VISUALIZING POPULATION DATA USING GEOGRAPHIC INFORMATION SYSTEMS

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Abstract

Population data are mostly represented using choropleth maps, which display statistics by administrative units. However, the purpose of this paper is to apply the choropleth and cartogram mapping techniques to present the 1991, 2006 and 2016 census data of Nigeria as opposed to the use of numeric and tabular representations, which is deficient in spatial content. The use of Geographic information system (GIS) will assist in the presentation of census data in a spatial form as well as for visualization. Applying the GIS technique, the population census data were transformed into cartogram and choropleth maps of population density. The methodology indicates that GIS is an effective and reliable tool for the presentation and visualization of population data and an accurate method for the display of population distributions.

Keywords: GIS, Choropleth, Census, Population, Cartogram

1.0 Introduction

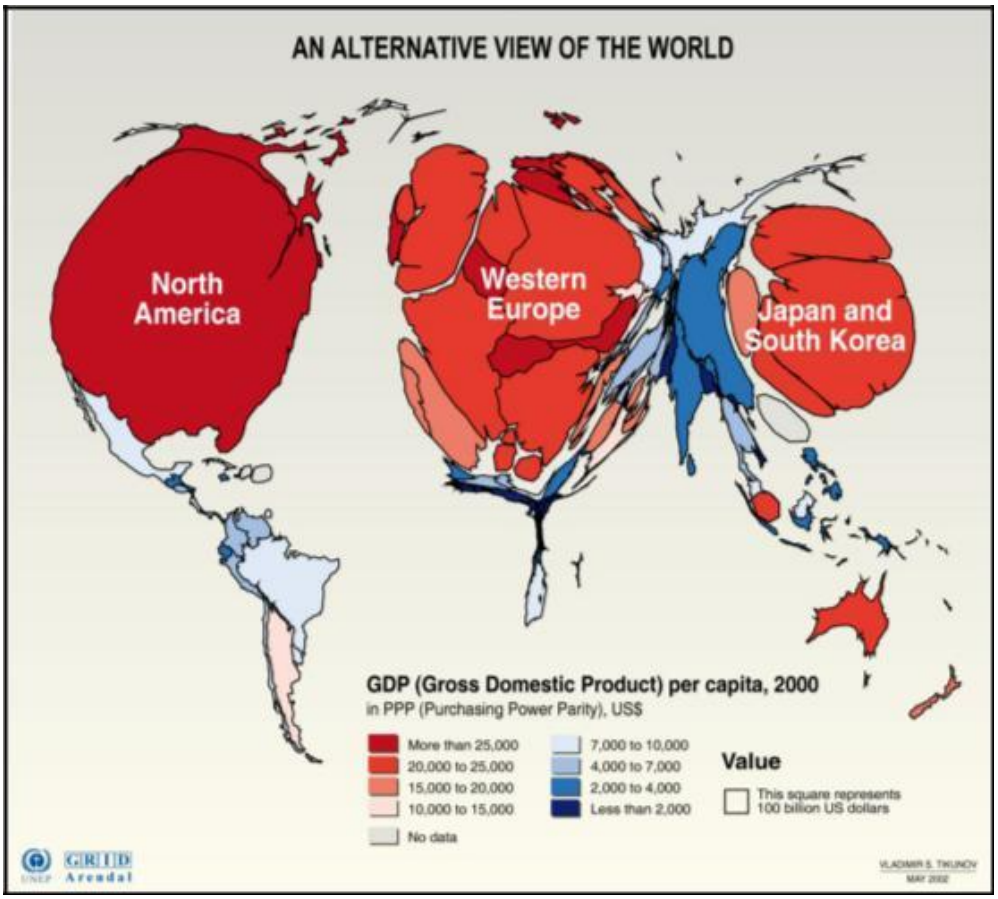
Studies have shown that demographic data are mostly displayed in cartography using the choropleth mapping methods.

Choropleth maps answer the question of how to spatially display data like population density that is population per kilometer instead of the absolute values of total population. Alsino (2015) stated that "Choropleth maps employ shading of relatively small statistical divisions such as census tract of countries to depict geographical patterns in a larger region." This type of mapping takes into cognizance a larger statistical division like states when an entire country is considered. The data range of the map is initially determined and the division for each segment is subsequently established. The statistical division of the country in this case Nigeria is mapped using shading which will inadvertently show clearly the difference in the spatial pattern of the country. Once the range of the data for the area to be mapped has been determined, divisions are made to partition the range into classes.

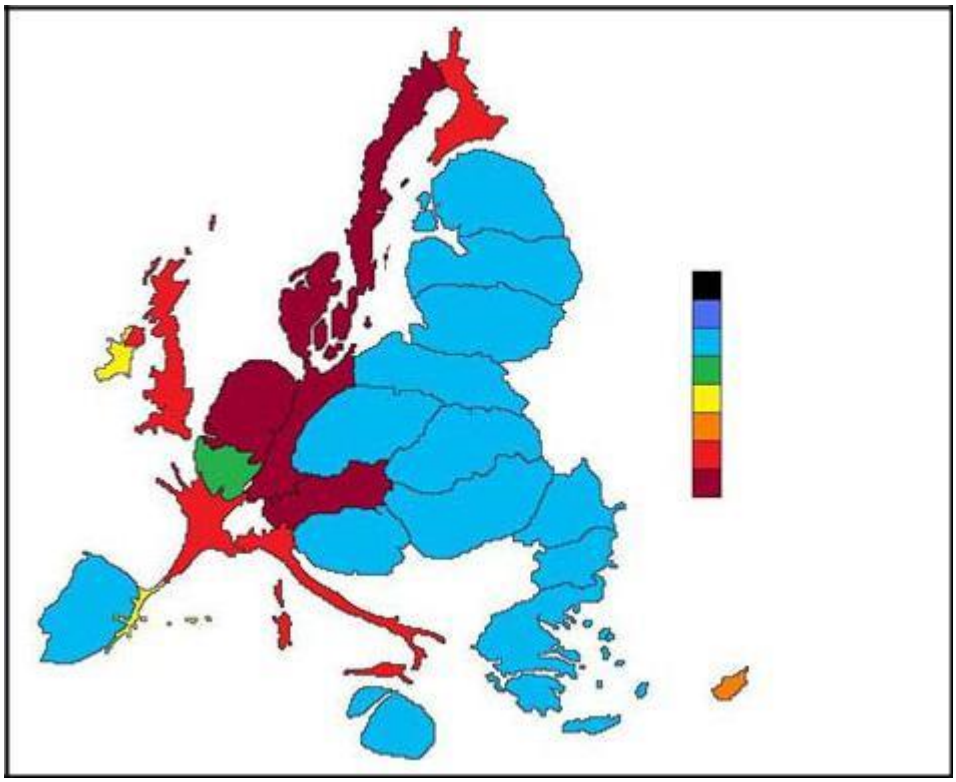
2.0 Cartogram maps

While Choropleth maps helps to map quantitative areal data so as to portray relative areas, cartograms provides an opportunity for the representation of spatial phenomena which involve some degree of distortion of geographic space (Alsino, 2015). In this type of mapping each state is sized according to the number of population in the country. Cartograms can also be used to compare population data (Dorling, et al. 2006), visualization of non-geographic data, and user-generated content (Bruggmann et al 2013), Wake and Vredenburg (2008) applied cartograms in the study of global amphibian species.

Cartograms have been used to present election results in Germany dating back to 1903 (Nusrat and Kobourov 2016**)** and for the 2012 US presidential election between the Democrats and the Republicans. In this study, we present the methodologies for the representation of population data, using choropleth and cartogram maps.



Map 2.1: A cartogram of world GDP in 2000 (Rekacewicz et al. 2002)



Map 2.2: Cartogram showing EU net budget per capita 2007-2013 (https://nl.wikipedia.org/wiki/Bestand:EU accessed 14/01/2019)

3.0 Materials and Method

The main source of data for the choropleths and cartograms are the population census and area data of Nigeria in 1991, 2006 (Abia: 2845380, Adamawa: 3178950, AkwaIbom: 3902051, Anambra: 4177828, Bauchi: 4653066, Bayelsa: 1704515, Benue: 4253641, Borno: 4171104, Cross River: 2892988, Delta: 4112445, Ebonyi: 2176947, Edo: 3233366, Ekiti: 2398957, Enugu: 3267837, FCT: 1406239, Gombe: 2365040, Imo: 3927563, Jigawa: 4361002, Kaduna: 6113503, Kano: 9401288, Katsina: 5801584, Kebbi: 3256541, Kogi: 3314043, Kwara: 2365353, Lagos: 9113605, Nasarawa: 1869377, Niger: 3954772, Ogun: 3751140, Ondo: 3460877, Osun: 3416959, Oyo: 5580894, Plateau: 3206531, Rivers: 5198716, Sokoto: 3702676, Taraba: 2294800, Yobe: 2321339, Zamfara: 3278873) and 2016 obtained from NPC website online. Nigeria being the study area is located in the western part of Africa. It was selected because we wanted an area that is large both in size and in population so as to adequately depict the spatial relationships and the population. Alsino pointed out that cartogram depicts geo-visualization and choropleths highlights the differences in the geographical distribution of data by spatial unit such as boundaries of a country. Again, Nigeria is the most populous country in Africa with a 2016 census population of nearly 190 million and a landmass of more than 900,000 square kilometers. Nigeria has thirty-six contagious states with a federal capital territory. With the vast landmass and huge population, Nigeria

is therefore and important region to be mapped demographically using the mapping techniques earlier mentioned.

3.1 Preparation of Data used

The approach here uses the choropleths and the cartograms mapping techniques to display the population density of the study area. The choropleth maps of the population density were generated using population data of 1991, 2006, and 2016 (NPC). The maps were produced using ArcGIS 10.2 software. The attribute data were presented in excel format. Furthermore, the cartogram maps for Nigeria for 1991, 2006, and 2016 were also produced. The area cartogram of Nigeria with each state rescaled in proportion to its population. The area cartogram is also referred to as Isodemographic map especially in this case as applied for population (population cartogram). The shape and relative location of every state is retained as much as possible; however some amount of distortion is experienced. The geo-processing tool of the ArcGIS software was used to generate the cartogram maps of the study. In this method of map visualization, the sizes and shapes of the states are exaggerated based on the population of each state. The tool creates density equalization of cartograms a technique earlier developed by Gastner and Newman (2004). The density equalizing cartograms change the shape of map polygons in such a way that their size is based upon an attribute like population (ESRI, 2015).

4.0 Results and Discussion

The results are shown in Figure 4.1 and 4.2 in which the sizes of the states are proportional to the states populations. The maps show simultaneously the state with the highest population and population density. Each state area is inflated of deflated according to their population data (1991, 2006 and 2016) for example; Lagos (in brown) appears much bigger in cartogram than in initial map or classic map, according to its huge population. The state with the highest population is Kano while the state with the least population is Bayelsa state with about 1.7 million and FCT with a little over 1.4 million in population. Redrawing the state by state population on a cartogram as shown in figure 4 and 5 again gives an accurate display of the population spread. The area cartogram of Nigeria with each state rescaled in proportion to its population. Colors refer to the population and size of the state relative to the census year. This paper show that the cartograms presented will ameliorate the challenges usually faced with the ordinary geographic representation of population data.

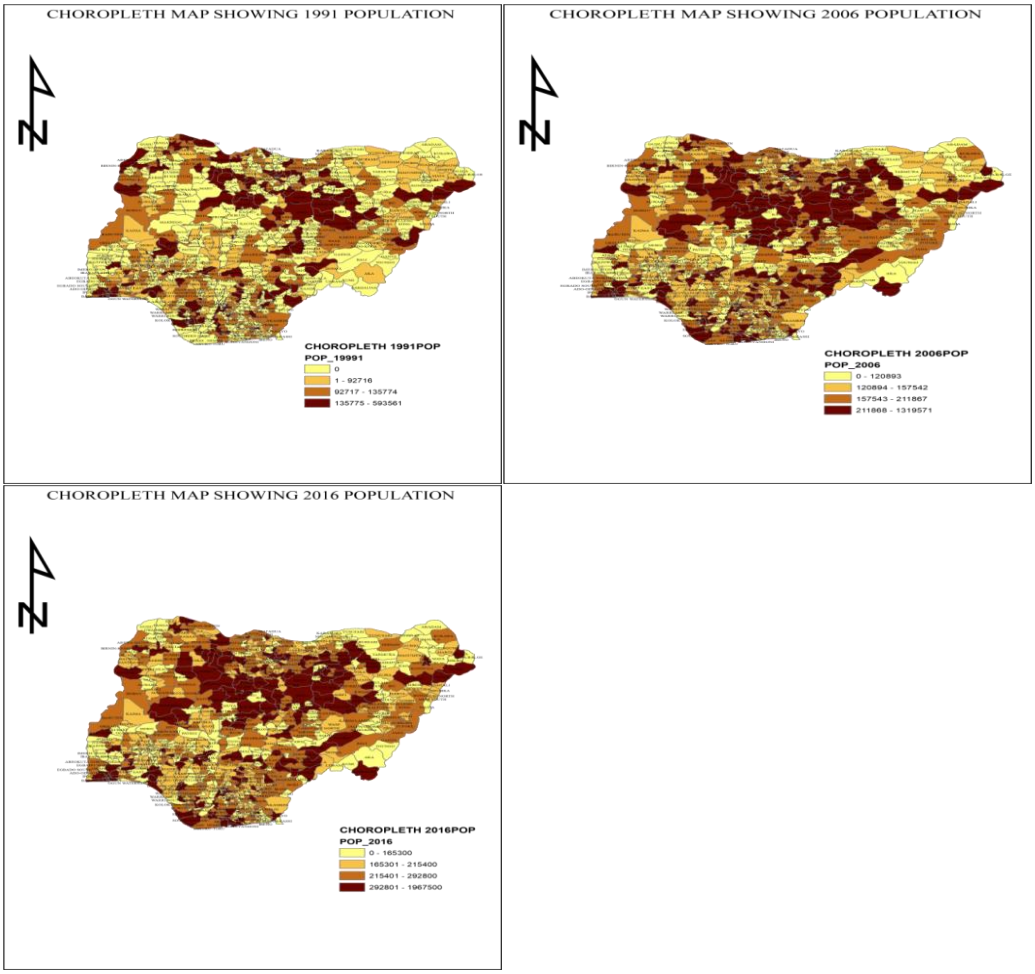


Figure 4.1: Choropleth maps of population of the Study area (1991, 2006 and 2016)

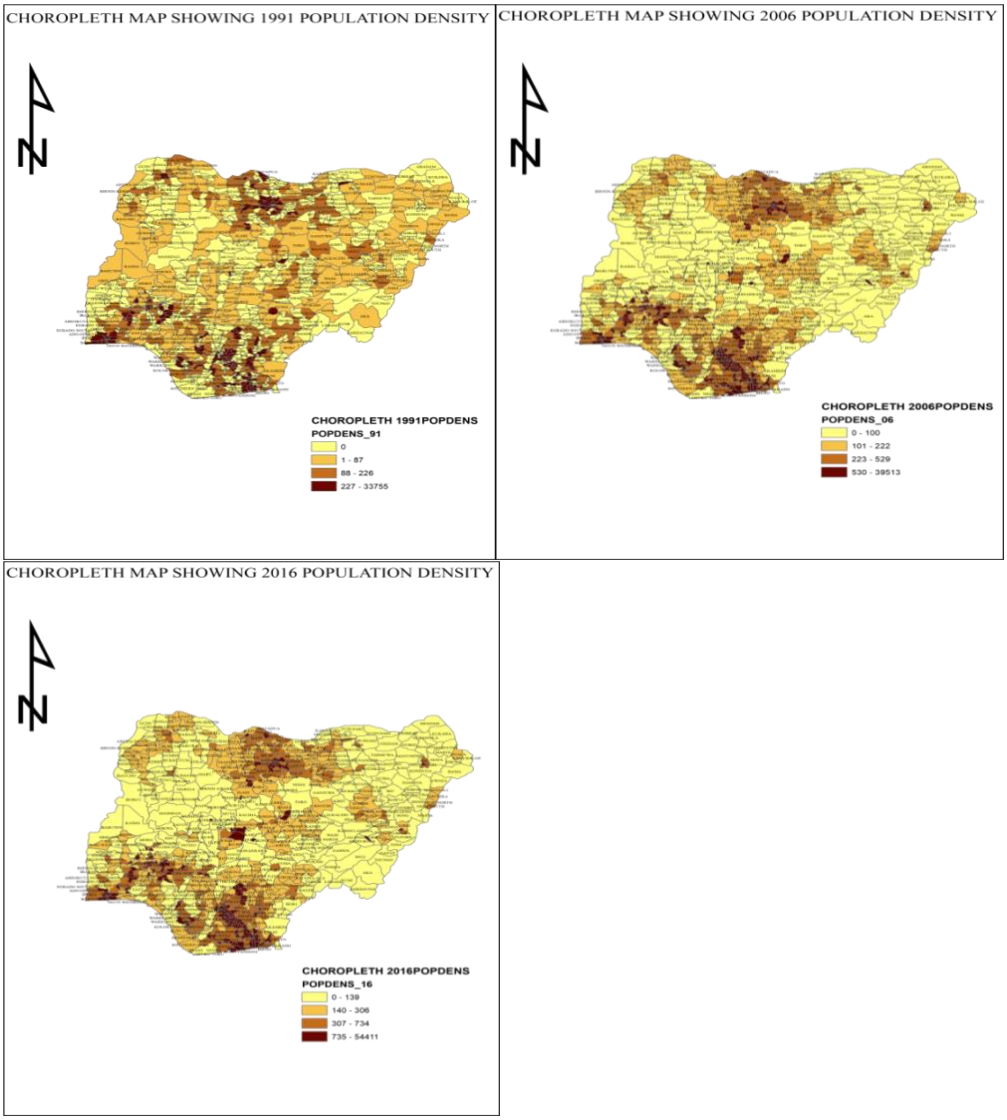


Figure 4.2: Choropleth maps of population density of the Study area (1991, 2006 and 2016)

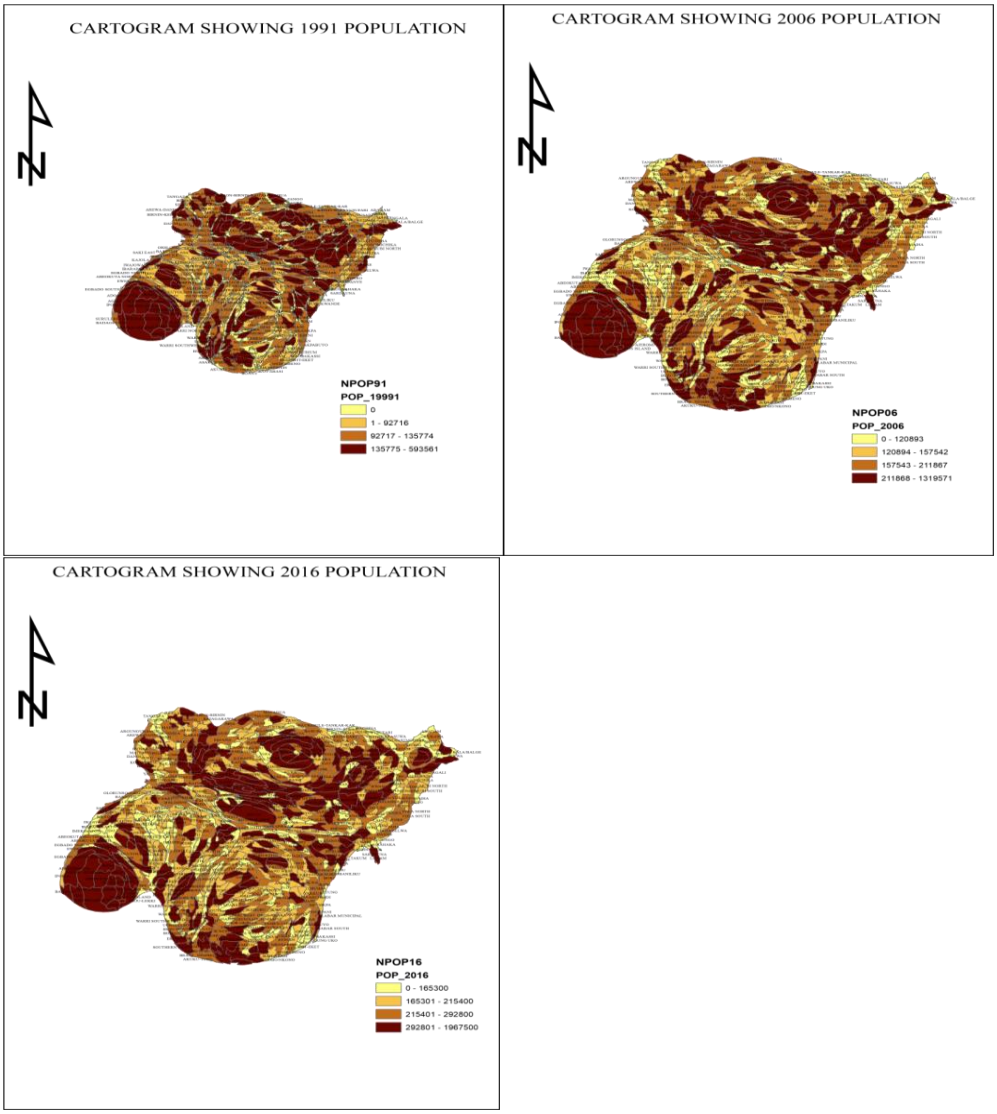


Figure 4.3: Cartogram maps of population of the Study area (1991, 2006 and 2016)

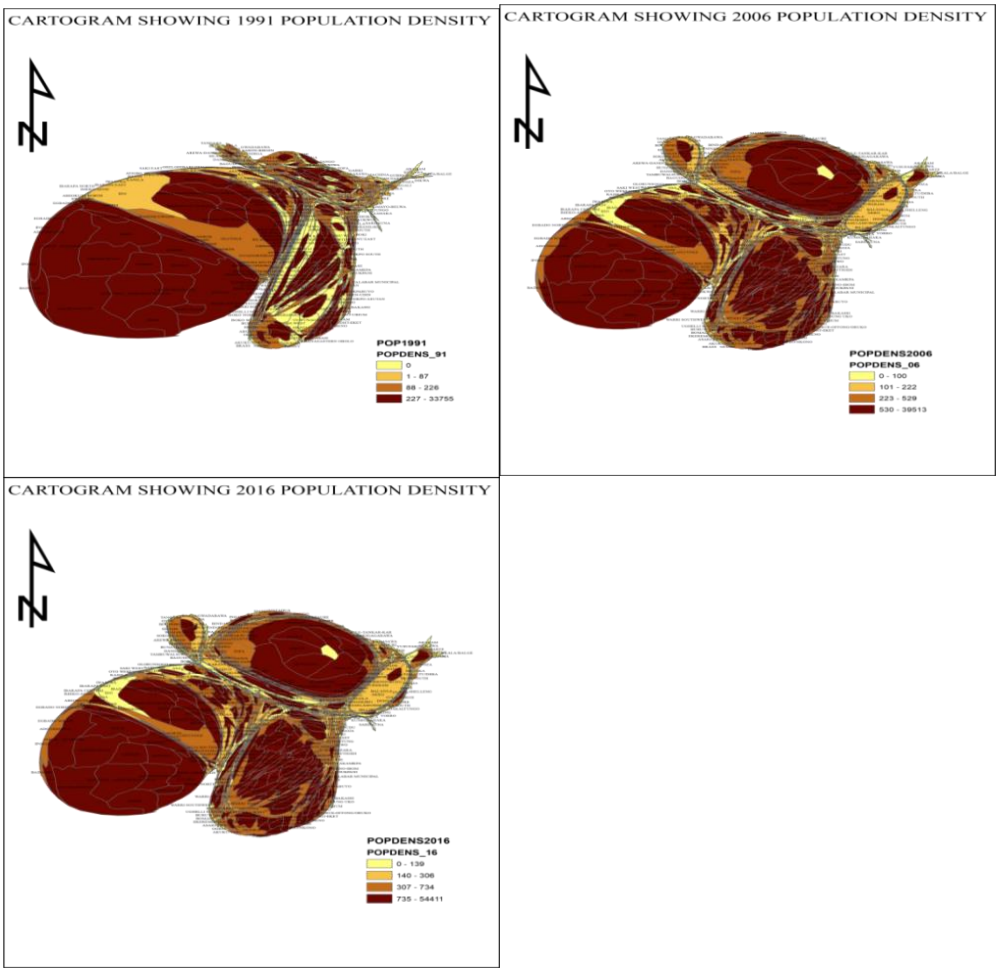


Figure 4.4: Cartogram maps of population density of the Study area (1991, 2006 and 2016)

5.0 Conclusion

This paper has presented an overview of the method choropleth and cartogram maps for the visualization of population data. It has presented the two techniques in illustrative manner. The two techniques have gained a wide range of acceptance particularly in the academia for visualization of the information and the display of static variables. The paper has also show that GIS is an effective and reliable tool for analyzing and visualizing population data. The ability of GIS to combine spatial data as well as aspatial data provided the impetus for the population data to be spatially displayed and appreciated. Furthermore, maps produced using GIS techniques can be easily updated, thus providing an opportunity for any new change in population data to be reflected on the maps. We recommend that further studies be carried out the will integrate other spatial data in order to fully establish the value of analyzing and visualizing census data.

Reference

Alsino S. (2015) Beyond Choropleth Maps: A Review of Techniques to Visualize Quantitative Area GeodataInfovis Reading Group WS 2015/16

Bruggmann A., Salvini M., Fabrikant S. (2013) Cartograms of self-organizing maps to explore user-generated content. In 26th international cartographic conference (2013), pp. 25-30.

Dorling, D., Barford, A., and Newman, M., (2006) "Worldmapper: The world as you've never seen it before," Visualization and Computer Graphics, IEEE Transactions on 12(5), pp.757–764

ESRI (2015): Environmental Systems Research Institute Inc.

Gastner, M. and M. Newman (2004)."Diffusion-based method for producing density-equalizing maps".Proceedings of the National Academy of Sciences.101 (20): pp.7499 – 7504

National Population Commission of Nigeria (NPC):2018 History of Population Census in Nigeria

Nusrat S. and Kobourov S. (2016): The State of the Art in Cartograms Star – State of the Art Report 35, 3, pp. Computer Graphics Forumc 2016 The Eurographics Association and JohnWiley & Sons Ltd Published by John Wiley & Sons Ltd.

Rekacewicz, P., UNEP/GRID-Arendal, Tikunov, S. V. (2002) World economy cartogram [online]

. Arendal, Norway: UNEP/GRID-Arendal, Available from http://maps.grida.no/go/graphic/world_economy_cartogram [Accessed 14/01/2019].

Wake D. B., Vredenburg V. T. (2008): Are we in the midst of the sixth mass extinction? A view from the world of amphibians. Proceedings of the National Academy of Sciences 105, Supplement 1, 11466–11473.

Table 1: Showing Population, Land Area and Population Density for all Nigerian states and FCT

STATE	POPULATION	LAND AREA (KM^2)	POPULATION DENSITY
Abia	2845380	6320	450.2183544
Adamawa	3178950	36917	86.11073489
AkwaIbom	3902051	7081	551.0593137
Anambra	4177828	4844	862.4748142
Bauchi	4653066	45837	101.5133189
Bayelsa	1704515	10773	158.2210155
Benue	4253641	34059	124.8903667
Borno	4171104	70898	58.83246354
Cross River	2892988	20156	143.529867
Delta	4112445	17698	232.3677817
Ebonyi	2176947	5670	383.9412698
Edo	3233366	17802	181.6293675
Ekiti	2398957	6353	377.6101055
Enugu	3267837	7161	456.3380813
FCT	1406239	7315	192.2404648
Gombe	2365040	18768	126.0144928
Imo	3927563	5530	710.2283906
Jigawa	4361002	23154	188.3476721
Kaduna	6113503	46053	132.7492889
Kano	9401288	20131	467.0055139
Katsina	5801584	24192	239.8141534
Kebbi	3256541	36800	88.49296196
Kogi	3314043	29833	111.0864814
Kwara	2365353	36825	64.23226069
Lagos	9113605	3345	2724.54559
Nasarawa	1869377	27117	68.93745621
Niger	3954772	76363	51.78911253
Ogun	3751140	16762	223.7883307
Ondo	3460877	15500	223.2823871
Osun	3416959	9251	369.361042
Oyo	5580894	28454	196.1374148
Plateau	3206531	30913	103.7275903
Rivers	5198716	11077	469.3252686
Sokoto	3702676	25973	142.5586571
Taraba	2294800	54473	42.12729242
Yobe	2321339	45502	51.01619709
Zamfara	3278873	39762	82.46247674
TOTAL	140431790		