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FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA, NIGER STATE, NIGERIA

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SETIC 2020
INTERNATIONAL CONFERENCE

BOOK OF PROCEEDINGS

MAIN THEME:
Sustainable Housing And Land Management

📅 **3RD -5TH MAY, 2021**

📍 SCHOOL OF ENVIRONMENTAL TECHNOLOGY COMPLEX,
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School of Environmental Technology International Conference (SETIC 2020)

3RD – 5TH MAY, 2021

Federal University of Technology Minna, Niger State, Nigeria

CONFERENCE PROCEEDINGS

EDITORS IN CHIEF
R. E. Olagunju
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Proceedings of
The 3rd School of Environmental Technology International Conference
(SETIC 2020)

Published by
School of Environmental Technology,
Federal University of Technology Minna.
PMB 65, Minna,
Niger State Nigeria.

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ISBN 978-978-54580-8-4

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PREFACE

The School of Environmental Technology International Conference (SETIC 2020) is organised by School of Environmental Technology, Federal University of Technology Minna, Nigeria. In collaboration with Massey University New Zealand, Department of Civil Engineering Faculty of Civil Engineering and Built Environment Universiti Tun Hussein Onn Malaysia, Malaysia Centre For Professional Development and Industrial Project Development School of Professional and Continuing Education (SPACE) UTM-KL Malaysia, Global Academia, Department of Architecture, Faculty of Engineering and Architecture, Istanbul Gelisim University Istanbul Turkey, Sustainable Environmental and Technology (SET) Research Group, Department of Architecture, Universiti Sains Islam. The main theme for this year conference is "SUSTAINABLE HOUSING AND LAND MANAGEMENT". This promotes and encourage innovative and novelty for policy issues for inclusive and sustainable housing, access to finance for housing and land development, sustainable building materials, building cost management, sustainable and resilient cities, geoinformatics for land management, rapid urbanization, sustainable land use and spatial planning, gender issues in access to land.

The responses from participants for this conference are overwhelming, well attended, and successful. The operation mode was Virtual for all participants who choose the oral presentation mode. While, Physical for all poster medium presenters. Our participants are from various Universities and other sector across the globe, from countries like United State for America (USA), Turkey, Malaysia, China, Saudi Arabia, Kenya, New Zealand just to mention a few. Hence, this conference provides a good platform for professionals, academicians and researchers to widen their knowledge and approach on latest advances in research and innovation. Papers presented in this conference cover a wide spectrum of science, engineering and social sciences.

Finally, a note of thanks must go to SETIC 2020 Local Organizing Committee (LOC) for their remarkable dedication in making this conference a success. We hope the event will prove to be an inspiring experience to all committee members and participants.

ACKNOWLEDGEMENTS

- Dr. Said Alkali Kori, *General Manager, Projects and Portfolio management, Family Homes Fund, Federal Ministry of Finance, Abuja*;
- Ts. Dr. Sasitharan Nagapan, *Department of Civil Engineering, Faculty of Engineering and Built Environment, Universiti Turn Hussein Onn Malaysia, Malaysia*;
- Dr. Mercy Nguavese Shenge, *AIA Assoc. Historic District Commissioner, City of Rockville, MD, USA*.

for accepting to share from their knowledge, wealth of experience and be available to interact with participants on varied issues on "**Sustaining Housing and Land Management**".

As reflected on the Conference program, the Conference activities will be Virtual for power point presenters to run in four parallel sessions on the Zoon platform while the participants for Poster presentations (mostly Postgraduate students) are expected to have their Posters displayed in the Environmental Complex Building of the Federal University of Technology, Minna. With a total of One Hundred and One (101) articles captured in the Conference Proceedings covering the seven subthemes of the Conference, I have no doubt that we are all in for an impactful experience at SETIC2020 as we brainstorm, exchange ideas, share knowledge and participate in evolving more approach to sustainable housing and land management drives.

I implore us all to enjoy every moment of the deliberations and ensure we maximize the great opportunity offered by the Conference to network for better research and career development as we also make new friends.

I also on behalf of myself and the LOC express our appreciation to the Dean, School of Environmental Technology and the entire Staff of the School for giving us the opportunity to steer the ship for SETIC2020. To the Reviewers and various Committees that served with us, I say thank you for helping us through despite the pressure of work.

Thanks, and God bless you all.

Olawuyi, B.J. (PhD)
Chairman, LOC
SETIC2020

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3rd MAY 2021

TO WHOM IT APRIL CONCERN

I wish to state that all the papers published in SETIC 2018 Conference Proceedings have passed through the peer review process which involved an initial review of abstracts, blind review of full papers by minimum of two referees, forwarding of reviewers' comments to authors, submission of revised papers by authors and subsequent evaluation of submitted papers by the Scientific Committee to determine content quality.

It is the policy of the School of Environmental Technology International Conference (SETIC) that for papers to be accepted for inclusion in the conference proceedings it must have undergone the blind review process and passed the academic integrity test. All papers are only published based on the recommendation of the reviewers and the Scientific Committee of SETIC

Babatunde James OLAWUYI
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Analysis of Urban Densification and Housing Market in Bida, Niger State, Nigeria

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***Abstract**:*
This study examines pattern of urban densification as an element of urban growth and how it can provide extra spatial information explaining variances of housing market of Bida. Census sampling techniques was adopted in sampling all 31,410, 46,489 and 47,394 buildings for the years 2008, 2013 and 2018 respectively and also 138 houses managed by the 3 registered estate firms in Bida. Data were collected using Google Earth to capture satellite imageries for the years 2008, 2013 and 2018, while handheld GPS was used to take coordinates of rental houses managed by registered estate surveyors and valuers. Point Density spatial analyst tool and Ordinary Kriging (OK) was used to analyse residential density and rental prices respectively, while Artificial Neural Network (ANN) was adopted to analyse and forecast residential density and housing prices with the aid of Map Algebra tool in ArcGIS. It was found out that the pattern of densification process confirmed urban economic theory for monocentric open cities, while OK model disconfirmed Alonso's monocentric theory. The ANN model revealed that residential densities increase shall continue along the urban – rural gradient thereby causing a transition of open spaces and low density areas in to medium and high density areas in the coming years, while rental prices of housing apartments shall continue to decreases with decreasing distance to the city centre. It was therefore recommended amongst others that there is the need for rational densification for urban development in order check the increasing residential density that reduces green and open spaces.

Keywords: Urban densification, Housing market, Kriging, Artificial Neural Network,

INTRODUCTION

Access to adequate and affordable housing is a current and growing problem in developing countries (UN-Habitat, 2011). In Nigeria, like in many other developing nations of the world housing problems are multi-dimensional. The problems of population explosion, urban drift, and the inadequacy of basic infrastructure required for good standard of living have intensified housing problems over the years (Mohammed & Aremu, 2017). Access to this basic need by the poor who constitute the largest percentage of Nigeria has remained a mirage and it needs to be critically addressed. It has been observed that the disparity between the price and quantity of housing on one hand, and the number of households and the money available to them to pay these prices on the other, this is a central issue in the Nigeria housing sector (Adedeji & Olotuah, 2012).

The cost at which houses reach the market goes a long way to determine affordability. Where the unit cost of houses is abnormally high only a few people are able to afford the houses. In the Nigeria housing sector, there is a very wide gap between income and housing market. This has almost wiped out the low-income earners from the housing market (Adedeji & Olotuah, 2012). However, urban densification is one of the major hindering factors.

Urban densification is as a result of increase the level of urbanisation of a limited area which causes challenges in the housing affordability due to the increase in price of houses, high rental values, high demand and shortage in supply to meet the need of the urban residence. Bida is experiencing urban densification which has attracted people from different parts of the country

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which has consequently led to increases in housing demand. The intensity of housing demand in the city has also resulted in increased house rents.

However, a large body of literature has formed on housing market (Leung, 2004; Wu, Deng, & Liu, 2014; Muehlenbachs, Spiller, & Timmins, 2015; Muehlenbachs et al., 2015; Yang, Hu, Li, Zhang, & Torres, 2017; Tupenaite et al., 2017; Zhou, 2018; Cameron, 2018; Cheung, Wetherell, & Whitaker, 2018; Wang, Wang, & Wang, 2018). For example, Xiao (2012) studied urban morphology and housing market with emphases on street network pattern appears to be a fundamental determinant of house prices since street network pattern influences accessibility. Wang, Wang and Wang (2018) analyses the spatial patterns and driving forces of housing prices in China where multiple theoretical perspectives on housing demand, supply, and market, are combined to establish a housing price model to explore the impact of land prices on housing prices. These authors ignore housing submarkets.

Studies of urban morphology (densification specifically) in relation to the housing market are rare, due to the lack of a powerful methodology to quantify the urban form accurately (Xiao, 2017a). On this context, this paper employs conventional methods such as Artificial Neural Network, hedonic and spatial analysis methods to analyse urban density and housing market. By doing so, it attempts to make a significant contribution to urban scholarship by exploring how measured residential density associated with urban form.

However, the monocentric urban economic model (Alonso, 1964) and polycentric variants emphasize location, hypothesizing that house prices decrease with a growing distance to the CBD, but more recent studies show that distance to CBD has become less important or even insignificant, suggesting either that people no longer choose their residential location based on minimum travel cost to work or that work has significantly dispersed within cities(Xiao, 2017b). There are many literatures on housing market where few captured urban forms and housing market (Mohammed & Sulyman, 2019a). However, little have been done on urban densification and housing market.

This research shall seek to analyse urban densification and housing market of Bida and as well, assess the trends in urban densification and housing market of Bida for a period of ten years and predict future densification and housing market. Also, this study is of paramount importance because urban densification has either negative or positive impacts on the housing sector, most especially the housing market. It can therefore be stated that, the outcome of this research work would be beneficial, which shall focus on developing a methodology aimed at ensuring sustainable housing market aimed at providing affordable housing alongside proffering solution to ailing consequences of urban densification in Bida.

STUDY AREA

Bida town is a Local Government Headquarter in Niger State, located on the A124 highway (a regional road) linked Ilorin to Minna and Abuja. The LGA has an area of 1.698 km² and a population of 266,008 (NPC, 2006) with 9°05′N, 6°01′E, 9.083°N, 6.017°E, Coordinates. Bida is the second largest town in Niger State. It is located southwest of Minna, capital of Niger State, and is a dry, arid town. The major ethnic group is the Nupe. Bida is the headquarters of the Nupe Kingdom led by the Etsu Nupe. The town is known for its production of traditional crafts, notably glass and brassware. Bida is also known for its Durbar festival. It is also the home of the Federal Polytechnic, Bida (Mohammed & Sulyman, 2019b). The locational map of the study area is shown in Table 1.
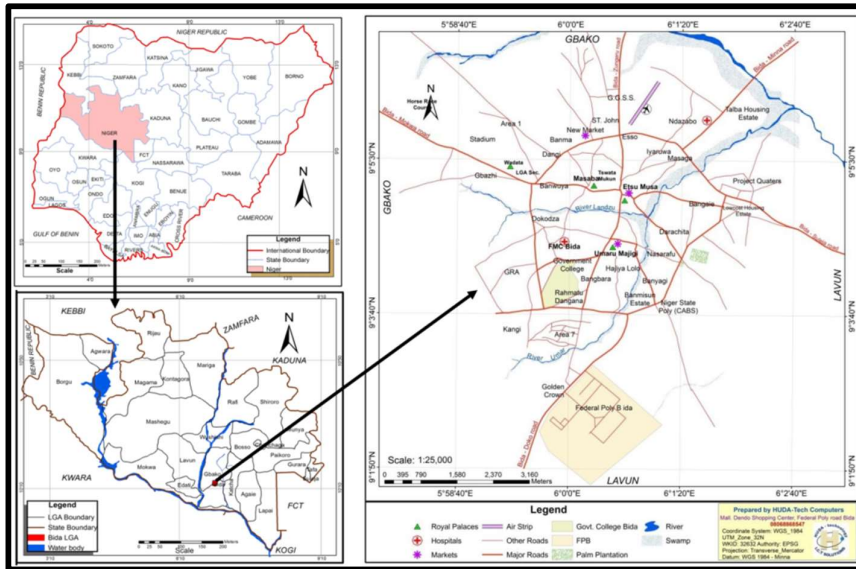
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Figure 1: Locational Map of the Study Area
Source: Niger State Ministry of Lands and Housing

METHODS

The required sample size for this research includes all building units in the entire study area which is 31,410 buildings, 46,489 buildings and 47,394 buildings for the years 2008, 2013 and 2018. Also total number of 138 houses managed by the 3 registered estate firms in Bida; Usman Maishera & Associates, Okoh Okuoma & Co. and Pat Egbeduma & Partners was sampled which includes; 60 one bedroom, 54 two bedroom and 24 three bedroom.

Data needed for this research were collected through interviews, physical observations, Satellite imageries and handheld GPS. Satellite imageries were captured to examine the residential density changes that occur within the study period. Handheld GPS was used in collecting coordinates of rental apartments managed by estate surveyors. Data on type of housing, rental value, changes that occur in the rental years, location of houses and data on rate at which rent changes in different submarkets were recorded from the estate surveyors.

Point density spatial analyst tool of ArcGIS 10.6 was used to analyse residential density of the study area for the years under study. Geo-pressing procedure produces raster files for the densities for the year 2008, 2013 and 2018. This is adopted where 'buildings within a fixed distance *d* from *i*' is calculated in ArcGIS by using the 'Point Density' tool.

The interpolation method adopted was Ordinary Kriging (OK) using Esri's ArcGIS software to automatically select the interpolation parameters of the examined data. Rental value of residential rental apartment form group of X variables and space forming Y variable was interpolated with filled contours to show areas with higher rental values for a particular year.

ANN Model and GIS

Machine learning approach using ANN was adopted to analyse the changes that occur in the residential density and housing market within the 10 years period and forecast to 10 years. The ANN learns patterns of urban densification (using density raster cell counts) and housing market (using rental value raster cell counts); this information is then saved and used to forecast change in urban densification and housing market. The projected data from ANN was computed in a model built using Raster to polygon conversion of ArcGIS 10.6 Toolbox to produce maps for projected raster cell counts for both residential densities and rental prices to 2023, 2028 and 2033 respectively.

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RESULTS AND DISCUSSION

As a result of residential densities increase along the urban – rural gradient, the observed increase in residential densities associated with the presence of restrictive spatial planning is in line with expectations from urban economic theory. However, in the study area the restrictive spatial planning is not in place. This analysis provides some empirical underpinning for city structures in line with the monocentric model. Similar pattern were observed by Broitman and Koomen (2015) who studied residential density change focussing on densification and urban expansion – that in urban development, increasing densities and number of housing units increases towards the city centre. Wang et al. (2019) find a similar importance for the growth centres in their analysis of urban densification dynamics and future modes in south-eastern Wisconsin, USA. However, it can be inferred from the research findings that residential development occurs more in areas that are rich in amenities but in the study it occurs more in the areas with less or no physical planning regulations.

Findings of this study revealed that there is unique pattern of housing prices across the study period in most part of the town. The city centre which is referred to the CBD in this study has the lowest rental value through the study period. The study also shows the differences in rental value of apartments between the CBD and other neighbourhoods which continue to widen. For example, One bedroom apartments, in the year 2008 commands rental value of around N70,000 in GRA area and in the CBD it was around N15,000 to N20,000. Ten years later, rental value for one bedroom apartment increases to around N120,000 in GRA area and N28,000 around the CBD. This result is in conformity with the result by Cichociński and Dąbrowski (2013) but contrary to findings by D'Acci (2018) whose findings shows that housing value decreases with the increasing distance from the city centre. D'Acci' findings confirms Alonso's monocentric model.

However, general pattern from the geospatial model of this study demonstrate a unique housing prices pattern for the CBD while a divergence pattern for other areas. The model shows that housing prices in the Polytechnic area increases more than other regions for all types of houses under study and throughout the study period. Consequently, the model disconfirmed Alonso's monocentric model which suggests that housing prices decreases with increasing distance to the city centre but it provides a new dimension and perspective for understanding the spatial urban structure.

Geospatial data of residential density and housing rental prices were used in the data used for the Artificial Neural Network (ANN) model. The model focused on traditional urban economic model such as Alonso who states that densities and rental values increases with decreasing distance to the CBD. The model use techniques such as data augmentation, pre-training, and sparsity which allow train a large model with a relatively small dataset. The raster data sets were reclassed in equal specification as earlier explained in the methodology. The output of the model include was forecast data for raster class count values. However, ANN output data were used to forecast spatial morphology of residential density and housing prices. The outcome of the ANN and spatial model shows in Figure 2 that residential density of the study area shall continue increasing in the nearest future and shall not deviate from the Alonso's monocentric model. The study also revealed that densification may occur in the urban fringes but lower than that of the CBD.

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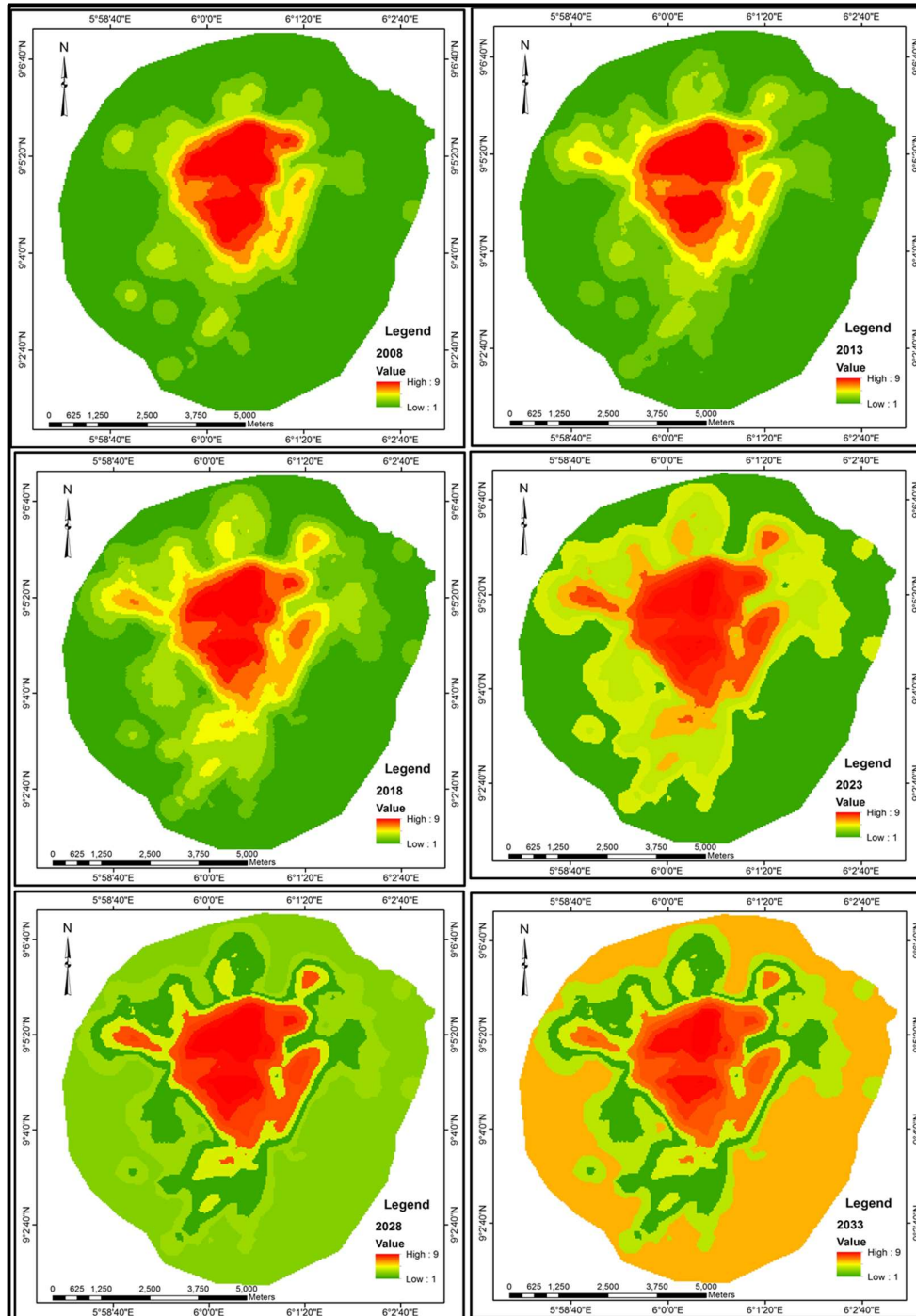
Figure 2: Forecast for Residential Density from the Year 2008 - 2033
Source: Field survey, 2019

The implication of this result is that residential densities increase shall continue along the urban – rural gradient thereby causing a transition of open spaces and low density areas in to medium and high density areas in the coming years maintaining its monocentricity. Therefore, it can be inferred that demand for housing shall increase along the urban fringes thereby attracting development of more housing apartments. But the consequential effects of this is that if there

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is no effective planning regulations that would check the uncontrolled development, the morphology of the town continue to grow in organic manner.

Also, the model suggests in Figures 3, 4 and 5 that rental prices of one bedroom, two bedroom and three bedroom apartments will maintain the trend of rents recorded between years 2008 to 2018 in the future. The geospatial model of rental prices earlier explained shows deviation from the traditional urban economic theory such as monocentric model of Alonso. The model therefore suggests that the trend shall continue in the nearest future against monocentricity.
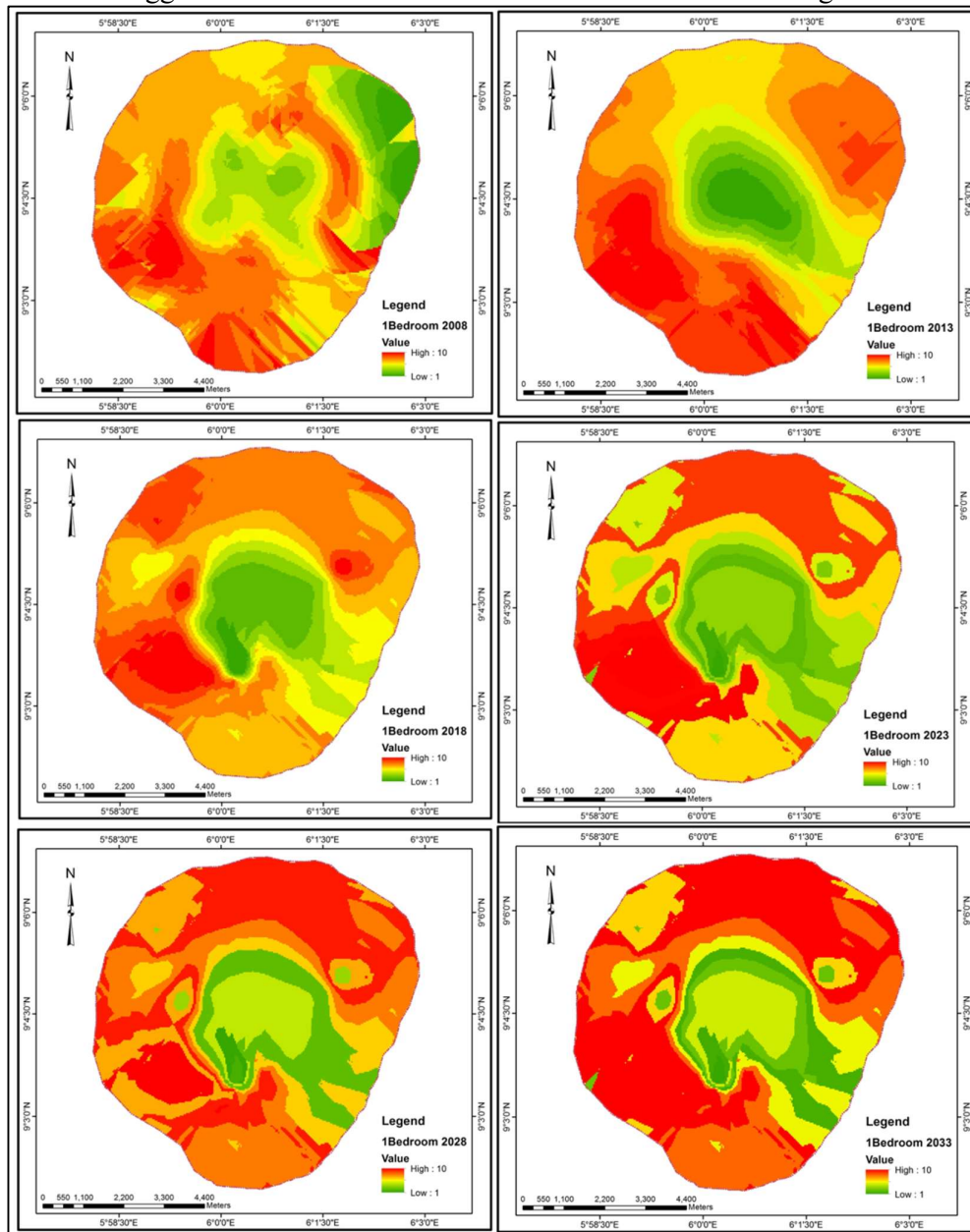
Figure 3: Forecast for One Bedroom Rental Prices
Source: Field survey, 2019

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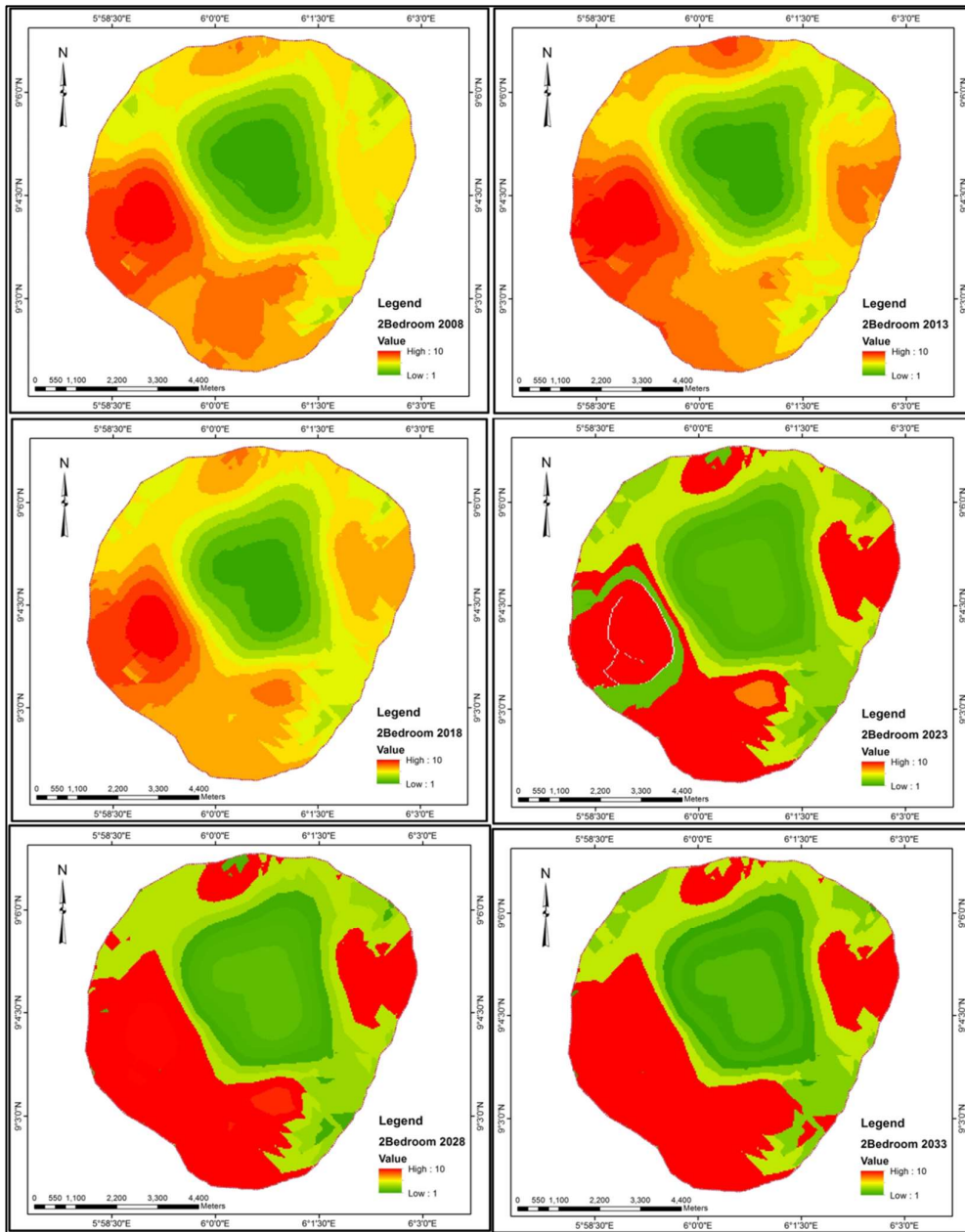
Figure 4: Forecast for Two Bedroom Rental Prices
Source: Field survey, 2019

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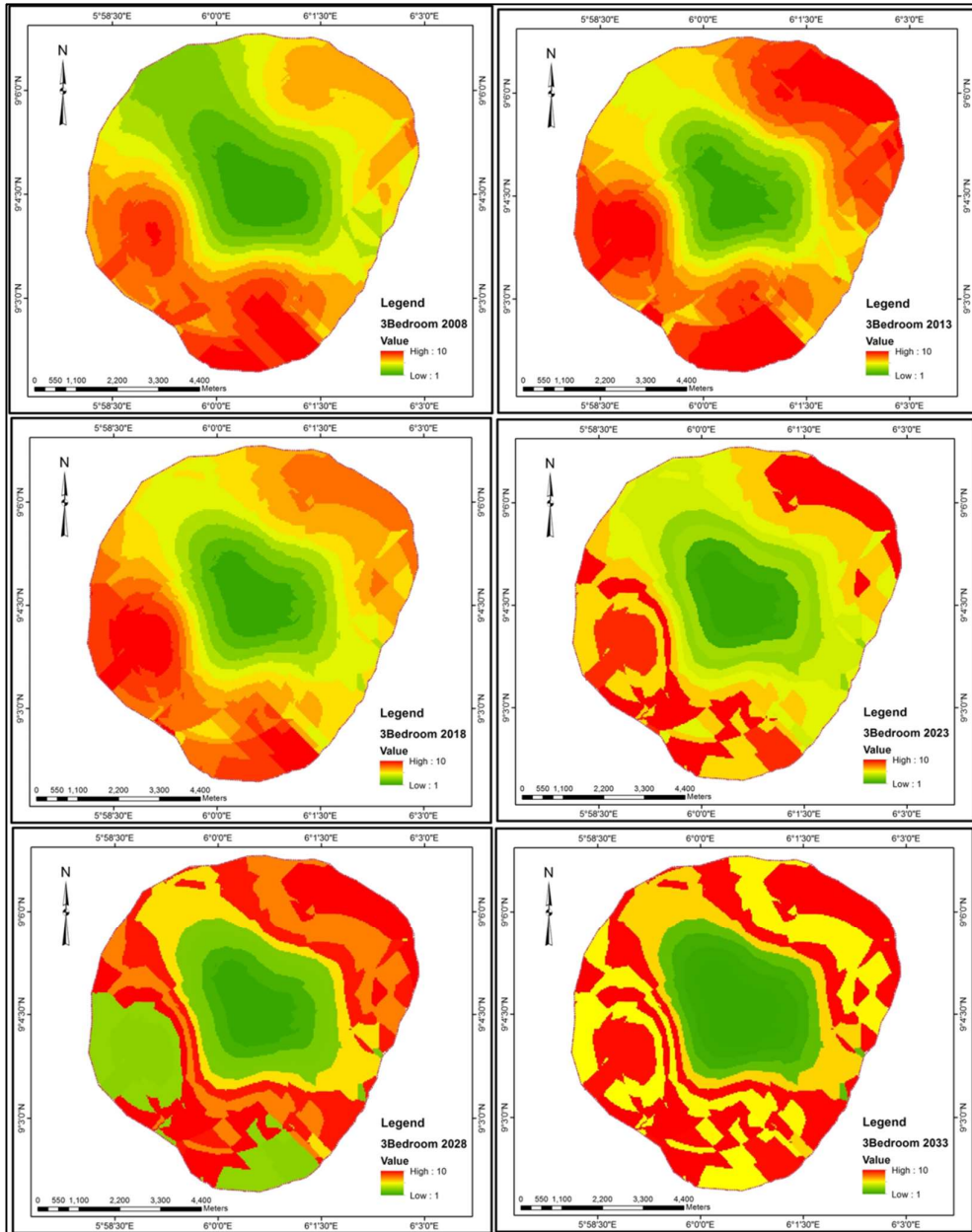
Figure 5: Forecast for Three Bedroom Rental Prices
Source: Field survey, 2019

This result implies that the Alonso's monocentric model as earlier disconfirmed in terms of rental prices shall continue in the future. Therefore rental prices of housing apartments shall continue to decreases with decreasing distance to the city centre. This also implies that this new dimension and perspective for understanding the spatial urban structure is how the study area would look like in the coming years.

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CONCLUSIONS

From the study, the residential densities increase along the urban – rural gradient was observed which is in line with urban economic theory, though restrictive spatial planning is not in place. The study area depicted trends in the polycentric urban morphology contrary to urban spatial structure of the monocentric housing market. However, general pattern from the geospatial model of this study demonstrate a unique housing prices for the CBD while a divergence pattern for other areas. This study further demonstrate the benefits associated with the use of GIS technology in housing research and the benefits obtained by modelling the spatial as well as the temporal dependence of housing price data. The residential densities increase shall continue along the urban – rural gradient thereby causing a transition of open spaces and low density areas in to medium and high density areas in the coming years maintaining its monocentricity. Therefore, demand for housing shall increase along the urban fringes thereby attracting development of more housing apartments. Also, the rental prices of housing apartments shall continue to decrease with decreasing distance to the city centre, and may continue to maintain its unique spatial pattern of housing prices in the coming years.

In line with the implication of findings of this research, recommendations are: that with increasing residential density and reducing green and open spaces it could have negative implications on the environment, hence the need for rational densification in urban development; need for the use of Machine Learning techniques such as Artificial Neural Network (ANN) in examining housing related issues such as density, housing demand and other related issues; need for the use of geospatial techniques such as Ordinary Kriging in modelling housing management studies, particularly, trends in the housing market.

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