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Full Length Research Paper

How has Population Growth and Demand for Housing Affected Land Use in Port Harcourt, Nigeria

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The fast urbanization/industrialization and population growth in the city of Port Harcourt as well as changes in human activities/ modern lifestyle has brought about demand on Land Use. Sequel to this the demand for infrastructure and different house types have brought about a lot of changes in land cover and land use in Port Harcourt. The methodology used was Geographic Information Systems (GIS) and remote sensing which provided a cost effective and accurate alternative to understanding landscape dynamics. Digital change detection techniques based on multi-temporal and multi-spectral remotely sensed data was also used. Also a mathematical model using Matlab numerical scheme called ordinary differential equation to complement the relationship of population growth, housing demand and land use in the city of Port Harcourt was used. Objectives of the Study are; To examine the population growth of Port Harcourt since it was created. To examine the housing needs and current land availability. To examine how much land has been used for housing development. The findings of the research showed the Built – Up area had an increase from 16.50% in 1984 to 51.38% in 2014. A lot of development has taken place using up most of the Gallery Forest, Vegetation Area and the Water Bodies. Development of Built – Up area needs to be controlled so that all of the vegetation is not used up because the city needs some vegetation to allow the city breath. From the mathematical model the best –fit parameter value is $\beta_1 = 0.00000068338$ for the carrying capacity value of 650,000 population size. The model has helped complement the relationship of population growth, housing demand and land use in the city of Port Harcourt in Nigeria. Some recommendations from the research are; The 1978 Land Use Act should be revised because government does not have control of land as stated on paper. The Rivers State Physical Planning and Development Law No 6 of 2003 should be implemented. Green buildings and Green technologies should be utilized.

Keywords: Population Growth, Land Use change, Housing, Development

INTRODUCTION

Land is one of the most important and finite resources needed by humans, particularly for the development of housing. Housing is one of the three most important necessities of man second to food; therefore putting the land to superlative use is of essence. The proficient management of the accessible land by experts in the building industry will ensure the ultimate benefits for the good of our society. This will equate into; What Percentage of a Plot should a building occupy in certain locations according to the Building Code, Building Type for the particular area, Zoning of the city according to Town Planning Laws, Maintaining the water ways, How much of the Water Bodies can be reclaimed, Gallery Forest and Vegetation can be used

for building.

City development and changes in land-use patterns have various social and environmental impacts, including the loss of natural spaces, increased vehicular congestion, landscape fragmentation and homogenization, the loss of highly productive agricultural lands, alterations in natural drainage systems, and reduced water quality (Pickett and Cadenasso 1995, Pickett et al. 1997, 2001)

Nigeria has experimented with virtually all of the approaches in the housing sector that were fashionable in the 1960s, 1970s, and 1980s — slum clearance schemes, which caused much distress and social dislocation, sites-and-services schemes, which tried to open up new land and have it subdivided into serviced residential plots for distribution, and slum or squatter upgrading, which tried to fit new infrastructure and services into already disorderly and crowded settlements, sometimes with the participation of local residents.

Like many cities in Nigeria, Port Harcourt has recorded rapid growth in population and aerial spread. From an estimated population of 500 in 1915 it grew to 30,200 in 1944. By 1963, its population was 179,563 and by 1973 it has reached 231, 532 persons. The Port Harcourt municipality's population was given as 440,399 by the 1991 national census. The 2006 national census show this population is about 541,115 (Obinna, Owei and Mark, 2010). In terms of its physical size, the city grew from 15.54 sq. Km in 1914, to a metropolis covering an area of 360 sq. Kilometres in the 1980s.

There is a 2003 law for Physical Development provided for the establishment of a State Planning Board and Planning Authorities in all (23) local government areas of River State, it has never been implemented. The same asses-faire attitude has also been taken in the implementation of the State land development and land registration laws. Section 4 of the Land Development (Provision for Roads) Law Caption 73 initially dated 1933 makes provisions that are to be complied with before land is sold off in lots. This includes the making of lay-out plans that indicate what parts of the land were to be reserved for roads. Local land owners are obviously not acting in recognition of this law. CAP 74 of the laws of Rivers State dates back to 1917 and provide for land registration. This is obviously abused by both the government officials, communities and private buyers as the transfer of titles to land in Greater Port Harcourt City goes on mostly outside the formal governmental processes and channels. The greater proportions of developers do not possess the Certificate of Occupancy which is the recognized title to land. Greater Port Harcourt City has no clearly defined settlement development policy; neither does it have a clearly defined urban policy. The implementation of the Land Use Act of 1978 in facilitating access to land has been very selective, especially benefiting those in public office and their supporters. Public sector land delivery has proved to be an inefficient regulatory tool for urban land management. Thus, the inefficient urban planning system has promoted urban sprawl.

Aim

The aim of the study is to show through the data generated from this research that the population growth of Port Harcourt has a direct link on the land use in in relation to the built environment.

Objectives of the research were to;

1) To examine the population growth of Port Harcourt since it was created
2) To examine the housing needs and current land availability
3) To examine how much land has been used for housing

Background Information about the Study Area

Port Harcourt is the capital of Rivers State in Nigeria. It lies along the Bonny River and is located in the Niger Delta. The Port was built in 1912 but was not given a name until 1913, when the Governor of Nigeria, Sir Frederick Luggard, named it Port Harcourt instead of Port Rebisi (Ikwerre land) in honour of Lewis Vernon Harcourt, the then secretary of the state for colonies. The area that became Port Harcourt in 1912 was before that part of the farmlands of the Diobu village of the Ikwerre ethnic nationality (one of the numerous ethnic group of the Niger Delta Region of Nigeria). The colonial administration of Nigeria created the port to export coal from the collieries of Enugu located 151 miles (243km) north of Port Harcourt to which it was linked by a railway called the Eastern Line, also built by the British.

In 1956 crude oil was discovered in commercial quantities at Oloibiri, ans Port Harcourt's economy turned to petroleum when the first shipment of Nigerian crude was exported through the city in 1958. Through the benefits of the Nigerian petroleum industry, Port Harcourt was further developed, with aspects of modernisation such as overpasses and city blocks. The urban nature of Port Harcourt metropolis has undergone dramatic changes during the last decades. From a colonial city clearly delineated in its historic boundaries, Port Harcourt has grown and continues to grow into surrounding landscape, swallowing even more villages, coastline and previously reserved landscape,

transforming into an ever increasing urban conglomerate. Port Harcourt experienced tremendous structural transformation and due to population and economic growth and development of its transportation and communication systems and the impact of globalization (Obinna, Owei and Mark, 2010). After 1980s, multi-centre development of the city has had a catalytic impact on reshaping of the economic landscape into a metropolitan area which has drawn much attention as stated in similar cities (Hackworth, 2005).

The population of Rivers State from the census of 2006 is five million, one hundred and ninety eight thousand, seven hundred and sixteen (5,198,716) people in total. The number of males is two million, six hundred and seventy three thousand and twenty six (2,673,026), while the number of females is two million, five hundred and twenty five thousand, six hundred and ninety (2,525,690). The total number of Households is one million, one hundred and twenty three thousand, nine hundred and ninety eight (1,123,998).

This research will be looking at three local government areas out of the eight that form the Greater Port Harcourt; they are Port Harcourt, Obio – Akpor and Ikwerre LGAs. A lot of Private Housing Development is taking place more in these LGAs. The population for the three LGAs from the 2006 census figures is one million, one hundred and ninety five thousand, six hundred and thirty (1,195,630) people. Also the total number of households in the three LGAs is two hundred and seventy five thousand and thirty five (275,035)

From the figures of the 2006 census Port Harcourt LGA has two hundred and seventy six thousand, four hundred and sixty four (276,464) males while the females are two hundred and sixty four thousand, six hundred and fifty one (264,651). This gives a total of five hundred and forty one thousand, one hundred and fifteen (541,115) people.

Obio - Akpor LGA has two hundred and forty four thousand, eight hundred and seventy five (244,875) males and two hundred and nineteen thousand, nine hundred and fourteen (219,914) females. This gives a total of four hundred and sixty four thousand, seven hundred and eighty nine (464,789).

Ikwerre LGA has one hundred and one thousand, and eighty (101,080) males and eighty eight thousand, six hundred and forty six (88,646). This gives a total of one hundred and eighty nine thousand, seven hundred and twenty six (189,726).

METHODOLOGY

The methodology used was Geographic Information Systems (GIS) and remote sensing which provided a cost effective and accurate alternative to understanding landscape dynamics. Digital change detection techniques based on multi-temporal and multi-spectral remotely sensed data was also used. This demonstrated great potential for understanding landscape dynamics especially on how to detect, identify, map and monitor differences in Land Use and Land Cover patterns over time (Jensen, 1996).

Models of land-use change relied on simple parameters, including the urban area's present extension, main transport routes, distances to workplaces and goods, topographical conditions, and the existence of land with special conditions, e.g., protected areas. The main purpose of modelling is to identify the physical and socio-economic factors that determine or condition pressure for land-use change at the urban–rural interface (White and Engelen, 2000). The two prevalent approaches to modelling spatial land-use change patterns are regression-based models and models based on spatial transition (Theobald and Hobbs 1998 and Pijanowski et al. 2002). In the former approach, a relationship is established between a wide range of predictive variables and the probabilities of Land-Use
change; the latter approach is an extension of Markov's a spatial technique and a form of stochastic cellular automaton (Zhou and Liebhold 1995). A spatial database was generated between 1984–2014 using geo-referenced digital aerial photographs. Thematic coverage maps were obtained using photo-interpretation techniques and included urban Land Use. Spatial database and maps were produced for 1984, 1999, and 2014 using geo-referenced digital aerial photographs. Thematic coverage maps were obtained using photo-interpretation techniques and included urban and rural land use. This involved the analysis of images from 1984, 1999, and 2014 and classification of the spatial pattern of land-use change; the construction of digital coverage in GIS; the selection. Pattern

Also a mathematical model using Matlab numerical scheme called ordinary differential equation to complement the relationship population growth, housing demand and land use in the city of Port Harcourt.

FINDINGS AND DISCUSSION

The 2006, National Population Census statistics showing the distribution of the households by type, a total of 126,010 households were recorded in Port Harcourt. The data shows that houses on a separate stand or yard were 49,115, traditional/hut structure made of traditional materials were 371, flat in block of flats 27,676, semi - detached house 8074, room/let in house 36,584, informal/improvised dwelling 2078 and others 2112. Also distribution by tenure in Port Harcourt there were a total of 126,010 households, owner occupier were 25,882, Owned but not yet paid 1107, rented

Table 1: Population Showing Total Number of Persons and Households

State/LGA	Total	Male	Female	Total Household
Rivers State	5,198,716	2,673,026	2,525,690	1,123,998
Port Harcourt	541,115	276,464	264,651	126,010
Obio - Akpor	464,789	244,875	219,914	108,777
Ikwerre	189,726	101,080	88,646	40,248

Source: National Population Commission (Census 2006)

Table 2: Population Showing Household by Tenure

State/LGA	Total Household	Owned	Owned but not yet paid off	Rented	Occupied rent - free	Squatting	Others
Rivers State	1,123,998	709,025	11,995	302,007	89974	8309	2688
Port Harcourt	126,010	25,882	1107	90412	7229	957	423
Obio - Akpor	108,777	28341	821	73019	5745	565	276
Ikwerre	40,248	26797	369	10107	2657	236	82

Source: National Population Commission (Census 2006)

Table 3: Population Showing Ownership Status of Dwelling Unit

State/LGA	Total Household	Head of household	Spouse to head of household	Other household member	Relative but not household member	Privately owned(Landlord)	Private employer	Other private agency	Public/Government ownership	Others
Rivers State	1,123,998	747,674	31,541	60,997	44,932	182,779	12,239	11,212	27,032	5592
Port Harcourt	126,010	43402	2790	5376	2034	57900	3077	3355	7078	998
Obio - Akpor	108,777	43409	2478	4350	1819	47274	2152	2503	3866	926
Ikwerre	40,248	27916	1646	1451	684	5086	627	299	2319	220

Source: National Population Commission (Census 2006)

Table 4: Population Projection from 2006 to 2014

State/LGA	Census of 2006	Projection for 2014
Rivers State	5,198,716	6,688,576
Port Harcourt	541,115	696,189
Obio - Akpor	464,789	597,989
Ikwerre	189,726	244,098

Source: Source: National Population Commission (Census 2006) and Projection

90,412, occupied rent free 7229, squatting 957 and others are 423. The 2006 Census data shows that most of the houses are privately owned. The recommended rate of about 8-10 dwelling units per 1,000 populations as by the United Nations (Anthonio, 2002). Although this does not give the total picture of built housing in Port Harcourt, this level of provision is still a far cry from the UN recommendation (table 1-4).

Port Harcourt's housing is privately owned and many families in Port-Harcourt are inadequately housed because of low incomes or other circumstances which prevent them from competing successfully in the private housing market

For these families, the city or government has the obligation of improving their living conditions by providing adequate low and moderate income housing or by administering state public programmes which create opportunities for improved housing (Ogiongwo, 1979).

From Table 5 the Land Use/ Land Cover statistics in hectares and percentage showed a large increase in

Table 5: Land Use/ Land Cover Statistics in Hectares and Percentage

LANDUSE	Year	Area (Hect.)	Area (%)	% Diff
BUILTUP AREA	1984	9228.79	16.50	0
	1999	17522.90	31.32	14.83
	2014	28993.51	51.38	13.35
GALLERY FOREST	1984	13552.74	24.23	0.00
	1999	12472.46	22.30	-1.93
	2014	10140.28	18.13	2.98
VEGETATION	1984	26795.81	47.90	0.00
	1999	19881.49	35.54	-12.36
	2014	11772.75	21.04	-14.49
WATERBODY	1984	6364.50	11.38	0.00
	1999	6064.99	10.84	-0.54
	2014	5035.29	9.00	-1.84

Source: Author's field work

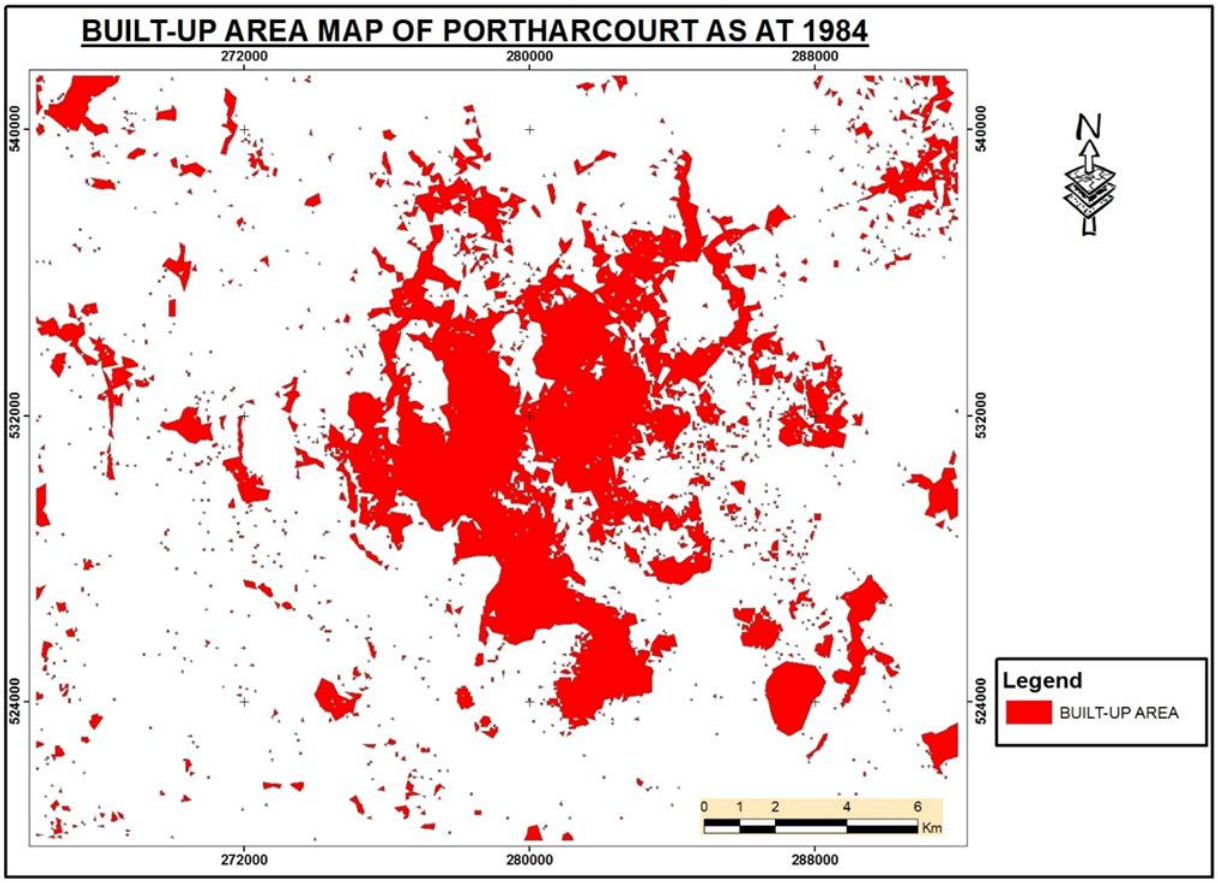

Figure 1: Source: Rivers State Ministry of Physical Planning and Urban Development

the Built-up Area. In 1984 it was 16.50%, 1999 it was 31.32% and in 2014 it was 51.38%, while the Gallery Forest, Vegetation and Water Body reduced sharply. This is clearly represented in the maps in Figure 1, 2 and 3.

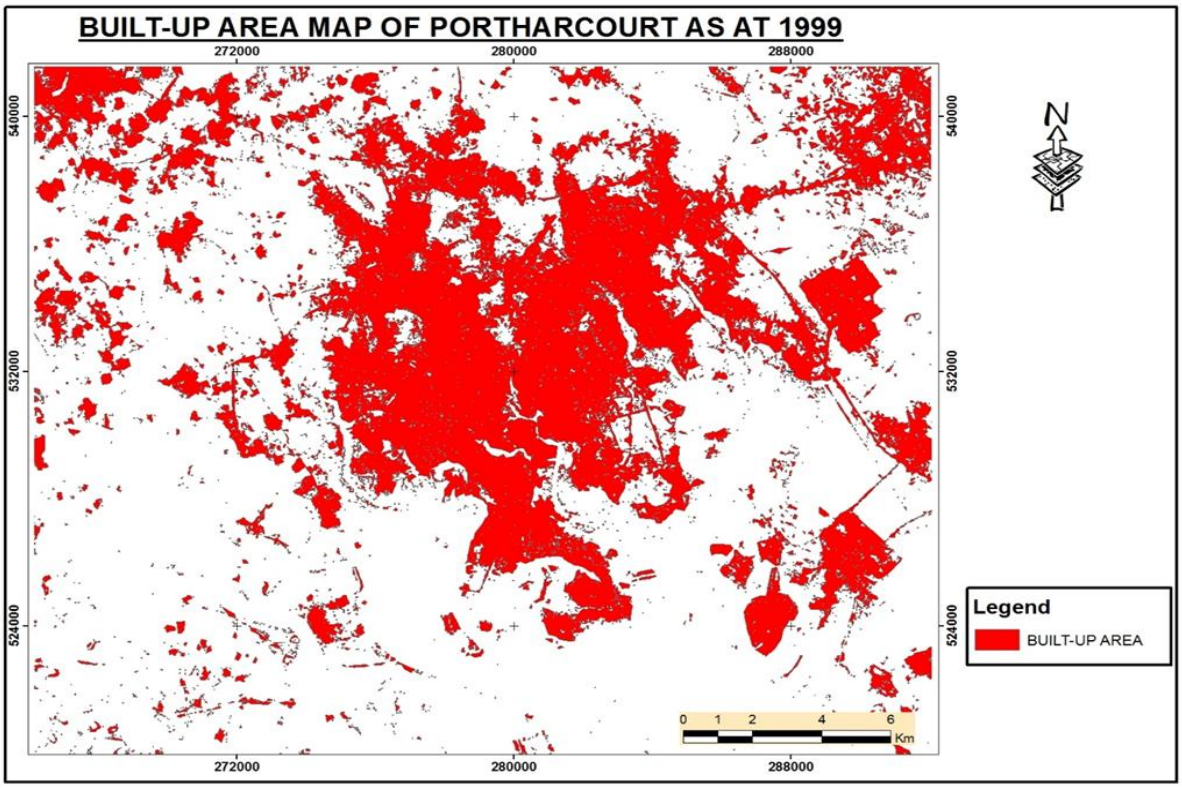

Figure 2: Source: Rivers State Ministry of Physical Planning and Urban Development

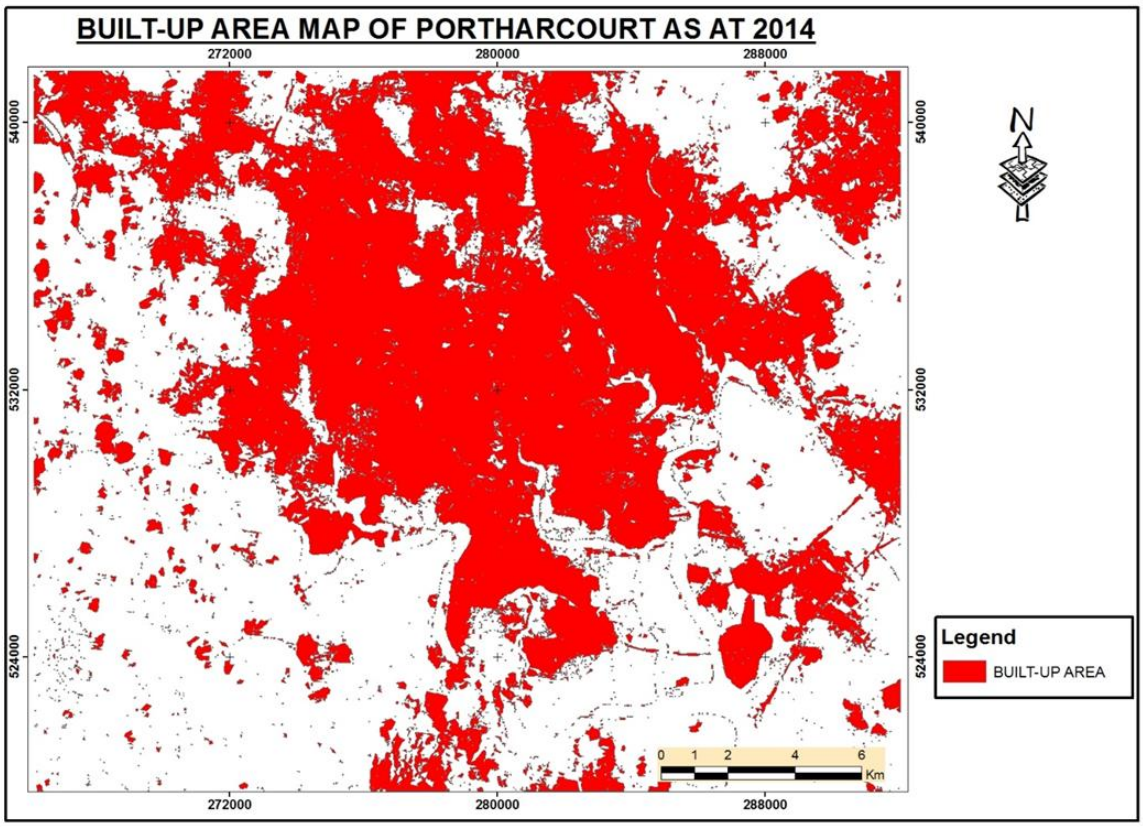

Figure 3: Source: Rivers State Ministry of Physical Planning and Urban Development

Table 6 has shown a progressive growth in the population of Port Harcourt since it was created and this has a direct relationship to housing and generally the Built - Up Area. As the population is growing so is the housing demand increasing and this has to be managed adequately because land is finite. There is need to measure the rate of growth using a mathematical model, which will give an accurate rate of growth. When the rate of growth in the city of Port Harcourt is know it will enhance better planning and management of our Land Use and Land Use Cover. Below is a table that explains the bit fit model.

Table 6: Showing Population of Port Harcourt from 1915 – 2011

Year	Population
1915	500
1921	7,185
1931	15,201
1944	30,200
1953	71,634
1963	179,563
1973	213,443
1991	440,399
2006	538,558
2011	638,360

Source: National Population Commission Census 2006 and projection

What do we learn from Table 7? In our bid to construct the best fit logistic parameter value here by known as β_1, p- norm measures of errors depicted by ;

1-norm Sensitivity Value
2-norm Sensitivity Value
∞-norm Sensitivity Value

Table 7: Selection of a Best Fit Model Parameter for the Growing Human Population of Port Harcourt, Part 1

α_1	cc	β_1	1-norm	2-norm	∞-norm
0.4442	100,000	0.000004442	4349500	1504100	538430
0.4442	156,000	0.000029613	3929100	1362400	488430
0.4442	200,000	0.0000022210	3514700	1221300	438450
0.4442	250,000	0.0000017768	3104600	1080700	388570
0.4442	300,000	0.0000014807	2697700	940490	338410
0.4442	350,000	0.0000012691	2293300	800560	288350
0.4442	400,000	0.0000011105	1891700	661110	238420
0.4442	450,000	0.00000098711	1491800	521870	188390
0.4442	500,000	0.00000088840	1093600	382900	138370
0.4442	550,000	0.00000080764	696830	244190	88329
0.4442	600,000	0.00000074033	301380	105690	38265
0.4442	**650,000**	**0.00000068338**	**92811**	**32569**	**11802**
0.4442	700,000	0.00000063457	485710	170550	62486
0.4442	750,000	0.00000059227	877560	308320	112360

This shows that the best –fit parameter value is β_1 = 0.00000068338 for the carrying capacity value of 650,000 population size.

However in order to present a detailed data analysis that is based on a rational thinking the best-fit value needs to be studied further between the carrying capacity value of 600,000 and 650,000 inclusive. To enable us find out the most best –fit value.

What do we learn from Table 8? As a good practise in numerical simulation we have utilized a Matlab numerical scheme called ordinary differential equation of Order 45 denoted as ODE 45 which is computationally more efficient than ODE 23, ODE 23TB

Table 8: Selection of A Best Fit Model Parameter For The Growing Human Population Of Port Harcourt, Part 2

α_1	cc	β_1	1-norm	2-norm	∞-norm
0.4442	610,000	0.00000072820	22490	78035	28258
0.4442	615,000	0.00000072228	183050	64205	23252
0.4442	620,000	0.00000071645	143580	50364	18241
0.4442	625,000	0.00000071072	104170	36542	13236
0.4442	630,000	0.00000070508	64759	22719	8229.9
0.4442	631,000	0.00000070396	56860	19948	7226.3
0.4442	632,000	0.00000070285	49007	17193	6228.4
0.4442	633,000	0.00000070174	41129	14430	5227.4
0.4442	634,000	0.00000070063	33,227	11,658	4,223.2
0.4442	635,000	0.00000069953	25372	89,01.8	3,2249
0.4442	636,000	0.00000069813	15,340	5382	1949.8
0.4442	637,000	0.00000069733	9,589.1	3,364.4	1,218.9
0.4442	638,000	0.00000069624	1733	608.05	220.2958
0.4442	638,100	0.00000069613	938.87	329.41	119.35
0.4442	**638,200**	**0.0000006902**	**144.4632**	**50.687**	**18.3638**
0.4442	638,300	0.00000069591	650.1852	228.1274	82.6502
0.4442	638,400	0.00000069580	1445.1	507.0291	183.6961
0.4442	638,420	0.000069578	1589.6	557.7478	202.0716
0.4442	638,430	0.00000069577	1661.9	583.1083	211.2597
0.4442	638,440	0.00000069576	1734.2	608.4695	220.4481

and ODE 15s to select
∞ = 0.4442, cc = 638, 200, β_1 = 0.0000006902,
Having the 1-norm local minimum of **144.4632**
2-norm local minimum of **50.687**
∞- Infinity norm local minimum of **18.3638**

On the basis of this best- fit parameter values based on the smallest error associated with the best –fit parameter values, we hereby formulate a logistic mathematical model that describes the population growth of the city of Port Harcourt with the initial population value of 500 for 1915 as follows.

$$\frac{dp(t)}{dt} = P(t)(\infty - \beta 1\, \mathrm{P(t)})$$

Where P (0) = 500
∞ = 0.4442
β_1 = 0.0000006902

This proposal model is in the absence of the socio demographic variable that can affect the demographic transition of Port Harcourt City in Nigeria.

We will expect our presentation modelling insight to complement the relationship population growth, housing demand and land use in the city of Port Harcourt in Nigeria.

CONCLUSIONS

The current population growth has been on the increase and has no indication that it may slow down soon. This could be due to the numerous multi - national oil and oil servicing companies, factories and industries, explains in influx of several people into the city and shows that the urban planning policies have been largely overcome by private interests beyond the planned urban area. As a consequence, city sprawl has occurred partly in a diffuse manner. This, along with other effects, has caused the increasing socio-spatial segregation of the population and the permanent modification of urban planning instruments. Sequel to this access to land is contributing negatively to housing productivity in Port Harcourt. Regular modelling is important to help identify the physical and socio-economic factors which will determine or condition pressure for land-use change at the urban–rural interface. This demonstrated great potential for understanding landscape dynamics especially on how to detect, identify, map and monitor differences in Land Use and Land Cover patterns over time.

The mathematical model using Matlab numerical scheme called ordinary differential equation to complement the relationship population growth, housing demand and land use in the city of Port Harcourt. This further gave the research an additional approach in regards to planning for the future and projections for the city of Port Harcourt. This has complemented the relationship of population growth, housing demand and land use in the city of Port Harcourt in Nigeria.

RECOMMENDATIONS

i. The 1978 Land Use Act should be revised because government does not have control of land as stated on paper. There is a parallel land market in Port Harcourt,

i.e. the Land Use Act is not functioning as intended because individuals sell their family or inherited land at their discretion. The Land Use Act should be abrogated but government can create an enabling environment where land sale is regulated.

ii. The Rivers State Physical Planning and Development Law No 6 of 2003 should be implemented. The city is zoned and these areas should be maintained so that developments are not carried out where they should not be and penalties should be given to offenders.

iii. Green buildings and green technologies required; The optimum design solution is one that effectively emulates all of the natural systems and conditions of the pre-developed site – after development is complete; for example, the use of high performance windows and window frames. This can be supervised under the Rivers State Ministry of Urban Development and Physical Planning.

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REFRENCES

Anthonio, J. B. (2002). *Housing for all by the year 2015.* Paper presented at the 2002 Building week seminar. Obafemi Awolowo University, Ile-Ife, Nigeria.

Hackworth, J.(2005). Emergent Urban Form or Emergent Post Modermism? Large U.S Metropolitan Areas. Urban Geography.

Jensen, J. (2007).*Remote sensing of the Environment. .* An earth Resources Perspective (2nd Edition) pg. 450, Pearson Education, Inc.

Jensen, J.R. (1996).*Introductory Digital Processing*. A remote sensing perspective (2nd Edition) N.J., Upper Saddle River, Prentice Hall.

National Population Census of Nigeria (NPC), (2006)., Federal Republic of Nigeria.

Obinna, V.C., Owei, O.B. and M. Okwakpam, I.O. (2010). Impacts of Urbanization on The Indigenous Enclaves of Port Harcourt and Concomitant Policy Measure. In The *Social Sciences*. 5[3].

Ogionwo, W. (1979).*A Social Survey of Port Harcourt*. Ibadan. Heinemann Educational Books Nigeria, Limited, 273.

Pickett STA, Burch WR Jr, Dalton SD, Foresman TW. 1997. Integrated urban ecosystem research. *Urban Ecosyst.* 1:183–84

Pijanowski, B.C., D. Brown, B. Shellito and G. Manik. (2002). Using neural networks and GIS

to forecast land use changes: A Land Transformation Model. Computers, Environment and

Urban Systems.26(6).Rivers State Ministry of Urban Development and Physical Planning (2013)

Theobald, D.M. and Hobbs, N.T., (1998). Forecasting rural land use change: a comparison of regression and spatial-transition models. George. Environ. Model. 2, 57–74.

White, R. and G. Engelen**.** (2000). High-resolution integrated modelling of the spatial dynamics

of urban and regional systems.*Computers, Environment and Urban Systems* 24:383-400.

Zhou, G., and A. M. Liebhold. (1995). Forecasting the spatial dynamics of gypsy moth outbreaks using cellular transition models. *Landscape Ecology*10:177-189.