ASSESSMENT OF THE EFFECTS OF URBANIZATION ON AGRICULTURAL LAND IN ZARIA USING REMOTE SENSING AND GIS

K. E. Oluleye [1]

[1] Department of Geography Ahmadu Bello University, Zaria

Abstract

This study assesses the effects of urban expansion on agricultural land use in Zaria using Remote Sensing and Geographic Information System (GIS). Two satellite images of two epochs were used for the study. GIS and Remote Sensing techniques were employed for the digital image analyses and interpretations while descriptive statistical techniques were used for data presentation. The result reveals a drastic reduction in the agricultural land use, being converted to residential land use. The agricultural land use which was 293.52 km^2 (62.99 %) of the total land area in 1999, reduced to 174.54 km^2 (37.45 %) in 2009. If this trend continues, it could lead to the gradual disappearance of agricultural land use with grave consequences on food security and sustainability. Recommendations to address this are that government and planners should create and protect agricultural areas the same way residential layouts are created and protected; storey buildings should be encouraged that maximize vertical space; also studies like this should be carried out regularly for continuous monitoring of land use changes in the study area. In conclusion, the study proved that the uncontrolled physical development and urban expansion have serious effects on other land uses which require a multidimensional approach.

Key words: Landcover, Landuse, Agricultural land. Remote Sensing, Thematic Mapper, Urbanization.

1. Introduction

Landuse can be defined as the total of all arrangements, activities and inputs that the people undertake on a certain landcover type while landcover, is the observed physical and biological cover of the earth surface such as vegetation, rocks, and water body or man-made features (Nyerere, 2010). Landuse is generally the use to which land is put or the various activities that land is being used for (Ojeifo, 2005). Such activities include built up areas, which covers residential use, commercial use, educational use, administrative use and so on. Agricultural use basically comprises farming and animal production. Landcover can equally be further defined as the natural features that cover the land surface. Such features as vegetations, water bodies, forest, rock outcrops, bare surface *etceteras* (Ojeifo, 2005). Changes in landuse and landcover are among the most important human alterations affecting the surface of the earth. Landuse / landcover directly affect biological diversity (Nyerere, 2010).

Agriculture, indeed farming, is a landuse activity which constitutes the principal means of livelihood of the majority of the people in Zaria (Nyerere, 2010). Any increase in residential land use would consequently reduce the available lands for farming. The rapid growth in the population of Zaria had consequently brought about urban growth. This had consequently resulted to increase in human activities on the land and changes in the landuse of Zaria. Whenever there is growth, in an area, it means that some things have changed to give way to others. When a town expands, green areas and farm lands would have to give way for new buildings and other land use types. This implies that there will be internal changes in the land use land cover pattern of the area. Adequate and up-to-date information about such changes and their effects is therefore needed for effective planning, problem solving and decision making.

There is a fast rate of urbanization in Zaria with effects and changes on the environment, most importantly, the conversion of agricultural land use to residential purposes which is quite difficult to appropriately quantify using conventional methods. It is therefore necessary to study this change using modern technique hence; this paper addresses the effects of urbanization on agricultural land use in Zaria using GIS and Remote Sensing. The study can be used to monitor the land use changes resulting from urbanization especially as it affects agricultural land use. The study will also provide up-to-date information about the land use land cover changes that occur in the study area. The specific objectives are to: (i) create landuse / landcover classification scheme for the study area, (ii) carry out change detection and change analysis of the classified satellite images of the study area, and (iii) examine the changes on agricultural land use for the specified periods

2. Materials and Methods

Both primary and secondary data were used for this work. The data used and their sources are discussed as well as the procedures for analysis. The geographical coordinates of the study area was extracted from the topographic map of Zaria, sheet 102, scale 1:100,000 second edition produced by Federal Surveys, Nigeria in 1965. The map was obtained from the map library of Department of Geography, Ahmadu Bello University Zaria. The coordinates extracted from the topographic map was then used to subset the satellite images of the study area. This was for the purpose of extracting the study area from a large scene of satellite image. Knowing the study area from the topographic map, a field survey

(reconnaissance) was then undertaken. This enabled proper acquaintance with the environment and the parameters studied. Relevant published and unpublished literature was also used for this work. These include published and unpublished materials from journals, articles, theses and books. These literatures were obtained from the Internet and library sources. Another important data acquired for this work were satellite images of the study area. The satellite images used for this work are shown in Figures 1- 2.

i. 1999 LandSat Thematic Mapper (TM) image of Zaria taken with a resolution of 30 meters.

ii. NigeriaSat-1 image of Zaria of 2009 with a resolution of 32 meters.

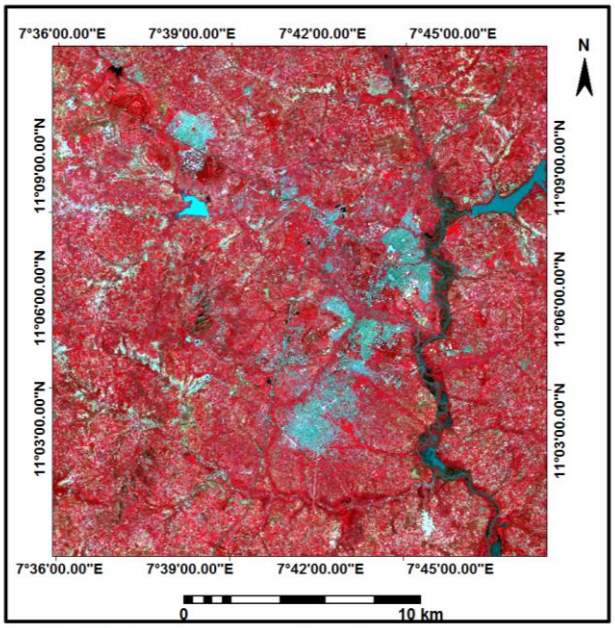

Fig. 1: 1999 LandSat ETM Image of Study Area

Source: National Center for Remote Sensing (NCRS), Jos, 2010

When images are obtained from the satellite, they are usually in raw form. That is to say, they are usually associated with some distortions which are geometric and radiometric distortions. Radiometric distortion occurs when the brightness of the pixel of the image is affected by differences between sensors or the atmosphere. While geometric distortion occurs when the pixels are of different shapes, sizes and in different places from what one would naturally assume (Jeb, 2008). These distortions have to be corrected before the images can be used. The process of doing this is referred to as image restoration and rectification (pre-processing) (Paul, 1992). However, the images used for this work were not pre-processed because the agency that provided the images had already done that. Digital image processing (DIP) technique was employed in the analysis of this work. DIP is a process of image interpretation involving the use of an electronic computer to perform feature identification, recognition and classification based on image data in digital form (John, 2000). The processes of the analysis carried out were: image sampling, image classification, change detection and change analysis (See figure 3). The image sampling was done using the landuse/ landcover classification that are commonly identified in the study area (See Table 1). During the sampling and classification, the maximum likelihood algorithm and the supervised classification techniques were used. This exercise resulted to classified maps and histograms. The histograms showed the statistical data of the changes that had taken place.

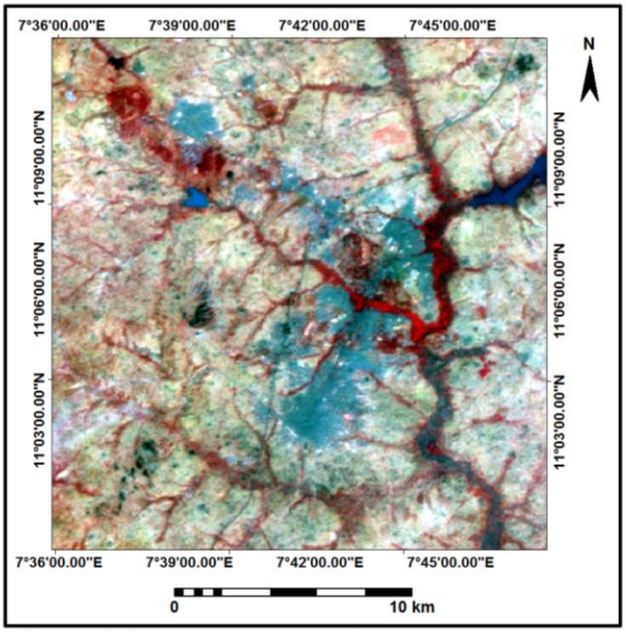

Fig. 2 : 2009 NigeriaSat1 Image of the Study Area

Source : National Center for Remote Sensing (NCRS), Jos, 2010

Table1: Classification Scheme

Code	Land use /Land cover Type	Interpretation
1	Built up	All developed lands such as: Administrative, industrial, commercial, residential and educational land uses
2	Scattered cultivation	All lands used for farming activities such as fadama and wetlands.
3	Forest s/ Plantations	All vegetations that are characterized by very big trunks, of tall trees with closed canopies i.e. thick undergrowths.
4	Bare Surface	All bare surfaces, sites of buildings under constructions, and dilapidated buildings
5	Water Bodies	All water surfaces such as: rivers, streams, dams and ponds
6	Shrub lands	All vegetations characterized by scattered and stunted vegetation of between or less than 1-2 metres without any defined single trunk (as bunches of stems).

Source: Author, 2012

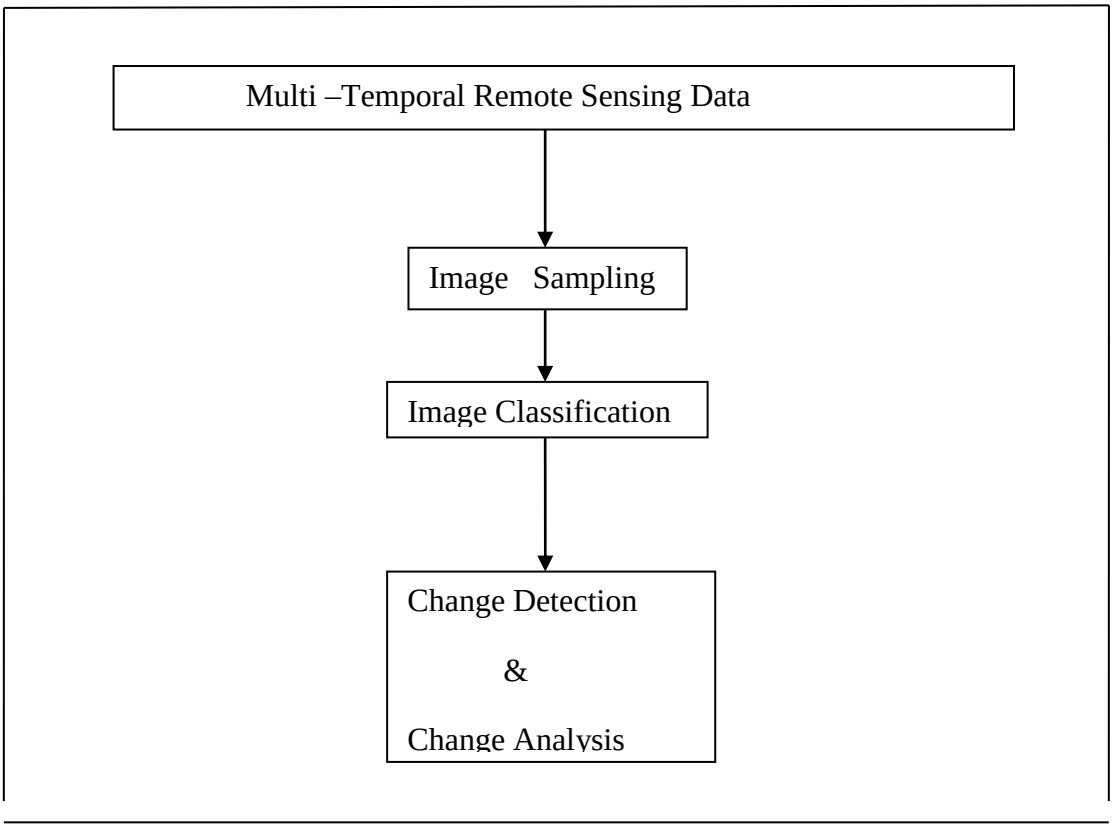

Figure 3: Procedures for Image Analyses
Source: Field Survey, 2012

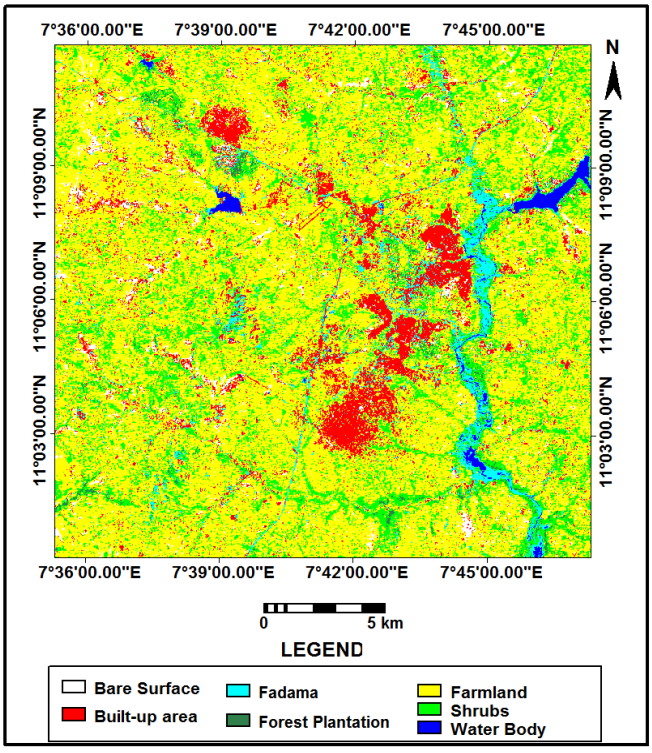

Figure 4 : Classified ETM Image of Study Area
Source: Laboratory Analysis, 2012

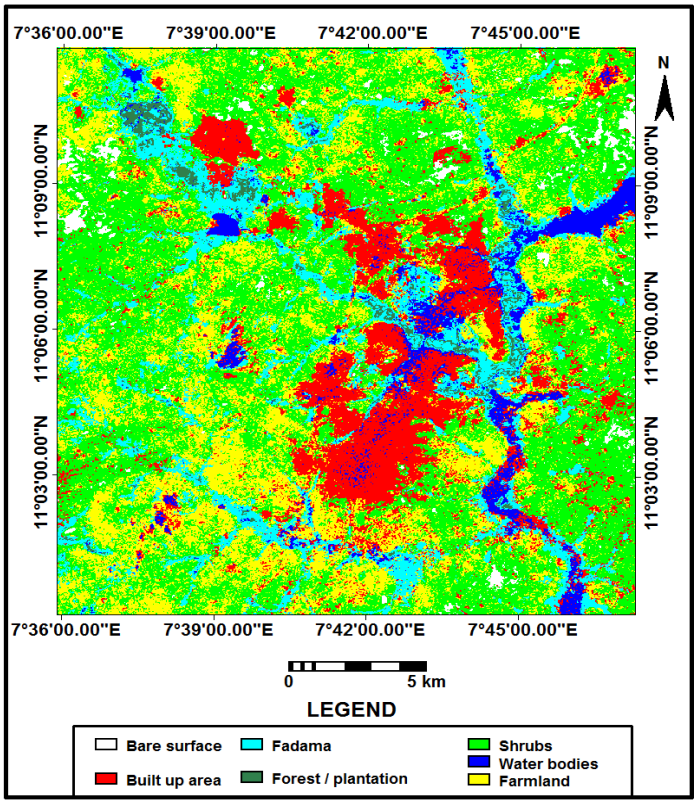

Figure 5: Classified NigeriaSat-1 Image of Study Area

Source : Laboratory Analysis, 2012

Table 2: Change detection table

LAND USE LAND COVER TYPE	ETM 1999	NIGERIA SAT-1 2009
Bare surface	14.76	8.59
Built up area	42.68	63.10
Fadama / Wetland	19.96	34.63
Forest /plantatiobn	5.57	3.66
Scattered cultivation	293.52	174.54
Shrub land	85.38	161.33
Water body	4.09	20.11
Total land area (Km^2)	465.96	465.96

Source: Laboratory analysis, 2012

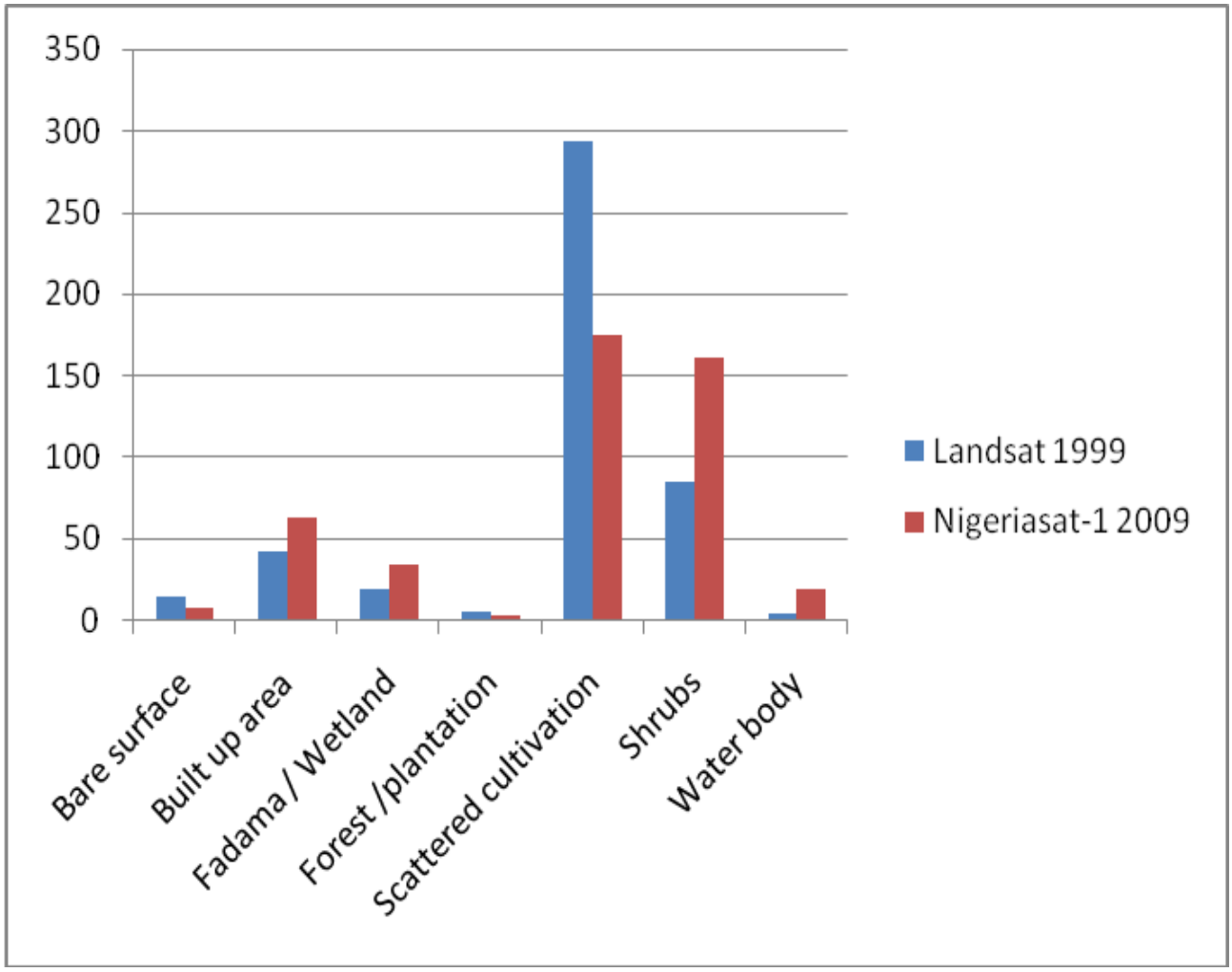

Figure 6: Comparative Histogram
Source: Laboratory analysis, 2012

3. Results and Discussion

After the classification of the images, the results were shown in figures 4 and 5, a table was then created, see table 2, the table showed the changes that occurred in the study area in a quantitative form. From the table, a change graph was created (see figure 6). This was referred to as comparative histogram. The histogram showed the change in a graphical form. From table 2 and figure 6, the drastic reduction of cultivated land from 293.52 km^2 in 1999 to 174.54 km^2 in 2009 became clearer. The result showed that in 1999, the cultivated land was 62.99 % of the total land area. But by 2009, this percentage had reduced to 37.45 % of the total land area.

This also implies that food production is most likely to reduce by the same percentage. This situation may likely get worse because the population is increasing daily so also the continuous conversion of agricultural land use to residential land use continues. The main reason for this change is the increase in the population of Zaria. From the provisional result of the 2006 census as given by National Population Commission (NPC) the population of Zaria as at 2006 was 695,069. This increased to about a million in 2009 (Oluleye, 2011). This increase had led to high demand for accommodation; this invariably had made the lease of houses for residential purposes a lucrative business in the study area. Hence the rich are

out to purchase all available lands for building purposes. This had led to the drastic conversion of agricultural land use to residential land use. Secondly, the relative peace that was enjoyed in Zaria within the period in consideration (1999 – 2009) had really encouraged most Zaria settlers especially civil servants and retired civil servants to have desire for their personal houses. This also resulted to the purchase of most agricultural lands in Zaria for the purpose of converting them to residential land uses. Beside this change, other changes showed in the result were increase in fadama/wetland from 19.96 Km^2 in 1999 to 34.63 Km^2 in 2009.

The water body also increased from 4.09 Km^2 in 1999 to 20.11 Km^2 in 2009. This was as a result of higher rain fall in 2009 when compared with the 1999 rain. From the 2012 record of Nigerian Meteorological Service (NIMET), the annual rainfall of Zaria in 1999 was 754.30mm. This increased to about 1,165.9mm in 2009. This was also why the bare surface reduced from 14.76 Km^2 in 1999 to 8.59 Km^2 in 2009 and the shrubs increased from 85.38 Km^2 in 1999 to 161.33 Km^2 in 2009. Another reason for this was also the fact that the 2009 NigeriaSat1 image used for the study was taken in October, 2009. At this period in Zaria, the rainy season had barely stopped, so there was still much water and wet lands around. While the ETM image of 1999 was taken in the month of November which was during the dry season and so there were more bare surfaces than the 2009 image.

4. Recommendations

One of the ways of achieving development is through food security and sustainability. But this cannot be achieved when agricultural land use is been converted to residential land use. In order to solve this problem therefore, the following recommendations are made:

(i) Government should create layouts as reserve lands for agricultural purposes and such layouts should be protected just as forest reserves areas are protected.

(ii) Government should restrict the conversion of fadama lands for residential purposes.
This will allow agricultural activities to continue all year round in such places and also reduce the rate of conversion of the agricultural land for residential use.

(iii) Studies like this should be carried out on a regular basis so that the land use changes
can be monitored.

5. Conclusion

The period under study was 10 years, and within this period, we had a drastic change of the agricultural land use reducing from 62.99 % in 1999 to 37.45 % in 2009. This change was due to urban growth resulting from population increase in the study area. As the population was increasing, so also urban expansion was taken place and consequently, high demand for land for residential use. This situation led to the conversion of agricultural land use to residential land use. Given another 10 years from 2009, one can imagine the change that could occur and the effect this change would bring to farming activities in the study area. This study has shown therefore that with time, agricultural land use may likely disappear in Zaria. If this happens, it then means that the major source of livelihood of the people is gone. This will eventually translate to food scarcity, high cost of living, unemployment and increase in poverty. All these put together, will lower the standard of living of the people.

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INFORMAL SOLID WASTE MANAGEMENT AND LIVELIHOOD DIVERSIFICATION IN ZARIA, NIGERIA

J.E. Ukoje[1]

[1] Department of Urban and Regional Planning, Ahmadu Bello University, Zaria

Abstract

Informal solid waste management is associated with the activities of scavengers, waste collectors and pickers, middlemen and processors of mixed waste in the urban areas. The operators engage in these activities to generate employment and income for sustenance. The paper examines the contributions of informal solid waste management to livelihoods of the urban poor in Zaria. Based on the examination of the structure and socioeconomic aspects of solid waste activities, the paper identifies the potentials and challenges of the operators. The paper utilised data collected using questionnaire survey on the operators to collect base line information in order to establish indicators for the study. The principal finding is that apart from the scavengers, all the operators earn income that compares favourably with wages for formal sector employees. As much as 81 percent of middlemen and 75 percent of the reuse and recycling operators earn more than ₦15 000 per month. In addition, the sector has potentials to absorbing low skilled labour as operators require little formal training to undertake the activities. Because of these, the paper advocated for intervention of governments, non-governmental and civil society organisations for raising the productivity of the operators, training and organising cooperative activities to enhance their income.

***Keywords*:** Informal solid waste management, Livelihoods, Scavengers, Recycling, Reuse, Middlemen.

1. Introduction

Informal solid waste management (SWM) has been expanding in recent decades in Nigeria. According to Meagher and Yunusa (1996) and Ahonsi (2002) the economic downturn in Nigeria which followed the introduction of Structural Adjustment Programme (SAP) loosens state control over certain municipal services such as waste collection and others. This provided opportunities for a great number of urban dwellers to obtain livelihood opportunities by engaging in these areas underserved by government. In the context of municipal solid waste management (MSWM), the informal sector refers to the waste collection and recycling activities of scavengers, waste collectors and pickers, middlemen and the processors (Bernstein, 2004). These terms are used to describe those involved in the extraction of recyclable and reusable materials from mixed waste (Wilson, et al, 2005).

Generally, in developing countries, the rapid rates of urban growth experienced, increasing poverty, inadequate public services, and a generally low-skilled labour force have made urbanites to increasingly rely on informal means of income earning. With respect to SWM in Nigeria, unreliable services in waste collection and disposal make refuse to be readily available for the informal sector waste managers. For many people within the urban context it is a means of employment for the unemployed. Many authors have celebrated the role of this sector in the achievement of one of the inns of modern waste management-that is, to move up the waste hierarchy by reducing the reliance on disposal through recycling (Wilson et al, 2005; Ahmed and Ali, 2004).

The significance of these developments have generated advocacy by scholars and policy makers for adoption of informal SWM for poverty alleviation in urban areas and the integration of informal with the formal SWM system. This provides the perspective for this study. Given the potentials of the informal solid waste activities shown above, it is imperative to examine the ability of the sector to deliver a means of livelihood for the urban poor in Zaria. This paper seeks to establish the structure of informal SWM and its impact on income, the challenges the operators face and how this can be addressed.

Since the early 2000, increased attention is being paid to the livelihood of households, especially poor households in middle-and low-income countries. The position stem from the recognition that few rural or urban households in these countries rely on a single income generating activity to support themselves (Rakodi, 2002; Phillips, 2002). Drawing from Chambers and Conway (1992), a livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living (Carney, 1998. p. 4). As Rakodi (2002) explains, households construct their livelihood both on the basis of the assets which are available to them and within a broader socio-economic and physical context.

Central to understanding the livelihood of the poor is the need to recognise that assets of the poor may not be in cash or other savings, but other materials or non-materials assets like their health, labour, knowledge and skill, friends and family and the natural resources around them (Rakodi, 2002; Moser, 1998). At the household, community and societal levels, the assets available are said to constitute a stock of capital (Narayan and Pritchett, 1999). These capitals which could be human, social, political, physical, financial and natural can be put to work to generate a flow of income or other benefits. In this regard, waste materials become resources as they are scavenged reused and recycled by urban dwellers. The capitals or assets are influenced by the context which is related to the sources of insecurity to which poor people and their assets are vulnerable to (Rakodi, 2002; Meikle, 2002). Access to and uses of assets are said to be influenced by policies, organisations and relationships between individuals and

organisations. The survival strategies which individuals and households adopt for support to overcome crisis or shock produce outcomes and protect their well-being (Rakodi, 2002; Moser, 1998). Solid waste management has thus become a part-time or full-time means of livelihood for many people in Zaria and the processes through which these are negotiated are the focus of this paper.

2. Materials and Methods

The data for this paper were based on both available literature on the informal SWM and the author's fieldwork conducted between 2010 and 2011. Detailed reports on participation of stakeholders in SWM, informal solid waste collection and recycling in Zaria have been discussed elsewhere (Ukoje, 2011; Ukoje, 2012). The survey involved administration of questionnaire on the three categories of informal SW operators from all the neighbourhoods in Zaria. To generate data for this study, purposive sampling of each category of informal solid waste activity was undertaken. From these, 25 percent of the population was sampled for adequate representation. Altogether, 320 respondents, constituting 224 scavengers, 64 junkshop/middlemen and 32 reuse and recycling operators were randomly selected as sample. The questionnaire included information on the activities of the informal SW operators, their capabilities, assets and strategies used to overcome factors which influence the operation of their enterprises. Governments officials connected to SWM were also interviewed. The data were analysed using descriptive statistics (frequencies and percentages).

3. Results and discussion

3.1. Category and functions of participants in informal solid waste activities in Zaria

Several informal SW stakeholders are involved in waste collection, storage, recycling and processing chain in Zaria. These activities all fall neatly into three main categories, namely, waste picking (scavenging), waste storage/junkshops/ middlemen and, reuse and recycling industry. In several cases, there is more than one type of activities in one category (Table 1).

Scavengers constitute 70% of the operators. These are itinerant waste buyers, waste pickers from the streets and dumps, and direct waste collectors, who play important roles of selective waste collection and separation. This category of informal SW activities is associated with recovery of recyclable materials from streets, waste bins, containers, communal collection sites, vacant lots and final disposal sites. Recovered materials are usually sold to dealers, and thereby indirectly providing local industries with secondary raw materials.

Table 1: Functions of Informal Solid Waste Activities.

Activity	Number	Percentage	Functions
Waste Scavenging	224	70	Recovery of materials, provision of secondary raw materials.
Junk shops/middle men	64	20	Waste storage, sorting and separation. Compacting.
Reuse and Recycling	32	10	Utilise recovered materials as feedstock. Provide cheap products.
Total	320	100	

Source: Field Survey 2011

The data also indicate that 20% of the sample is in the waste storage/middlemen category. These operate junkshops on small or large scale basis and undertake sorting, temporary storage and compacting of selected waste materials from waste pickers. Data obtained for this study indicates specialisation in the items collection by the junkshop owners who act as dealers for the materials. While some of the junkshops deal with plastics and bottles, the majority deal with metals which comprise aluminium, car parts, irons etc. In their operations, the dealers sort and separate waste into their component parts. By sorting and separation, junkshop owners add value to the waste. Some of the dealers compact the products to change the shape and reduce the volume of the materials for ease in handling and transportation. This category serves as intermediary between waste pickers and reuse and recycling industries.

Only 10% of the operators undertake reuse and recycling activities. This group utilise the materials of the first two categories for reuse trade and as feed stock for manufacturing. The recycled products from their activities are cheaper than the ones manufactured in modern industries. Their products include pots, buckets, cups, etc which are utilised in virtually every home in Zaria.

Generally, the activities of informal SWM provide clear economical and environmental benefits to the city through providing and recycling secondary raw materials. The widespread nature of informal SWM throughout urban areas of developing world provide livelihood to so many households (Medina, 2000). In addition, the sector performs important roles in the reduction of the cost of waste disposal and environmental problems of uncollected waste.

3.2. Socio-economic characteristics of participants in informal solid waste management

Informal SWM are undertaken by both the young and the old, but unlike the findings by Abdoul (2002) women do not operate in the last two categories in Zaria. This paper only considered those who are owners of the operation and does not take into account help from family members. In this survey however, 68 percent of the respondents in scavenging trade are children while 32 percent are above 18 years of age (Table 2). All the operators in the intermediate and recycling activities are adults. Here, a kernel of industrialisation exists in the hand-fabrication of pots, buckets, baking trays and so forth.

Table 2: Socio-economic characteristics of participants in informal solid waste activities in Zaria

Aspects	Characteristics	No of Respondents (n=320)			Percentage (100)		
		Scavenging	Intermediate Dealers	Reuse and Recycling	Scavenging	Intermediate Dealers	Reuse and Recycling
Age	< 18 years > 18 years	152 72	64	32	68 32	- 100	- 100
Educational Level	Primary Secondary Tertiary Not Literate	16 - - 208	18 4 - 42	12 4 - 16	7 - - 93	28 6 - 66	36 13 - 51
Average \Monthly Income (₦)	< 7000 7001-11000 11001-15000 15001-20000 > 20000	224 - - - -	- 4 8 19 33	- 2 6 11 13	100 - - - -	- 6 13 30 51	- 7 18 33 42

Source: Field Survey (2010/2011)

One of the findings of this study is the low level of education of participants in the sector. The respondents in the waste picking category are the least educated as only 7 percent have primary education and 93 percent do not have formal education at all. The most educated groups are in the reuse and recycling operation with 36 percent and 13 percent having primary and secondary education respectively. To operate informal SW activities do not require much formal education (Wilson, et al 2005) except the recycling aspect, but all the operators need to acquire the skills for the activities they undertake. All the fabricators, foundries, etc were once apprentices in the activities they now undertake. This result does not suggest that formal training is useless but rather indicate its limited usability outside the formal sector, necessitating informal retraining for operators in the sector.

An important finding of this study is the level of income earned by informal SWM enterprises. Informal sector has generally been considered to earn marginal income compared to the income from the formal sector (Meagher and Yunusa, 1996; Abdoul, 2002). However, this study revealed that operators are able to make substantial amount of income from their activities. All the waste pickers earn less than ₦7,000 per month while 6 percent and 7 percent of the intermediate dealers and recyclers earn about ₦7,000 and ₦11,000 respectively. The highest levels of income are earned by the last two categories where 51% and 42% of the middlemen and reuse and recycling trade have incomes of more than ₦20,000. The income compare favourably with wages for formal sector employees at their level of training. For instance, the minimum monthly income in the civil service is ₦18,000. The incomes derived are considered to be adequate for meeting the needs of the family by most of the participants. The highlighted favourable level of income obtainable from informal SWM notwithstanding, the operators fare differently and undertake several activities to produce favourable outcome..

3.3. The structure of informal solid waste activities in Zaria

The structure of the informal SWM in Zaria portrays the drive for survival among the practitioners. Income earning abilities of the informal SW operators are not even, as there are differences in the level of income based on the type of activities undertaken. The way informal SW operators are organised has important consequences for income generation. The less organised the operation is, the less the people involved are capable of earning enough income, and more vulnerable to exploitation by intermediate dealers. The waste trade network takes the form of a hierarchy (Wilson, et al, 2005). The higher a secondary raw material is traded, the greater the added values it possesses.

Waste picking tend to occupy the base of the secondary raw material trade hierarchy (fig 1). Usually the collected materials by the waste pickers are traded locally to refuse shops, local industries, craftsmen and artisans through a chain of intermediate dealers. Possible end users are local industries including craftsmen and artisans. Scavengers and waste pickers are the most vulnerable category of the waste trade as they do not have an organised supportive network. They have limited capacity for processing or sorting materials and are easily exploited. Those involved are vulnerable individuals such as children, women and the elderly. From the findings of the study the price waste pickers get on a product is about half of the price traded by middlemen. To maximise profit, waste pickers tend to boycott intermediate dealers and sell directly to end users. In addition, value added activities through; sorting, cleaning, pre-processing and storage to obtain large volume of the raw materials enable the operators to increase their profit margin.

The middlemen and craftsmen occupy an intermediate position in the hierarchy and serves as linkage exist between scavengers and end-users. The category may contain dealers, recycling operators, junkshops, intermediate processors and wholesalers. This involve groups that undertake a range of value added activities like sorting, cleaning, pre-processing, changing shape of materials to facilitate ease of transport and storage to aggregate large volume of raw materials into commercially viable quantity. Junkshops are able to provide a steady supply of secondary raw materials for the end users while craftsmen provide low cost, affordable products from recycled materials.

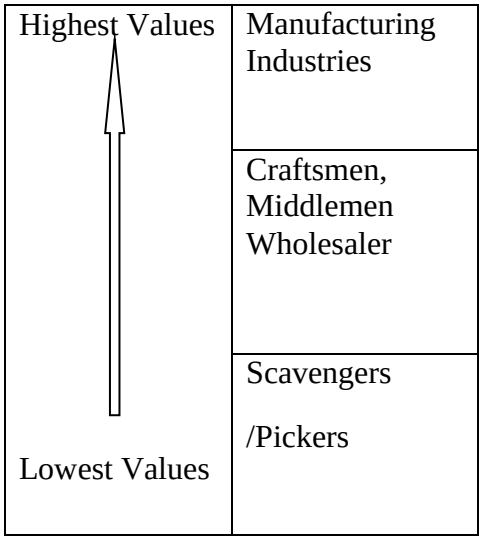

Fig 1. Hierarchy of Informal Solid Waste Management Operators

Source: Field Survey, 2012

At the top of the waste trade are the manufacturing industries with a strong dependency on secondary materials. These industries are essentially outside the study area and include such towns as Kano, Lagos, Aba and Ibadan. These are mainly formal industries which have direct link with the intermediate category. These converts the secondary materials into finished goods with high profit margin.

3.4. Challenges faced by informal solid waste management operators

Studies by Haan, et al (1998), Scheinberg (2001:525), ILO (2004:20) and Bernstien (2004:126) have indicated the problems that informal SWM operators encounter in their operational activities. The findings of this study seem to support this view. Operators have a set of the following difficulties which they struggle with to stay within the informal SWM.

3.4.1 Limited start-up capital and credit facilities

The cost of starting up an informal SWM operation, particularly, the intermediate junkshop and recycling industry is high. While the waste pickers require very little capital, the recyclers and middlemen claimed that between ₦50,000 and ₦100,000 is required to acquire basic equipment. Some of the junkshop owners pay about ₦20,000 per annum for renting of premises. The survey shows that the costs of starting up the operation are beyond the means of some of the respondents. Initial capital outlay by the respondents was obtained from personal savings, friends or relatives. In the sample, 63 percent of the operators claimed they

got their start-up capital from their personal savings, 31 percent from relatives and 6 percent from friends. None of the respondents got credit facilities from financial institutions.

Limited start-up capital and credit facilities explain why these activities are small scale and the activities are undertaken in the open and dilapidated buildings. In fact, the respondents are not willing to take up loan from financial institutions because of the conditionality for accessing loan from formal financial institutions.

3.4.2 Cost of inputs

Another challenge for the informal sector solid waste recycling industries is the capital to buy inputs. Locally inputs are bought in small quantities due to limited financial resources at their disposal of operators. The cost of raw materials in Kaduna and Abuja are relatively lower and cheaper in bulk purchase. As claimed by respondents, while scrap aluminium cost ₦150 per feet locally, buying in bulk from Kaduna, Abuja and southern part of Nigeria is cheaper by 25 percent. While 56% of the reuse and recycling operators identify input as a significant part of their cost of production, lack of access to credit facilities serve as a hindrance to their cutting down the cost of production and the ultimate potential profit margin that could accrue.

3.4.3 Erratic and insufficient physical infrastructure

High cost of urban utilities is frequently cited as constituting problems for informal activities (Kazimbaya-Senkwe, 2004). Even though middlemen and recyclers pay between ₦2,500-₦3,000 annually as taxes to local governments, urban utilities are increasingly been unable to maintain or expand physical infrastructure such as water and road to them. Respondents operating the junkshops complained of erratic water supply for their cleaning operation. They therefore resorted to water vendors to bring water for them from commercial wells and boreholes. Electricity bills and rents have risen and for most respondents, landlords now demand for 12 months payment in advance. To cope, operators resort to squatting on open spaces within self erected shades and ramshackle structures. This tends to create tension between the operators and local government officials who are concerned about maintaining aesthetic environment.

3.4.4 Limited Organisation

Membership of trade organisations are noted by Ahonsi (2002:145) and Adetula (2002:372) as coping strategies for informal sector which confer on members ability to adapt to social and institutional constraints (Abdoul, 2002). However, apart from junk shop owners and recyclers who are members of Yan Gwangwan and Yan Tinka organisations respectively, there is no evidence of trade organisations among the waste pickers. Throughout Zaria, none of the waste pickers sampled belonged to any union while 84% of the junkshop owners and 91% of the recyclers participate in trade organisations.

Even for the groups with trade organisation, the unions are not concerned with business-related issues such as buying raw materials in bulk, providing direct support such as funds and training programmes, instead the existing organisations .only resolve conflicts and maintain peace among members. At the time the union of recyclers was given financial aid by the Government of Kaduna State under Governor Makarfi, the organisation was not able to utilise the fund for the needs of members. Even though some respondents claimed to have received a loan advance from their union to upgrade their trade, about 21% of them confessed that the capital at the disposal of the union was too little to meet their needs.

Some of the older recyclers and their apprentices have expressed a strong willingness to work through their association to establish a waste recycling plant so as to reduce their dependence on middlemen and therefore expand their profit margins.

4. Recommendations

The paper examined the contributions of informal SWM to livelihoods of urban dwellers in Zaria, the income and employment generation and the functions towards raw materials provision for the manufacturing industries. The findings show adequate level of income generation for operators, significant potentials for employment of low skilled labour and children. However, the operators are found to encounter so many difficulties that need to be addressed.

To minimise some of these challenges and increase the benefits by extension means that governments, NGOs and others need to address the needs of the operators along many fronts. These will involve technical solutions to raise productivity of scavengers and waste pickers. This can be done through vocational and skill training to enhance their employment options, assistance to help them start and operate recycling enterprises and with organising cooperatives to strengthen their bargaining position with middlemen.

Also for the fact that middlemen and recyclers lack access to financial support necessitated the small scale nature of the operations. Unless they can access funds to invest in their operations, their businesses are not likely to expand. The importance of relaxing the conditionality for accessing credit facilities from formal banking institutions and organising viable unions to champion the course of members cannot be over-emphasised.

5. Conclusion

This study of the informal SWM in the livelihood of urban poor in Zaria has shown a combination of processes at work. The economic recession in Nigeria and a general low level of urban employment force a large number of the population to rely on informal means of income earning. The ready availability of SW associated with insufficient collection and disposal, present an opportunity to earn income for survival by the unemployed. Even though the sector has demonstrated great potentials for employment generation for low skilled labour and reduction in cost of waste disposal and environmental problems, urban planners and managers have not paid attention to the sector. Government is required to take necessary measures to address the needs of the operators as experiences in many African countries have shown it is easy to upgrade the income of operators. Several approaches are available that can be undertaken by governments, NGOs and civil society organisations to address the needs of the informal SWM. In Zaria this should involve measures to raise the productivity of the operators, provide training opportunities to enhance their employment options outside the waste trade, relaxing difficulties to accessing credit facilities, and help with organising cooperatives.

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TIME SERIES PREDICTION OF WEATHER VARIABLES AND RAINFALL FORECASTING USING THE FUZZY LOGIC BASED RAIN FORECAST MODEL

M. B. Mu'azu[1] and B. G. Bajoga[1]

[1]Department of Electrical and Computer Engineering, Ahmadu Bello University, Zaria

Absract

The Neuro-Fuzzy System developed using the Soft Computing technique of Neuro-Fuzzy is implemented as a pure Fuzzy Logic System as the Rain Forecast Model (RFM). The Rain Forecast Model (RFM) used as its inputs the weather variables: Relative Humidity, Wind Direction, and Wind Speed (from 1993 to 2002) and in order to forecast into the future (2003 to 2010), these weather variables were determined using a hybrid statistical technique comprising of Moving Averages and Exponential Smoothing. Two statistical tests (Root Mean Squared Error (RMSE) and Correlation Factor (R)) were carried out in order to measure the performance of the developed model with the validation data and with the forecasted weather variables. The developed model, using the validation data of 2003 to 2005, produced the following performance results: RMSE=28.02 and R=0.97. This formed the basis for comparing the performance of the developed model when subjected to the forecasted weather variables (2003 to 2010). The performance function results obtained were: RMSE=54.99 and R=0.88**.** Considering the nature of the problem, that is the unpredictability of rainfall, these are reasonable results.

Keywords: Soft Computing, Rain Forecast Model, Rainfall, Wind speed, Wind direction, Relative Humidity

1. Introduction

Weather forecast in general and rainfall forecast in particular, especially on the long term, is a difficult task considering its extreme variability. A number of possible interactions within the atmosphere and between the atmosphere and other influences make it impossible to make long-range forecasts with the same degree of accuracy as short-range forecasts. The root of this problem is referred to as 'Chaos'. This chaotic effect, also called the "butterfly effect" was first described by Edward Lorenz, a meteorologist working at the Massachusetts Institute of Technology, and has become a field of study in its own right (Mu'azu, 2006).

Rainfall is governed by the interaction of the moist tropical maritime air mass and the dry, cool tropical continental air mass. Air mass is defined as a large uniform (with respect to temperature and water vapour) body of air within the atmosphere. Rainfall is characterized by its extreme variability, both of intensity and duration with a temporal and spatial pattern. The characteristic and intensity of the prevailing weather conditions are determined by the surface location of the moisture boundary zone separating the two air masses. The boundary is known as Inter Tropical Divergence (ITD). It is the location of a place in relation to the position of the Inter Tropical divergence (ITD) that determines its weather situation (Mu'azu, 2006).

Rain is one of nature's greatest gifts and is very vital to the agricultural economies and food security of developing countries like Nigeria and also sustenance of the environment. In Nigeria, rainfall determines the zonal pattern of crops and the seasonal activities of farmers. It is then important that rainfall trends be identified as any unforeseen deviations can cause unwanted disruptions. This has assumed an even greater importance due to the threats posed by global warming and greenhouse effect (Mu'azu, 2006).

This work is aimed at the development of a Neuro-Fuzzy based Rain Forecast Model (RFM) and time series forecasting of weather variables using Zaria as a case study. A Neuro-Fuzzy System is an amalgamation of the soft computing techniques of neural nets (with their learning capabilities) and fuzzy logic (with their knowledge base and transparency). It, therefore, combines the advantages of fuzzy logic systems, which deal with explicit knowledge that can be explained and understood, and neural nets, which deal with implicit knowledge, which can be acquired by learning. The objective then is to develop a data driven method using the soft computing technique of Neuro-Fuzzy to forecast the rainfall using the following weather variables: Relative Humidity, Wind Direction and Wind Speed. The Neuro-Fuzzy System developed is implemented (using the fuzzy technology language (FTL)) as a pure fuzzy logic system as the Rain Forecast Model (RFM). In order to forecast into the future, these weather variables are forecasted using a hybrid statistical technique comprising of moving averages and exponential smoothing. The forecast period is between 2003 and 2010.

A time series is a set of observations of a variable at regular intervals over time. A basic requirement for time series is that the data be displayed in the order in which they occurred, since it is possible that successive observations may probably be dependent (Rojas and Pomares, 2004, Monks, 1996). According to Rojas and Pomares (2004)**,** the challenge of predicting future values of a time series spans a variety of disciplines and as such time series techniques find application in such diverse data sets as equity market prices, disease control, meteorological measurements, astronomic observations, etc. Typical statistical time series techniques include simple moving averages and exponential smoothing. According to Easton and McColl (1997) and Roberts (2004), a moving average is a form of average which has been adjusted to allow for seasonal or cyclical components of a time series

while exponential smoothing is used to reduce irregularities in the time series data thus providing a means of predicting future values of the time series.

Time series prediction is basically a modeling problem, which can better be solved using Soft Computing techniques. This is because it is possible that the underlying relationship between the data may not be known. The first step in the solution is establishing a non-linear mapping between inputs and outputs, after which the model can be used to predict future values based on past and present observations.

2. Study Area

Zaria is located within the Sudan Savannah zone lying on a plateau of about 670.56m above sea level and on latitude 11°8′N and longitude 7°41′E. It lies within a region with distinct dry and wet seasons, which are influenced by two distinct air masses. The wet season occurs in the high sun period and is dominated by the South-West winds coming in around April or May and lasting till around October. About 65% of the rains occur between July and September. The dry season lasts between November and March and is practically rainless. The months of December to February, the harmattan season, are usually cold and dry due to the influence of the continental air mass (dry-dusty wind) from the desert regions of North Africa (Grodsky and Carton, 2002, Mu'azu, 2006)

3. Materials and Methods

4.

Using weather variables (Wind Direction, Wind Speed and Relative Humidity) collected from the Nigeria Meteorological Agency (NIMET), Zaria and the Meteorological Unit of the Department of Soil Science, Ahmadu Bello University, Zaria on a monthly average basis over a thirteen- (13) year period (1993 – 2005), a rainfall prediction model is to be developed. Data from 1993 to 2002 is used as the training set whilst the data from 2003 to 2005 is used as the validation data. However, since the exact relationships between these variables are not known, data driven methods are more suitable in developing the prediction model. These methods perform a kind of function fitting by using multiple parameters on the existing information in order to predict the possible relationships in the near future.

The overall methodology adopted in carrying out this investigation involves the following:

i) Data training and development of the Neuro-Fuzzy System using the fuzzyTECH Neuro-Fuzzy module.
ii) Implementation as a pure fuzzy logic system using the Fuzzy Technology Language (FTL) resulting in the development of the Rain Forecast Model (RFM).
iii) Validation of the Rain Forecast Model (RFM) using the validation data.
iv) The weather variables, relative humidity, wind direction and wind speed are forecasted using the time series techniques of simple moving averagesand exponential smoothing. The forecasted values are used to forecast for the rainfall using the Rain Forecast Model (RFM) developed in i) – ii)

The methodology adopted in data training and in developing the Neuro-Fuzzy System using the fuzzyTECH Neuro-Fuzzy module involves the following:

i) Obtain training sample data. The weather data used in this work were obtained from the Nigeria Meteorological Agency (NIMET), Zaria and the Meteorological Unit of the Department of Soil Science, Ahmadu Bello University, Zaria for the period, 1993 – 2005. The data for 1993 – 2002 is used as the test data while that of 2003 – 2005 is used as the validation data.

ii) Cluster the sample data (if necessary). The data obtained may have to be pre-processed to remove redundant data and to resolve conflicts in the data.

iii) Create an empty Fuzzy Logic System i.e. the rule set will have all rules with DoS (Degree of Support) = 0. This means the rule set is COMPLETE but FALSE**;** this is required as Neuro-Fuzzy training can only start with an existing rule set. A DoS value gives the weight for each value to be used in the rule aggregation step of fuzzy inference. The value is between 0 and 1.

iv) Collection of expert knowledge about the process and entering all existing knowledge (if any) in the solution.

v) Selection of the components of the Fuzzy Logic System to be trained. All or specific components can be opened for learning.

vi) Configuring the Neuro-Fuzzy module by specifying the LEARNING METHOD and setting parameters for it. The learning method can be any of **RealMethod, RandomMethod, Batch_Learn** and **Batch_Random.**

vii) Train with the sample data to learn parameters of the Fuzzy System.

viii) Evaluate system performance and validation of results. This is accomplished by testing trained system with sample **test data.** This will help in minimizing the occurrence of "**over training".**

ix) Manual optimization using an interactive approach with the aid of the watch window to eliminate functionally redundant or unnecessary rules**..**

The result of the Neuro-Fuzzy Module training is a 'pure' Fuzzy Logic System, which, can be, implemented on computers, microcontrollers or industrial controllers (Inform GmbH, 2001). The 'pure' fuzzy logic system developed for this work, named the Rain Forecast Model (RFM), is implemented using the Fuzzy Technology Language (FTL).

3.1 Rain Forecast Model

The Fuzzy Technology Language (FTL) is a hardware and vendor independent description language for Fuzzy Logic Systems with definition formats and no loops and branches. Such chip manufacturers as Intel, SGS-Thomson, Siemens, Texas Instruments, Microchip, etc support the Fuzzy Technology Language (FTL). The Fuzzy Technology Language (FTL) consists basically of two entities:

i) **Objects:** Each object consists of an object name and an object body in **"{ }".** Within an object body, other objects and slots can be defined.

ii) **Slots:** A slot consists of a slot name to the left of an **"="** and a value for the slot to the right.

Comments are put into **"/* … */"** marks (Von Altrock, 1995).

The general flow of the Rainfall Forecast Model using the Fuzzy Technology Language (FTL) is described as follows:

PROJECT{
/*Main section for project data*/

SHELLOPTIONS{
/*Section containing terminal configurations for the project*/

}/* SHELLOPTIONS**/

MODEL{

/*Section containing the entire model definitions (Variable and Object Section)*/

VARIABLE_SECTION{

/*Section containing all definitions of linguistic variables*/

LVAR{

TERM{

}/*TERM*/

}/*LVAR*/

}/*VARIABLE SECTION*/

OBJECT_SECTION{

/*Section containing all structural elements of a Fuzzy Logic System*/

RULEBLOCK{

RULES{

}/*RULES*/

}/*RULEBLOCK*/

}/*OBJECT SECTION*/

}/*MODEL*/

}/*PROJECT*/

The Rain Forecast Model is shown in Figure 1

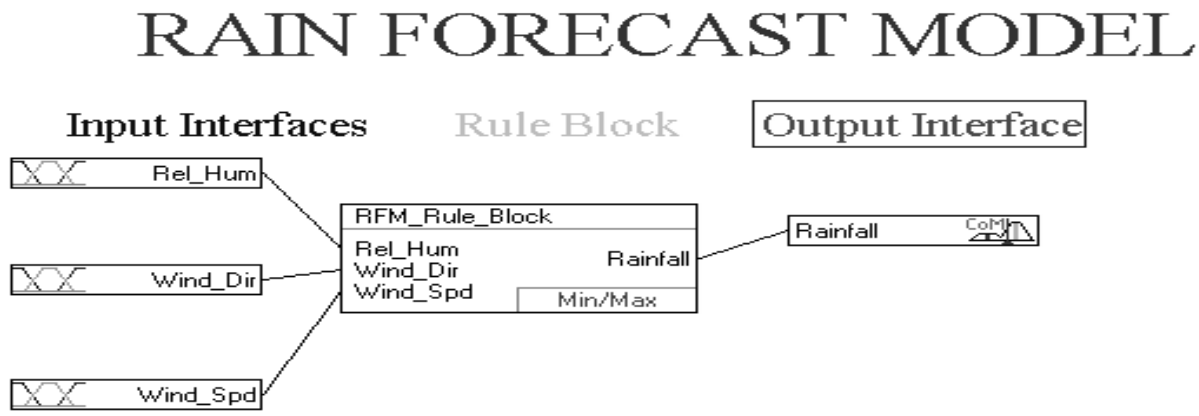

Figure 1: Structure of the Rain Forecast Model Fuzzy Logic System

Time Series Analysis

Time series analysis relies, at least in part, on understanding or exploiting the dependence among the observations. Because of this reliance, the goal of time series prediction can, therefore, be stated thus: Given a sequence up to time t, $x(1), x(2), \ldots, x(t)$, find the continuation $x(t+1), x(t+2), \ldots$ (Rojas and Pomares, 2004). The method to be employed in finding this continuation is a hybrid of the simple moving averages method and that of exponential smoothing.

3.2 Simple Moving Averages

The basic components of a time series are:

i) TREND, which is the underlying direction (upward or downward tendency) and rate of change in a time series, when allowance has been made for the other components.
ii) SEASONAL EFFECTS, which describe similar variations occurring during corresponding periods.
iii) CYCLICAL FACTORS, which describe any regular fluctuations.

The simple moving averages method is a smoothing technique that uses a type of average that is adjusted to allow for seasonal or cyclical components of a time series and which helps make the long term trends clearer (Monks, 1996, Roberts, 2004).

In the simple moving average method, only the **n** most recent periods of data points need to be maintained. At the end of each period, the oldest period's data is discarded and the newest period's data is added to the database. The database is then divided by **n** and used as a forecast for the next period (Monks, 1996, Roberts, 2004).

In order to determine the moving average $x(t+1)$ for a period $(t+1)$, the following expression is used:

$$x(t+1) = \frac{\left[D_t + D_{t-1} + \ldots + D_{t-n-1}\right]}{n}, \quad n \le t \qquad 1$$

Where, n = number of observations used in the calculation

D = time series data

A critical issue in using the simple moving average method is in the choice of **n**. It can be determined by selecting a value that minimizes the Mean Squared Error (MSE) of the forecasting, which is given by (Roberts, 2004):

$$MSE = \frac{\sum_{t=1}^{n} \left(D_t - x_t\right)^2}{n} \qquad 2$$

The simple moving average method was used for each of the weather variables on a monthly basis, that is, say for relative humidity, April 1993 to April 2010 and so on. A moving 'window' of three-year, five-year, seven-year and nine-year width (n=3, n=5, n=7 and n=9) respectively was applied on the validation data of 2003 to 2005 in order to determine the choice of n to minimize the Mean Squared Error (MSE). The result is as shown in Table 1.

Table 1: MSE Values For n=3, n=5, n=7 and n=9

	2003				**2004**				**2005**			
	n=3	n=5	n=7	n=9	n=3	n=5	n=7	n=9	n=3	n=5	n=7	n=9
REL_HUM	111.1	73.9	59.96	**53.08**	285.4	87.68	94.4	**60.09**	150.1	43.94	30.97	**15.65**
WIND_DIR	685.4	116.33	63.34	**38.76**	928.6	222.4	179.58	**103.2**	1342	401.78	292.44	**160.6**
WIND_SPD	568.6	185.1	251.33	**152.5**	285.4	191.6	222.89	**125.5**	150.1	81.97	40.395	**79.66**

On the basis of Table 1, the choice of **n=9** was decided upon since, on the overall, it exhibits the least Mean Squared Error (MSE) values. The Mean Squared Error (MSE) values obtained, as in Table 1, also indicate that the higher the value of **n** the lower the value of the Mean Squared Error (MSE). It should also be noted that in this case the highest possible value of n is 9. The selected value is then used to determine preliminary forecast values for the weather variables from 2003 to 2010. The exponential smoothing method is then applied to obtain the forecast values to be used with the developed Rain Forecast Model (RFM).

3.3 Simple Exponential Smoothing Method

Exponential smoothing is a forecasting technique that weighs past data in an exponential manner so that the most recent data carries more weight. This means that an exponentially smoothed moving average is based not on a sequential average of individual time periods but on the most recent data and the average prior to it adjusted by a smoothing constant, α. The smoothing constant, α, is a number in the range [0, 1] with smaller values resulting in less weight given to the current time period. It can be determined on a trial-and-error basis but Roberts (2004) has determined an empirical expression for the smoothing constant as:

$$\alpha = \frac{1}{\frac{n}{2} - 1} \qquad 3$$

Where n is the moving window width.

The smoothed series is recursively updated as new observations are recorded using the following expression:

$$S(t) = \alpha D(t) + (1 - \alpha) S(t - 1) \qquad 4$$

Where S(t) is the value of the smoothed series at period t.

The current smoothed value is an interpolation between the previous smoothed value (S(t-1)) and the current observation, where α controls the closeness of the interpolated value to the most recent observation.

Based on the choice of n=9 from Table 1, and from equation 3, a value of α=0.286 is used to determine the forecast values of the weather variables using Microsoft Excel®. A sample Microsoft Excel® spreadsheet showing the procedure is as shown in Figure 2.

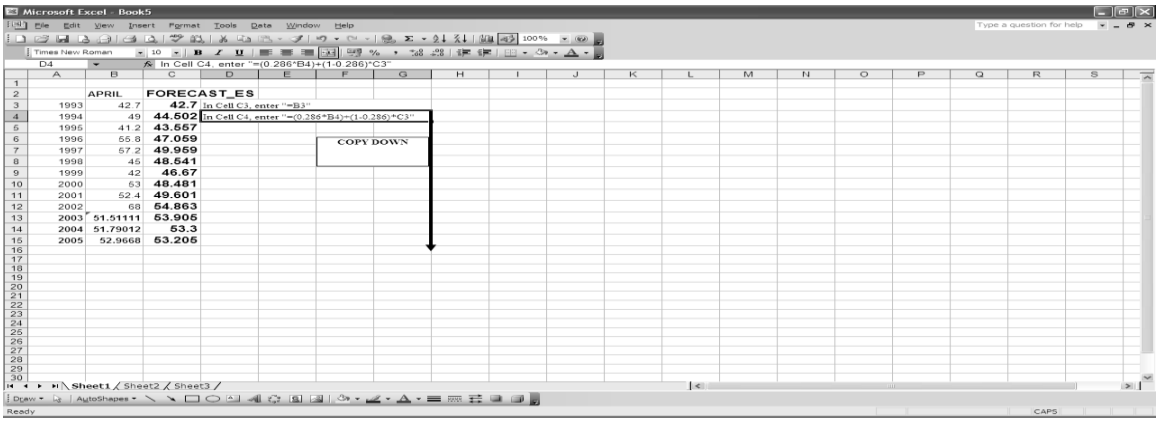

Figure 2: Sample Microsoft Excel® Spreadsheet Showing Exponential Smoothing Procedure

4. Testing with rain forecast model (RFM)

The forecasted values of the weather variables are then used to forecast the monthly rainfall amounts for 2003 to 2010 using the developed Rain Forecast Model (RFM). Sample watch window outputs for October 2005, April 2006, August 2008 and July 2010 are as shown in Figures 3 – 6.

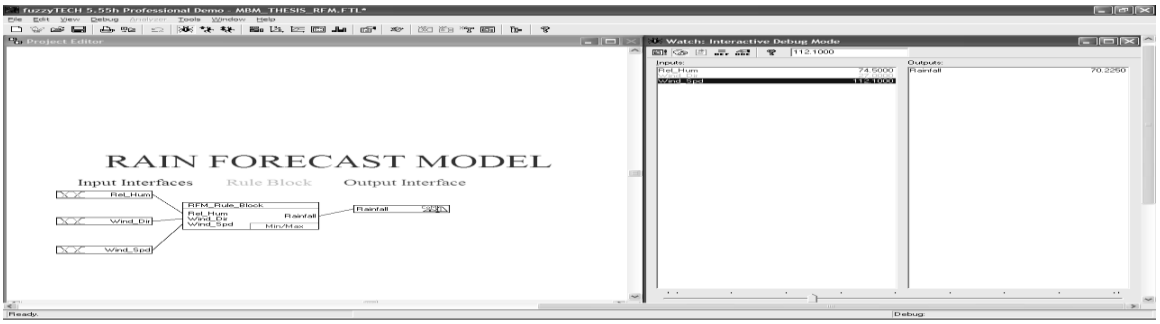

Figure 3: Watch Window Output For October 2005

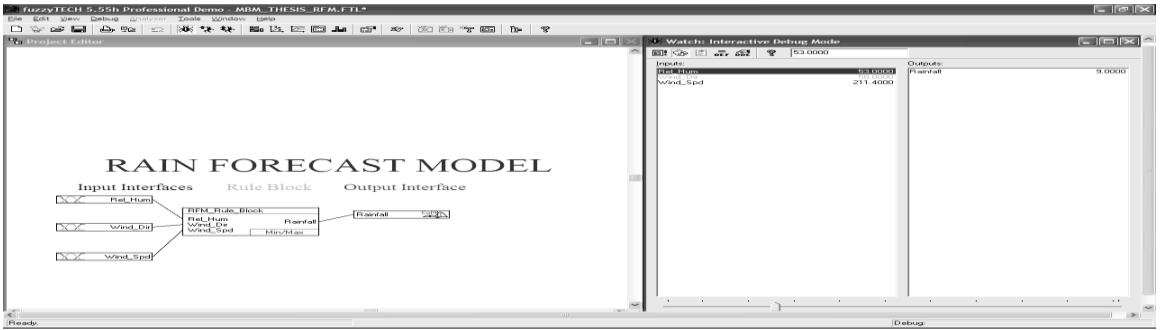

Figure 4: Watch Window Output For April 2006

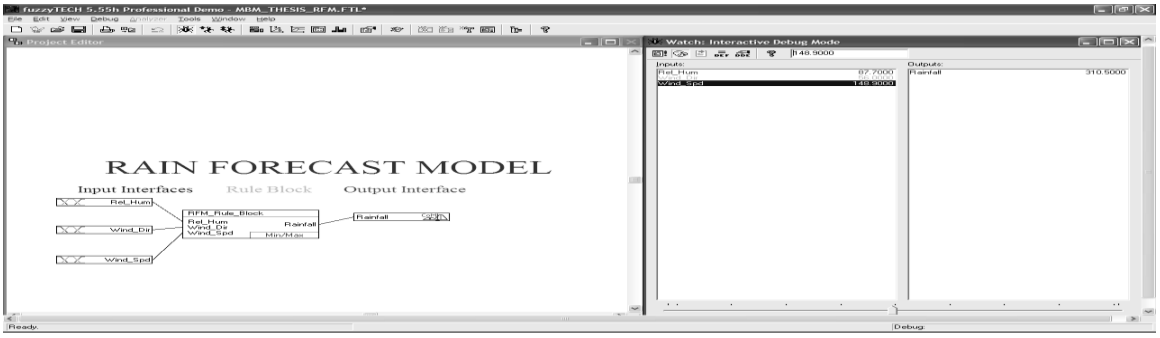

Figure 5: Watch Window Output For August 2008

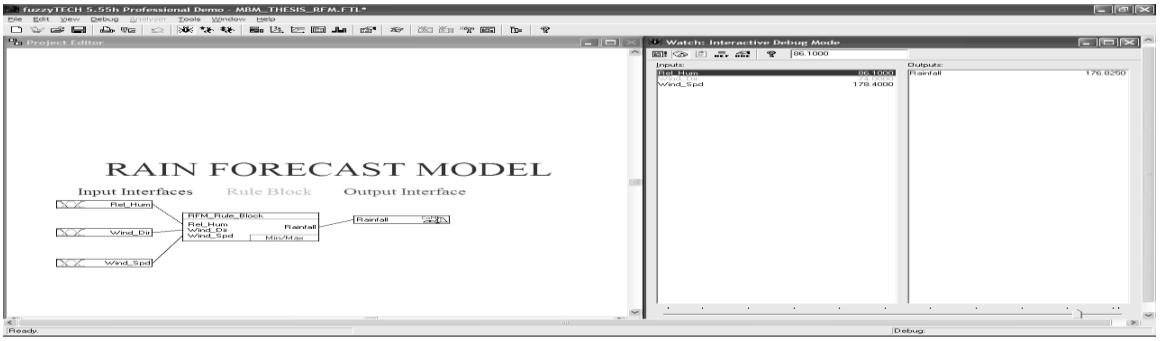

Figure 6: Watch Window Output For July 2010

A plot of the rainfall data, forecasted (2003 to 2010) and actual (2003 to 2005) is shown in Figure 7. Figure 8 shows a plot of the rainfall data, actual (2003 to 2005), forecasted (2003 to 2010) and that obtained from subjecting the actual weather variables of 2003 to 2005 to the Rain Forecast Model (RFM).

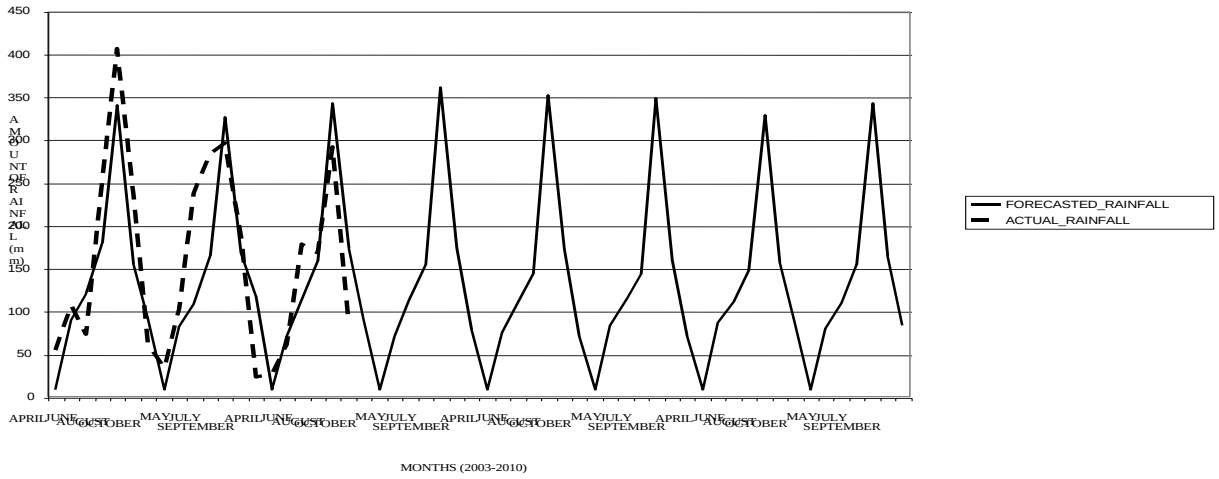

Figure 7: Plot of Actual (2003-2005) And Forecasted (2003-2010) Rainfall Data

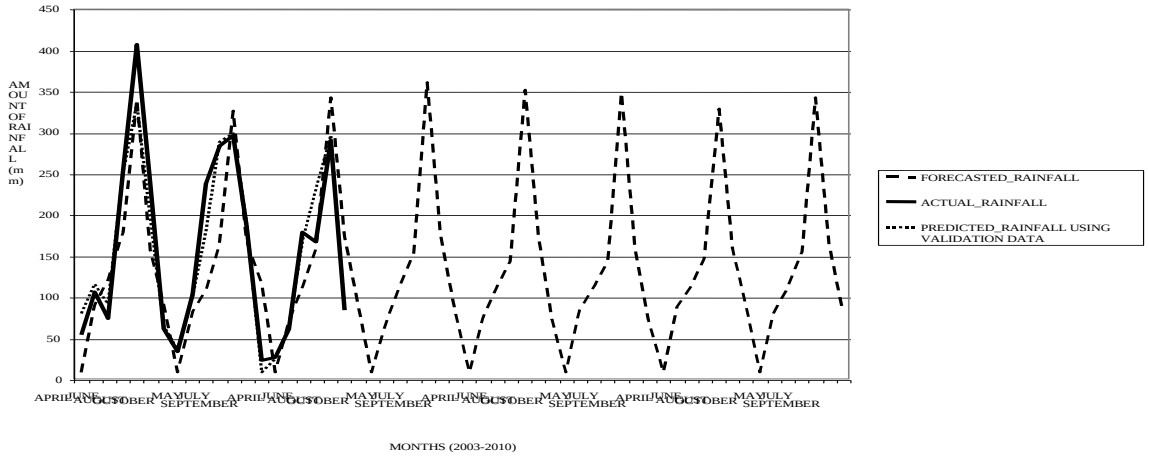

Figure 8 Plot of Actual (2003-2005), Validation (2003-2005) and Forecasted (2003-2010) Rainfall Data

5. Analysis and discussion of findings

The plot of the actual rainfall data for the validation period and that forecasted using the Rain Forecast Model (RFM) is shown in Figure 12. The Root Mean Square Error (RMSE) between the actual rainfall and forecasted rainfall generated by the Rain Forecast Model (RFM) is used as the performance function. The Root Mean Square Error (RMSE) is determined from:

$$RMSE = \sqrt{MSE} \qquad 5$$

Where, $$MSE = \frac{\sum_{t=1}^{n} \left(Actual\_Rainf all_t - Predicted\_Rainf all_t \right)^2}{n} \qquad 6$$

In addition to this, the Pearson's correlation factor, R, between the actual rainfall and forecasted rainfall generated by the Rain Forecast Model (RFM) has also been determined. The correlation coefficient, a number between 0 and 1, is a measure of how well trends in the validation values using the developed Rain Forecast Model (RFM) follow trends in the actual data. What constitutes a good value of R is dependent on the problem domain. In this case, R > 0.8 is an indication of a good model considering the volatility of weather variables in general and rainfall in particular.

The Root Mean Square Error (RMSE) is 28.02, while the correlation factor, R is 0.97.

The Root Mean Square Error (RMSE) between the actual rainfall and forecasted rainfall generated by the Rain Forecast Model (RFM) based on the forecasted weather variables is used as the performance function. In this case also, the model is only be tested for the validation period (2003 to 2005). In addition to this, the Pearson's correlation factor, R, between the actual rainfall and forecasted rainfall generated by the Rain Forecast Model (RFM) has also been determined.

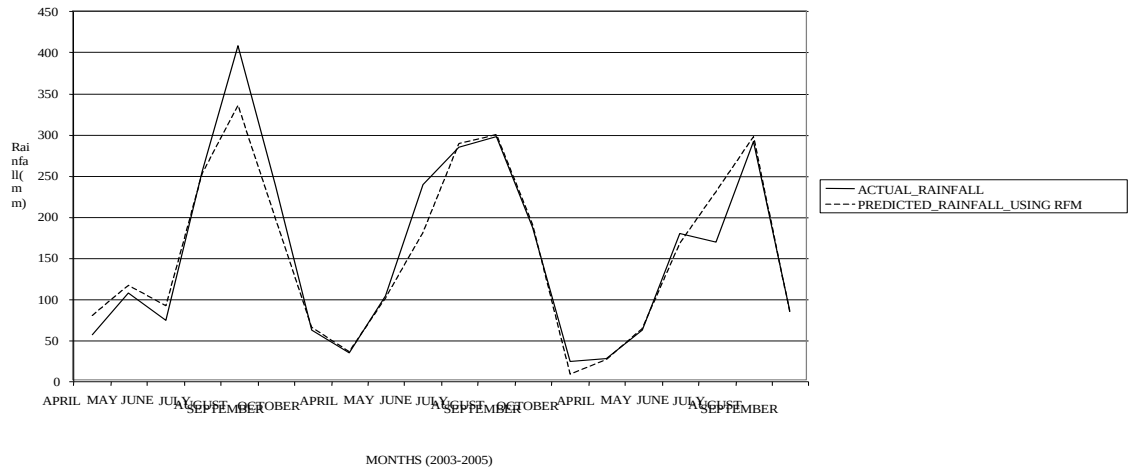

Figure 8: Plot of Actual Rainfall And Forecasted Rainfall Using Validation Data of 2003 – 2005

The correlation factor, here, is a measure of how well trends in the forecasted values using the developed Rain Forecast Model (RFM) follow trends in the actual data. The Root Mean Square Error (RMSE) is 54.99, while the correlation factor, R is 0.88. This is a good indication of the efficiency of the model

5. Conclusion

Weather is very difficult to predict despite the data and information that may be available. This is because weather can change very quickly (e.g. if the wind changes direction slightly, the rain may pass over and fall elsewhere) which means the forecast can quickly be out of date. In general, climate and rainfall in particular, are highly non-linear phenomena in nature. Soft Computing techniques are well suited for developing the prediction model as a result of the non-linear nature of rainfall. The idea of using a Neuro-Fuzzy approach came both, from Neural Nets' abilities to learn and generalize from sets of historical patterns, and the complexities of the problem (unpredictability of rainfall), which is more suitable to be modeled using fuzzy techniques.

The Rain Forecast Model (RFM) used as its inputs the weather variables and in order to forecast into the future, these weather variables were forecasted using a hybrid statistical technique comprising of Moving Averages and Exponential Averages. The forecast period is between 2003 and 2010. A fuzzy time series technique was also applied to forecast for the rainfall so as to have a basis for comparison with the developed Rain Forecast Model (RFM).

Two statistical tests were carried out in order to measure the performance of the developed model and that of the fuzzy time series method namely Root Mean Squared Error (RMSE) and Correlation Factor (R). The developed model was tested with the validation data of 2003 to 2005 and the following performance function results were obtained: RMSE=28.02 and R=0.97. This formed the basis for comparing the performance of the developed model when subjected to the forecasted weather variables for the same period. The performance function results obtained were: RMSE=54.99 and R=0.88. Considering the nature of the problem, that is the unpredictability of rainfall, these are indicators of a good model.

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ASSESSMENT OF THE MAGNITUDE OF SUSPENDED SEDIMENT PRODUCED BY THE GORUBA TRIBUTARY OF THE KUBANNI RIVER, ZARIA

Y.O.Yusuf, [1], E.O Iguisi.[1], A.L. Bello, [1] and O.F. Ati.[2]

[1]Department of Geography, Ahmadu Bello University, Zaria, Nigeria
[2]Department of Geography, Federal University, Dutsinma, Katsina State, Nigeria

Abstract

The Ahmadu Bello University (ABU) dam, constructed to provide water for the university community, receives water and sediments from the upstream catchment area of River Kubanni, which is made up of four tributaries. An earlier study attempted an assessment of the magnitude of sediment produced by the northernmost (Malmo) tributary of the river where a Channel Sediment Yield (CSY) of 482 tons/yr and Specific Sediment Yield (SSY) value of 92 tons/km^2/yr were derived for the catchment area. Part of the recommendation was that future studies should look into the spatial spread of sediment contribution into the reservoir by all the in-flowing streams so as to determine which inflow is the most problematic in terms of reservoir sedimentation. An attempt is being made here, using similar method, to look at the southernmost tributary which is the Goruba tributary in order to make a comparison between the two. The study area was monitored for one year with data on sediment concentration and stream discharge collected from the gauging station. The discharge was derived using the Velocity-Cross sectional area method while suspended sediment samples, collected at the gauging station using the USDH 48 sampler with onward analysis in the laboratory were used to determine the suspended sediment concentration and the rating curve was used to allow a reasonable estimate of suspended sediment yield for the study area. Although the number of days of continuous flow differ significantly for the two sub-basins, with that of Goruba being much lesser, the statistics including the channel and specific suspended sediment yield of the Goruba stream (12880.547 tons/yr and 702.7 tons/km^2/yr) is more than that of the Malmo stream in folds. The higher sediment yield value and the information thus provided portend the need for increasing catchment management and conservation measures to control sediment yield into the Ahmadu Bello University reservoir as it was observed that sand mining and intensive cultivation is still going on within the basin.

Key Words: Discharge, Suspended Sediment Concentration, Suspended Sediment Discharge, Channel Sediment Yield, Malmo Stream and Goruba Stream.

1. Introduction

Water is essential to life and its distribution and availability are closely associated with the development of human society. Apart from air, water is the most important resource to man. He can survive longer without food than without water. Without it, life is impossible. It is a foundation for human prosperity because adequate and high quality water supplies provide a basis for the growth and development of human, social, economic, cultural and political systems (Young, 2006). The demand for water doubles every 20 years which is more than twice the rate of the world's population growth. New water resources are becoming scarcer and to treat and remediate existing sources more expensive (Clothier *et al.*, 2008).

Inevitably, modern man needs water for three basic purposes: agriculture, industry and domestic and municipal use (water for drinking, cooking, washing, general sanitation and so forth), and he depends largely on the rivers, lakes and aquifers to meet his water needs (McCully, 2006).

Rainfall is determined by uneven weather patterns and as a result, some area of the world gets more precipitation than others. As a result of extreme fluctuations in river discharges in some climatic regions, dams are constructed across rivers to create water reservoirs for power generation, irrigation, flood control, recreation and domestic water supply (Spencer, 2003).

When a dam is constructed across a river, the resultant reservoir receives water and sediments from the catchment area of the river network. Eroded sediments are transported and deposited into the reservoir and this becomes worrisome if the dam is not designed to flush out such sediments as they will continue to settle at the bottom of the lake and overtime increase in thickness. This tendency ultimately reduces the actual depth of the lake, and the volume of water that can be retained in the reservoir.

The materials carried by rivers are termed sediment load. Sediment load is composed of eroded materials of different shapes and sizes, determining their mode of transportation downstream. It is possible to divide sediment load into bedload, suspended load, and solution or solute load. Sediment yield is the total amount of sediments that are generated within the catchment area of the river and subsequently moved from a drainage basin through a cross-section during a specified period of time to be deposited on flood plains, in storage reservoirs, or carried off to the seas and has been identified as the major cause of reservoir sedimentation.

Glymph (1973), for instance, reported that some small reservoirs in the United States incure up to 25% storage loss annually as a result of sediment deposited in them. Dasma *et al*. (1973), identified a similar phenomenon for reservoirs downstream of mining areas while Platt (1971), reported similar occurrence in reservoirs downstream of logged areas. In Nigeria, Imevore *et al.* (1988) for example, reported that some dams in Nigeria which include the one near Ile-Ife at Oke Odo had become totally silted up and turned into weed-infested marshes due to rapid urban development and farming activities at the headwaters of the lake. Another example is that of Effon Alaye reservoir in Ondo State, which would have completely silted up, but for perennial dredging. Adedeji and Jeje (2004) have also observed significant channel erosion of the Opa basin in southwestern Nigeria. The situation in northern Nigeria where there is marked seasonality in rainfall is even worse (Ologe, 1973a).

The problem of reduction in the installation capacity of dams, especially in the northern part of the country, as a result of rainfall seasonality cannot be overemphasized. The Kubanni

dam, on which the entire community of the Ahmadu Bello University and immediate environs depend, is not an exception.

Prior to 1973, Ahmadu Bello University (ABU) water demand had always been met, though inadequate and irregularly, by the Zaria water treatment plant, located some 25 km south-east of the institution. The desire to achieve equilibrium between water supply and demand led the ABU authority, in 1973, to start the construction of a small earth dam across River Kubanni in order to retain water that would meet the community's present and future needs. At the completion of the dam, in 1974, it had a storage capacity of 2.6×10^6 m^3 with maximum depth of about 8.5m, a catchment area of 57km^2, a lake surface area of 83.4 ha and supply capacity of 13.64 million litres per day to cater for about 50,000 people (Committee on Water Resources and Supply, 2004).

The dam was designed to have a hollow spill way, such that excess water over the storage capacity of the lake spills into this hollow and is evacuated through pipes under the embankment. However, the facility for flushing out sediments was not provided. It has therefore had its fair share of the sediment yield problem over the years. Although efforts have been made by the authorities concerned to nip the problem in the bud, it seems to persist.

Iguisi (1997), in his study of the extent of sedimentation in the dam recorded a maximum depth of 5.2m as against the initial 8.5m which indicate a loss of about 3.3m (i.e. about 30% loss in storage capacity in 23 years) and an average annual loss of depth of about 14.3cm. This is the result of eroded materials transported and deposited on the reservoir floor.

In 2008, the report of the ABU committee on protection of the Kubanni dam surmised that from year 2023, rationing of water will start; first during dry season, later in both seasons. From year 2039, there will be no more water in the reservoir during dry season. In year 2059, the reservoir, completely silted up, will disappear from maps (Committee on the Protection of Kubanni Dam, 2008).

Thus, sediment production within the basin is very high confirming Ologe's statement in 1973 before the construction of the dam that unless precautions are taken, the Kubanni reservoir is likely to silt up like the Daudawa dam in Katsina state, where dredging has been carried out in an attempt to restore storage capacity (Ologe, 1973b). It also confirms the statement of Ogunrombi (1979) that high rates of sediment supply to the reservoir by sheet erosion and from gullies, which are widespread in the catchment, should normally be expected.

The study of Iguisi (1997) did not address the issue of sources and nature of sediment delivery into the dam. His primary concern was the net accumulation of sediments in the dam. It is however, important to find out the relative contribution of sediments and their nature for the purpose of designing strategies for controlling sedimentation of the dam.

Yusuf (2006), assessed the magnitude of suspended sediment produced by the northernmost (Malmo) tributary of the Kubanni River. A high Channel Sediment Yield (CSY) value of 482 tons/yr and a Specific Sediment Yield (SSY) value of 92 tons/km^2/yr were derived for the catchment area of the tributary and part of his recommendation was that future studies should look into the spatial spread of sediment contribution into the reservoir by all the in-flowing streams so as to determine which inflow is the most problematic in terms of reservoir sedimentation. An attempt is being made here to look at the southernmost tributary which is the Goruba tributary in order to make a comparison between the two.

The aim of this study is to assess the magnitude of sediment produced by the Goruba tributary of River Kubanni and the objectives are to: determine the stream discharge and suspended sediment concentration; establish a rating curve for discharge and suspended sediment discharge; and, determine the river's suspended sediment yield.

2. Study area

The study area is in Zaria, Kaduna State. Zaria is located between latitudes 11°03′ and 11^0.10' North and between longitudes 7°30′ and 7°45′ East of the Greenwich meridian. The town is almost centrally located in Northern Nigeria and is a major city in Kaduna state. The plain of Zaria is on an undulating one, which is gently rolling and about 670m above mean sea level and has numerous valleys and streams (Wright and McCurry, 1970).

Zaria experiences the typical seasonal climate of northern Nigeria. It belongs to the Aw climate of the Koppen's classification that has two distinct seasons; the dry or the harmattan season lasting between October to May, while the other season is the rainy season and lasts from May to October. The temperature of Zaria varies throughout the year. Mean monthly minimum temperature rises gradually from its lowest 9.4°C in December to its highest 26.0°C in April while mean monthly maximum temperature rises gradually from its lowest 29.7°C in January to highest 40.6°C in April (Oladipo, 1985).

The soil of Zaria is termed "the Zaria soil group" and usually has material covering up to 14 feet (4.27m) in depth and consists of deposited silt and overlying sedimentary decomposed rocks. Alluvial soils are expansive in Zaria and in low land areas they are easily drained to produce what is known as the Hydromorphic fadama soils. These are found around the Kubanni and Galma river basins and are mainly for sugarcane cultivation. It also supports vegetables like onions, spinach, pepper, tomatoes; hence contributing to market gardening (Ologe, 1973a).
Although the Zaria environment belongs to the northern guinea savannah which is moist woodland undergrown with thick bushes and shrubs, the vegetation is gradually becoming artificial. Some of these vegetation include elephant grass, *Isoberlinia doka, Isoberlinia tomentosa*, *Tamarindus* spp, locust beans, silk cotton trees, and baobab tree are commonly seen. Human activities such as cultivation, construction, bush burning and grazing have greatly modified the natural vegetal cover and composition (Jaiyeoba, 1995).

The accumulated sediment in the Kubanni reservoir of Ahmadu Bello University, Zaria come from the catchment area of the river network composed of four tributaries including the northernmost (Malmo), Tukurwa, Maigamo and Goruba streams. The Goruba stream is the focus of this study (fig.1).

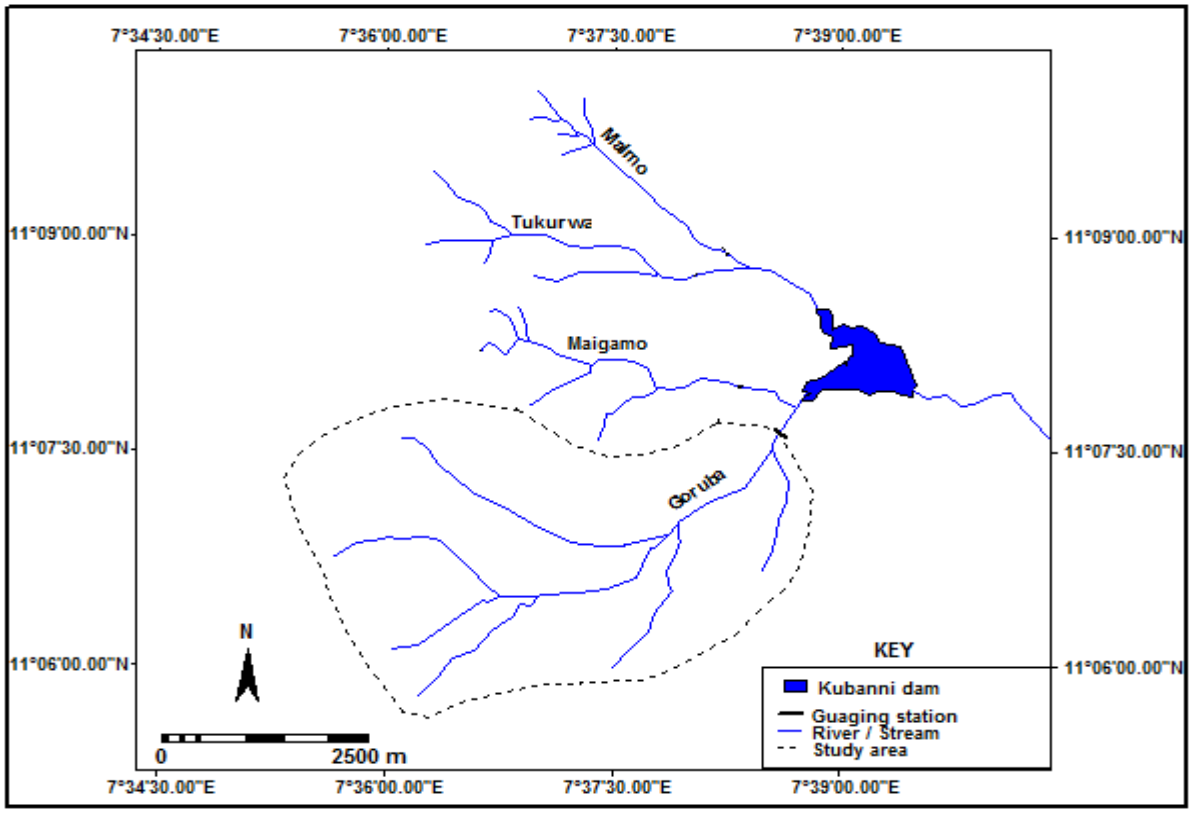

Fig.1 The Kubanni Dam, Goruba Stream and Gauging Station Upstream
Source: Adapted and Modified from Zaria SW Topographic Map

3. Materials and methods

In order to achieve the aim and objectives of this study, data on sediment concentration and stream discharge were collected from the gauging station indicated in Fig.1 during the study period from May to November, 2011 which marked the flow period of the Goruba stream.

***3.1 Stream Discharge*:** The measurement of stream discharge usually involves consideration of both stage and velocity. There are a number of ways in which river discharge can be measured. These include velocity-area technique, dilution gauging, volumetric gauging, the slope area technique, weirs and flumes (control structure method) and the rated section. The velocity-area (AV) technique, the most widely used for spot measurements of discharge (Gregory and Walling, 1973) was adopted. Measurements were observed after rainfall events and twice a day; in the morning (around 7.00am) and in the evening (around 6.00pm) everyday, which represent instantaneous and regular interval monitoring (Ogunkoya, 2000). Subsequently, the daily average readings were calculated in order to obtain the stream discharge.

3.2 Sediment Concentration: Suspended sediment samples were collected at the gauging station using the USDH 48 sediment sampler designed by the United States Federal Inter-Agency Sedimentation Project after rainfall events during discharge measurements. The samples were stored in clean plastic bottles, labelled and taken to the laboratory for analyses following the procedure of Matthes *et al* (1991).

3.3 Estimation of Suspended Sediment Yield: As suspended sediment measurements are rarely continuous, temporal extrapolation is often required to enable a reasonable estimate of

suspended sediment yield to be made. This is usually achieved through the sediment rating curve which relates suspended sediment concentration, suspended sediment load; a product of suspended sediment concentration and discharge to stream discharge, on the basis of a limited number of sediment measurements (Ferguson, 1987; Walling and Webb, 1992; Richards, 1993; Yusuf, 2006).

3.4 Statistical Analyses: The significance and reliability of the results obtained were tested by the use of appropriate statistical parameters including the correlation coefficient (r) to measure the strength of the linear correlation between variables and the ratio of explained variation to the total variation, t-ratios to check the significance of the regression coefficients, F-ratio to check the statistical significance of the correlation coefficient of determination (r^2). All analyses were carried out by the use of Microsoft Excel and SPSS statistical package. The confidence level that will be used in accepting or rejecting the hypotheses is 95% corresponding to an alpha value of 0.05.

4. Results and discussion

4.1 Discharge: Table 1 and figure 2 show the summary statistics for the daily mean instantaneous discharge and the discharge regime for the Goruba tributary respectively.

Table 1 Summary Discharge Statistics for the Goruba Tributary

Statistics	**Value**
N (Days)	175
Minimum (m^3/s)	0.0004
Maximum (m^3/s)	22.2786
Range	22.2782
Mean (m^3/s)	1.4744
Std. Error of Mean	0.2842
Std. Deviation	3.7592
Variance	14.131
Sum (m^3/s)	258.01

The table above shows that the Goruba stream had flow period of 175 days with the measured daily mean instantaneous discharge values in m^3/s throughout the study period recording the highest and lowest values of 22.2786 and 0.0004 on 18th of August and 27th November, 2011 respectively. The total instantaneous discharge is 258.01 m^3/s while the mean discharge for the year is 1.4744 m^3/s. These values are much higher than those of the Malmo stream and the reason can be attributed to the much larger size of the Goruba stream; 18.33 km^2, except for the flow period of Malmo that was almost throughout the year (359 days). The two situations however confirm contribution to surface flow by subsurface flow during the dry season (Gregory and Walling, 1973; Knighton, 1998; Rawat, 2011).

A careful observation of the regime diagram in figure 2 reveal that September is the month with highest discharge with the fact that the discharge regime is noticed clearly as from May to October with a single maximum which correlates with the rainfall period in the study area and relegates the significance of the contribution to discharge by subsurface flow during the dry season as was evident in the Malmo stream except for the difference in the month of maximum discharge that is August. This can be attributed to the difference in their sizes and

therefore lag time as was the result in River Kaduna which is bigger in size (Muhammad, 2012).

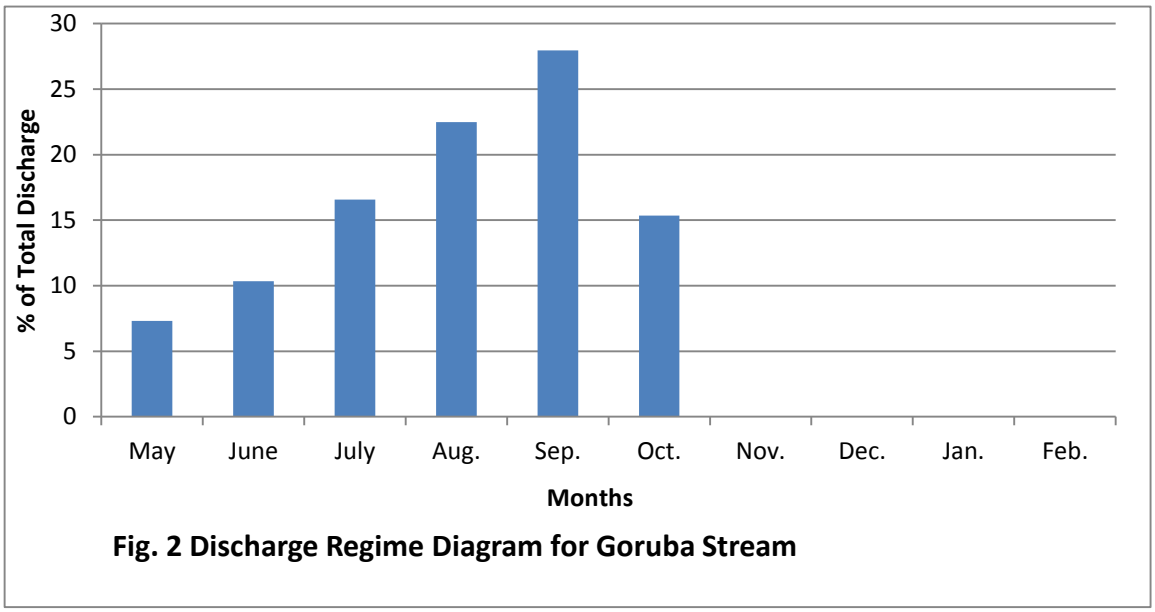

Fig. 2 Discharge Regime Diagram for Goruba Stream

4.2: Suspended sediment concentration/load–discharge relationship

Table 2 presents the summary statistics for the suspended sediment concentration (Cs) derived in the laboratory from the water samples collected at the gauging station during instantaneous discharge monitoring and the summary statistics for the instantaneous suspended sediment loads (Qs) while Table 3a and b present the coefficients of Qs-Q relation and their model summary.

Table 2 Summary Statistics for Instantaneous Suspended Sediment Concentration and Load

Statistics	Cs	Qs
N	26	26
Minimum	68	13.32
Maximum	4984	97800
Mean	1060.15	8270.9
Std. Error of Mean	256.6384	3727
Std. Deviation	1308.6041	19004
Variance	1712000	361200000
Sum	27564	215000

Table 3a Coefficients of Qs-Q Relation

Basin	Factor	Coefficients	Std. Error	t	Sig.
Goruba	Constant	2.847	0.114	24.931	0.000
	LOGQ	0.895	0.119	7.552	0.000

3b Model Summary for Qs-Q Relation

R	r^2	Std. Error of the Estimate	F	Sig.
0.839	0.704	0.46018	57.034	0

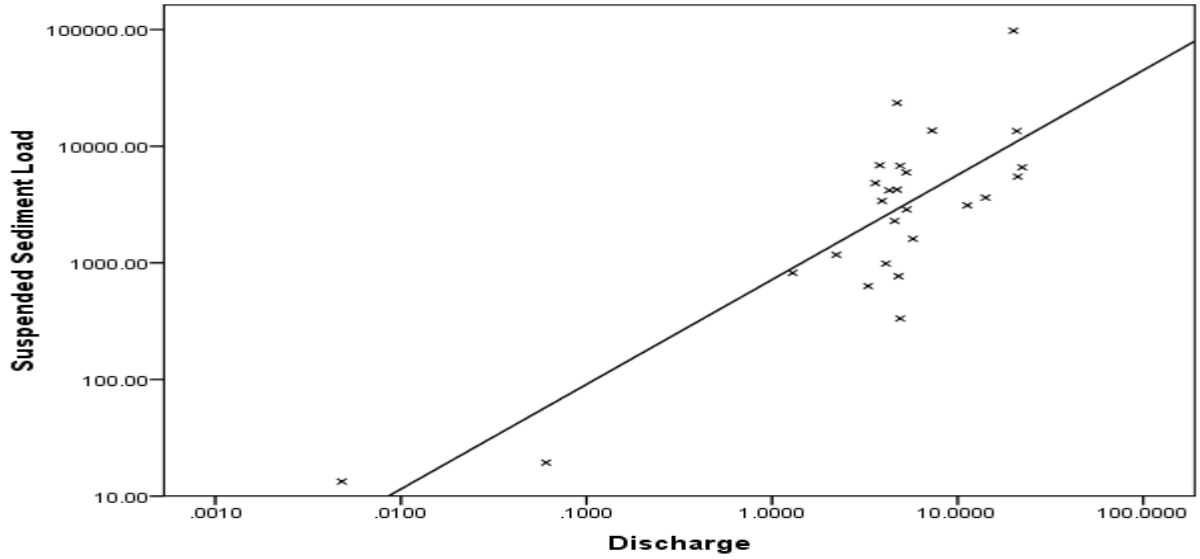

Fig. 3 Qs-Q Relation for Goruba Stream

The coefficient of correlation (r) and coefficient of determination (r^2) were also high. Although the values are high, inference on these values cannot be made without checking the statistical significance of the r^2 computed, as their high values do not conclude that the independent variable (Q) is a good determinant of the dependent variable (Qs). Using the F-ratio (ANOVA) test, the regression coefficient of determination (r^2) was found to be statistically significant at the 0.05 level of significance, indicating that discharge (Q) is a good determinant of the suspended sediment discharge (Qs) as illustrated in table 3b. The situation in the Malmo stream is almost the same except for the higher correlation coefficients.

Consequently, using the regression coefficients, Table 4 presents the summary statistics for the continuous suspended sediment loads including the sediment yield and channel sediment yield in kg/yr and tons/yr after dividing by 1000. Also included is the specific sediment yield in tons/km^2/yr after dividing by the basin area while figure 4 shows the suspended sediment load regime diagram in an attempt to examine the temporal variation. The summary statistics indicate that, although the number of days of continuous flow differ significantly for the two sub-basins, the statistics including the channel and specific suspended sediment yield of the Goruba stream (12880.547 tons/yr and 702.7 tons/km^2/yr) is more than that of the Malmo stream (Yusuf, 2006).

A very interesting observation however is that the difference in channel sediment yields is much higher than that in the specific sediment yields which is undoubtedly as a result of the difference in size and goes a long way to confirm that the decrease in sediment yield can be explained by increases in deposition and sediment storage within the channel network with increasing watershed size (Gottschalk, 1964; Nichols and Renard, 1999).

Table 4 Summary Statistics for Derived Suspended Sediment Load for the Goruba Tributary

Statistics	Values
N (Days)	175
Minimum (mg/s)	0.64
Maximum (mg/s)	11307.32
Mean (mg/s)	851.8846
Std. Error of Mean	149.2601
Std. Deviation	1974.5261
Variance	3898753.316
Sum (mg/s)	149080.4
Sediment Yield (kg/yr)	12880547
Channel Sediment Yield (tons/yr)	12880.547
Specific Sediment Yield (tons/km^2/yr)	702.7

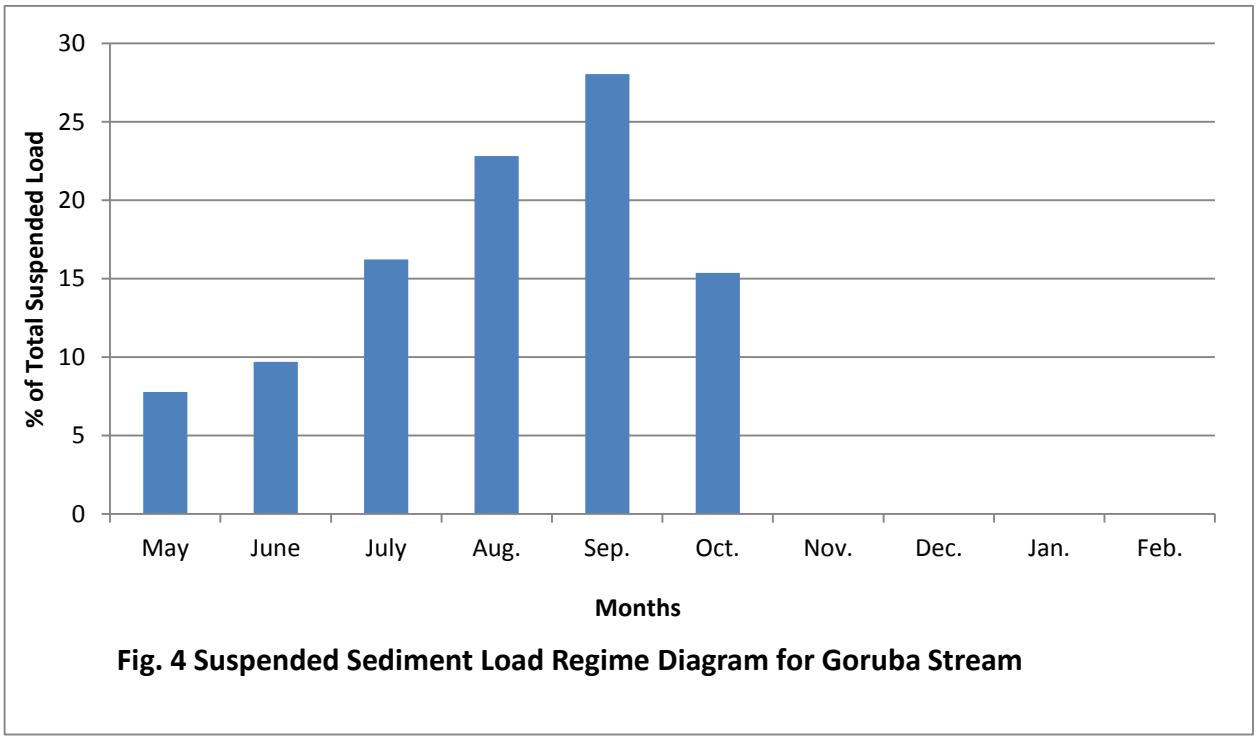

Fig. 4 Suspended Sediment Load Regime Diagram for Goruba Stream

The suspended sediment load regime diagram below reveal that the month of September, which is the month with highest discharge, has the highest suspended sediment load while the month of May has the least value. Unlike the Malmo stream regime diagram with double maxima in Yusuf (2006), that of Goruba has a single maximum in September relating perfectly with the discharge regime diagram as illustrated in figure 2 confirming the strong correlation between discharge and suspended sediment yield as indicated in Table 3b.

5. Conclusion

The sedimentation of the Ahmadu Bello University (ABU) reservoir which provides water for the University community is the result of eroded materials transported and deposited on the reservoir floor which consequently affects the water holding capacity of the dam. The reservoir receives water and sediments from the upstream catchment area of River Kubanni, which is made up of four tributaries. Yusuf (2006) attempted an assessment of the magnitude of sediment produced by the northernmost (Malmo) tributary of the river where a Channel Sediment Yield (CSY) of 482 tons/yr and Specific Sediment Yield (SSY) value of 92 tons/km^2/yr was derived for the catchment area. Part of his recommendation was that future studies should look into the spatial spread of sediment contribution into the reservoir by all the in-flowing streams so as to determine which inflow is the most problematic in terms of reservoir sedimentation. An attempt was made here, to look at the southernmost tributary which is the Goruba tributary in order to make a comparison between the two.

Although the number of days of continuous flow differ significantly for the two sub-basins, with that of Goruba being much lesser, the statistics including the channel and specific suspended sediment yield of the Goruba stream (12880.547 tons/yr and 702.7 tons/km^2/yr) is more than that of the Malmo stream in folds. A very interesting observation however is that the difference in channel sediment yields is much higher than that in the specific sediment yields which is undoubtedly as a result of the difference in size and goes a long way to confirm that the decrease in sediment yield can be explained by increases in deposition and sediment storage within the channel network with increasing watershed size (Gottschalk, 1964; Nichols and Renard, 1999).

The higher sediment yield value and the information thus provided portend the need for increasing catchment management and conservation measures to control sediment yield into the Ahmadu Bello University reservoir as it was observed that sand mining and intensive cultivation is still going on within the basin under studied.

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ASSESSMENT OF THE CHANGES BROUGHT BY TEGINA–MAKERA ROAD TO RURAL DWELLER'S WELFARE

M.O Akhadelor[1] ; I.J.Musa[1]; S Abubakar[1]; and H, Mohammed[1]

[1]Department of Geography, Ahmadu Bello University, Zaria

Abstract

This study assesses of changes brought by Tegina-Makera road to rural dwellers welfare to the residential housing types, ownership and changes in farm sizes, involvement in secondary occupation and status of social infrastructures. The data were obtained through inventory survey, focus group discussion, oral interviews and administration of 150 copies of questionnaires to respondents in the survey villages of Tegina, Tashan Bala, Gada, Dogon Hawa, Kangon Inga, Manigi and Makera. These villages were selected based on their location along the road. The sampling technique adopted in this study is purposive sampling. The finding of is that construction and shortening of Tegina to Makera via Kontagora road from 238km to 120km had brought Tegina to Makera closer, thereby reducing the distance and cost between them. Also improvement in the housing types and construction materials from 23.3 percent to 70.7 percent; increment in farm land for 80 percent and occupational diversification for 46.5 percent of respondents are other welfare benefits attributable to the road. Tegina and Makera have the highest number of infrastructure while Dogon Hawa has the least infrastructure. Key recommendation is that government and non-governmental organisations should develop sustainable housing policy for rural dwellers who cannot afford to own modern housing types and provision of farming materials at a subsidized rate.

Key words: Changes, Communities, Road and Rural Development,

1. Introduction

World Bank (2001) indicated that a significant improvement in socioeconomic living conditions of rural dwellers was estimated with rural roads investment such as improved accessibility to social infrastructure [schools and health centers], increased opportunities to access education and health facilities and improved social interaction and mobility, which are important for social and economic development.Rural development is to improve the quality of life of rural people. This makes it essential to go beyond the income-related factors such as prices, production, and productivity to a range of non-income factors that influence quality of life and hence inclusiveness of rural dwellers (Chino, 2000).

Inclusive rural development is a more specific concept than the concept of rural development. In broad terms, inclusive rural development is about improving the quality of life of all members of rural society. More specifically, inclusive rural development covers three different but interrelated dimensions (UNDP, 2005). The first is the economic dimension that encompasses providing both capacity and opportunities for the poor and low-income rural households in particular to benefit from the economic growth process in such a way that their average incomes grow at a higher rate than the growth of average incomes in the sector as a whole. Second is the social dimension of supporting social development of poor and low-income households and disadvantaged groups, eliminating inequalities in social indicators, promoting gender equality and women's empowerment, and providing social safety nets for vulnerable groups. Third is the political dimension of improving opportunities for the poor and low-income people in rural areas, including women and ethnic minorities, to effectively and equally participate in the political processes at the village level and beyond.

Rural infrastructure provides rural dwellers with access to the markets and basic services that they need. Second, it influences rural economic growth and employment opportunities and thereby incomes and social development. For example, "good feeder roads can allow the supply of perishable foods to high-value urban markets, and the income generated can be invested in health and education to improve the productivity of eventual migrants to the cities" (ADB, 2005).

Jalan and Ravallion (2002) noted that the differences in rural infrastructure across counties have strong explanatory power for subsequent consumption growth at the farm household level in rural China. The impact of high quality rural infrastructure on the quality of life of the rural population can be substantial.

Road can play an important role in the structural transformation of the rural economy and rural welfare. This is because the construction of good roads serves as a stimulus for economic growth, easy interaction and in the provision of basic facilities such as schools, markets, health centres and farm inputs (Mabogunje, 1980 and Olawepo, 2003). In other words, a good network of rural roads is most important to rural development. This is because without roads, the provision of other infrastructures becomes extremely difficult, if not impossible. Once a road is provided, other facilities can follow (Redclift, 1991 and Aluko, 2000).

The *raison d'etre* of transport is the movement of goods and people from an origin to a destination which can be achieved through various modes of transportation. These modes include water, air, railways, road and pipe line. Of all these modes, road transport is the most beneficial to rural areas because of its flexibility and diversity of the means for moving people and goods. Road development in Nigeria has a long history and since independence, the rate with which Nigeria has pursued road construction is encouraging. Many roads linking cities and region have been constructed to make accessibility easy. Most of the roads were constructed to link state capitals, local government headquarters, major urban centers and natural mineral producing areas. But for a long time since independence rural areas benefited little from road development (Usman, 2006).

Rural transport is viewed as an integral part of the national transportation system. And the various types of road(s) are constructed to permit movements and different kinds of flows that are

discerned. The Tegina-Makera "new" road is an inter-regional highway which links northern and southwestern Nigeria. The purpose of this road is to reduce the distance between Tegina and Makera from 238km to 120km, which is from almost two and half hours to less than one hour journey on a normal day. The road was designed to cut across Rafi, Mashegu and Lavun local government areas (LGAs) respectively and its alignment took it through a few isolated rural settlements.

The construction of Tegina-Makera road started in 1983 and was completed in 1988. Prior to the construction of the road, one can only go from Tegina via Kontagora to reach Makera, a distance of 238km. the new road (Tegina-Makera) reduce the distance to 120km.

The thrust of this paper is to assess the changes brought by Tegina-Makera road to rural dwellers welfare on residential housing types, ownership and changes in farm sizes, involvement in secondary occupation and status of social infrastructures.

2. The study area

The study area, Tegina-Makera road passes within the middle belt region of Nigeria and lies between latitudes 8^0 20^l N and 11^0 30^l N and longitude 3^0 30^l E and 7^0 20^l E. Tegina–Makera road is the road linking the northern with the southwestern Nigeria, (see fig 1 and 2).

The road is not a completely new road, but that portion of interest which justifies this study is the shortened distance between Tegina and Makera settlements, by-passing Kontagora town, which covers a distance of 120km. The road is two-lane track which can conveniently permit vehicular movement that passes through many settlements.

The Tegina–Makera road has become one of the busiest roads in the Nigeria since after construction. It is always busy with different modes of vehicles carrying both raw and finished products (agricultural commodities, livestock, industrial goods, petroleum products and spare parts) from the north to the southern part of Nigeria and vice versa.

3. Materials and methods

Data were generated for the study using the following; Primary and inventory methods, and the secondary and focused group discussion methods. Tegina, Tashan Bala, Gada, Dogon Hawa, Kangon Inga, Manigi and Makera villages were identified along the road were considered for this study. One hundred and fifty questionnaires were developed and administered to the respondents purposively. They constitutes district heads (*maiunguwa*), heads of household, religious and NGOs leaders, heads of business and people who are willing, because their houses were not numbered and some were afraid. They provided information on the effects of Tegina- Makera road and state of welfare infrastructures. The selection of respondents was based on those who were willing to be interviewed; meaning that when a respondent refuses the next willing respondent is interviewed. All information collected was subject to percentage calculation and summarized using tables for discussion in this study.

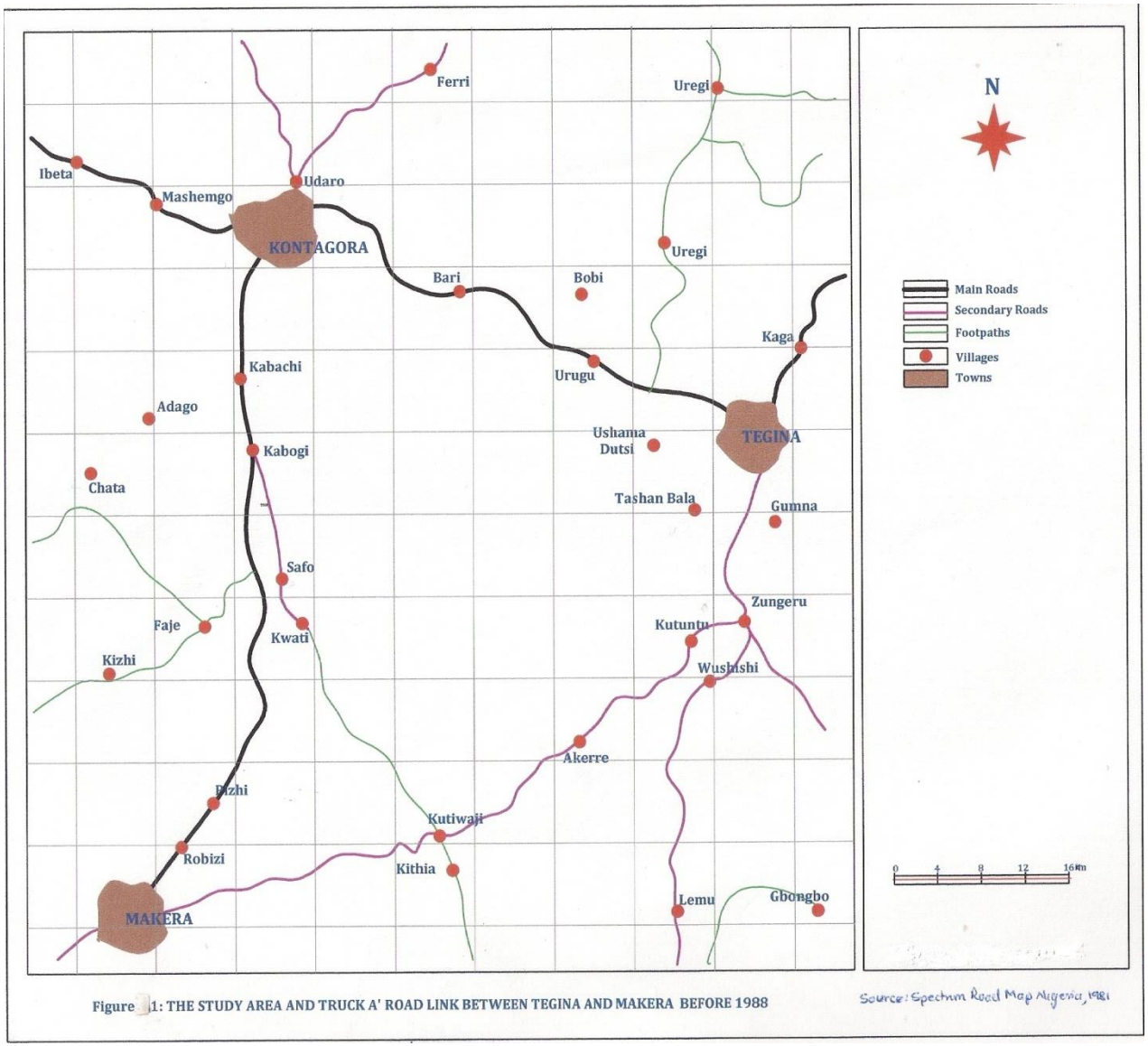

Figure 1: THE STUDY AREA AND TRUCK A' ROAD LINK BETWEEN TEGINA AND MAKERA BEFORE 1988

Source: Spectrum Road Map Nigeria, 1981

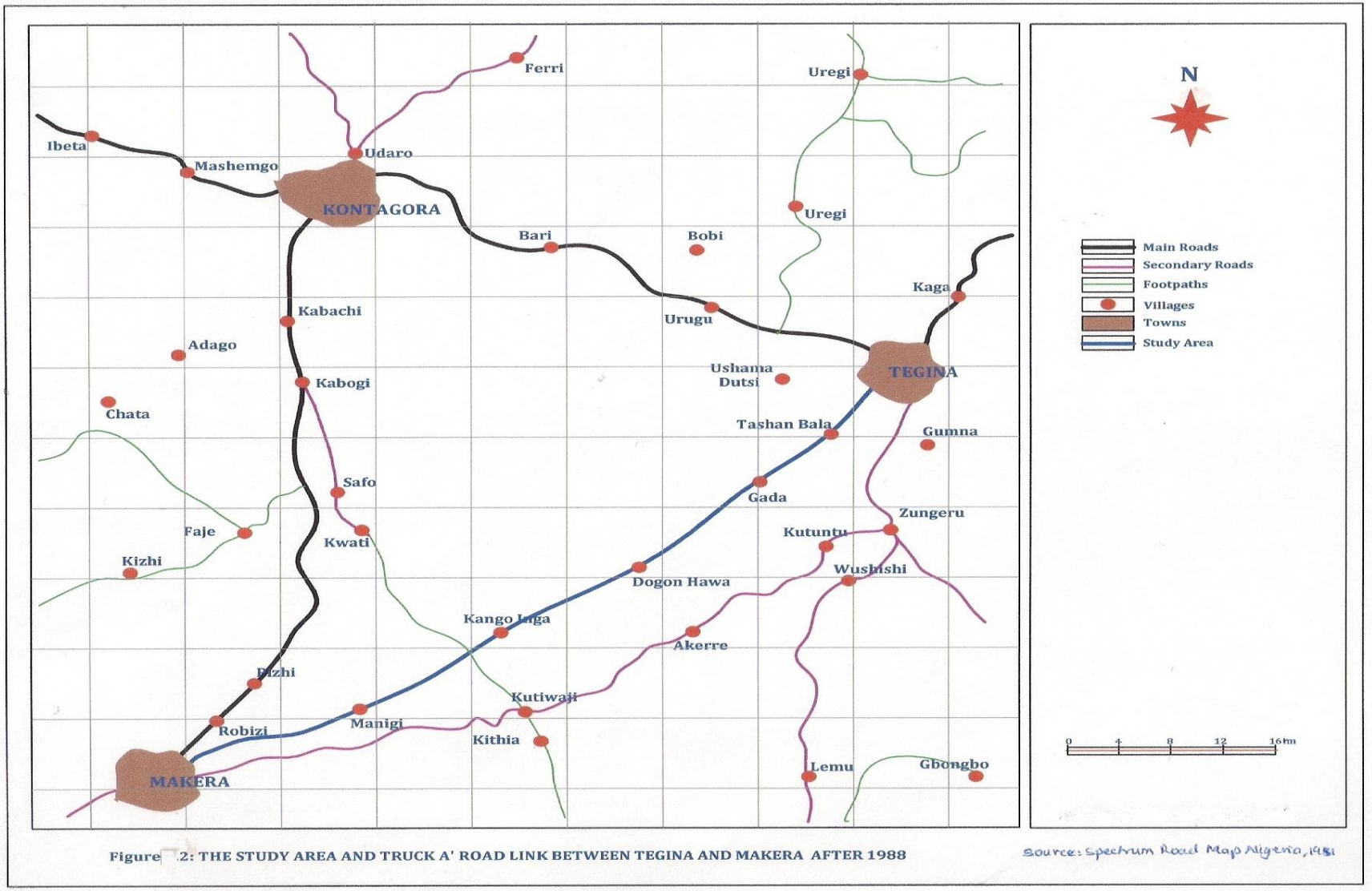

Figure 2: THE STUDY AREA AND TRUCK A' ROAD LINK BETWEEN TEGINA AND MAKERA AFTER 1988

Source: Spectrum Road Map Nigeria, 1981

Inventory of business activities and welfare infrastructures such as farm produce sellers, provision shops, craft traders, tailoring activities, saw mill, fire wood seller was also developed. Others include schools, hospitals, health centres, cinemas, viewing centres, police stations, courts, fuel stations, churches and mosques were also identified by their location and date of establishment, to determine those established before and after new Tegina-Makera road was constructed.

Secondary data sources comprise road map which was obtained from Kwara state ministry of works. It was used to show the road before and after construction, the location, and size and pattern settlements. This map was then updated through field survey to show changes in the settlements (pattern and construction materials) and status of welfare infrastructures as at the time of this study. Relevant information was obtained from unpublished thesis and projects, journals, text books and websites to support literature.

4. Results and discussion

The result obtained shows that the reconstruction and up grading of Tegina-Makera road took a linear pattern along its course. It was found out that most settlements both from within and elsewhere have moved closer to the roads and are now aligned along road corridor, thereby changing the former settlement pattern from nucleated to linear pattern. It was found out that after the construction of the road, houses changed from mud with thatched roofs to cement wall or brick with corrugated and galvanised iron sheet roofs. The shape of the houses changed from round to rectangular houses. It was also observed that recent settlers have built their houses in the form of bungalows or duplexes with kitchens, toilets and garages.

Table 1. Distribution of Residential Housing before and after Road Construction

	Before road construction	After road construction	Percentage change
	Mud wall and thatched roof	Cement wall and zinc roof	(b-a/a x 100)
Villages	No of respondents (a)	No of respondents (b)	
Tegina	07	23	228.6
Tashan Bala	02	08	300
Gada	05	20	300
Dogon Hawa	03	12	300
Kangon Inga	10	10	-
Manigi	04	16	300
Makera	13	17	30.8
Total	44	106	
%	29.3	70.7	

Source: Authors' compilation

The result on Table 1, revealed a decline in the use of traditional construction materials of 29.3% and increase in the use of modern ones of 70.7%. The improvement is more in Tegina, Gada, Makera, and lowest in Tashan Bala settlements. The percentage change is 41.4%.

The construction of Tegina-Makera road has enable farmers to expand their farmlands and produce more crops than they did before. More variety of food and cash crops are now cultivated in greater quantities because fear of wastage has been removed by the construction of the new road. This

is evident by the presence of many farm products such as yams, cassava, maize, millet, beans, groundnut, vegetables and fruits, which are seen displayed all-year-round along the road corridor.

The farmers in the study area practice both irrigation and rain-fed farming, so land is of great importance to them. It was discovered that land used for agricultural purposes is obtained through many sources which include inheritance (41.7%), gift (23%), rent and purchase. These forms of ownership have effects on the degree to which the land is used before and after the road construction. After the construction of the road, value of land for farming increased and new dimensions of ownership were introduced apart from inheritance. The non-indigene migrants acquire land through purchase, pledge, loan, rent and gift from the indigenous land owners.

Table 2.Ownership and Change in farm sizes before and after Road Construction

	Number of respondents		
Farm land Sizes (Ha)	Before road construction (a)	After road construction (b)	Percentage change (b-a / a x 100)
$^1/_2$	13	00	-
1-2	46	13	-71.7
3-4	39	46	17.9
5+	52	91	75
Total	150	150	

Source: Authors' compilation

The result on Table 2, shows increase number and size of farm (above 80% of those interviewed own between 3-5 ha of land), this means that smaller farm sizes before the road was constructed gave way to ownership of larger farm sizes after the road was constructed. This could be, because the road has opened up the areas, increased demand for primary produce facilitated establishments of new markets and develop agricultural marketing.

Agricultural land in this study comprises all the land used fully or partly for purposes of crop cultivation, livestock rearing, poultry management and felling of trees. It was found out that the development of Tegina-Makera road has improved awareness of the importance and ownership of land for all the purposes, leading to increase in farm size (see Table. 2). This confirms that there is increase in area cultivated and growing importance in cash crops and grains farming, introduced by migrant from the northern Hausa land to this area.

Table 3 Involvement in Secondary Occupations before and after Road construction

Occupation	Number of respondents		
	before road construction	after road construction	Percentage change (b-a / a x 100)
Farming	53	58	9.4
Wood selling	42	45	7.1
Trading	23	25	8.6
Hand work	18	05	72.2
C / Motorcycle	14	17	21.4
Total	150	150	

Note: C / Motorcycle = Commercial Motorcycle

Source: Authors' compilation

The construction of Tegina-Makera road has encouraged creation of secondary occupations. The results on Table 3, show that significant percentage of the people are engage in off farm activities like commercial motor cycle operator 11.3%, fuel wood selling 30% (Plate 1), trading 16.7%, mechanic work and other hand works 0.3%.

Plate 1: Firewood for sale at Makera

This occupational diversification which came with construction of Tegina-Makera road provided additional income which has multiplier effects on the welfare of the people. It was found out that commerce and food vendor activities have catalyzed growth of Gada settlement. Gada is presently a major stop over for travelers and different socio-economic activities have increased because of daily movement of people.

The Tegina-Makera road was constructed between1983-1988. Before then, it was reported that there were no social infrastructure like food canteens, film house, and drug shops. But after the construction a number of these welfare infrastructures like heath centers, motor park, mechanic workshops, olice station and worship places were constructed.

Table 4, present the information on status of socio-economic infrastructures in settlement along Tegina-Makera road. This confirmed that Tegina and Makera settlements have highest number of the socio-economic infrastructures before and after the road construction. This is because they are old settlements, which have better chance or political opportunities to attract additional infrastructures. While others like Gada and Manigi settlements evolved after the road was constructed.

The cutting of trees for sale as firewood is one of the major occupations practiced by residents in all the seven sizeable settlements not more than 5km from the road during the research in the study area. The firewood is use for cooking at home, burnt to produce charcoal and sold to travelers or lorry drivers (Plate, 2).

Table 4. Status of Social infrastructures before and after Road Construction

Social Infrastructures	Tegina	T/Bala	Gada	D/Hawa	K/Inga	Manigi	Makera
Bank	-	-	-	-	-	-	-
Central Mosque	1963	1997	1985	2008	1992	1985	1970
Church	1970	-	-	-	-	1985	1974
Court	-	-	-	-	-	-	1995
Fuel Station	1978	-	-	-	-	1990	1980
Health Centre	1999	-	2002	-	-	2000	1994
Hotel	1998	-	-	-	-	-	1995
Market Place	1975	1998	1989	-	1989	1973	1976
Mechanic Workshop	1970	1998	1989	-	1989	1973	1976
Motor Park	1975	-	2000	-	-	1980	1978
Patent Medicine store	1988	-	1989	-	2000	1989	1989
Police Station	1990	-	2005	-	-	1998	1990
Primary School	1970	-	1989	-	-	1995	1975
Secondary School	1978	-	1999	-	-	2003	1989
Tertiary Institution	1978	-	-	-	-	-	
Viewing Centre	1997	2008	-	2007	2005	2005	2006
Well / Borehole	1981	-	2005	-	2001	1986	1980

Note: T/Bala= Tashan Bala, D/Hawa=Dogon Hawa, K/Inga=Kangon Inga.
Source: Authors' compilation

Plate 2: Firewood of fuel Tanker at Dogon Hawa

5. Summary and conclusion

This research on the effects of Tegina-Makera road on rural people's welfare is an attempt to identify the opportunities that usually accompany road construction in rural areas and how it provides opportunities for increased livelihood growth. It focused on how rural people availed themselves of these opportunities and its adverse environmental effects.

The settlement pattern has changed and housing types have improved; ownership and size of farm land has increased; new job opportunities have developed and people in the area are currently

involved in secondary occupations, like fuel wood selling, trading and commercial motorcycle operation.

There are improvements in the location of social and welfare infrastructures. The continuous cutting down of trees for firewood and charcoal for supply to urban centress has resulted in loss of forest vegetation, biodiversity reduction and erosion. This road has generated many opportunities and it is as well, creating challenges for the people and authority concerned.

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EFFECTS OF "ABEGA" AND "RAOIN" MODELS ON STUDENTS' ACADEMIC ACHIEVEMENT IN ENVIRONMENTAL EDUCATION IN SCHOOLS OF NURSING, ZARIA, NIGERIA

S. S. Obeka[1]

[1]Geographical and Environmental Education, Department of Science Education Ahmadu Bello University, Zaria

Abstract

The study investigates the effects of "ABEGA" and "RAOIN" models on students' academic achievement in traditional concepts of environmental education in schools of nursing, Zaria Nigeria. The study made use of two hundred (200) students from school of Nursing ABU Zaria and School of Nursing Wussasa – Zaria. Radioactivity and radiation concepts were used in the teaching. Two research questions and one hypothesis guided the conduct of this research exercise. The quasi-experimental non-equivalent control group, pre test – post test study was designed to determine the efficacy of "ABEGA AND RAOIN" models on students achievement in radiation concepts. Achievement test was used as instrument for data collection in experimental I&II ("ABEGA" AND "RAOIN" MODELS), lectures was used as control. The instrument (ERAT) was validated by two experts of Science Education, A.B.U Zaria. An item analysis was done with item difficulty level of 0.30 and 0.70 and item discrimination index of 0.22 and 1.00. The study revealed that Instructional model I and II yielded better achievement gains in environmental health education programmes than lecture. It also reveals that male students did better academically than the female students. It is recommended that environmental health education programme should be introduced in secondary and tertiary institutions and teachers should be encouraged on the use of modern techniques of instructions.

Key words: ABEGA, RAOIN, Nursing, environmental education

1. Introduction

Science and Technology Education (STE) play a significant role in the development of scientifically literate citizen in our society. It is therefore imperative that science and technology education should be appreciated from conceptual and instructional values by literate citizens. Such values according to STAN (2000) are either intrinsic (i.e. by virtue of its very native) or extrinsic (i.e. externally or traceable to it from its effect). In either case, such values help to define the objectives of the S and T.E programme with the aim of:

- Solving our economic and social problems
- Acquisition of relevant concepts and processes of scientifically literate society which is a prerequisite for national development given that we live in a world ruled by science and technological advancement.
- Improving the society through increasing the efficacy of both science and technology education and fostering international relations.
- Contribute to improving man's living conditions generally and improvement in environmental health education through the acquisition of appropriate concepts and instructional skills.

In order to appreciate Science and Technology Education better, the National science teachers Association of the United States of America, as cited in Yagar (1993) identified some features of science and technology education to include the following.

- Students identification of problems with local interest and impacts
- The use of local resources and materials to locate information that can be used to solve environmental problems.
- The active involvement of students in seeking information that can be applied to real life problem solving.
- The extension of learning outcomes beyond the class to global environment.
- A focus on the impact of science and technology on the individual students.
- A view on the development of science and technology education content and concepts.
- An emphasis on acquisition of science process skills to solve environmental problems.
- Emphasis on career awareness and opportunities for students to act in their environment as they attempt to resolve indentified say to day problems of life. (Yagar, 1993).

The development of Environmental Health Education Curriculum of Science and Technology Education in schools require awareness programmes for primary, secondary and tertiary levels. According to STAN (2000), S.T.S curriculum at these levels include the followings:

2.1 STE at the primary level

At the primary school level, some STE topics are embedded in some themes of the core
curriculum for primary science. These are:

Theme	Topic
Exploring the Environment	The Child is part of the environment Erosion Pollution Exploitation of natural resources Conservation practices - natural resources, energy use, recycling Fertilizing the soil Garbage and sewage disposal Drainage and irrigation
Using the Senses	Sorting of common objects by smell
Bulb and Battery	Lighting torch bulbs Conductors and insulators Simple electric circuits Uses of switch and fuse in everyday life Common uses of electricity in everyday life (domestic, commercial and industrial).
Sound	Making flutes or string instruments with local materials
Magnetism	Uses of magnets
Our Earth and Our Sky Technology	Earth's movement and its effects Local examples of things and practices we do to make work easier Identification of simple machines and tools
Heat Energy and Temperature	Uses of heat in everyday life Uses of Thermometers - domestic, industrial and commercial
Soap and Alkali	Making soap with local materials Uses of soap
Water	Uses of water at home Water cycle
Common Foods	Common f3ods eaten at home Uses of food Balanced diet
Simple Machines	Uses of levers, pulleys and inclined plane Useful and harmful effects of friction in everyday life
Health & Safety	Keeping the surroundings. clean Good personal health habits Keeping safe at home, at school and along the road Simple first aid on how to clean wounds, stop bleeding, dress wounds, treat stings, bites from snakes, dog, scorpion and wasp. How to tell when you must see the doctor How to carry out artificial respiration.
Housing and Clothing	Need for houses Need for clothing
Farm Animals	Rearing chicken

2.2 STE at the Secondary level

At the secondary level of education, STE is not taught as a separate subject. STS topics are included in the Core Curriculum for Integrated Science. Details are as follows:

Unit	Topic
Living Things	Identifying self as a living thing Human intelligence shown by his/her organisation, problem solving skill, etc.
Feeding	Keeping teeth clean
Excretory System	Excreta are poisonous Need for excretion
Respiratory system	Problems connected with breathing Need for respiration
Circulatory System	Blood defects or diseases
Nervous System	Types of eye defects and their correction with glasses/lenses
Reproductive System	Reproduction and family tree Changes that accompany puberty in boys and girls
Health	Good health, its maintenance and for growth Keeping fit through good exercise, good diet, good hygiene Drug abuse Improving personal cleanliness Polluted water in the home Polluted air in the home Dirty environment and the home
Child's Growth and development	Factors that affect growth – food diseases hereditary factors
Energy and Appliances in the home	Use of Energy in the home
Continuity of the Family	Number and extended of Dominant and recessive traits in successive generations
Ecology	Transfer of energy from the non - living to the living world by green pts Food chain and food webs
Resources from Living	Cash crops, livestock, fishery, diary products
Components of the Environment	
Observing samples of non-living Things	Limitation of out senses Use of devices to aid senses
Water	Purification and uses Soft anti hard water
Man in space	Climate and seasons Space travel Gravitational pull
Pure and Impure stances	Salt from sea water Petroleum refining
Rusting	Conditions necessary for rusting
Acids, Bases and salts	Acids in nature
Energy Conversion and Transfer	Echoes and vibrations, noise, music
Science-Related Occupations	Farming, fishing, carpentry, engineering , medicine
Force	Friction in use Advantages of friction Effects of force
Maintenance of Machines	Importance of regular maintenance of machines Need for reducing friction in machines Uses. of grease, oil, ball bearing to reduce friction
Environmental Sanitation	Disposal of refuse in villages and towns Compost Sewage Flush toilets
Disease Vectors	Mosquito and housefly Use of insecticides River blindness, sleeping sickness, and malaria
Preventive Medicine	Clean water - cholera, diarrhea, typhoid Immunization - vaccination, inoculation
Wildlife Conservation	Man's activities and Wildlife preservation
Pollutants	Air borne solid and gaseous pollutants Pollutants from home and industry Replanting our forests
Erosion	Causes of erosion and prevention of erosion
Oil Spillage and Burning of Natural Gas Resources	Effect of oil spillage and burning of natural gas in a riverine environment
Deterioration of the Environment Due to Human activities	Our disappearing forests Encroaching deserts Other fue1 Cooking

2.3 STE at the Tertiary Level

At the tertiary level, there are components of STE in some general courses in Universities, Polytechnics and Colleges of Education. However, at the postgraduate level, some Universities offer courses on STE. The exact content varies from one University to another. However, the following content areas may be deduced.

(a) Introduction to STE

- Dimensions of science: The Historical (history of science), the sociological (Sociology Science), the psychological (psychology q science), and the Philosophical (the epistemology and linguistics of science).
- Overview of interaction of science-technology-society.

(b) Developments in Science, Technology and Society

- Science and human goals - Basic needs
- Mechanization and automation at home and industry:
- Developments in science-technology-society.
- Materials & Manufacture: (1) Natural Substances (proteins, carbohydrates, natural rubber, wood, fibres-cotton, wool, silk); (2) synthetic products (plastics, synthetic fibres, synthetic rubber, synthetic fuel, etc.); (3) petrochemicals, (4) Synthetic foods. (5) biotechnology and genetic engineering.
- Communications & transportation
- Weather and Climate: Meteorology and human activities.

(c) Science-Technology and Organization of Family and Social Life

- Effects of science & technology on human Social environment; Sciencetechnologjca1 developments & consequences for social systems: Food, sexuality, and survival; population problem, its contextual variables, consequences, controls & checks; biology of affluence: the urban ecosystem.
- War and peace: science & technology and weapons of war: biological, chemical, and nuclear (physical) warfare.
- The present and future problems of science and technology: (i) Natural resources - use and misuse; (ii) pollution of air, water, and food; (iii) space explorations and consequences; (iv) (iv) Conservation - renewable and non-renewable resources, limits of growth, energy (fuel) and power for the future; (v) biological engineering genetic engineering, cloning, test-tube babies, eugenics, euthenics, etc.
- Adjusting to technological changes

(d) Scientists and Public Affairs

- Science-Technology policies: National International priorities in science technology for developing countries. problem of resources (human and material) allocation to science and technology government. Administrative structures. Science technology and government.
- Promotion of science and technology in Nigeria: Science as a social institution. The learned societies. The government & scientific-technological developments – Research institutes.
- Promotion of science and technology in Africa.
- The social responsibility of scientists and technologists.

(e) Research in STE

Research is the systematic investigation to increase knowledge and/or understanding Obeka (2011). Research in STE, understandably, has a short history and provides an interface between research in the sciences and research in social sciences. This is because research in STE deals with both science and human beings. In Nigeria, few studies on STE have been carried out:

Consequent studies in various concepts in Science and Technology Education (S.T.E) are necessary to enlighten and educate the populace on recent trends in S.T.E. A study on radioactivity and radiation concepts model involves some environmental health education concepts. (Alpha (A), Beta (BE), and Gamma (GA) = "ABEGA" model and Radiation model (Radiation and Radio therapy (RA) and Conization Radiation (10N) = "RAOIN" model). Hence the word "ABEGA" and "RAOIN" are acronyms derived from the environmental health education concepts of study.

The word radioactivity refers to the particles which are emitted from nuclei as a result of nuclear instability. Because the nucleus experiences the intense conflict between the two strongest forces in nature, it should not be surprising that there are many nuclear Isotopes which are unstable and emit some kind of radiation. The most common types of radiation are alpha, beta and gamma radioactivity (Osein, *et al*, 2007).

Historically, the products of radioactivity were called alpha, beta and gamma when it was found that they could be analyzed into three district species by either a magnetic field or an electric field (Lawrence, 2008).

Alpha radioactivity is composed of protons and two neutrons. The alpha particle is a nucleus of the element helium. Because of its very large mass (more than 700 times the mass of beta particle and its change, it has a very short range hence, it is not suitable for, radiation therapy since its range is less than a tenth of millimetre inside the body. Its main radiation hazard comes when it is ingested to the body. It has great destructive power within its short range. In contact with fast-growing membranes and living cells, it is positioned for maximum damage. The alpha particle is the nucleus of the helium atom and is the nucleus of highest stability (Noda, *et al* 2009).

Bête Join later Gamma ray emission on the other hand usually occurs with α and $\pi^{1/}{}_{2}$ emission. Gamma rays have no charge or mass, so their emission doesn't change the chemical composition of the atom. Instead, it results in a loss of radiant energy. Gamma ray emission occurs because the nucleus often unstable after α and $\pi^{1/}{}_{2}$ decay. There are cases where pure Gamma emission occurs and this is where an Isotope exists in two forms (Nuclear Isomers). They have the same atomic and mass numbers, but have different nuclear energy content. So gamma emission occurs when the Isomer goes from a higher to a lower energy form. The Isotope protactinium – 234 exists in two different energy states and it emits rays when undergoing transition to the lower energy state.

Radiation and Radiation Therapy of Environmental Health education are crucial concepts of day to day living in our contemporary society. Radiation is a process in which energetic particles or energy or waves travel through a medium or space. There are two types of radiation (Ionizing and non-Ionizing). Ionizing – having sufficient energy to ionize an atom and non – ionizing: as radio waves or visible light). The energy radiates or travels outward in straight lines in all directions from its source. Both cognizing and non-ionizing radiation can be harmful to organisms and can result in changes to the national environment.

Nevertheless, radiation can be useful in medicine, in communication and in science. In medicine radiation and radioactive substances are used for diagnosis, treatment and research. X – ray for example pass through muscles and other soft tissues but are stopped by dense materials. This property of X – rays enables doctors to find broken bones and to locate cancers that might be growing in the body. Doctors also find certain diseases by injecting a radioactive substance and monitoring the radiation given off as the substance moves through

the body. Radiation used for cancer treatment is called ionizing radiation because it forms ions in the cells of the tissues. It passes through as it dislodges electrons from atoms. This can kill cells or change genes so that cells cannot grow. Other forms of radiation such as radio waves, micro – waves and light waves are called non-ionizing. They don't have much energy and are not able to ionize cells.

In communication, all modern communication systems use forms of electro-magnetic radiation. Variations in the intensity of the radiation represent changes in the sound, pictures or information being transmitted. For example, human voice can be sent as a radio wave or micro-waves by making the wave vary to correspond variations in the voice.

In science too, researchers use radioactive atoms to determine the age of materials that were once part of a living organism. The age of such materials can be estimated by measuring the amount of radioactive carbon they contain in a process called radio carbon dating. Environmental scientists use radioactive atoms known as tracer atoms to identify the pathway taken by pollutants through the environment.

Radiation is also used to determine the composition of materials in a process called neutron activation analysis. In this process scientist is bombard a sample of a substance with particles called neutrons. Some of the atoms in the sample absorb neutrons and become radioactive. The scientists can identify the elements in the sample by studying the emitted radiation.

Radiation therapy is relevant in detecting and killing cancerous cells in the body. Radiation therapy uses high energy radiation to shrink tumors and kill cancer cells. X – rays, gamma rays and charged particles are types of radiation used for this purpose. The radiation may be delivered by a machine outside the body (external bean radiation therapy) or it may become from radioactive material placed in the body near cancer cells (internal radiation therapy) (factsheet on radiation undated).

Consequently, toward improving teaching and learning in environmental health education concepts of radiation therapy, doctors and other researchers are conducting research studies to examine effectiveness of instructional techniques in this subject area. This study therefore is one of such contribution to knowledge

The objectives of the study are to: examine the efficacy of "ABEGA" and "RAON" instructional models on students' understanding of radiation concepts of environmental health education, and examine the effects of the models on the achievement scores of male and female students exposed to environmental health education achievement test.

The following research questions guided the conduct of this study:

1. Is there any difference in the academic achievement of students exposed to environmental health education achievement test and those not exposed?
2. What is the relative difference in academic achievement by gender in experimental class ABEGA and RAOIN (I & II) and lecture class when students were exposed to environmental health education achievement test?

The hypothesis posited is that there is no significant difference in academic achievement of students taught Environmental Health Education Concepts using models and those taught using lecture.

3. Materials and Methods

The study was a quasi: - experimental with a non-equivalent control group design involving three groups namely: "ABEGA" Model, "RAOIN" Model and lecture (control). Two schools were selected in Zaria Metropolis namely: Ahmadu Bello University (ABU) School of Nursing, and St. Luke Anglican School of Nursing Wussasa – Zaria. Two hundred sample population of the students were used. Environmental Concepts Achievement Test (ECAT) was used as instrument for the study.

Reliability of the instrument was established using Kudder Richardson formula with r-value of 0.92. The instrument Environmental radiation Achievement Test (ERAT) was validated by three expert of Science Education ABU Zaria. Two research questions and a hypothesis guided the study. Mean, Standard Deviation and analysis of covariance (ANCOVA) were used to analyze the data at 0.05 level of significance.

4. Presentation and discussion of Result

Table 1: Mean Achievement scores of students exposed to Environmental Health Education Achievement Test (EHAT).

Instructional techniques	N	Mean $\overline{X}$	Standard deviation (SD)
Exp 1	67	48.23	9.54
Exp 2	67	45.20	11.62
Lecture	66	41.09	12.01

Table 2: Mean achievement scores of students by gender in experiment I and II and lecture Groups.

Instructional techniques	N	Gender	N	Mean $(\overline{X})$	Standard deviation (SD)
		Male	30	46.40	3.30
Exp 1	67	Female	37	42.23	3.32
		Male	30	40.20	3.38
Exp 2	67	Female	37	38.40	3.48
		Male	30	30.20	3.67
Control	66	Female 36	36	28.47	4.75

Table 3: Environmental Health Achievement Test (EHAT) Analysis of Covariance of Students post Achievement Scores.

Sources of variation	Sum of squares	Df	Mean score	f-value	Significant at P
Covariate	10142.450	1	10442.456	132.299	.000
Pre-achievement	10142.450	1	10442.450	132.247	.000
Main effect	2517.139	3	839.130	109.45	.000
Treatment	2446.690	2	1223.347	15.957	
Gender	42.828	1	42.828	.559	.000
2 – ways interaction	9.135	2	4.571	.060	.945
Treatment – X	9.155	2	4.577	.060	.945
Explained	12668.996	6	2111.499	27	.000
Ragidual	36866.185	22	76.664	545	-
Total	**29535.181**	**22**	**130.687**	**-**	**-**

Source: Author's analysis.

The result in table 1 reveals that experimental I model group of instruction achieved statistically better result followed by experiment 2 and lastly ; lecture group with mean scores of 48.23, 45.20 and 41.09 respectively. The result in table 2 indicate that males in experiment group 1, Exp groups 2 and control group did better academically, than female when they were taught with environmental health education concepts of radiation model "ABEGA" and "RAOIN" models.

Table 3 showed p-value ratio for the effect of treatment on the students cognitive achievement in environmental Health Education Concepts of Radiation to be beyond 0.05 level of significance.

Thus, the Null hypothesis was rejected and alternative accepted that significant difference exist in academic achievement of students exposed to models of instruction in some environmental Health education concepts of radioactivity and radiation.

5. Summary and recommendations

The study established that a study on radiation concepts using "ABEGA" and "RAON" models of instruction in environmental education amongst school of nursing students in Zaria yielded positive academic achievement by gender. Literatures reviewed also showed that radiation, use of models and radio-therapy are relevant concepts in educating the child. The study is therefore quite relevant in science and technology education, hence should be encouraged at all levels of education.

From the findings of this study, the following recommendations were made:

1. That the use of new models of instruction should be encouraged in higher institutions by National University Commission, National Board for Technical Education and other agencies responsible for education.
2. Seminar, conferences and workshops should be organized by education and medical stakeholders on the utility value of current models.
3. Conducive teaching and learning environment should be created by all educational administrators to reduce gender inequality noticeable in academic achievements.

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APPENDIX I

Alpha, Betta and Gama Radioactivity

Fig I: Alpha Radioactivity

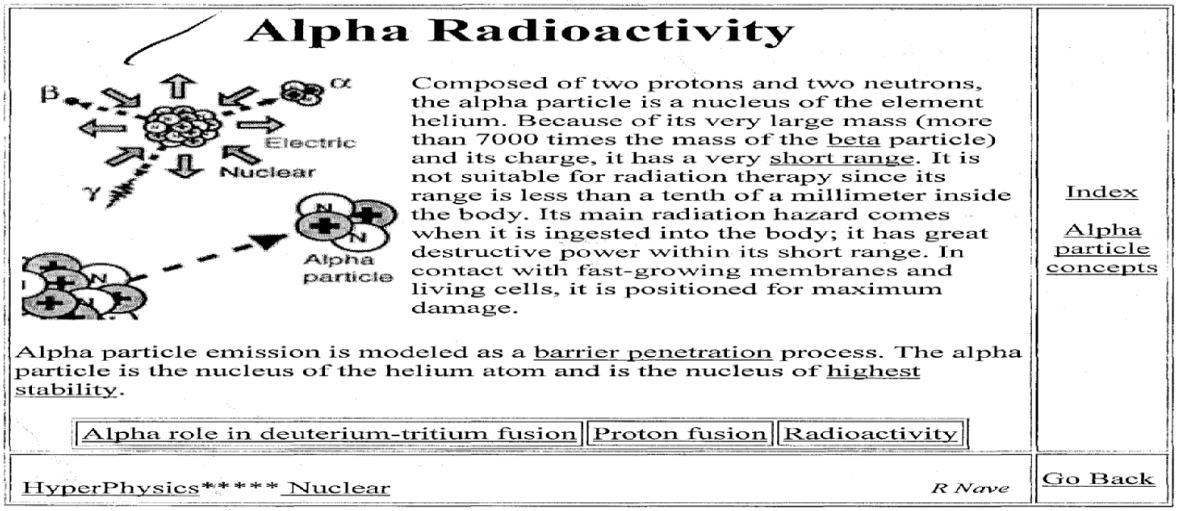


Fig. II: Alpha Binding Energy

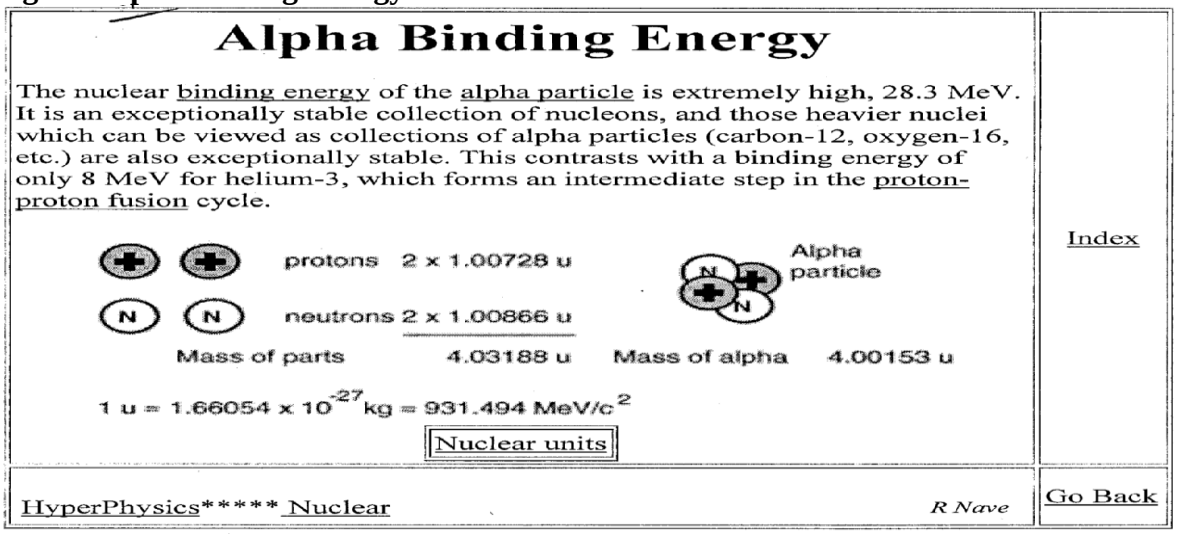
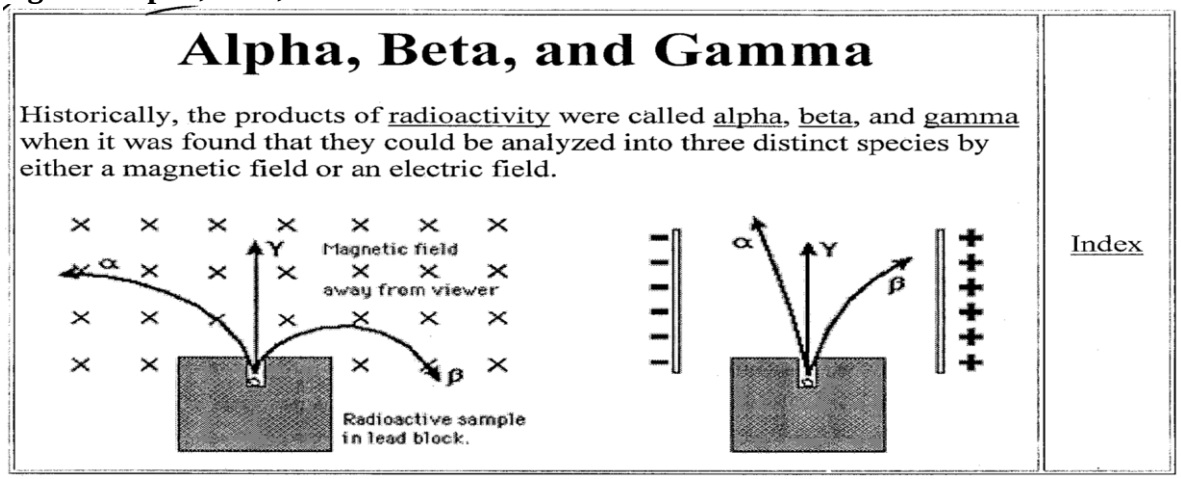


Fig. III: Alpha, Beta, and Gamma



Sources:(http://e.wikipedia.org/wiki/Radiation) and (http://lib:thinkquest.org/17940/test/radioactivity/htm)

FORECASTING RIVER KADUNA DISCHARGE USING HYBRID MOVING AVERAGES AND SMOOTHING EXPONENTIAL METHODS

J. O. Folorunsho[1]

[1]Department of Geography, Ahmadu Bello University, Zaria, Nigeria

Abstract

This paper explores the use of hybrid moving averages and smoothing exponential (HMAs & SE) methods for river flow forecasting. In this study, four major variables for river discharge (rainfall, temperature, relative humidity and stage height), and the discharge values of River Kaduna drainage basin for the period 1993-2004 (Apr-Oct) was used. The variables were used as the input data while the discharge values were used as the output data for the model. The modeling tool was applied to the initial data in order to predict new sets of input values for the period 2005-2015, and subsequently used to generate the output for the same period. The efficiency and accuracy of the HMAs & SE was measured based on the comparison of the initial discharge values (1993-2004) and the forecasted discharge values for the period 2005-2015. From the result using a plot, it was shown that the model provided the best fit and the forecasted discharge trend followed the observed data closely. These result shows that Hybrid Moving Averages and Smoothing Exponential Methods is an effective tool in forecasting river discharge.

Keywords: River Discharge, Hybrid Moving Averages and Smoothing Exponential Methods, River Kaduna

1. Introduction

The discharge forecast model developed for forecasting monthly average of discharge expected in the River Kaduna drainage basin is the Hybrid of Simple Moving Averages and Smoothing Exponential Methods. This is dependent on weather variables namely rainfall, temperature, relative humidity, and stage height and the river discharge data. These variables are basically time series data. According to Abbasov, *et al*,(2003), time series represent a consecutive series of observations of variable(s) taken at regular time intervals over time. One basic requirement for time series is that the data must be displayed in the order in which they occurred, since it is possible that successive observation may probably be dependent (Rojas and Pomares, 2004; Monks, 1996).

The challenge of predicting future values of a time series span a variety of disciplines and as such, time series techniques find applications in such diverse data sets as equity market pricing, disease control, hydrological predictions, meteorological measurements, astronomical observations among others (Rojas *et al*, 2004). The idea of using set of values to certain time, t, to predict the future at another time, t+P, is termed ***Time Series or Stochastic Variables Prediction***.

A time series is a set of a variable at regular intervals over time. A basic requirement for the time series is that the data must be displayed in the order in which they occurred, since it is possible that successive observations may probably be dependent (Rojas, et al., 2004; Monks, 1996). Thus, a time series possess three basic components namely Trend, Seasonal effects, and finally Cyclical factors. The trend is the underlying direction (upward or downward tendency) and rate of change in a time series, when allowance has been made for the other components; seasonal effects describe similar variations occurring during corresponding periods, and cyclical factors describe any regular fluctuations of a time series (Mu'azu, 2006). Time series analysis relies, at least in part, on understanding or exploiting the dependence among the observations. Due to this reliance, the goal of time series prediction can, therefore, be stated thus as: Given a sequence up to time t, the prediction is based on creating a data point, D, scenario "sample every **Δ** units in time **(x(t-(D-1)Δ),..., x(t-Δ), x(t))**, to a predicted future value **x(t+P)"** (Rojas and Pomares, 2004; MATLAB (R2009b). The method to be employed in finding this continuation is a combination of the Simple Moving Average method and Exponential Smoothing, which find applications in stochastic and Erlang distributed data (Kennedy and Davis, 1993).

2. Study Area

River Kaduna drainage basin lies between latitude $9^0$30'N and latitude $11^0$45'N; longitude $7^0$03'E and longitude $8^0$30'E with a total basin area of approximately 21,065 km2 (Figure 1). The basin enclosed major rivers such as Kubanni, Galma, Tubo which are tributaries to the main River Kaduna and a greater part of the Kaduna metropolis. The basin lies on the High Plains of Northern Nigeria at altitude of about 670m above sea level and situated within the Northern Guinea Savanna. Typical of the savanna climate, River Kaduna drainage basin experience distinct wet and dry seasons. The wet season (May-Oct) is

characterized by conventional rainfall followed by intense lightning and thunderstorms. The annual rainfall can be as high as 2000mm in wet years and as low as 500mm in drought years, but with a long term average of 1000mm (Folorunsho, 2004). The dry season (Nov-Apr) is characterized by a period of low temperature with harmattan season around Dec-Feb; and the hot dry season between Mar-Apr with temperatures as high as 32^0C. Relative Humidity is high only during the raining season, but drops during the dry season (Sawa and Buhari, 2011).

3. Materials and Method

Monthly averages of rainfall (Zaria, Kaduna and Jos), temperature, relative humidity for Kaduna metropolis and stage height of River Kaduna (input variables) and discharge data (output) for River Kaduna was used for the forecast. The data covering a period of twelve (12) years (1993 – 2004) and for the rainy months in the basin (Apr-Oct) were sourced from the Hydrology Department, Kaduna State Water Board, Kaduna, and Nigerian Meteorology Agency, Oshodi, Lagos, Nigeria.

Simple Moving Averages (SMA) is the average of the absolute deviations of the series of data above from their mean. Equally, it is a technique that uses a type of average that is adjusted to allow for seasonal, cyclical components of a stochastic variables and help brings either short, mid, long term trends clearer.

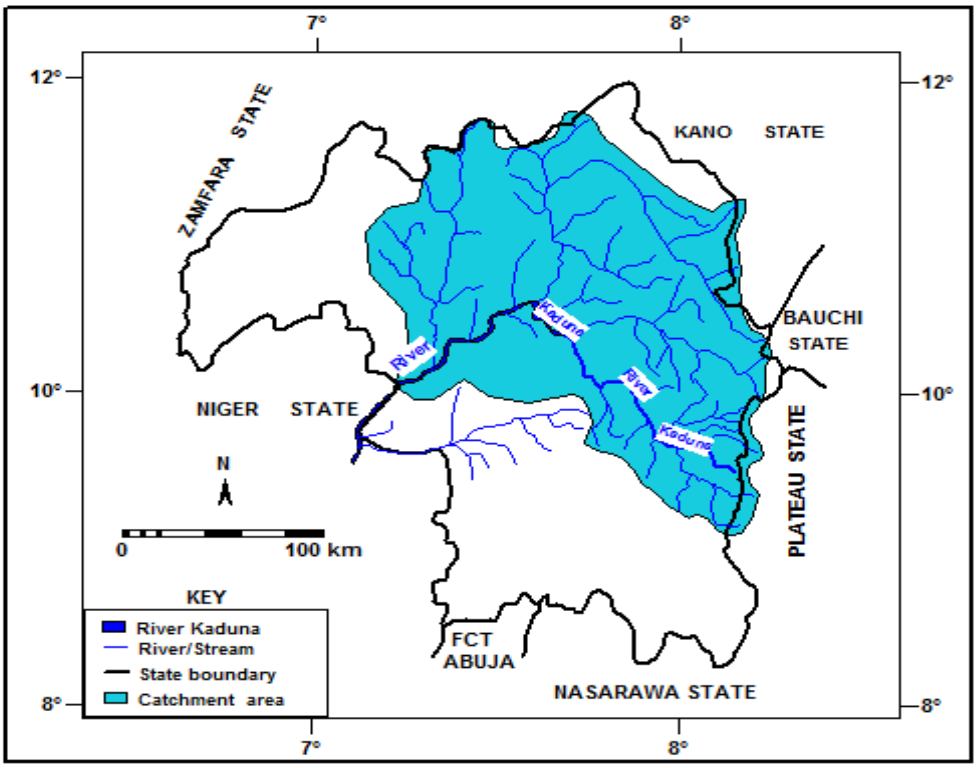


FIG. 1 : THE DRAINAGE BASIN OF RIVER KADUNA
Source: Modified from Drainage Map of Kaduna State

In SMA only **n** most recent periods of data points need to be maintained. At the end of each sequence of **n**, the oldest sequence is discarded and the newest data is added to the database. The database is then divided by **n** and used as a forecast for the next period (Monks, 1996; Mu'azu, 2006). The moving average **x(t + 1)** for stochastic data of a period **(t + 1)** is given by equation 1 (Mu'azu (2006):

$$\boldsymbol{x(t+1) = \frac{[D_1 + D_{t-1} + \cdots + D_{t-n-1}]}{n}, n \leq t} \qquad 1$$

where, **n =** number of observations used and **D** = stochastic data

Determination of Number of Observations (n)

The number of observations (n) determined by selecting a value that minimizes the Mean Square Error (MSE) of prediction is given by equation 2 (Mu'azu, 2006):

$$\boldsymbol{MSE = \sum_{i=1}^{n} \frac{[(D_i - x_i)]^2}{n}} \qquad (4.\ 2$$

where, $\boldsymbol{x_i}$ = mean of the data set

The value $\boldsymbol{x_i}$ was obtained using a moving window of thirty-six (36)-months, fourty-eight (48)-months, sixty (60)-months and seventy-two (72)-months width (**n** = 36, **n** = 48, **n** = 60 and **n = 72**) on the input variables.

Smoothing Exponential method is a forecasting technique that weighs past data in an exponential manner, so that the most recent data carries more weight. The exponentially smoothed moving average is based not on a sequential average of individual stochastic periods, but on the most recent data and the average prior to it adjusted by a smoothing constant, α. The expression for the smoothing constant is in equation 3 (Mu'azu, 2006).

$$\boldsymbol{\alpha = \frac{1}{\frac{n}{2} - 1}}$$

The smoothed series is updated as new observations are recorded using the expression in equation 4:

$$\boldsymbol{S(t) = \alpha D(t) + (1 - \alpha) S(t - 1)} \qquad 4$$

where, S(t) is the value of the smoothed stochastic series.

The current smoothed value S(t) is an interpolation between previous smoothed value (S(t-1)) and the current observation, and α controls the closeness of the interpolated value of the recent observation (Mu'azu, 2006).

4. Results and Discussion

Using equations 1 and 2, the simple moving averages operations was performed on the obtained data and the values shown in Tables 1 and Table 2 were obtained. Subsequently $\boldsymbol{x_i}$was applied to the input data in order for the choice of the **n** in order to minimize the Mean Square Error (MSE) value to be used. The result is shown in Table 2.

Table 1: Mean ($\boldsymbol{x_i}$) values for River Discharge Input Variables

N	Rainfall (mm)	Temperature (^{O}C)	Rel. Humidity (%)	Stage Height (m)
36	5.5011	25.3914	72.7853	0.2039
48	5.5044	25.3529	73.1463	0.1977
60	5.4325	25.3045	74.0068	0.2013
72	5.5379	25.2576	74.5751	0.2026

Source: Author's analysis, 2011

Table 2: MSE values for number of observations (n's)

Input variables	Mean Square Error			α = 0.03
	N			
	36	48	60	72
Rainfall	8.35	7.62	7.05	7.53
Temp	3.47	2.97	2.82	2.68
Rel Hum	99.54	87.80	82.96	82.90
Stght	0	0	0	0

Source: Author's analysis, 2011

From Table 2, **n = 72** generate the least Mean Square Error (MSE) value **α**, therefore it was chosen. The selected value of **n wa**s then used to forecast the input variables values for the drainage basin for the raw data (April- October, 1993 – 2004) Similarly, using equations 3 and 4, **α** value of **0.03** was obtained, and subsequently

used to make a complete forecast of input variables values and the discharge values for April to October 2005 – 2015 and the plot of the newly forecasted discharge result is shown in
Figure 2.

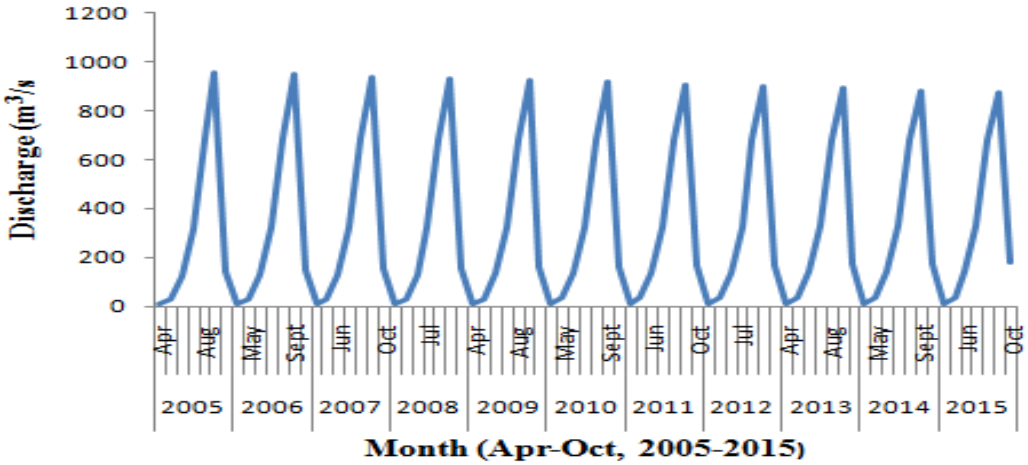


Figure 2: Showing the Plot of River Kaduna Discharge forecasted for Eight Years (Apr – Oct., 2005 - 2015)

Considering the plot in Figure 2 above (a compressed figure), the monthly forecasted discharge trend between April and October 2005 – 2015 exhibit a similar trend, cycles and seasonality expected in the drainage basin, a definite peak usually observed around August in the study area. These discharge trend correspond with the rainfall seasonality experienced in the drainage basin with the wet season usually covering the months of April – October each year. This condition confirm the research findings by Lafaje (2008); Oloniyo (1995); Musa (1997); and recently by Folorunsho (2004) on River Yobe, River Niger, River Werram and River Kaduna respectively Also, it was discovered from Figure 2 that the discharge values of River Kaduna without doubt has strong correlation to the rainfall trend, cycles and seasonality. . The condition observed in this study and past research findings further confirm the strong seasonality of rainfall and other variables in this drainage basin.

5. Conclusion

The sustainable development of any region is of paramount importance to the planning, development and management of its water resource. Thus, developing model to effectively forecast the river discharge is quite apt. In this research work, the Hybrid Moving Averages and Smoothing Exponential Methods was employed in the forecast of all the input

variables and the discharge data for River Kaduna between April – October for the years 2005- 2015 and the results obtained were very promising.

As such, with the trend, cycles and seasonality of the forecasted discharge variable obtained for April – October, 2005 – 2015 is assuring that with the collective and collaborative efforts of the policy makers, researchers and private partners, the water resources development of the drainage basin under the study is near over. From the foregoing, it can be concluded that the Hybrid Moving Averages and Smoothing Exponential Methods is a veritable tool in overcoming the discharge record paucity, inconsistency, unavailability, and unreliability hampering water resources planning and development in the study area.

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ANALYSIS OF TRENDS IN MONTHLY RAINFALL PROFILE FOR KATSINA, KATSINA STATE (1946-2006).

Y.G. Hassan[1] and A.I .Abdulhamed[1]

[1]Department of Geography, Ahmadu Bello University, Zaria

Abstract

This study examines the trends in annual totals and pattern in monthly distribution of rainfall in Katsina lat. $12^{0}03^{-}$ N Long $08^{0}32$'N. Daily records of rainfall over a period of 60 years(1946-2006) were used. The annual and the monthly rainfall data were subjected to normality test using Fisher's standardized co-efficient of Skewness (Z_1) and Kurtosis (Z_2). The result shows that over 85% of the data conform to the Gaussian normal distribution at 95% significant confidence limit. A linear regression technique was used to determine trend in both monthly and annual distribution. To further determine the trend, ten years and five years running mean were also used. The results show that, all the rainy months under study conform to the annual rainfall trends which started to decline in the 1960's. Monthly rainfall value shows an abrupt and frequent extreme variability between years with the exception of August. However, some times increase in monthly values reduces the frequency and intensity of such occurrence. This extreme variability is often described as catastrophic to crops at all stages of development.

Key words; Rainfall ,Annual, Monthly ,Skewness ,Trends

1. Introduction

In the tropics rainfall assume significance in nearly every phase of agricultural activity. From the timing of cultivation, planting and harvesting operation, to the timing of fertilizer application, variety selection and transplanting. The movement of the rainfall belt therefore provides a framework for the correct timing of these operations (Ilesanmi, 1972).The gross feature of rainfall pattern in Nigeria, as in parts of west Africa are usually considered in association with the inter-tropical discontinuity (Adejokun, 1965, Garnier, 1967 and Ilesanmi, 1969).The discontinuity is a moisture boundary separating the air of northern origin from that of the southern origin. The climatological significance of the ITD is that it provides a framework for following the south-north motion of the rain- bearing southerly air. The depth and motion of this moist air mass not only influences the rate of fall of rainfall, but also affects the duration and the spread of rains (Ilesanmi, 1972).

Rainfall in this region is low, highly erratic and unpredictable. Dry spells often occur at the beginning of the rainy season in this area and at times become disastrous to crops shortly after planting (Ati, 1996). . The start of the rain in the tropics is seldom abrupt, but is usually foreshadowed by a succession of isolated showers of uncertain intensity with intervening dry period of varying duration (Ojo, 1977, Ati, 2002).The break of the rainy season may be early in some years, greatly delayed in others (Bationo et al, 1997). Annual totals show a wide variation from year to year, whereas in any given year the incidence may show remarkable irregularities since the rains fall almost entirely as heavy showers or thunderstorms and this will greatly affect the yield of crops as observed by Anuforum and Okpara (2003).The annual rainfall variability is between 20-30 per cent in the Sudan savanna (Kassei and Afuakwa, 1993). Most of the researches in the Sudano-Sahelian region especially on annual rainfall amount show declining trend (Adefolalu, 1986b, Oladipo, 1989 and Anyadike, 1992).However, recent researches on trend especially those that encompasses data of mid 1990s and early 2000s indicate an increase in the annual rainfall amount. However, August rainfall is on the decline in the region (Ati, 2006).So if the annual rainfall is on the increase and August rainfall is on the decrease, then the rainfall structure might be witnessing changes in the region, as August is considered traditionally the wettest month in the region. This study attempts to investigate the pattern of monthly rainfall profile in Katsina. It has been observed that the quantity and quality in some months is critical to certain stages of plant growth, (Ilesanmi, 1972, Adebayo and Adebayo, 1998, Ibrahim et al, 2006).

2. Study area

Katsina is located on latitude $13^{0}01'$N Longitude $07^{0}41'$.The study area belong to the savanna bio-climatic type with alternating wet and dry season. It is characterized by a strong seasonality in rainfall and relatively high temperature (Iguisi, 2002).Rainfall is less than 1000mm per annum and occurs in only five months in the year between May and October. Rainfall is highly variable and onset of the rains is erratic (Ati, 2002). The daily sunshine duration is 8 hours. Air temperatures are constantly high with high evaporative demands. The potential evapotranspiration is only exceeded by actual rainfall from June to September and not very often in June (Mortimore and Wilson, 1965, Oguntoyinbo, 1983, Sivakumar et al, 1991, Falola et al, 1993).

The vegetation of the study area is of Sudan Savanna type, made up of short grasses 1-2 meters high and stunted trees. The predominant tree species are locust bean, and various species of Acacia and fig families (ficus), the dump palm, the silk cotton and baobab. A prolonged period of bush burning, over

grazing, cultivation and tree harvesting for cooking purposes has considerably degraded the vegetation cover to open grassland, bare surface and scattered scrubs. The grass communities sprout up shortly after the onset of the rainy season, blossom and become luxuriant almost completely covering the ground surface towards the later part of the rainy season. The grasses wither and turn rustic brown in the dry season (Iguisi, 2002).

3. Materials and methods

Materials for the research includes record of daily rainfall for 60 years (1946-2006) from the stations spread and were sourced from the Nigerian Meteorological Agency (NIMET) Office Oshodi Lagos. The data from the stations were subjected to normality test to examine whether the data is normally distributed using the standardized coefficient of Skewness (Z_i) and Kurtosis (Z_2) defined by Brazel and Balling (1986) as

Skewness

$$Z_1 = \{[\sum_{i=1}^{N}(x_1 - \bar{x})^3 / N]/[\sum_{i=1}^{N}(x_i - x)^2 / N]^{3/2}\}/(6/N)^{1/2}$$

Kurtosis

$$Z_2 = \left[\frac{\sum_{i=1}^{N}(x_i - \bar{x})^4}{N} / \sum_{i=1}^{N}(xi - \bar{x})^2 N\right] / \sqrt{24/N - 3}$$

Annual and monthly rainfall totals were calculated by summing up the daily rainfall data for each year in the station within the period under study.

Linear regression technique was used to test for trends in the rainfall series (Annual and monthly totals) in order to determine whether there is any monotonic increases or decreases in the average values between the beginning and the end of the series

Five -year and ten-year running means were calculated to further specify the character of the rainfall totals (annual and monthly).

The computed means stand as long term means for the annual totals (for the entire period). The period under study was sub-divided into non-overlapping sub-periods (1947-1956, 1957-1966, 1967-1976, 1977-1986, 1987-1996, and 1997-2006).

The decadal mean were compared with long term mean and their significance tested using crammer's test.

$$t_k = \left[n(N-2)/N - n(1+t^2{}_k)\right]^1/_2 t_k$$

4. Discussion of results

The annual rainfall value in Katsina from 1946-2006 are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean indicate values above the long term mean in the first two decade. From then the value decline and remain below the long term mean with a sudden increase between 1977-1983.

The decadal means of annual rainfall shows the first two decade with high values above the long term mean. While the last four decades have values below the long term mean.

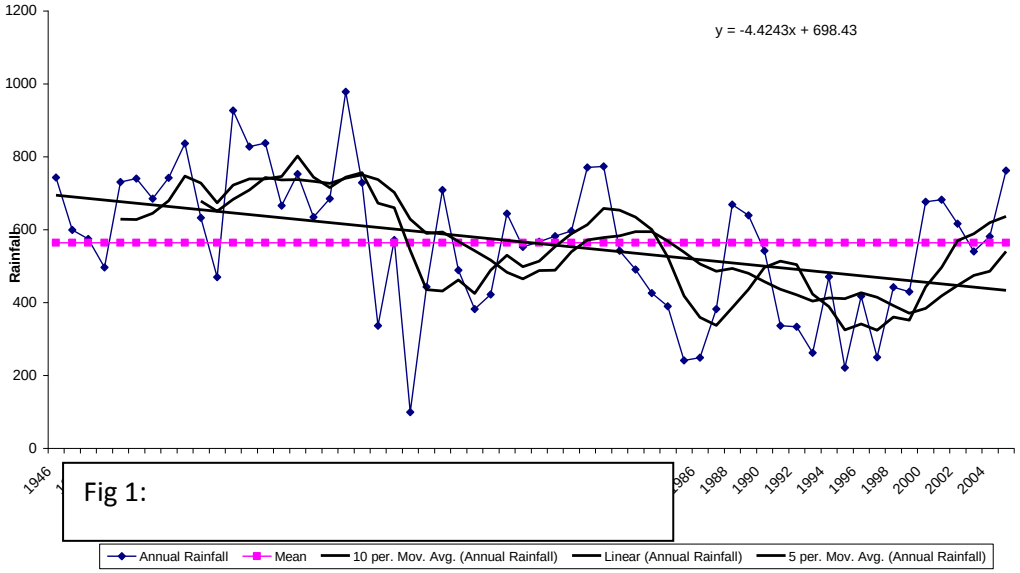

Fig 1: Annual rainfall trend for Katsina

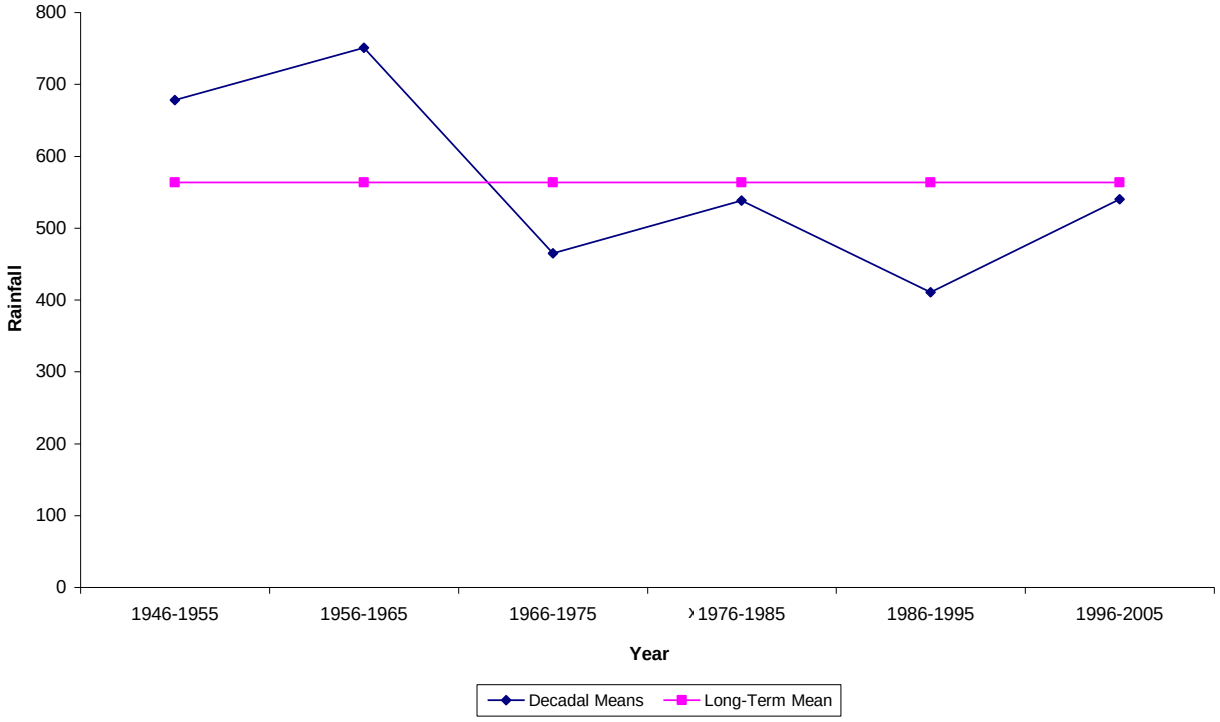

Fig 2: Relationship between decadal means and long-term mean for annual rainfall in Katsina

The May rainfall values are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean from figure 1 indicates values above the long term mean from the beginning until early 1960's, then the value decline until early 1970's with a sudden increase between 1965-1968 and then the values remain below the long term mean with a sudden increase between 1992-1995.

Table 1: Statistics of Monthly Rainfall in Katsina 1946-2005**.**

	May	June	July	August	September	October
Mean	28.11967	68.7845	152.7472	208.7017	94.32819	10.80167
S/Dev	29.39122	41.53965	80.33017	87.33501	53.1479	19.23772
CV	104.5219	60.391	52.59028	41.84682	56.34302	177.9842
Skew	1.133265	0.316402	0.103044	0.575623	0.453303	2.049501
Kurt	0.640993	-0.75015	0.02087	-0.43257	0.385882	3.309658

Source: Authors' computation

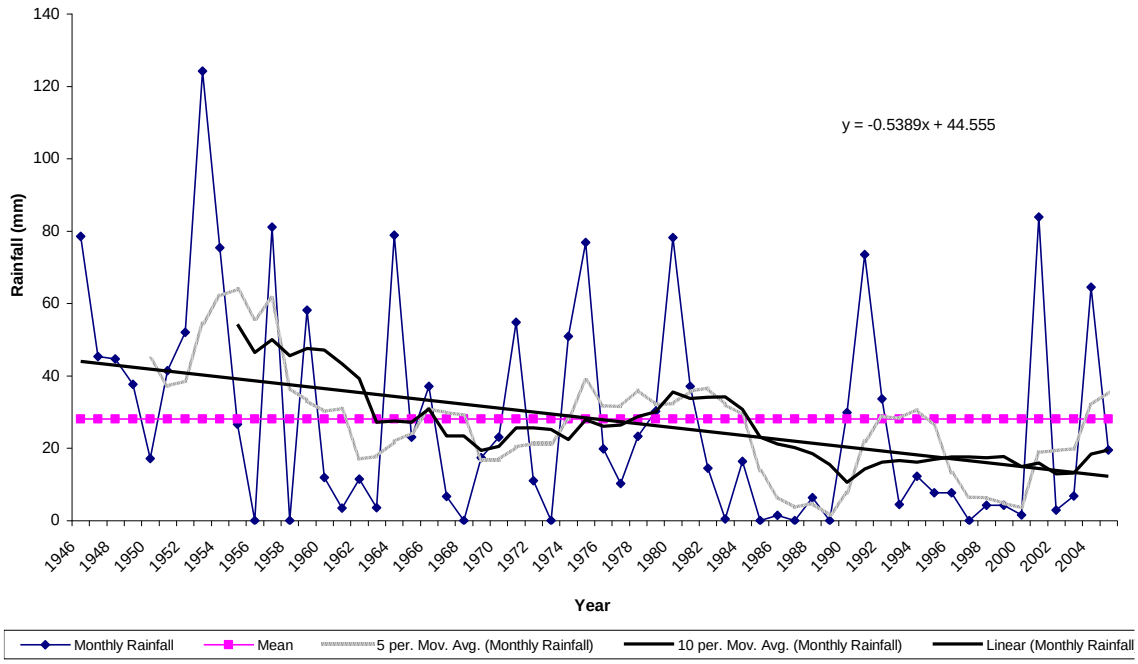

Fig 3: **Trends in May rainfall in Katsina for 60 years (1946-2005)**

The June rainfall values are also normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean in figure 2 indicate values below the long term mean from the beginning with sudden increase in the first decade, then values decline below the long term mean in late 1960's and increase again in mid 1970's and the value decline below the long term mean in mid 1980's only to increase in the mid of the last decade.

The decadal mean of rainfall value shows high value above the long-term mean in the first, second and fourth decade. The third and fifth decade are having low values below the long term mean. The last decade had moderate value along the long-term mean.

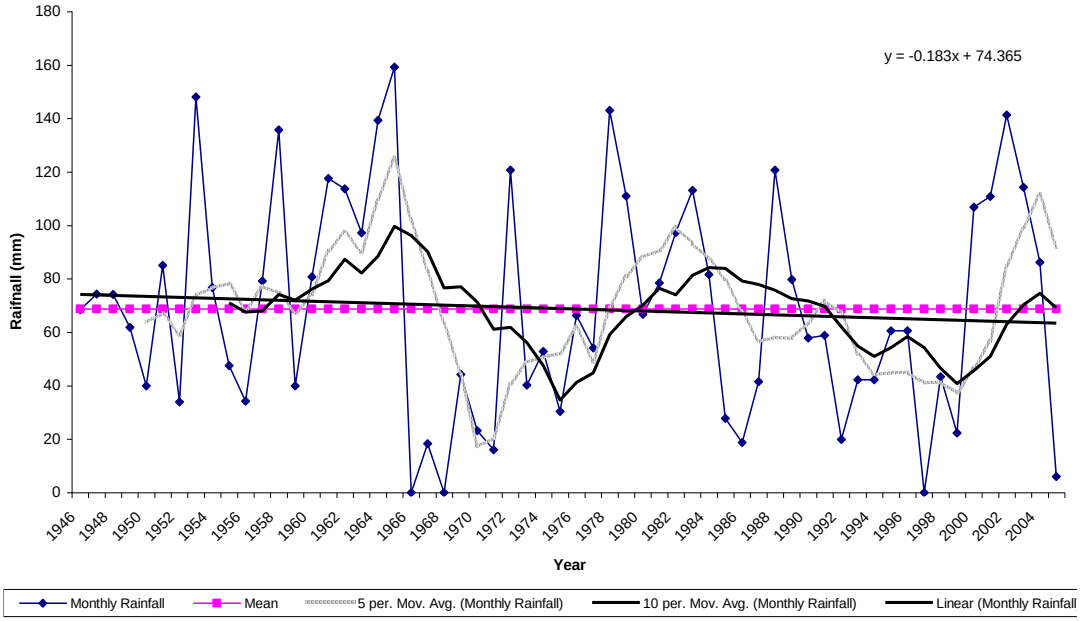

Fig 4: **Trends in June rainfall in Katsina for 60 years (1946-2005)**

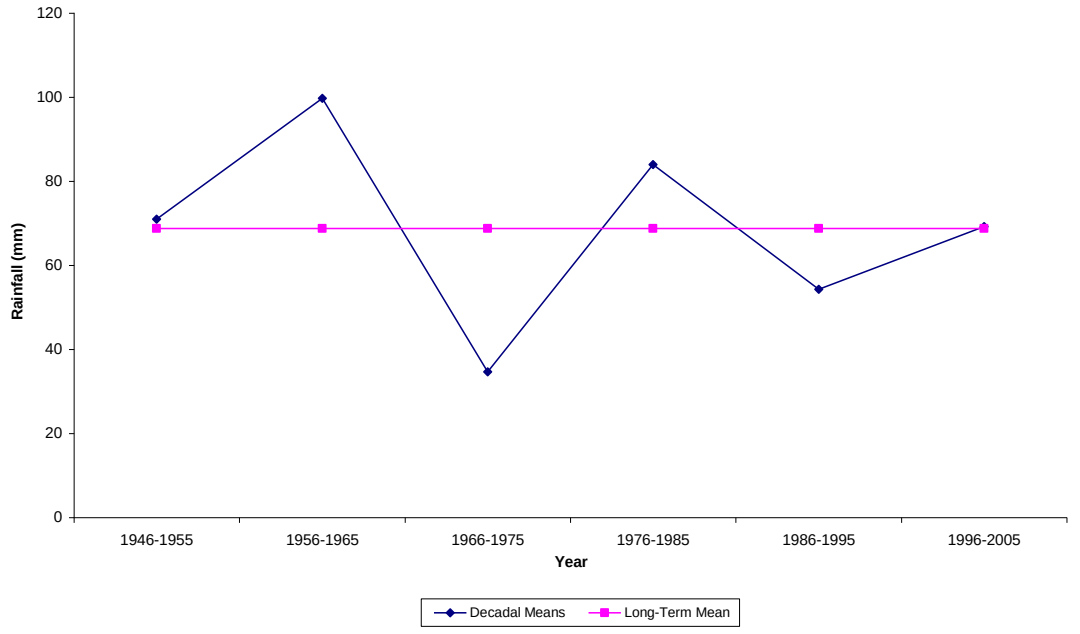

Fig 5: **Relationship between decadal means and long-term mean for June rainfall in Katsina**

The July rainfall values are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean in figure 3 indicate values above the long term mean in the first two decades. From then the values decline and remain below the long term mean until toward the end of the last decade with a sudden increase between 1977-1984.

The decadal mean of July rainfall value shows values above the long term mean in the first, second and fourth decade. The third, fifth and last decade indicates low value below the long-term mean. Fig. 6.

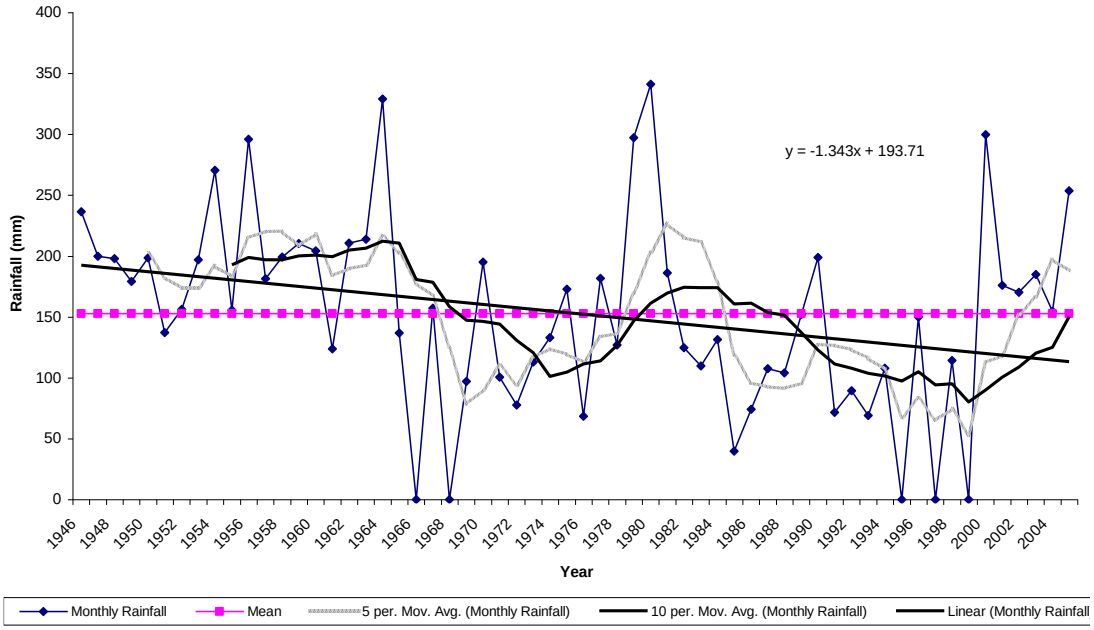

Fig 6: **Trends in July rainfall in Katsina for 60 years (1946-2005)**

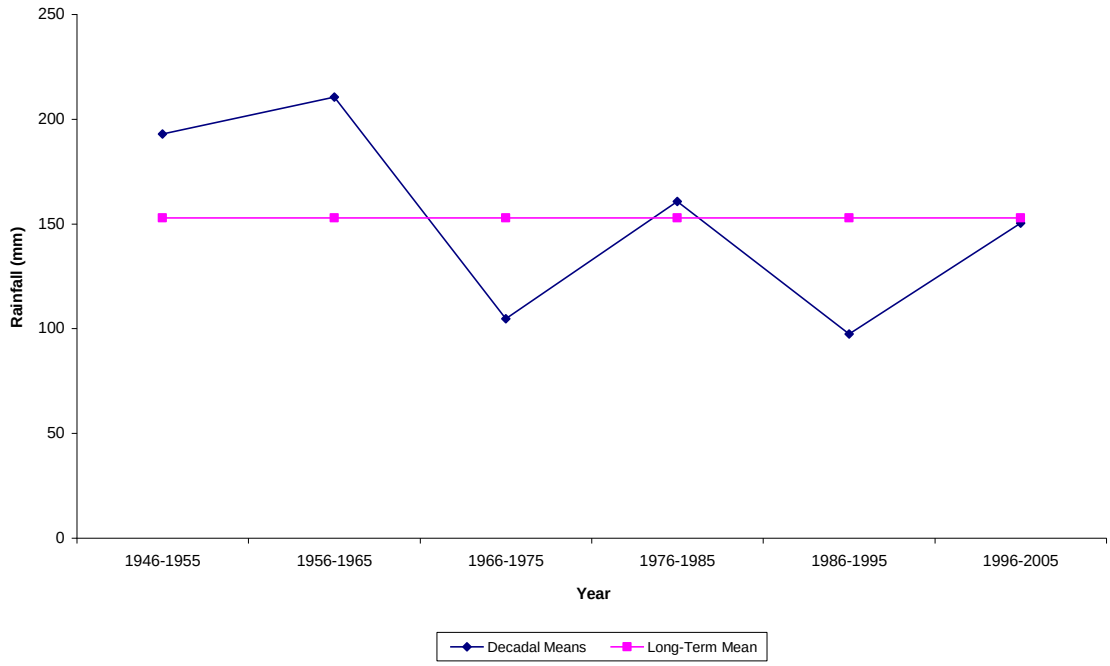

Fig 7: **Relationship between decadal means and long-term mean for July rainfall in Katsina**

The August rainfall values are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean in figure 4 indicates values below the long term mean from the beginning with a sudden increase the first decade. From then the value remain above the long term

mean until early 1970's. From then the value decline and remain below the long term mean with a sharp increase between1975 and 1977-1978

The decadal mean of August rainfall value shows the first three decade with high values above the long-term mean. While the last three decades have values below the long-term mean.

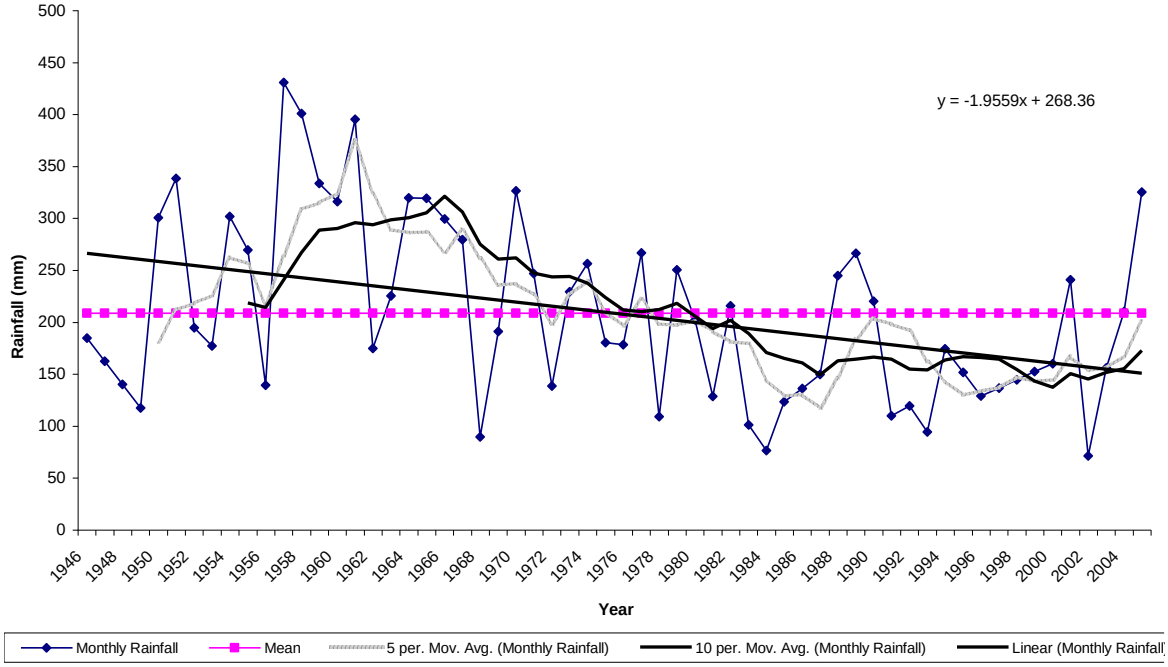

Fig 8: **Trends in August raiinfall in Katsina for 60 years (19462005)**

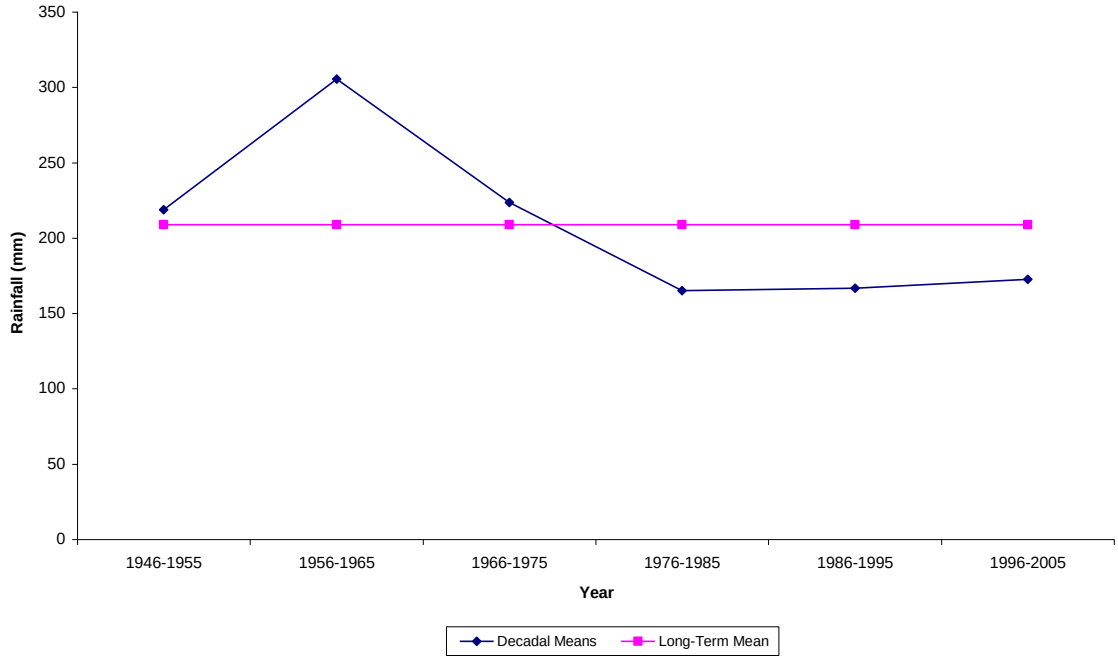

Fig 9: **Relationship between decadal means and long-term mean for August rainfall in Katsina**

The September rainfall values are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean in figure 5 indicates values above the long term mean in the first two decade. From then the value decline and remain below the long term mean until early years of the last decade with a sudden increase between 1977-1981.

The decadal mean of September rainfall value shows the first, second and the last decade with values above the long-term mean. While the third, fourth and fifth decade are having values below the long-term mean.

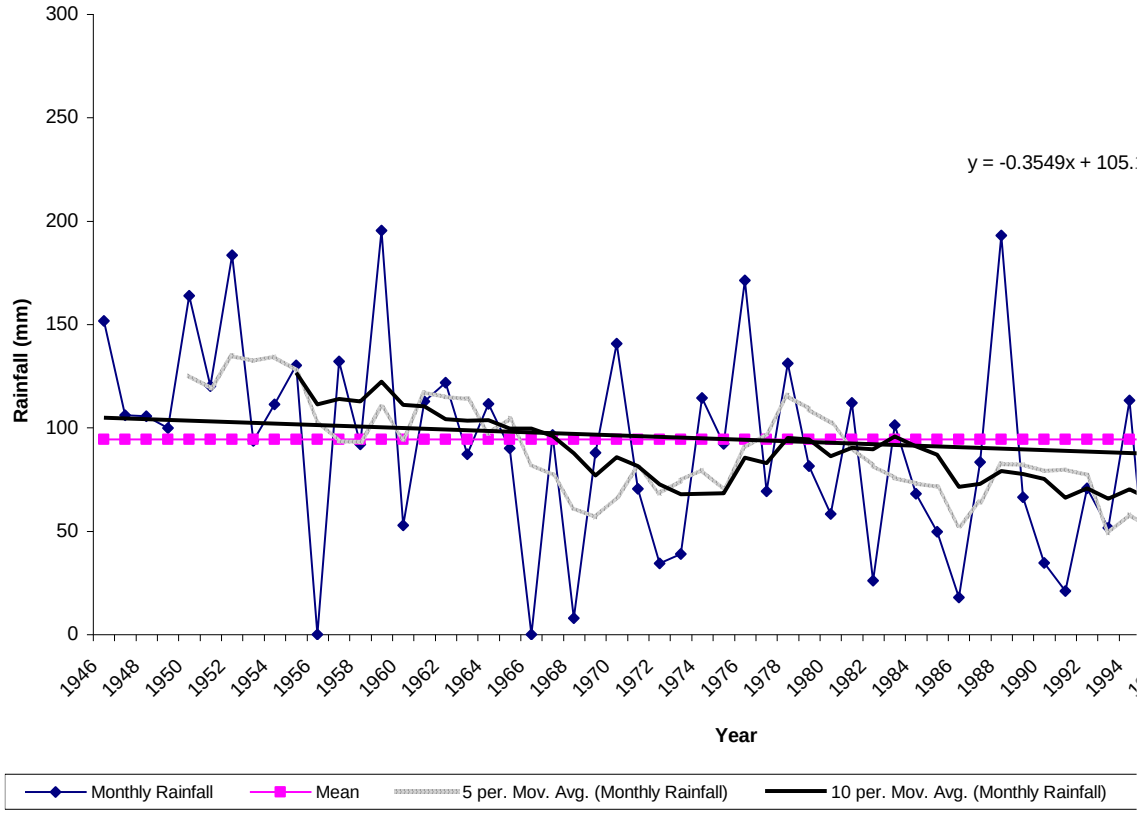

Fig 10: Trends in September rainfall in Katsina for 60 years (1946-2005)

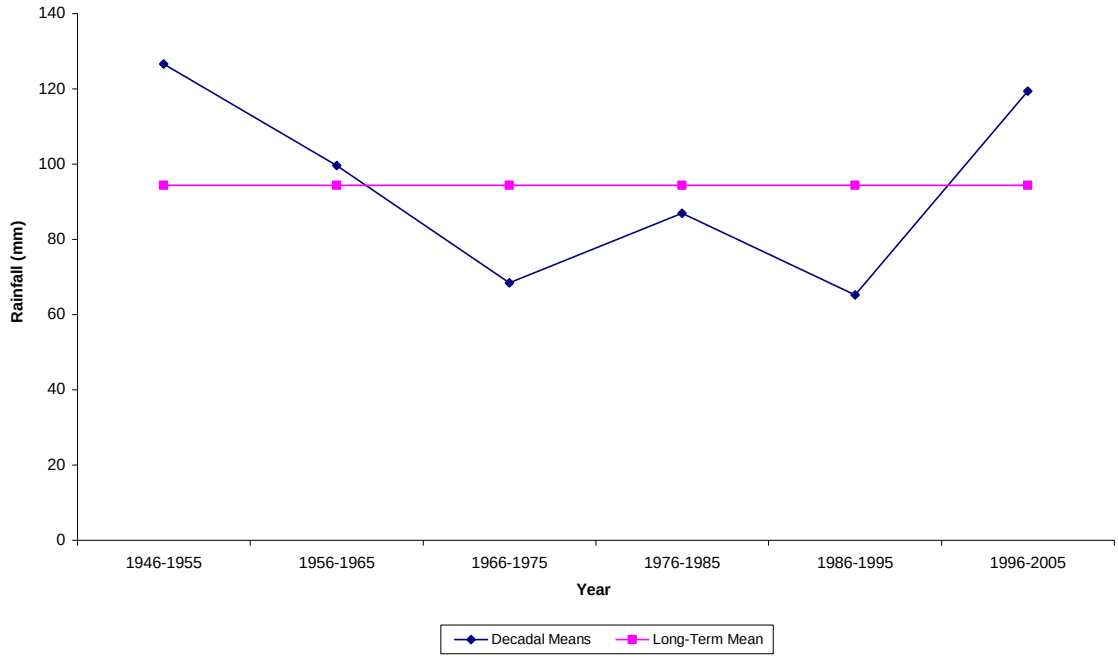

Fig 11: **Relationship between decadal means and long-term mean for September rainfall in Katsina**

The October rainfall values are normally distributed at 95% confidence limit. Regression line indicates a declining trend. Five year running mean in figure 6 indicates values above the long term mean in the first decade. From then the value decline below the long term mean in the second two decade with an increase between 1963-1968. The value decline again toward the end of the fourth decade and remain below the long term mean until mid of the last decade with a sudden increase between 1989-1995.

The decadal mean of October rainfall value shows high values above the long-term mean in the first and fourth decade. While the second, third, fifth and the last decade were having low value below the long-term mean.

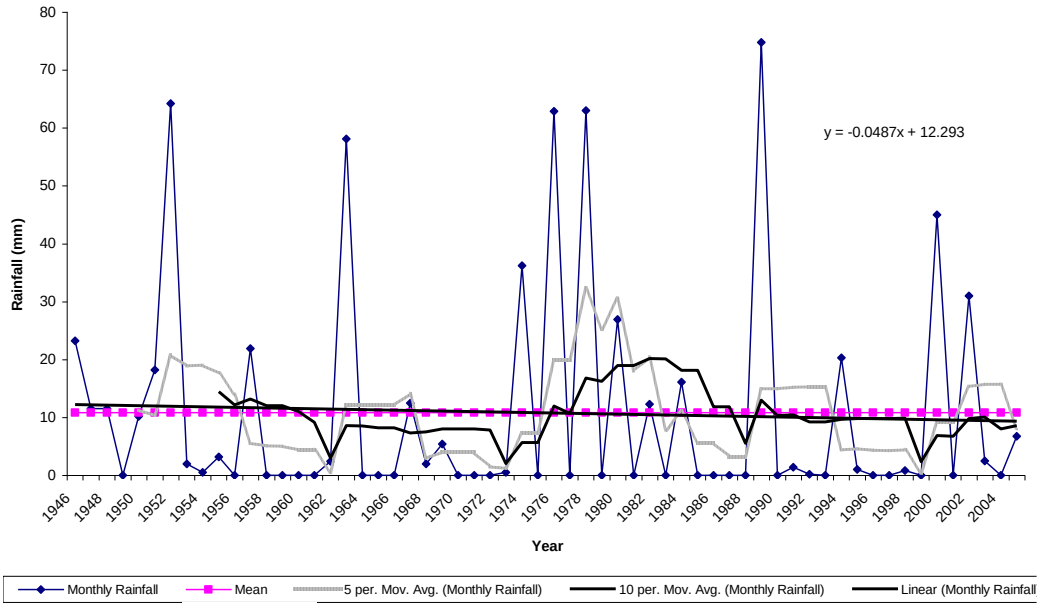

Fig 12: **:6: Trends in October rainfall in Katsina for 60 years (1946-2005)**

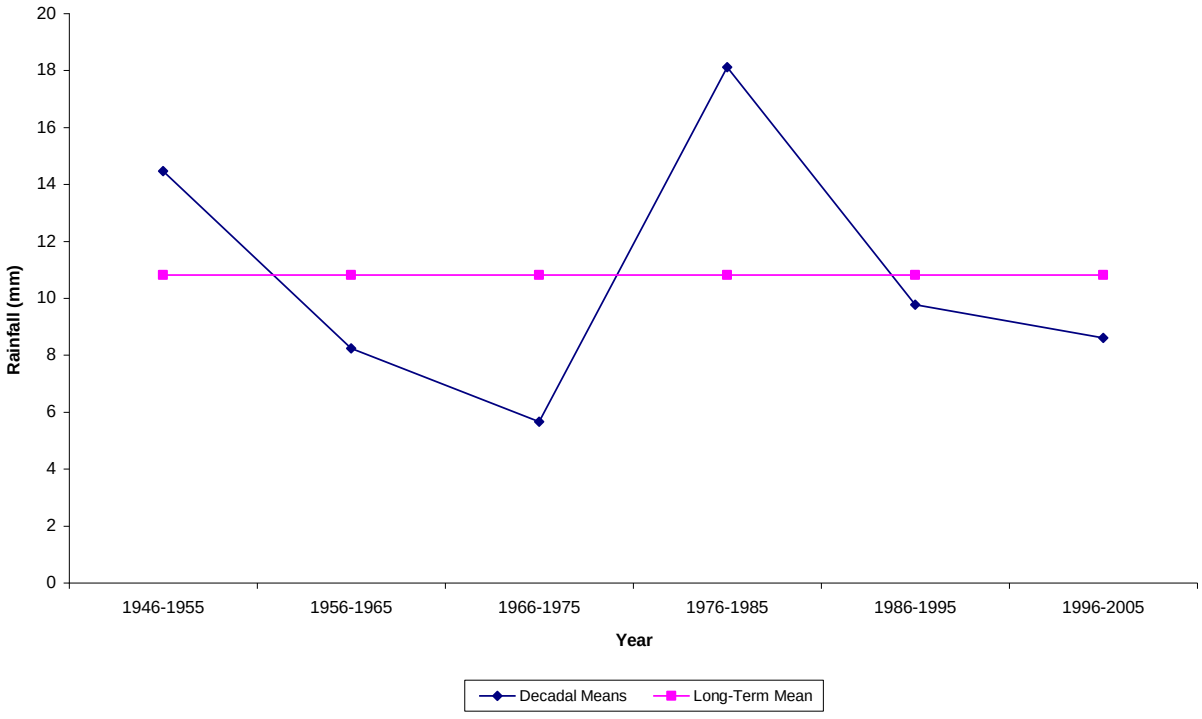

Fig 13: **Relationship between decadal means and long-term mean for October rainfall in Katsina**

5. Conclusion

All rainy months in the station conform to the annual trend of a declined trend. This indeed conform to the earlier findings in the region(Oladipo and Salahu,19 93).Decrease in May and October monthly rainfall value may shortens the length of the growing season, as both onset and cessation are determine by certain accumulated moisture value (Cocheme and Fraquin,1967;Walter,1967;Ilesanmi,1972;Benoit,1977 and Sivakumar,1988).Decline in May monthly

value will lead to increase risk in determining optimum planting date. Because, the spread of rain, frequency and intensity are largely determined by the amount of rainfall received in that particular month (Oladipo and Salahu, 1993).This will lead to repeated planting on one hand and late sawing on the other. This will directly affect crops yield as rainfall may cease before crops reach maturity.

In general, government should constantly be monitoring rainfall variation in the region for proffer management of the recourses. Farmers should be provided with durable crops that can resist damaging dry spells as rainfall reliability are determined by the amount(annually or monthly).

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EFFECTS OF PENTAD DRY SPELLS ON THE YIELD OF SOME CROPS IN THE SEMI-ARID ECO-CLIMATIC REGION OF NORTHERN NIGERIA

B.A.Sawa[1] and A. A. Adebayo[2]

1 Department of Geography, Ahmadu Bello University Zaria-Nigeria

2 Department of Geography, Modibo Adama University Of Technology, Yola, Nigeria

Abstract

This paper examines the impact of pentad dry spells on the yield of maize, millet, sorghum, groundnuts and cowpea in the semi arid region of northern Nigeria using daily rainfall data from 1960 to 2009 and crop yield per hectare for 4 synoptic stations. Bivariate Correlation Analysis was used to deduce the statistical relationship between occurrence of pentad dry spells and the yield of the crops. Stepwise Multiple Regression was used to isolate dry spell parameters that are critical to crop yield in the region. Results obtained show that occurrence of pentad dry spells in all the months and total dry spells have significant effect on the yield of sorghum and groundnuts. Maize yield showed a significant relationship with 1 and 2 pentads as well as total dry days. While only total dry spells show a significant relationship with the yield of millet. Maize shows more sensitivity to dry spells than the other crops and millet showed more resistance to dry spells than the other crops. Two dry spell parameters (10-day dry spells in August and total dry spells during the growing season) were identified as being critical to the yield of the crops in the area. These two factors jointly accounted for about 74.1%, 21.5%, 52.9%, 51.4% and 40.1% of the variations in the yields of the crops respectively in the region.

Key words: Bivariate Analysis, Coefficient of Determination, Drought, Dry Spells, Pentads,

Stepwise Regression,

1. Introduction

One of the impacts of climate change on rain-fed agriculture in the arid and semi arid region of northern Nigeria is the increasing frequency and magnitude of occurrence of dry spells. A dry spell is a period of 3 or more days of lack of rainfall during the wet season. A pentad dry spell is a dry spell of five days duration. Dry spells, apart from limiting soil moisture for plant use, pose serious threat to uptake of nutrients thereby affecting crop yield. Occurrence of dry spells during the growing season which cause deficiency of soil moisture therefore, poses the greatest threat to food security in this region. Dry spell occurrence has not only reduced the yield of crops in this region but have in many case lead to complete loss during extended period of occurrence, leading to drought. The 1972/73 and 1984 droughts in Nigeria were a consequence of cumulative effect of dry spells of long duration that led to the droughts in the extreme northern states of Nigeria.

Adejuwon (1962), Oguntoyinbo (1966, 1967), Olaniran and Babatolu (1987a & b) and Adebayo (1997) among others, have researched into crop–climate relationships for a number of places in Nigeria where records of both climatic parameters and agricultural yields exist. Adejuwon (1962) established the relationship between rainfall and cocoa distribution in south- western Nigeria and concluded that the areas favourable for the cultivation of cocoa should have a mean annual rainfall of between 1,270mm and 1,524mm. Oguntoyinbo (1967), related rainfall and computed evapotranspiration to cotton yield at Samaru in north- central Nigeria and recommended that the optimum rainfall for growth of rain-fed cotton is about 762mm during the growing season, concentrated mainly in the first three months; and the mean five-day rainfall should not be less than 5.08mm for the first three months from the month of planting. The rainfall should also extend to October.

Kowal and Kassam (1973) examined the effect of variability in the length of the growing season on yield of groundnuts on the assumption that the groundnut crop can continue pod-filling for about 20 days on residual moisture stored in the soil after the end of the rains. They found that as the growing season reduced by 30 to 50 days, groundnut yield also declined by 28 to 56 per cent respectively. Kowal and Adeoye (1973) illustrated the use of empirical approach in determining the geographical limits of crop production in Nigeria by matching water requirements of millet in terms of water availability and length of the rainy season separately with latitude. They delineated the northern boundary for the successful cultivation of the crop without irrigation as latitude 14.7^0N. Kowal and Kassam (1973) using the same approach presented regression equations derived between total annual rainfall and latitude on the one hand and water use by groundnut crop and latitude on the other and found out that the water requirements of a 120-day crop of groundnut would be met south of latitude 11.8^0N. Eghareva *et al* (1980) and Fakorede (1985) investigated the effects of rainfall and date of planting on millet and maize yields in Nigeria respectively. According to them, when planted at less than 50mm of rainfall or far into the rainy season, less moisture in the soil and decreased heat unit respectively adversely affect the yield of these crops.

Akintola, (1983) analyzed the effects of climate on production of food crops in Ibadan noted that the agro-climatic factors correlate with the yields of rice, maize, yam and cowpea. Fisher (1984) observed that there is a great impact of climate on crop yield stability. While Yayock and Owonubi (1986) reported the influence of weather on groundnut production in Nigeria and stressed that rainfall is a critical factor.

Adebayo and Adebayo (1997) in their study of relationship between rainfall and rice yield in Yola, north-eastern Nigeria noted that four critical climatic factors: hydrologic ratio, onset dates of rains, number of dry spells (in pentads) during the growing season and rainfall in June influence rice yields in Adamawa state. Adebayo (1998) studied the effect of dry spells on rice yield in Yola and noted that the incidence of dry spell was responsible for the variation in rice output in Yola between 1996 and 1997. Abdulhamid and Adebayo (2006) observed that total rainfall, relative humidity and seasonality index together accounted for about 76% of the variation of Sorghum yield at Wailo (Bauchi state). Adebayo *et al* (2006) in their study of the influence of climatic factors on the growth and yield of sugar cane at Numan observed that total rainfall, relative humidity, minimum temperature and evaporation are critical to sugar cane growth and yield at various stages of development.

The statistical relationships between the occurrence of dry spells of 5, 10 and 15 or more days and the yield of five selected staple crops (maize, millet, sorghum, groundnuts and cowpea) in the semi arid region of northern Nigeria is the thrust of this paper.

2. The study area

The study area is the extreme northern part of Nigeria corresponding to the drought prone parts of the country. This is an area that experiences frequent dry spells of different magnitudes. The study covers four stations: Sokoto (13^0 10N – $05^0$11′E), Katsina (13^0 10N – 07^0 – 41′E), Kano (12^0 03N – 08^0 32′E) and Maiduguri (11^0 51N – 13^0 05′E) see Fig 1.

The climate of northern Nigeria north of latitude 11^0N is of tropical continental (AW) type characterized by distinct wet (April – October) and dry (November – March) seasons respectively as dictated by the oscillation of the Inter-tropical Discontinuity (ITD). The study area is characterized by northern Guinea savanna to scrubland in the extreme northern parts. The soils are typical leached tropical ferruginous soils that are sandy in texture.

The study area is located on the High Plains of northern Nigeria between about 450m and 750m above sea level with granitic inselbergs such as the Kufena hills of Zaria and volcanic plateaux like the Jos Plateau occasionally interrupt the monotonous high plain.

3. Materials and methods

Fifty years' (1960–2009) daily rainfall observations sourced from the Nigerian Meteorological Agency were used to derive dry spells of 5, 10 and equal to or longer than 15 days using Stern and Dale's (1982) method. In their method, the last day of rainfall of 0.25mm or more in October was coded ¯1, the following dry days were coded 1, 2, 3 …n into November until the next wet day in the preceding year.

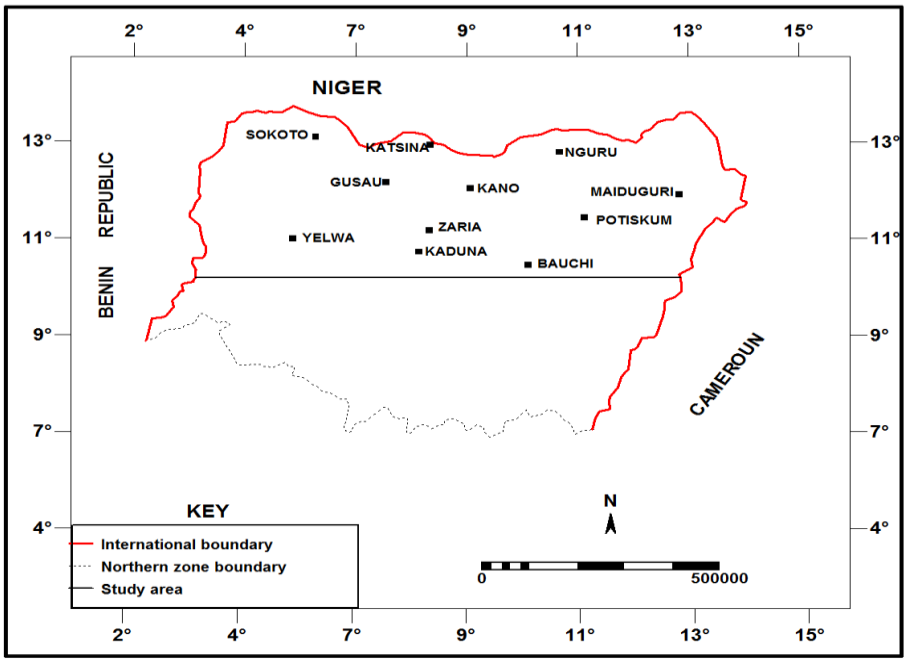

FIG. 1: MAP OF THE STUDY AREA AND SELECTED METEOROLOGICAL STATIONS.

Consecutive wet days were coded ¯1, ¯2 …¯n so that the daily observations were recorded as sequences of wet and dry days. From this, runs of dry spells of 1 pentad (5) days, 2 pentads (10) days and equal to or greater than 3 pentads (15) or more days were computed directly month wise for each of the rainfall stations. Records of crop yield per hectare for the five selected crops (maize, millet, sorghum, cowpea and groundnuts) within the region of the meteorological stations were also sourced from the state Agricultural Development Programme of each state. The relationship between the occurrence of pentad dry spells and the yield of the selected crops in the study area was tested. Bivariate correlation analysis of the form:

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}}$$

r = Correlation coefficient

where x and y = individual observations of dependent and independent variables respectively

$\bar{x}$ and $\bar{y}$ = Mean of dependent (x) and independent (y) variables respectively

was used to determine this relationship. The crop yield values were taken as the dependent variables Y_1, Y_2, Y_3, Y_4 and Y_5) and dry spells of 5, 10, 15 and greater than 15 days, taken as the independent variable X_1 to X_5 respectively. The dry spell parameters that have shown

significant correlation with crop yield were subjected to stepwise multiple regression to determine which ones are more critical to the yield of the crops

4. Results and discussion

4.1. Relationship between occurrence of pentad dry spells and crop yield at Sokoto

Table 1 gives the correlation matrix between occurrence of pentad dry spells and the yield of the five crops at Sokoto. From Table 1, it is seen that maize yield has a significant negative relationship with occurrence of 1 and 2 pentad dry spells in June and July respectively at 0.05 level of significance. These two months correspond with the planting/germination and vegetative development of maize at Sokoto.

Table 1: Correlation Matrix of Pentad Dry Spells and Crop Yield at Sokoto

Months	Maize	Millet	Sorghum	G/nuts	Cowpea
May 5	.034	.247	-.168	.307	.064
May 10	-.099	.063	.383	.209	-.100
May ≥ 15	-.001	.141	-.054	.322	-.179
June 5	-.267*	.086	-.031	.161	-.039
June 10	-.153	.562*	.379	.044	-.017
June ≥ 15	.260	-.333	.109	-.441	.328
July 5	.321	-.340	.307	.129	.166
July 10	-.362*	.248	.243	-.017	-.202
July ≥ 15	.(a)	.(a)	.(a)	.(a)	.(a)
Aug 5	.061	-.131	-.001	-.006	.307
Aug 10	-.088	-.013	-.727**	.135	-.361
Aug ≥ 15	-.437	-.013	-.142	.569*	-.633*
Sept 5	.053	.353	-.450	.785**	-.094
Sept 10	.185	-.100	.535	-.432	.165
Sept ≥ 15	-.088	-.013	-.727**	.135	-.361
Total dry	.015	-.127	-.084	.414	.007

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

a Cannot be computed because at least one of the variables is constant

Source: Authors' computation

These periods depend on high rainfall otherwise if dry spells set in, lack of good germination and stunted growth will be the case and consequently low yield. The yield of millet has a significant positive correlation with occurrence of 10-day dry spells in June at Sokoto. This implies that if dry spells of 2 pentads occur in June at Sokoto, there will be higher yield of millet if all other conditions remain the same.

The occurrence of 2 or more dry pentads in August and September respectively has significant negative relationship with the yield of sorghum at 0.01 level of significance. This is so because August and September correspond with the period when sorghum grains are produced and ripen at Sokoto. This stage requires high rainfall for grains to develop well. Occurrences of dry spells during this stage will therefore, causes less moisture as a result the grains will not develop properly and the yield will be reduced.

The occurrence of 15 and 5-day dry spells in August and September respectively both show significant positive relationship with the yield of groundnuts at Sokoto. This implies that the occurrence of dry spells in these months encourages better groundnuts yield at this place. This is because at Sokoto, groundnut ripens within these two months and during this ripening stage, a short dry spell is needed. Thus the significant positive correlation between yield and dry spells in these two months.

4.2 Relationship between occurrence of pentad dry spells and crop yield at Katsina

The relationship between occurrence of pentad dry spells and the yield of the crops is given in Table 2. From Table, it is observed that all the significant relationships are negative.

A significant negative correlation is indicated at 0.05 level between 15-day dry spells in June and July; 10-day dry spells in September and the yield of maize at Katsina. This implies that the occurrence of these dry spells all cause reduced maize yield in the area. May is the planting period while July corresponds with part of the vegetative growth period of maize in the area.

These two stages require adequate rainfall therefore, the occurrence of dry spells in May and July means low or no rainfall, implying low soil moisture content during these two periods, as a result, poor germination and vegetative development will follow respectively consequently low yield.

Dry spells of 2 pentads in June, 1 pentad in July and total dry spells in the year all have significant negative correlation with millet yield at 0.05 level of significance. This also implies that their occurrences all have significant negative impact on the yield of millet. At Katsina, millet is planted in June. Its proper germination is based on enough rainfall that will provide enough soil moisture.

Table 2 Correlation Matrix of Pentad Dry Spells and Crop Yield at Katsina

Months	Maize	Millet	Sorghum	G/nuts	Cowpea
May 5	.199	.286	.222	.041	.130
May 10	.237	-.281	.173	-.306	-.228
May ≥ 15	-.255*	-.102	-.193	.113	.168
June 5	.275	.011	.176	.156	.138
June 10	-.017	-.253*	.207	-.690**	-.017
June ≥ 15	-.255*	.026	-.499*	.527	-.253*
July 5	-.036	-.255*	-.314*	-.308	-.082
July 10	.390	.204	.178	.149	.288
July ≥ 15	-.172	-.153	.041	.334	-.111
Aug 5	-.261	.066	-.290	-.269	.148
Aug 10	.319	-.341	.099	.(a)	.169
Aug ≥ 15	-.172	-.153	.041	.334	-.111
Sept 5	.077	.028	.213	-.411	-.295*
Sept 10	-.288*	-.122	-.416*	-.116	-.201
Sept ≥ 15	.175	-.212	.184	-.028	.026
Total dry	-.048	-.289*	-.110	-.611*	.005

* * Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
a Cannot be computed because at least one of the variables is constant.
Source: Authors' computation

Proper vegetative growth of millet occurs under high rainfall between June and August. The occurrence of dry spells during these stages leads to reduced rainfall and consequently poor germination, poor vegetative development and diminished yield. Sorghum yields show significant negative relationship at 0.05 level of significance with occurrence of 15-day dry spells in June, 5-day dry spells in July and 10-day dry spells in September. This is so because the successful planting, germination and vegetative development of sorghum in June and July respectively depend on high rainfall. The occurrence of dry spells in these months certainly

reduces rainfall and leads to low yield. Sorghum needs high rainfall for its 'eying' and ripening in October. This moisture is derived from September rainfall, as October is usually a dry month. Occurrence of dry spells in September will lead to lack of moisture for the 'eying' in sorghum and this will reduce its yield.

Groundnuts yield shows a negative significant relationship at 0.05 and 0.01 levels with 2 dry pentads in June and with total dry spells at 0.05 level. The vegetative growth of groundnuts occurs in June and it requires adequate rainfall. Dry spell occurrence during this period is detrimental to the yield of groundnuts.

Cowpea yield shows a negative correlation with the occurrence of 15-day dry spells in June and 5-day dry spells in August. Cowpea is planted in June and needs adequate rainfall for germination. Dry spell occurrence will not only affect the germination but will also reduce the production of cowpea leaves that photosynthesize the food for the plant. This will lead to reduced yield. The rainfall that occurs in September provides the moisture used by cowpea for flowering and pod development in October. If dry spells occur in September, there will be reduced moisture in October and this will adversely affect cowpea yield.

4.3 Relationship between occurrence of pentad dry spells and crop yield at Kano

Table 3 shows the correlation matrix of between occurrence of pentad dry spells and the yield of maize, millet, sorghum, groundnuts and cowpea at Kano.

From Table 3, it is evident that there is a general negative relationship between occurrence of pentad dry spells and the yield of the five crops. Although millet and groundnuts do not show any significant correlation with any dry spell, maize indicates a negative correlation with the occurrence of dry spells of two pentads in June. This implies that the occurrence of this length of dry spells in June leads to reduced yield of maize at Kano.

Late May to early June, correspond to the sowing period of maize at Kano. This period requires adequate moisture for the proper germination of the planted seeds. The occurrences of dry spells of up to 10 days at this stage will therefore, lead to poor germination and consequently reduced maize yield. Sorghum shows a significant negative relationship with the occurrence of 3 or more dry pentads in June but a significant positive relationship with occurrence of 2 dry pentads in September both at 0.05 level of significance. This implies that while the occurrence of 15-day dry spells in June leads to diminution of sorghum yield, occurrence of 10-day dry spells in September is beneficial and leads to an increase in the yield of sorghum. June to August represent the vegetative growth stage of sorghum when high rainfall (high soil moisture) is needed, hence the negative relationship between sorghum yield and dry spells of 15 or more days in June.

Table 3 Correlation Matrix of Pentad Dry Spells and Crop Yield at Kano

Months	Maize	Millet	Sorghum	G/nuts	Cowpea
May 5	-.342	.090	.422	.145	-.008
May 10	.075	-.049	.042	-.045	-.434
May ≥ 15	-.222	-.059	-.129	-.098	.352
June 5	-.295	-.068	.463	.027	-.647*
June 10	-.613*	-.266	.236	.328	.208
June ≥ 15	.015	-.121	-.549	.092	-.375
July 5	.161	-.179	-.164	.387	.019
July 10	.(a)	.(a)	.(a)	.(a)	.(a)
July ≥ 15	.(a)	.(a)	.(a)	.(a)	.(a)
Aug 5	.191	.306	.169	.257	.300
Aug 10	.(a)	.(a)	.(a)	.(a)	.(a)
Aug ≥ 15	.(a)	.(a)	.(a)	.(a)	.(a)
Sept 5	.194	-.317	-.420	-.152	-.195
Sept 10	-.481	-.100	.597*	.060	-.003
Sept ≥ 15	.139	.321	.393	.080	.076
Total dry	-.300	-.079	.405	.538	-.334

*Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
a Cannot be computed because at least one of the variables is constant.

Source: Authors' computation

September corresponds with the ripening stage of sorghum at Kano, therefore, dry spell is needed at this stage, hence the positive relationship between sorghum yield and the occurrence of 10-day dry spells in September. Cowpea shows a negative relationship with the occurrence of 5-day dry spells in June. This is the planting period for cowpea at Kano and high rainfall (high soil moisture index) what is needed at this stage. The occurrence of dry spells at this stage therefore, will definitely lead to cowpea yield diminution.

4.4 .Relationship between occurrence of pentad dry spells and crop yield at Maiduguri

The relationship between the occurrence of pentad dry spells and the yield of the five crops at Maiduguri is given in Table 4.

From Table 4, it could be seen that the yields of all the crops show negative relationship with most of the dry spell lengths. Maize yield indicates a significant negative correlation at 0.01 level of significance with the occurrence of 15-day dry spells in September. As already highlighted earlier, 'eyeing' stage (grain development) for maize takes place in September. This stage requires high soil moisture index for successful development of grains.

The occurrence of dry spells of equal to or greater than 15 days at this stage therefore, causes soil moisture diminution leading to shortage of nutrients for the crops consequently low maize yields will be the result. Millet yield has significant positive relationship with the occurrence of 5-day dry spells in September at 0.05 level of significance at Maiduguri. This implies that millet does not need high soil moisture (high rainfall) in September. This could be explained by the fact that the ripening of millet grains at Maiduguri occurs in September. This stage of development in millet requires a short dry condition with high sunlight. The occurrence of high rainfall at this stage will discourage the proper ripening of millet seeds to grains, thus low yield.

Table 4 shows that the yields of sorghum and groundnuts both have significant negative correlation at 0.05 level with the occurrence of 5-day dry spells in July. At Maiduguri, the vegetative growth of sorghum and groundnuts takes place between June and August. This requires a lot of soil moisture (high rainfall). If dry spells occur within these months, particularly in July and August, this stage is disturbed therefore; this will reduce the yield of these two crops.

There is a significant positive correlation between occurrence of 5-day dry spells in September and the yield of cowpea. As expected, cowpea does not need heavy rainfall in September, as it will only enhance vegetative growth and not seeds. Cold dry condition is what is needed by cowpea in September; otherwise, high rainfall will lead to vegetative development of cowpea. The occurrence of dry spells in September enhances cowpea flowering and pod development.

4.5. Critical pentad dry spell parameters for crop yield

Results of the stepwise multiple regression that identified the critical dry spell parameters to crop yield in the region is given in Table 5. Two-day dry spells in June and August are the most critical dry spell parameters for the yield of the grain crops in the region. The coefficient of determination (R^2) from Table 5 shows that while the three factors are jointly responsible for 74.1% of the variation in maize yield, they account for 21.5% and 52.9% of the variations in the yield of millet and sorghum in the area. 51.4% and 40.1% of the variations in the yield of ground nuts and cowpea respectively are accounted for by these three dry spell parameters.

Table 4 Correlation Matrix of Pentad Dry Spells and Crop Yield at Maiduguri

Months	Maize	Millet	Sorghum	G/nuts	Cowpea
May 5	.198	-.179	-.252	-.383	-.243
May 10	-.112	-.404	-.281	-.171	-.440
May ≥ 15	.005	.188	.047	-.107	.245
June 5	-.378	-.002	.078	.409	-.038
June 10	.019	-.326	-.360	-.356	-.359
June ≥ 15	-.035	-.066	.173	-.079	.001
July 5	.320	-.144	-.645*	-.607*	-.034
July 10	.(a)	.(a)	.(a)	.(a)	.(a)
July ≥ 15	-.485	-.327	.225	.334	-.296
Aug 5	.482	.182	-.308	-.283	.257
Aug 10	.(a)	.(a)	.(a)	.(a)	.(a)
Aug ≥ 15	-.489	-.209	-.071	.482	-.178
Sept 5	.469	.573*	.222	.054	.546*
Sept 10	.353	.318	.192	.266	.297
Sept ≥ 15	-.676**	-.410	.201	.406	-.365
Total dry	.083	.043	.001	.193	.110

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
a Cannot be computed because at least one of the variables is constant.
Source: Authors' computation

5. Summary

In summary, results of the correlation between pentad dry spell occurrence and crop yield indicate that maize shows more sensitivity to dry spells than the other crops. Among the five selected crops, Millets is the least sensitive to monthly occurrence of dry spells. This implies that millet is a drought – resistant crop that is not affected by occurrence of mere 1 or 2 pentads. It is only the total dry spells in the growing season that show significant negative relationship with millet yield. While Sorghum and Groundnuts are moderately sensitive to

dry spells, Cowpea, which is planted in late August yields better with much dew than rainfall. Its yield is not dependent on occurrence of dry spells in earlier months at most stations.

Table 5: Coefficient of Determination (R^2) Values for Critical Pentad Dry Spell Parameters in the Region

Crop	Critical Dry Spell Parameters	R^2
Maize	2 dry pentads in June and August and Total numbers of dry spells	74.1
Millet		21.5
Sorghum		52.9
G/nuts		51.4
Cowpea		40.1

Source: Authors' computation

6. Conclusion

From the results of this study, it is concluded that not all dry spell occurrences are detrimental to crop yield in the study area. At least a pentad dry spell is needed for most crops during the period of first weeding and application of fertilizer say two weeks after germination. Such is the case with maize, sorghum and ground nuts. During the grain production and development period, occurrence of any length of dry spell affects the yield of these crops negatively. Finally, during the maturing period, dry spell of short duration is important for the proper maturity and drying of the seeds for harvesting.

7. Recommendation

In northern Nigeria, agriculture is a weather-sensitive operation, farmers should therefore, seize the opportunity of occurrence of dry spells at the appropriate periods either for weeding and application of fertilizer or harvesting in order to maximize their yield.

Good viable seeds should be reserved as dry occurrence of dry spells can cause crop wilting and drying up which will call for second planting.

The study region is a drought-prone region, therefore, more drought –resistant early maturing and high-yielding varieties of the grains need to be developed and planted in the area.

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ENVIRONMENTAL PERCEPTION OF QUALITY OF LIFE IN DOGARAWA, SABON-GARI LOCAL GOVERNMENT AREA, KADUNA STATE NIGERIA

R.O.Yusuf [1] and I.O. Orire[2]

[1]Department of Geography, Ahmadu Bello University, Zaria

[2]Department of Geography and Environmental Management, University of Ilorin, Ilorin

Abstract

Environment is the totality of all bio-physical, socioeconomic, cultural and policy surroundings of man. In rapidly changing rural-urban transitional settlements, wellbeing of the residents is linked to the provisioning and regulatory functions of the environment and where these are deficient; the quality of life is undermined. This paper addresses this theme in Dogarawa, though the headquarters of Sabon-gari local government area of Kaduna state yet a settlement in transition from rural to urban. Data were collected from 180 systematically selected households through a questionnaire survey. Data were analyzed with descriptive statistical techniques and multiple regression analysis to identify the environmental variables that explains quality of life. The key findings include that 172 of the sampled households depended on well some of which were unprotected, all the residents did not have access to modern waste disposal facilities and more than 87% of the sampled households suffer diseases of diverse causes. About 78% of the respondents perceived their quality of life as low compared to neighbourhoods like Sabon-gari central area and Zaria city with indicators such as burden of diseases and infection, insecurity of people and properties and exposure to environmental nuisance. Multiple regression result indicates that of the seven selected variables, four: X_1 (incidence of communicable diseases), X_7 (vulnerability to domestic armed-robbery attacks), X_5 (environmental nuisance) and X_3 (socioeconomic status-related diseases) have r^2 of 0.7458 indicating about 74.5% of the variance in low quality of life. Policy recommendations include advocacy planning on self-help efforts to fill the gaps in infrastructural deficiency by government, public awareness on the unrivalled need to adopt environmental sanitation efforts, and, utilization of some human-induced landscapes such as excavation pits for eco-supportive infrastructure in order to turn negative environmental phenomena to positive spatio-temporal uses. The conclusion is that various degrees of negative anthropogenic-environmental interaction of humans impact the ability of the environment to continuously support high quality of human life.

Key words: Environmental perception, quality of life, transitional rural settlements, Dogarawa, Sabon-gari LGA.

1. Introduction

Natural increase and migration are the two major processes of population increase that transform rural settlements to urban. The process of transformation then intensifies with complex change of socioeconomic milieu; organized housing structure in grid neighbourhood; provision of market; availability of formal occupation and wage employment from industries and civil service; complex life improving infrastructure; socio-spatial organization in transportation; complex and hierarchical political authority; and changed behavioural trait from traditional to modern are some evidences (Mabogunje 1980).At the climax, previous rural areas are transformed to urban settlements.

In between these two distinctive settlement categories are some in the spatio-temporal process of transition. Consequently, some attributes of rural and urban areas are observable in such landscape. Such settlements are referred to as either fringe settlements or rural-urban fringes (Mayhew 2009) or transition rural settlements. These milieus affect the quality of life domains of the inhabitants of such settlements and the overall socio-economic wellbeing (Millennium Ecosystem Assessment (MEA) 2006).

The pervasive influence of environmental phenomena on the overall development process is always a subject of geographical enquiry (Baba, 1994; Ofomata 2001; Adedayo 2006). Environment is defined by different authors such as (Botkin and Keller (1998); Conelly and Smith (1999); Eyo and Ogban (1999); Hughes (2001); United Nations System (UNS) (2001) and Aluko (2006) among others. Ololobu (1999) defined environment as a sum total of conditions which surrounds man and ensure survival. These various conceptualizations affect environmental perception of humans as abode of livability, security and human comfort. As stated by Abler, Adams and Gould (1972), experiences are our perception of events. Whether an event appears to us to have occurred externally or internally, the knowledge of it as it impinges upon on our existence is the most imperative. Perceptual reality of humans can indeed be designative or appraisive (Cox,1972) depending on location and circumstances.

Quality of life is used to evaluate the general well-being of individuals and societies. Some indicators of quality of life include employment, wealth and income, the built environment, physical and mental health, education, recreation and leisure time, and social belonging. Quality of life is a desired outcome of environmental provision and development policies that guarantee access and consumption materials and services perceived to improve well-being. These vary from culture and society hence no watertight indicators of quality of life exist. As a result, researchers select indicators suitable for the socio-economic circumstances, cultural-environmental peculiarities and research objectives. Social geographers in rural and urban studies thus assemble previous quality of life indicators and adopt those suitable for their studies (Oyebanji 1984). Geographers and other researchers that have employed this approach include Knox and Coltam (1981); Oyebanji (1988); Adedayo (1988) and David-swain (2002). Nations also adopt different indicators (Borough of Macclesfield 2004),

Transitional rural settlements have their associated environmental conditions that affect the quality of life as well as the perception of the inhabitants. Investigating this aspect advances the course of human development as they enhance formulating and implementing actionable policies that will transform the people socio-economically while improving the environmental circumstances. Indeed, as emphasized by Abler, Adams and Gould (1972), humans as conscious and self-conscious beings must concern themselves with events in their

environment and events within them as well as the relationships between the two. Available research evidences indicate that such perception issues have not been examined in Dogarawa which incidentally is the headquarters of Sabon Gari local government area (LGA). This research gap is filled with this paper. Quality of life has multiple indicators which no single paper can satisfactorily examine. The scope of this study is therefore limited to housing and the built environment, outdoor environmental nuisance, potable water and sanitary environment, and security. The objectives are to: (1) characterize housing type, pattern and factors determining the choice of residence; (2) examine the factors that account for quality of life in Dogarawa, and, (3) examine the interaction between environmental factors and quality of life among the residents.

2. Study area

Dogarawa is the politico-administrative headquarters of Sabon-gari LGA, though by far the least urbanized among the nine urban wards in the LGA. This, in addition to its spatio-location peculiarities and socio-economic attributes informs the classification as transitional rural albeit the claim that all local government headquarters in Nigeria are urban centres. Dogarawa, a previously obscured village, along the old Zaria-Kano expressway shot to prominence when Sabon-gari LGA was carved out of Soba LGA in 1991 and Dogarawa was made the headquarters (Personal Communication, Salihu Ungwa Nomi).

Dogarawa derived its name from the Hausa word *Dogari* which means traditional police or security guards. The origin dates back to the period when the present Zaria area was still under the Islamic authority of the Sokoto caliphate. Then, Shehu of Sokoto usually delegates one of his scholars to govern the people in communities under his domain. There was a footpath the appointed representative used to take on his way to be turbaned in Sokoto and a small hamlet serve as a resting place. Later, armed bandits began to attack the people passing the route and there were wild animals around the area which were threat to travelers as well. The need to check the bandits and prevent attack from wild life led to positioning the *Dogaris* at that settlement. The settlement derived its name (Dogarawa) there from and the head of the *Dogaris* was known as *Makama*. Not long afterwards Kabama village developed. This made Dogarawa to be under three traditional *Ungwa* authorities viz Sarkin Ungwa Dogarawa, Sarkin Kabama, and Sarkin Ungwa Makama (Personal Communication, Salihu Ungwa Nomi).

During colonialism and immediate post independent Nigeria, Dogarawa lost its prominence when Sabon Gari, Hanwa, Samaru and other urban settlements were established obscuring Dogarawa by size, socio-cultural and economic complexity. When Soba LGA was created, these settlements that were previously under Zaria LGA were moved to Soba LGA (Personal Communication Kasumu Jasper). In September I991, when Sabon-Gari LGA was created, Dogarawa was chosen as the headquarters by virtue of its spatio-historical ascendancy but neither by population size nor socio-economic diversity. Dogarawa shares the same environmental conditions with other areas in Sabon-Gari LGA; hence it is discussed under this context.

Sabon Gari LGA is located approximately within latitude 10^{o} 90’ and 11^{o} 30’N and longitudes 7^{o} 30 and 7^{o} 70 ˙E (Fig.1). The area falls within the northern Kaduna sub-region. According to the 2006 census, the population of the area is 286871 (Federal Republic of Nigeria, 2007) over 65% of which are rural dwellers. Socio-culturally, the indigenous people are Hausa by Language and culture. However, in Dogarawa there is ethno-cultural intermingling but Islam is the dominating religion with few Christians.

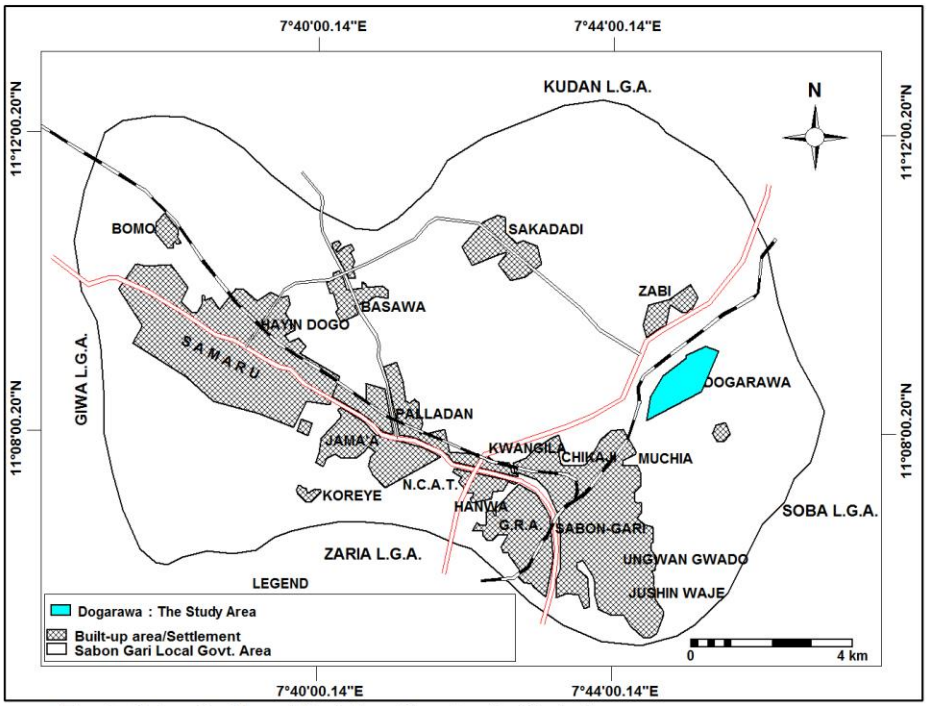

Fig. 1 : Sabon Gari Local Govt. Area Showing the Study Area
Source : Adapted and modified from Sabon Gari Local Govt. Area Map

3. Materials and methods

Data obtained were from primary and secondary sources. The primary sources were questionnaires survey with sampled respondents while interviews were with opinion leaders and staff of the health facilities, and the Sabon-Gari LGA secretariat. Secondary sources were extracted to fill the gaps in primary data such as published and unpublished works.

Both quota and systematic sampling method were employed in this research. The quota sampling method was first used to delineate the study area into three different sections; A, B, and C according to the characteristics of the study area into Dogarawa, Ungwa Nomi/Nassarawa and Ungwa Makama. In each quota, two streets were sampled as equal representation of the population. Systematic sampling was then employed in choosing respondents based on households to ensure spatial coverage. Accordingly, every third house was selected and the most elderly and matured member of the household available at the time of survey was requested to answer the questionnaire. On each street, 30 questionnaires were equally administered to give a total of 180 questionnaires.

Data were analyzed through descriptive and inferential statistics. The descriptive statistics used were frequency tables, percentages, and charts to summarize socio-economic data of respondents and quality of life and environmental variables. Multiple regression analysis (MRA) was employed to identify environmental indicators of quality of life. This multivariate analytical technique was employed because of its robustness and strength of isolating statistically significant factors responsible for observable variation from an assemblage of variables. This study employed Statistical Package for Social Sciences (SPSS).

4. Analysis and discussion of findings

4.1 Socio-Economic Characteristics of Respondents

From the data, about 92.8% of the respondents were males while less than 7.2 were females. This was due to the socio-cultural background of the study area, which is Muslim dominated. The educational attainment of respondents reflects the rural-urban characteristics of the study area where 20% and 43.9% of respondents were primary school and Islamic school graduates respectively. These were mostly in the traditional sectors of Dogarawa. Another 18.9% respondents had secondary school certificate while 5% of the sampled house hold heads had acquired tertiary education.

Majority of the respondents were not so young. For instance 37% of the respondents in the traditional areas of Dogarawa were between 50-59 years while respondents in that age category in Ungwa Nomi were 19 %. About 24% of respondents were between 40-49 years while only 20% were below 39 years. Only 1.7% of respondents were single and about 85% were in marital union; (monogyny, 37% and polygyny, 48%). The marital characteristics reveal that Dogarawa is just emerging from a traditional rural setting where many wives with high fertility rate give birth to many children to help in farming activities.

Occupational characteristics reveal that about 10% of respondents were civil / public servants working in the local government secretariat, police and military forces, and educational institutions while 15 % were either business men or women. Artisans were less than 10% while more than 66% of respondents claimed to combine farming and other off-farm activities like transportation (vehicle and motorcycle), bricklaying and masonry, tailoring and so on. Besides, farming is still prominent among the residents particularly in traditional areas like Bagadasa, Kwantaresha and the inner part of Dogarawa.

4.2 Residential and housing condition in Dogarawa

Factors responsible for choice of place of residence are the "pull" factors especially if such locations are not seriously urbanized. Table 1 presents these with respect to the Dogarawa.

Table 1: Reasons for residential choice in Dogarawa

S/No.	Primary/major factor	Frequency	%
1.	Headquarters Status	37	20.6
2.	Cheap land/ rent	33	18.3
3.	Infrastructure (electricity)	38	21.1
4.	Nativity	57	31.7
5.	Non congestion and serenity.	15	8.3
	Total	180	100

Source: Author.

Table 1 shows that about 20% of the respondents claimed to reside in Dogarawa because being the head-quarters, basic amenities will supposedly be provided and more than 18% were attracted by the cheapness of the land. For example, a respondent claimed that in 2007 he bought about half plot of land for 240,000.00Naira** in Ungwa Nomi area of Dogarawa while the same size of land in Hayin Dogo area (Samaru) sold for about 500,000.00 Naira. Another 21.1% claimed that electricity was the major attraction in 2006 when the Kwantaresha electricity project was just concluded and the residents enjoyed fairly better power supply than other locations in Sabon-Gari LGA. About 20% responded claimed that their houses were between 1-5 years old, 25.6% of the houses were between 6-10 years another 21.1% claimed their houses were aged between 11-15 years and houses for about 33.3% of the were above 15 years.

**** 1 US Dollar is equivalent to 160 Naira as at the time of survey.**

Based on this result, many houses, sand-brick made were more than 15 years old particularly in the traditional areas of Dogarawa as such the houses are considerably old and dilapidated. However in the newly occupied section of Ungwa Nomi/Nassarawa, the houses are less than ten years. The implication of this is variable quality of life quality because many of the old houses were also without modern facilities compared to the newer ones.

4.3 Environment and Quality of Life in Dogarawa

The level of perception of satisfaction with quality of life among residents in any area is linked to environmental provisioning. Views on the issues that could be used to classify quality of life of respondents include water supply, waste management, health and disease burdens as well as serenity of the place. These issues were analyzed in succeeding sub-sections.

4.3.1 Water supply to respondents

About 4.4% of the respondents used public boreholes and wells as their sources of domestic water supply 58.9.1% relied on wells dug in their homes. Water supply in Dogarawa is a problem though but has not reached a crisis stage. The landlords thus dig wells for their households. Households that cannot dig their well (17.8%) relied on neighbours for water supply. About 18.9 % of the respondents also depended on wells and water vendors (*Mai- ruwa*) especially during the peak of dry season.

4.3.2 .Waste management and environmental health in Dogarawa

Waste management takes a variety of forms. Some can be considered environmentally friendly or otherwise. Generally, 62.2% of respondents usually dump domestic waste in excavation pits and drainage channels while more than 33% burn their refuse. Only 1.7% dispose waste through scavengers and 2.2% bury their refuse. The residents obviously lack access to environmentally-healthy waste disposal infrastructure, hence the use of unconventional means.

4.3.3 Environmental Health and Disease Burden in Dogarawa

There is an intricate link between environmental health and quality of life. If the environment is save from pathogenic organisms, communicable diseases will not be burden. The finding indicates that about 45% claimed that the major household disease burden was malaria fever while 19.4% claimed that typhoid fever was the commonest. The least reported case was scabies and skin infections by 7.2% while respiratory infections were the

commonest among 12.3% of respondents. It can be deduced that the residents of Dogarawa suffer various ailments that are both environment- as well as low socio-economic status-related because they are mostly infectious diseases.

The type and choice of toilet facilities is based on housing types, preference and cost. Toilet facilities available to 62.8% households were pit latrine, while only 28.3% households use flush toilet or water closets. Open space was option for 6.7% households used while less than 3% households defecate on refuse dumps. Generally, toilet facilities of many respondents were inadequate and the methods adopted constitute environment harm to other residents of the area.

4.3.4 ***Environmental indicators of quality of life***

Multiple regression analysis was employed to identify the environmental determinants of quality of life. The factors were arrived at after a rigorous examination of the research objectives and the peculiarity of the environment under investigation. For the multiple regression analysis, the factors hypothesized as quality of life indicators were $X_1 - X_7$. Where,

Y = Dissatisfaction with level of living as quality of life indicator,

X_1 =Per cent population affected by communicable diseases

X_2 =Per cent population living in houses older 25 years

X_3 =Per cent population that suffer from socioeconomic status-related diseases

X_4 = Per cent population with below 50years of life expectancy

X_5 = Per cent population exposed to environmental nuisance

X_6 = Per cent population exposed to intolerable noise

X_7 = Per cent population that suffer domestic armed-robbery attack in the last 6 months

The step wise multiple regression method isolates four major factors as indicators of quality of life. These four explanatory variables that enter into the model at 0.5% significant level are X_1, X_7, X_5, and X_3 (Table 2). As revealed in table 2**,** the variables that explain quality of life are X_1 (population affected by communicable diseases), X_7 (population exposed insecurity of lives and properties), X_5 (population exposed to environmental nuisance), and X_4 (socioeconomic status-related diseases).All the variables have r^2 of 0.7458 indicating about 74.5% of the variation in low quality of life. Several findings can be inferred from the multiple regression analysis result. Firstly, variable X_1 (population affected by communicable diseases) undoubtedly is the most important indicator. It has r^2 of 0.2704 and a contribution of about 27.0% to the total variance. These variables reflect the poor state of environmental health typical of a rapidly expanding rural-urban fringe. Environment is expected to regulate diseases and infection but when this capacity is overwhelmed, human health is compromised (MEA, 2006).

Table 2: Multiple Regression Analysis Result.

Variables	Parameter Est.	Standard Error	R	r 2	Coefficient of of determination %
Intercept	-3.07	1.245		-	
X_1 (Communicable diseases)	6.21	2.34	.52	0.2704	27.0%
X_7 (Insecurity of lives)	3.04	1.25	.47	0.2209	22.1%
X_5 (Environmental nuisance)	1.03	3.92	.39	0.1521	15.2%
X_3(Social status-related diseases)	-2.61	1.00	.32	0.1024	10.2%
Total				0.7458	74.5%

Source: Author

For illustration, most of the area is not properly or legally lain out as different individuals purchase their plots of land and erect their structures almost haphazardly hence, drainage channels are not constructed on many streets. Besides, there are excavation pits, where earth materials for constructing local mud houses have been removed forming stagnant pools thus serving as breeding grounds for disease vectors like houseflies and mosquito (Fig. 5). The health situation is made worse by unpardonable absence of health infrastructure. As at the time of survey (December, 2011 and June, 2012), only one poorly equipped public health centre was available (Fig. 5) and private medical facilities were also absent.

Apart from outdoor environment, water is a basic needs and its accessibility influences the quality of life. Majority of the respondents lack access to pipe-borne water. Many households were not connected to the municipal (Zaria) water works, the public wells were unprotected and the available public boreholes were malfunctioning (Figs. 2 and 3). Consequently, only the financially buoyant residents dig wells and boreholes in their private homes. As at the time of survey, the cost of digging a well was N50,000.00 while the cost of a bore hole ranged between N200,000–N350,000.00. Apart from cost, availability of water is seasonal; all the respondents face water scarcity during the dry season, a shortcoming of the provisioning role of the environment. This inaccessibility to water heightens the low quality of life of people (Oyebanji, 1988; Adedayo and Fabiyi, 1999; UNS, 2001)

Variable X_7 (population exposed to insecurity of lives and properties) with a contribution of about 22.1% is the second significant variable. Many residents of Ungwa Makama, Nomi and Nassarawa suffered armed robbery attack at night as well as burglar infiltration of their homes. These resulted in permanent bodily injuries and loss of personal effects worth thousands of Naira. This insecurity is attributed to absence of organized crime prevention and security management services in the area. Despite being the headquarters, Dogarawa does not have a police post.

Population exposed to environmental nuisance from waste (X_5) is the next important environmental indicator of quality of life in the study area. Dogarawa despite being the Sabon-Gari LGA headquarters has no modern waste disposal infrastructure not even roll-in roll-out bins. The residents dump refuse in unbecoming places like drainage channels and excavation pits

while the rest openly burn their waste or leave it to rot. Also many residents keep cattle whose dung litter the street as they move in the neighbourhoods.

Finally, population suffering from socioeconomic status related diseases (Variable X_4) is another variable with a high 10.2% additional explanation. This explains the polluted indoor air quality and poor sanitation. People without indoor toilet defecate in open space, uncompleted buildings and bush paths that compromise environmental aesthetic and health. In these areas, diseases vectors and pathogens probably contaminate edible food and refreshments such as fried cowpea meal (*Kose*) soybean cake *(Awara),* bread, grilled/seasoned meat (*Suya* or *Tsire,*) and other unprotected but ready to eat food items. Besides, inadequate drainage system due to poor planning make many houses to allow their bathroom and kitchen effluent to flow onto the street (Fig. 7). This adds to burden of diseases such as *Gardiasis, Amoebiasis, Ascariasis*, and Hookworm (Omudu, 2003).

A holistic appraisal of environmental perception reveals that Dogarawa mirrors a typical Nigerian rural area in transition which is an appraisive perception of about 78% of respondents (see Cox, 1972). Their perception of quality of life is low compared to expectation of a local government headquarters which is supposedly a central place for adjacent settlements. Although only four variables have statistically significant contributions as predictors of quality of life, it does not preclude other factors. For example noise constitute environmental/ health nuisance to humans while life expectancy is supposedly a good measure of quality of life. However, the co-efficient of these other variables is too low to offer any meaningful explanation to quality of life in Dogarawa.

The regression equation could thus be written as $Y = -3.07 + 6.21\ X_1 + 3.04\ X_7 + 1.03\ X_5 + -2.61\ X_3 + 1.245$. Other possible factors not included in the current variable may include outdoor air pollution, soil degradation and erosion, dampness of house among others.

5. Conclusion.

The foregoing analysis reveals the low quality of life suffered by residents of a typical rural-urban fringe in a Nigerian setting. The people are exposed to a variety of environmental constraints such as poor sanitation typified by improper waste disposal infrastructure and toilet facilities. This is coupled with absence of efficient and actionable policies to provide hospitals and potable (pipe-borne water) for the people. As a predictive model, the MRA reveals that in any transitional rural settlements where environmental indicators similar to the present study are operational, quality of life of the residents often leave much to be desired.

Some policy implications can be proffered towards improving the quality of life among the residents. These relate to both the physical and policy environment.

Firstly, there is a need for positive discrimination in provision of infrastructure in Dogarawa. This is not only because it is the administrative headquarters of the local government council but also that the residents deserve a quality of life befitting human beings. The local government council should embark on provision of sustainable potable water to the residents by facilitating the connection of pipes to the Zaria water works. These recommendations are for the purpose of satisfying various developmental goals on social well-being that improves quality of life and the environment. Waste management should also be improved.

Policy makers should be committed improving quality of life of the people while local government authority should implement policies that address the peculiar environmental challenges of the area. For example, all the excavation pits can be harnessed for eco-system supportive (eco-supportive) infrastructure especially rain-water harvesting instead of serving as breeding grounds for disease pathogens.

Dogarawa is fast becoming a heterogeneous community hence, the need to encourage self-help activities among the residents. It was observed that as at June, 2012 residents of Ungwa Nassarawa successfully employed Vigilante Corps for security and the Ungwa Nomi Neighbourhood Association made serious progress to initiate community policing. Since government appears incapable of providing the infrastructure requisite for improved quality of life, with self-help, infrastructure projects and services can be provided by pooling financial resources to provide infrastructure such as potable water, waste management facilities and even community health centres and dispensaries

Fig. 2: Unprotected/ Open well used by several households on Kabiru Maigoro road, Ungwa Nomi Dogarawa

Fig. 3: A non-working borehole on Kwara road, Dogarawa

Fig. 4: An excavation pit used as refuse dumpsite on Makama Road, Ungwa Nomi,Dogarawa

Fig. 5 : An excavation pit to which several households link their bathroom/toilets and empty their waste in Ungwa Makama, Dogarawa

Fig. 6. The only public Health post in Dogarawa adjacent to the UBE primary school in Dogarawa

Fig. 7: A house where the domestic waste and bath effluent to flow on to the street in Dogarawa

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FACTORS AFFECTING AIRPORT CHOICE OF CARGO ROUTING IN NIGERIA

J.A .Adenigbo [1] and A.E. Ubogu [1]

[1] Department of Geography, Ahmadu Bello University (ABU), Zaria, Nigeria

Abstract

This paper identifies and examines the myriad of factors that influence the choice of airport for cargo routing in Nigeria's major international airports. The study made use of primary data collected by administering questionnaire to cargo agents randomly at the four major international airports in Nigeria. In all, a total of 367 respondents were interviewed. The respondents were asked to rank-order 13 variables that influence their choice of routing cargo. These variables were analyzed using factor analysis. The results show that all the identified variables are important factors that affect airport choice of cargo routing. It also revealed that airport service quality is the most significant factor that affects choice of airport cargo routing in Nigeria. The study therefore recommends that service quality of airports in Nigeria be standardised to encourage patronage of agents and airlines alike.

Key words: Air cargo, airport, Nigeria, service quality, routing.

1. Introduction

Airports are essential part of the air transport system. They provide all the infrastructures needed to enable passengers and freight to transfer from surface to air mode and to allow airlines to take off and land. The basic airport infrastructure consists of runways, taxiways, apron space, gates, passenger and freight terminals, and ground transport interchanges. Airports bring together a wide range of facilities and services in order to be able to fulfil their role within the air transport industry. These services include air traffic control, security, fire and rescue in the airfield. Handling facilities are provided so that passengers, their baggage, and freight can be successfully transferred between aircraft and terminals, and processed within the terminal (Graham, 2003).

Air cargo transportation system is designed to provide fast and efficient shipment of goods. Air transport is the fastest mode of transport. It is used safely to carry high-valued and time-critical goods. The meaning of air cargo in this work takes the definition provided by the International Air Transport Association (IATA) as being the equivalent of goods, meaning any property carried or to be carried on an aircraft except mail or other property carried under terms of an international postal convention, or baggage carried under a passenger ticket and baggage check, but baggage moving under an airway bill or shipment record.

The proper functioning of air cargo transport affects the economic viability not only of the aviation industry, but also of the national and international high-value, just-in-time supply chain that serves many other manufacturing, service and trading industries. Indeed, the trend in air cargo logistics of most manufacturing and distribution system that relies on meeting immediate needs, as opposed to carrying large inventories "just-in-case" is the adoption of Just-In-Time (JIT) techniques (Boeing, 2005). In the new fast-cycle logistics era, air cargo enables businesses, regardless of their location, to connect distant markets and global supply chains in an efficient, expeditious, and reliable manner (Kasarda and Sullivan, 2006). The emergence of globally integrated, Just-In-Time (JIT) production and distribution systems and the emergence of e-commerce and e-business have made air cargo the fastest growth area in the cargo sector (Hui *et al* 2004). Furthermore, Hsu *et al* (2005) argued that the way to deliver high-tech products by liner shipping is less efficient than by airline and it shows the importance of air cargo.

Various factors can affect an airport's ability to attract the flow of air cargo. The study of Hiroshi *et al* (2005) on Northeast Asia airports identified few factors to include; the airports' low current cargo traffic patterns, poor airport infrastructure capacity and activities, lack of linkage with regional and intercontinental airport network, poor service quality, and airport cost factors. It is apparent that these factors could influence airport choice in Nigeria. Potentially, this could lead to one airport having a larger share of the flow of cargo, at the same time enhancing specialized handling of some cargo type in an airport at the expense of others. This can therefore give a perception that there are underlying reasons for which more cargoes are preferably routed through a particular airport.

A review of studies on Nigeria air transport has revealed that not much attention had been accorded to air cargo, while deliberate attention had been given to the analysis of the flow of passengers, aircraft movement, flight operations emphasising safety and security, and issues on policy and bilateral agreements. Such works include that of Ayakpat (2010) which examined the effects of liberalisation and open skies agreement on Nigeria's airline passenger operations in Nnamdi Azikwe international airport, Abuja. In the same vein, Idrisu (2004) worked on the commercial and regulatory implications for air transport liberalization and open skies agreement in Nigeria while Chikwe (2001) also examined open skies policy of air transport and assessed its regulatory and commercial implications and opportunities for

Nigeria. In addition, Gambiye (2010) carried out an assessment of the ticketing and reservation operations of IRS Airline in Yola; while Oladele (2005) assessed the African air transport in the 21st century by contrasting Nigeria's and Kenya's experiences; Similarly, Yahaya (2005) carried out an assessment of airport capacity utilization in Nigeria.

However, related works on air cargo carried out in Nigeria are in different dimensions and not as intensive compared to what has been done in other countries. Specific works on air cargo in Nigeria are that of Afolabi (2005) on the bane of air cargo development in Nigeria, which highlighted the problem of warehouses in air cargo handling, and suggested that it is the prerogative of the Federal Airport Authority of Nigeria (FAAN) to provide and build warehouses that can house different kinds of goods. Conversely, Olateru's (2005) study on the importance of air cargo business to the economy of Nigeria revealed that most airlines relied so much on cargo business for revenue generation even though they were not dedicated cargo airlines. Furthermore, the study asserts that cargo business is a 40 billion-dollar business which the airlines and government can make a lot of money from, and recommended that the government should close the gap between the volume of import and export of air cargo in the country.

This dearth of empirical studies relating to the factors affecting airport choice of cargo routing in Nigeria is as a result of underdevelopment of supply chain management in the air cargo industry. According to Ayodele (2010) facts and figures on cargo movement in and out of Nigerian airports show that cargo transportation can contribute significantly to Nigeria's Gross Domestic Product (GDP), if properly developed. The author further asserted that air cargo is the most vital and lucrative aspect of air transportation, yet the most neglected. However, in other countries, there are compact of body of researches in related areas that identify common themes and provide the basis on which to develop empirical research for this study. Examples of such works include Zhang (2003); Hui *et al* (2004); Gardiner *et al* (2005) and Kasarda *et al* (2006).

A cursory assessment of these studies reveals that most of these studies in the Nigerian aviation sector ignored the role choice factors play in the routing of cargo through certain airports. Meanwhile, these factors play important roles in the ability of an airport to compete optimally in a competitive aviation cargo market. This study therefore examines the factors influencing airport choice for routing cargo in Nigeria with a view to identifying the explanatory factors that are most significant in the choice of airport for cargo routing in Nigeria

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2. Materials and Methods

This study relied on primary source of data collection which involves the use of well structured and self administered questionnaire at the four major international airports in Nigeria. The study sampled a total of 392 out of the 18,780 Nigerian Aviation Handling Company (NAHCO) registered agents as at 2010. The agents operate under the Association of Nigeria Custom Licensed Agents (ANCLA) at the premises of the airports on a daily basis. Copies of the questionnaire were proportionally distributed at the airports and administered randomly to the agents (see Table 1). The sample size for the study was determined using a formula developed by Yamane (1967) for determining the sampling size where a population is known.

The formula is as follows;

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

Where,

n = Sample size;
N = Population size;
and *e* = level of significance (set at 0.05 for this study)
Hence, $n = \frac{18780}{1 + 18780(.05)^2}$

$= 392$

Table 1: Distribution of Questionnaire

Airports	Total No of Cargo Agents in 2010	Sample Size
Lagos	10,414	217
Abuja	5,883	123
Kano	1,486	31
Port Harcourt	997	21
Total	18,780	392

Source: Authors' computation

The respondents were required to rank 13 independent variables of airport location, airport capacity, concentration of industries/firms in the zone, cargo security, airline flight route, market size, cost of cargo handling, busiest airport, airport infrastructure, service quality, customs efficiency, airport charges and airline flight frequency in order of importance as it affects their choice of routing cargo through airports in Nigeria. Out of the 392 respondents sampled, a total of 367 copies of the questionnaire were successfully retrieved and found worthy to be used for the analysis.

Factor Analysis (FA) was employed to determine the relationship between a dichotomous dependent variable (airport choice) and the independent variables. FA is concerned with whether the covariances or correlations between a set of observed variables can be explained in terms of a smaller number of unobservable constructs known as common factors. It determines the number of common factors needed to adequately describe the correlations between the observed variables, and estimating how each factor is related to each observed variable, that is estimating the factor loadings (Oyesiku, 2000).

According to Sabine and Brain (2004), exploratory factor analysis is concerned with whether the correlations between a set of observed variables x_1, $x_{2,}$..., x_q can be explained in terms of a smaller number of unobservable common factors, $f_{1,}$ $f_{2,}$...f_k, where k<q and hopefully more less. In mathematical terms, the factor analysis model can be written as follows;

$$\chi_1 = \lambda_{11} f_1 + \lambda_{12} f_2 ... + \lambda_{1k} f_k + u_1$$

$$\chi_2 = \lambda_{21} f_1 + \lambda_{22} f_2 ... + \lambda_{2k} f_k + u_2$$

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.

$$\chi q = \lambda_{q1} f_1 + \lambda_{q1} f_2 ... + \lambda_{qk} f_k + u_q \qquad (2)$$

The equations above can be re-written as:

$$\chi = \Lambda f + u, \tag{3}$$

Where,

$$\chi = \begin{bmatrix} x_1 \\ . \\ . \\ . \\ xq \end{bmatrix}, \Lambda = \begin{bmatrix} xu \ldots \lambda_{1k} \\ . \\ . \\ . \\ \lambda q_1 \ldots \lambda qk \end{bmatrix}, \quad f = \begin{bmatrix} f_1 \\ . \\ . \\ . \\ fk \end{bmatrix}, \; u = \begin{bmatrix} u_1 \\ . \\ . \\ . \\ uq \end{bmatrix} \tag{4}$$

Furthermore, since the factors are unobserved, their location and scale can be fixed arbitrarily, therefore we can assume that only part of the variation in a given population is contained within the variables used to define that population. For this reason, only some of the observed variations in choice factors in the study area are due to variations in all the variables under consideration.

The study area is Nigeria with four major international airports that are strategically located to serve as regional airport hubs for air traffic in passengers and cargoes. These airports are located in Lagos, serving as hub for traffic in southwestern part of Nigeria; Kano, hub for traffic in northwestern and northeastern parts; Port Harcourt, hub for traffic in southeastern and Abuja, hub for traffic in north-central parts of Nigeria.

3. Results and Discussion

The role airports play in the movement of cargo from location to location cannot be overemphasised. Cargo handlers, shippers and airlines alike are so conscious of this that efforts are put in place individually to ensure business is transacted with utmost efficiency at airports.

Table 2 shows the result of the reliability test using KMO and Bartlett's Test of sampling adequacy to determining if the variables were sufficiently reliable to allow the use of Factor Analysis. The KMO result shows a reliability value of 0.80 which indicates that the data obtained is adequate and reliable for the analysis. According to Cornish (2007), a KMO result should be over 0.700 to be sufficiently correlated. Therefore, with an r value of above this threshold the variables are well correlated and reliable for the analysis.

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.800
Bartlett's Test of Sphericity	Approx. Chi-Square	717.809
	Df	78
	Sig.	.054

Source: Authors' computation

The Correlation matrix of the variables in Table 3 revealed that all the variables are positively correlated. This implies that all the variables have a close relationship with one another. Indeed, any effect on one factor will produce a corresponding measure of effect on the other. The result as presented in Table 3 shows that the most correlated pair of variables are cargo security and airport service quality (r = 0.673). This is obvious as the better the airport service quality, the more secured will be cargoes handled. Airport charges was also found to be positively and strongly correlated with custom efficiency (r = 0.641). This is because the custom efficiency has a close relationship with airport charges. The more efficient the custom services, perhaps the more charges that importers have to pay. This is true of the recently introduced electronic data interchange which helps in fast clearing of cargoes at the airports but with corresponding increased airport charges.

Similarly, airport infrastructure showed a strong correlation with airport service quality with an r value of 0.639. In fact, this result clearly implies that the better the airport infrastructures, the more efficient will be the perceived airport service quality. Another pair of variables that are strongly correlated is airport infrastructure and the capacity/size of the airport. This revealed an r value of 0.621. Indeed, airport capacity has a close relationship with airport infrastructure. Therefore, airports with better infrastructures all things being equal, approximates the international airports with large capacity to handle cargoes.

The level of infrastructure provided at any airport is a measure of its size/capacity. The more infrastructures are provided at any airport, the more the size/capacity of the airport because infrastructural provisions take up more land mass. Airport infrastructural facilities provided enhanced cargo security and the cost/efficiency of cargo handling at any airport. That cargo is secured at airports is a reflection of service quality which by extension is a function of adequate infrastructure at the airport. Efficient customs operations and services improve air cargo security and service quality. When customs operations are not efficient, airport service quality will depreciate and manifest in cargo insecurity. But customs efficiency with increased airport charges will relate to influence the airport overall performance. While frequency of airline flight at any airport is a function of airport service quality and charges.

Table 4 presents the communalities estimates of the variables after the extraction of the three common factors shows that very little of the variance of the item “busiest airport” (with 23.1%) can be attributed to the three common factors. Also, the variances of items ‘location of airport’, ‘route of airline flight’, ‘cost and efficiency of cargo handling’ and ‘frequency of cargo flight’ with 43.1%, 43.4%, 43.6% and 45.9% respectively will have little to attribute to the common factors. It implies from Table 4 that agents in their choice for routing cargo through airports in Nigeria do not consider whether the airport is busy or not. This indicates that the item “busiest airport” can be taken out of the variables to be examined. Nevertheless, the communality values equally indicates that of all the variables under consideration, airport charges displayed the highest variance of 79.7% which means that this variable can be attributed to the three common factors.

Table 3: Correlation Matrix Table of the Airport Choice Factors

	Location of Airport	Size/Capacity of Airport	Concentration of Industries	Cargo Security	Route of airline flight	Size of market	Cost/ Efficiency of Cargo Handling	Busiest Airport	Airport Infrastructure	Airport Service Quality	Custom Efficiency	Airport Charges	Frequency of Cargo Flight
Location of Airport	1.000	.520	.128	.502	.214	.031	.300	.165	.522	.420	.263	.067	.256
Size/Capacity of Airport		1.000	.455	.452	.496	.281	.437	.160	.621	.449	.188	.033	.283
Concentration of Industries			1.000	.318	.402	.616	.450	.314	.388	.359	.175	.128	.303
Cargo Security				1.000	.470	.108	.526	.252	.555	.673	.552	.260	.338
Route of airline flight					1.000	.313	.423	.387	.404	.446	.337	.280	.485
Size of market in the zone						1.000	.294	.373	.043	.222	.151	.143	.167
Cost /Efficiency of Cargo Handling							1.000	.233	.509	.478	.380	.326	.334
Busiest Airport								1.000	.170	.276	.218	.248	.220
Airport Infrastructure									1.000	.639	.339	.214	.415
Airport Service Quality										1.000	.602	.399	.519
Custom Efficiency											1.000	.641	.434
Airport Charges												1.000	.602
Frequency of Cargo Flight													1.000

Source: Authors' computation

Table 4: Communalities of the Airport Routing Choice Factors

	Initial	Extraction
Location of Airport	.460	.431
Size/Capacity of Airport	.588	.635
Concentration of Industries	.566	.635
Cargo Security	.629	.602
Route of Airline Flight	.502	.434
Size of Market in the Zone	.524	.670
Cost and Efficiency of Cargo Handling	.448	.436
Busiest Airport	.277	.231
Airport Infrastructure	.648	.677
Airport Service Quality	.662	.667
Custom Efficiency	.612	.599
Airport Charges	.613	.797
Frequency of Cargo Flight	.556	.459

Extraction Method: Principal Axis Factoring.

Source: Authors' computation

Three (3) factors with eigen-values greater than one (1) were produced and altogether accounted for 65% of the total variance of the variables (Table 5). In determining the number of factors needed to represent the data set, the Kaiser's procedure of selecting the factor with eigenvalue greater than 1 criterion was adopted. The first factor accounted for 41% of the variance with eigenvalue of 5.317 while the other two factors have 12.21% and 11.89% of the total cumulative variance with eigenvalue 1.587 and 1.545 respectively.

Table 5: Percentage of Total Variance Explained by the Three Factors

Factor	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	5.317	40.900	40.900
2	1.587	12.207	53.107
3	1.545	11.888	64.995

Extraction Method: Principal Axis Factoring.
Source: Authors' computation

Table 6 shows the rotated factor matrix of the explanatory variables. In the table, three factors were extracted to explain the underlying similarities of the 13 variables. The factors were rotated using varimax rotation in order to maximise their orthogonality and clearly describe the pattern of the three factors, and the relative factor score of each factors are named. Variables

with absolute value of factor score below 0.4 were suppressed because in practice, according to Sabine and Brian (2004), a largely arbitrary threshold value of 0.4 is often equated to 'high' loadings; in addition, variables were sorted by size (see Table 6).

Table 6: Rotated Factor Matrix

	Factor		
	1	2	3
Airport Infrastructure	.786		
Size/Capacity of Airport	.713		
Cargo Security	.672		
Location of Airport	.651		
Airport Service Quality	.613	.499	
Cost/Efficiency of Cargo Handling	.471		
Airport Charges		.885	
Custom Efficiency		.712	
Frequency of Cargo Flight		.573	
Size of market in the zone			.815
Concentration of Industries			.742
Route of airline flight			.426
Busiest Airport			.403

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization

Source: Authors' computation

It is seen from the Table 6 that all the 13 variables are loaded on the three extracted factors. This implies that all the variables are significant to influence the choice of routing cargo through airports in Nigeria. Loaded on Factor 1 are; airport infrastructure, airport size/capacity, cargo security, airport location, service quality and cost/efficiency of cargo handling. Factor 2 has airport charges, custom efficiency, frequency of cargo flight and airport service quality; while Factor 3 loads on size of market in the zone, concentration of industries, route of airline flight and busiest airport. Therefore, the extracted factors 1, 2 and 3 can be labelled as Airport Infrastructure and Service (AIS), Airport Charges (AC) and Airport Patronage (AP) respectively.

Of all the 13 variables identified and factor analysed, 6 of them loaded on Factor 1- AIS (see Table 6). Airport infrastructure and size/capacity of airport loaded high with 78.6% and 71.3% respectively, followed by cargo security, location of airport and airport service quality with 67.2%, 65.1% and 61.3% respectively. This shows that airport infrastructure with the highest loaded value accounts to be the most significant of the variables correlated with Factor 1. Of the four variables that rotates on Factor 2, airport charges seems to be the most significant with load value of 88.5%, followed by customs efficiency with 71.2%. The variables that load on Factor 3 have size of market in the zone to be the most significant with 81.5%, followed by concentration of industries in zone with 74.2%. This implies that cargo agents, even airlines alike, desire to carry out their businesses at reduced cost.

Airport charges have a significant impact on the choice of airport for cargo routing in Nigeria. It is also of magnificent influence for the choice of airlines patronage of an airport. The work of Berechman and De Wit (1996) found out that airport charges had influence on passenger

airlines' location decision. This will indirectly affect the flow of cargo at any airport since most airlines carry cargo in the belly of their passenger aircrafts. And cargo operations involve individual shippers represented by agent(s), if airport charges are high, agents will tend to route cargo through airports with reduced charge for him to gain more confidence from the shipper by handling cargo at a reduced rate.

As a matter of fact, customs operations at any airport in the world is a factor that influence choice of airport usage for both passenger and cargo traffic. Zhang and Zhang (2002) identified the importance of customs efficiency to cargo flow and stated that any customs administration that can provide reliable, timely clearance, or immediate release based on pre-clearance, creates a competitive advantage for the station airport. The frequency of cargo flight refers to a factor that has to do with how often does the airport receive or dispatch cargo aircraft on either scheduled or charter basis.

Only four of the variables rotated on Factor 3. The importance of market size especially in relation to population was brought out by the study to reflect another significant factor that influences the choice of airport cargo routing in Nigeria. Though, this variable rotates on Factor 3, of a fact, it is the variable with the highest loadings (81.5%). Concentration of industries that follows also attributes to the influence of population.

The special note here is that only airport service quality loads and rotates on both Factor 1 and 2. This implies that it is the most significant factor among the variables in the discussion of factors that influence the choice of airport for cargo routing in Nigeria. This is in line with the findings of Hiroshi *et al* (2004). Airports overall service quality is produced as a result of the combined activities of various organisations such as airlines, handling agents, customs and immigration officials, as well as concessionaires. These different bodies may have different ultimate objectives and conflicting views on what determines satisfactory or quality service (Lemer, 1992). In effect, the airport operator only has partial control of all the processes which make up the final product. Areas of responsibility, therefore, have to be very clearly identified and the airport operator must define a common goal for all as regards service quality.

Graham (2003) pointed out queuing and waiting processes as an area of concern regarding airport's quality of service as a result of increased emphasis on cargo security. Similarly, Hiroshi et al (2004) considered airport service quality in terms of time costs factors to include cruising/flight time, loading/unloading and customs clearance time, and waiting time caused by schedule delay. But Maiden (2000), measured airport service quality using objective and subjective measures. Objective indicators measure the service delivered and can cover areas such as flight delays, availability of lifts, escalators and trolleys, and operational research surveys of factors such as queue length, space provision, waiting time, and baggage reclaim time. These objective measures can only cover a limited range of issues and service dimensions. For instance, while they can measure the reliability of equipment, they cannot tell whether consumers feel safe, assured and satisfied with their use of the equipment (Graham, 2003). Subjective measures enable the quality of service to be assessed through the eyes of users rather than airport management.

In another way, airport service quality can be assessed by looking at the speed of movement, frequency of service, and reliability of service, susceptibility to loss and damage, and spatial accessibility of service. The greater the speed of movement for shipments, the higher the quality of the airport service, since shipments arrive at their destinations within a shorter period of time. Frequency of service is how often the service is provided; with higher frequencies, service will be available more often (thereby the higher the quality of service).

4. Policy Implications and Recommendations

While it is imperative for shippers to decide which airport to route cargo because of the locations of origin and destination of cargo, it is also important that airports are equipped and driven to handle cargo traffic of varying nature in Nigeria. The airports' management structure should focus on increasing airlines' patronage in Nigeria. Just as this study has identified airport service quality as the most important airport choice factor for routing cargo in Nigeria, it therefore implies that it would be more effective for airports management to attract cargo by reducing air cargo connecting time, rather than reducing airport charges because agents and airlines will prefer to operate at airports with high quality of service.

International air transport is regulated by a complex web of bilateral air service agreements signed between countries. Although liberal bilateral agreements have become more widespread, many still impose restrictions (Cheung, 2002). Bilateral air services agreements and inter-airline agreements influence flight frequencies. In countries where more than one national carrier operates international services, the country's own licensing or regulatory controls may influence the sectors on which their airlines operate. For Nigeria, the focus on bilateral agreements should be driven towards increase flight frequency of both passenger and cargo at the airports

Historically, revenue collection was a major function of customs administration. The importance of this role diminishes as tariff barriers are gradually being removed. Customs administration increasingly plays an important role in attracting international air cargo. Unpredictable delays in customs clearance procedure or unexplained changes in the classification of goods disrupt efficient logistic flows, and thus hinders hub development in air cargo traffic. New technology, such as Electronic Data Interchange system, simplifies the customs procedure by computerizing shipment information, and makes it more efficient by allowing pre-clearance of the shipment. The government of Nigeria should consider establishing bonded areas so that the cargo can be cleared close to their destination points.

This study did not observe the extent of efficiency enhancement achieved at the airports in customs clearance process. Since the efficiency of customs is often measured by time, a concern might arise based on the correlation between customs efficiency and airport charges. Similarly, if the airlines realize that freight forwarders have a higher willingness to pay for the airports that have efficient customs administration, and that there are routes in which such airlines have some degree of market power, they might increase the line-haul cost to increase their revenue.

5. Conclusion

The government, at present is actively pursuing economic policies that would help develop designated airport in the country into regional transport and logistics hub. The ability of the airports to attract carriers and air cargo traffic is crucial to the establishment of a transport and logistics hub. In view of this, Nigeria government needs to galvanise efforts that will ensure a reduction of the degree at with identified factors affect cargo traffic and handling in our airports.

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SPATIAL VARIATION IN DIARRHOEA PREVALENCE AMONG CHILDREN IN KADUNA STATE

Y.A. Arigbede [1],M. Mamman[1], J.G. Laah[1]
[1]Department of Geography, Ahmadu Bello University, Zaria

Abstract

This study was carried out to map the spatial variation in diarrhoea prevalence and their attendant causes among children in Igabi, Zaria and Zangon Kataf Local Government Areas of Kaduna State. The data used included were from hospital records and questionnaire survey, of 477 respondents. Qualitative data from in depth interviews and Focus Group discussions were also used. The data for disease prevalence was aggregated within GIS environment to produce the disease maps and Chi square was used to determine the relationship between economic and sociodemographic characteristics of mothers, and diarrhoea prevalence in their children. The incidences of diarrhoea is most prevalent in Zaria with 50% of the cases, followed by Igabi(30%) and lastly Zangon- Kataf(20%) LGAs. Socioeconomic attributes of the mothers of the sick children had influence on the occurrence of diarrhoea in the children. Some of these included: educational attainment ($p=0.029$); the method of excrement disposal (0.025) and source of drinking water ($p=0.007$). To help manage diarrhoea prevalence, recommendations include the practice of disease preventive measures such as better sanitary environment, adequate nutrition of children, improved hygiene and education of mothers to at least secondary level. In conclusion, mapping childhood diseases such as diarrhoea present a better way of understanding variation in diseases and provide location-specific management measures.

Key words: Childhood, Diarrhoea, Drinking Water, Excrement disposal, Geographic Information Systems (GIS), spatial variation.

1. Introduction

According to United Nations Children's' Emergency Fund 'UNICEF' (2010), diarrhoea is the second largest killer of children, causing as many as 17% of the deaths of those under the age of five. This is largely a result of unsafe water and poor hygiene. About 4 billion cases of diarrhoea are annually reported with resultant death of 1.7 million people, most of who are children under the age of five (UNICEF, 2010). Diarrhoea is defined as having loose or watery stools at least three times per day, or more frequently than normal for an individual (UNICEF/WHO, 2009). Though most episodes of childhood diarrhoea are mild, acute cases can lead to significant fluid loss and dehydration, which may result in death or other severe consequences if fluids are not replaced at the first sign of diarrhoea. About 46% of deaths due to diarrhoea occur in Africa alone, and Nigeria happens to record mortality cases due to diarrhoea, at a staggering figure of 151,700 annually (UNICEF/WHO,2009).

Children with poor nutritional status and overall health, as well as those exposed to poor environmental conditions, are more susceptible to severe diarrhoea and dehydration than healthy children. Children are also at greater risk than adults of life-threatening dehydration since water constitutes a greater proportion of children's bodyweight. Young children use more water in a day given their higher metabolic rates, and their kidneys are less able to conserve water compared to older children and adults.

Reducing childhood diarrhoea requires interventions to make children healthier and less likely to develop infections that lead to diarrhoea; clean environments that are less likely to transmit disease; and the support of communities and caregivers in consistently reinforcing healthy behaviours and practices over time.

El Samani *et al* (1989) studied the predictors of diarrhoea in children under five in Sudan; they collected data on 445 children under the age of 5 and categorised them according to their weight for age. A strong association between malnutrition and diarrhoea was observed. It was also discovered that undernourished children had close to twice the risk of diarrhoea of well nourished children. Gascon *et al* (2000) studied the prevalence of diarrhoea in children under five years old in Ifakara, Tanzania. Data were collected on a total of 103 children suffering from acute diarrhoea, with watery stool presentation at least 24 hours to the time information was collected. Conditional logistic regression was used to evaluate how the risk of having a case of disease varied for different risk factors and pathogens. The analysis was performed using Stata statistical software, and the results showed that lesser distance to water source, open latrines and non exclusive breastfeeding of children above six months were associated with a higher risk of diarrhoea.

Furthermore, Girma *et al*, (2008) studied the environmental determinant of diarrhoea infection among under five children in Western Ethiopia. A community based study and data were collected randomly from 407 mothers/caregivers of children less than five years of age. The results showed that a number of risk factors including distance from drinking water sources, availability and ownership of the latrine, refuse disposal, the presence of faeces around the pit-hole and presence or absence of pit-hole cover and faeces seen in the compound were significantly associated with under-five childhood diarrheal morbidity.

Some cases of diarrhoea are prolonged, with the child continuously passing loose and watery stool for more than seven days. Many children in this critical state end up adding to mortality figures if not managed with utmost care. Ekanem *et al* (1994) investigated diarrhoea incidence among 628 children a semi urban area of Lagos State and the results showed that a significantly high risk of prolonged diarrhoea was found among children who were fed maize pap as the main diet. Children who were fed with food purchased from food vendors were also significant sufferers of prolonged and persistent diarrhoea, with frequent exposure to the illness, exacerbated by low energy and low nutrient meals like pap. Other studies were that of Oni (1996) and others. Most of the studies were outside Kaduna State, the non-availability of study that compare variation in diarrhoea incidence in Kaduna State is long overdue because of the peculiarity of the mixed cultural and socioeconomic attributes of mothers in the area.

This study is focused on mapping diarrhoea incidence in Kaduna state. This study is important in Kaduna state, as there had been an unacceptably high mortality rate and burden of the disease in the state (PATHS, 2006). This research would reveal areas of high prevalence of diarrhoea among children, due to certain factors, thereby helping to provide a strategy for effective management for the disease in the state.

The aim of this research is a purposeful analysis of the spatial variation of diarrhoea prevalence among children in Kaduna State. The key objectives are therefore to: determine the prevalence of diarrhoea in the study area, analyse the probable causes of diarrhoea prevalence in children, and produce a map showing the spatial variation of diarrhoea in Kaduna state.

The underlying hypotheses are that
1. There is no spatial variation in prevalence of diarrhoea in children in Kaduna State and

2. Sanitary conditions do not affect the prevalence of diarrhoea in children in Kaduna State

2. Materials and methods

A reconnaissance survey was carried out for getting acquaintance with the study area, and ground truthing was also done to verify the features on ground, as noticed in the satellite imagery. Primary sources of data were satellite imagery of Kaduna State, obtained from National Research and Space Development Agency, (NARSDA) Abuja; field survey whereby questionnaires and structured interviews were administered at homes and health facilities to mothers of children under the age of 5 years, and medical personnel using systematic random sampling method. Every 5^{th} house was selected for questionnaire administration.

Kaduna State has a population of 6,066,562 (NPC, 2006). It comprises of twenty three (23) local government areas, grouped into three senatorial districts. Three local government areas were selected for the study. The selections of these three LGA's were based on the following criteria:

i. Their location in each of the senatorial districts. One was chosen from each of the three senatorial districts, to ensure adequate spatial coverage of the study.
ii. The LGA with the highest population of females in each of the senatorial districts in Kaduna State.

Based on the criteria stated above, the three LGAs chosen for study were Zaria, Igabi and Zangon-Kataf. With reference to table 1, the number of copies of the questionnaire administered was based on the population size. The total female population in the selected LGAs was 556,550, of which 0.1% was used as sample for the questionnaire administration. This percentage is adequate, as it surpasses the required sample size prescribed by research advisors (2006), for the administration of questionnaires within a population. The copies of the questionnaire administered were 556, distributed among the mothers and caretakers of children under five years of age in the selected LGAs.

Table 1: Distribution of Female Population in the selected LGA's, and questionnaire administration

Selected LGA	Population of females	No of questionnaires administered per LGA
Zaria	196,090	196
Igabi	213,339	213
Zangon-Kataf	157,121	157
Total	556,550	556

Source: Adapted from NPC (2006)

Three Focus Group Discussions (FGD's) were carried out, to obtain attitudinal data and information on culture, myths and other sensitive issues relevant to the research, which the questionnaire may not have captured. A FGD session was done in each LGA, comprising of 10 women between the ages 15-45 years. Secondary data were from hospital medical records from selected hospitals.

Data from field survey were analysed using both descriptive and inferential statistics. The descriptive statistical analysis was adopted for the summarization of data in tables and percentages. In establishing the relationship between childhood diarrhoea prevalence and causative factors, the chi square analysis was used. This revealed the statistical influence of some of the socioeconomic factors on incidence of diarrhoea in children, using the SPSS 12 statistical package. Out of the 556 questionnaires administered, 477 valid questionnaires were recovered from the respondents and analysed

3. Results and discussion

3.1 Factors responsible for diarrhoea incidence

3.1.1: Source of Drinking Water and Prevalence of Diarrhoea

Table 2 shows the different sources of drinking water in the study area. On the average, 34.5% of the respondents get their potable water from tap. This is followed closely by the respondents who rely on well (32.0%). Borehole as a source of potable water is for 24.5% respondents as it seems to be more reliable in terms of safety and supply, while only 0.7% of respondents sourced their drinking water from rivers and streams.

Table 3 show that all of the respondents whose major source of drinking water was tap, had children with diarrhoea. This may be an indication that the pipe borne water is contaminated either from source or storage before consumption.

3.1.2: Excrement disposal and prevalence of diarrhoea

With reference to table 4, the method of excrement disposal affects the health of children in many ways. On the average, of all the methods of human waste disposal in the study area, 47.0% use the pit latrine. This figure is followed closely by the water closet at 46.3%. The open field/bush serve 1.9% of the respondents, while 0.7% use the bucket/pan. Lastly, the public toilet is utilised by 3.3%.

In all the three LGAs, the commonest method of excrement disposal is pit latrine and water closet. Interestingly however, while majority (74.4%) of the respondents in Zaria LGA utilize the water closet system, Zangon Kataf has 42.6% usage and Igabi only 22% usage. This spatial difference could be due to the status of each of the LGA's with regards to their urban settings. Zaria LGA being the most urbanize followed by Zangon Kataf LGA and lastly Igabi LGA.

Table 5 shows that about 59% of the respondents' children who have suffered diarrhoea utilise the pit latrine; 3.3% use the bucket/pan. The chi square result reveals a calculated value of 9.319, with 3 degrees of freedom and a P value of 0.025 to indicate a statistically significant relationship between method of excrement disposal and in prevalence of diarrhoea in children. This could be an indication of greater exposure to germs in the pit latrine compared to other forms of excrement disposal.

3.2 Spatial variation in Diarrhoea incidence in Kaduna state.

With reference to Table 6, Igabi LGA reveals a statistically significant result with a calculated Chi square value of 0.75, with 3 Degrees of freedom and a P- value of 0.001; Zaria LGA on the other hand also had a statistically significant result with a calculated Chi square value of 0.75, with 3 Degrees of freedom and a P- value of 0.001;The result in Zangon Kataf however shows a non significant Chi square relationship with a calculated value of 66.7 at 5 degrees of freedom and p value of 0.070. This shows that in the locality, the method of excrement disposal has no influence on diarrhoea prevalence in children.

With reference to Table 7, the spatial variation in the Chi square results across the three LGAs indicates a statistically significant relationship in Igabi and Zaria LGAs, with a p value of 0.009 and 0.010 respectively. A non significant relationship as indicated by a p value of 0.069 in Zangon Kataf LGA with a shows that drinking water does not influence the prevalence of diarrhoea in the locality.

Table 2: Distribution of respondents by sources of drinking water

Variables	Igabi LGA		Zaria LGA		Zangon Kataf LGA		Total LGA	
Source of Drinking Water	Number of Respondents	%	Number of Respondents	%	Number of Respondents	%	Number of Respondents	%
No response	0	0	0	0	4	2.7	4	0.9
Tap/pipe borne	53	26.5	49	38.0	58	39.2	160	34.5
Tanker/water vendor	6	3.0	15	11.6	2	1.4	23	5.3
Well	112	56.0	9	7.0	49	33.1	155	32.0
Borehole	25	12.5	51	39.5	32	21.6	108	24.5
River/stream	1	0.5	1	0.8	1	0.7	3	0.7
Total	200	100	129	100	148	100	477	100

Source: Field Survey,2012

Table 3: Source of drinking water and prevalence of Diarrhoea

Prevalence of diarrhoea	Total					
	Drinking water					
	Tap/pipe borne	Tanker/ Vendor	Well	Borehole	Others	Row total
Yes	23(100.0)	2(50.0)	16(84.2)	8(57.1)	1(100.0)	50(100.0)
No	0(0.0)	2(50.0)	3(15.8)	6(42.9)	0(0.0)	11(100.0)
Column total	23(37.7)	4(6.6)	19(31.2)	14(22.9)	1(1.6)	61(100.0)
Calculated X^2 value = 13.947; Degree of freedom= 4; P- value= 0.007; Remark= Significant						

Source: Field Survey,2012

Table 4: Distribution of Respondents by method of Excrement Disposal

Variables	Igabi LGA		Zaria LGA		Zangon Kataf LGA		Total LGA	
Excrement Disposal								
No response	0	0	0	0	4	2.7	4	0.9
Water closet	44	22.0	86	66.7	63	42.6	193	40.5
Pit latrine	145	72.5	39	30.2	68	45.9	252	52.8
Bucket/ pan	0	0.0	1	0.8	2	1.4	3	0.6
Public toilet	8	4.0	2	1.6	6	4.1	16	3.4
Bush/field	3	1.5	1	0.8	3	2.0	7	1.5
Others	0	0.0	0	0.0	2	1.4	2	0.4
Total	200	100	129	100	148	100	477	100

Source: Field Survey, 2012

Table 5: Excrement disposal and prevalence of Diarrhoea

Prevalence of diarrhoea	Total				
	Excrement disposal				
	Water closet (%)	Pit latrine (%)	Bucket/pan (%)	Public toilet (%)	Row total (%)
Yes	22(36.1)	36(59.0)	2(3.3)	1(1.6)	61(100.0)
No					
Column total	22(36.1)	36(59.0)	2(3.3)	1(1.6)	61(100.0)
Calculated X^2 value = 9.319; Degree of freedom= 3; P- value= 0.025; Remark= Significant					

Source: Field Survey, 2012

Table 6: Spatial variation in excrement disposal and prevalence of Diarrhoea

Igabi LGA				
Variables	Observed X^2 value	Degree of freedom	P- value	Remark
Excrement disposal and Diarrhoea incidence	0.75	3	0.001	Significant
Zaria LGA				
Excrement disposal and Diarrhoea incidence	0.26	4	0.001	Significant
Zangon-Kataf LGA				
Excrement disposal and Diarrhoea incidence	66.7	5	0.070	Not significant

Source: Field Survey, 2012

With reference to Figure 1, the children in Zaria LGA suffered the highest prevalence of diarrhoea (40.1%). Igabi has 32.78% of total diarrhoea cases, while the least number of cases are found in Zangon Kataf LGA with 29.51% of total incidence. Reports from various studies show that, lack of excreta disposal facility, the presence of excreta within the residential yard, lack of latrines and absence of refuse disposal pit are associated with higher diarrhoea morbidity (Getaneh *et al*,1997; Root,2001).

Source of drinking water is also linked to the prevalence of diarrhoea. The main sources of drinking water in the study area generally are tap water, well and borehole. The highest number of respondents that patronised water vendors for drinking water is found in Zaria LGA. This may be a reason why the prevalence of diarrhoea is high in Zaria LGA. Feeding practices such as the feeding of infants with semisolid cereal pap has also been linked to diarrhoea in children (Ekanem *et al,* 1994).

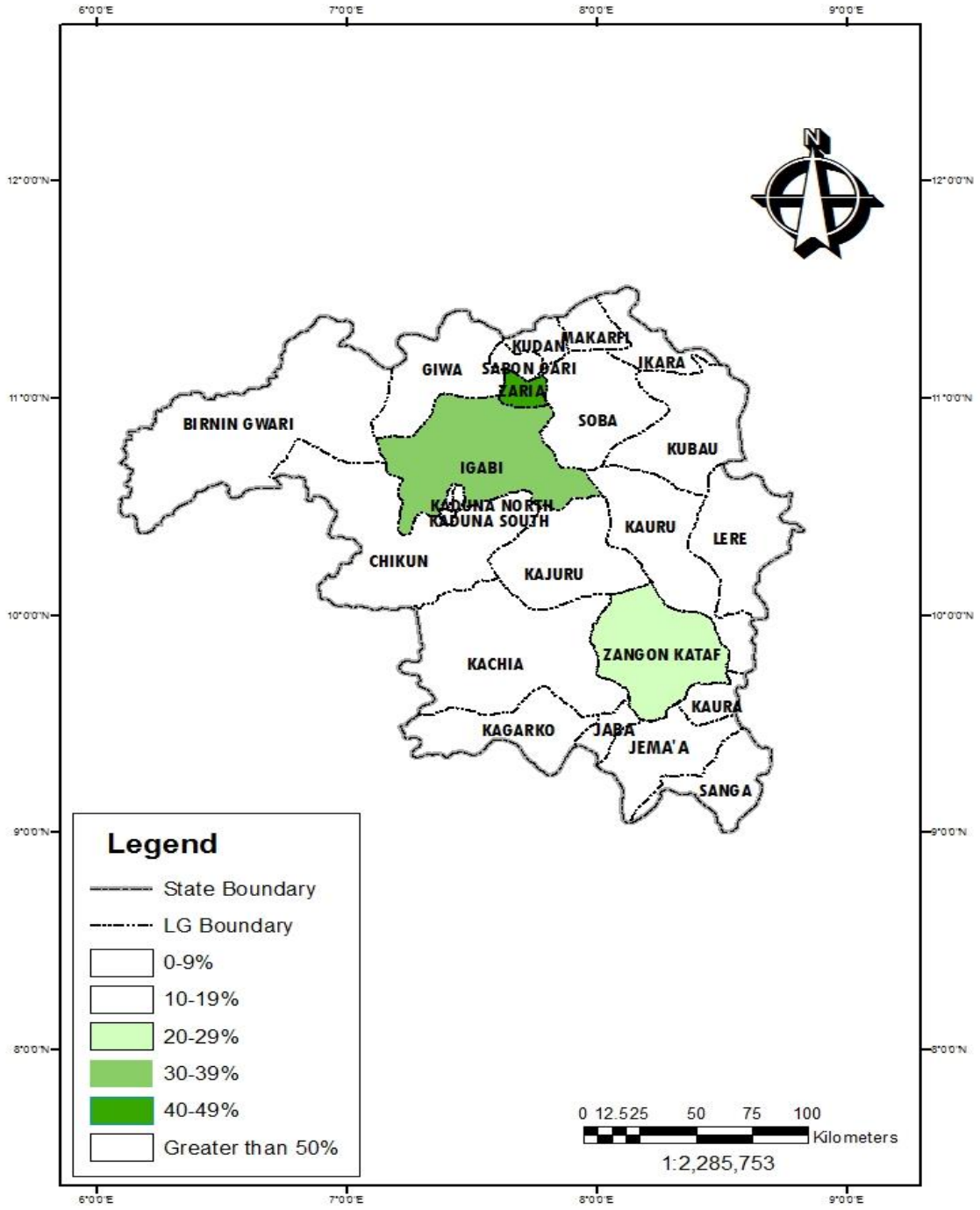

Fig 1: Diarrhoea Prevalence in the Study LGAs

Source: Authors' field survey, 2012

Table 7: Spatial variation in source of drinking water and prevalence of Diarrhoea

Igabi LGA				
Variables	Observed X^2 value	Degree of freedom	P- value	Remark
Drinking water and diarrhoea prevalence	11.640	3	0.009	Significant
Zaria LGA				
Drinking water and diarrhoea prevalence	13.313	4	0.010	Significant
Zangon-Kataf LGA				
Drinking water and diarrhoea prevalence	3.555	2	0.069	Not significant

Source: Field Survey, 2012

This is the case in Zaria LGA, as a good number of the respondents are civil/public servants, hence the inability to exclusively breastfeed their infants, thus augmenting feeding with cereal pap. As observed in figure 1, the spatial variation in the prevalence of diarrhoea within the study area is evident, with the most prevalence in Zaria LGA as indicated by the darkest shade of colouring, followed by Igabi LGA and then Zangon Kataf LGA, having lighter shades respectively.

4. Conclusion and recommendation

The spatial variation in the prevalence of child diseases within the study area is evident, and is shown in the Chi square results and the map produced. This map is a relevant tool to aid Government interventions in better management of child diseases such as diarrhoea where they occur, and prevention in places possible.

The source of drinking water and the method of excrement disposal were factors associated with under-five diarrheal morbidity. Appropriate intervention programs targeting availability of refuse disposal facilities, appropriate care of latrines and potable drinking water should be designed. Mothers and caregivers of children should also be sensitised on better hygiene practices so as to reduce diarrhoeal infection in children.

Better attention should be paid to the feeding routine of children, particularly those younger than 6 months of age. More emphasis should be placed on the WHO/UNICEF guidelines on exclusive breastfeeding for 6 months after birth. Mothers should also be educated on how to enrich the nutritious content of the meals of their children through affordable and local food which is readily available.

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REMOTE SENSING AND GIS-BASED ANALYSIS OF URBAN EXPANSION AND ENCROACHMENT ON FLOODPLAIN IN KADUNA METROPOLIS, NIGERIA

B. Akpu [1]

[1] Department of Geography Ahmadu Bello University, Zaria

Abstract

The inadequate planning and control of the spatial growth of Kaduna metropolis has resulted in the encroachment of physical development on floodplain in the area with adverse consequences. The aim of this paper is to analyze the encroachment of urban expansion on floodplain in Kaduna metropolis. Landsat MSS imagery of 1973; Landsat TM captured in 1990; Landsat ETM+ of 2001 and Nigeriasat-1 image of 2009 were used to generate the built-up layer for the four epoch time series. Visual or manual image interpretation technique was used to extract the built-up landuse which was digitized to create segment maps. The segment maps were polygonized and rasterized. Using the Digital Elevation Model (DEM) constructed from the topographical map of the area, the floodplain was determined and digitized. The built-up area of the various periods was overlain on the floodplain and the extent and rate of built-up encroachment on the floodplain were determined. An interview was also conducted with the management of Kaduna State Urban Planning and Development Authority (KASUPDA) and Lands and Surveys in order to elicit information on the planning and management of urban expansion in the area. Coding and description were used to analyze the data from the interview. The findings reveal that 22.15% of the floodplain has been taken up by physical development as at 2009. The built-up land in the floodplain was increasing at the rate of 9.61% per annum. This paper recommends that: i) KASUPDA should engage adequate and well trained personnel in order to improve efficiency in the control of growth; ii) Remote Sensing and Geographic Information System (GIS) techniques should be adopted for proper monitoring of the rapid urban expansion.

Key words: Built-up; Encroachment; Floodplain; Geographic Information System; Remote Sensing; Urban Expansion

1. Introduction

Urban land expansion is the most easily identifiable characteristic of urbanization process as it affects land cover/use at both regional and global scales. Although the definitions of urban land expansion tend to vary, the most commonly accepted one is that it is the spreading out of a city and its suburbs towards non built-up areas at the periphery of an urban area (Liu, Zhan & Deng, 2005). According to Liu, *et al.* (2005), this process involves the conversion of other land use categories into built-up developed land over time.

The built-up is generally considered as the parameter for quantifying urban expansion (Torrens & Alberti, 2000, Barnes *et al.*, 2001 & Epstein *et al.*, 2002 cited in Jat & Khare, 2008). It is quantified by taking into consideration the impervious or the built-up as the key feature of urban expansion (Jat,& Khare, 2008). The extent of urban expansion is one of the phenomena that drive the change in land use patterns.

Cities world-wide are experiencing rapid spatial growth. Liu, Zhan and Deng (2005) identified demography and economies as the most important driving factors for urban expansion. On the whole, urban built-up areas in the world consumed about 400,000 square kilometers in the year 2000 (about 0.3% of the total land area of the globe). This is projected to reach 1,100,000 (about 0.85%) by 2030 if the sane growth rate is maintained (Angel, *et al*, 2005). According to Angel, *et al.*, cities in the less developed countries would account for more of this growth. For instance, the built-up environment in Kaduna city was reported to be expanding at the rate of about 167.8ha annually between 1990 and 2000 (Ishaya, Ifatimehin & Okafor, 2008). Such rapid urban expansion could lead to uncoordinated growth and consequently, environmental problems may occur if proper planning and monitoring strategies are not adopted to control the growth.

One of the consequences of uncontrolled spatial growth in cities is the encroachment of physical development on floodplains. This could lead to disruption of the earth's ecological balance which could aggravate environmental problems in the city. Settlement of flood-prone areas is a major cause of flood damage (Prima on Natural hazard Management in Integrated Regional Development Planning, 1991). The occupants of the floodplains are exposed to high risk of flood devastation as being experienced in parts of Nigeria and Kaduna metropolis in particular.

Floodplains can be viewed from various perspectives based on the aim of the author. Topographically, floodplain is a flat land that lies adjacent to a stream. Geomorphologically, it is a landform composed mainly of unconsolidated depositional material derived from sediments being transported by the related stream. From hydrological perspective, floodplain refers to a landform that is subject to periodic flooding by a parent stream (Schmudde, 1968 cited in Primer on Natural Hazard Management in Integrated Regional Development Planning, 1991).

Most simply put, a floodplain is generally a strip of relatively smooth land adjacent to rivers and streams which is subject to recurring floods at periods of high water (Prima on Natural hazard Management in Integrated Regional Development Planning). They are therefore, "flood-prone" and are hazardous to development activities if the vulnerability of those activities exceeds an acceptable level (Prima on Natural hazard Management in Integrated Regional Development Planning, 1991). Floodplains are a vital part of the river or stream

ecosystem. They act as flood buffers, water filters, nurseries, and are major centers of biological life in the river or stream ecosystem (Floodplains, Not Dated).

The rapid uncontrolled spatial growth of Kaduna like most cities in Nigeria, is manifested in the encroachment of physical development or built-up land on flood-prone areas. The extent of built-up encroachment on floodplains in Kaduna metropolis has increased from 4.08% in the 1967 to 52.2% in 2001 (Ndabula, 2006). Kaduna has being experiencing devastating flooding events of varying magnitudes which destroy property worth millions of naira and displace thousands of people (Dartmouth Flood Observation (DFO), 2003). The residents occupying the floodplains have been mostly affected.

Remote Sensing provides a unique perspective of how cities evolve; it can be used to classify landuse in an economic and repetitive manner over large areas. Remote Sensing also has the capability to quickly identify and map floodplains (Fundamentals of Remote Sensing (not dated). Geographic Information System (GIS) has the unique capabilities to integrate data from different sources, store, manage, analyze, up-date, and quickly output information. Therefore, Remote Sensing and GIS are powerful technologies for effective monitoring and controlling of rapid urban expansion.

The aim of this paper therefore, is to analyze the spatial growth of Kaduna city and its encroachment on floodplain using Remote Sensing and Geographic Information techniques in order to provide information for proper planning and monitoring of the growth. The objectives pursued include to: i) extract the built-up area for 1973, 1990, 2001 and 2009; delineate the floodplain in Kaduna metropolis; and determine the extent and rate of built-up encroachment on the floodplain in Kaduna.

2. The Study Area

Kaduna got her name from River Kaduna known as *kogin kadduna* in hausa meaning "river of crocodiles". The name Kaduna was derived from the plural form of the Hausa word for crocodiles (*Kadduna)* which was abundant in River Kaduna (Oyedele, 1987). Kaduna metropolis is located between latitudes 10^{o} 20' N and 10^{o}37'N of the equator and longitudes 7^{o} 22' E and 7^{o}31'E of the Greenwich meridian. The city cuts across Kaduna North, Kaduna South, as well as parts of Igabi and Chikun local government areas of Kaduna state (see fig.1). Kaduna is mainly drained by River Kaduna which tends to divide the city into two unequal parts. The main tributaries of River Kaduna are rivers Rigasa, and Romi.

Lying under the Tropical Continental climate, Kaduna experiences seasonal alternation of moist maritime air mass and dry continental air mass. The rainy season begins in April and ceases in October while the dry season (hamattan) lasts from November to March (Bello, 1993). The temperature is high throughout the year with the peak in March and April (37^{o}c). Humidity is constantly high (above 60%) at mid-day and close to 100% at night during the rainy season (Ati,1998 in Ndabula, 2006).

The 1991 census puts the human population of Kaduna metropolis at 971,070 which comprised 515,373 males and 455,697 females (NPC, 1991). Based on projection, the population of the city in 2012 was estimated to reach 1,729,142 with 917,702 males and 811,440 females. The movement of the West African Frontier Force between December 1912 and March 1913 and labourers from Kano province and Zungeru in 1913 and 1917 respectively as well as individual migrations marked the beginning of the urbanization process in Kaduna (Bello & Oyedele, not dated). Since then, the city has continued to grow in both population and geographical extent.

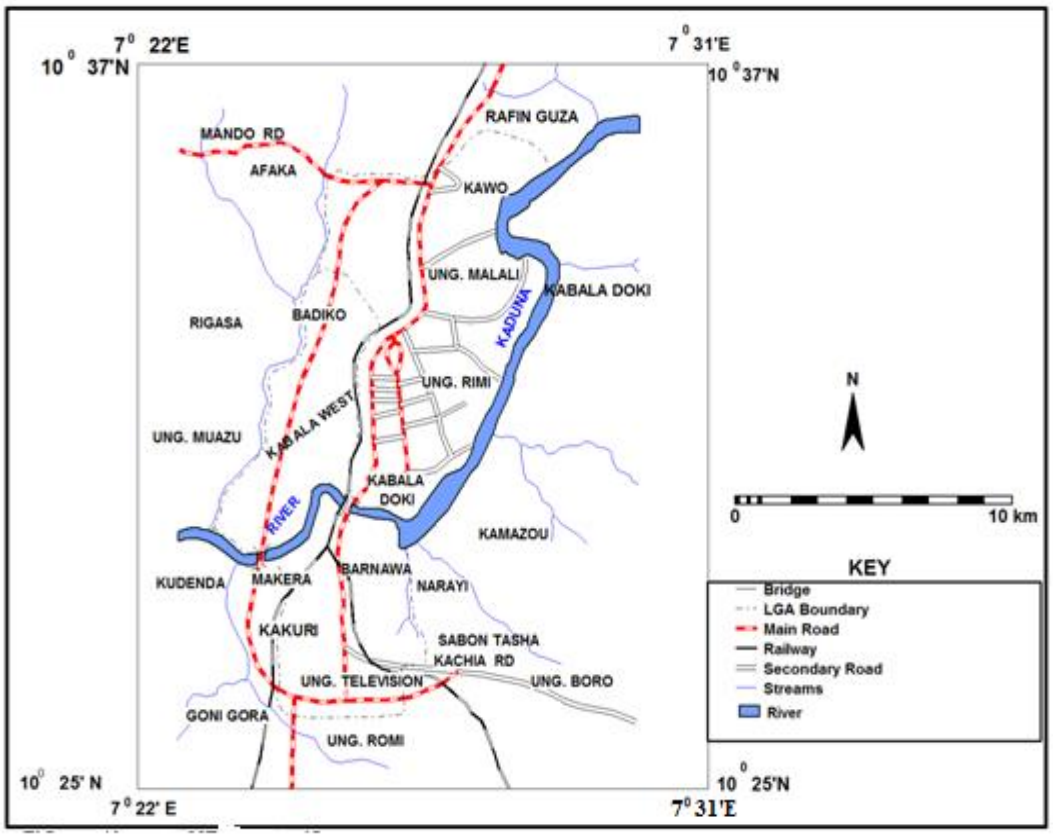


Fig. 1 Kaduna Metropolis
Source: Modified from Kaduna Environmental Protection Agency

3. Materials and Methods

Landsat MSS imagery of 1973 with 80m spatial resolution; Landsat TM captured in 1990 whose spatial resolution was 30m; Landsat ETM+ of 2001 with 30m spatial resolution and Nigeriasat-1 image of 2009 with 32m resolution were used to generate the built-up layer. Subsetting of the portion of interest (Kaduna metropolis) was done from each of the larger scenes using ERDAS IMAGINE 9.2 software. Since the data used were auto-rectified, there was no need for geometric and radiometric correction to be performed on them. However, the data sets were geo-referenced or geo-coded that is registered to a geographic coordinate system. The nearest neighbor resampling method was used to resample the 1973 and 2009 imageries to 30m resolution in order to bring all the datasets to a common resolution and projections. This was necessary in order to make it possible for overlay and other GIS operations to be carried out.

Visual or manual image interpretation technique was used to extract the built-up or urban landuse which was digitized to create segment maps for the four epoch time series. The segment maps were polygonized and rasterized. These were done in ILWIS 3.3 environment. Using the Digital Elevation Model (DEM) constructed from the topographical map of the area, the floodplain was determined and digitized. With overlay analysis of the Geographical Information System (GIS) in ILWIS 3.3 environment, the built-up area of the various periods

were overlain on the floodplain to ascertain the extent of built-up encroachment on the floodplain. The rate of encroachment was also calculated. An in-depth interview was also conducted with the managements of Kaduna State Urban Planning and Development Authority (KASUPDA) and the Planning Unit of Lands and Surveys in order to elicit information concerning the planning and management of urban growth in the area. The analysis of the unstructured interview data was done by coding and description.

4. Results and Discussion

The extent of built-up area in Kaduna in 1973, 1990, 2001 and 2009 is shown in table 1. The extent and rate of built-up encroachment on floodplain in the area for the four time period is shown in tables 2 and 3. The result is visually presented in figures 1-4 and further illustrated by plates 1 and 2.

Table 1: Extent of Built-up Area in Kaduna metropolis

Year	Built-up Area (Ha)
1973	6,410.4
1990	10,101.4
2001	12,965.4
2009	19,707.2

Source: Author's GIS Analysis, 2012

The extent of the built-up land as shown in table 1 reveals that about 6410.4 hectares of land in Kaduna was built-up in 1973. The built-up area more than doubled (12965.4 hectares) by the year 2001 (28years) and more than tripled in 2009. This implies that the city is experiencing a rapid spatial growth.

Table 2: Extent of Built-up Encroachment on Floodplain

Year	Total Floodplain (Ha)	Extent Encroached on Floodplain (Ha)	Proportion Encroached on Floodplain (%)
1973	4341.38	215.57	4.96
1990	4341.38	447.79	10.31
2001	4341.38	533.32	12.28
2009	4341.38	961.54	22.15

Source: Author's GIS Analysis, 2012

The analysis as shown in table 2 reveals that only a small proportion (4.96%) of the entire floodplain (4,314.38ha) was occupied by physical development in 1973. However, by the year 1990, the built-up area in the floodplain more than doubled (10.31%); and by the 2009, as much as 22.15% of the floodplain was already built-up. About 215.57 hectares of the floodplain in Kaduna metropolis was occupied by physical development in 1973. This increased by about 107.72% in 1990 at the rate of 6.34% annually during that period. The period 2001-2009 recorded the highest growth rate (10.04%) of built-up land within the floodplain.

Table 3: Rate of Built-up Encroachment on Floodplain

Period	Year	Built-up on Floodplain (ha)	1ncrease		Arithmetic Mean (Rate of Increase)	
			Ha	%	Ha/Year	%/Year
1973-1990	1973	215.57	232.22	107.72	13.66	6.34
(17years)	1990	447.79				
1990-2001	1990	447.79	85.53	19.10	7.78	1.74
(11years)	2001	533.32				
2001-2009	2001	533.32	428.22	80.29	53.53	10.04
(8years)	2009	961.54				
1973-2009	1973	215.57	745.97	346.05	20.72	9.61
(36years)	2009	961.54				

Source: Author's GIS Analysis, 2012

In other words, about 53.53 hectares of the flood-prone area was transformed to built-up land every year during that period. This coincides with the period when the highest spatial growth rate was experienced in the metropolis (Akpu,2012). The growth was not adequately planned for and monitored hence, haphazard development occurred and consequently, encroachment on the floodplain. On the average, between 1973 and 2009, the built-up area within the flood- prone land was growing at the rate of about 9.61% annually. If this development of the floodplain continues at this rate, in no distant time, the entire floodplain would be lost to built-up land use which would be detrimental to the ecological system.

Some of the consequences of such development may include the occurrence of devastating flooding which may claim lives and property, as well as loss of biodiversity which is housed by the floodplain. Parts of the neighborhoods occupying the floodplain in Kaduna include: Kabala Costain,Kabala Doki, Barnawa, Nasarawa, Kakuri, Ungwan Rimi, Malali, Tudun Wada and Kudenda. These areas often experience flooding which destroy property and displace large number of people. Plates 1 and 2 show examples of houses built on a floodplain in Nassarawa and Kabala costain respectively. These buildings are at a high risk of been flooded due to its location. The extent of built-up encroachment on floodplain in Kaduna metropolis is shown in Figs. 1-4

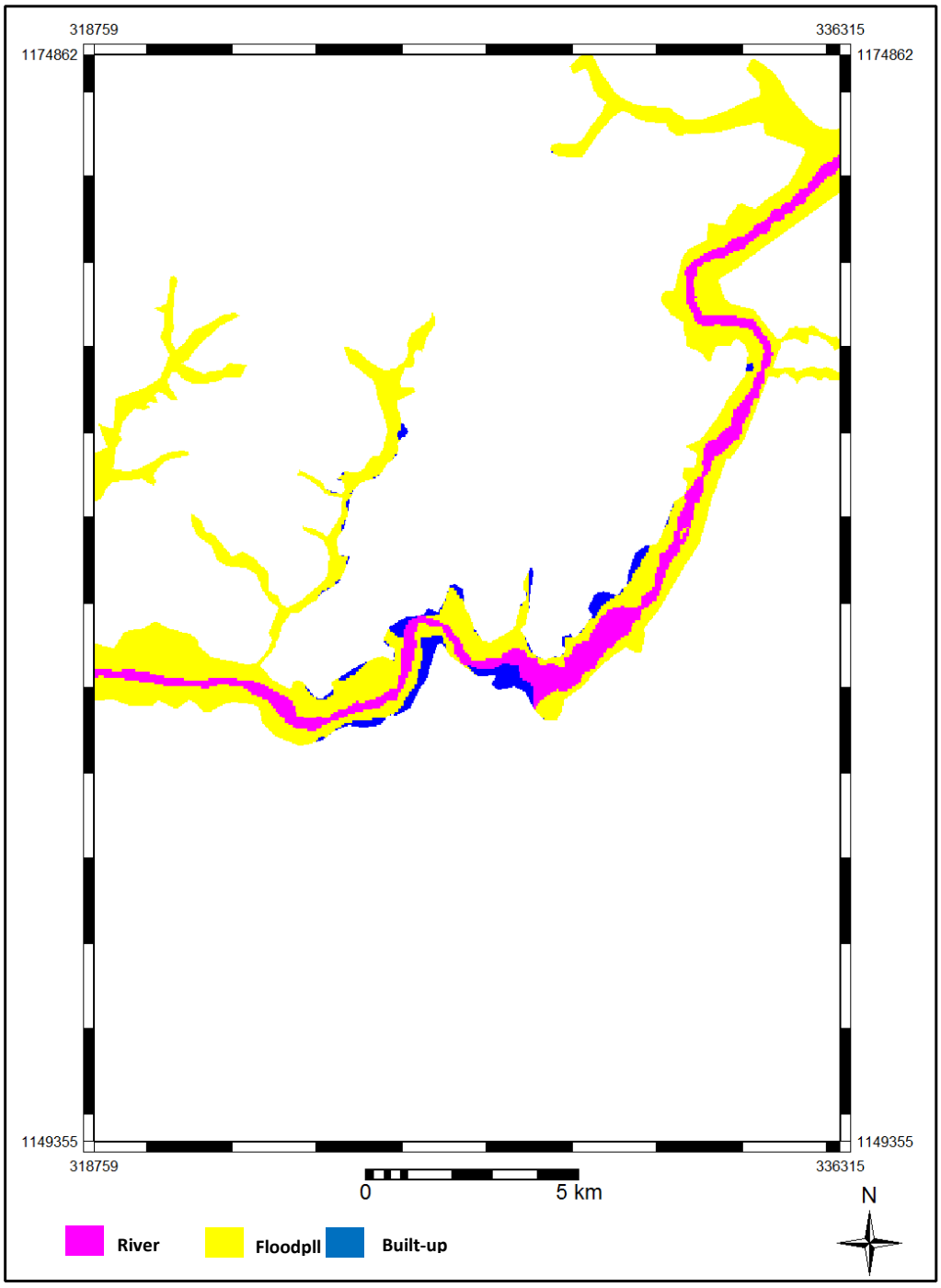


Fig.1 Built-up Encroachment on Floodplain in 1973
Source: Author's GIS Analysis

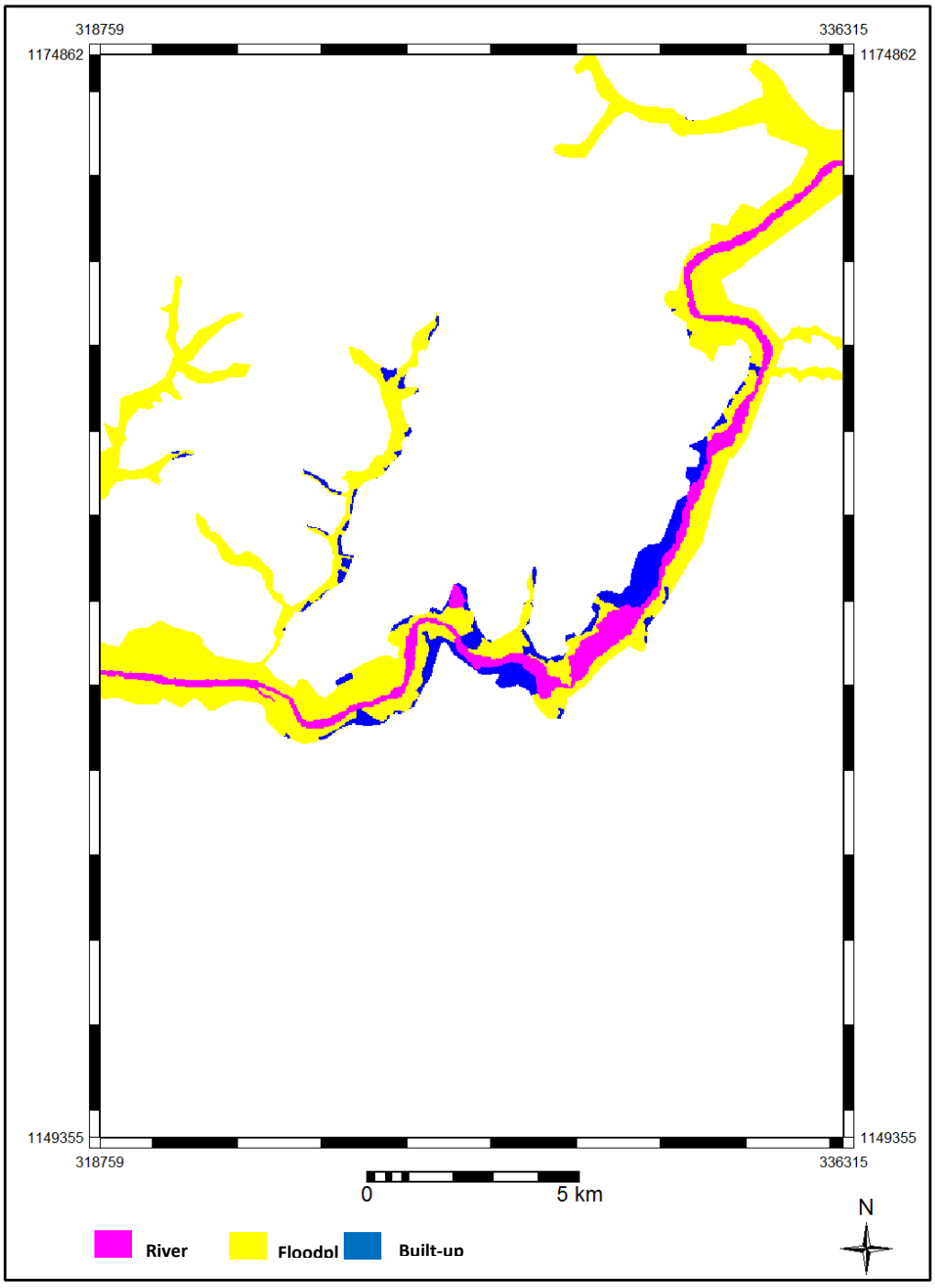
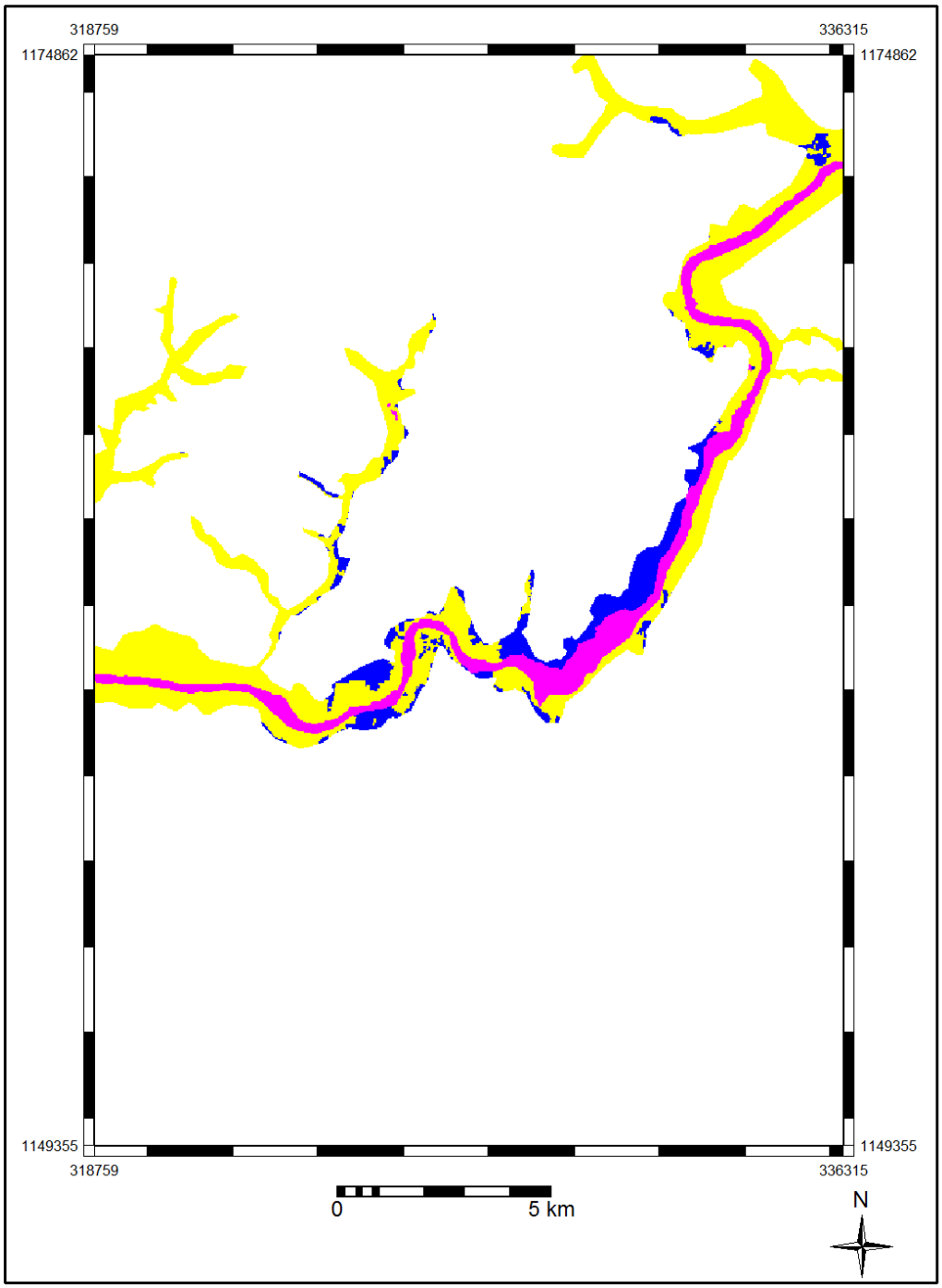


Fig. 2 Built-up Encroachment on Floodplain in 1990
Source: Author's GIS Analysis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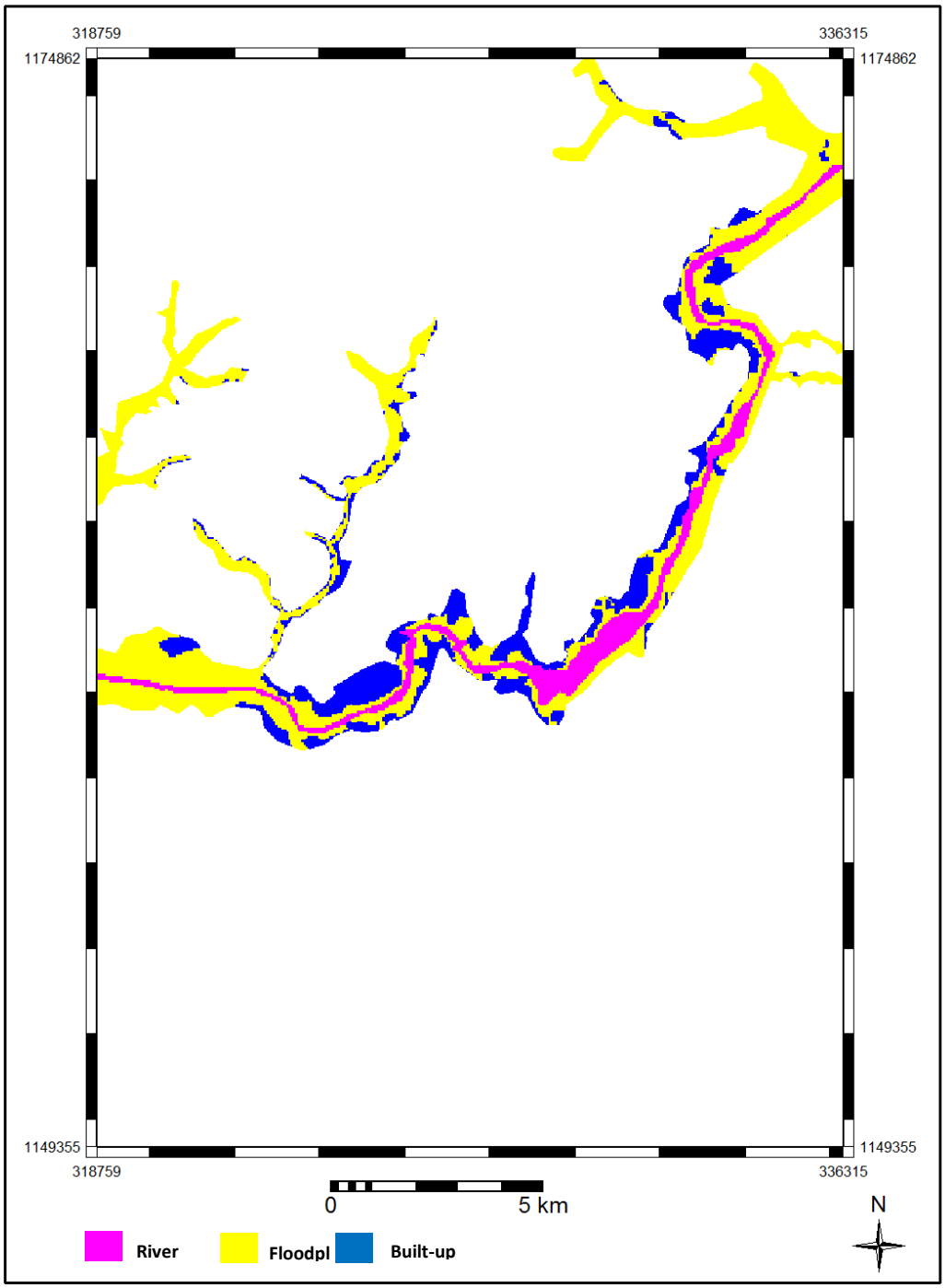

Fig.4 Built-up Encroachment on Floodplain in 2009
Source: Author's GIS Analysis

Plate 1 Building on Flood prone Area in Nassarawa, Kaduna These houses are on a floodplain and are consequently at the mercy of flooding whenever rainfall increases.

Source: Author's Field Survey

Plate 2 Buildings on Flood- Prone Area in Kabala Costain, Kaduna. These buildings are on a floodplain and therefore, experience flooding at the slightest increase in rainfall

Source: Author' s Field Survey

The interview with personnel of KASUPDA revealed that the inability of the government to create new layouts in order to keep pace with the pressure of the high urban expansion has given rise to the development of illegal layouts and encroachment on floodplain. The interview further identified corrupt practices of some of their agency's staff and interference by government officials who have no respect for land use plan as other factors. Lack of properly trained planners and inadequate remuneration of the staff in addition to the various ethno-religious crises experienced in the area were other factors.

5. Conclusion and Recommendations

The inadequate planning and monitoring of the rapid spatial growth of Kaduna has resulted to encroachment of physical development on lands that are liable to flooding which may have serious adverse effects on the environment and the residents. This paper discovered that the extent of built-up encroachment on floodplain increased from 4.96% in 1973 to 22.15% in 2009. In other words, 22.15% of the entire floodplain in the area was already built in the year 2009.

This paper recommends that KASUPDA should engage adequate and well trained personnel in order to improve efficiency in controlling development. In addition, Remote Sensing and Geographic Information System (GIS) techniques have the capability for efficient monitoring of such rapid urban expansion and should therefore, be adopted for the control of urban

expansion. The establishment of agencies like Kaduna Geographic Information System (KGIS) is a step in the right direction but these units should be well equipped and adequately funded. The government should partner with the private land owners in order to developed adequate layouts to keep pace with the rapid growth of the city. The government should also integrate and standardize the informal land market since it is the easiest source of land for development accessed by urban dwellers.

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URBAN VEGETABLE PRODUCTION AMONG WOMEN IN ILORIN, NIGERIA

A.M. Tunde [1]

[1]Department of Geography & Environmental Management, University of Ilorin, Nigeria

Abstract

Women contribute significantly to agricultural production in both rural and urban areas in order to be food secure as well as alleviate poverty. This paper focuses on the contributions of women to agriculture within an urban setting emphasizing vegetable production in Ilorin metropolis. The study specifically examines the demographic characteristics of the women vegetable cultivators, reasons for cultivating vegetables, types of vegetable cultivated, sources of production resources, marketing and the income realised from sales of vegetables for an improvement in their well being. Precisely, 90 women farmers from three different locations within the metropolis were purposively surveyed with copies of questionnaire. Focus Group Discussions (FGDs) were also organised with the women farmers. Percentages were employed to analyze the socio-economic data and Chi-square was employed to test hypothesis. The result of the chi-square (0.918) revealed that there is a relationship between women's involvement in urban vegetable production and the well being of their households. The study concludes by encouraging more women to be involved in vegetable production in order to make vegetables available to their families and other urban dwellers.

Key words: Farming, Urban areas, Food security, Standard of living, Vegetables.

1. Introduction

Urban agriculture has been seen to play crucial roles in the lives of its practitioners as well as the people employed to work on the farm. This is basically because it is a source of food, employment and income. The practice is found among the poor, low and middle income group. At times, the high income group engaged in it for myriad of reasons. One area of urban agriculture that women contribute significantly to is vegetable production. Generally, women are the main food producers in developing countries and yet they are one of the most vulnerable groups (Karki, 2009), their economic empowerment to produce more and to participate in policy formulation is critical to addressing poverty and food insecurity. The urban poor households, especially the female headed ones, are forced to prioritize their basic needs including food. Women in Nigeria contribute an average of 70percent labour force to agricultural production especially in the urban areas (World Bank, 2003).

Urban vegetable production by women complements rural vegetable production since vegetables brought from rural areas are no longer in their fresh state and not sufficient for the increasing urban population. Its production serves as an important source of food for the urban population in developing countries and a critical food "insurance policy" and it is one of the food security options for households (Nugent, 2000). Additionally, it is a way of using urban open spaces in a productive way, treating and/or recovering urban solid and liquid wastes and managing freshwater resources more effectively.

A vegetable is defined as an edible plant or an edible part of a plant (e.g. cabbage, lettuce, bean, potato etc). Vegetables have both curative and preventive measures against diseases, and reduce repetition of nutrition (Hang, 1994). Sirmin *et. a*l (2000) reported that high intake of fruits and vegetables reduces cardiovascular diseases. Furthermore, vegetables provide better balanced diet, vitamins and minerals. Report has shown that there has been an undulating pattern in the trend of vegetable production in Nigeria, for instance about 4924.9 thousand tonnes were produced in 2005, while 2487.7 thousand tonnes were produced in 2006 (CBN, 2006).

Urban vegetable production allows women to strengthen food provisioning and work close to the homestead. It encourages their traditional child care-taking, general household management, control over household resources, budget, decision-making and benefits. Incomes realised from this are re-invested into their children's education. Various studies have confirmed that women's income has a greater positive impact on the health and nutritional status of the children than does men's income. Hovorka (2003) noted that if most urban women producers are provided with production resources, they will engage more in self-provisioning to a larger extent than men. Essentially, women tend to dominate urban cultivation because they are marginalized in other forms of employment in the formal sector of the urban economy. Past studies have indeed focused on urban agriculture generally in different parts of the country, but very few concentrated on vegetable production by women in the study area. Also, increasing demand for vegetables as a result of rapid urbanization in Ilorin has necessitated the need for a study of this kind. Hence, this study examines the contribution of women to vegetable production in Ilorin, Kwara State, Nigeria. Specifically, the study will examine the reasons for women's involvement in vegetable production and types of vegetables grown; examine major sources of production resources, determine the impact of income realised from vegetable production on the standard of living of its practitioners; and challenges encountered in vegetable production.

2. Study Area

Ilorin the state capital of Kwara state, Nigeria is the study area. It is located on latitude $8^{0}30^{1}$ and $8^{0}50^{1}$N and longitude $4^{0}20^{1}$ and $4^{0}35^{1}$E of the equator (fig.1). The city is situated in the transitional zone within the forest and the guinea savannah regions of Nigeria and occupies an area of about 468sqkm. The climate is tropical and is under the influence of the two trade winds prevailing over the country. The daily average temperatures are in January with 25^{0}C, May 27.5^{0}C and September 22.5^{0}C. The mean monthly temperature is generally high throughout the year, (Ajibade, 2002). The rainy season is between March and November with average rainfall of about 1000mm-150mm and September is the wettest month while the dry season is between November and March.

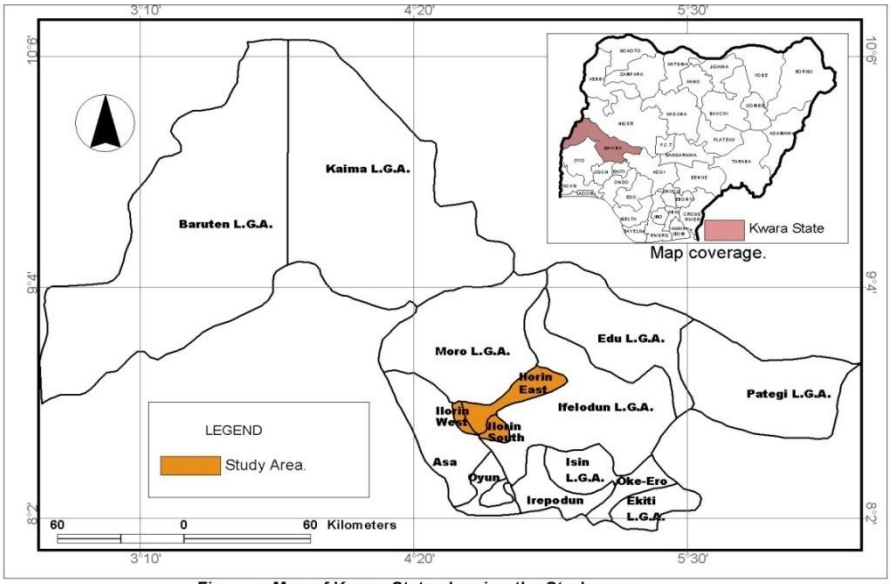

Fig. 1: Kwara State showing the Study Area.

The vegetation type found here is derived savannah with riparian forest along the river bank. The drainage system of Ilorin is dendritic in pattern due to its characteristics. The most important river is Asa River which flows in south-northern direction. Asa River occupies a fairly wide valley and goes a long way to divide Ilorin into two parts namely the Eastern and the western part. The major rivers are Asa, Agba, Alalubosa, Okun, Osere, Oyun and Aluko. Some of these rivers drain into river Niger or river Asa (Oyegun, 1986). The soil type that exists in Ilorin is namely ferruginous which support various plant species because of its variability in terms of fertility. The 2006 census put the population at 766,000 (NPC, 2006).

3. Materials and methods

Ilorin comprises of three local government areas namely Ilorin West, South and East. Purposive sampling technique was used to select 90 women vegetable cultivators randomly from three different farm locations, one from each local government area. This is basically because there is no record of registered women vegetable cultivators in the study area. Farm locations chosen were Irewolede in Ilorin West, Onireke from Ilorin South and Oyun in Ilorin East Local Government Areas. Thirty copies of questionnaire were randomly administered to women farmers in each location. Focus Group Discussions were also held with them at the different selected locations in order to explore their views on the challenges confronting them in vegetable production and the impact that vegetable production have on the well-being of their households. Simple percentages were employed to analyze the socio-demographic characteristics of the respondents and chi-square was used to test the hypothesis whether or not relationship exists between women's involvement in urban vegetable production and the wellbeing of their households.

4. Results and discussion

4.1. Location of farms

The three locations selected include Irewolede, Onireke and Oyun vegetable farms. Respondents were asked to indicate the reasons for locating their vegetable farms along river banks and their responses were encouraging. About 70% of total respondents sampled indicated that the reason is as a result of availability of water to irrigate the farms since vegetables need regular supply of water to survive especially during dry season, 30% indicated that it is as a result of distance from their houses. The former is definitely because farming along river banks will give them the opportunity to cultivate both during dry and rainy seasons. The later will afford them the opportunity to monitor their vegetable farms from intruders such as animals and theft as well as ability to sell on farm site at any time. Fig. 2 shows a woman vegetable farmer in her farm located behind Irewolede housing estate and fig 3 shows a vegetable farm in Onireke, Ilorin.

Fig. 2: A woman farmer in her vegetable (ugu) farm at Irewolede Area, Ilorin

Fig. 3: Vegetable farm in Onireke Area, Ilorin

4.2. Socio-demographic characteristics of urban women vegetable farmers

The socio-demographic characteristics of the women vegetable cultivators (Table 1) revealed that 97.8% of the women farmers were between 40 and 69years of age except in Onireke where only 2.2% were between 30 and 39years. About 85.6% of the women farmers were married and from different ethnic groups. This means that a lot were married with family responsibilities such as ensuring food and income self-sufficiency in their households. Also, 58.9% had at least 7people in their households, 48.9% had no formal education, and 43.3% had primary education while the rest had secondary education.

This is an indication that majority of the sampled women farmers are not well educated for adoption of new innovation. It was further discovered that 70% owned less than 0.25ha of land except in Oyun where 4.4% had above 0.5ha of farmland. Majority were full-time farmers (85%) and 88.8% had over five years farm experience.

Table 1: Socio-Demographic Characteristics of Sampled Women Vegetable Farmers

Characteristics	Irewolede	Onireke	Oyun	Total
Age of Respondents				
18-29 years	-	-	-	-
30-39 years	-	02	-	02(2.2)
40-49 years	18	13	16	47(52.2)
50-59 years	10	12	14	36(40.0)
60-69 years	02	03	-	05(5.6)
Total	30	30	30	90(100)
Marital Status				
Married	28	25	24	77(85.6)
Single	-	-	-	-
Divorced	-	01	01	02(2.2)
Widowed	02	04	05	11(12.2)
Total	30	30	30	90(100)
Number in Household				
1-3 persons	-	-	-	-
4-6 persons	09	11	17	37(41.1)
7-9 persons	04	09	05	18(20.0)
10-12 persons	12	05	08	25(27.8)
Above 12 persons	05	05	-	
Total	30	30	10(11.1)	
Level of Education			30	90(100)
No formal education	19	12		
Primary Education	09	16	13	44(48.9)
Secondary Education	02	02	14	39(43.3)
Post Secondary Education	-	-	03	07(7.8)
Total	30	30	-	-
Farm Size			30	90(100)
Less than 0.25ha	26	19		
0.26-0.50ha	04	11	18	63(70.0)
0.51-1.00ha	-	-	08	23(25.6)
Total		30	04	04(4.4)
Farming Status			30	90(100)
Full-time	27	29		
Part-time	03	01	21	77(85)
Total	30	30	09	13(15)
Farming Experience			30	90(100)
Less than 5years	04	08		
5-10years	02	-	08	20(22.2)
11-15years	03	-	-	02(2.2)
16-20years	19	15	-	03(3.3)
Above 20years	02	07	02	36(40.0)
Total	30	30	20	29(32.3)
Farm Distance			30	90(100)
Less than 0.5km	10	11		
0.51-1.00km	13	14	10	31(34.4)
Above 1km	07	05	09	36(40.0)
Total	30	30	11	23(25.6)
			30	90(100)

Source: Author's Research
Note: Percentages in Parentheses

Furthermore, larger percentage (75%) of the women farmers have their vegetable farms located at distances of less than 1km while only 25% have their farms located at distances that are more than 1km. The implication of this is that those that are far away from their farms will have to add the cost of transportation from their houses to the farms and to the market to the cost of vegetables thereby making their vegetables to be a little bit costly. More so, this group of vegetable cultivators will not be able to spend the same time that others whose houses are nearby spent tendering their vegetables.

4.3. Reasons for cultivating vegetables

Women vegetable cultivators gave different reasons (Table 2) for growing vegetables. In all, about 85% of the sampled women farmers were involved in cultivating vegetables in order to generate income while 15% cultivated to supplement their main income. This is in support of Karim and Wee (1996) that about half of vegetable spices and fruits grown in the homestead were sold to supplement the family income. Other reasons for cultivating vegetables include food security (75.6%) and unemployment (5.5%), 18.9% had no other reason while nobody indicated interest as part of the reasons for cultivating vegetables. This is an indication that women are involved in vegetable production not only for income but also for food security both for their households as well as the metropolis as a whole.

Table 2: Reasons for Cultivating Vegetables

Reasons	Irewolede	Onireke	Oyun	Total
Main Reason				
Generate Income	19	28	30	77(85)
Income Supplement	11	02	-	13(15)
Total	30	30	30	90(100)
Other Reasons				
Food Security	28	20	20	68(75.6)
Unemployment	-	-	05	05(5.5)
Interest	-	-	-	-
None	02	10	05	17(18.9)
Total	30	30	30	90(100)

Source: Author's Research

4.4. Types of vegetables grown

Consumption of vegetables makes vitamins, minerals and energy available to human body. During the survey, it was discovered that women vegetable cultivators grow different types of vegetables but the ubiquitous one is fluted pumpkin. All of the sampled women farmers (100%) cultivate fluted pumpkin (*Telfaira occidentalis)* locally called *ugu*. The reason for this is because fluted pumpkin is very nutritious and gives short-term nourishment to the body. It has the capacity to increase the red blood cells within a short time after consumption and very rich in vitamin C. For instance, Ogunlesi, *et.al* (2010) reported that fluted pumpkin is about 129.39 mg/100g rich in vitamin C. Some other vegetables cultivated but not in large quantities by the sampled women farmers include spinach (*Spinacia oleracea)*, amaranths (*Tete* in Yoruba), water leaves (*Gure* in Yoruba), bitter leaves (*Ewuro* in Yoruba), mint leaves (*Efinrin* in Yoruba) and jute mallow leaves (smooth edge) (*Ewedu* in Yoruba).

4.5 .Major sources of production resources

When the major sources of production resources as revealed in Table 3 were asked during the survey, about 47.5%, 42.5% and 10% obtained investment capital and credit facilities from personal savings, friends/relation and cooperative societies respectively. Furthermore, 70% cultivate on rented and common land, while others such as borrowed and purchased recorded low scores. Common lands in Ilorin are wetlands that people do not claim ownership, invariably farmers take over. Also, 56.3% employed the use of personal/family labour to work on the farm while the rest used hired labour. Mechanization method was not used by anybody. Also, 85% obtained farm input from personal purse while the remaining

farmers acquired farm input from friends and relations. None of the respondents obtained farm input from KWADP despite the fact that their farms are within the state capital.

4.6. Marketing and marketing channels of vegetables

Women were asked about the marketing outlets for vegetables grown, frequency of sales, methods of sales of vegetables. Larger percentage (66.7%) of the women farmers particularly those in irewolede sell their vegetables in urban market. This is as a result of high demand for vegetables in the urban market. It was further revealed that 75% of the farmers dispose their vegetables weekly, while only15% and 10% sell on fortnight and daily basis respectively. This is attributed to the fact that women vegetables cultivators operate on small holdings and expansion is very difficult for them because of restricted accessibility to land.

Table 3: Major Sources of Production Resources

Sources	Irewolede	Onireke	Oyun	Total
Credit Facilities				
Personal Savings	15	13	15	43(47.5)
Friends/relations	09	17	12	38(42.5)
Cooperative societies	06	-	03	09(10.0
Total	30	30	30	90(100)
Land				
Purchased	03	06	09	18(20)
Rented	10	14	20	44(48.9)
Common	09	09	01	19(21.1)
Borrowed	08	01	-	09(10)
Total	30	30	30	90(100)
Labour				
Personal/Family	17	23	11	51(56.3)
Hired	13	07	19	39(43.7)
Total	30	30	30	90(100)
Farm Input				
Personal	18	29	30	77(85)
Family/relation	12	01	-	13(15)
Total	30	30	30	90(100)

Source: Author's Research
Note: Percentages in Parentheses

The little land they cultivate is what they farm on and dispose the vegetables as soon as they mature usually every week especially during rainy season. Furthermore, the low cost per unit of resource use in the production, short gestation period and quick returns on invested capital compared to other crop enterprises (Udoh and Akpan, 2007) make the sales to be fast. Method of sales is both on retail and in bulk.

4.7. Income from vegetable production and well being of women farmers

Income generated from vegetable production has assisted women farmers in terms of purchasing other needed foods, landed property, clothing, healthcare, electricity bill, water rate, housing and settling children's education among others. All these have assisted in improving the wellbeing of the practitioners and their households. From the survey, majority of them pointed out that growing vegetable has given an assurance of improved wellbeing and they now live a better life

than when they were not involved in it. It was further gathered that 86.6% of the women farmers make over N20, 000 monthly from sales of vegetables. Only 4.5% at Onireke and Oyun earned less than N10, 000 per month because of inaccessibility to land. The women vegetable cultivators (60%) indicated income realised was used to acquire landed property such as land and buildings. About 30% of the respondents revealed that income was used to pay house rent and other services such as electricity bills, water rate and purchase of household items among others. This is in support of Adedayo and Tunde, (2012) that urban agriculture is a coping strategy in dealing with poverty and economic hardship in the urban areas.

Table 4: Income from Vegetable Production and well being of Women Farmers

Income	Irewolede	Onireke	Oyun	Total
Monthly income				
Less than N10,000	-	03	01	04(4.5)
N10,001-N20,000	02	02	04	08(8.9)
N20,001-N30,000	04	03	02	09(10)
N30,001-N40,000	07	11	03	21(23.3)
N40,001-N50,000	15	04	08	27(30)
Above N50,000	02	07	12	21(23.3)
Total	30	30	30	90(100)
Assets acquired				
Land	15	11	11	37(41.1)
Build House	09	05	03	17(18.9)
Education	03	01	05	09(10.0)
House rent	01	05	06	12(13.3)
Health Services	02	03	03	08(8.9)
Others (such as electricity bills and household items	-	05	02	07(7.8)
Total	30	30	30	90(100)

Source: Author's Research

Furthermore, 10% pay children school fees with the income realised. This is an indication that growing vegetables has positive impact on the wellbeing of the practitioners. According to the sampled women farmers during a focus group discussion, income generated is sufficient to take care of their families needs. This is because; basically it provided them with employment as well as income. A woman farmer in Oyun farm indicated

> *"Money realised from sales of vegetables this week was used to pay my children's school fees"* (FGD Ilorin, June 22nd, 2012).

Another woman farmer in Irewolede says:

> "*We make more money during dry season than rainy season because consumers purchase vegetables more during dry season since most of them cannot undergo the burden of wetting their backyard vegetable farms"* (FGD Ilorin, June 23rd, 2012).

The responses of the women farmers were subjected to Chi square analysis to test the hypothesis. Table 5 reveals the relationship between cultivating vegetables and the wellbeing of the households of women cultivators in the sampled locations.

Table 5: Chi-Square Analysis

Observed	Expected	O-E	$(O-E)^2$	$(O=E)^2/E$
13	10.2	2.8	7.84	0.768
12	12.4	0.4	0.16	0.013
15	20.3	5.3	28.09	1.383
2	4.6	2.6	6.76	1.470
3	5.6	2.6	6.76	1.207
13	7.8	5.2	27.04	3.467
8	8.2	0.2	0.04	0.005
13	10	3	9	0.900
11	13.9	2.9	8.41	0.605

Source: Author's Research/Computer Output

Chi Square = 9.818

H_0 is rejected because 9.818 is greater than 9.488 (for alpha = 0.05), therefore we accept the alternative hypothesis (H_1) that there is a relationship between women involvement in urban vegetable production and the wellbeing of their households.

4.8. Production challenges of urban vegetable production by women

In order to determine the challenges confronting women vegetable farmers in the course of cultivating vegetables, women farmers were asked about constraints facing them on their farms. Some of the challenges experienced by all the sampled women in the course of producing vegetables in the three selected locations are: restricted accessibility to land in the urban areas as a result of competition from non-agricultural land uses, lack of improved farm techniques and low level of education. Water deficiency especially during dry season, theft and intrusions by animals are peculiar to respondents in Onireke. Also, lack of farm input, inadequate information and distance from market especially for those whose farms are at far distances are the other challenges facing women vegetable farmers in all the selected locations. At times during rainy season, some rivers like Asa and Oyun do overflow and result to flooding and damaging the farms especially those around Asa River as claimed by 33.3% of the respondents.

5. Implication of the Study for Planning

It has been widely reported that women play significant roles in socio-economic development of many developing countries. The study has actually confirmed the significant contributions of women in vegetable production in the study area. The implication of this is that women in the urban areas should be encouraged to contribute more to food security of their households in order to reduce poverty and improve their standard of living. Women should be empowered economically through programmes that will further complement their efforts in agricultural production. Furthermore, time and labour saving technologies should be developed by agricultural research institutes and made readily available at subsidized rates to women farmers. Encouragement and opportunity should be given to women in order to improve their expertise in areas where they have comparative advantage so as to achieve an egalitarian society.

6. Conclusion

This paper made effort to examine the significant contributions of women to household development, improvement in standard of living and economic growth through vegetable production in Ilorin. The study revealed that there is a relationship between women's involvement in urban vegetable production and the wellbeing of the women farmers' households. More women should therefore be involved in vegetable production in order to make fresh and nutritious vegetables available to both their families as well as the urban setting. This will translate to food security, improvement in the standard of living and poverty reduction in the urban households and the city as a whole.

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FAMILY PLANNING PRACTICE AMONGST MEN IN A NORTHERN NIGERIAN URBAN CENTRE

Abubakar, M[1], Mamman, M[1] and J. G. Laah[1].

[1]Department of Geography, Ahmadu Bello University, Zaria

Abstract

Many studies carried out on family planning (FP) focused immensely on women neglecting men's role and attitude. Despite Government programmes and facilities to encourage family planning in Nigeria, the uses of such facilities are still low in Zaria LGA. The aim of this study is to assess the role of men in and their family planning practice in Zaria Local Government Area (LGA). A total of 408 respondents were purposively sampled for questionnaire administration and data were analyzed through percentages and Chi square tests. In spite of high knowledge of FP, only 34.2% of the respondents are currently practicing FP. Respondents that ever used FP were slightly higher (38.4%) than those currently current using it. While injectables and oral contraceptive pills were the most used methods by women, condom was the most used method by men. The Chi square analysis (X^2) revealed that marital status and educational attainment with P values of 0.000 and 0.003 respectively, have significant relationship with knowledge of FP. Age, religion and ethnicity with P values of 0.000 each; education and income with P values of 0.003 and 0.032 respectively also have significantly positive influence on FP practice. The conclusion is that due to maternal and child health and socioeconomic issues arising from not practicing planning, FP programme in northern Nigeria should focus on Muslim men as joint decision makers in modern FP practice to improve. This can be achieved through targeted family planning education and promotion of programme to enlighten husbands. Religious leaders must also be involved in clarifying religious misconceptions on issues regarding family planning.

Key words: Attitude, Family Planning, Men, Role, Zaria.

1. Introduction

The end of the last century witnessed increased recognition of the need to involve men in sexual and reproductive health issues and initiatives, and to understand their needs and perceptions in reproductive health matters. The role of men in family planning (FP) decision-making in Nigeria has not always been recognized in the demographic literature. This is evident from the large volume of studies focused on women, seeking to know their family size intentions, FP practice among other issues. Often, information on husbands' attitudes towards family size and contraceptive use is obtained through their wives on whom most researchers have focused their interest. However, such information based on wives' perceptions of their husbands' attitude may indeed differ significantly from men's actual attitudes and perceptions, if reported by them (Isiugo-Abanihe, 2003).

Men play an instrumental role in every aspect of sexual and reproductive dynamics, from the timing of intercourse and contraceptive use to sexually transmitted disease treatment and antenatal care. They also function as 'gatekeepers' to women's sexuality and reproductive health because of many powerful roles they play as husbands, fathers, uncles, religious leaders, doctors, policy makers, local and national leaders (Varga, 2001; Drennan, 1998). This is because men in these societies contribute more resources in running the family, which gives them more authority to control the sexuality of their wives among other matters. Thus, the perceived wishes of the husband may influence the behavior of the wife (Duze and Muhammad, 2006).

In recent years, the Government of Nigeria has intensified efforts to educate the generality of her population on the need for reproductive health and responsible parenthood in particular. However, in spite of the introduction of family planning services as a means of curbing high fertility rates, the population still increases because of the attitude of the people involved. This is noticed especially in men and the role they play in reproduction (Olawepo and Okedare, 2003). From the results of the National Demographic Health Survey (NDHS) of 2008, the North-West zone ranks lowest in male use of family planning methods with 0.1%, the North-East is 0.2%, the North-Central (1.9%), the South-West has the highest (6.1%), the South-East (4.6%), and the South-South (4.4%). There is also an indication that FP practice is generally low in Nigeria with 31.7% in the South-West, 26.2% in the South-South, 23.4% in the South-East. In the North-Central it is 13%, North-East is 4.0% and 2.8% in the North-West (NDHS, 2008).

Zaria LGA, a Hausa society located in northern Nigeria is patrilineal with a strong male influence on many household decisions including those involving reproduction. This makes the attitudes of male towards family planning and contraceptive use a significant factor influencing the overall fertility level in the region. Given the decision-making powers of Nigerian men and the fact that they also control economic resources, it is important to consider their attitudes towards and willingness to use contraceptives to control family size. The objective of this paper therefore is to assess the attitude of men towards family planning in the study area.

2. Study area

Located on a plateau at a height of about 2200 feet above sea level in the centre of northern Nigeria, Zaria lies at latitude 11^0 13"N and longitude $7^0$68"E. Zaria Local Government Area is located in the northern part of Kaduna State, bordered by Makarfi on the northeast, to the east by Soba, to the west Giwa and to the south by Igabi Local Government Areas.

The continentality of its climate is more pronounced during the dry season, especially December to January. The mean daily maximum temperature shows a major peak in April and a minor one in October. The daily maximum temperature rises gradually from 15.3^0 C in January and attains its highest value of 36.3^0 C in April. It drops rapidly to its lowest value in August 26^0 C and rises again to its secondary peak (34.1^0C) in October. The natural region in which Zaria lies is termed by plant-geographers the Northern Guinea Savannah zone, a designation which implies a woodland vegetation type characterised by the presence of *Isoberlinia doka, Isoberlinia tomentosa and Upaca togonensis*, with well developed grass layer of tufted and low ground cover of Andropogoneae. The soil type of Zaria is reddish ferruginous in nature. The lower part of the soil is derived *in situ* from underlying weathered gneiss and still contains pieces of quartz and mica. The upper part is a mixture of the same material together with transported, probably windblown particles (Mortimore, 1970).

The urban area of Zaria is made up of the old walled city, the colonial township, Tudun Wada, Sabon Gari and Samaru village. The old-walled city, known as 'Birnin Zaria' or Zaria-City serves as the political, administrative and market centre. Zaria's economy is primarily based on agriculture. It is an important centre for the marketing and processing of agricultural products. Farming is the major economic activity in which much of the populace of Zaria engage in. The people of Zaria are also involved in commercial activities such as banking transactions, wholesale, retail and petty trading, commercial transportation, hotel and communication services.

Zaria LGA has the second largest population in Kaduna State of 408,198 with 210,900 are males and 196,090 females (NPC, 2009). The indigenous people are generally referred to as 'zazzagawa' or 'zage zagi', and they constitute 'Hausawa' and 'filani. They speak Hausa and Fulfulde - the major languages across northern Nigeria and some sub-Saharan African countries. There are other ethnic minorities such as Yoruba and Igbo among others, who have come as immigrants from the western, eastern and other parts of the country. Islam is the major religion with Christianity and other traditional religions forming a minority group. Despite being an administrative, commercial, transportation and manufacturing centre; it is Zaria's educational function that today most influences its character and gives it distinction as an urban settlement. The most important central place activity of all is education, for which Zaria is the greatest centre of Northern Nigeria (Field Survey, 2010).

The diverse socioeconomic and cultural setting of Zaria provides an adequate rationale for examining men's attitude towards family planning. This will not only provide a

basis for comparism with other parts of Nigeria but also an avenue for intervention in ensuring maternal and child health in northern Nigeria.

3. Materials and methods

Zaria LGA has a population of 408,198 (NPC, 2009) with 13 administrative wards. There are six wards within and seven wards outside the city wall. Arranging these wards alphabetically, the even numbered wards were chosen, from within and outside the city wall to ensure geographical spread. This gave a total of six wards which are: Angwan Juma, Kwarbai A, Limancin Kona, Dutsen Abba, Kufena and Tukur Tukur.

A sample of 0.1% of the total population of the study area was taken, giving a total of 408 respondents. The 408 questionnaires were distributed uniformly among these selected wards, with 68 in each ward. The reason for this is due to the non-availability of population figures for each ward from the 1991 and 2006 census results. These copies of questionnaire were administered using purposive sampling technique, which only targeted those respondents who were willing to be part of the survey. Chi square analysis was used to separately and individually ascertain the relationship between family planning and age, religion, ethnicity, marital status, and educational attainment, type of occupation, and income. Socioeconomic characteristics and other results were presented using descriptive statistics.

4. Results and discussion of findings

4.1 Knowledge of family planning

About 97.7% of respondents reported they have been told or have heard of family planning heard of FP. This corroborates the finding of the NDHS (2008) report where 72% of all women and 90% of all men know of at least one FP method. Umoh's *et al* (2012) study in Uyo also had similar result where knowledge of FP by respondents was 92.6%. The wide spread in knowledge of FP may be related to education, intensive campaign in the media (as the Nigerian government is putting immense effort in providing information about FP programmes, thus people are becoming more exposed to FP issues), and the state of the economy (harsh economic conditions) etcetera. Chi square analysis show that marital status and educational attainment with P values of 0.000 and 0.003 respectively, have significant relationship with knowledge of FP.

Knowledge of family planning is a key variable in any discussion of fertility regulation and in the evaluation of FP programmes. Acquiring knowledge on FP is an important step towards gaining access to and using a suitable contraceptive method in a timely and effective manner.

4.2 Sources of information on family planning

Table 1 reveals the sources of information on family planning where 41.6% of respondents got information on family planning from radio and television. Exposure to mass media in family planning campaign increases contraceptive use; this is not surprising because the most effective and fastest means of communicating with people is through the use of mass media. The second major source of information is medical personnel such as doctors, nurses or midwives accounting for 32.4%. This corroborates the Nigerian Demographic Health Survey {NDHS} (2008) finding which showed that the radio is the most frequent source of FP messages for both men (59%) and women (40%) age 15-49 years. One-quarter of women and one-third of men reported seeing a FP message on the television.

Table 1: Distribution of Respondents by Sources of information on Family Planning

Sources of information	Number of respondents	Percentage
Radio / television	144	41.6
Medical personnel	112	32.4
School/institution	36	10.4
Friend	24	6.9
Family member	16	4.6
Magazine/newspaper	12	3.5
Others	2	0.6
Total	346	100

Source: Authors' survey, 2010

This is true regardless of age, residence, region, education or economic status. Newspapers and magazines are the least sources of FP messages for both men and women with 9% and 21% respectively. This finding is similar to that of Odimegwu (1999) and NDHS (2003).

4.3 Attitude towards family planning

Information on the attitude of respondents towards FP is very useful in the development of family planning policies because it indicates the extent to which further education and publicity are needed to gain general acceptance of FP. And if there is widespread disapproval of FP, this can be a barrier to the adoption of FP methods. When couples have a positive attitude towards FP, they are more likely to adopt a FP method.

4.4 Approval and disapproval of family planning

The study reveals that 53.6% of the respondents approved of FP. This indicates that more than half of the respondents support the use of FP methods similar to finding of Mamman (1992).

All the respondents were asked about their attitude towards FP. It is vital to know the reasons for respondents' approval of FP in the study area in order to understand what motivates people to use FP methods. Table 2 reveals that 29% of the respondents approve of FP methods because they want to promote the health conditions of their wives; only 3.7% of the respondents said due to support for FP by either husband or wife. Husbands have great influence on women's ability to use FP methods, particularly in Northern Nigeria where wives are not allowed to use FP methods in some hospitals without approval from their husbands. During the IDI, a male respondent said:

"*Definitely FP is prohibited in Islam, but in our day to day life, it will be better to minimize the number of children in order to take care of them in a good way".*(44 year old Malam Jibril, Limancin kona)

Table 2: Distribution by Reasons for Approval of Family Planning

Reasons for approval of FP	Frequency	Percentage
Promote family's health	55	29.0
Want to have the number of children one can properly cater for	33	17.4
Harsh economic condition	28	14.7
Child spacing	22	11.6
Reached the desired number of children	18	9.5
Complications during pregnancy and child birth	11	5.8
Spousal approval	7	3.7
Others	16	8.4
Total	190	100

Source: Authors' survey, 2010

Reasons for the disapproval of FP in the study area are important because they explain why people shun the practice of FP. This will be of great help in finding solutions to the long lasting objection of FP programmes. Table 3 shows that contradiction with religious belief (39.5%) is the strongest reason because people here are Muslims and Islam is against FP. Not surprising too, the Catholic Christians strongly abhor FP, just as Muslims and they believe

one commits a heinous sin by practicing FP. Lack of interest in FP with 32.1% is the next reason.

Table 3: Distribution of Reasons for Disapproval of Family Planning

Reasons for Disapproval	Number of Respondents	Percentage
Contradicts religious belief	64	39.5
Not interested	52	32.1
The desire for many children	18	11.1
Unwanted side effects	7	4.3
Spousal disapproval	5	3.1
Promotes promiscuity	4	2.5
Cultural abomination	4	2.5
Others	8	4.9
Total	162	100

Source: Author's survey, 2010

Utilization of FP shows that 38.4% of the respondents have ever used one of the FP methods and 56.5% have not used FP at all. This result does not agree with that of Umoh *et al* (2012) in their study of fertility intentions of women in Uyo where 52.6% of respondents have used FP. The disparity might be because the study focused on women only or perhaps due to socio-cultural differences among the respondents in Uyo and Zaria.

However, only 34.2% of the respondents are currently using a FP method. This reveals that the utilization of FP is low, even though many respondents have high preference for modern methods of FP. The result corresponds with Ekpo's (2011) finding in Kaduna where 32.0% of respondents were currently using FP methods against 59.1% who were not using any FP method. It is very important to know that there is a wide gap between knowledge and use of FP methods. The study also reveals that age, religion and ethnicity with P values of 0.000 each; education and income with P values of 0.003 and 0.032 respectively also have significantly positive influence on FP practice.

Considering the wide gap between the proportion of population that has ever heard of FP 97.7% on the one hand, and the proportion that has ever used (38.4%) or is currently using (34.2%), some doubts may be cast on the reliability of the responses on the question under review. It is suspect that some of those who reported having heard of FP perhaps find it difficult to admit having ever used or currently using a method. Generally, questions on the

practice of FP seem to attract a high degree of 'no' response. Given the moral and religious backgrounds of many respondents, a sense of guilt normally surrounds the practice of FP.

*4.5 Respondents that have ever used and currently using FP methods **

Family planning may be used by couples to either space births or limit family size. Contraception is used to space births when there is an intention to delay a possible pregnancy. In this survey, the use of modern FP methods exceeds that of traditional means of FP both in ever and current uses (Table 4). This might be because modern FP methods have more of female methods than male methods, which are sometimes regarded as a reason why FP is only women's concern.

The table 4 also shows that injectables, oral contraceptive pills, and condoms are the most patronized modern methods of FP. For current use, the injectables has the highest patronage with 29.0%, followed by oral contraceptive pills (22.3%), condom (17.4%). Solomon *et al* (2010) in their study in northern Nigeria also revealed that injectables was the most used FP method with (50%), followed by pills (21%) and the least used were LAM, herbs and condom with 2.3% each

4.6 Future Use of Family Planning

Intention to use FP methods in the future is an important indicator of the changing demand for FP because it reveals the extent to which non users plan to use FP methods in the future. Respondents who were not using any FP method at the time of the survey were asked about their intentions to use FP in the future. Figure 8 reveals that 26.8% (56) of the respondents said they would want to use FP methods in the future. This corresponds with the result of NDHS (2008) report where only 21% of non users intend to use a FP method in the future.

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Table 4: Distribution by Ever Use and Current Use of Family Planning by Methods

	Ever Use	Current Use

Response	Number	Percentage	Number	Percentage
Abstinence	14	10.3	8	6.6
Withdrawal	18	13.2	10	8.3
Condoms	31	22.8	21	17.4
Oral contraceptive pills	36	26.5	27	22.3
Injectables	22	16.2	35	29.0
Intra Uterine Contraceptive Device (IUCD)	4	2.9	9	7.4
Diaphragm	1	0.7	1	0.8
Tubectomy	0	0.0	1	0.8
Herbs	6	4.4	3	2.5
*LAM/Breastfeeding	4	2.9	6	5.0
Vasectomy	0	0.0	0	0.0
Ring	0	0.0	0	0.0
Total	136	100.0	121	100

Source: Authors' survey, 2010

*LAM=Lactational Amenorrhea Method

4.7 Spousal Discussion on Family Planning

The degree of spousal communication between couples determines how much the couple can open up to talk about sexually related matters especially FP. Although discussion between a husband and wife about the use of FP methods is not a precondition for adoption, its absence may be an impediment for use. Inter spousal communication is thus an important intermediate step along the path to eventual adoption, and especially continuation of contraceptive use. Lack of discussion may reflect a lack of interest, hostility to the subject, or customary reticence in talking about sex-related matters (NDHS, 2003).

To gain insight into inter spousal communication on FP, currently married respondents in this survey were asked whether they have ever discussed FP issues with their spouses in the past. Around 46.3% (164) of the respondents claimed to discuss FP with their spouses and 48.6% (172) do not. Spousal communication on FP matters in the study area is encouraging. Responses on spousal communication from discussants during the FGD were thus:

"Men should discuss FP matters with their wives and also attend FP counseling together with their wives. (27 year old Samuel, Kufena)

"My advice to men is that they should seek the opinions of their wives on FP matters, because they are directly affected by its side effects". (40 year old Mr. Solomon, Kufena)

4.8 Reasons for not discussing family planning with spouse

Table 5 shows the distribution by respondents' reasons for not discussing FP with their spouses where 70.3% said it is due to religious objection of FP.

Table 5: Reasons for Not Discussing Family Planning with Spouse

Reasons	Frequency	Percentage
Religious objection	121	70.3
Cultural taboo	19	11.0
Spousal disapproval	4	2.3
Not of mutual interest	18	10.5
Others	10	5.8
Total	172	100

Source: Authors' survey, 2010

5. Conclusion

Although a good proportion of respondents approve of and discuss FP with their spouses, the small proportion of respondents currently using FP as discovered in this study does not indicate a positive attitude towards FP. It is imperative to change people's attitude towards large family size due to its inherent advantages. Involving men and obtaining their support and commitment to family planning is of crucial importance in Nigeria, given their elevated position in the African society.

6. Recommendations

Many sub-Saharan African countries are still decades away from attaining lower fertility levels. It is not possible to legalize abortion for everyone in a country like Nigeria where FP stirs a lot of controversies. However, women are losing their lives to illegal and unskilled abortion due to unwanted pregnancies. This is a huge problem, but FP offers hope because it prevents women from having unplanned pregnancies. However, if FP programmes are to accelerate the process of demographic change in Nigeria and Africa at large, then they would require the following:

i. Religious leaders must be involved in clarifying religious misconceptions on issues regarding family planning.
ii. Greater political will from national leaders, which includes more commitment in implementing FP programmes and not just population policies on paper.
iii. Government should encourage western education particularly the girl-child education in Muslim dominated areas like Zaria LGA. This will empower women to make rational decision and enhance the effective utilization of FP.
iv. Government should provide jobs and increase the income levels of Nigerians, which could improve their standards of living and make people desire smaller family sizes.
v. Men should be encouraged to ginger spousal communication especially on FP matters, where both can come up with reasonable mutual decision on reproductive health issues. This will help facilitate transition to lower fertility.
vi. Husbands should be made to see the need to support their wives by giving them permission to visit FP clinics as well as organizing transportation to the clinic, paying for family planning methods and services, and taking care of children during clinic visits.
vii. Government and non-governmental organizations should provide a holistic knowledge (appropriate method of choice, correct use, side effects and the benefits of use) of FP methods among Nigerian men considering the country's varied cultural context.

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