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SUSTAINABLE BUILT ENVIRONMENT AND CLIMATE CHANGE: THE CHALLENGE OF POST 2015 DEVELOPMENT AGENDA

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ASSESSMENT OF THE IMPLICATIONS OF URBAN GROWTH IN SULEJA BETWEEN 1987 AND 2014

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Cities in developing countries are often characterized by uncoordinated growth. Accompanying this growth are various problems which include traffic congestion, emergence of slum, flooding, uncollected solid waste and poor sanitation. These problems pose a critical challenge to cities in developing countries. Suleja which is one of the most urbanized local governments in Niger State and also proximate to Abuja the Federal Capital Territory is experiencing the identified problems.This study therefore examines the extent and implications of urban growth in Suleja between 1987 and 2014. Spatial analysis of the city for the period understudy (1987 - 2014) and implication of the growth on the residents and environment were determined.Primary and secondary data as well as Geospatial techniques were used for the study.Two sets of satellite imageries were used for the study that is,Thematic Mapper for 1987 and Enhance Thematic Mapper for 1997, 2007 and 2014. The findings of the geo-spatial analysis were corroborated with the findings of the primary and secondary data sources.The analysis reveals that Built-up area in Suleja increased from 10.91km^2 in 1987 to 46.25km^2 in 2014. While the 35% of the building plans submitted for approval to Niger State Urban Development board, Suleja are approved annually. The study also revealed that the pollution level of Suleja which was consequential to the increase in growth recorded a high value of 15.97 ppm for CO, 0.67 ppm for NO_2 and 1.33 ppm for SO_4.The study recommends that the planning and management of Suleja should be based on inclusive planning approach more so, infrastructure should be systematically expanded at a rate equal to the rate of the urban growth in Suleja.

Keywords: Pollution, Slum, Solid waste, Spatial growth, and Urban growth

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INTRODUCTION

In less developed countries of the world before 1950 the pace of urbanization was very slow, however, after this period the rate of urban growth increased substantially (McCatty, 2014). Most of the world's urban centres are rapidly urbanizing at an alarming rate this assertion was proven by Donk (2006), who believes that the world is increasingly becoming urbanized and the rate at which city populations and urban centres grows is an indication of the pace of social and economic change. In recent times rural-urban drift has led to an increase in urban growth in most developing countries. This growth is attributed to the "Push" of the rural areas and the "Pull" of urban centres (Aluko, 2010). The push and pull in this regard are with respect to the population, which can be traced to the effects of regional imbalances (Oyeleye, 2013) in other words regional imbalance and urban drift has led to increase in population in urban centres. According to Tibaijuka (2006), it has been estimated that one third of the world's population lived in cities In 1976 and 30 years later (2006), this population rose to one-half of the entire humankind and by the target year for the Millennium Development Goals (MDGs); cities in the world are estimated to grow to two third that is, 6 billion people by 2050 (UN- Habitat 2006).

Africa is presently ranked among the least urbanized continent of the world, it is, however, prominent for its highest rates of urbanization. According to the United Nation's projection, it is expected that 61% of the world population will be urban by 2030 and over half the population in Africa will be urban by 2020 (UN, 2004; Ajala, 2005). Jiboye (2005), Osasona et al (2007) opined that, this phenomenal growth anticipated for cities can be attributed to the incidence of globalization, industrialization and population explosion. Urban growth can be refer to the rate of growth of an urban population or a growth that makes intensive use of land for the location of buildings and impermeable surfaces (Oyeleye, 2013). On the other hand Ioannides, et al (2008) referred to urban growth as the process of growth and decline of economic agglomerations. UNICEF (2012), in her report defined urban growth as an absolute increase in the number of people who live in towns and cities, and believes that the pace of urban population growth depends on the natural increase of the urban population and the population gained by urban areas through both net rural-urban migration and the reclassification of rural settlements into cities and towns.

The effects of this population changes in African cities in particular has produced miseries that are often difficult to understand because most of the African primate cities including those in Nigeria are faced with the problem of deteriorating physical and living conditions. The deterioration manifests itself in form of slums, urban sprawl and squatters' settlements, increasing traffic congestion, flooding and erosion and deteriorating infrastructures (Olurin 2003 and Olujimi 2009). Urbanization has enormous negative consequences in Nigeria and other developing countries, Population increase as index of urbanization in Nigeria is driven by rural-urban migration and not by natural increase (Oyeleye, 2013). Many scholars see rural-urban migration in urbanization process as the genesis of urban problems in different part of the world (Wahab, 1990; Agbola, 2004; Olujimi 2009). In order to achieve sustainable urban planning in our cities, it is imperative for planners to monitor the ongoing changes in land use/land cover pattern of an area over a period of time. Against this

background, every bit of the available land will be used in most rational and best possible way so as to ensure orderly development.

Aim and Objectives of the Study

This study aims at examining the nature and consequences of urban growth in Suleja with a view to achieving sustainable development. In executing this study, the trend of physical growth of Suleja between 1987-2014 was analysed and the implications of the growth on the residents and the environment was examined.

Nature of Urban Growth in Nigeria

Urban growth and physical expansion of urban settlements is not peculiar to Nigerian states alone, but a global phenomenon which has occurred significantly all over the world. In recent times, urban growth has had an intense drive in the third world regions (Aina, 1992 as cited by Abiodun et al., 2011). This assertion is also supported by the UN (2012) who professed that the population of the world is expected to be concentrated in the third world countries whose population is projected to increase from 2.7 billion in 2011 to 5.1 billion by the year 2050. Over the years, population growth in Nigeria has been growing at an alarming rate and Olujimi (2009) opined that the Urban population growth in Nigeria in the last thirty years is 5.8 percentage per annum and this is amongst the highest urban growth rate in the world. The rate of urban growth in Nigeria can be tied to three major processes which are natural increase in the population; rural-urban migration and city annexation into the surrounding rural areas (Agbola, 2006).

It is noteworthy that urban growth processes in Nigeria and most developing countries are expanding without significant urban planning. Celik et al. (2009) noted that physical manifestations of rapid urbanization in third world countries like Nigeria are often chaotic and shows far-reaching demographic, social and economic transformations. Regrettably, the opportunities tied to urbanization in these countries are lost due to inadequate resources, basic infrastructure, services and well-conceived planning (Celik et al., 2009). These occurrences are responsible for millions of people in Nigeria, living in environment overwhelmed by slums, filth and squalor having grossly inadequate social amenities (Bankole and Bakare, 2011). The nature of urban growth experienced in Nigeria is evident in the conversion of land from nonurban area to an urban area, or expansion of urban areas into adjoining neighbourhoods, agricultural land, forest area, wetland and other nonurban lands.

Ndabula et al., (2014) opined that urban expansion in itself may not be a problem, but rather the nature and patterns of the urban growth, which may be characterized based on urban land use pattern and its associated impact on the urban spatial form, the rate of land conversion and land use intensity. The concept of urban growth includes spreading outwards of a city and its suburbs to its outskirts, auto-dependent development on rural land, excessive,

ineffective urban space consumption, poor distribution of open spaces, scattered development away from the central city and existing infrastructure (Hasse and Lathrop, 2003).

Methodology

The longitudinal design method was adopted in this study. Data for the study was generated from two main primary sources and secondary sources. Since this study involved change detection, the use of imageries taken at different times were adopted. Data for the secondary sources were obtained from journals and other materials from the internet; Solid waste data were obtained from Niger State Environmental Protection Agency, lists of building plan approvals were obtained from Niger State Urban Development Board while crime reports were obtained from the Nigerian Police Force Suleja. Four sets of satellite images for Suleja for 1987, 1997, 2007 and 2014. All the imageries are the American Land-sat series Thematic Mapper (TM) and Enhance Thematic Mapper (ETM^{+}). All the satellite imageries were obtained from the National Centre for Remote Sensing, Plateau State (table1. 1). Data for the primary sources were acquired from Oral interview and the use of "Rasi 700" gas meter which was used to measure the level of Pollution in Suleja.

Table 1.1: Image Properties

S/No	Image Year	Path and Row	Data Set	Image Captured Date
1	Suleja 1987	P189 R53	TM	21/12/1987
2	Suleja 1997	P189 R53	ETM^{+}	27/12/1997
3	Suleja 2007	P189 R53	ETM^{+}	09/12/2007
4	Suleja 2014	P189 R53	ETM^{+}	04/3/2014

Source: Fieldwork, 2014

The data generated were processed; tabulated and analysed using the Statistical Package for Social Science (IMB SPSS) ver.20. The software package used for images analysis was the Integrated Land Water Information System (ILWIS 3.3 Academic). The ILWIS Academic was used for Image Classification and Post Processing. A supervised classification was carried out on all the imageries using three parameters which are, Built-up Area, Bare Surface and Vegetation. Geospatial techniques were employed in determining the spatial growth of Suleja between 1987 and 2014. In order to make this research scientific, four imageries of ten years intervals were processed that is, Thematic Mapper for 1987, the Enhance Thematic Mapper for 1997, 2007 and 2014.

The images obtained were "sub-set" on ILWIS 3.3 Academic so as to determine the Area of interest which is Suleja. Band combination of 4, 3, 2 were used to develop a "false colour composite" for the study area. The 4, 3, 2 bands have a potential of being used for urban studies, on this colour composite Vegetation appears in shades of red, urban areas in cyan blue, soils vary from dark to light browns. "Training sets" were created on all the imageries

and these "Training sets" include: Built-up area, Vegetation and Bare Surface. These training sets were subjected to a supervised (full Gaussian) maximum likelihood classification; this was done using the "classifier" tool on the operation list of ILWIS 3.3 Academic software.

Study Area

Suleja Local Government Area (fig 1) lies between latitude 9°6'13.8'' and 9°17'49.35'' north of the equator and longitude 7°6'58.6' and 7°12'18.41' east of Greenwich Meridians. Suleja local government has a population of 216,578 in 2006 (NPC, 2006). In the year 2014, the population figure increased to 278,735 (projected figure).

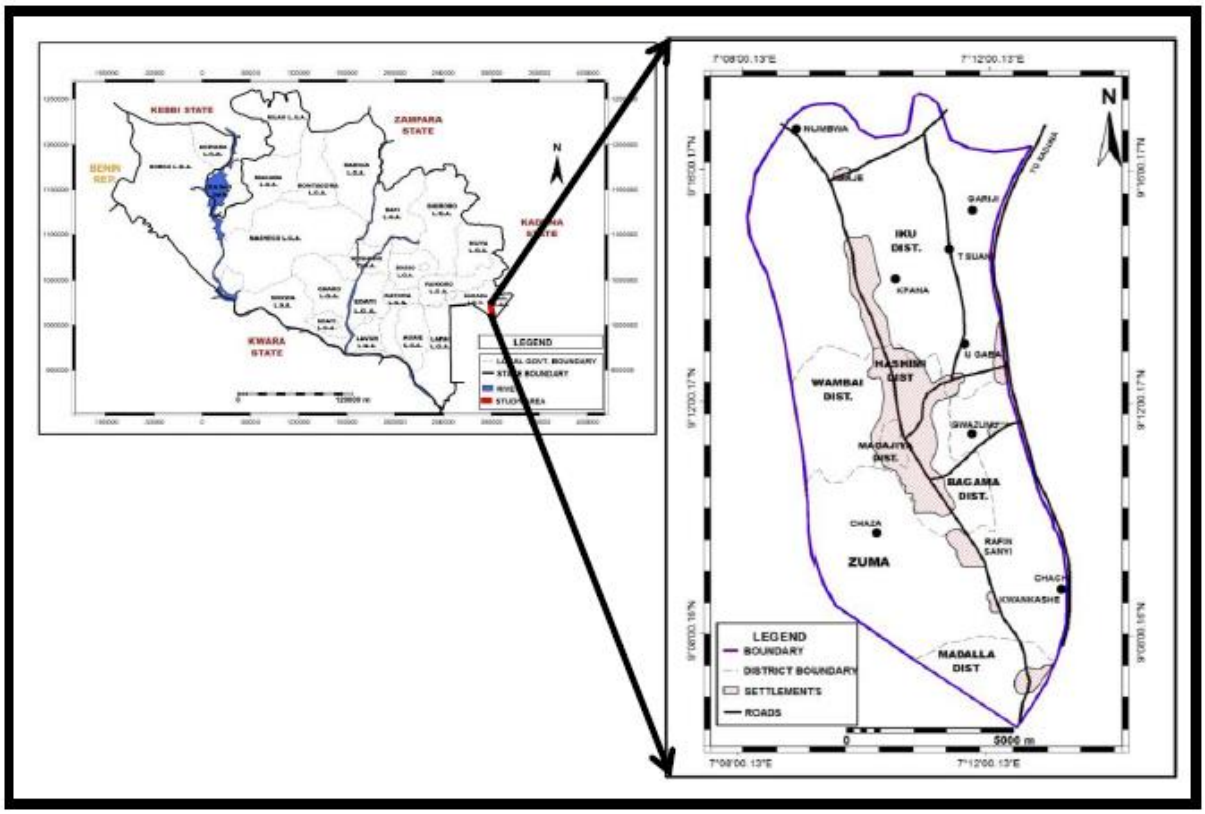

Figure 1: Administrative Map of Suleja highlighted in Map of Niger
Source: Department of URP FUT Minna.

Discussion and Findings

In analysing the images, three classes of landuse landcover were identified in Suleja, these classes are Built-up areas, Bare Surfaces and Vegetation. The built-up areas are represented in red colour, while bare surfaces and vegetation are represented in Grey and Green colour respectively (fig 2).

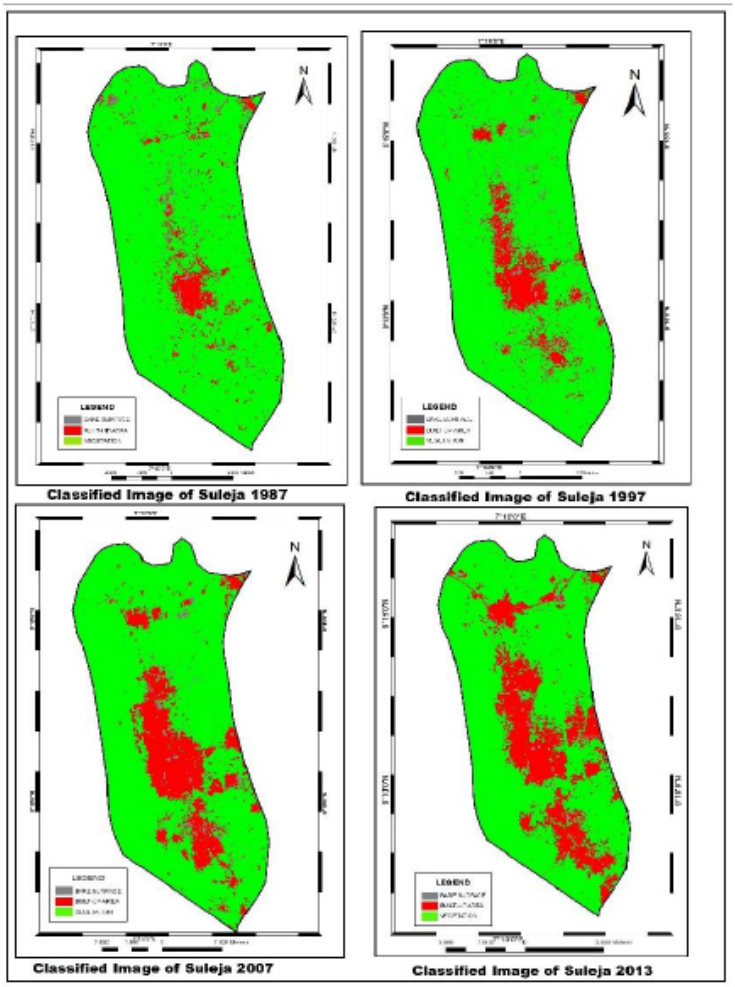

Fig 2: Composite Map for Suleja
Source: Author's Field Survey, 2014.

Table 1 shows the landuse landcover of Suleja in 1987, the table (table 1) reveals that the study area was forested in 1987 with vegetated area covering a total of 194.20 km^2 (91.77%) of the total land use. Built-up area and Bare Surface covers a land area of 10.91Km^2 (5.16%) and 6.51Km^2 (3.07%) respectively. Built up area increased from 10.91km^2 (5.16%) in 1987 to 17.46 km^2 (8.25%) in 1997. This increase led to a slight decrease in vegetated area from 194.20 km^2 (91.77%) in 1987 to 190.56 km^2 (90.60%) in 1997. Bare surface also decreased in the year 1997 with a total land area of 3.57 km^2 (1.69%). All these changes can be attributed to increase in human activities and increase in population (table 1).

In 2007 (table 1), there was a drastic increase in the size of built-up area in the study area. The built-up area increased to 30.52 km^2 (14.42%) as against 17.46 km^2 recorded in 1997. The Niger State Urban Development Board attributed the increase in growth to the influx of people moving into Suleja from Abuja as a result of "mass" demolition done within that period (2007) by Federal Capital Development Authority, Abuja. Increase in human activities in Suleja also gave rise to decrease in vegetation and bare surface in 2007. Vegetated area decreased to 178.15 km^2 (84.16%) while Bare Surface also decreased to 3.02

km^2 (1.43%) as against 190.56 km^2 (90.60%) and 3.57 km^2 (1.69%) recorded for vegetation and bare surface respectively in 1997.

Table 1 shows that the study area witnessed a considerable increase in socio-economic activities. The built-up area increase from 30.52Km^2 (2007) to 46.25 Km^2 in 2014, due to increase in human activities in Suleja more vegetal cover and Bare Surfaces were lost. The vegetal cover decreased from 178.15km^2 in 2007 to 164.02km^2 in 2013 as Bare Surface also decreased from 3.02km^2 in 2007 to 1.41km^2 in 2013. The change in landuse landcover (table 1) in this year can be attributed to increase in Population of Suleja. Between 1987 and 2014 the changes in built-up areas were progressive.

Table 1: Land use/Land Cover Change (1987-2014)

Sample Set	Land cover Area (Km^2)							
	1987	%	1997	%	2007	%	2014	%
Bare Surface	6.51	3.07	3.57	1.67	3.02	1.43	1.41	0.67
Built-up Area	10.91	5.16	17.46	8.25	30.52	14.42	46.25	21.85
Vegetation	194.20	91.77	190.59	90.07	178.15	84.16	164.02	77.48
Total	211.62	100	211.62	100	211.69	100	211.68	100

Source: Author's Field Survey, 2014.

Extent of Change between 1987 and 2014

The magnitude of change (table 2) from 1987-1997 is calculated by subtracting the area of each Landuses Landcover type for the year 1987 from 1997 that is, B-A. The annual frequency of change (D) is determined by dividing the magnitude of change of each of the Landuse landcover category by the number of years between the period, that is, 10 years for 1987 -1997, 10 years for 1997 to 2007 and 7 years for 2007 – 2014. The percentage of change (E) is calculated by dividing the magnitude of change C of each Landuse Landcover category by the figure of the base year that is, 1987 then multiplying the result by 100. This same process is done for the periods 1997 to 2007 and 2007 to 2014 where 1997 and 2007 are the reference year respectively. The results of the analysis show a tremendous change in the Landuse Landcover of the study area during the 27 years period from 1997-2014. It is noticed that the percentage change in the proportions of some Landuse sample sets increased while others decreased.

Table 2 also reveals that Bare Surface between 1987 and 1997 recorded an annual frequency of change of -0.29Km^2 with a percentage of change -45.16; this implies that 0.29km^2 is converted into built-up areas annually. This period (1987 - 1997) also recorded a decrease in vegetal cover. The analysis unveils that 0.36 km^2 of vegetal cover are lost annually due to human activities. Built-up area within this period (1987 -1997) gained a total of 0.66 km^2 annually. The dynamics indicate that there was an increase in spatial growth between 1987 and 1997.

Table 2: Extend and percentage of change between 1987 and 1997

Sample Set	A Year 1987 (KM^2)	B Year 1997 (KM^2)	C Magnitude of change (B-A)	D Annual Frequency of Change C/10	E Percentage of change C/A x100
Bare Surface	6.51	3.57	- 2.94	- 0.29	- 45.16
Built-up Area	10.91	17.46	6.55	0.66	60.04
Vegetation	194.20	190.59	- 3.61	- 0.36	-1.86
Total	211.62	211.62	0	0.01	13.02

Source: Author's Field Survey, 2014.

Table 3 shows a further decrease in the size of Bare Surface and Vegetation. The analysis reveals a magnitude of change of - 0.55km^2 for Bare Surface and - 12.44km^2 for vegetation. This magnitude of change reveals that a total of 0.06 km^2 and 1.24 km^2 are loss annually for both Bare Surface and Vegetation respectively. This trend also reveals a 1.24km^2 of vegetal cover are cleared annually for urban expansion. This period (1997- 2007) shows an increase in built up area with a magnitude of change of 13.06 km^2 and a percentage of change of 74.80%. The analysis also shows that a total 1.31km^2 of disturbed vegetation and Bare Surface are added to the built-up areas. The increase in Built-up area between 1997 and 2007 can be attributed to the influx of people into Suleja.

Table 3: Extend and percentage of change between 1997 and 2007

Sample Set	A Year 1997 (KM^2)	B Year 2007 (KM^2)	C Magnitude of change (B-A)	D Annual Frequency of Change C/10	E Percentage of change C/A x100
Bare Surface	3.57	3.02	- 0.55	- 0.06	- 15.41
Built-up Area	17.46	30.52	13.06	1.31	74.80
Vegetation	190.59	178.15	- 12.44	-1.24	- 6.53
Total	211.62	211.69	0.07	0.01	52.86

Source: Author's Field Survey, 2014.

The magnitude of change of naturally vegetated area between 2007 and 2014 was -14.13km^2, (table 4) with an annual frequency of change of -2.36 km^2 which implies that a total of 2.36km^2 of vegetal cover are loss annually due to increase in human activities in the study area. There was also a decrease in Bare Surface, as 0.27km^2 are loss annually with a magnitude of change of -1.61km^2 and a percentage of change of -53.31. This period (2007 - 2014) also shows an increase in Built-up Area, which can be attributed to the residents' quest for space for development and the influx of people coming into the study area in search of economic opportunities. The magnitude of change for Built-up area for this period was 15.73km^2 with a percentage change of 51.54%. 2.25km^2 is added to the Built-up area annually.

Table 4: Extend and percentage of change between 2007 and 2014

Sample set	A Year 2007 (KM^2)	B Year2013 (KM^2)	C Magnitude of change (B-A)	D Annual Frequency of Change C/7	E Percentage of change C/A x100
Bare Surface	3.02	1.41	- 1.61	- 0.23	- 53.31
Built-up Area	30.52	46.25	15.73	2.25	51.54
Vegetation	178.15	164.02	-14.13	- 2.02	- 7.93
Total	211.69	211.68	- 0.01	- 0.01	-9.7

Source: Author's Field Survey, 2014.

The rate in crime was progressive between 2006 and 2014. The study reveals that a total of 905 cases were reported in the last 8 years in Suleja. The highest numbers of cases reported were in 2008 (31) and 2011 (124). The Nigerian Police Force in 2008 attributed the high crime rate recorded during that period to the influx of people from Abuja, a resultant effect of the Abuja mass demolition by the FCDA while that of 2011 was attributed to the Suleja Madalla bombing in which 113 people were arrested. As the population of the study area grew in 2013, 122 cases were reported and a total of 156 people were apprehended. This figure (156) marked the highest number of people apprehended in Suleja in the last eight years. 967 persons were apprehended in all the crimes committed in Suleja, 896 of which are males while 71 are females. This indicates that males are more involved in crime than their female counterpart. The prevalent crime record can be attributed to the spatial growth of Suleja, unemployment coupled with inadequate security arrangement for the city. Global standard for the ratio of a police to a person is 1:50 but in Nigeria, especially in a growing city like Suleja the ratio range between 1:600-1000. This gross shortfall encourages criminal activities to grow.

Environmental problems experienced in Suleja are Flooding, Erosion, Uncollected Waste and land Degradation. Fig 4.16 reveals that, 2.2% of the respondents are faced with the problem of flooding, 21.2% of the respondents are faced with the problem of Erosion. 57.6% and 19.1% of the respondents believed that uncollected waste and land Degradation respectively, are more pronounced in their area. The study reveals that Suleja has prevalent cases of uncollected waste and this occurrence can be attributed to increase urban growth. Table 5 shows that 62,928 cubic meters were collected in the year 2009. In the year 2010 123,120 cubic meters of solid waste were collected, 184,680 cubic meters, 247,152 cubic meters and 308,940 cubic meters were collected for the year 2011, 2012 and 2013 respectively. The increase in cubic meters of solid waste collected in the study area can be attributed to increase in population. A total of 926, 820 solid waste was collected between 2009 and 2014. The Niger Environmental Protection Agency believes that these statistics does not give a true record of waste collection in Suleja because lots of solid waste are left uncollected daily.

Table 5: Volume of Waste Generated in Suleja per Population between 2009 and 2013

Year	Population	Volume of Solid Waste Generated (m^3)
2009	238,040	62,928
2010	245,664	123,120
2011	253,526	184,680
2012	261,626	247,152
2013	270,008	308,940
Total	**1,268,864**	**926,820**

Source: Author's Compilation, 2014.

Hypothesis:

H_0: the volume of waste generated in Suleja does not vary significantly with the annual population

H_1: the volume of waste generated in Suleja is directly proportional to increase in annual population

Based on the available data on the volume of solid waste generated between the five years period of 2009 and 2014, attempt was made to correlate the annual volumes of generated solid waste with the population figure for the corresponding years (table 6). The goal is to investigate if the volume of waste generated annually increases as the annual population increases. The result, as summarised in table 7, shows a perfect positive (1.0) correlation coefficient, which is significant at 99% confidence level. Hence, the null hypothesis is rejected and the alternative hypothesis is accepted. This shows that, the volume of waste generated in Suleja is, actually, directly proportional to the annual population increase. The observed pattern is, therefore, real and not attributable to chance occurrence.

Table 6: Correlation between Volume of Waste Generated and Annual Population

		Population	Volume of Solid Waste Generated (m3)
Population	Pearson Correlation	1	1.000**
	Sig. (1-tailed)		.000
	N	5	5
Volume of Solid Waste Generated (m3)	Pearson Correlation	1.000**	1
	Sig. (1-tailed)	.000	
	N	5	5

***. Correlation is significant at the 0.01 level (1-tailed).*

Source: Derived from Table 5

The Rasi 700 gas meter was used in collecting data on the quantity of Co, No_2 and So_2 concurrently and the emission level of Suleja 2014 was deduced.

Table 7: Level of Gas Emission in Suleja between 2012 and 2014.

	Standard	2012	2014
Gases	**Unit (PPM)**	**Unit (PPM)**	**Unit (PPM)**
CO	10	13.48	15.97
NO_2	0.04 -0.06	0.073	0.67
SO_2	0.01	0.0163	1.33

Author's Compilation 2014

Table 7 reveals the level of gas emission in Suleja in 2012, after the mean emission of the were recorded CO constitutes 13.48ppm, while No_2 and So_2 reads 0.073ppm and 0.0163ppm respectively (Gazali *et al*., 2013). The level of gas emission increased in 2014, 15.97ppm was recorded for CO, 0.0133ppm was recorded for SO_2 and 0.67ppm was recorded for NO_2. The value recorded in 2014 were higher than the stipulated value by the NESREA which state 10ppm for CO, 0.04 -0.06ppm for NO_2 and 0.01ppm for SO_2 (FEPA, 1999). The High pollution values can be attributed to urban growth and large concentration of Motorcycles.

Ineffective development control as a result of urban growth has led to emergency of Slum in Suleja between 1987 and 2014. According to the Niger State Urban Development Board only 35% of the building plans submitted to the Ministry are approved. The Board (NSUDB) noted that developers frequently go ahead with their development without having their plans approved and this contravention by developers often defaces Suleja. Table 8 shows the numbers of building plans approved between 1993 and 2013.

Table 8: Building plans approved from 1993 to 2013 in Suleja

Year	No. of Applications	No. of Plans Approved	No. Of Plans not Approved
1993	145	51	94
1994	150	53	97
1995	136	48	98
1996	90	32	58
1997	117	41	76
1998	134	47	87
1999	135	47	88
2000	79	28	51
2001	140	49	91
2002	108	38	70
2003	81	28	53
2004	82	29	53
2005	99	35	64
2006	174	61	113
2007	171	60	111
2008	227	79	148
2009	181	63	118
2010	129	45	84
2011	119	42	77
2012	79	28	51
2013	80	28	52
TOTAL	2656	932	1734

Source: NSUDB, 2014.

The number of building plans approved yearly, does not reflect the true population of Suleja. More so, the inability of the Niger State urban Development board to approve more than 35% of the applications made yearly has encouraged the erection of illegal buildings, contravention and chaotic planning in Suleja.

Conclusion

This study has effectively examined the implications of urban growth in Suleja between 1987-2014. It is important to note that crime, uncollected waste, pollution, land degradation, and slum emergence are consequential to urban growth in Suleja within the period under study. To accurately determine the extent of growth in Suleja within the 27 year study period, remote sensing tool was employed. This tool (remote sensing) provides an important catalyst in understanding of the way that urban areas grow and change over time.

Recommendations

On the basis of the findings of the study, recommendations are made to ameliorate the implications of urban growth in Suleja. Recommendations made are:

- The Niger State Government should partner with the National Centre for Remote Sensing and the Federal University of Technology, Minna for the training and capacity building of the staff of the Niger State Urban Development Board so as to bordering their knowledge in monitoring urban growth.
- The Niger State Urban development should give more attention to development control so as to check the emergence of unlawful development. More so, the process of building plan approval should be made less cumbersome by the planning board so as to encourage developers.
- The planning and management of Suleja should be based on the concept of Environmental Planning and Management (EPM). This is a bottom-up and community driven planning and management system, promoted by UN-Habitat.

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