IOSR Journal Of Humanities And Social Science (IOSR-JHSS)
Volume 20, Issue 4, Ver. 1 (Apr. 2015), PP 66-72
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Spatial Modelling Of Economic Activity in Nigeria Using Gross Domestic Product of Economically Active Population

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Abstract: *In order to enhance our understanding of recent and future global changes our analyses needs to be holistic, quantitative and spatially-explicit. However, there is disconnect between socioeconomic and geophysical analyses as a result of differences of interest and unit of examination. The study aims to develop spatially explicit model of economic activity which bridge this divide. The study used GDP as a proxy of economic activity across the country, in conjunction with data on population, total labour force and unemployment. Processing was carried within a GIS platform and output were classified using geometrical intervals. Annual values for total and total non-oil economic activity were computed at 100m grid resolution. The result shows that mean total economic activity is around 0.5 million Naira, this is about 16% higher than mean annual non-oil economic activity. A maximum of about 321 million Naira was recorded for total economic activity with a standard deviation standing at 3.7 million Naira. There is spatial concentration of high economic activity across major cities. And as one move away from the city towards another city there is more or less an "economic dead zone" between cities. There is a considerable number of ED, which is more extensive in size in the Northern and Middle belt of Nigeria. Such EDs are found to be smaller in the South but more widespread. This attempt signifies an initial step in the development of spatially explicit socioeconomic data, further effort will be required to fine tune this database to reflect other differences which were not captured by the data used for this study.*

Keywords: *Economic activity, GDP, Socio-ecological research, Spatial model, economically active population*

I. Introduction

There has been tremendous changes across the surface of the planet in the last few decades and these changes have had significant consequences (Houghton, 1994). Therefore, to enhance our understanding of these global changes in recent times, how the globe might change in the future, our analyses needs to be holistic, quantitative and spatially-explicit (Lawal, 2009).

In recent times there has been a tremendous growth in the amount of geospatial data collected and freely available. This could be attribute to advances in Information and Communication Technology (ICT), remote sensing (RS), geographical information systems (GIS), and improvement (as well as reduction in cost) in storage devices/facilities. The increasing understanding of how complex the interaction across different spheres of our planet is, has also spur this increasing trend in geospatial data collection. And consequently the use of such data, has also increased significantly across various fields of science.

The study aims to develop spatially explicit model of economic activity which would enhance the integration of economic and environmental data in the analysis of complex issues across various discipline requiring such data. This would help in furthering the development of knowledge and understanding of the influence of bio- and geophysical factors in driving economic activity across the country. Thus, serving as valuable source of information for social and natural scientists. This work will also enhance the initial attempt made by G-Econ database at Yale University (Nordhaus, 2006). It examined the spatial pattern of economic activity across the country using Gross Domestic Product (GDP).

Intense man-environment interaction has led to various forms of change across the globe. The process of these changes are never the same for any particular place. And their pathway may be driven by policy/planning, economic rewards and attributes of the place in question. Moreover, the changes observed over the year across the world are borne out of complex interaction of physical, biological, political and social and economic factors. For example, simplistic analysis of land use change may reveal the preclusion of certain types of land use by biophysical factors. However, the result of such analysis can be totally different at another location with similar biophysical conditions due to the interplay of socioeconomic factors. Thus, there is a need to include these aspects in order to gain better understanding of the dynamics of various processes on the planet. However, there is disconnect between socioeconomic and geophysical analyses. Due to differences in the unit of examination - pixel for natural sciences/geospatial data versus political boundaries or households for socioeconomic/political analysis and the difference of interest across these domains. Studies examining relationship between socioeconomic factors and economic activities are often tied to political boundaries or households. But, there are extensive analysis which shows that location plays a significant role in economic activity and development of places. The work of Hall and Jones (1999) concluded that differences among countries in capital accumulation and national and per capita productivity are driven by social infrastructure which are determined by location and other factors partly inherent in the language of the people. Mellinger, Sachs, and Gallup (2000) focussed on the physical geography in their examination of differences in economic development across the world. Their work shows that Coastal and temperate zones have a significantly higher economic performance in comparison to other zones across the world. Furthermore, they discovered that while temperate region proximate to the sea account for about 8% of world's inhabited landmass, its population of just around 23% of world's total accounts for 53% of word's GDP. Allen, Bourke, and Gibson (2005) concluded in their study of Papua New Guinea (PNG) that, instead of market forces, severe environmental constraints are primarily responsible for the spatial inequalities in income across PNG. Sachs (2003) argued and evidenced the primacy of geography on economic development. This is opposed to the work of Rodrik, Subramanian, and Trebbi (2004); Easterly and Levine (2003); Rodrik, Subramanian, and Trebbi (2002); Acemoglu, Johnson, and Robinson (2000) all of which purported the primacy of institutions over geography in accounting for pattern of per capita incomes across the world. Sachs (2003) showed that level of economic growth, per capita income and other economic and demographic indicators are strongly correlated. All of these works have showed the importance of geography, however they are all still tied to political boundaries.

Consequently, generation of data – geographically linked and scaled socioeconomic data will enhance the development and utilisation of method of analysis which employs the benefits of both aspects - natural and social sciences. For example, while land use data are mostly derived from satellite imageries at pixel resolution, socioeconomic data are derived at administrative unit resolution (Lawal, 2014). This issue of difference in data model has hampered the incorporation of these dataset in land use modelling (Irwin & Geoghegan, 2001; Van Der Veen & Otter, 2001; Mertens, Sunderlin, Ndoye, & Lambin, 2000).

The Brundtland report in 1987 popularised the concept of sustainable development. And defines the need for development using strategies which promote economic and social wellbeing while avoiding environmental degradation, over-exploitation or pollution (WCED, 1987). The dimensions are evident within this submission - social, economic and environmental or simply put as social progress; economic growth; and protection of the environment. The definition may appear to treat these aims as equals, worldwide observations has shown that economic growth takes forefront in most cases (Lawal, 2009). This has led to the principle of trade-offs, culminating in the development of distinction between weak and strong sustainability - where trade-offs are permissible (weak sustainability – i.e. environmental capital could be exploited at the expense of increasing the economic capital). However, such trade-off has not stemmed the continued degradation of the environment and desirable equity goals they aimed at across different society (Sneddon, Howarth, & Norgaard, 2006; Adams, 2006). This further highlights the need for integrated modelling of complex processes which bring about changes across the world thereby helping to inform better decision making in managing resources for sustainable development.

Therefore, there is need for development of pixel based or gridded socioeconomic data which can be easily and readily incorporated into analysis of climate change, land use/land cover change, impact of geophysical attributes on economic activity etc.

II. Materials And Method

2.1 Data

Data for this study was collated for 2010. Economic data for this study includes GDP data from the Central Bank of Nigeria (Central Bank of Nigeria, 2015), total labour force statistics from the World Bank recent database (World Bank, 2015). In addition to these, unemployment data for the year was also extracted from National Bureau of Statics Data Portal. (National Bureau of Statistics, 2015) data is available as total national value while total labour force was estimated as 31% of total population based on long term values from the source dataset. Unemployment data were available as percentage of total labour force at the State level.

Gridded population data for this study was obtained from Geodata Institute maintained web site - ww.worldpop.org.uk (GeoData Insitute, 2015). Methods use in the production of this dataset is described by Linard, et al (2012). This dataset is available at 100 meters grid for the entire globe.

2.2 Methods

After collation of dataset further operation were carried within ArcGIS (ESRI, 2011). The gridded population data served as the basis for all data processing and analysis. The first stage of the data operation is the computation of total labour force from the total population of the country. The baseline proportion is 31% of the total population. The assumption prior to the computation is that proportion of the total labour force across the country is the same. This computation led to the creation of the grid of total workforce of the country for the year 2010. A grid of total contributing labour force (TCLF) – economically active population, was also computed within ArcGIS. To obtain this, the population of unemployed labour force at the State level was converted to a grid. This proportion (unemployed workforce) was deducted from the total labour force. The output was further refined to show the contribution of each grid cell to the total amount of contributing labour force. GDP data has total values and sector contributions, the total GDP and the non-oil GDP were extracted and computed for this study. The non-oil GDP was computed by subtracting from the total GDP, GDP values for the oil refining; and crude oil and natural gas sectors. The total GDP and non-oil GDP was then converted to single value grid maps (raster).

The last stage of the GIS data processing involves the weighted redistribution of the GDP and non-oil GDP across the country. The redistribution is weighted using the TLCF proportion per grid cell computed earlier. While there is definitely a clear understanding that GDP contribution varies from place to place, as there are no established data to ensure this, the assumption of equal contribution by every place was made. The outcome of this operation is the gridded economic activity of Nigeria weighted by proportion of contributing population. To examine the distribution of the economic activity, descriptive statistics were computed for the raster file. Total and non-oil economic activity maps generated were reclassified such that each grid cell falls into one of ten classes using geometrical interval classification, with first class been the least economically active and tenth as the most economically active. This classification method was adopted because of the nature of the data – not normally distributed and heavily skewed. This classification method created class breaks based on intervals with geometric series, the algorithm used created these intervals through square-sum minimisation of element per class (ESRI, 2007). Therefore, range of each class is relatively similar in the number of value it contains and there is consistency in the change between intervals.

Errors are inherent in any computation such as this. However since most of the dataset used do not specify an error inherent in the data, error for the maps is assumed to be similar to the error computed for the population data grid upon which the entire computation was based.

III. Results And Discussion

3.1 Geovisualisation and Descriptive Analysis

Economic activity based on total GDP (Figure 1) and non-oil GDP (Figure 2) shows that across many parts of the country there is low economic activity. However, the descriptive statistics for these two shows that, on average for each 100m square across the country, economic activity worth 0.51 million naira is generated (Table 1), this is about 16% higher than that generated without the oil industry.

Table 1: Descriptive statistics of gridded national economic activity

Statistics	Economic Activity (million Naira)	
	Total	Total Non-oil
Maximum	321.98	270.94
Mean	0.51	0.43
Standard Deviation	3.71	3.12

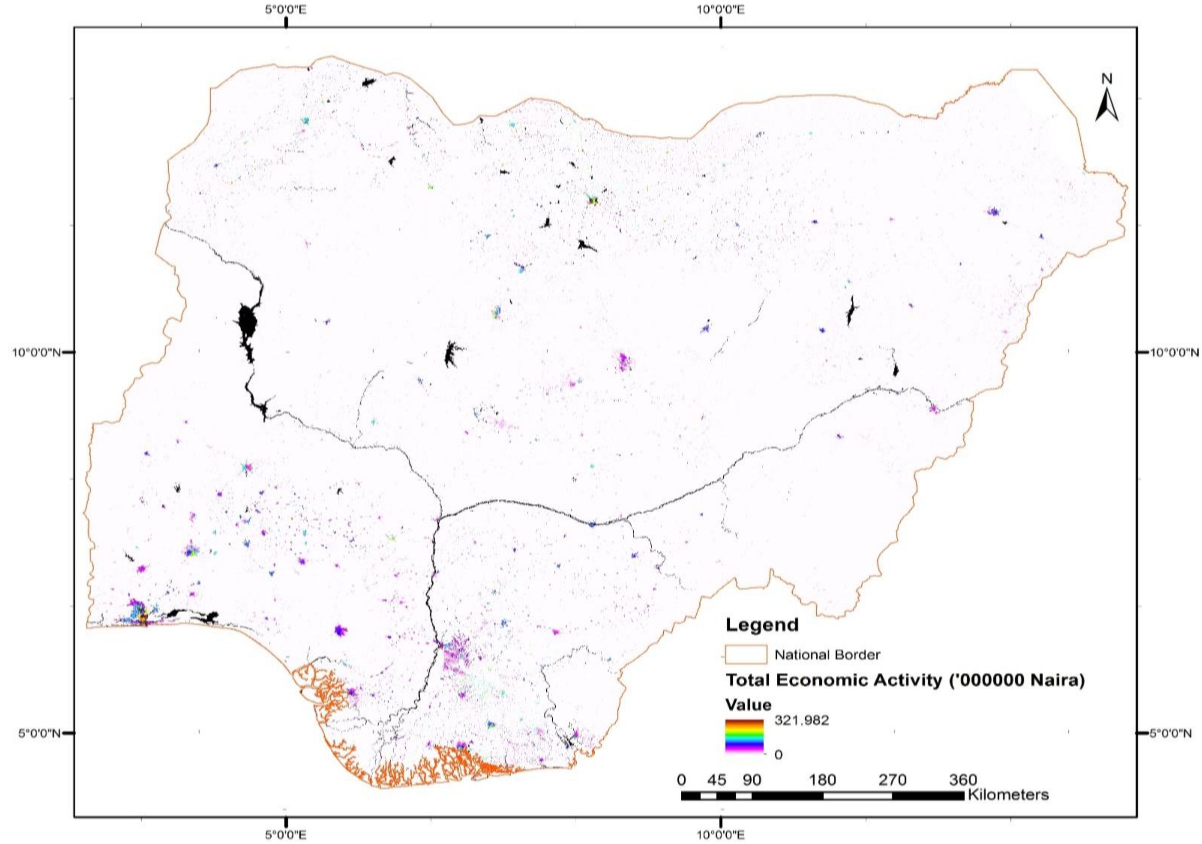

Figure 1: Gridded map of total economic activity across Nigeria for 2010

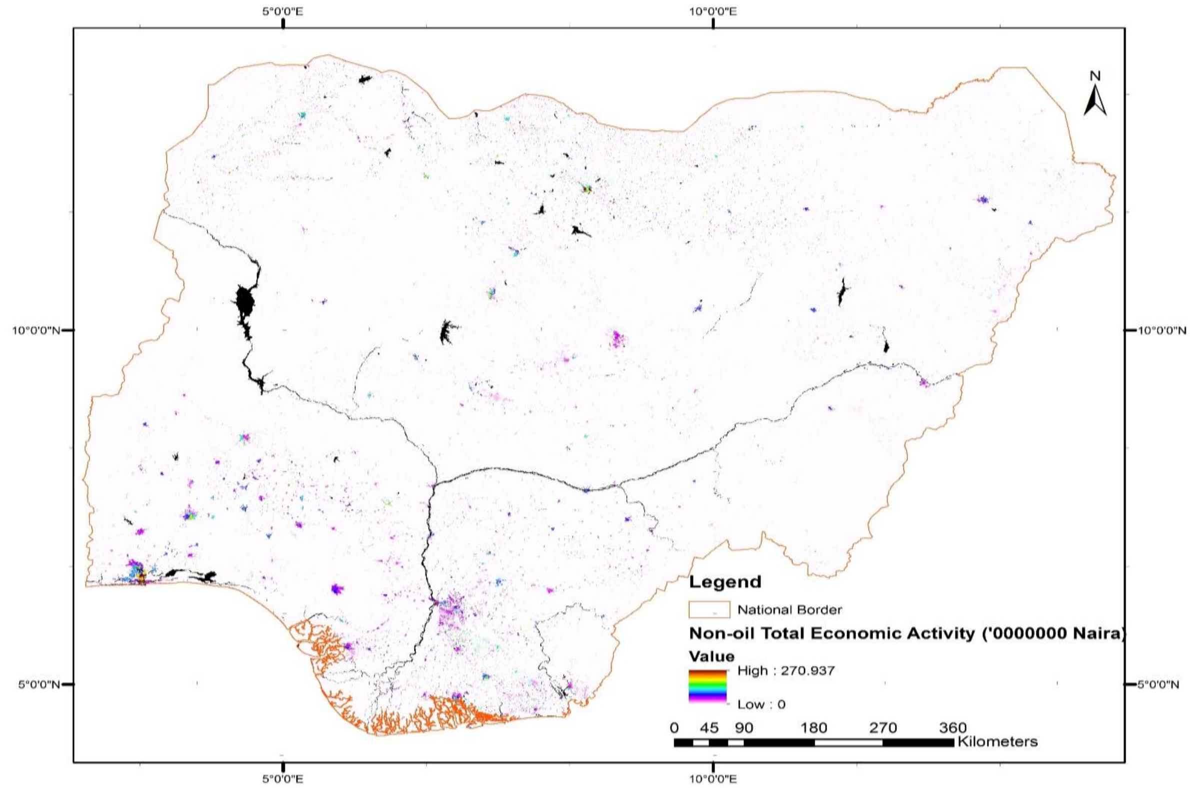

Figure 2: Gridded map of total non-oil economic across Nigeria for 2010

The gridded map also distinguish water bodies (black grid cells), these cell were computed as having 0 economic activity. This is true based on the population data used. However, it is known that there are riverine communities across the countries with some measure of economic activity. On the other hand, it is very difficult to capture such detail within the population distribution model used.

Other than in magnitude, total activity and non-oil activity do not have considerable differences in the zones of intense economic activity observable across the country. However, one could argue that the contribution of crude oil, natural gas and allied industries are more pronounced across the oil producing States than others. The challenge therefore, is how to quantify this on a map.

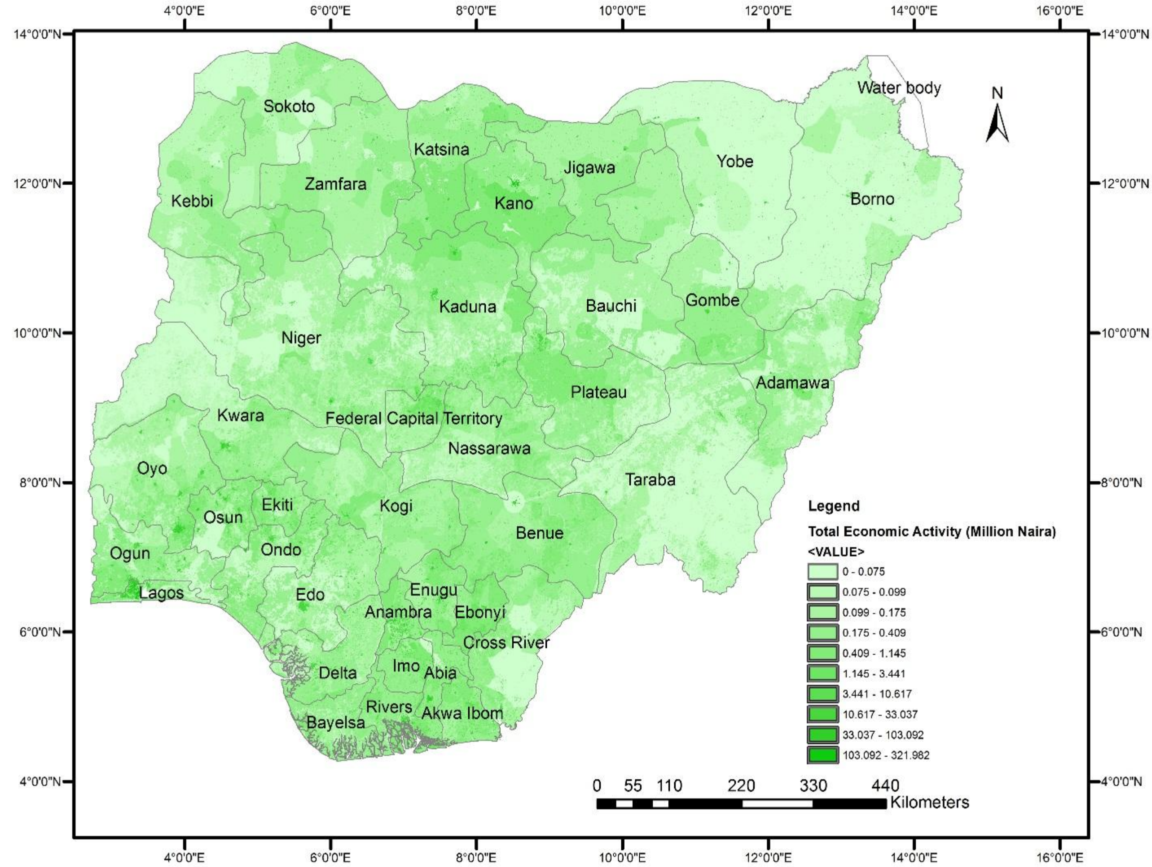

Figure 3: Geometrical interval classification of total economic activity by States across the country

Examining total economic activity from a different classification scheme allows for clear identification of "economic desert" (ED) across the country. From figure 3, some zones of ED could be identified. In the Northern part of the country, a considerably large proportion of Yobe and Borno States have very low levels of economic activity. Furthermore, Gombe, Adamawa, Plateau, Bauchi, Niger, Sokoto and Zamfara States have also relatively large areas that could be considered as ED. However, relatively high level of economic activities in the Northern part of the country, appears to have its centre around the junction between Kano, Kaduna and Kastina States.

Across the middle belt, there is a fairly high economic activity zone spanning from the southern part Kwara State eastwards over Kogi, Niger, Federal Capital Territory (FCT), Nasarawa and Plateau States.

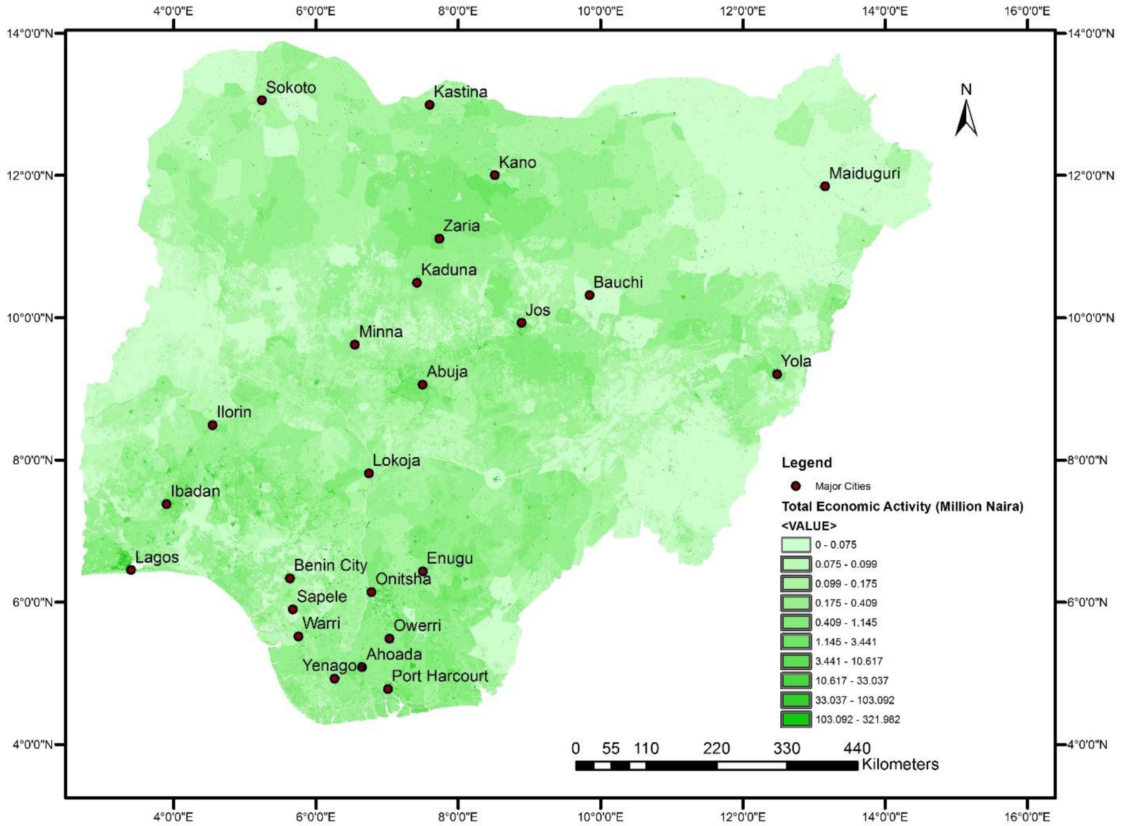

Figure 4: Total economic (geometrical interval) map of Nigeria showing major cities and highlights of ED.

Through the southern region, the Northern part of Oyo State, large tract across Osun, Ondo, Edo, Cross River, Delta, Ondo and Ogun State has very low economic activity. However, there are a number of high economic activity zones in this region. One spanned across Lagos and Ogun State, another extends from Oyo to Osun, Ekiti and Ondo State. Edo has a visibly high economic zone which corresponds to Benin City. As one moves towards the Delta region of the country, economic activity also becomes dispersed. There are high levels of economic activity but such zones are small and much dispersed across the region.

Careful examination of total economic activity in respect to the location of major cities (Figure 4) shows that across the country there is often a discontinuity of economic activity from the city down to the next major city. The only exception is Lagos city, which has a relatively large area of influence i.e. high level of economic activity spanning a wide area, well beyond the city and into neighbouring State (Ogun).

IV. Conclusions

The study developed spatially explicit model of economic activity, which would serve to foster the integration of economic and environmental data in the analysis of complex issues in the country. Thus, helping towards the drive of “socialising the pixel and pixelising the social”. This development is pertinent in furthering development of socio-ecological research in the country and beyond. The study used GDP as a proxy of economic activity across the country.

From the results, we could conclude that total economic activity by economically active population in the country is still concentrated across the major cities where the greatest intensity of human activity can be found. Moreover, there is little or no connection between cities in terms of overlap of zones of economic activity. In essence as one move away from the city towards another city there is more or less an “economic dead zone” between cities. This show the lack of rural development which could mitigate such. Furthermore, across the length and breadth of the country there are a considerable number of EDs, most of which are extensive in size in the North and Middle belt of Nigeria. Such EDs are found to be smaller in size in the South but more widespread.

This attempt signifies initial step in the development of spatially explicit socio-economic data,. Further effort will be required to fine tune this database to reflect other differences which were not currently captured by the data used for this study. For example, there is need to represent the differences in contribution to economic activity by oil and gas exploration in the Niger Delta region. Furthermore, there is need to represent the difference between urban and rural areas in the total economic activity generated. In order to foster dissemination, usage and further development of this dataset, it would be made available online for other researchers and stakeholders.

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