertification and other which are the narrow consumer of the vegetation cover. This has been the major problems in several parts of Northeastern Nigeria, causing loss of arable grazing land and consequently population migration, conflict over the limited resources and economic loss for the people in the area. Loss of arable land due to intensive cultivation and erosion also contribute to the reduction of vegetation cover vis a vis soil quality suitable for perennial tress across the savannah regions. However, this study discovered that little attention has been paid to environmental and socioeconomic stability which lacks spatial and temporal information about land use and land cover changes especially in northeastern part of Nigeria, where the activities of terrorists, climate change, desert encroachment and over utilization of biomass is highly predominant.

Having taken all the identified characteristics into the consideration, the case of Yamaltu-Deba community in Gombe State is not an exception due to change of vegetation cover. To prevent further damage to natural environment, the past vegetation cover changes need to be assessed at spatial and periodic interval. Assessing spatial and temporal land use and land cover change creates awareness and improves understanding of environmental impacts of natural vegetation reduction. Temporal and spatial observation of land use change over specific periods of time can provide reliable information for mapping and to analyze vegetation cover change at local, regional and global scales (Campbell and Wynne, 2011). The aim of the study is to analyse the temporal changes in vegetation cover in Northeastern part of Nigeria's sudan

savannah using Yamaltu-Deba area of Gombe State as the spatial focus with specific interest in periodic rate and trend pattern of vegetation cover changes due to anthropogenic activities.

MATERIALS AND METHODS

Yamaltu-Deba is one of the Local Government Area in Gombe State, located between Latitude 10^0 13N and 10^0 23N of the Equator and Longitude 11^0 23E and 11^0 38E of the Greenwich Meridian. It is bounded to the North by Kwami L.G.A, to the East by Borno State, to the South by Balanga L.G.A, and to the West Akko L.G.A. The area shares boundary with Bauchi State in the West and Yobe State in the North, Borno State in the East and Adamawa and Taraba States in the south (Figure 1). According to NPC (2006), it has a total population of 255,726 and projected to be 444,100 with population growth rate of 3.3% as at 2023. Yamaltu-Deba L.G.A occupies a landmass of 1,981 km and is located 7 km east of Gombe town, and the major tribes are Tera, Fulani and minor tribes like Kanuri, Hausa, Jara and Waja. The study area is naturally agrarian, characterized with crop annual crops cultivation and animal rearing.

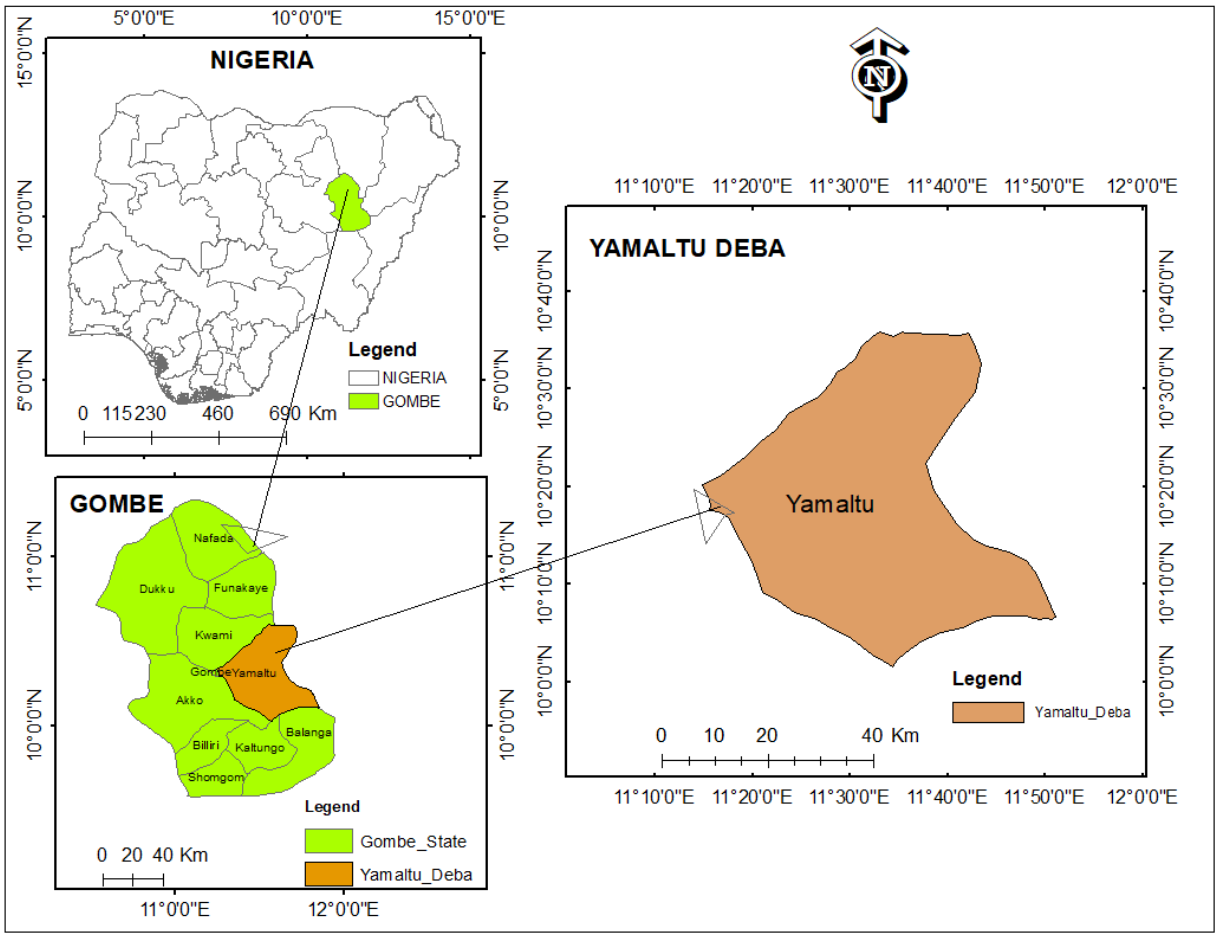

Figure 1: Map of Yamaltu-Deba
Source: DIVA GIS Laboratory (2023)

The climate of the area is characterized by high temperatures and seasonal rainfall with rainy season between 5-6 months and a comparatively dry season is between 6-7 months which fluctuates from year to year. Rainy season usually begins in late May and end in mid-October. The mean annual rainfall of the area

ranges from 800-l000 mm with average temperatures between 30^0C - 32^0C and the area experience a relative humidity of 17–90 percent (Ibrahim and Abubakar, 2013). The vegetation of the study area is Sudan savannah, most of the forest cover in the area has been reduced to semi desert shrubs due to human activities. Its geomorphology comprises of greatly undulating plains and pediments (Ibrahim and Abubakar, 2013). The soil mostly found in Yamaltu-Deba L.G.A is the vertisol; dark in colour and contains measurable amount of heavy clay. The soil is shallow to deep clay, loamy and sandy vertisol and cracking clay that have weathered and are very fertile and support intensive agriculture.

Landsat images of Yamaltu-Deba were downloaded from United State Geological Survey for three (3) decades (1990-2020) at 30 m spatial resolution and 16 bit of radiometric resolution. In order to identify the vegetative areal coverage of the study area, image processing and data analysis was used and to determine the trend pattern of vegetation cover changes overlay analysis was used to produce vegetation cover change map. Normalized difference vegetation index (NDVI) was used to analyze the downloaded imageries.

RESULTS AND DISCUSSION

Vegetation cover change pattern maps were produced with the combination of bands of remotely sensed images from 1990 to 2020 with a decade periodic interval (Figure 2-5). The result revealed that human factors such as bush burning, over cultivation, deforestation and construction were found to be the major factors responsible for reducing vegetative cover resulting from the effect of land use (Ishaya *et al*., 2021). The rate of vegetation cover change is displayed in Table 1 and revealed that high vegetation was reduced by -9.32% between 1990 to 2000, -35.08% between 2000 to 2010 and -29.81% between 2010 to 2020. This affirms the work of Luyssaert (2014), globally, about three-quarter (¾) of the Earth's land surface has been changed by anthropogenic activities within the last millennium.

Table 1: Temporal Analysis of Vegetation Cover in Yamaltu-Deba

	1990		**2000**			**2010**			**2020**		
Vegetation Class	**Area (km^2)**	**(%)**	**Area(km^2)**	**(%)**	**Δ%**	**Area (km^2)**	**%**	**Δ%**	**Area (km^2)**	**(%)**	**Δ%**
High Vegetation	225.44	10.94	204.59	9.92	-9.32	132.69	6.44	-35.08	93.18	4.52	-29.81
Low Vegetation	841.72	40.83	876.14	42.50	4.09	1017.81	49.37	16.16	1030.95	50.01	1.30
Moderate Vegetation	712.84	34.58	560.74	27.20	-21.34	461.45	22.38	-17.72	300.27	14.57	-34.8
No Vegetation	190.73	9.25	319.92	15.52	67.78	355.12	17.23	11.01	511.14	24.80	43.3
Water body	90.73	4.4	100.07	4.85	10.23	94.38	4.58	-5.56	125.91	6.11	33.41
Total	**2061.47**	**100**	**2061.47**	**100**		**2061.47**	**100**		**2061.47**	**100**	

Source: Author's Data Analysis (2023)

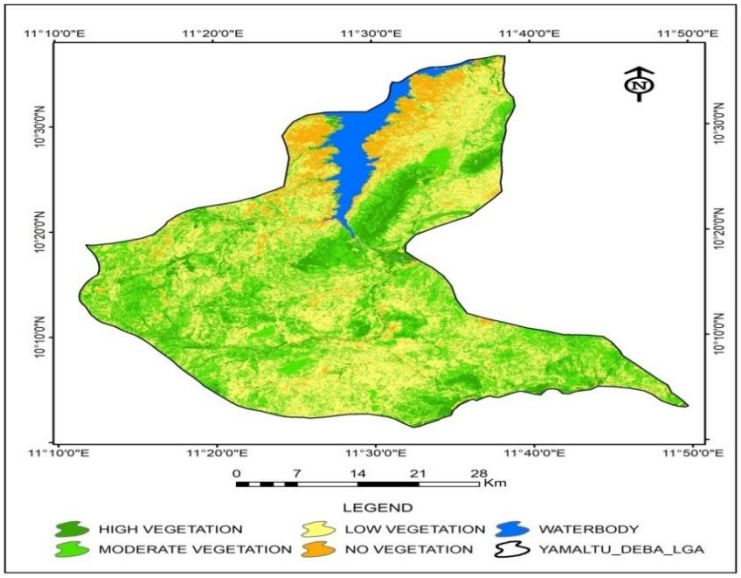

Figure 2: Landuse Change (1990)

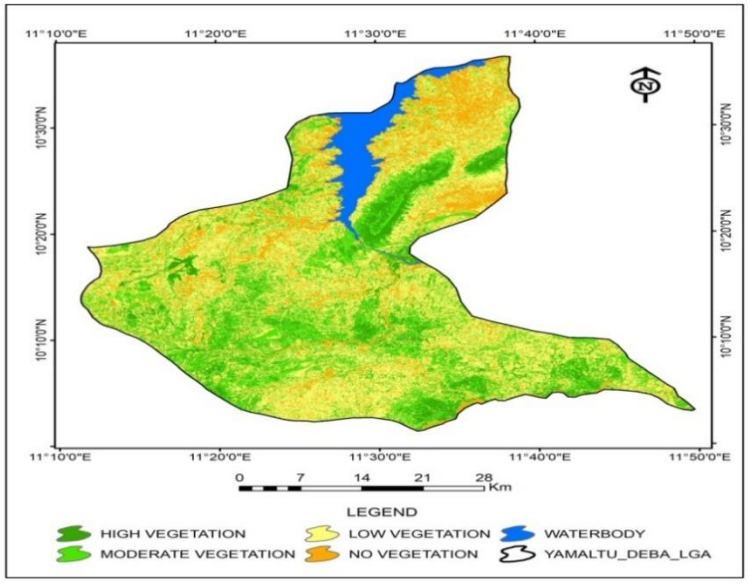

Figure 3: Landuse Change (2000)

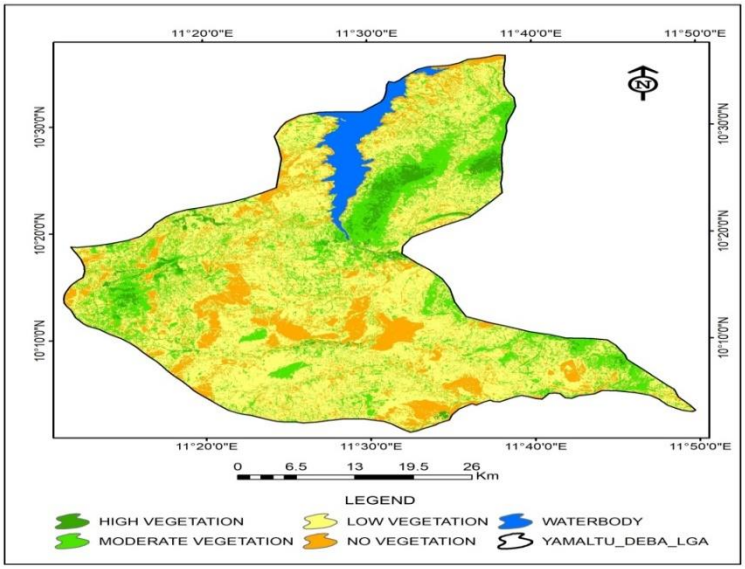

Figure 4: Landuse Change (2010)

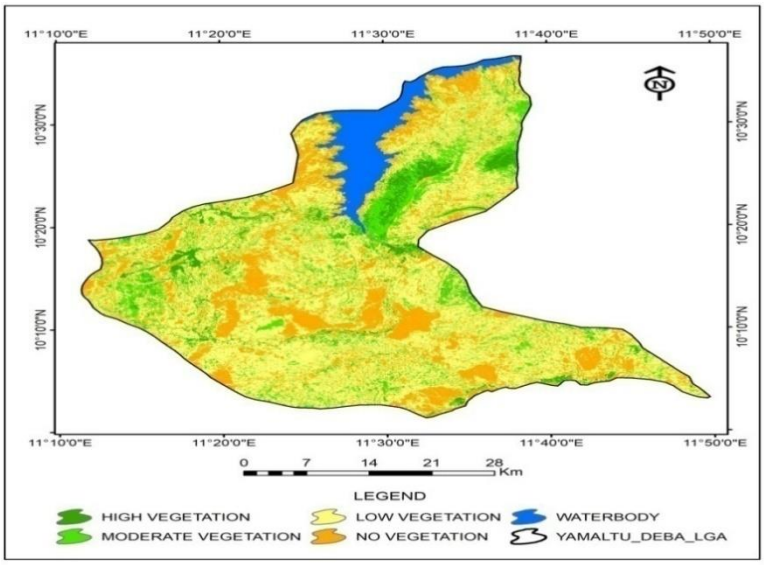

Figure 5: Landuse Change (2020)

Gradual declination was experienced in the first decade of observation when compared with rapid rate of vegetation cover change in the second and third decades which may be due to climate change and urbanization process. Gombe State is regarded as the most peaceful State in the Northeast geopolitical zone; serving as transition zone for the security affected areas. In developing countries, extensive farming practice and vegetation modification are inseparable; that is as population and development are increasing, vegetation cover area would be at the receiving end of reduction. Low vegetation cover changes has increased from 4.09% in 2000 to 50.01% in 2020, the circumstance that may be attributed to the reduction of high vegetation cover. There is no doubt of possibility of low vegetation expansion; the consequential effect of intermittent utilization of land for various landuse especially farming activities without lag of recovery.

The survival of the teeming population of the North-east requires more land for farming and area ravaging with both natural (low rainfall duration, climate change and land degradation) anthropogenic (poverty and poor soil management) problems, sustainable management of vegetation with efficient landuse management maybe a difficult task. The human influence and alteration of landscape has occurred globally but has increased incidence and consequence in the developing countries mostly as a result of population growth, looseness of landscape and unplanned development (Hamad *et al.,* 2018). Natural vegetation declination in sub-sahara Africa is generally linked to the level of poverty in relation to over-utilization of biomass for fuel, teeming population needs and urbanization (Afolayan and Agbebaku, 2023). High vegetation and moderate vegetation also reduced which ranged from -17.72% in 2010 to -34.8% in 2020. The adverse consequence results to the decrease in vegetated area at the rate of 67.78% (1990-2000), 11.01% (2000-2010), and 43.30% (2010-2020). Also, anthropogenic activity prominently farming has modified terrestrial to semi aquatic areas ranging from 4.4% in 1990 to 33.41% in 2020.

However, the consequential effects of changes in vegetation cover from high to low are enormous and disastrous beyond recovery level if not quickly addressed. Impact of land use change on natural environment include climate change, changes in hydrological cycle, increase water extraction, impairment of water quality, degradation of soil nutrient, increased surface erosion and loss of biodiversity (Turner, 2007). Angelson (1995) emphasized that the conversion and fragmentation of temperate semi-natural rangeland leads to progressive loss of biodiversity, species connectivity, and means for recovery.

CONCLUSION AND RECOMMENDATIONS

The study discovered that the problem of vegetation cover changes is attributed to the consequential effect of human activities especially expansion of farming activity rather than urbanization processes. Reflection of vegetation cover change implication is preponderance in savannah due to short duration of precipitation in relation to nutrient cycling in savannah compared to forest region. Also, survival of agricultural activity in developing countries of the south rests on diminishing of natural environment. Findings have showed that anthropogenic activity such as farming and vegetation cover change are inseparable; as one is increasing the other is decreasing and vice versa. In conclusion both high and moderate vegetation cover in the study area have been reducing at alarming rate; resulting to increase in low vegetation cover. Therefore the study hereby recommended spatial integration of soil-nutrient improved trees into the farming system and legislation against all form of deforestation.

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