LATVIA UNIVERSITY OF LIFE SCIENCES AND TECHNOLOGIES

UNIVERSITY OF WARMIA AND MAZURY IN OLSZTYN (Poland)

VYTAUTAS MAGNUS UNIVERSITY (Lithuania)

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FOREWORD

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The journal includes original articles on land administration, land management, real property cadastre, land use, rural development, geodesy and cartography, remote sensing, geoinformatics, other related fields, as well as education in land management and geodesy throughout the Baltic countries, Western and Eastern Europe and elsewhere. The journal is the first one in the Baltic countries dealing with the mentioned issues.
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CONTENT

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SPATIAL PATTERN OF RESIDENTIAL DENSIFICATION IN HOUSING SUBMARKET OF A TRADITIONAL URBAN AREA

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Abstract
The study aimed at examining the spatial pattern of residential densification in housing submarkets of Bida, an ancient traditional town in Nigeria. The study adopted the 2015 standard residential density of Niger State Urban Development Board to determine the level of residential density and occupancy rates of the various submarkets of the town. The study also adopted primary method of data collection through the use of satellite images, handheld GPS and georeferencing of demarcated areas and the buildings, using point features and vector approach in ArcGIS environment to achieve the area coverage, number of buildings and buildings per hectare (ha) in the housing submarkets. The finding of the study reveals that in 2008 Town housing submarket has the highest area coverage, followed by the Project Quarters and then GRA, but in terms of residential density, four housing submarkets of Town, Rahmatu Dangana, Gbazhi and Wadata have high densities above the other seven submarkets. The study further reveals that in the year 2013, additional eight housing submarkets have high residential densities, GRA medium density while Eyagi and Prject Quarters had low densities respectively. It was therefore recommended that there is the need for rational densification (planned densification) for urban development in order to check the increasing unplanned residential density that reduces the green and open spaces in urban environment.
Keywords: housing submarket; residential densification; spatial pattern; traditional urban area

Introduction

Nigeria's urban population is estimated at 44% in the year 2005 with an annual growth rate of 3.7% (United Nations, 2009) and increases to 48% in the year 2014 with 4.7% annual growth rate (United Nations, 2014). With this unprecedented rates of urban population expansion since 1996, it is perhaps not surprising that the housing supply of many cities are falling (Asian Development Bank, 2012; Asian Development Bank, 2015). Estimate by UN-Habitat shows that there are eight hundred and eighty-one million people currently dwelling in slums in the cities of the developing world compared to seven hundred and ninety-two in the year 2000. By 2025, adequate and affordable housing will likely be required by another 1.6 billion. This is, however, a wake-up call to authorities, advising them to take action resolutely to allow all urban residents to have access to housing (UN-Habitat, 2015). As rapid urban agglomeration is experienced globally, building additional living apartments has to be complemented by urban gentrification and densification actions. (Lin et al., 2015).

The on-going debate over the environmental sustainability of different urban forms is both assuming a high profile and contentious. In the context of urban planning (of the Global North) the discussion however seems to be primarily focused on the issue of densification (Schmidt-Thomé et al., 2013). Several policies promote urban densification (i.e., compact city forms creation or the densification of existing cities) in order to achieve reduction in urban sprawl. Urban densification denotes upsurge in the urbanisation level of a limited area, which could have negative impact on the urban green spaces biodiversity through habitats destruction, pollutions or increase of soil temperature, fragmentation and alteration of sociospatial structure (Vergnes et al., 2014). Although, urban densification is also viewed as problem solving approach (Leffers & Ballamingie, 2013, 2013).

However, urban densification conceived as intensification of built-up area as a result of concentrated urbanisation. This has great impact on urban forms and has caused changes in the housing sector most especially the housing market. Density has a wide range of application in urban form, population studies, transport studies, residential development, commercial development, in architecture and also by a varied range of professions (Medayese et al., 2015). According to Obateru (2005) density in urban forms can be measured in various ways; residential density, population density, housing density, occupancy rate, accommodation density, bedspace density and floor space rate.

Residential density is the ratio of a population to residential land area. This measure can be further classified in terms of net and gross residential densities based on the definition of the reference area. However, there is no consensus on the definitions of net and gross areas; as they vary across cities and countries (Medayese et al., 2015). Obateru (2005) conceived residential density to be the entire built-up area of human settlement. Broitman and Koomen (2015) sees urban densification as the housing units

added within the existing urban area. Therefore, this study conceived urban densification in form of residential density growth (i.e., growth in the built-up area).

Measuring urban density has been a problem of many researchers (Ståhle, 2008). Broitman and Koomen (2015) measured residential densification using a high level detail spatial data that covers the whole of Netherland. Wang et. al. (2019) generate a land use transition of 2001 to 2011 matrix using land use maps with the aid of ArcGIS and examines the spatial and temporal urban density changes. In contrast, Jiao (2015) acquired high quality Landsat TM/ETM+ images, where the images classified using the Maximum Likelihood Classification method in ENVI 4.5. Urban densification was also measured using microclimate simulations with different models. The results are compared, and uncertainty ranges are documented by testing the impact of urban fabric on current climate (Loibl, 2019). Shahtahmassebi (2016) also developed a framework for measuring urban densification using time series of impervious surface fractions (ISFs) derived from remotely sensed imagery.

Housing submarkets are typically defined as geographic areas where the price per unit of housing quantity (defined using some index of housing characteristics) is constant (Goodman & Thibodeau, 1998). Although as an urban economic, land use and residential location model – the residential location theory (Alonso, Muth, Mills) is also applicable to housing market segmentation. Even without certain factors, segmentation of an urban area can still be carried out, if there is disparity in households' preferences and/or income with respect to accessibility and space (Kauko et al., 2002).

Although, there is agreement by several researchers on using locational and structural features to define a submarket, identifying a submarket and approach to be adopted have little consensus (Xiao, 2012). Usually, spatial and non-spatial specifications for housing submarket are the main two methods (Islam & Asami, 2009; Xiao, 2017). People's housing choice of homogenous preferences based on geographic predefined areas are enphasised by spatial specifications which is the main index (e.g. political districts, north/south, inner/outer city, and postcode districts) (Xiao, 2012).

Hitherto, several studies were conducted on housing segmentation based on spatial specification For example, McCluskey & Borst (2011) uses utilises Geographically Weighted Regression (GWR), a geostatistical modeling method to identify and demarcate the housing submarkets. Goodman & Thibodeau (1998) describes housing submarkets as a geographical area where housing price per service unit is constant and characteristics of individual housing are available for purchase. Wu & Sharma (2012) developed a methodology for submarket classification based on spatially constrained data-driven to achieve spatially integrated housing market segments. Park (2013) proposes spatial housing submarkets division basis in enhancing the housing market understanding. Manganelli et al. (2014) adopted Geographically Weighted Regression (GWR) in housing market analysis, in homogeneous areas through identification and defining a single location marginal contribution to the property's value at the housing market. Accuracy of estimation is emphasised by non-spatial submarket specifications, promoting a data driven method, without considering the pre-defined geographic area (Goodman & Thibodeau, 1995; Xiao, 2012).

These techniques are used in building the submarket emphasis on the house prices supply-side and uses housing stock characteristics (e.g., square feet of living area, dwelling type, dwelling age) to build the submarkets and/or neighbourhood characteristics (e.g., neighbourhood schools quality, local police quality). Other techniques in delineating submarket emphasis on demand-side of house prices determinants and form housing submarkets based on household incomes or other socioeconomic/demographic characteristics (Goodman & Thibodeau, 2007; Xiao et al., 2016). Both spatial and non-spatial approaches to housing market segmentation have received wide range criticism. It make scientific research complex and not simply replicated (Xiao, 2012), while non-spatial approach is said to be ambiguities in presentation for interventions of policy (Xiao, 2017).This indicates that both spatial and non-spatial approaches of housing submarket delineation cannot effectively represent true nature of the submarket.

Bida a typical traditional setting is experiencing urban densification which has attracted people from different parts of the country and consequently led to an increase in housing demand. The intensity of housing demand in the city has also resulted in increased residential densities of various housing submarkets.

Several literatures have emerged on housing submarket (for example, Royuela Mora & Vargas, 2007; Park, 2013; Manganelli, Pontrandolfi, Azzato, & Murgante, 2014), very little is written on delineation of housing market (for example, Wu & Sharma, 2012; Manganelli *et al.*, 2014). Wu & Sharma (2012) classified housing submarket by developing a spatially constrained data-driven methodology to segment the housing market. Specifically, the model based on cluster analysis and Principal Component Analysis

(PCA) was developed for housing submarket delineation. The model constitutes a number of locational attributes which were used for PCA, and also the incorporation of spatial locations of the houses into the cluster analysis. Manganelli *et al*., (2014) adopted Geographically Weighted Regression in analysing housing market, in order to identify homogeneous areas and to define housing submarkets. The studies focus on the spatial specification of housing submarket delineation which has been criticised (Xiao, 2012). However, none of these studies focus on the residential density changes in housing submarkets.

Therefore, this study focused on the spatial specification of housing submarket delineation due to the nature of data and type of investigation which is best explained using this method of housing submarket classification. It is on this premise this paper intends to examine the pattern of residential densification of housing submarket in Bida, Nigeria between years 2008 – 2018.

Methodology

This study is carried out in Bida town, an ancient traditional Nupe settlement in the north central Nigeria. The settlement is located on latitude 9.083N and longitude 6.017E (Fig. 1). The town is headquarters of Nupe speaking nation, which is ruled by both the Chairman of the Local Government and the Emir as the traditional ruler. The town has a total built up area of about 67.45km^2 and 255,008 inhabitants, according to the last national population figures census (Mohammed & Sulyman, 2019).

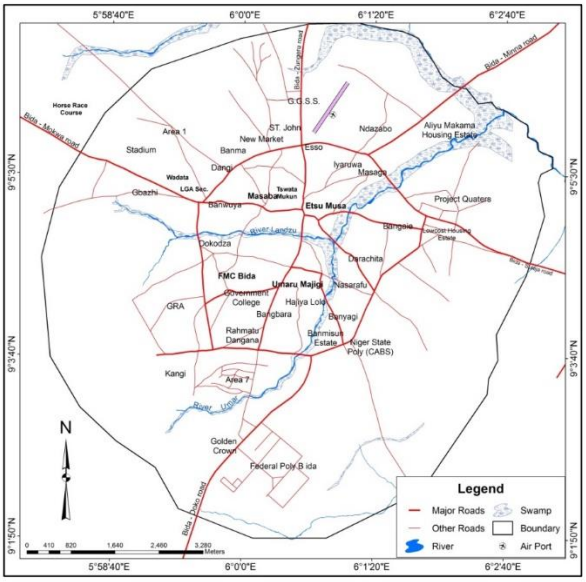

Fig. 1. Map of Bida, the Study

The housing submarket was demarcated based on the market structure by professional estate surveyors and valuers in the study area. Satellite imageries were captured for the housing submarkets using the area demarcations. For each demarcated area, three satellite imageries were captured for three different periods, i.e., 2008, 2013 and 2018 using 6 metres resolution on the Google Earth application. Images captured using area demarcation gives better resolution. The choice of Google Earth is due to its user friendly and historical images available.

Satellite images captured based on the demarcated areas were georeferenced where vector approach was adopted in digitising all the buildings using point features in ArcGIS environment for better data handling. The entire buildings for each year under study were represented by points.

This paper adopted residential density measurements by Niger State Urban Development Board (2015). Using this, residential density vis-à-vis the occupancy rates of building in a given location to give level of density, which was calculated as:

$$\text{Building occupancy rate} = \frac{Number\ of\ buildings\ in\ a\ submarket}{Total\ land\ area\ of\ the\ submarket}$$

For example, low density is between 0 – 1.49 occupancy rate, medium density is between 1.5 – 1.99 occupancy rate while high density is 2.0 and above occupancy rate (Table 1).

Table 1

Residential Density Level Measurement

Occupancy Rates	Residential Density Level
0 – 1.49	Low
1.5 – 1.99	Medium
2.0 and above	High

Source: Niger State Urban Development Board (2015)

Results

The pattern of urban densification dynamics in terms of level of residential density by housing submarkets and number of buildings and area coverage by housing submarkets is discussed in this section. This was achieved by measuring the total area of the housing submarkets, number of buildings in the housing submarkets and buildings per hectare (ha) in the housing submarket. It was found out that Town housing submarket have highest area coverage with 1,214.97ha. This is followed by Project Quarters with 984.31ha; Poly Area and GRA have area coverage of 823.13ha and 800.08ha respectively (Table 1, 2 and 3).

Table 2

Residential Density Level and Building Units Per Hectares by Housing Submarkets 2008

Submarket	Area Coverage (Ha)	No. of Buildings	Occupancy Rate	Density Level
Kangi	457.52	661	1.44	Low Density
Rahmatu Dangana	14.5	83	5.72	High Density
Town	1214.97	25945	21.35	High Density
Poly Area	823.13	787	0.96	Low Density
Eyagi	725.34	165	0.23	Low Density
Gbazhi	215.81	489	2.27	High Density
Wadata	398.51	1020	2.56	High Density
Avenue	417.08	524	1.26	Low Density
Ndazabo	692.99	605	0.87	Low Density
Project Qtrs	984.31	358	0.36	Low Density
GRA	800.08	773	0.97	Low Density

Source: Authors' field survey, 2019

Residential density is measured by the residential development within the housing submarkets. The study revealed in Fig. 2 that in the year 2008 four housing submarkets i.e., Town, Rahmatu Dangana, Gbazhi and Wadata each are of high residential density respectively, where the remaining seven submarkets are of low residential densities in that year. The implication of this result is that residential density pattern was classified in to two – i.e. low residential densities and high residential densities for the year 2008.

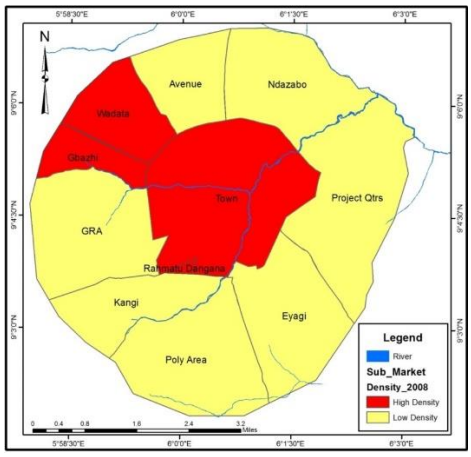

Fig. 2. Level of Residential Density by Housing Submarkets in the Year 2008
Source: Authors' field survey, 2019

This implies that people live in the Town housing submarket than any other submarkets in the study area. The Town housing submarket is also the traditional city centre where major commercial and cultural activities take place. The result also implies that Rahmatu Dangana with smallest area coverage is highly developed.

Table 3

Residential Density Level and Building Units Per Hectares by Housing Submarkets 2013

Submarket	Area Coverage (Ha)	No. of Buildings	Occupancy Rate	Density Level
Kangi	457.52	1103	2.41	High Density
Rahmatu Dangana	14.5	132	9.10	High Density
Town	1214.97	34242	28.18	High Density
Poly Area	823.13	1648	2.00	High Density
Eyagi	725.34	304	0.42	Low Density
Gbazhi	215.81	2077	9.62	High Density
Wadata	398.51	1707	4.28	High Density
Avenue	417.08	1283	3.08	High Density
Ndazabo	692.99	1758	2.54	High Density
Project Qtrs	984.31	793	0.81	Low Density
GRA	800.08	1442	1.80	Medium Density

Source: Authors' field survey, 2019

The result in Table 3 shows that in the year 2013 Town housing submarket had highest number of building units with 34,242. This is followed by Gbazhi with 2,077, Ndazabo 1,758, Wadata 1,707 building units respectively. During this period, the study reveals that Rahmatu Dangana had smallest number of building units. The result also shows that Town submarket recorded highest number of building to area ratio with 28.18, followed by Gbazhi with 9.62, Rahmatu Dangana 9.10 and Wadata 4.28 respectively. The lowest building to area ratio is recorded for Eyagi with 0.42.
The study further reveals in Fig. 3 that in the year 2013 eight housing submarkets have their residential densities to be high while GRA had medium residential density and Eyagi and Project Quarters had low residential densities respectively. The pattern of the residential density implies that there is tremendous shift in the residential density changes in the study area in that year.

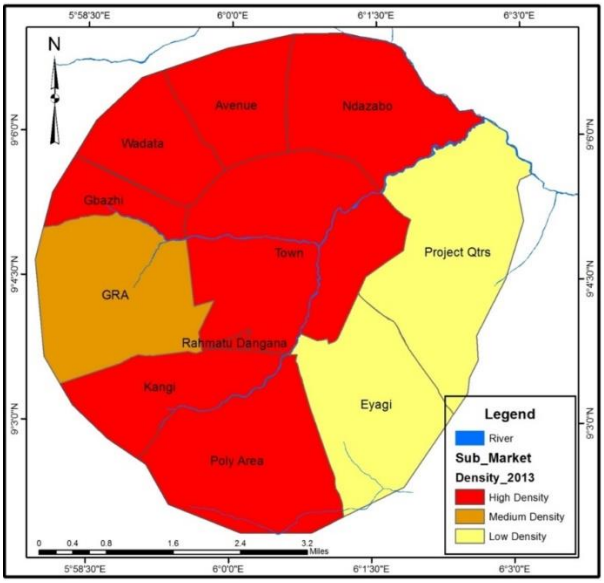

Fig. 3. Level of Residential Density by Housing Submarkets in the Year 2013

Source: Authors' field survey, 2019

The study revealed in Table 4 that in the year 2018 Town submarket had highest number of buildings with 29,985 followed by Poly Area with 2,450, Ndazabo 2,346, Gbazhi 2,331, Wadata 2,300 and Kangi 2,134 building units respectively. The lowest number of building units recorded was in Rahmatu Dangana with 124. The Table also revealed that Town submarket had highest building to area ratio with 24.68. This is followed by Gbazhi with 10.80 and Rahmatu Dangana 8.55. The lowest building to area ratio was recorded for Eyagi with 0.54.

Table 4

Residential Density Level and Building Units Per Hectares by Housing Submarkets 2018

Submarket	Area Coverage (Ha)	No. of Buildings	Occupancy Rate	Density Level
Kangi	457.52	2134	4.66	High Density
Rahmatu Dangana	14.5	124	8.55	High Density
Town	1214.97	29985	24.68	High Density
Poly Area	823.13	2450	2.98	High Density
Eyagi	725.34	393	0.54	Low Density
Gbazhi	215.81	2331	10.80	High Density
Wadata	398.51	2300	5.77	High Density
Avenue	417.08	1976	4.74	High Density
Ndazabo	692.99	2346	3.39	High Density
Project Qtrs	984.31	1466	1.49	Low Density
GRA	800.08	1889	2.36	High Density

Source: Authors' field survey, 2019

In the year 2018, urbanisation effects have a great impact on the urban form. The study in Fig. 4 shows that all the housing submarkets in the study area are of high residential densities except for Eyagi and Project Quarters who were of low residential densities respectively. This implies that there is transition from low residential density areas to high residential density areas in the study area. The entire housing market is becoming more developed as built-up areas increases in all dimensions.

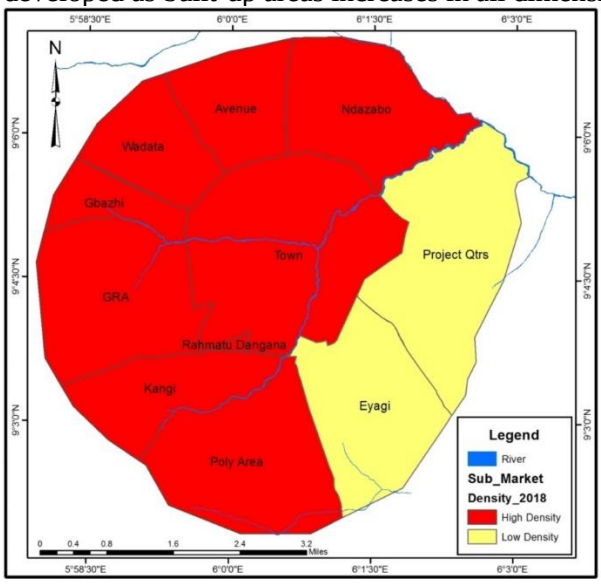

Fig. 4. Level of Residential Density by Housing Submarkets in the Year 2018

Source: Authors' field survey, 2019

The implication of this result is that transition in the urban morphology experienced tremendous changes where number of buildings in the Town submarket reduced from 34,242 in the year 2013 to 29,985 in the year 2018. This could be attributed to Bida old market razed by fire in early 2018. The result also

implies that there was high residential development in Poly Area, Ndazabo and Gbazhi submarkets during this period which may have occasioned the sudden reduction.

Discussion

It was found out that in the year 2008, Town housing submarket have highest area coverage with 1,214.97ha. This is followed by Project Quarters with 984.31ha; Poly Area and GRA have area coverage of 823.13ha and 800.08ha respectively. It also revealed that people lived in the Town housing submarket than any other submarkets in the study area in all years under review, because the Town housing submarket is the traditional city centre where major commercial and cultural activities take place. The result revealed that Rahmatu Dangana with smallest area coverage is highly developed in the year 2013. The implication of this result is that transition in the urban morphology experienced tremendous changes where number of submarkets increases from 4 (Fig. 2) to 8 (Fig 3) and subsequently to 9 (Fig. 4) with additional high residential densities due to rapid urbanisation and development of built-up areas in all dimensions, but buildings in the Town submarket reduced from 34,242 in the year 2013 to 29,985 in the year 2018. This could be attributed to Bida old market razed by fire in early 2018. The result also implies that there was high residential development in Poly Area, Ndazabo and Gbazhi submarkets during this period which may have occasioned the sudden reduction. This finding is contrary to findings of Broitman and Koomen (2019) which opines that number of housing units located within the first several hundreds of metres around the city centre is usually low as an example of typical feature of historic cities.

The study revealed that in the year 2008 four housing submarkets i.e., Town, Rahmatu Dangana, Gbazhi and Wadata are of high residential density respectively, where the remaining seven submarkets are of low residential densities in that year. Findings of this study also showed that in the year 2013 eight housing submarkets have their residential densities to be high while GRA had medium residential density and Eyagi and Project Quarters had low residential densities respectively. The study also revealed that all the housing submarkets in the study area are of high residential densities except for Eyagi and Project Quarters who were of low residential densities respectively. The study also revealed that spatial approach to housing submarket allow easy analysis of data related to housing market and submarkets such as residential densification, and related housing studies. This is because homogeneous geographic locations can easily be identified and analysed.

Conclusion

From the study, it can be concluded that the inner part of the city has higher number of buildings throughout the study period and it is the region where commercial and cultural activities are carried out. The city centre maintains consistent high number of buildings units/ha and high residential density through the years under reviewed. This study therefore concludes that there has been consistent residential development from Town submarket in the year 2008 towards the north and south in the year 2013 with additional high density housing submarkets due to rapid urbanisation and increasing built-up areas with only low density housing submarkets in Eyagi and Project Quarters in 2018, indicating an evidence for increasing uncontrolled residential densification in the study area. Hence, the unplanned densification in urban environment could have negative implications through reduce green and open spaces, on optimal land resources utilisation and urban housing market. The study therefore recommends rational densification that could deliberately curb the increasing residential densities and its attendant negative implications. The study also recommends the application of GIS and spatial approach to housing market studies, particularly, the housing submarket and related studies.

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