Implications of Population Sizes on Per Capita of Landuse Land Cover in Yobe State, Nigeria

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Abstract

Population size is the major demographic factor that affects landuse land cover. Socio-economic activities like arable farming, wood harvesting, construction of roads and shelters change the land cover at the detriment of the natural resources. The study was embarked upon to identity the effects of increase in population on per capita of landuse and land cover. The data used are areal cover, population sizes of 1990 and 2020, and types of landuse land cover and magnitude of each. The landuse land cover types and magnitude of each was generated from landsat imageries of 1990 and 2020 using varied GIS and remote sensing techniques. Data on population sizes and landuse land cover were analyzed by dividing the magnitude of the area covered by the population sizes of the corresponding year. The results indicate population and density increased by 16.04% 46 persons per km^2 while the land per capita decreased by $16,225.75m^2$. The effects of decrease in land per person on the environment cause reduction in surface resources like vegetation cover and fertile soils. To the inhabitants, the decrease caused reduction in economic activities like arable farming. The result of the finding indicates that increase in population of Yobe State by 16.04% between 1990 and 2020 leads to decrease in land per capita from 6.19% to 2.63%. The increase in population and density, and decrease in land per capita suggest sustainable use of the limited land resource like vegetation cover, surface water and fertile soil by the populace. The study recommends the state government should educate the populace on the implication of large family size on the environment, quality of life of the household, and the need for conserving the environment. Likewise, farmers should adopt environmentally friendly arable farming like mixed cropping and to conserve the vegetation cover.

Keywords: Economic activities, landuse landcover, per capita, physical resources, population size and resource depletion

Introduction

There is complex integration between human societies and the environment. For example, human requires shelter, clothing materials, water, food and fuelwood from components of the environment. On global scale, the highest proportions of dependence on the bio-physical environment are in the semi-arid developing countries (Simmons, 1991). Population size is an important factor in measuring causes of environmental change. Thus, the combined effects of population growth, consumption, overuse and misuse of physical resources has stressed the capacity of the Earth's resources to sustain human requirements. Therefore, more population requires more agricultural production, more removal of vegetation cover for varied purposes, reclaiming wet lands, more space to construct shelter and road networks, and more consumable goods (Mittal & Mittal, 2013).

Landuse change has been the main reason for the degradation of terrestrial environment along with global economic development, population explosion, urbanization, built-up area (Zeng, Ye, Cao, Chuai & Xu, 2023). The expansion of human transformed land surface like built-up and agricultural lands provide opportunities for social and economic development to man, but the expansion leads to loss of more natural areas, threatening the sustainability of human survival activities. Therefore, in this era of population explosion, understanding how the expansion of landuse area affect other land covers is essential for resolving social and environmental problems that changes the sustainable development of human society (Yang, Lou, Zhang & Jiang, 2022).

In developing country like Nigeria, pronatalism affects biophysical environment adversely. The belief that people should reproduce throughout their child bearing ages cause decrease in share of land per person (Ciancio, 2021; Shaib, 1991). Human activities like arable farming, pastoralism, mining, infrastructural development and urbanization exert more pressure on the land thereby transforming significant deteriorating landuse land covers of Nigeria (Shaib, 1991).

Most of the world's developing countries are experiencing rapid landuse land cover change driven by population growth and the lifestyle changes that result from income growth. Therefore, there is a need to accurately quantify the drifts in landuse land covers to understand the impacts of the changes on the environment and human activities (Hasan, Zhen, Miah & Ahamed, 2020). Population growth affects natural resources like freshwater, arable lands, vegetation covers and settlement sites through increase in demand (Kate, 2016). As a tradition, community land continues to decline in size due to increase in population. Because of the diminishing size, the share per person decreases with disadvantage on decrease in gainful utility of the areas (Shaib, 1991).

The study is conceived from the observations that from 20th century the magnitude of environmental degradation is linked to human population size and resources use per person (National Academy of Sciences, 2018). Jolly and Torrey (1993), maintained that technological development in agriculture and infrastructural development have transformed the Earth's surface from initial cover to man-made environment. Aina and Salau (1992), observed that the growth of Nigeria's population contributes substantially to changes in the landuse land cover and sources of livelihood. None of the studies quantified the effects of changes in population sizes on land per capita nor compared population sizes and share of land per person of Yobe State between 1990 and 2020.

The aim of the study is to identify the effects of changes in land per capita on the environment and human activities in Yobe State between 1990 and 2020. To achieve this, the population sizes, landmass, landuse land cover types and magnitude of each, and the per capita of landuse land cover in 1990 and 2020 are identified. The scope compared the per capita of landuse land cover of Yobe State between 1990 and 2020. Per capita is adopted to ascertain the quantity of changes in surface cover to each member. Share of area per person is considered because it is associated with the output of individual's production of economic activities like arable farming. Likewise, the changes in quantity of land available to individual provides an idea on carrying capacity in 1990 and 2020 for socio-economic planning like expansion of settlements.

Conceptual Framework

The concept of "system theory" brings together different components of an interrelated groups to function as a whole. Thus, the system brings together components of the environment in a single framework within which there is interaction (Lockwood, 1976). The environment provides variety of resources like water, vegetation cover, fertile soil, floodplains, animals, and well drained sites that are used by man (Ballinger, 2011). However, the commons like soil fertility, vegetation cover and surface water have been affected adversely due to increase in population manifested by explosion in diverse socio-economic activities like more demand in farmlands and building sites (Boyle, 2020). In Yobe State with 70% of rural population that depends predominantly on arable farming, fishing and nomadic pastoralism, the components of the land cover are affected adversely (Maternal, Newborn and Child Health Programme, 2021).

Literature Review

Result of study on global livelihood of people indicates that 2.5 billion people live directly on soil fertility for crop cultivation and pasture for livestock, 1.6 billion rely on vegetal resources for their livelihood while 560 million derive their livelihood from water resources (Kaye, 2012). Result of study on effects of increase in population in India indicate that population growth and economic development are degrading the environment through the uncontrolled urbanization, expansion and intensification of arable farming that adversely affects the natural resources like vegetation cover. The result reveals that increase in human numbers combined with rising levels of consumption per capita and poverty are depleting natural resources on which the livelihood of present and future generations depends. The growing trends of population and consequent demand for food, energy, and housing have considerably altered landuse practices and severely degrade the environment (Nagdeve, 2018).

According to Bekele, Wu, and Yirsaw (2019), landuse land cover change is driven by several interacting factors that originated from anthropogenic-induced changes like population growth; natural factors like volcanic eruption, earthquake, landslide, drought, flooding and erosion. de Sherbinin, Carr, Cassels, and Jiang (2007a), stated that there is relationship between population size, growth, distribution, density, age and sex composition and environmental changes. The conversion of natural lands to croplands, pasture lands, urban areas and road networks represents the most visible and universal form of human impact on the environment. According to de Sherbinin *et al* (2007b), human population size is pleasing to environmental change because data are easily accessible or projected contrary to other human variables such as values, culture and institutions.

Landuse land cover change effects sources of livelihood of the populace because of changes in economic activities like arable farming and pastoralism (Projet cofinancé par la Union Européenne, 2012). Jolly and Torrey (1993), stated that both numbers of people in a unit area and their consumption behavior should be considered in determining quantitative relationship between population sizes and landuse land cover changes. Ahlenius (2021), opined that the amount of land area available per person provides a rough measure on the current carrying capacity for food security (availability, accessibility and affordability) and for the development of additional agricultural production, settlement development and reserve lands. According to Jolly and Torrey (1993), landuse change has occurred at much faster rates as well as on much larger scales since 1900. Likewise, it is the absolute population size that has been more important in affecting landuse change in both urban and rural areas (Mittal & Mittal, 2013).

Result of study on the impact of landuse and land cover changes on socio-economic factors and livelihood in the Atwima Nwabiagya District of the Ashanti Region, Ghana indicate that landuse land cover change have been occurring due to increase in population manifestoed by diverse activities such as urbanization, arable farming, settlement construction, over dependence on land-based resources like minerals, and increase in wood harvesting have converted vegetation cover into several other dissimilar land uses (Kullo, Forkuo, Biney, Harris & Quaye-Ballard, 2021). The study assessed the driving forces for landuse land cover change, and the negative impact on livelihood of the people. The study adopted RS and GIS as geoinformation techniques to generate data on the changes between 1989 and 2019 while the impact on livelihood of the people were generated from the respondents. From the study, the social and economic activities such population increase, farming activities, urban-growth, settle construction and infrastructural development are the major drivers to landuse land cover changes. The changes affect livelihood of the people negatively due to reduction in vegetation cover the main source of wild fruits and vegetables, source of fuelwood, and pastoral area.

Result of study on Yobe State revealed that change in landuse land cover is a driver of environmental change at the detriment of vegetation cover, wildlife habitat, wetlands, and sources of human livelihood. The study used landsat imageries to generate data on landuse land cover and magnitude of each for 1986, 2002 and 2019. The result indicates there is significant changes in the landuse land cover due to climate change, overgrazing, increase in farmlands and building sites, increase in vegetation removal, increase in the use of wetland for farming, and a southward movement of dunes from the Sahara Desert (Eze & Onokala, 2020). The study did not relate the categories of landuse land cover to population sizes neither compared the changes in land per capita between 1990 to 2020 nor highlight the effects of population on land per capita.

Description of the Study Area

Yobe State is situated between Latitudes $10^0$30' to $13^0$25'N of the Equator and Longitudes $9^0$35' to $12^0$30'E of the Prime Meridian (Eze & Onokala, 2020). The state borders the Republic of Niger to the North and Borno State to the East, Gombe State to the Southwest, Bauchi State to the West, and Jigawa State to the Northwest (Encyclopedia Britannica, 2015). Different studies reveal varied landmass of Yobe State, for example, 47,153km^2 (Eze & Onokala, 2020), 45,502km^2 (Nigeria Galleria, 2021; Maternal, Newborn & Child Health Programme, 2021); and 46,910km^2 (Landsat Images of 1990 and 2020). For the purpose of this study, the landmass of 46,910km^2 is adopted because it is generated from landsat imageries.

The state lies mainly in the dry savanna belt, hence, the state is dry and hot for most of the year except in the southern part which has a milder climate (Nigeria Galleria, 2021). The region is both semi-arid and arid with low rainfall amount of about 300mm per annum (FAO, 2019). The cumulative rainfall in 2020 was 700-1100mm. The annual mean maximum temperature is from 34-36^{0}C while the mean annual maximum temperature is 18.5-21.5^{0}C (Nigerian Meteorological Agency, 2020).

The terrain consists of plains that are drained by River Hadeja, Komadugu and its tributaries in the north, and Gongola River in the south (Encyclopedia Britannica, 2015). The state's vegetation cover is predominantly of the Sahel savanna type dominated by scattered woody plants that are adapted to the semi-arid region. In the southern part, there are few woody plants which consist of short trees and shrubs that are widely dispersed while in the far north associated with sandy soils, it is dominated by acacia species (Encyclopedia Britannica, 2015).

The population of the state in 2001 was 2,765,300 with density of about 61 per km^2 (National Population Commission, 2006). In 2012 it rose to 2,757,322 (Maternal, Newborn and Child Health Programme, 2021). Using an annual rate of increase of about 3.0% per annum (National Population Commission, 2006), the population was estimated to 1,639,824 in 1990 and 3,806,460 in 2020.

About 70% of the population is predominantly rural while the sex distribution between urban and rural across the state is 51.9% male and 48.1% female. Age distribution indicates that 48% of the population are 15 years and below while 16 years and above form 52%. The dependency ratio indicates 1:1, thus, 1 dependent to every economically active person in the population (Maternal, Newborn and Child Health Programme, 2021).

From Table 1, the population increased by 16.04%, the density increased from 35 to 81 persons per km^2 while the land per capita decreased from 28,571.43 to 12,345.68m^2. Table 1 shows trends in population sizes and land per capita of Yobe State.

Table 1: Population Trends and Land per Capita of Yobe State in 1990 and 2020

S. No.	Year	Population	Percentage increase	Population density (km^2)	Land per capita (m^2)
1.	1990	1,639,824	12.15	35	28,571.43
2.	2001	2,765,300	20.48	59	16,949.15
3.	2006	2,532,395	18.76	54	18,518.52
4.	2012	2,757,322	20.42	59	16,949.15
5.	2020	3,806,460	28.19	81	12,345.68
Total Population		**13,501,301**	**100.00**		
Landmass		**46,910km^2**			

Source: National Population Commission, 2006, and Researchers' Estimate

The major source of livelihood is arable farming, fishing and nomadic pastoralism. The population is about 70% rural (Maternal, Newborn and Child Health Programme, 2021). Crops like cotton, sugar cane and rice are cultivated on the riverine plains while sorghum, millet, cowpeas, cassava and groundnuts on upland areas. Vegetables such as onions, tomatoes, pepper, garden egg, lettuce and cabbage are cultivated. Much of the land in the state is used for grazing cattle, goats, sheep and camels among others (Encyclopedia Britannica, 2015). Damaturu and Kafin Zaki *dams* provide water for irrigation farming. Arable farming, fishing and livestock rearing provides employment to over 80% of the state's population. Likewise, there is deposit of minerals like gypsum, kaolin and quartz that are mined (Nigeria Galleria, 2021).

Materials and Methods

Data procured are categories of landuse land cover and area covered by each. The land covers are restricted to agricultural tree crop plantation, built-up area, dominantly shrubs and dense grasses with a minor tree component, dominantly trees/woodlands/shrubs with a subdominant grass component, extensive small holder rainfed agriculture, floodplain, floodplain agriculture, grassland, gullies, intensive small holder rainfed agriculture, area earmarked for livestock project, natural water bodies, reservoir, sand dunes/aeolian. Others include landmass and population sizes of Yobe State for 1990 and 2020. The sets of data were used to determine changes in per capita of landuse land cover in 1990 and 2020. Types and magnitudes of landuse land cover were generated from landsat imageries of 1990 and 2020 while population sizes of the corresponding years were obtained from National Population Commission. Likewise, areas on orchard gardens, grazing lands, floodplain agriculture, gullies and sand dunes were generated through participatory methods involving inhabitants.

To generate the varied landuse land cover and magnitude of each from the ETM landsat imageries, signature files were developed using fourteen (14) colour bands that were run on a supervised classification model that generate statistics for the signature files. ArcGIS 9.3 version software was used to analyze the imageries using ETM 15m resolutions. Accordingly, political base map of Yobe State was imposed on the landsat imageries of 1990 and 2020 separately to produce landuse land cover maps. The population of Yobe State for the period under observation was estimated using an annual rate of increase of about 3.0% per annum (National Population Commission, 2006).

To highlight the influences of population sizes on landuse land cover change, population size and magnitude of each of the landuse land covers were related. The change detection was based on magnitudes of area cover of the various landuse land covers and the population sizes. The magnitude of area cover of each landuse land cover categories were converted from km^2 to m^2, and divided by the population sizes of the same year to show land per capita in m^2. Quantitative evaluation of population trends on landuse land cover change is essential to identify the extent of population sizes on area covers of surface resources of Yobe State in 1990 and 2020.

Results of the Findings

The population and density of Yobe State increased by 2,166,636 and 46 persons per meter square while the land per person decreased by 16,225m2 between 1990 and 2020. Landuse land cover of Yobe State indicates significant variations. For example, agricultural tree crop plantation, built-up area, floodplain agriculture, gullies, intensive small holder rainfed agriculture, reservoir and sand dunes/aeolian increased by 0.01%, 0.16%, 1.33%, 0.11%, 19.13%, 0.07% and 2.23% in that order while dominantly shrubs and dense grasses with a minor tree component, dominantly trees/woodlands/shrubs with a subdominant grass component, extensive small holder rainfed agriculture, floodplain, grassland and natural water bodies decreased by 12.53%, 0.04%, 1.55%, 1.17% and 7.69% in 1990 and 2020 respectively. Share of landuse land cover per person decreased from 1.82 to 5474.51m^2.

1990 and 2020 Landuse Land Cover Categories

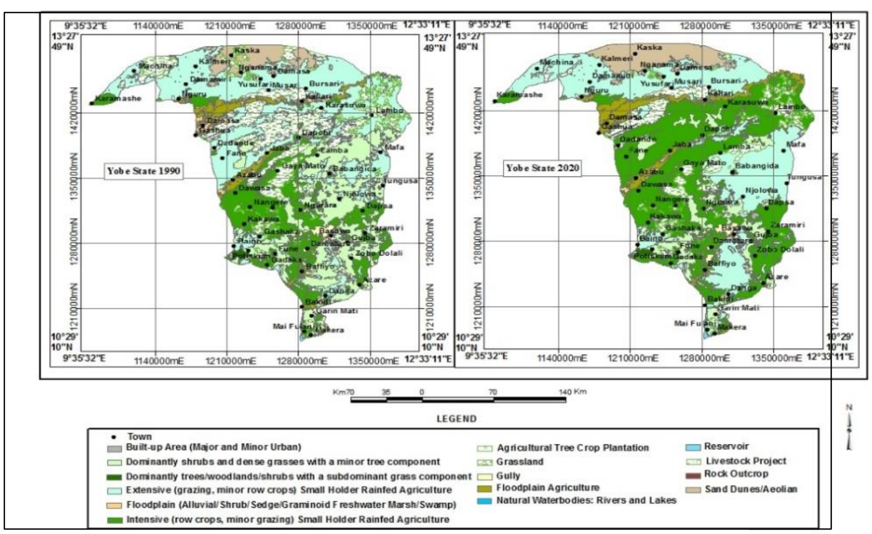

Figure I: Composite Map of Landuse Land Cover of Yobe State
Source: Landsat Imageries of 1990 and 2020

Figure 1 shows the composite map of landsat imageries of 1990 and 2020 from which the statistics on landuse land cover categories on Table 2 were generated.
Table 2 shows the types of landuse land cover distributions and magnitude of each. For more emphases the influences of changes in land per capita on the environment and human activities are highlighted below.

Table 2: 1990 and 2020 Magnitude of Landuse Land Cover Types of Yobe State

S. No.	Landuse and Land cover Types	1990 Area (km^2)	1990 Percentage	2020 Area (km^2)	2020 Percentage	Magnitude of Variation (%)
1.	Agricultural Tree Crop Plantation	6.34	0.01	6.87	0.02	+ 0.01
2.	Built-up Area (Major and Minor Urban)	61.81	0.13	136.53	0.29	+ 0.16
3.	Dominantly shrubs and dense grasses with a minor tree component	9385.50	20.01	3508.61	7.48	- 12.53
4.	Dominantly trees/woodlands/shrubs with a subdominant grass component	138.96	0.30	120.20	0.26	- 0.04
5.	Extensive (grazing, minor row crops) Small Holder Rainfed Agriculture	15224.67	32.46	14501.93	30.91	- 1.55
6.	Floodplain (Alluvial/Shrub/Sedge/ Graminoid Freshwater Marsh/Swamp)	855.68	1.82	306.34	0.65	- 1.17
7.	Floodplain Agriculture	1945.46	4.15	2569.31	5.48	+ 1.33
8.	Grassland	8251.39	17.59	4645.86	9.90	- 7.69
9.	Gullies	643.27	1.37	696.26	1.48	+ 0.11
10.	Intensive (row crops, minor grazing) Small Holder Rainfed Agriculture	8237.04	17.56	17211.29	36.69	+ 19.13
11.	Livestock Project	9.84	0.02	9.84	0.02	Static
12.	Natural Waterbodies (Rivers, Lakes and ponds)	52.99	0.11	21.43	0.05	- 0.06
13.	Reservoir	29.42	0.06	60.48	0.13	+ 0.07
14.	Sand Dunes/Aeolian	2067.39	4.41	3114.81	6.64	+ 2.23
	Landmass	**46,909.76**	**`100.00**	**46,909.76**	**100.00**	
	Approximate	**46,910.00**	**100.00**	**46,910.00**	**100.00**	

Source: Landsat Imageries of 1990 and 2020, and Researchers' 2021 Compilation

From Table 2, some landuse land cover increased while others decreased. The highest landuse land cover in 1990 was extensive small holder rainfed agriculture with 32.46% while the least was agricultural tree crop plantation that accounted for 0.01%. In 2020, the major surface cover was intensive small holder rainfed agriculture with 36.69% while the least are agricultural tree crop plantation and livestock project with 0.02% each.

Per Capita of Landuse Land Cover Categories of Yobe State (1990 and 2020)

Table 3: Landuse Land Cover Types and Per Capita of Yobe State for 1990 and 2020

S. No.	Landuse and Land cover Types	1990 Area (km^2)	1990 Per capita (m^2)	2020 Area (km^2)	2020 Per capita (m^2)	Per capita variation (m^2)
1.	Agricultural Tree Crop Plantation	6.34	3.87	6.87	1.80	- 2.07
2.	Built-up Area (Major and Minor Urban)	61.81	37.69	136.53	35.87	- 1.82
3.	Dominantly shrubs and dense grasses with a minor tree component	9385.50	5723.48	3508.61	921.75	- 4801.73
4.	Dominantly trees/woodlands/shrubs with a subdominant grass component	138.96	84.74	120.20	31.58	- 53.16
5.	Extensive (grazing, minor row crops) Small Holder Rainfed Agric.	15224.67	9284.33	14501.93	3809.82	- 5474.51
6.	Floodplain (Alluvial/Shrub/Sedge/ Graminoid Freshwater Marsh/Swamp)	855.68	521.81	306.34	80.45	- 441.36
7.	Floodplain Agriculture	1945.46	1186.38	2569.31	674.99	- 511.39
8.	Grassland	8251.39	5031.88	4645.86	1220.52	- 3811.36
9.	Gullies	643.27	392.28	696.26	182.92	- 209.36
10.	Intensive (row crops, minor grazing) Small Holder Rainfed Agriculture	8237.04	5023.12	17211.29	4521.60	- 501.52
11.	Livestock Project	9.84	6.00	9.84	2.59	- 3.41
12.	Natural Waterbodies (Rivers, Lakes and ponds)	52.99	32.31	21.43	5.63	- 26.68
13.	Reservoir	29.42	17.94	60.48	15.89	- 2.05
14.	Sand Dunes/Aeolian	2067.39	1260.74	3114.81	818.30	-442.44
	Total landmass	**46,909.76**		**46,909.76**		
	Approximate	**46,910.00**		**46,910.00**		
	Population	**1,639,824**		**3,806,460**		

Source: Landsat Imageries of 1990 and 2020, and Researchers' 2021 Compilations

From Table 3, in 1990 the largest share of landuse land cover per person was extensive small holder rainfed agriculture with 9284.33m^2 while the least was agricultural tree crop plantation with 3.87m^2. In 2020, the largest share per person was extensive small holder rainfed agriculture with 3809.82m^2 while the smallest was agricultural tree crop plantation with 1.80m^2. The landuse land cover per person decreased from 1.82 in 1990 to 5474.51m^2 in 2020 due to increase in population and density. The increase in population and density, and decrease in land per capita implies more fragmentation of the landscape that leads to decrease in environmental resources like vegetation cover and surface water.

Effects of Population Increase on Per Capita of Landuse Land Cover Types and Human Activities

Agricultural Tree Crop Plantation

The result of the findings as shown in Table 2 reveals that agricultural tree crop plantation increased from 6.34 km^2 in 1990 to 6.87km^2 in 2020. The 0.53km^2 increase is due to growth in population by 16.04% (Table 1) that adopt woodlots cultivation on exotic species like Eucalyptus camaldulensis. Relating the area covered by agricultural tree crop plantation in 1990 and 2020 to the population sizes of 1,639,824 and 3,806,460 (Table 1) there is decrease in per capita from 3.87 to 1.80m^2 (Table 3). The reason for the 2.07m^2 decrease in agricultural tree crop plantation per person is due to conversion of the woodlots into farmlands. The increase in farmlands in 2020 on annual crops like Pennisetum glaucum (Pearl millet) cause removal of the exotic tree species like Mangifera indica (Mango) and Cascabela thevetia (Yellow cashier) that were planted in 1990. The decrease caused loss in biodiversity of the cultivated tree species. The indigenes have lose accessible products like edible fruits and vegetables, and fuelwood from the cultivated tree species like Anacardium occidentale (Cashew), Mangifera indica, Moringa oleifera (Zogale), Azadirachta indica (Neem) and Eucalyptus camaldulensis (River Red Gum). Likewise, the 2.07m^2 decrease in share of agricultural tree crop plantation per person (Table 3) create more area to practice dissimilar economic activities like cultivation of annual crop like millet, maize, beans, and animal rearing especially on the crop residues.

Built-up Area (Major and Minor Urban)

The result of the findings as shown in Table 2 reveals that built-up area increased by 74.72km^2 between 1990 and 2020. The 0.16% increase is due to increase in population from 1,639,824 in 1990 to 3,806,460 in 2020. The increase in population caused increase in density from 35 to 81 persons per km^2 (Table 1). In between 1990 and 2020 the per capita of built-up area decreased from 37.69 to 35.87m^2 (Table 3). The 1.82m^2 could be attributed to the insurgence that disrupted settlements in northern Nigeria since 2009. The smaller settlement migrated to more populated areas like the local government headquarters and the state capital for security reasons. The decrease has advantage on the environment, for example, the abandoned settlement site (1.82m^2) is colonized by vegetation cover. To the inhabitants, the 1.82m^2 decrease in built-up area per person increased arable and grazing lands.

Dominantly Shrubs and Dense Grasses with a Minor Tree Component

The result of the findings as shown in Table 2 reveals that in 1990 the dominantly shrubs and dense grasses with a minor tree component covered 20.01% of the landmass but decreased to 7.48% in 2020. The 12.53% decrease is attributed to increase in activities such as arable farming and fuelwood harvesting demonstrated by the population that increased by 16.04% (Table 1).

Comparing the land per capita in 1990 to 2020, the share in dominantly shrubs and dense grasses with a minor tree component decreased from 5,723.48m^2 to 921.75m^2 (Table 3). The 4,801.73m^2 decrease affects the environment adversely, for example, the vegetation cover is fragmented. Likewise, more pressure is exerted on accessible community reserve lands which lead to depletion of vegetation resources like fuelwood. The 4803.73m^2 decrease per person of natural vegetation cover affects the inhabitants adversely. For example, the pastoralists are affected due to decrease in grazing lands, there is decrease in accessibility of fuelwood which is the major sources of generating domestic energy to the populace.

Dominantly Trees/Woodlands/Shrubs with a Subdominant Grass Component

The result of the findings as shown in Table 2 reveals that the dominantly trees/woodlands/shrubs with a subdominant grass component decreased from 138.96km^2 in 1990 to 120.20km^2 in 2020. The 0.04% decrease is due to increase in population density from 35 to 81 persons per km^2 (Table 1). Considering the share of surface cover per person between 1990 and 2020, there is decrease from 84.74m^2 to 31.58m^2 (Table 3). The 53.16m^2 decrease affects the environment adversely. For example, the conversion of area covered by dominantly trees and grass into dissimilar landuse cause degradation of vegetation cover that increase in erosion by wind and water, and siltation of surface water like river Damaturu. Also, there is reduction in wildlife habitat due to fragmentation and removal of the vegetation cover. However, the 53.16m^2 decrease per person affects economic activities of the inhabitants by reducing accessible and available vegetal resources like fuelwood, native fruits and vegetables, and reduce grazing lands.

Extensive (grazing, minor row crops) Small Holder Rainfed Agriculture

Result of the study indicate that area on extensive small holder rainfed agriculture decreased by 1.55% between 1990 and 2020 (Table 2). The reason for the 1.55% decrease is caused by increase in population density by 36 persons per square kilometer (Table 1) manifested by increase in small holder rainfed agriculture.

Linking the magnitude of change in extensive small holder rainfed agriculture per person between 1990 and 2020, the area decreased from 9284.33 to 3809.82m^2 (Table 3). The 5,474.51m^2 decrease in share of land on rainfed agriculture per person due to conversion into heterogeneous landuse like built-up area, and land cover like sand dunes inhibit regeneration of plant species on the affected areas. To the individuals, the 722.74m^2 reduction in share of small holding rainfed farmland per person leads to decrease in crop yields like Pennisetum glaucum. This affects income generation from sale of the crops. Likewise, the reduction inhibits grazing of animals on crop residues on the rainfed farmlands.

Floodplain (Alluvial/Shrub/Sedge/Graminoid Freshwater Marsh/Swamp)

The result of the findings as shown in Table 2 reveal that land cover under floodplain shrub decreased by 549.34km^2 between 1990 and 2020. The 1.17% decrease in floodplain shrub is due to increase in population density by 46 persons per square kilometer (Table 1). The decrease in floodplain shrub is attributed to construction of dams like Damaturu and Kafin Zaki to store water for irrigation farming, animal watering and domestic use for the population that increased by 16.04%.

Associating the share of floodplain shrub per person between 1990 and 2020, there is decrease from 521.81to 80.45m^2 (Table 3) due to increase in population density by 46 persons per square kilometer (Table 1). To the environment, the 441.36m^2 decrease caused reduction wildlife habitat on the basin of Rivers Hadejia and Komadugu. Likewise, the decrease aid erosion and flooding due to devegetation on the affected river basins. To the inhabitants, the decrease reduces vegetal resources like fuelwood, native fruits and vegetables. Similarly, to the pastoralists, the floodplain grasses that provide palatable pasture to animals like cattle, goats and sheep especially during the dry season have been reduced.

Floodplain Agriculture

The result of the findings (Table 2) reveals that the area under floodplain agriculture increased by 623.85km^2 representing 1.33% between 1990 and 2020. This is due to increase in population by 2,166,636 representing 16.04% (Table 1) that embarked on floodplain crop cultivation on the basin of rivers Komadugu and Hadejia. Relating the share of the area under floodplain agriculture to the population sizes in 1990 and 2020, the per capita decreased by 511.39m^2 (Table 3).

The decrease in per capita of floodplain agricultural land by 511.39m^2 affects the indigenes adversely. This is because the reduction in farmland sizes lead to decrease in crop yields like sugar cane and rice that are cultivated on the floodplains, and reduce source of income accruing of the farmers from sale of the crops. To the environment, the decrease in per capita of floodplain agricultural land by 511.39m^2 reduced arable farming activities like massive vegetation removal, plowing and clean weeding with positive advantage on regeneration of different species of plants.

Grassland

The study findings (Table 2) reveal that between 1990 and 2020, area covered by grassland decreased by 3,605.53km^2 representing 7.69% decrease is due to increase in population by 16.04% (Table 1) manifested by increase in arable farming, pastoralism, expansion of road networks and shelters to improve the social and economic livelihood of the populace.

Equating the magnitude of changes in share of grassland per person between 1990 and 2020, the share decreased by 3,811.36m^2 (Table 3). The decrease in grassland cover by 3811.36m^2 has negative advantage on the environment. For example, the grassland cover is converted into bare surface such as road networks and built-up areas at the detriment of wildlife habitat due to fragmentation and massive removal. The decrease in grassland cover by 3,811.36m^2 per individual affects the inhabitants by reducing area for pastoralism.

Gullies

The study findings (Table 2) reveals that the area covered by gullies increased by 52.99km^2 equivalent to 0.11%. The 0.11% increase is due to expansion of farmlands, road networks and settlements of the population that increased by 16.04% (Table 1). Comparing the magnitude of changes in gullies per person between 1990 and 2020 there is decrease of 209.36m^2 (Table 3). The decrease is due to adaption of gully control measures like tree planting, sand bagging and land filling by the increased population.

The decrease in gully by 0.11% has positive advantage on the livelihood of the people because every person has additional 209.36m^2 of the reclaimed land that is used for economic activities like arable farming and grazing. On the other hand, the decrease in gully has positive advantage on the environment. For example, the reclaimed gully is invaded by different native plants that are adopted to the area, the severity of erosion by wind and water is reduced, and there is reduction in drift of sand that is deposited into surface water body like Damaturu, Kafin zaki and Hausani Babban dams.

Intensive (row crops, minor grazing) Small Holder Rainfed Agriculture

The result of the study (Table 2) reveal that the area covered by intensive small holder rainfed agriculture increased from 8,237.04km^2 in 1990 to 17,211.29km^2 in 2020 representing 19.13% increase. The expansion of intensive small holder rainfed agricultural land is due to increase in population by 16.04% (Table 1) that embarked on rainfed agriculture. Comparing the magnitude of change in per capita of intensive small holder rainfed agriculture between 1990 and 2020, the area decreased from 5023.12 to 4521.60m^2 (Table 3). The 501.52m^2 decrease (Table 3) per person is beneficial to the environment. For example, the conversion of rainfed agricultural land to tree crop plantation have increased vegetation cover of the area that reduced severity of wind and water erosion and increase wildlife habitat. Likewise, the decrease has negative effects on the inhabitants by reducing farmland size at the detriment of maize and millet yields. On the other, the decrease in rainfed agriculture creates more land for other socio-economic activities like pastoralism and infrastructural expansion.

Livestock Project

The result of the findings (Table 2) reveals that the area ear-marked for livestock project (ranchlands or grazing land) remain static at 9.84km^2 in both 1990 and 2020. From the result, it can be deduced that there is no intervention with the 1990 ear-marked grazing land in 2020. Thus, the increase in population size by 16.04% between 1990 and 2020 (Table 1) did not influence grazing lands. The static area cover of grazing land implies the land cover remains unchanged with positive advantage on vegetation cover conservation. Relating the land per capita of grazing land in 1990 to 2020, the share decreased from 6.00m^2 in 1990 to 2.59m^2 in 2020 (Table 3). At an individual level, the 3.41m^2 decrease affects the populace adversely by reducing grazing lands for herders.

Natural Water Bodies (rivers, lakes, oasis and ponds)

Water per capita is measured in cubic metre which is not achieved because the quantity of all surface water bodies like rivers, streams, lakes, ponds and dams cannot be measured in cubic metre. In this study, the area covered by surface water body in square kilometer is related to the population size to determine share per person. From Table 2, natural water body decreased by 31.56km^2 representing 0.06% between 1990 and 2020. The increase in population by 16.04% (Table 1) have necessitated constriction of dams like Damaturu, Kafin Zaki and Hausani Babban to meet the water demand of the populace. This have caused decrease in natural water bodies like Komadugu river downstream while Tulo-Tulowa (marshy land with abundant water in a low valley) oasis in Yusufari LGA decreased due to over harvesting by the increased population, and deposition of sand drifted by wind.

The share per person of natural water bodies decreased by 26.68m^2 between 1990 and 2020 (Table 3). The adverse effects of the decrease on the individual is reduction in water resources like fisheries, animal watering, sanitation, and irrigation farming. However, individuals derive benefit from the dry river beds by harvesting clean sand for in addition to commodity of trade. The 26.68m^2 decrease per person affects the environment adversely. For example, the species diversity of aquatic life like fish is reduced.

Reservoirs

The Area cover of stored water (dams) increased by 31.06km^2 representing 0.07% (Table 2). The 31.06km^2 increase is due to construction of dams like Damaturu, Kafin Zaki and Hausani Babban to have reliable water for the increasing population. The people use the water for domestic use, irrigation and animal watering among others.

Considering the magnitude of change in per capita of the stored water, there is decrease from 17.94m^2 in 1990 to 15.89m^2 in 2020 (Table 3). The 2.05m^2 decrease per person reduce utility of the water for irrigation, fishing, domestic use and animal watering by individual. However, the dry surfaces are used for cultivation of vegetables like onions, tomatoes, pepper, garden egg, lettuce and cabbage. To the environment, the reduction in reservoirs by 2.05m^2 per person affects aquatic habitat for fisheries.

Sand Dunes/Aeolian

Sand dune/aeolian is used to identify the land over that does not significantly provide resources like vegetation cover, agricultural land, water and settlement sites. From Table 2, area covered by sand dunes/aeolian increased from 4.41% in 1990 to 6.64% in 2020. The 2.23% increase is attributed to the activities like massive vegetation removal of the population that increased by 16.04% (Table 1).

Subjecting the area covered by the sand dunes/aeolian to the population sizes in 1990 and 2020, the per capita decreased by 442.44m^2 (Table 3). The reason for the decrease per person is due to adoption of tree planting by individual on tree species like *Azadirachta indica* (neem) that can withstand the semi-arid environment. The decrease initiated by individual has positive advantage on the environment like conversion of the sand dunes at Tudun Tsira and Geidam into plant cover those adapted to the loose, bare and dry sand dunes. To the populace, individuals manage the small portion by adopting tree planting to serve as wind break, to provide shade and fuelwood.

Conclusion

This study has examined the implications of population size on per capita landuse land cover in Yobe State, Nigeria. The result of the study reveals that the increase in population from 1,639,824 in 1990 to 3,806,460 in 2020. Consequently, the increase of 2,166,636 people depends on a fixed landmass of 46,910km^2 for their source of livelihood is the main driving factor for the landuse land cover change. The area covers of the adopted categories of landuse land cover compared between 1990 and 2020 varied from -0.04 to +19.13%. The per capita of the landuse land cover decreased from 3.87 to 15,224.67m^2 in 1990 while 1.80 to 3,809.82m^2 in 2020.

The decrease in land per capita from 1.82 to 5,474.51m^2 cause vegetation removal on areas dominated by shrubs and grasses due to increase in human activities like arable farming. The decrease in vegetation cover affects the livelihood of the populace because the source of fuelwood, wild fruits and vegetables, and grazing community land have been reduced in area cover. More importantly, the decrease affects the indigenes by reducing farmland sizes that reduce crop yield and additional income accruing from the sale of the crops. Expansion of landuse like built-up area and agricultural land affect the natural landscape through fragmentation of vegetation cover.

Recommendations

Based on the results of the study, the following recommendations are suggested:

i. Policy makers should conduct enlightenment campaign involving massive participation of the populace on the implications of high population on the environment and quality of life of the inhabitants.

ii. Policy makes should provide guidelines on land management practice for sustenance of the environmental resources like vegetation cover and surface water.

iii. Individuals should adopt wise management of resources like fuelwood, soil fertility and range lands.

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