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A REFLECTION FOR PLANNERS AND POLICY MAKERS IN UTILITIES AND FACILITIES PLANNING: POPULATION GROWTH RATE IN NIGERIA

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Abstract

This paper contains a detailed analysis of population of Nigeria. Population data of Nigeria was collected by states from National Population Commission (NPC), Abuja. The population data were analysed using standard population projection techniques. Design parameters in arithmetic, geometric or logarithms, graphical and ratio projection techniques were obtained. The population data of each of the states were projected using selected projection techniques. Projected populations were evaluated using statistical techniques such as total error, model of criterion (MSC); coefficient of determination (CD) and statistical reliability (SR).

The study showed that population of Nigeria increased from 88584304 in 1991 to 139983289 in 2006 with Kano and Lagos states having the largest of over 9 million people each. It was revealed that average growth rate for arithmetic, ration, geometric and logarithms projection techniques are 92611 per annual, 0.0137 per year, 0.03212 per year respectively. Statistical evaluation revealed that MSC values for arithmetic, geometric or logarithms, graphical and ratio projection techniques were 1.082, 4.168, 4.173; 4.269 and 0.072 respectively. CD values for arithmetic, geometric or logarithms, graphical and ratio projection techniques were 0.861, 0.984, 0.984; 0.986 and 0.626 respectively. Statistical analysis revealed that there is a significant difference between the population among the states. States like Delta, Gombe, Imo, Lagos, Osun and Zamfara shown no significant difference between NPC projection and projection using the three techniques.

It was concluded that logarithms, geometrical and graphical projection techniques are the best techniques for projecting the population based on the values of CD, MSC and SR.

Keywords: population projection; engineering design, waste disposal, sanitation, environmental health, proper planning

Introduction

Population projection and facilities as well as infrastructure planning are fundamental to improving global access to clean drinking (potable) water and safe sanitation as well adequate housing is one of the least expensive and most effective means to improve public health and save lives. The concept of clean water and safe sanitation as well as adequate housing as essential to health is not a novel, but noble idea. In 350 B.C., Hippocrates recommended boiling water to inactivate "impurities". The U.S. and Central Europe, where water and sanitation services are nearly universal, significantly reduced water, sanitation-, and hygiene-related diseases by the start of the 20th century by protecting water sources and installing sewage systems [1,2]. However, in developing countries such as Nigeria, Togo, Ghana and in Asian countries, water and sanitation services as well proper disposal of wastes are still severely lacking. As a result, millions of people suffer from preventable illnesses which result in deaths every year [2].

Ojo et al [3]; Oke [2] and many other literature reported that incidents of water borne disease are bound in some states in Nigeria due to lack of quality and quantity water supply, proper planning for sanitation and disposal of both solid and liquid wastes. Many obstacles must be overcome to reduce problem of access to safe water, good sanitation and proper disposal of solid and liquid wastes. Figures 1 to 4 present status of global water coverage and sanitation from 1990 – 2011 [4;5]. The integration of public health, proper planning of our cities and management of land size into solving settlements' physical planning and engineering problems is critical, but current efforts are insufficient. Through proper planning, adequate engineering design, the application of adequate design parameters and partnerships with local communities to implement water and sanitation solutions that consider environmental, cultural, and economic conditions, progress toward achieving and sustaining global coverage of water and sanitation services will be greatly enhanced. Adequate engineering design and proper planning are important ingredients in obtaining adequate quality and quantity in the water supply, good sanitation and proper environmental health. In water supply systems, production and distribution are two major ingredients that influence the quality and quantity of the water to the community [2;6]. In good environmental health, adequate planning, exact engineering design parameters and adequate predictions are essential parameters. It is a well known phenomenon that water production, sanitation and environmental health are continuous processes which cannot be altered easily, but there is a need to meet specific standards and limits. Adequate population prediction and computation or population figures are important parts of these health related processes. In this article the authors assessed and discussed conventional techniques of population prediction or projection using population of Nigeria with a particular attention to adequacy of the techniques and the application of projection to national figures in an attempt to provide useful technique for projecting population of Nigeria to aid engineers, planners and policy makers.

Materials and Methods

Population data (1991 and 2006) of Nigeria were obtained from National Population Commission (NPC), Abuja. Figure 5 shows map of Nigeria with 36 states and federal capital territory. Design parameters in Arithmetic, geometric or logarithms, graphical and ratio projection techniques were obtained using observed population. The population data of each of the states were projected using selected projection techniques. Projected populations were evaluated using statistical techniques such as total error, absolute error, relative error, mean error, root squares error, model of criterion (MSC); coefficient of determination (CD), reliability and statistical reliability (SR). The best three techniques were used to project population of the 36 states and federal capital territory (FCT) from 2007 to 2012. Statistical analysis was conducted on the projected population and compared to NPC projected population using chi squared and analysis of variance. In addition land size of the 36 states and FCT were obtained. Literature such as Oke [2]; Tebbutt [7]; Fair et al.[8], Viessmand and Hammer [9]; Hammer and Hammer [10];Martins and Martin [11]; Steel and McGhee [12] stated that population projection can be conducted using any of the followings:

- Arithmetic method which is based on the hypothesis that the growing rate is constant. The method can be expressed as:

$$P_t = P_o + K_a t \qquad (1)$$

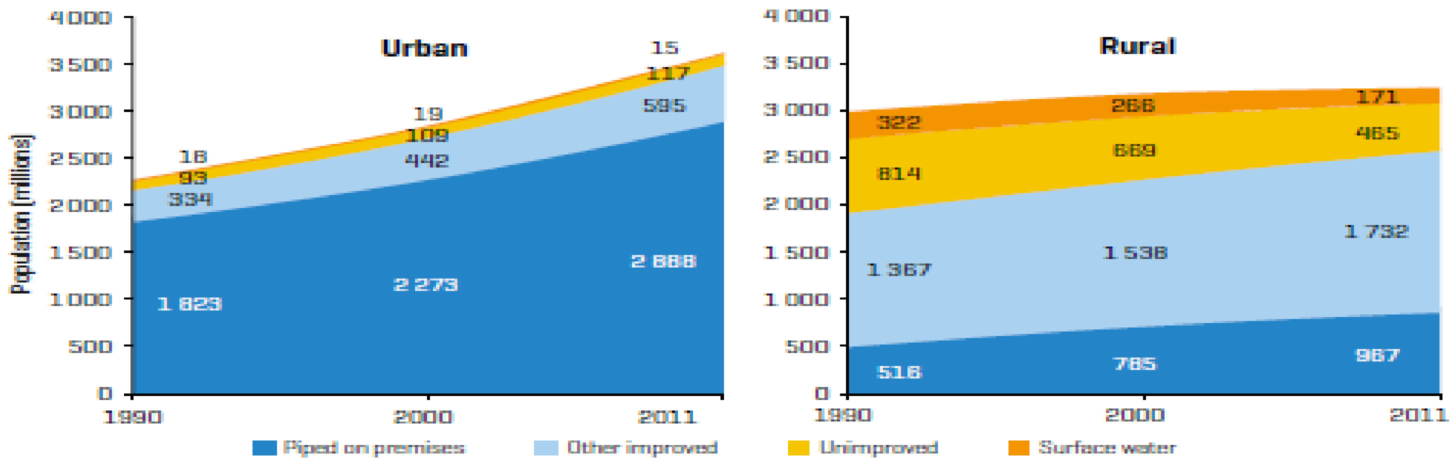

Figure 1: Global Drinking water Coverage trends in urban and rural areas, 1990 – 2011 [5]

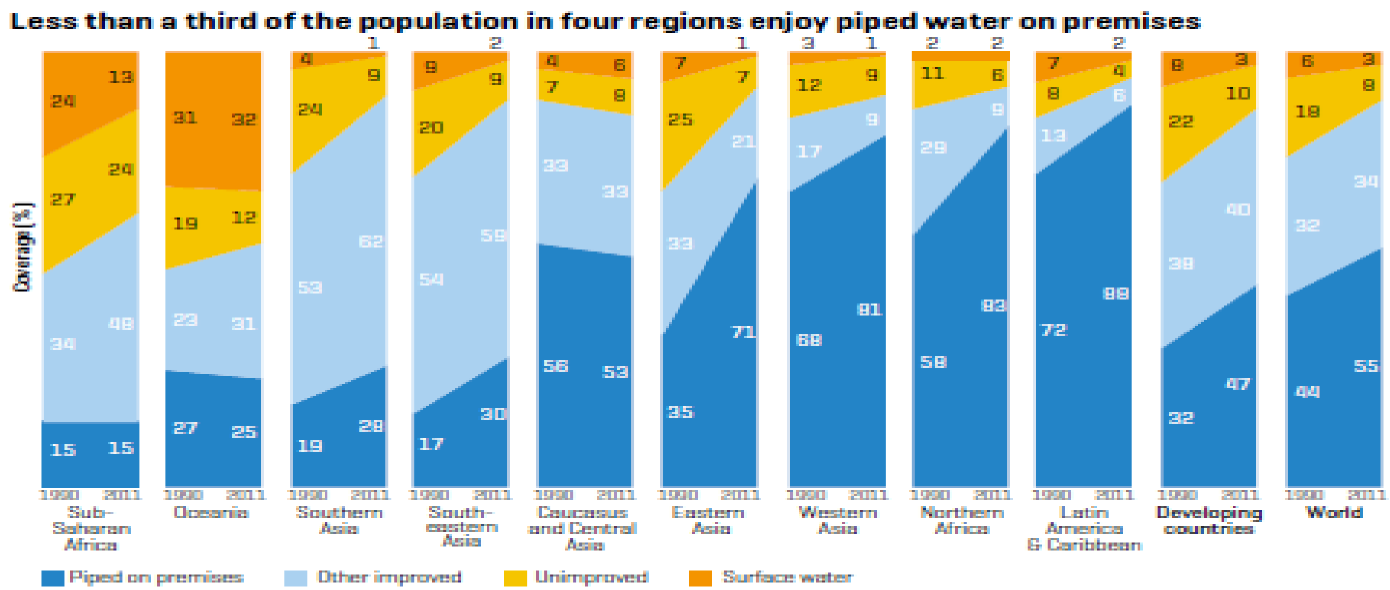

Figure 2: Drinking water Coverage trends by developing regions and the World, 1990 – 2011 [5]

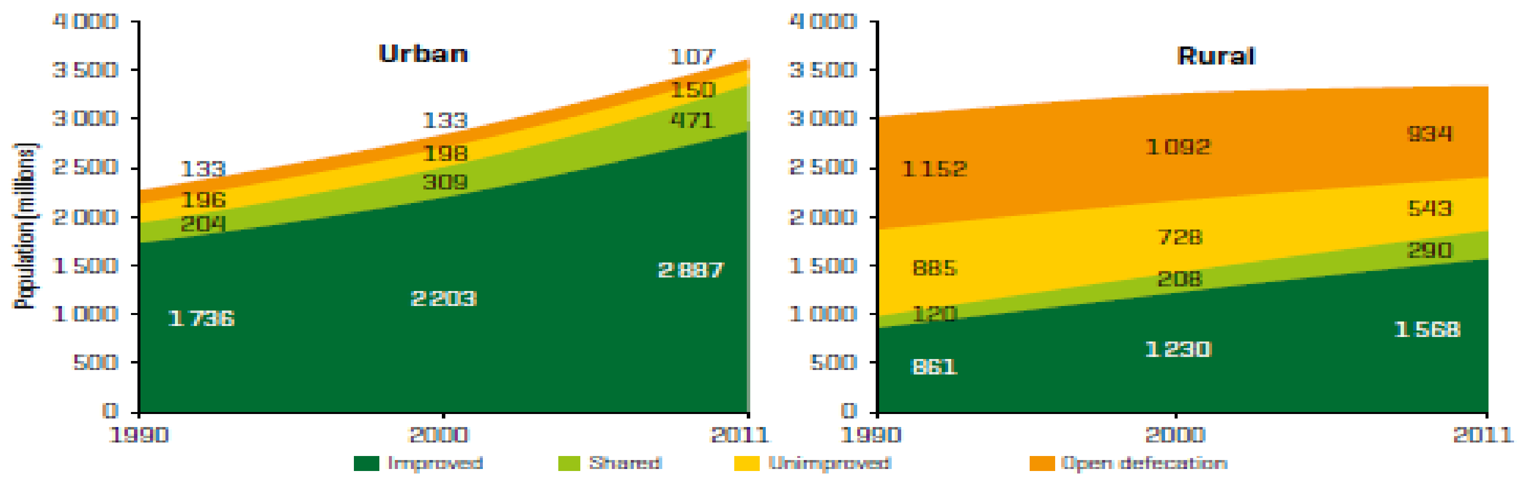

Figure 3: Global Sanitation Coverage and open defecation trends in urban and rural areas by population 1990 – 2011 [5]

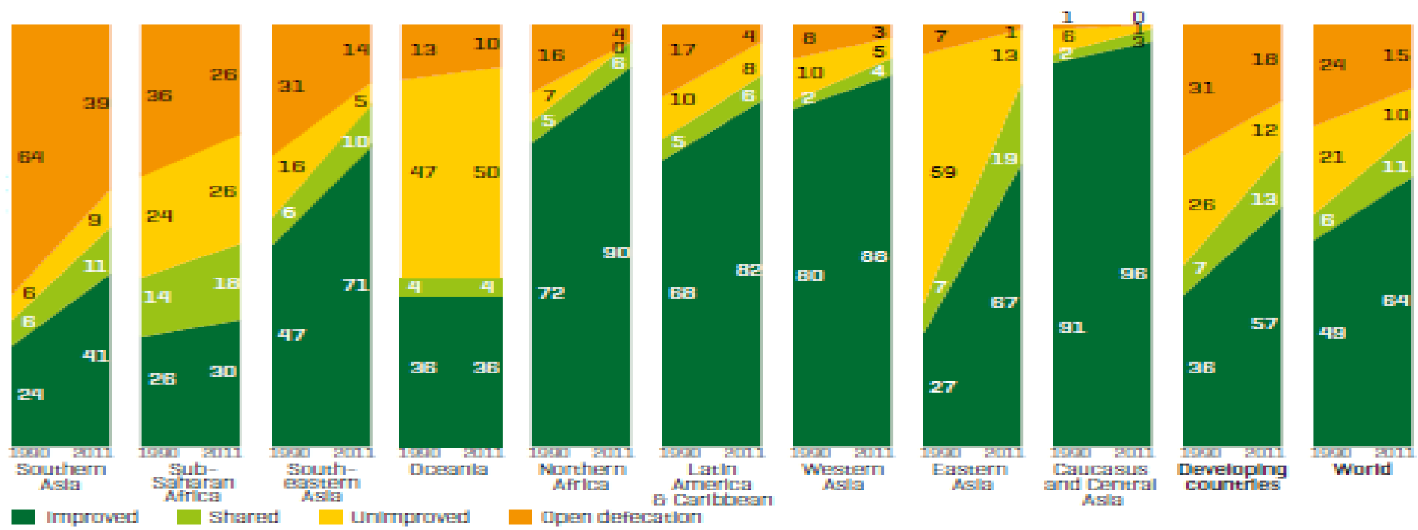

Figure 4: Sanitation Coverage trends by developing regions and the World, 1990 – 2011 [5]

Figure 5: Map of Nigeria showing the 36 states, FCT and ethnic groups

(Source: [13])

- Uniform percentage (geometric or logarithm) method which is based on the hypothesis that the growing rate is proportional to the population. The method can be expressed as:

$$Log_e(P_t) = Log_e(P_o) + K_e t \quad (2)$$

$$Log_{10}(P_t) = Log_{10}(P_o) + K_{10} t \quad (2a)$$

$$(P_t) = (P_o)(1 + r_e)^t \quad (2b)$$

- Curvilinear (graphical) method: this technique involves the graphical projection of the past population growth curve, following whatever tendencies the graph indicates.
- Logistic method: The technique used in modeling population trends has an S shape. The hypothesis of logistic growth may be tested by plotting recorded population data on logistic paper on which it will appear as a straight line if the hypothesis is valid (Viessman and Hammer, 1993). The model can be expressed as follows:

$$P_t = \frac{P_{sat}}{1 + \exp^{(a + b\Delta t)}} \quad (3)$$

$$P_{sat} = \frac{2P_0 P_1 P_2 - P_1^2 (P_0 + P_2)}{P_0 P_2 - P_1^2} \quad (4)$$

$$a = Log_e\left(\frac{P_{sat} - P_0}{P_0}\right) \quad (5)$$

$$b = \frac{1}{n} Log_e\left(\frac{P_0 (P_{sat} - P_1)}{P_1 (P_{sat} - P_0)}\right) \quad (6)$$

- Declining growth method: This technique, like logistic method, assumes that the community has some limiting saturation population and that its rate of growth is a function of its population deficit. Following estimation of the saturation population upon some rational basis such as land available and existing population density, the method can be expressed as follows:

$$P_t = P_0 + (P_{sat} - P_0)\left(1 - \exp^{(K_2 \Delta t)}\right) \quad (7)$$

- Ratio method: This method of forecasting relies on the population projections of the community and the presumption that the community in question will maintain the same trend in the change of the ratio of its population to that of the entity. Application of the method requires calculation of the ratio of the community to the regional population in a series of census years. Projected population can be expressed as follows:

$$P_t = P_o (r_{re})^t \quad (8)$$

Results and Discussion

The results of this study are presented and discussed in the following ways: population of Nigeria by state in 1991 and 2006; engineering design parameters in population projection techniques; statistical evaluation of the projection techniques; statistical analysis of projected population; relationship between NPC projected population and projection from the best three techniques.

Population of Nigeria by state in 1991 and 2006: Table 1 presents population of Nigeria by states in 1991 and in 2006 respectively. The table also shows the number of females, number of males and land size of each of the states. From the table states in Nigeria can be categorized into three categories as follows:

- **Highly populated states:** These are the states with population size greater than 5 million people. The states are Kaduna, Kano, Oyo, Rivers and Lagos. These five states are among the first generation states created in Nigeria. . These states have either commercial cities, ancient city or both. Oyo state has Oyo town and Ibadan as ancient city and commercial town respectively. In Kano state kano city is an ancient city as well as commercial city. Lagos state has Lagos (commercial city), Badagary and Epe as ancient cities. Rivers state has Port Harcourt as commercial town (sit of oil and gas industries). These indicate that age of the city and state as well as commercial activities are major factors for population growth.

- **Medium populated states:** These are the states with population size less than 5 million but greater than 3 million people. The states are Adamawa, Akwa Ibom, Anambra, Bauchi, Benue, Borno, Delta, Edo, Enugu, Imo, Jigawa, Katsina, Kebbi, Kogi, Niger, Ogun, Ondo, Osun, Plateau, Sokoto and Zamfara. Most of these states are second generation states (states created in 1989, Figure 6) and they have ancient city with little or no big commercial activities in them.
- **Low populated states:** These are the states with population size less than 3 million people. They are Taraba, Yobe, Nassarawa, Kwara Abia, Balyesa, Cross river, Ebonyi, Ekiti and Gombe states. With exception of Kwara, Niger and Cross river states all the other states are new generation states (States created in 1991 or in 1996). They are located in North east, North Central, South-south and South west geopolitical zone of Nigeria. These indicate that location is another factor that must be considered in the population growth in Nigeria.

Engineering design parameters in population projection techniques: Table 2 shows engineering design parameters in population projection techniques. From the table the engineering design parameters in population projection techniques range from 92611 to 0.013. The highest value came from arithmetic technique and the lowest cam from the ratio technique. This indicates that design parameter (projection of population) is a function of the technique and its application varies. This is similar to observation made in Oke [2] in which population projection of an institution was made toward water treatment plant.

Statistical evaluation of the projection techniques: The total error, which is the sum of the squares of the errors between the obtained values and the predicted values, can be interpreted as a measure of variation in the values predicted unexplained by the values obtained data [17]. The lower the value of total error the higher the accuracy, validity and good fitness of the method. Total error (Err^2) can be computed using equation (9):

$$Err^2 = \sum_{i=1}^{n} \left(Y_{obsi} - Y_{cali}\right)^2 \qquad (9)$$

Table 3 shows the computation of total error for each of the techniques. The total errors are 1.47 x 10^{13}; 1.72 x 10^{12}; 1.74 x 10^{12}; 5.72 x 10^{13} and 1.46 x 10^{12} for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. These results indicate that graphical technique has the least error, next is Logarithms and geometrical techniques and ratio is with the higher. Higher errors in ratio and arithmetic techniques can be attributed to the fact that the two methods were developed using mathematical based expression and were accepted because of their simplicity.

Table 1: Population of Nigeria based on 1991 and 2006 Census [18]

State	Geopolitical Zones	Number of Local Government Areas	Male population In 1991	Female population in 1991	Total population in 1991	Male population in 2006	Female population in 2006	Total population in 2006	Land Size (Sq km)
Abia	SEZ	17	933039	980878	1913917	1434193	1399806	2833999	4902.24
Adamawa	NEZ	21	1050791	1051262	2102053	1606123	1561978	3168101	38823.31
Akwa Ibom	SSZ	31	1167681	1241633	2409314	2044510	1875698	3920208	6772.09
Anambra	SEZ	21	1374671	1421804	2796475	2174641	2007391	4182032	4816.21
Bauchi	NEZ	20	1443792	1418095	2861887	2426215	2250250	4676465	49933.87
Bayelsa	SSZ	8	584117	537576	1121693	902648	800710	1703358	9415.76
Benue	NCZ	23	1368965	1384112	2753077	2164058	2055186	4219244	31276.71
Borno	NEZ	27	1296111	1239892	2536003	2161157	1990036	4151193	75480.91
Cross River	SSZ	18	956117	537576	1493693	1492465	1396501	2888966	21636.60
Delta	SSZ	25	1271932	1318559	2590491	2074306	2024085	4098391	17239.24
Ebonyi	SEZ	13	670451	783431	1453882	1040984	1132517	2173501	6421.23
Edo	SSZ	18	1095156	1086849	2182005	1640461	1577871	3218332	19819.28
Ekiti	SWZ	16	759986	775804	1535790	1212609	1171603	2384212	5887.89
Enugu	SEZ	17	998157	1126911	2125068	1624202	1633096	3257298	7660.17
FCT	NCZ	6	205299	166375	371674	740489	664712	1405201	7753.85

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Table 1: Population of Nigeria based on 1991 and 2006 Census [18]

State	Geopolitical Zones	Number of Local Government Areas	Male population In 1991	Female population in 1991	Total population in 1991	Male population in 2006	Female population in 2006	Total population in 2006	Land Size (Sq km)
Gombe	NEZ	11	748631	740489	1489120	1230722	1123157	2353879	17982.03
Imo	SEZ	27	1166448	1319167	2485615	2032286	1902613	3934899	5182.82
Jigawa	NWZ	27	1455780	1419745	2875525	2215907	2132742	4348649	24515.62
Kaduna	NWZ	23	2041141	1894477	3935618	3112028	2954534	6066562	45711.19
Kano	NWZ	44	2958736	2851734	5810470	4844128	4539554	9383682	21276.87
Katsina	NWZ	34	1860658	1892475	3753133	2978682	2813896	5792578	24971.22
Kebbi	NWZ	21	1035723	1032767	2068490	1617498	1621130	3238628	37727.97
Kogi	NCZ	21	1039484	1108272	2147756	1691737	1586750	3278487	29581.89
Kwara	NCZ	16	773182	775230	1548412	1220581	1150508	2371089	34467.54
Lagos	SWZ	20	3010604	2714512	5725116	4678020	4335514	9013534	3496.45
Nasarawa	NCZ	13	602533	605343	1207876	945556	917719	1863275	27271.50
Niger	NCZ	25	1252466	1169115	2421581	2032725	1917524	3950249	74108.58
Ogun	SWZ	20	1147746	1185980	2333726	1847243	1880855	3728098	16980.55
Ondo	SWZ	18	1121898	1127650	2249548	1761263	1679761	3441024	15195.18
Osun	SWZ	30	1043126	1115017	2158143	1740619	1682916	3423535	8699.84
Oyo	SWZ	33	1711428	1741292	3452720	2809840	2781749	5591589	28245.26

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Table 1: Population of Nigeria based on 1991 and 2006 Census [18]

State	Geopolitical Zones	Number of Local Government Areas	Male population In 1991	Female population in 1991	Total population in 1991	Male population in 2006	Female population in 2006	Total population in 2006	Land Size (Sq km)
Plateau	NCZ	17	1054676	1049860	2104536	1593033	1585679	3178712	27216.95
Rivers	SSZ	23	1655441	1532432	3187873	2710665	2474735	5185400	10432.28
Sokoto	NWZ	23	1191618	1205382	2397000	1872069	1824930	3696999	33776.89
Taraba	NEZ	16	759872	752291	1512163	1189463	1091020	2280483	60291.82
Yobe	NEZ	17	714729	684956	1399685	1206003	1115588	2321591	46909.76
Zamfara	NWZ	14	1017256	1055920	2073176	1630344	1629502	3259846	35170.63

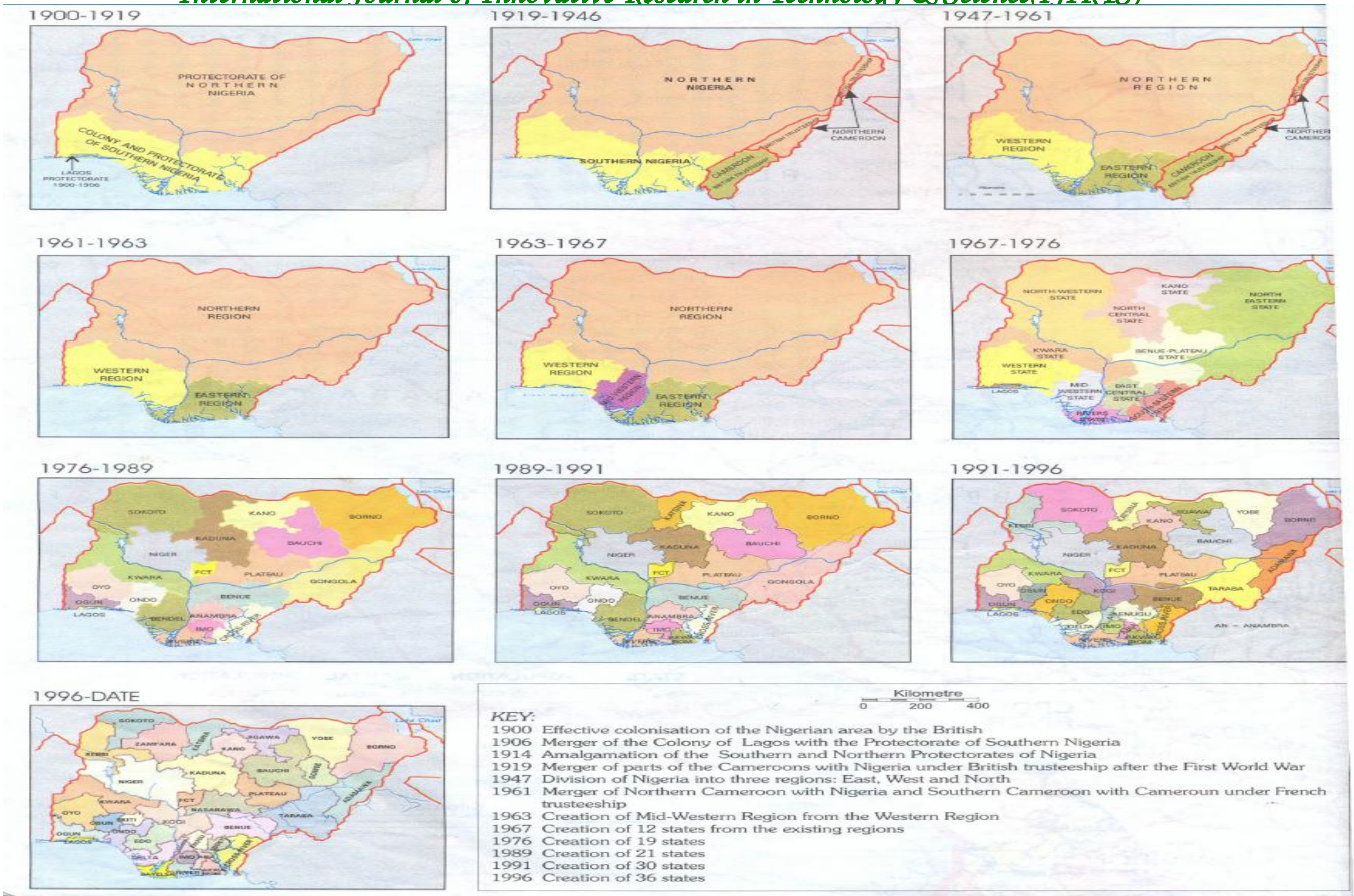

Figure 6: Map of Nigeria showing a summary of state creation in Nigeria [13]

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Table 2: engineering design parameters in population projection techniques

Technique	Equation	Design parameters
Arithmetic Projection	$P_t = P_o + K_a t$	$K_a = 92611$
Logarithms projection	$Log_e(P_t) = Log_e(P_o) + K_e t$	$K_c = 0.01371$
Geometrical Projection	$(P_t) = (P_o)(1 + r_e)^t$	$r_c = 0.03212$
Ratio Projection	$P_t = P_o(r_{re})^t$	$r_{rc} = 0.10862$
Graphical Projection	$P_t = aP_o + K_{as}$	$P_t = 1.5526 P_o + 66253$

Absolute Error: The lower the value of absolute error the higher the accuracy, validity and good fitness of the method. Absolute error (AbErr) can be computed using equation (10):

$$AbErr = \sum_{i=1}^{n} \left|(Y_{obsi} - Y_{cali})\right| \qquad (10)$$

Table 3 shows the computation of absolute error for each of the techniques. The absolute errors are 1.62 x 10 ^{7}; 5.88 x 10 ^{6}; 5.93 x 10 ^{6}; 4.18 x 10 ^{7} and 5.30 x 10 ^{6} for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. These results indicate that graphical technique has the least error, next is Logarithms and geometrical techniques and ratio is with the higher.

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Mean Error: The lower the value of mean error the higher the accuracy, validity and good fitness of the method. Mean error (MnErr) can be computed using equation (11):

$$MnErr = \frac{\sum_{i=1}^{n} \left|(Y_{obsi} - Y_{cali})\right|}{n} \qquad (11)$$

Table 3 shows the computation of mean error for each of the techniques. The mean errors are 4.38 x 10 ^{5}; 1.59 x 10 ^{5}; 1.60 x 10 ^{5}; 1.13 x 10 ^{6} and 1.44 x 10 ^{5} for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. These results indicate that graphical technique has the least error, next is Logarithms and geometrical techniques and ratio is with the higher.

Mean squared Error: The lower the value of error the higher the accuracy, validity and good fitness of the method. Error (Err) can be computed using equation (12):

$$Err = \sqrt{\sum_{i=1}^{n} (Y_{obsi} - Y_{cali})^2} \qquad (12)$$

Table 3 shows the computation of mean squared errors error for each of the techniques. The mean squared errors are 3.83 x 10 ^{6}; 1.31 x 10 ^{6}; 1.32 x 10 ^{6}; 7.56 x 10 ^{6} and 1.21 x 10 ^{6} for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. These results indicate that graphical technique has the least error, next is Logarithms and geometrical techniques and ratio is with the higher.

Relative Error: The lower the value of mean error the higher the accuracy, validity and good fitness of the method. Relative error (RelErr) can be computed using equation (13):

$$\mathrm{Rel}Err = 100\left(\frac{\left|(Y_{obsi} - Y_{cali})\right|}{Y_{obsi}}\right) \qquad (13)$$

Table 3 shows the computation of relative error for each of the techniques. The relative errors are 0.221; 0.123; 0.123; 0.521 and 0.112 for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. These results indicate that graphical technique has the least error, next is Logarithms and geometrical techniques and ratio is with the higher.

Coefficient of Determination: The coefficient of determination (CD) can be interpreted as the proportion of expected data variation that can be explained by the obtained data. Higher values of CD indicate higher accuracy, validity and good

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fitness of the method. CD can be expressed as follows:

$$CD = \frac{\sum_{i=1}^{n}\left(Y_{obsi}-\overline{Y_{cali}}\right)^2-\sum_{i=1}^{n}\left(Y_{obsi}-Y_{cali}\right)^2}{\sum_{i=1}^{n}\left(Y_{obsi}-\overline{Y_{cali}}\right)^2} \quad (14)$$

Like the errors, Table 3 shows the computation of CD for each of the techniques. The CDs are 0.861; 0.984; 0.984; 0.626 and 0.986 for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. These results indicate that graphical technique has the least error, next is Logarithms and geometrical techniques and ratio is with the higher errors. The lowest CD in ratio and arithmetic techniques can be attributed to linearised exponential equation and truncation of values respectively.

Model of Selection criterion: The model of selection criterion (MSC) is interpreted as the proportion of expected data variation that can be explained by the obtained data. Like, CD the higher the value of MSC, the higher the accuracy, validity and the good fitness of the method. MSC can be computed using equation (15) as follows:

$$MSC = \ln\frac{\sum_{i=1}^{n}\left(Y_{obsi}-\overline{Y_{obs}}\right)^2}{\sum_{i=1}^{n}\left(Y_{obsi}-Y_{cali}\right)^2}-\frac{2p}{n} \quad (15)$$

MSC values are 1.086; 4.173; 4.168; 0.072 and 4.269 for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. These results indicate that graphical technique has the least error (highest MSC), next is Logarithms and geometrical techniques and ratio is with the higher (lowest CD).

Reliability: Reliability of any method depends on the accuracy and the validity. The statistical approach developed to address reliability of any method is the testing of the hypothesis that there is no difference between the method and other methods. Sartory [14] describes relative difference between methods statistically as follows:

$$RD = 100\left(\log A_q - \log B_q\right) \quad (16)$$

Table 3 shows the computation of reliability for each of the techniques. The reliability are 192; 102; 102; 595 and 91.5 for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. The mean reliability are 5.19; 2.75; 2.76; 16.10 and 2.47 for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. These results indicate that graphical technique has the least error, next are Logarithms and geometrical techniques and ratio is with the higher.

Statistical Reliability (SR): The statistical reliability is interpreted as the proportion of expected data that can be explained by the obtained data. Like, coefficient of determination (CD) and model of selection criterion (MSC) the higher the value of SR, the higher the accuracy, validity, confidence level and the good fitness of the method. SR can be computed using equation (17) as follows:

$$SR = 1-\left(\frac{\left(Y_{obsi}-Y_{Cali}\right)}{Y_{obsi}}\right) \quad (17)$$

Table 3 shows the computation of SR for each of the techniques. The SR values are 0.788; 0.877; 0.877; 0.479 and 0.888 for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. These results indicate that graphical technique has the least error, next is Logarithms and geometrical techniques and ratio is with the higher.

The coefficient of correlation (CC) can be interpreted as the proportion of expected data variation that can be explained by the obtained data. Higher values of CC indicate higher accuracy, validity and good fitness of the method. CC can be expressed as follows [15; 16]:

$$CC = \frac{S_{oc}}{S_o S_c} \quad (18)$$

Like the errors, Table 3 shows the computation of CC for each of the techniques. The CC values are 0.861; 0.984; 0.984; 0.626 and 0.986 for arithmetic logarithms, geometrical, ratio and graphical techniques respectively. These results indicate that graphical technique has the least error, next is Logarithms and geometrical techniques and ratio is with the higher errors. The lowest CC in ratio and arithmetic techniques can be attributed to linearised exponential equation and truncation of values respectively.

Statistical analysis of projected population: Table 4 presents results of statistical analysis of the data using ANOVA and Chi square. Literature such as Loveday [15]; Guttman et al.[16]; Oke and Akindahunsi [17] highlighted the importance of ANOVA and Chi square in the ascertain of differences between selected data. From the table it can be said that there is significant difference between the projected population along the state (F = 3280.50 against F = at 99.5 % confidence level) and there is significant difference among the population projection technique (F = 156.14 against F = at 99.5 % confidence level).

These values of statistical evaluation and analysis revealed that the degree of accuracies of the logarithms, graphical and geometric techniques is compared favourably with respect to NPC projected population. From the tables (statistical evaluation and analysis) the three techniques predicted NPC projected population better than ratio and arithmetic based on lower errors and higher values of CD and MSC. This indicates that based on accuracy, time availability and cost wise logarithms, graphical and geometric techniques are preferable to ratio and arithmetic.

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Table 3:statistical evaluation of the techniques

Technique	Total error	Mean root squared error	Absolute error	Mean error	Relative error	CD	MSC	Mean reliability	Reliability	Statistical reliability	Correlation coefficient
Arithmetic Projection	1.47×10^{13}	3.83×10^{6}	1.62×10^{7}	4.38×10^{5}	0.221	0.861	1.086	5.19	192	0.788	0.861
Logarithms projection	1.72×10^{12}	1.31×10^{6}	5.88×10^{6}	1.59×10^{5}	0.123	0.984	4.173	2.75	102	0.877	0.984
Geometrical Projection	1.74×10^{12}	1.32×10^{6}	5.93×10^{6}	1.60×10^{5}	0.123	0.984	4.168	2.76	102	0.877	0.984
Ratio Projection	5.72×10^{13}	7.56×10^{6}	4.18×10^{7}	1.13×10^{6}	0.521	0.626	0.072	16.1	595	0.479	0.626
Graphical Projection	1.46×10^{12}	1.21×10^{6}	5.3×10^{6}	1.44×10^{5}	0.112	0.986	4.269	2.47	91.5	0.888	0.986

Table 4: statistical analysis of the techniques using ANOVA

ANOVA	Sum of Squared	Degree of freedom	Mean Sum of Squared	F- value
Methods	2.30×10^{13}	1.10×10^{01}	2.09×10^{12}	156.14
States	1.58×10^{15}	3.60×10^{01}	4.40×10^{13}	3280.50
Error	5.31×10^{12}	3.96×10^{02}	1.34×10^{10}	
Total	1.61×10^{15}	443.000		

Table 4: statistical analysis of the techniques using Chi squared

States	GeoZones	Pop2007	Pop2008	Pop2009	Pop2010	Pop2011	Pop2012	Average
Abia	SEZ	71.98	295.69	683.28	1247.54	2001.95	2960.71	1210.19
Adamawa	NEZ	29.88	122.99	284.74	520.89	837.51	1240.99	506.17
Akwa Ibom	SSZ	13.42	55.52	129.18	237.45	383.64	571.22	231.74
Anambra	SEZ	68.78	282.82	654.16	1195.53	1920.34	2842.76	1160.73
Bauchi	NEZ	16.01	66.23	154.09	283.26	457.64	681.42	276.44
Bayelsa	SSZ	16.07	66.12	153.09	280.06	450.29	667.23	272.15
Benue	NCZ	18.37	75.70	175.43	321.23	516.97	766.78	312.41
Borno	NEZ	14.22	58.79	136.79	251.44	406.24	604.88	245.39
Cross River	SSZ	27.25	112.15	259.66	475.00	763.71	1131.65	461.57
Delta	SSZ	0.06	0.24	0.55	1.01	1.62	2.41	0.98
Ebonyi	SEZ	35.75	146.99	339.98	621.34	998.05	1477.45	603.26
Edo	SSZ	81.74	335.79	775.95	1416.72	2273.44	3362.22	1374.31
Ekiti	SWZ	2.90	11.95	27.72	50.81	81.85	121.52	49.46
Enugu	SEZ	14.18	58.44	135.43	247.99	399.11	591.96	241.19
FCT	NCZ	5046.12	22079.76	54373.98	105857.17	181229.60	286099.57	109114.36
Gombe	NEZ	0.03	0.14	0.31	0.58	0.93	1.38	0.56
Imo	SEZ	0.05	0.23	0.53	0.97	1.56	2.31	0.94
Jigawa	NWZ	41.01	168.81	390.85	715.00	1149.59	1703.43	694.78
Kaduna	NWZ	26.42	108.84	252.23	461.87	743.32	1102.50	449.20
Kano	NWZ	7.04	29.09	67.62	124.17	200.42	298.14	121.08
Katsina	NWZ	25.22	103.92	240.84	441.01	709.75	1052.71	428.91
Kebbi	NWZ	3.94	16.23	37.66	69.02	111.18	165.07	67.18
Kogi	NCZ	14.28	58.82	136.31	249.60	401.71	595.81	242.75
Kwara	NCZ	10.32	42.54	98.58	180.52	290.52	430.91	175.57
Lagos	SWZ	0.13	0.52	1.21	2.21	3.57	5.30	2.15
Nasarawa	NCZ	8.11	33.43	77.47	141.86	228.30	338.62	137.97
Niger	NCZ	13.53	55.95	130.17	239.27	386.58	575.60	233.51
Ogun	SWZ	2.80	11.56	26.86	49.33	79.63	118.45	48.10
Ondo	SWZ	14.98	61.73	143.07	261.98	421.62	625.35	254.79
Osun	SWZ	0.05	0.20	0.46	0.84	1.35	2.01	0.82
Oyo	SWZ	19.15	79.20	184.25	338.69	547.20	814.76	330.54
Plateau	NCZ	80.73	331.66	766.39	1399.28	2245.45	3320.83	1357.39
Rivers	SSZ	17.76	73.44	170.86	314.09	507.45	755.57	306.53
Sokoto	NWZ	16.10	66.33	153.71	281.47	452.98	671.87	273.74
Taraba	NEZ	21.51	88.53	204.97	374.95	602.86	893.30	364.35
Yobe	NEZ	18.66	77.24	179.87	330.97	535.24	797.73	323.28
Zamfara	NWZ	0.05	0.19	0.44	0.80	1.29	1.92	0.78
Sum		5798.59	25177.77	61548.68	118985.92	202344.47	317396.33	

Relevance of Population Data to Development Planning: The relevance of population data to development planning – in terms of provision of the basic infrastructure facilities and public utilities cannot be overemphasized. This is because any planning effort, from the policy stage to implementation/execution level is about human welfare. More so, the population of a particular country or region, naturally is stratified along age, gender, social and cultural strata; and the needs and requirement of one stratum differs from the other. This is reason for literature to enthuse that:

Information about a country's population is fundamental to rational policy making, planning and programme implementation. Planners need population and development data to evaluate demographic trends; to assess the socio-economic situation of women, men and youths and to design population policies and programmes.

UNFPA further asserted that knowledge of the characteristics and trends of population is also required to integrate population factors into development planning. This is why prominent consideration for population details as a veritable resource and fundamental tool for Sustainable Development Planning (SDP) in the National Policy on Population. Apart from planning for physical infrastructure, population data is essential to incorporation of population dynamics, gender dimension, sexual and reproductive health, youth development, employment generation/poverty alleviation plans and; general development policies and public expenditure framework. In the National Policy on Population document (1988), it was established that essence of the document was for Development, Unity, Progress and Self-reliance in response to the pattern of population growth rate and its effects on national development. Since then, emerging issues highlighted by the 1991 Population Census, the 1994 International Conference on Population and Development, the 1999 AIDS/HIV Summit held at Abuja; poverty and food security and the population, environment, development nexus issues resulted in a revision of the National Population Policy which was adopted by the Federal Government of Nigeria in January 14th, 2004 [18a].

The Goal and Principles of the National Policy on Population (NPP): A critical study of the NPP (1988) would reveal that the spirit and intent of the Policy recognizes the fact that population factors, social and economic development, and environmental issues – micro and macro, natural and man-made are irrevocably inseparable – if sustainable development would be achieved in Nigeria.

The overall goal of the National Policy on Population [18], as reviewed, for Sustainable Development is "the improvement of the quality of life and the standards of living of the people of Nigeria; promote maternal, child and reproductive health, achieve a lower population growth rate through the reduction of birth-rates by voluntary fertility regulation methods compatible with the National Policy to achieve even distribution of population between the rural and urban areas, prevent the causes of epidemics, especially the HIV/AIDS pandemic and address the problem of intra-regional migration and spatial distribution of population; as implied in Dakar/Ngor Declarations (1992) and ICPD (1994) Programmes of Action [18]."

Achievement of the broad goal, which is a summary of ideas and amalgamation of inter-disciplinary decisions was operationally defined to be achieved on the following principles:

(i) The people of Nigeria are the most important and valuable resource
(ii) To achieve sustainable development and higher quality of life for all, Nigeria shall promote appropriate policies, including population related policies to meet the needs of the current generations without compromising the ability of the future generations to meet their needs
(iii) Everyone has the right to the enjoyment of the highest attainable standard of physical and mental health
(iv) The family is the basic unit of the Nigerian Society and as such shall be strengthened
(v) Every Nigerian has the right to information and education, which shall be directed to the full development of human resources, dignity and potential, with particular attention to women and children
(vi) Nigeria shall give priority to the well-being of the child

(vii) Young people are the future leaders of the nation. Appropriate provisions for their growth and development shall be made in recognition of their special needs

(viii) Government shall pursue issues relating to gender equality before the law

(ix) Government shall recognize the potentials and address the special needs of vulnerable groups such as people with disabilities, widows, the elderly and refugees; in accordance with the principles of the fundamental human rights of all Nigerians.

A critical examination of the broad goal and principles of the NPP above, which in the policy documents were broken into six and 17 goal and objectives (for the purpose of clarity and simplicity); would reveal that the purpose of the policy centers around human welfare. The goal, principles and objectives elucidate vividly, the sectoral and strata importance in population analysis. This is particularly to enable planners and policy/decision makers make people centered, realistic, holistic and sustainable development plans, policies and decisions that are relevant to all strata of the population and compatible with both micro and macro environment so as to achieve spatial-temporal sustainability in the management of human and environmental resources. Succinctly put, population matters matter in ensuring human welfare through provision of adequate (qualitative and quantitative) infrastructural facilities such as water, energy, roads, education, healthcare, security and so on. To achieve these, elements of population (demographic profile) such as; geo-political extent, gross population size, population growth rate, age structure, rate of fertility, morbidity and mortality; population distribution, urbanization and migration, and issues that are peculiar to geographical units must be adequately analysed and regularly updated.

Population Forecast and Demographic Profile in Development Planning: Inorder to develop any sustainable project, population forecast is a very fundamental requirement. It is an important step in calculating the hike service and facility demand in any given community, region or Nation. The simplest way to do this is to use municipal population forecast and select the year that best present the likely 'build out' date of the area [i.e. the year when the area will be fully developed from a population perspective]. The population forecasts can be presented in either single year age cohorts' format or five year age cohorts, or both. The single year age cohorts is always preferred because it is more flexible when selecting age ranges to apply to certain community infrastructure forms. For instance it may be appropriate to restrict the preschool services demand calculations to ages 3, 4 and 5.

The selected growth areas may already have the sufficient population to meaningfully extract and analyze the various demographic characteristics such as age, gender, occupation, level of education and so on. If this does not hold, it may be appropriate to analyze the characteristics of the neighboring established community to clearly indicate the likely demographic characteristics or profile of the subject planning area being evaluated. For this method to be effective, collaboration with the land use planners is important.

Other sources of statistical information such as voters' registration, national identity registration, school enrolment, and etcetera may also be used for planning purposes, information from census and population data from the National Population Commission (NPC) remains the most preferred. Age and household structures are among the most important variables because some key services and facilities are age-cohort specific (pre-school, school, youth services, aged, asylum etc). Other non age variables such as race/ethnicity, employment status, occupation can also be important and can influence participation and utilization trends (Australian ABS, 2009). Application of these variables is important taking dynamism of cities and the people into consideration. The assertions and explanations made above are important because planning is a systematic way of identifying a range of future activities needed to achieve a predeterming goal [19]. The future activities mentioned here, it must be noted are about welfare of the people and so, information about them (population) is important. The multiplicity of problems that the Nigerian cities dewellers are experiencing today has been largely due to poor planning which cannot be disassociated for lack of reliable information about the population. Onuogbo in [20] observes that poor provision of services in Nigeria has worsened, as population grows without adequate census conducted to help in the distribution of the nation's resources. Population avants planning with identification of the total number of people in particular area gender, age cohorts and components units (distribution). These are vital information that can be extrapolated in planning for the provision of infrastructural facilities and services in a country [20].

Conclusions

In Nigeria, population census exercises have been characterised with crises and controversies. This paper studied population of Nigeria using various techniques. The study revealed that population growth rate in Nigeria is graphical geometrical and logarithms. The average growth rate for the 36 state 3.212 % with higher values of 9.98 % in FCT, which is about three times the state. It can be concluded based on statistical evaluation that:

- Population of Nigeria follows geometrical growth;
- Graphical, geometrical and logarithms techniques can be used to project population in the 36 states with and 9.98 for FCT;
- In planning for facilities in these state and FCT appropriate growth ratio or rate must be used.

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SYMBOLS

K_e	logarithms growth rate (base e)
K_{10}	logarithms growth rate (base 10)
r_e	geometric growth rate
r_{re}	ratio growth rate
n	number of sample
P_a	population of the community
t	projected period or time
Δt	change in projected period or time
P_0	based population in base year
P_t	population of the community in t year
K_a	arithmetic growth difference
P_{sat}	Saturated population of the community
P_1 and P_2	population of the community in a fixed interval
a and b	constants in logistic growth rate
K_2	declining growth rate
exp	exponential
S_c	$\frac{1}{n}\sum_{i=1}^{n} Y_{cali}^2 - \left(\frac{1}{n}\sum_{i=1}^{n} Y_{cali}\right)^2$
S_o	$\frac{1}{n}\sum_{i=1}^{n} Y_{obsi}^2 - \left(\frac{1}{n}\sum_{i=1}^{n} Y_{obsi}\right)^2$
S_{oc}	$\sum_{i=1}^{n}\left(\frac{Y_{obsi}Y_{cali}}{n}\right) - \frac{1}{n}\sum Y_{obsi}\frac{1}{n}\sum Y_{cali}$
AbErr	Absolute error
RelErr	relative error
MnErr	Mean error
Err	Error
SWZ	South West Zone
NWZ	North West Zone
NEZ	North East Zone
NCZ	North Central Zone
SSZ	South-South Zone
SEZ	South East Zone
FCT	Federal Capital Territory
WHO	World Health Organization
JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation
UNICEF	United Nations Children's Fund

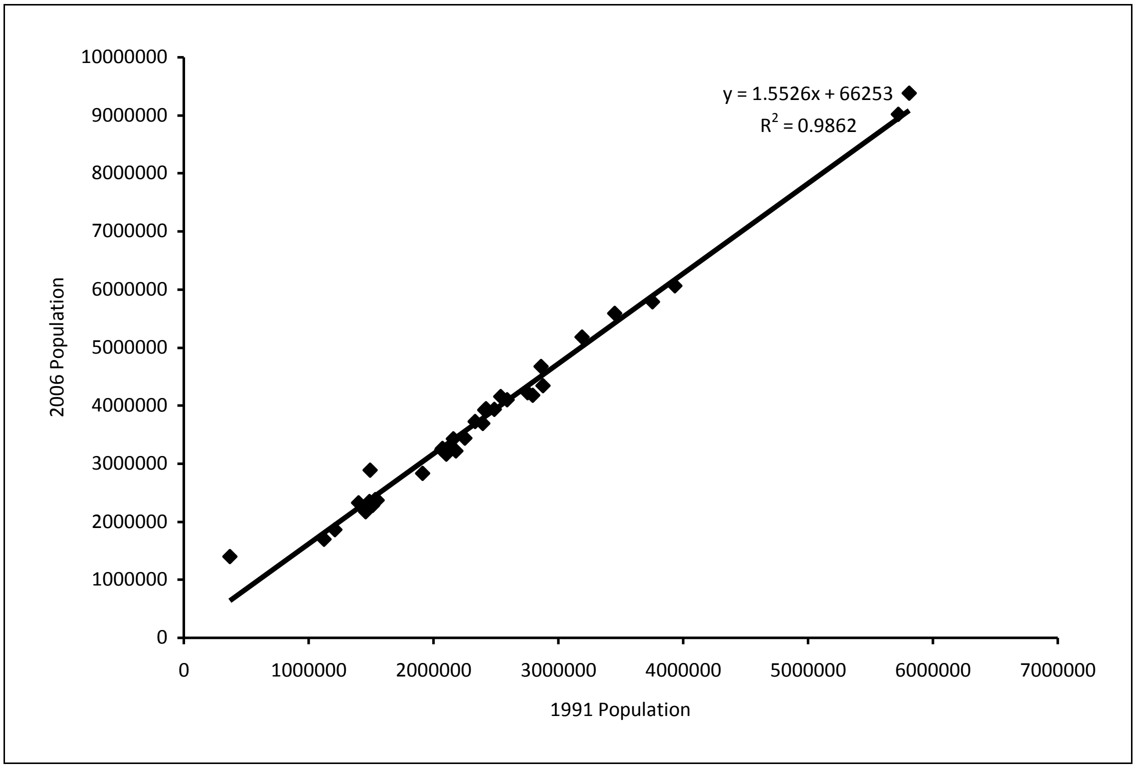

Figure A: Graphical technique of population projection