An Integrated Remote Sensing and GIS Approach in Monitoring Urban Expansion in Benin-City, Nigeria.

*****Dr. Ogunbodede, Emman Funmilayo
Dept. of Geography and Planning Science
Adekunle Ajasin University
Akungba Akoko, Ondo State, Nigeria
and
Balogun, Toju Francis
Dept of Geography and Regional Planning
University of Benin, Benin City, Nigeria
*corresponding author

ABSTRACT

The timely detection of trend in land use change and the quantification of such trends are of specific interest to planners. Accurate and up-to-date information on existing land use/land cover, and topographical map which are planning and monitoring tools are not adequate. The available ones are too old and out dated for an effective information base for planning. In an attempt to fill this gap, this study uses existing images for 1986, 2002 and 2007 to determine the spatial growth of Benin City at different times as well as determine the rate of growth, and direction of growth. On the basis of this finding, make a projection for the future growth, as well as, determine the effects of this growth on Benin urban environment. Satellite images of Benin City were obtained, processed and classified using supervised classification and minimum likelihood algorithm with ILWIS GIS software. It also uses questionnaire to elicit information on infrastructural provision, problems of growth on infrastructure as well as probable solution to problems identified. The result shows that Benin City in the last 16 years (1986 - 2002), has increased in area extent (built-up area) from 71.9426 sq km to 117.7559 sq km an increase of 45.8133sq km (38.91%) while in five years (2002 – 2007) it rose from 117.7559 sq km to 187.5211sq km (37.20 %). Absolute growth for the 21 years (1986-2007) was 115.5785 sq km while the annual rate of growth is 5.5sq km. The study observed that the location of educational establishment is a major driving force behind the growth of the city while residential expansion of low income earners at the periphery of the city account for the spatial expansion. The study observes that the Central Business District (CBD) and the core areas continued to be dilapidated while the decay in infrastructural facilities worsens. The new areas were also discovered to lack portable water supply, electricity, as well as motorable roads. The study recommends regular monitoring of urban expansion and its direction using integrated remote sensing and GIS approaches to determine the pattern of land use/cover as well as guide the provision of urban services and infrastructures.

Keywords: Land Use change, topographical map, Central Business District, periphery of the city.

BACKGROUND TO THE STUDY

In Nigeria, the last four decades have been characterized by rapid urbanization. From a total of less than 6 million in 1960, the urban population in Nigeria has risen by 1982 to over 19 million, in 2006 to over 140 million (NPC, 2008). Settlements grow in size and became more complex with the passage of time. The major pattern of city expansion in Benin City is rural - urban migration and by natural population increase. This is due to the perverted policies of location of socio-economic activities in favour of the cities. The growth of settlements in human numbers leads directly to the areal expansion of the city. These rapidly growing cities spread into the suburban areas and extend along the main roads that lead into the cities thereby increasing the total areas occupied by such settlement.

Urbanization has led to high population densities in Nigerian cities. As a consequence, urban settlements are characterized by shortfalls in housing and portable water supply, traffic congestion, pollution, poverty and social unrest making urban governance a difficult task. The strain on the natural environment is compounded by the unplanned or uncontrollable city growth in the context of rising consumption levels in terms of increasing demand for land for urban uses vis-à-vis industrial, institutional, commercial, recreational and other urban based uses, with the resultant effects that land hitherto used for primary production activities are now encroached upon (Mohammed, 2007). Demand for land for this purpose leads to encroachment into the urban fringe or farmland thereby degrading the natural environment and ecosystem.

Rapid urbanization has resulted in sharp land cover changes. Land use and land cover changes play an important role in local and regional environmental condition of a particular territory and they are linked to global environmental change. Cities in most developing countries like Nigeria have been undergoing unprecedented changes both in population and spatial extent (Adeboyejo and Abolade, 2006) and as a result are faced with a variety of problems such as uncoordinated land development, conflicting land uses, high densities in certain parts of the

urban area and the absence of adequate road network which could ensure efficient intra-urban mobility within the city. One of the most important features of all of these centres is their increasing territorial extent and attendant poor spatial pattern of land use developments which are largely uncontrolled and unmonitored due to paucity of data and non application of modern technology of information acquisition (Ikhuoria, 1995).

In Nigeria, the process of urbanization is so fast that it overtakes the capacity of planning authorities to address the situation. Monitoring this growth and planning for its control have been made more difficult by the expanse of time involved in producing reliable and up-to-date maps. Existing maps are usually old, out of date and, therefore difficult to use as an effective information base for planning. This if left unchecked, will undermine sustainable urban development, hence the need for enhanced planning of urban growth and development for better management of existing urban centre. It is a fact that cities are dynamic entities capable and expected to grow and expand. Urban expansion if not monitored and guided will lead to disharmony with the natural and social environment. A vague understanding of how cities grow results in muddled and misguided solutions to urban problems and vague awareness of opportunities that arise from that growth.

As a result of the aforementioned, it is essential to have updated information of urban growth pattern and its impact on the living environment. Effective planning relies on accurate and up-to-date information on existing land cover and land use. Thus, there is an obvious need for periodic studies on current phenomena of urban growth patterns. The timely detection of trends in land use change and a quantification of such trends are of specific interest to planners. It is therefore pertinent to note that the technique used in acquiring information and presenting such information goes a long way to determining how useful such information can be to planners and decision makers for effective urban management. The heterogeneous landscape of the urban

environment accompanied with its high dynamic nature has posed serious challenges to the application of conventional methods and technologies and theories in the wider field of remote sensing and social scientists and this has agitated series of urban studies (Yang, 2005).

The outdated nature of topographical map and the general lack of urban land use map in Nigeria, which are planning and monitoring tools, informed the need for this study. The technology that provides a proper means of monitoring land cover/land use changes and the spatial expansion of cities is satellite remote sensing and Geographic Information System (GIS). According to Jothimani, (1997) multi-temporal satellite data provide a unique opportunity for mapping and monitoring some of the elements of urban - core, its dynamics and the resultant urban structure. It is against this background that this research applies the use of GIS and remote sensing to determine the spatial expansion of Benin City and its implications on urban environment. To achieve this aim, the paper examines the spatial growth of Benin City at different times (1986, 2002 and 2007) and determines the rate of growth, direction of growth and also project for the future growth. The study also examines the factors responsible for the rapid growth of Benin City, the effects of growth and its planning implications so as to provide management strategies to monitor and control its growth.

STUDY AREA.

The ancient City of Benin was the seat of the most powerful forest kingdom in West Africa whose area of jurisdiction extended beyond the present day Benin division. Benin City is located in the Mid-Western portion of Southern Nigeria and is the capital of Edo State. The geographical co-ordinates of the city limits lie within the Latitudes $6°26^1$ and $6°34^1$ North of Equator and Longitude $5°35^1$and $5°4^1$ East of Greenwich Meridian (see figure 1). The history of Benin Kingdom dates back to the period of the Portuguese Foreign Mission in Nigeria when

slave trade was the focus of international commerce (Sada, 1975). As the principal centre of Monarch, social and trade activities in the old kingdom, all the people in the then Bendel State (Delta and Edo State) had to interact with the town.

During the past two decades, Benin City experienced tremendous growth both in population and in structural complexity. From a population of 53,753 in 1952, Benin City reached the size of 100,694 in 1963. In 1991 census it was 780,976 while in 2006 it rose to 1,147,188 (NPC, 2008). Another important feature of Benin Metropolis is its nodality which attracts its population from the neighbouring towns. This rural-urban migration in addition to natural population growth (birth) swells up the population of the town. The strategic position of Benin Metropolis also made it a gateway to the northern and eastern part of the country from the western axis.

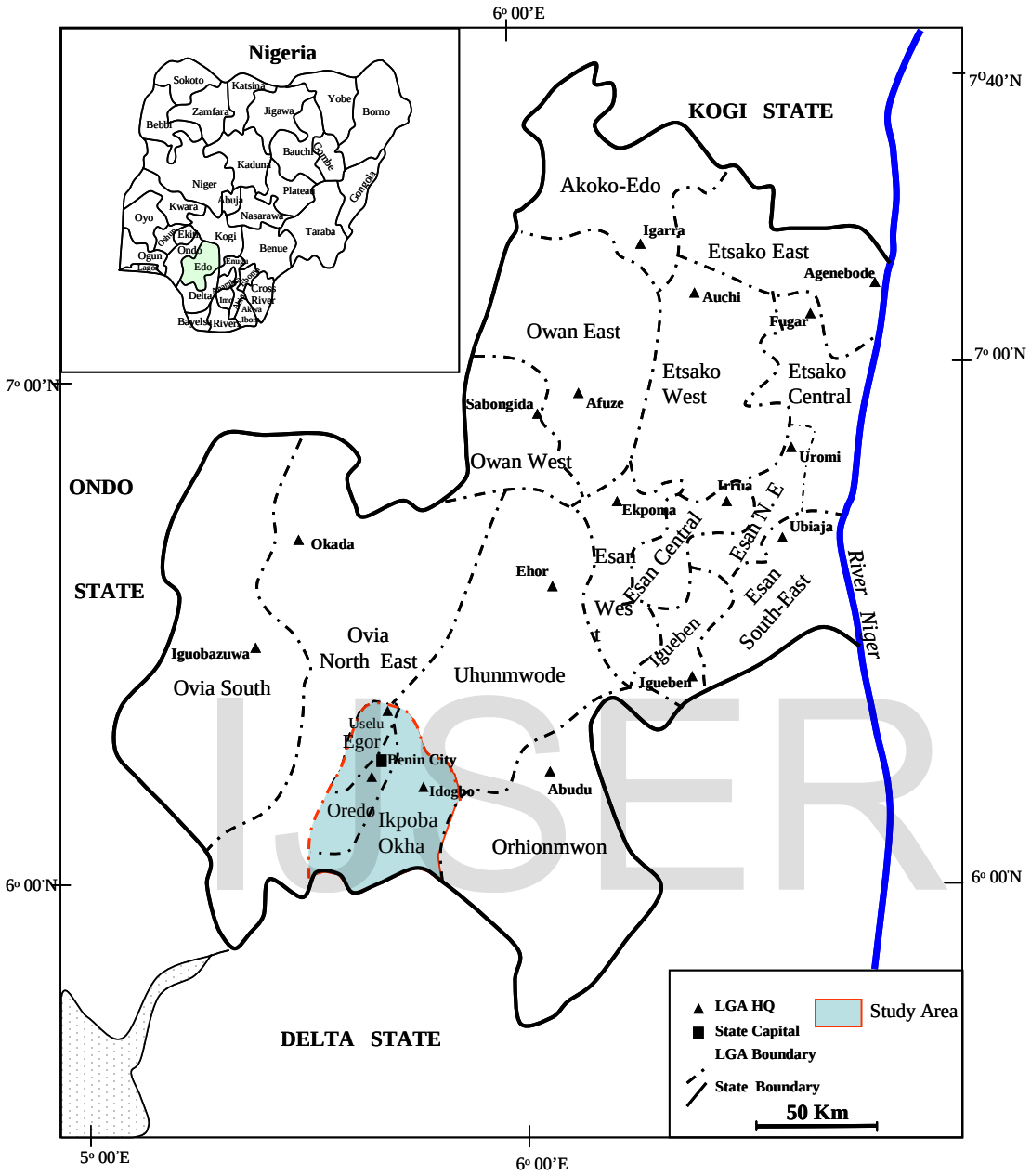


Figure 1: Edo State Showing the study Areas

RESEARCH METHOD

The focus of this study is the monitoring of spatial expansion of Benin City, using remote sensing and Geographical Information System. To monitor the extent of growth of Benin City, it was necessary to adopt an approach that will focus on the land use/land cover changes. The data used in this study to achieve the stated objectives were from two sources viz Primary and secondary. For the primary, copies of questionnaire were administered to elicit information mainly on urban expansion and infrastructural provision. Stratified Random Sampling Technique was adopted in the administration of the questionnaire. The city has three Local Government Areas and each of the Local Government Area was partitioned into wards. One third of the wards in each Local Government Area were selected for sampling. This gave us a total of 10 wards which was about 31% of the total wards in Benin City. Systematic random sampling technique was used to select respondents to fill the questionnaire administered. In each selected street a respondent was randomly picked and other respondents were picked from every fifth house thereafter. The respondent picked was always the household head. In all, five hundred (500) questionnaires were randomly administered in the selected wards. The data needed include demographic characteristics of respondents, factors influencing spatial growth of Benin City, and impact of the growth of Benin City on the environment. The questionnaires administered were analyzed to (i) determine the driving force behind the growth of Benin City, (ii) identify villages that have been absorbed by the urban expansion and those that would be absorbed in the next ten years if the rate of expansion continues, (iii) examine if adequate infrastructural provision was keeping pace with urban expansion and provide planning implications.

The second groups of data include: (i). Landsat TM (acquired in June 1986), Landsat ETM (acquired in October, 2002) and Nigeriasat-1 (acquired in June, 2007) were obtained from the National Center for Remote Sensing. (ii). Topographical map of Benin City with the scale of

1.50,000 produced in 1967 by Federal Survey, was used as a base information to identify the villages that were absorbed at different periods. (iii) Population figure of Benin City in 1963, 1991 and 2006 were collected from National Population Commission (NPC), Benin City to support the attribute data of the study area.

Image Interpretation and Data Analysis

A supervised Classification with a Maximum Likelihood Algorithm was used to classify the multidate satellite image using ILWIS GIS software (see figure 2, 3 and 4). Supervised classification requires the user to determine a classification scheme that comprises the desired land cover categories (Trotter, 1991 and ERDAS, 1994). The classification scheme adopted comprise of five classes: built-up area, water bodies, vegetated area, forest and cultivated farmland.

The objective of supervised classification is the construction of unique spectral classes from the remotely sensed data corresponding to unique signatures of land cover categories. For this purpose, training sites were identified for each image. A prior knowledge about the area, necessary for the determination of the training sites, was derived from 1:50,000 topographic maps, analysts' knowledge of the study area and through fieldwork. The classification used bands 1, 2 and 3. These bands combination exploits the full information content of the data and proved good results. Extensive field work check served as ground truth against which the classification results were

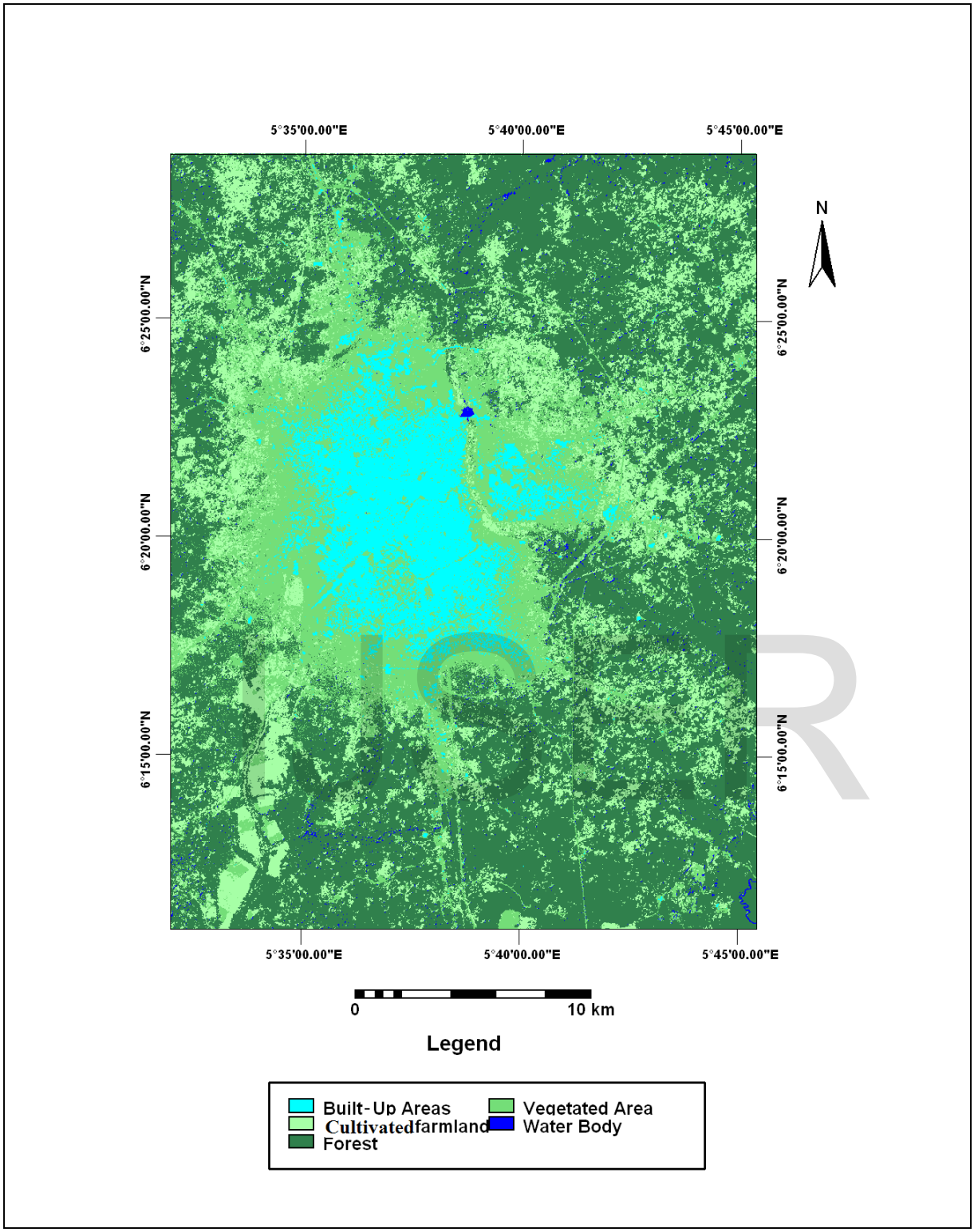


Figure 2: Land Use Classification (supervised) of Benin City and Environs as Derived from Landsat 1986

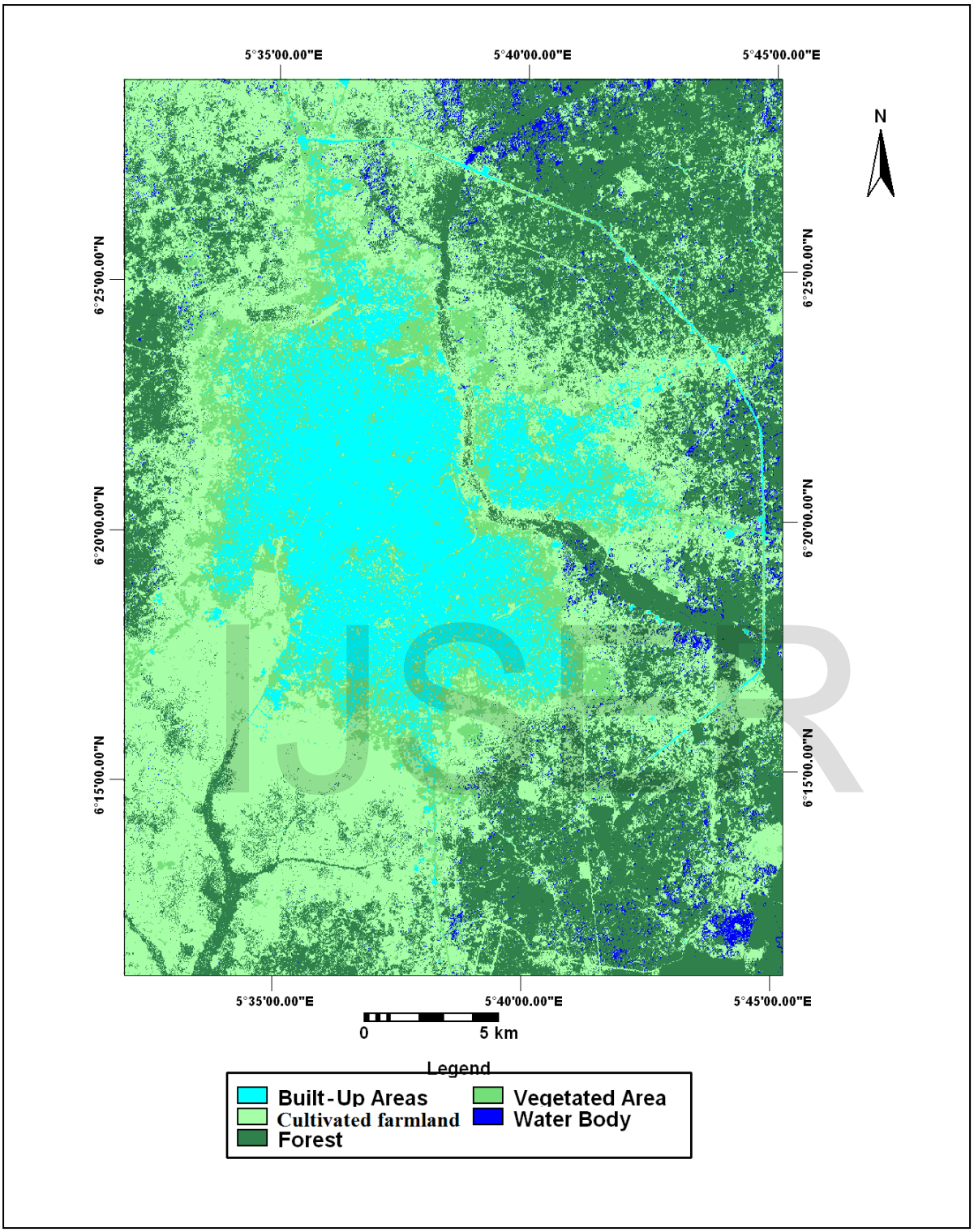


Figure 3: Land Use Classification (supervised) of Benin City and Environs as Derived from Landsat 2002

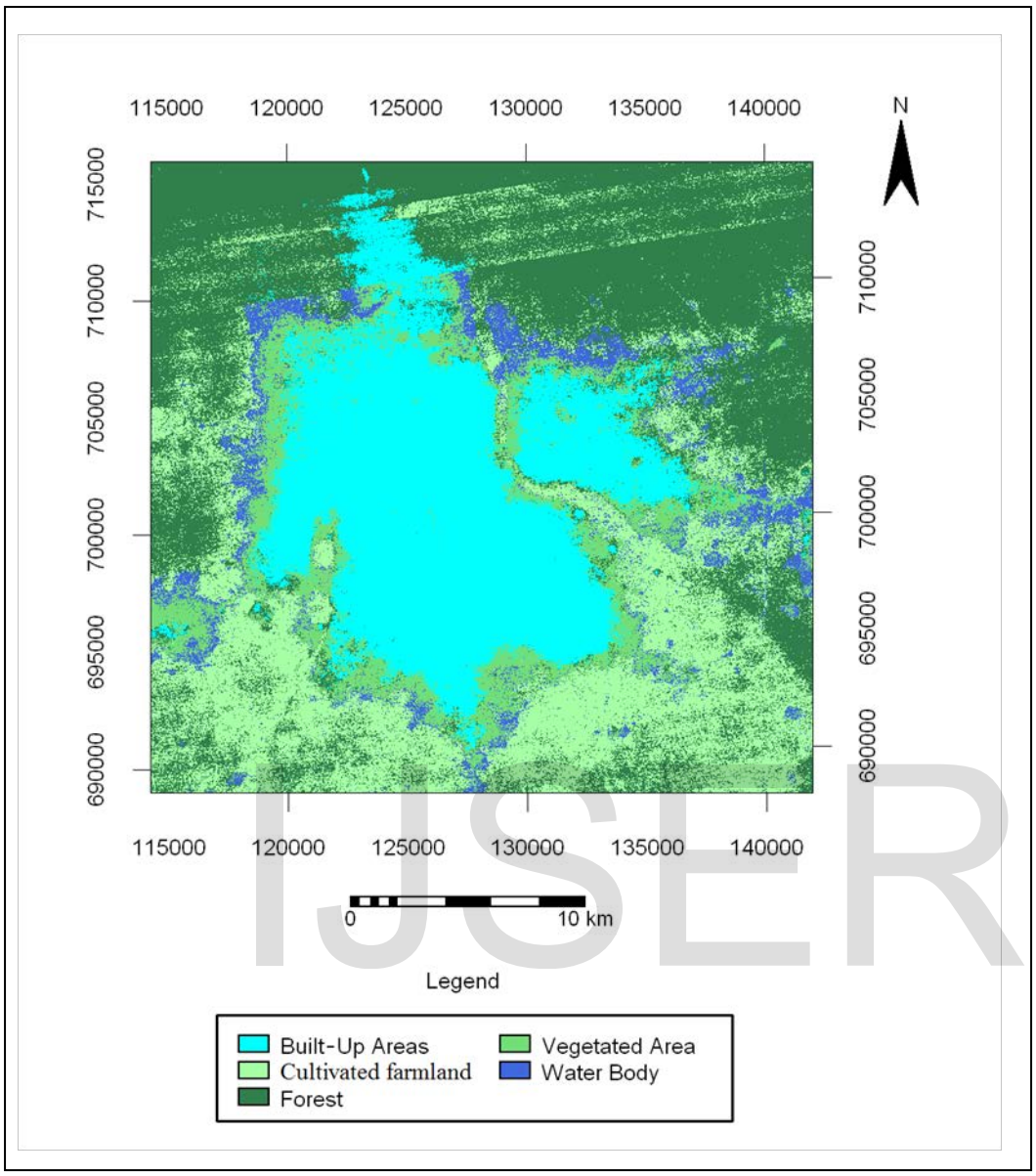


Figure 4: Land Use Classification (supervised) of Benin City and Environs as Derived from Landsat 2007

compared. In other to analyze the nature, rate, and location of the urban land use changes, image of the built-up area was extracted from each of the original images. The statistics of the extracted images were recorded to obtain an urban expansion data. The result of the interpretation,

combined with collateral information, the spatial expansion, direction of growth, rate of growth and projection of the future growth were then determined.

Results and Discussion

In Table 1, the built up areas was noted to increase throughout the three periods of study (1986, 2002 and 2007). Cultivated land increased in 2002 but decreased throughout the three periods of study.

Table 1: Areas Occupied by Different Land uses at Different Periods in Benin City (km^2)

Classes	1986	2002	2007
Built-Up Areas	71.942607	117.7559	187.5211
Cultivated farmland	152.690816	332.2939	181.3931
Forest	413.017754	263.0460	273.6190
Vegetated Area	170.986748	87.2967	74.23818
Water Body	6.367228	20.83842	38.04978
Total	**815.005153**	**821.2309**	**754.8212**

Source: Fieldwork 2008

In 16 years (1986 - 2002), built-up area rose from 71.9426 km^2 to 117.7559 km^2 an increase of 45.8133 km^2 (38.91%) while in five years (2002 – 2007) it rose from 117.7559 km^2 to 187.5211 km^2 (37.20 %).The rate of growth between 1986 and 2002 was 2.86 km^2 while the rate of growth between 2002 and 2007 was 13.95 km^2. Absolute growth for the 21 years (1986-2007) was 115.5785 km^2 while the rate of growth is 5.5 km^2 per year. (See Table 2 - a derivative of Table 1). Cultivated farmland increased from 152.6908 km^2 in 1986 to 332.2959 km^2 in 2002 but reduced to 181.3931 km^2 in 2007. The reduction in 2007 was due to the fact that areas previously used for farming had been taken over by built-up areas. The same trend was observed in the case of forest class as shown in table 1. The forest at the urban fringe has reduced due to its

conversion to cultivated farmland. The areas classified as vegetated lands are the undeveloped lands within the built-up area.

Table 2: Rate of Growth of Built-up areas in Benin City and its Projection (km^2)

Year	Built-up area	Absolute growth	Percentage growth	Rate of growth	Projection
1986	71.9426	-			
2002	117.7559	45.8133	38.905 %	2.86	-
2007	187.5211	69.7652	37.204 %	13.95	-
1986-2007	-	115.5785	61.63 %	5.50	-
2015					270.03
2020					321.60

Demographic Characteristics of Respondents

A total of 500 questionnaires were administered and retrieved for analysis. The respondents comprise of 318 males (63.6%) and 182 females (36.4%) residents of Benin City. Out of these respondents 192 (38.4%) are single, 256 (51.2%) married and 52 (10.4%) are divorced or separated. Among the respondents 54 percent have had above 20 years of unbroken continuous stay in Benin City. Thus their responses to questions on the growth of Benin City during the period under study can be accepted as realistic. Also 79 percent of the respondents were between the ages of 25 and 65years and therefore could be considered as matured and should be able to answer questions maturedly. In addition,

Table 3: Socio-economic variables of respondents.

Sex	**Frequency**	**Percentage**
Male	318	63.6
Female	182	36.4
	500	**100**
Age		
Below 25 years	100	20.4
26-34 years	180	36.0
35-44 years	86	17.2
45-54 years	78	15.6
55 years and above	56	11.2
	500	**100**
Marital Status		
Single	192	38.4
Married	256	51.2
Separated / Divorced	52	10.4
	500	**100**
Duration of stay of respondent in the study area		
0-10 years	94	18.8
11-20 years	136	27.2
21 years and above	270	54.0
	500	**100**
Educational Level		
No formal education	6	1.2
Primary education	26	5.2
Secondary education	144	28.8
Tertiary education	324	64.8
	500	**100**
Available infrastructure		
Pipe borne water	4	0.8
Electricity	64	12.8
Educational Institution	10	2.0
Electricity, educational institution	142	28.4
Recreational and waste disposal	50	10.0
Electricity, educational institution, good road, recreational and waste disposal	230	46.0
	500	**100**
Adequacy of pipe borne water		
Yes	103	20.6
No	397	79.4
	500	**100**

among the respondents, 63 percent had post secondary school education and hence understood the questions and responded very well (See table 3, 4,5,6 and 7).

The impact of severity of effects of urban expansion on infrastructure, urban dwellers and its implications to the government were identified. Respondents were given options ranging from "strongly agree" (SA); "agree" (A); "Disagree" (D) and "strongly disagree" (SD) from which to choose. The 4 point scale response was used to calculate the weight attached to SA, A, D, and SD. The Mean Weight Value (MWV) were calculated from these order and compared with Group Arithmetic Mean (GAM) to determine acceptance or rejection of a problem items for taking decision (see Ogunbodede, 2009). The respondents' perceptions and their rating using Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) are as shown in tables 4 to 7. The GAM for each problem items were set accordingly (see Tables 4 to 7)

Spatial Growth of Benin City

Eighty-two (82) percent of the respondents were of the view that Benin City had experienced rapid growth in recent years. This confirmed earlier view that Benin City had been expanding rapidly (Ozo and Ikhuoria, 1983 as well as in Akure by Ogunbodede, 2004 and 2009). This view was also confirmed by the result of this research as interpreted using satellite imageries of Benin City. In the respondents' view, the driving forces behind the rapid expansion of Benin include natural population growth and the status of Benin as the Capital town and seat of Government of Edo State. While 48 percent of the respondents are of the view that natural population growth is responsible for the rapid expansion of Benin City, 34 percent is of the view that Benin City being the state headquarters is the driving force. The factor of population growth and Benin City as the seat of government accounted for 82 percent of the reasons for the rapid

growth of Benin City. The concentration of socio-economic activities in the city coupled with its state headquarters status served as a centripetal force that draw migrants from the hinterland and neighbouring settlements while 1.1 percent of the respondents were not of the view that it was the driving force behind the growth of Benin City. This is a confirmation that the industrial base of Benin City is still very low.

The major pattern of growth of Benin City has been towards the major road network and allocation of educational institutions in the city. In the central part of the city, intensive land use is common. In the core areas of the city, old buildings used for residential purpose were converted to commercial purposes while some of them were also demolished and replaced with three or more storey type of building. The CBD and core areas is a beehive of centre of commerce hence they attract a lot of traffic. 34.4% of the respondents strongly believed that the pattern of growth of the town followed the new routes created at the periphery. This is true because as new roads are constructed, more unused lands are opened up for further development. Similarly, the location of primary and secondary institutions at the periphery also attracts people to locate their houses very close to such institutions.

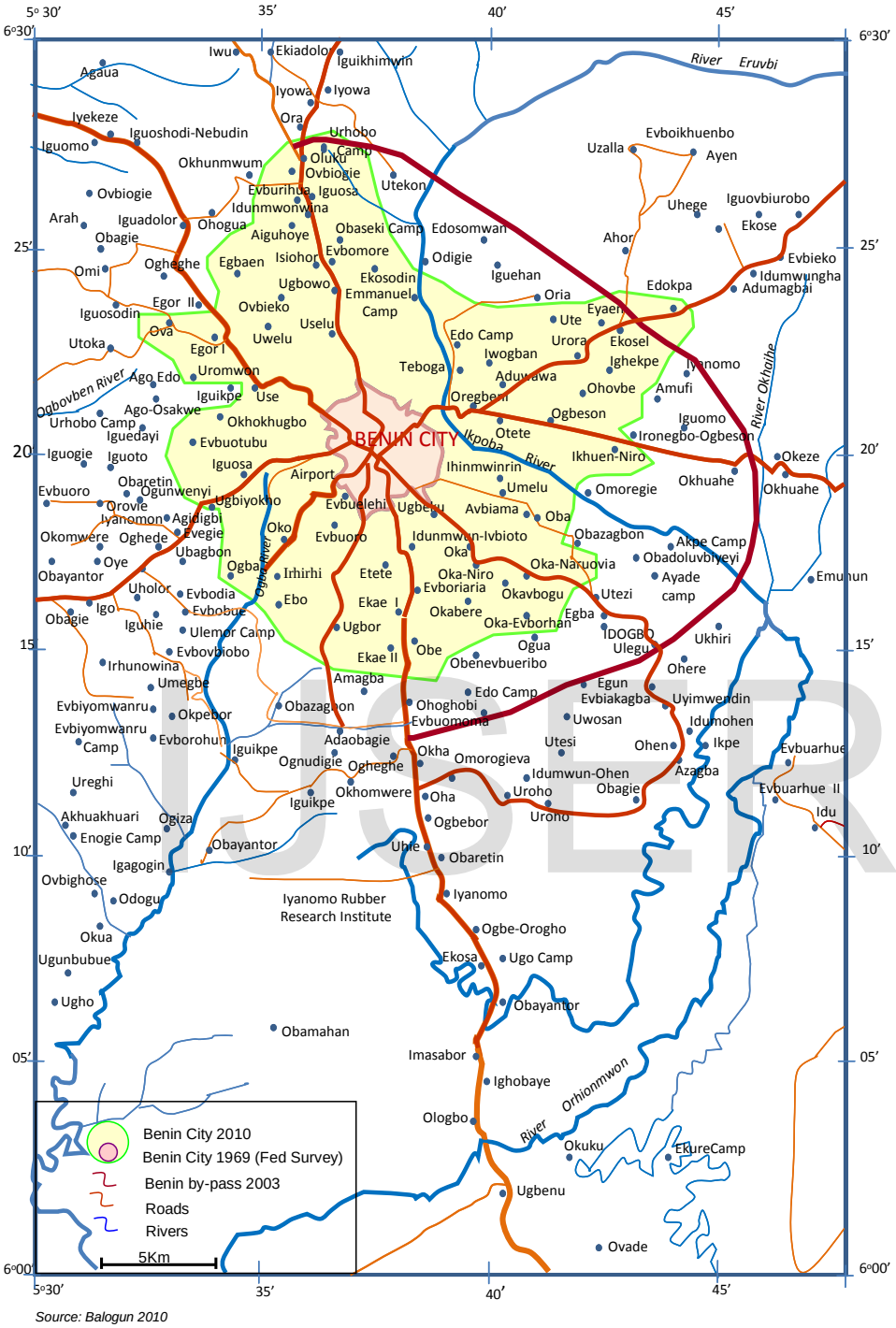
Eight routes emanating from Benin City to other parts of the states were noted to also constitute axis of urban development. When asked to rank the major transportation routes along which Benin City has been expanding mostly, Ugbowo-Lagos route axis came first. This was followed by Agbor Road and Sapele Road. Coincidentally, it is along Ugbowo-Lagos route that we have the major post secondary school establishments like University of Benin and University of Benin Teaching Hospital. Most workers of these institutions, because of proximity, to their place of work prefer to stay along Ugbowo-Lagos road. Those who commute from Benin City to College of Education, Ekiadolor, lgbinedon University, Okada, and the Polythenic, Usen also

prefer Ugbowo area since these institutions are located along the Ugbowo- Lagos route. This accounted for the reason why Ugbowo-Lagos road recorded more growth than other areas in the city.

Impacts of the growth of Benin City on its immediate Environment

The present limit of Benin City and villages that have been absorbed are shown in Figure 5. Other observations made by respondents include the following**:** Lost of identity of the villages. Change from rural life and rural economy to urban life and urban economy respectively.

This study noted that infrastructural provision was not matched with rate of urban expansion in the periphery of the city. This situation created problems for the people living in this part of the city from the way the residents perceived environmental problems as reflected in Table 4. It was observed that uncontrolled development ranked 2nd amongst the problems. Efforts were also made to determine which of the effects of urban expansion as perceived by respondents should be accepted or rejected using perception scale (likert scale). The Mean Weight Value (MWV) of all the six (6) effects was compared with the Group Arithmetic Mean (GAM). The first two statements (uncontrolled development and inadequate infrastructure provision) have their MWV



Source: Balogun 2010

Figure 5: Map of Benin City.

(138.0 and 132.4) greater than the GAM (129.13), hence they were accepted as being valid and having negative effects on the immediate environment while others were rejected because they fall below the calculated GAM of 129.13 (see Table 4)

Table 4: Effect of urban expansion on its immediate environment

	SA	A	D	SD	No of Respondent	% that agreed	% that disagreed	MWV	Rank	Remark
Sprawl development	192	170	46	10	418	86.6	13.4	138.0	1st	Accepted
Inadequate infrastructural provision	230	108	38	4	380	88.9	11.1	132.4	2nd	Accepted
Increasing crime	194	128	34	8	364	88.5	11.5	123.6	6th	Rejected
Housing shortage and increasing rent	232	98	28	6	364	90.7	9.3	129.0	3rd	Rejected
Increasing cost of land	238	86	22	10	356	91.0	9.0	126.4	4th	Rejected
Problem of waste management	222	102	24	12	360	90.0	10.0	125.4	5th	Rejected

Group Arithmetic Mean (GAM) = 129.13

Similarly, how people perceive the urban expansion as regards its effects on the provision of social infrastructures in the new area was also examined (see Table 5). Only three (3) statements have their MWV greater than the calculated GAM of 122.14. Thus, pressure on infrastructure, low productivity of the people and low standard of living were accepted as valid statements that shows the effect of urban expansion on infrastructure provision in the new area of Benin City.

Table 5: Effects of urban expansion on infrastructural

	SA	A	D	SD	No of Respondent	% that agree	% that disagree	MWV	Rank	Remark
pressure	220	150	50	18	438	84.5	15.5	144.8	1st	Accepted
Crime	158	142	42	16	358	83.8	16.2	115.8	6th	Rejected
Low productivity	182	142	34	8	366	88.5	11.5	123.0	2nd	Rejected
Slum development	138	148	52	8	346	82.7	17.3	110.8	7th	Rejected
Health hazard	204	80	52	28	364	78.0	22.0	118.8	5th	Rejected
Overcrowding	198	98	52	18	366	80.9	19.1	120.0	4th	Rejected
Low standard of living	204	106	34	24	368	84.2	15.8	122.6	3rd	Rejected

GAM = 122.14

Pipe borne water supply was chosen as example of infrastructure for consideration in other to explain this relationship between growth and infrastructure. Only 0.8 percent of the respondents agreed that they have pipe borne water. Among this 0.8 percent only 21.1 percent have adequate pipe borne water supply. In terms of reliability of supply 13.2 percent of this 0.8 percent has reliable supply of pipe borne water. Those who have pipe borne water supply are those within the core area of Benin City. 99.2 percent of the respondents who do not have access to pipe borne water supply depend on water from the private borehole owners.

Implication of the Study for Urban Managers

The implication of rapid urban expansion on the municipal Government as perceived by the respondents was also reported. The GAM of 138.27 was only valid for the 1st statement (see Table 6). The result shows that majority of the respondent believed that the Municipal Government in Benin have not been able to meet the infrastructural demand of the people living in the new area. This is true because electricity and water supply to the new areas are either non-existence or epileptic in nature. Other problems perceived by the respondents were rejected based on the fact that their MWV fell below the calculated GAM of 138.27.

Table 6: Implications of rapid urban expansion on the government

	SA	A	D	SD	No of Respondent	% that agree	% that disagree	MWV	Rank	Remark
Inability to meet infrastructural demand	308	106	40	12	466	88.8	11.2	164.2	1st	Accepted
Need for more tax	156	152	56	10	374	82.3	17.7	120.2	3rd	Rejected
Problem of ineffective management	242	100	16	4	362	94.5	5.5	130.4	2nd	Accepted

GAM = 138.27

The growth rate of urban area in Nigeria is put at 3.2 while that of population is 5.4 (both natural growth and migration) (NPC, 2008). The built-up area of Benin City is growing at the rate of 5.5 percent annually. This shows that the rate of growth of Benin City is higher than the Nigeria average urban growth put at 3.2 percent. Given this rate of growth, all things being equal it is projected that built-up area will increase to 270.03 sq km in 2015 and 321.60sq km in 2020. (See table 2) As the city is expanding in size so also the population is increasing. In like manner, demand for urban services also increased. Unfortunately, while the rate of population growth is 5.4 and Benin City population is currently 1,147,188, by the year 2015 and 2020 all things being equal Benin City population would be 1,347,001 and 1,713,327 respectively. Though it is rarely satisfactory to use past trend to judge the future especially human affairs since the conditions which gave rise to the trends are unlikely to remain the same. All the same if we relate this to growth in infrastructures, the situation will be better imagined than real. While the population and built-up area are growing rapidly the infrastructural provision is at best described as crawling and

overstretched, hence, there is need for urgent intervention by Government in the new areas of the city.

The people also perceived that ensuring compliance to urban planning law as well as acquisition of adequate, quality and current data of the people are important conditions necessary to meet urban management task (see Table 7). All other conditions which were stated in Table 7 were below the value of GAM (139.7) and so were rejected as being not important factors for urban management task purposes.

Table 7: Challenges to overcome in other to meet urban management task

	SA	A	D	SD	No of Respondent	% that agree	% that disagree	MWV	Rank	Remark
Ensuring compliance to urban planning laws	306	110	12	-	428	97.2	2.8	157.8	1st	Accepted
Acquisition of adequate, quality and current data	308	84	8	-	400	98.0	2.0	150.0	2nd	Accepted
Generation of more revenue	190	144	28	4	366	91.2	8.8	125.2	4th	Rejected
Involvement of private-public-participation	230	96	16	18	360	90.6	9.4	125.8	3rd	Rejected

GAM = 139.7

Conclusion and Recommendation

Urban growth represents specific response to economic, demographic and environmental conditions in any geographical setting. In this study, an integrated approach of remote sensing and GIS was used for the evaluation of the growth of Benin City and its impacts on its immediate environment.

The study observes that Benin City has been growing rapidly. It also observes that the major feature around which Benin is growing is along the major routes in addition to intensive use of land in the CBD and core area of Benin City. Apart from this, most of the residential buildings have been converted to commercial use in the core area thereby making the centre attractive to human and vehicular means of movement. Secondly, it observes that educational establishment is another driving force behind the growth of Benin City hence Ugbowo-Lagos road where most of the educational establishments are concentrated seems to be growing faster than other parts of the City. There is thus, the need for urban renewal strategy to manage the core areas as well as the periphery.

The population and built-up areas are growing rapidly while the rate of infrastructural provision is lagging behind. The developing areas are the worst hit while the core area suffers from overstress and dilapidation. This has implication not only on sanitary situation in the City but also on economic situation of the residents as judicious time is wasted queuing for water and repairing dilapidated infrastructures. There is also the need for intervention by Government to arrest this situation.

The study recommends that there should be regular monitoring of urban area using dynamic method such as Remote Sensing and Geographic Information System to provide current and accurate data for the urban mangers. Therefore, the urban managers should geo-informatics as a new tool for the purpose of monitoring and managing urban growth.

REFERENCES

Adeboyejo, A. T. and Abolade, O. (2006): Analysis of Spatial Changes in Ogbomoso City: *Journal of the NTP*, Vol. XIX NO 1,40th Anniversary Issue, 35-47.

Bairoch, P (1988), *Cities and Economic Development* Chicago, University of Chicago Press.

Blumenfield, H, (1965): The Urban pattern. *Annals of the American Academy of Political and Social Science.*

Dijkgraaf, C. (1987). The Urban Planet, *ITC Journal*, N03, pp 194-196

ERDAS Inc. (1994): *ERDAS Field Guild: Third Edition*. Atlanta, Georgia, ERDAS Inc.

Green, G. (1966) *Community size and Agglomeration of Trade Service and other locally oriented industries.* Washington: University St Louis.

Ikhuoria, I.A. (1984): Rapid urban growth and urban land use patterns in Benin-City, Nigeria in Sada, P.O. and Osirike, A. B. (Eds) Case studies in migration and urbanization in Nigeria: *Perspective policy Issues,* Department of geography and regional Planning, University of Benin, Benin - City.

Ikhouria, I. A. (1995) Urban Landuse Characteristics in Nigeria: A case Study of Benin, Warri, Ekpoma and Uromi, *Geocarto International* Vol. 10. Pp7 -16

Jothimani, P. (1997) *Operational Urban Sprawl monitoring using satellite Remote* Sensing: *Except from the Studies of Ahmedabad*, Vadodara and Surat, India. Urt:

Mabogunje, A. L. (1968) *Urbanization in Nigeria: London* University Press.

Mohammed, N. (2007) *Urbanization and Land use changes in Sharada and Wailari, Kano*. Paper presented at the 49th Annual National Conference of the Association of the Nigerian Geographers held at the University of Abuja, Nigeria, 15th -19th October.

N. P. C. (2008) *National Population Commission*, Abuja, Nigeria.

Ogunbodede, E. F. (2004). The Application of Regression Model on Travel Demand in Akure, Nigeria. *International Journal of Ecology and Environmental Dynamics.* Vol. 2. pp 46-62

Ogunbodede, E. F (2009) Application of Traffic Information System (TIS) to the Management of Traffic in a Medium Urban Centre: A Case Study of Akure, Nigeria. *Journal of Environmental Research and Policies*. 4 (3) 119-134

Ominu, F.G.I. (1986): The Growth of Benin and the Problem of Urban Transportation. In P. O. Sada and Makinwa P. K. (eds) *Benin: A Traditional City in Transition,* Ibadan: Heinemann Publishing Company. Ibadan.

Omuta, G. E. D. (2004): *The Good, the Bad and the Ugly: Man-Nature Interfaces.* Inaugural Lecture delivered at the University of Benin, Benin City.

Ozo. A. O. (1982). Open *Space Planning and Development,* A Paper presented at a Department Seminar, Centre for Social, Cultural and Environment Research, Benin City.

Ozo. A. O. and Ikhuoria I. (1983): Urban population growth and its spatial correlates. *Proceedings, National Seminar on Nigerian Population Dynamics.*

Sada, P.O. (1989) Migrants in Nigerian Cities with Special reference to Warri, Benin and Auchi in Sada, P. O. and Osirike, B. A. (eds). Case *Studies in migration and Urbanization in Nigeria: Perspective in Issues, pp 1-14.*

Thrall G. I, McClanahan, M and Elshaw-ThralI. S (1995) Ninety Years of Urban Growth as Described With GIS: An Historic Geography. *Geo Info system* Vol. 5, No. 4, Pp 20-24.

Tiwari, D. P. (2001) *Remote Sensing and GIS for Efficient Urban Planning.* . Map Asia Conference 2003. GISdevelopment.net

Trotter, C.M. (1991): Remotely-sensed data as an information source for geographical information systems in natural resources management a review, *International Journal of Geographical Information Systems* 5(2), 225-239.

Yang, X, Liu Z. (2005) Use of Satellite — derived Landscape Imperviousness Index to Characterize Urban Spatial Growth. *Computers, Environment and Urban systems* Vol. 29, Pp. 524 — 540.

Authors: *****Dr. Ogunbodede, Emman Funmilayo
Dept. of Geography and Planning Science
Adekunle Ajasin University
Akungba Akoko, Ondo State, Nigeria

Balogun, Toju Francis
Dept of Geography and Regional Planning
University of Benin, Benin City, Nigeria

*Corresponding author