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## A GIS BASED ASSESSMENT OF THE RELATIONSHIP BETWEEN HOUSING CONDITIONS AND RENTAL VALUE IN GOVERNMENT BUILT HOUSING ESTATES IN MINNA

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### Abstract

Housing management decisions require consideration of location and space. There is a constant need for more technology and training in the industry and Geographic Information System (GIS) is not known to have been used in tackling the problems of housing conditions and related problems in Minna. This study examines the relationship between housing conditions and rental value of selected housing estates in Minna with the aid of GIS. Census sample technique was adopted where all the houses in the housing estates were sampled. Satellite images of M.I. Wushishi Housing Estate, Bosso Estate and Oduoye Housing Estate were geo-referenced and maps were produced for various analysis. Conventional geo-database was created for conditions of houses in the housing estates and from it geo-statistical analyses was carried out which produce kriging and spatial autocorrelation analysis. In addition, correlation analysis was used to analyse the impact of building conditions on rental value. It was found out among others that building conditions has weak relationship with rental values in the housing estates. It was therefore recommended amidst others that Geo-statistical tools should be an instrument for measuring and monitoring of residential property development.

**Keywords:** building condition, rental value, GIS, Kriging analysis, ArcGIS 10.

### INTRODUCTION

Geographical Information System (GIS) potentially plays an important role in real estate research. Particularly, in the areas of spatial interaction models (Haynes & Fotheringham, 1984) and spatial diffusion models (Morrill et al, 1988). Spatial interaction models, which are often referred to as gravity models, forecast traffic flow, store patronage, and shopping center revenue and may be used to identify optimal site locations. Clapp and Rodriguez (1995) illustrate how real estate market analysis can be improved using GIS. Spatial diffusion models study the spread of a phenomenon over space and time. These are used to forecast the timing and characteristics of new development, the growth or decay of neighborhoods, population movement and absorption rates. GIS technology permits the study of location to be easily factored into the explanation of various phenomena (DeMers, 2000).

In particular, GIS software is ideal for examining the spatial component of real estate. With GIS, real estate data can easily be disaggregated according to existing spatial market segments (Nuhu 2009; Nuhu, 2011). Readily available boundary files (such as line segments that inscribe census tracts, census block groups, towns, counties, states, and other areas) can be joined together to define a market area. Market segments can also be described with a GIS according to any desired shape. However, such spatial segmentation is difficult to accomplish without a spatial database. GIS technology can be used to produce an unlimited number of variables that can be applied to a variety of real estate analyses. GIS supports spatial analysis in the same way that statistical packages support statistical analysis. (Mauricio et al, 1995).

However, the Estate Surveyors and Valuers in Nigeria are not too familiar with the use of GIS in research such researchers revolves around a particular research without getting in to current technological tool that can solve problems faster and more accurate. In addition, there is a constant need for more technology and training in the industry.

This paper is therefore aimed at assessing the relationship between housing conditions and rental value of selected housing estates in Minna using a GIS software by identifying types of tenure structures in Bosso estate, M.I. Wushishi estate and Oduoye housing estate using broad mapping analysis and determine the relationship between building conditions and rental value of the selected housing estates.

### LOCATION OF THE STUDY AREA

Minna, the capital of Niger State lies on latitude 9°33' N and longitude 6°33' E; the State is bordered to the North by Zamfara State, Northwest by Kebbi State, South by Kogi State, Southwest by both Kwara and Kaduna States, while the Federal Capital Territory, Abuja borders the State to both its Northeast and Southwest respectively. Minna is surrounded by Bosso Local Government Area and it lies within the central region of Nigeria known as the Middle Belt region, which is marked by the raining and dry seasons. The rainy season is brought about by the tropical marine air mass i.e. south west trade wind and it last between 190-200 days. The mean annual rainfall of Minna is 1334mm with August and September recording the highest rainfall of an average of 300mm. The highest average monthly temperature is in March at about 30°C and the lowest is in August at about 22°C. The dry (harmattan) season is brought about by tropical continental air mass (north east trade wind) and it last from October/November to March/April every year (NSMI&C, 2004).

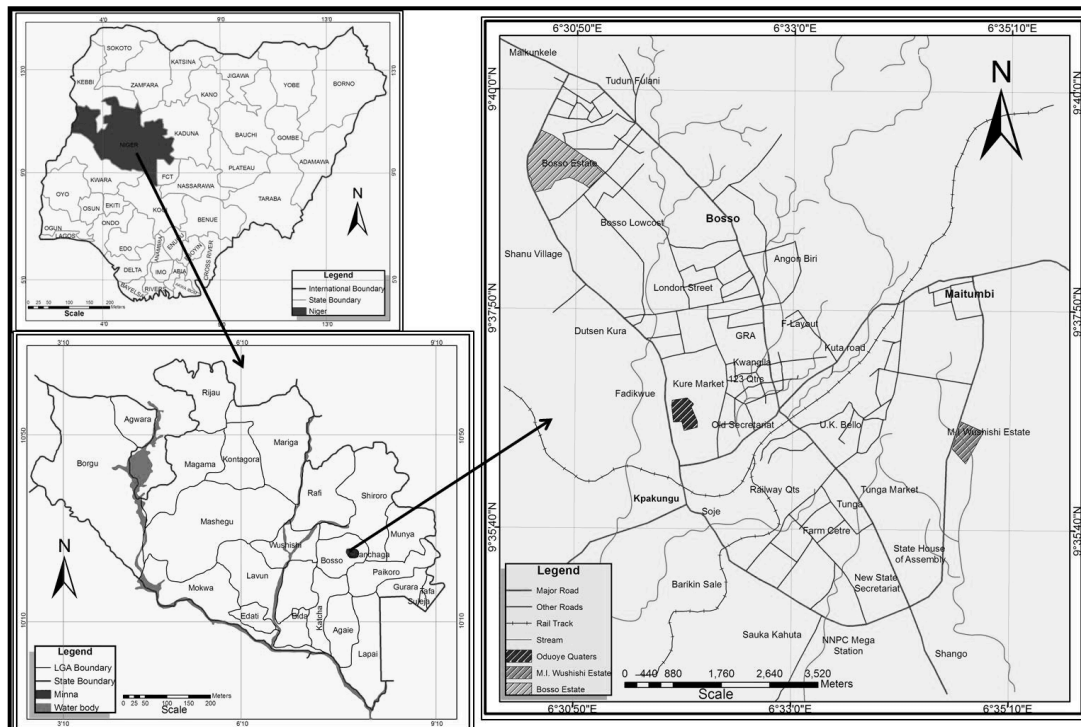


Figure 1: Map of Nigeria showing location of Minna and study areas.

### METHODOLOGY

Census sample technique was adopted where all the houses in the housing estates were sampled. Data needed for this study was collected through questionnaires, Interview, Satellite Image and Hand-held GPS.

**Satellite Image:** Satellite images were captured using Google Earth application. Recent satellite images of Bosso Estate, Oduoye Quarters and M.I. Wushishi Housing Estate were taken separately.

**Hand-Held GPS:** The position of the housing estates in terms of X and Y coordinates were taken using hand-held GPS before on-screen digitization in order to provide spatial information about the position of the study area. The coordinates were taken using the Universal Transverse Mercator (UTM).

**Image Geo-referencing:** Satellite images were loaded into ArcGIS environment, the data were duly Georeferenced since they are spatial. They were registered to conform to UTM (Universal Transverse Mercator) coordinates system with a sigma of 0.677 pixels. Coordinates of various established control points was recorded during the field mapping exercise, using the GPS handheld receiver was configured and projected to Universal Transverse Mercator (UTM) Zone 32N, using WGS 1984 with Minna as the Datum. From the above information the coordinates for the images were determined.

**Pearson Product Moment Correlation:** Pearson product-moment correlation coefficient, also known as  $r$ ,  $R$ , or Pearson's  $r$ , a measure of the strength and direction of the linear relationship between two variables that is defined as the (sample) covariance of the variables divided by the product of their (sample) standard deviations.

**Kriging Analysis and Spatial Autocorrelation:** Kriging has for many decades been used as a synonym for geostatistical interpolation. It originated in the mining industry in the early 1950's as a means of improving ore reserve estimation. The original idea came from the mining engineers D. G. Krige and the statistician H. S. Sichel. The technique was first published in Krige (1951), but it took almost a decade until a French mathematician G. Matheron derived the formulas and basically established the whole field of linear geostatistics (Webster and Oliver, 2001; Zhou et al., 2007). A standard version of kriging is called Ordinary Kriging (OK).

## RESULTS

### Spatial Distribution of Housing Tenure Structure in the Housing Estates

The study revealed that most of the houses in the housing estates were occupied by the owners (see Figure 2 – 4).

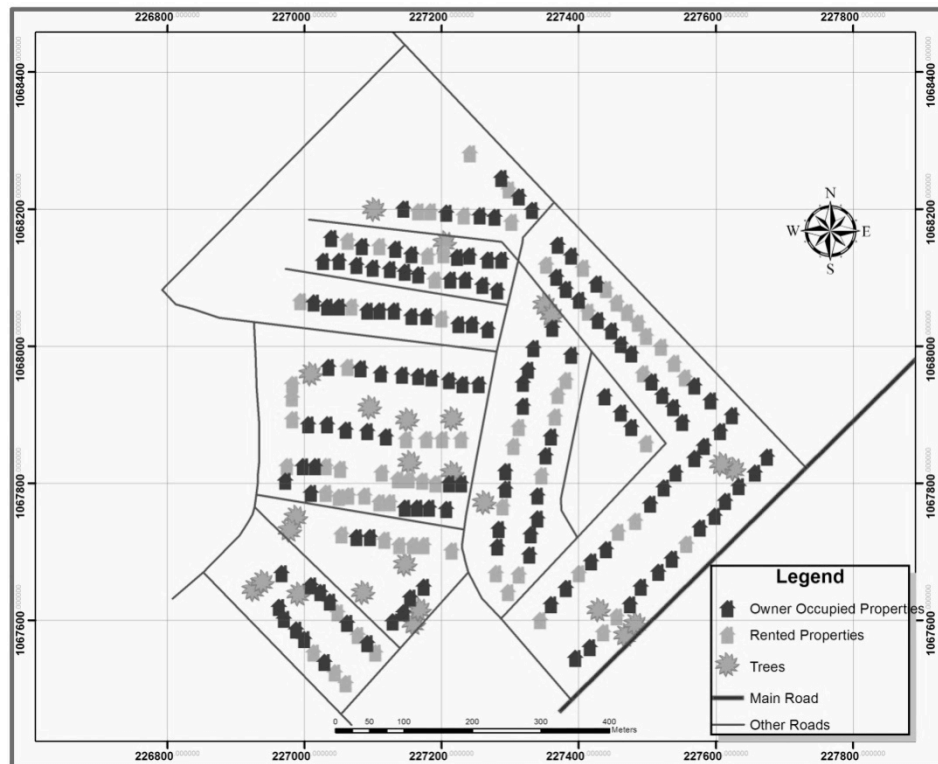


Figure 2: Tenure Structure of Bosso Housing Estate

Figure 2 shows spatial distribution of tenure structure of properties in Bosso Estate. The result revealed that there are 136 (63%) owner occupied properties spatially distributed in Bosso Estate while 79 (37%) rented houses are spatially distributed in Bosso Estate.

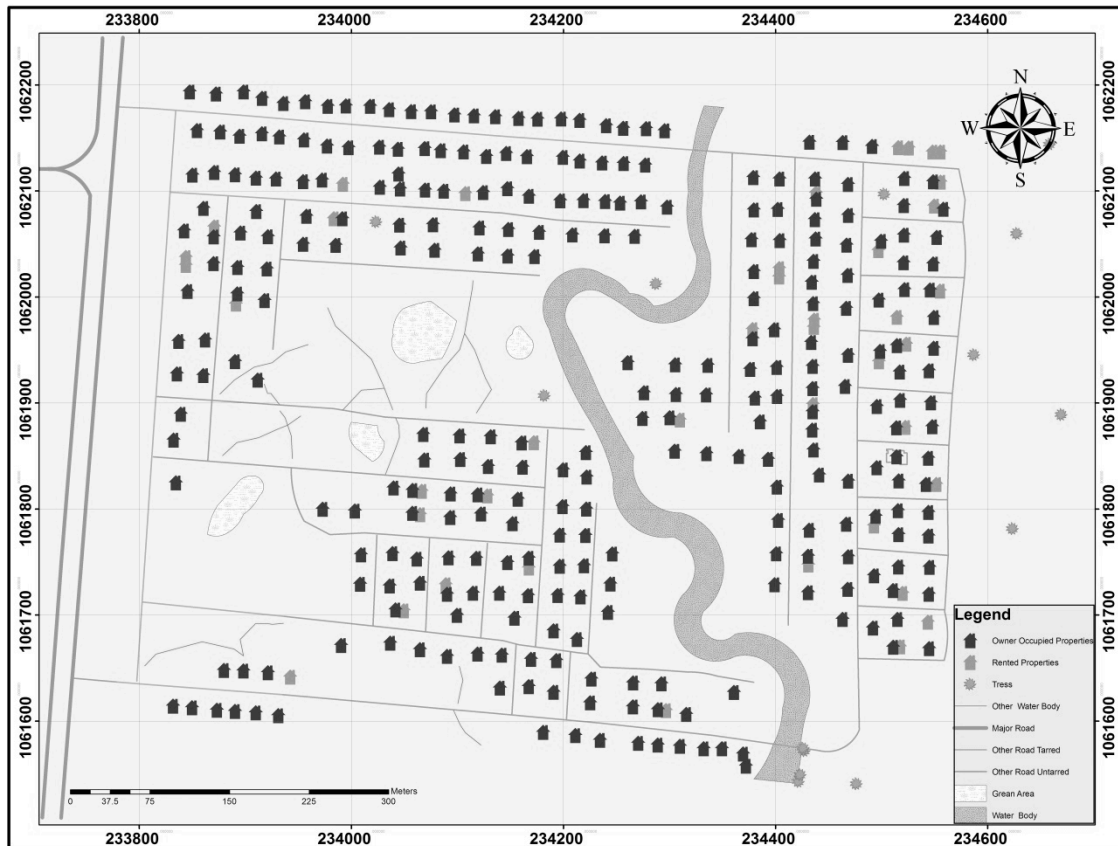


Figure 3: Tenure Structure of M. I. Wushishi Housing Estate

Figure 3 shows spatial distribution of tenure structure of properties in M. I. Wushishi Housing Estate. The study revealed that there are 398 (79.6%) owner occupied properties spatially distributed in M. I. Wushishi Housing Estate while 102 (20.4%) rented properties are spatially distributed in M. I. Wushishi Housing Estate.

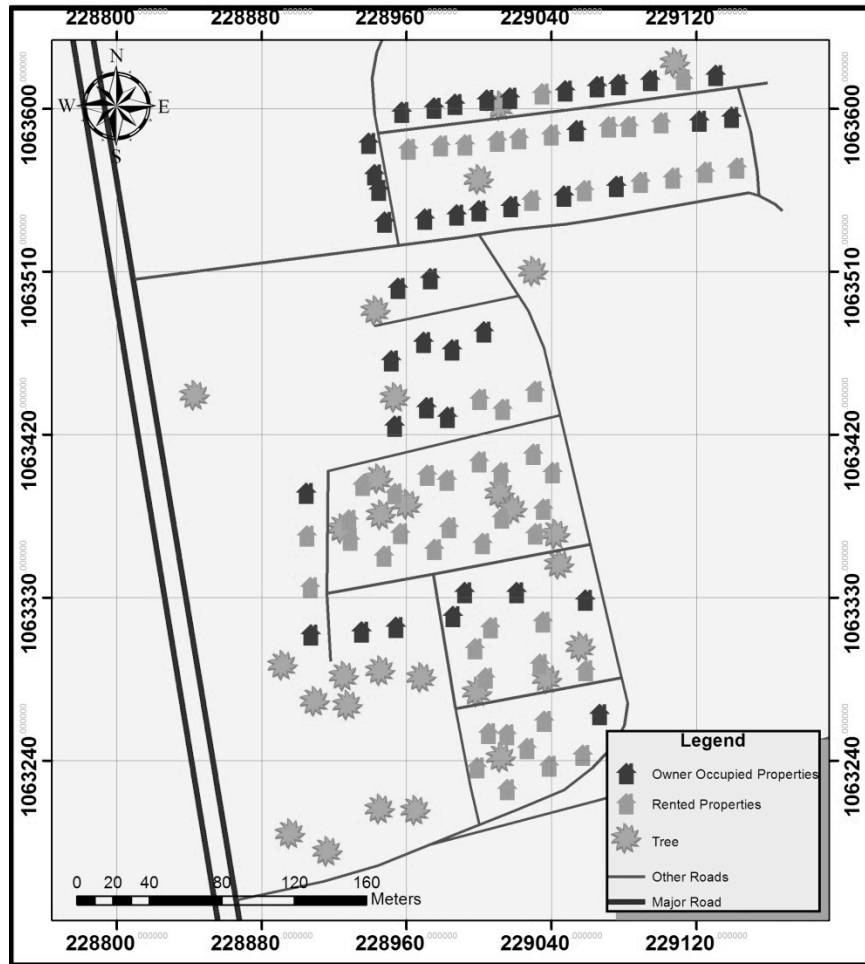


Figure 4: Tenure Structure of Oduoye Quarters

From Figure 4 spatial distribution of tenure structure of properties in Oduoye Quarters are shown. The study revealed that there are 41 (43.2%) owner occupied properties spatially distributed in Oduoye Quarters which is less than the rented properties. The study revealed that there are 54 (56.8%) rented properties spatially distributed in Oduoye Quarters.

#### Correlation of Building Conditions and Rental Value

Pearson's  $r$  is used for the correlation between the building condition and rental value for the housing estates. The correlation between the building condition and rental value variables is -0.235, 0.110 and -0.049 for Bosso estate, M. I. Wushishi housing estate and Oduoye quarters respectively.

Table 1: correlations of rental value and building condition in the study area

		Study Areas					
		Bosso Estate		M. I. Wushishi Estate		Oduoye Quarters	
Rental Value	Pearson Correlation	1	-0.235	1	0.110	1	0.49
	Sig (2-tailed)				0.014		0.633
	N	78	0.03878	500	500	97	97
Mean Value	Pearson Correlation	-0.235	1	0.110	1	-0.049	1
	Sig (2-tailed)	-0.038		0.014		0.633	
	N	78	78	500	500	97	97
*Correlation is sig at 0.05 Level		(2-tailed)					

Table 1 revealed that the Pearson's  $r$  for the correlation between the building condition and rental value variables is -0.235 for Bosso Estate. This means that changes in building conditions in Bosso Estate are strongly correlated with changes in the rental value. The empirical analysis result is that Pearson's  $r$  is -0.235. This number is not close to 1. For this reason, we can conclude that there is a weak relationship between building condition and rental value. However, we cannot make any other conclusions about this relationship, based on this number.

Table 1 also showed that the Pearson's  $r$  for the correlation between the building condition and rental value variables is 0.110 for M. I. Wushishi housing estate. This means that changes in building conditions in Wushishi housing estate are strongly correlated with changes in the rental value. The empirical analysis result is that Pearson's  $r$  is 0.110. This number is not close to 1. For this reason, we can conclude that there is a weak relationship between building condition and rental value. However, we cannot make any other conclusions about this relationship, based on this number.

It is also shown in Table 1 that the Pearson's  $r$  for the correlation between the building condition and rental value variables is -0.049 for Oduoye Quarters. This means that changes in building conditions in Oduoye Quarters are lightly correlated with changes in the rental value. The empirical analysis result is that Pearson's  $r$  is -0.049. This number is not close to 1. For this reason, we can conclude that there is a weak relationship between building condition and rental value. However, we cannot make any other conclusions about this relationship, based on this number.

### Kriging and Spatial Auto-Correlation Analysis

In order to depict structural and spatial patterns relation between building conditions and rental values in the housing estates, weighted scores for each area were entered into geo-database. These geo-statistical results are then indicated geographically in Figures 5 to 10. The essence of this approach is to examine the performance of each area with respect to relationship between building conditions and rental values in respect to space.



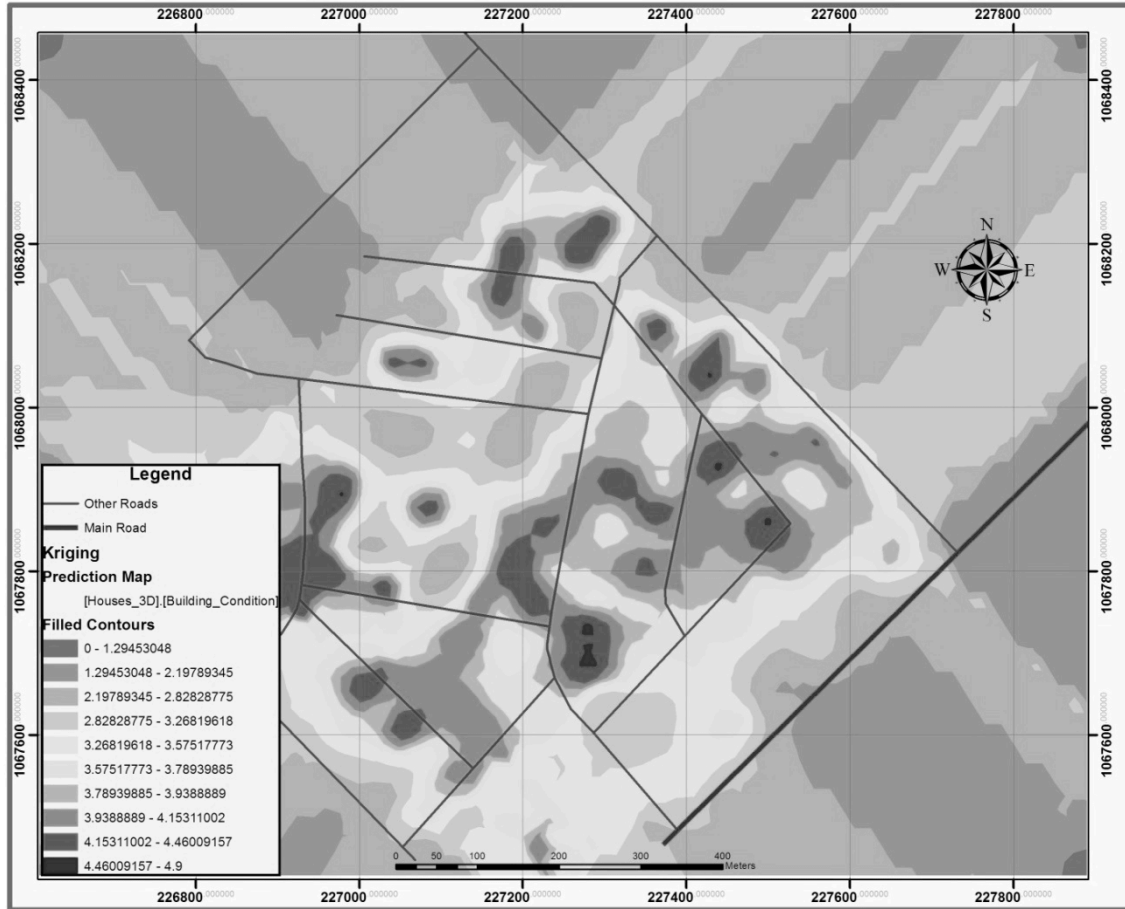


Figure 5: Kriging of Building Conditions for Bosso Estate

Spatial result shown in Figure 5 indicate that houses that are located within the filled contours value of 4.4 – 4.9 are better in terms of their conditions were as those that are located within the range of 0 – 1.2 filled contour value are poor in terms of their conditions.

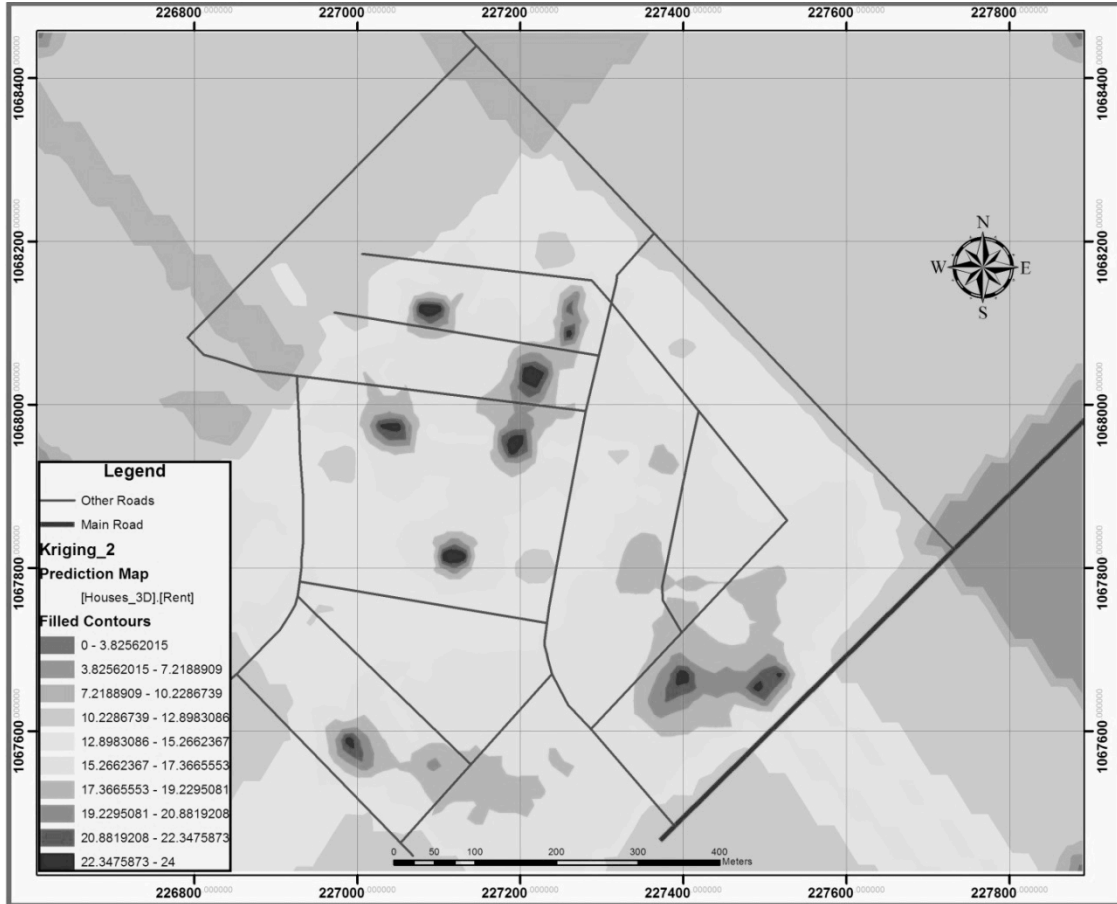


Figure 6: Kriging of Rental Value for Bosso Estate

Figure 6 revealed that houses that are located within the range of filled contour value of 22.3 – 24 command highest rent in Bosso estate likewise those houses that are located within the range of filled contour value of 0 – 3.8 command lowest rental value.

Comparing Figure 5 and Figure 6, it can be visualized that there is no strong relationship between the areas with highest rental value and those with the better building conditions. This spatial analysis is in conformity with the correlation analysis earlier explained.



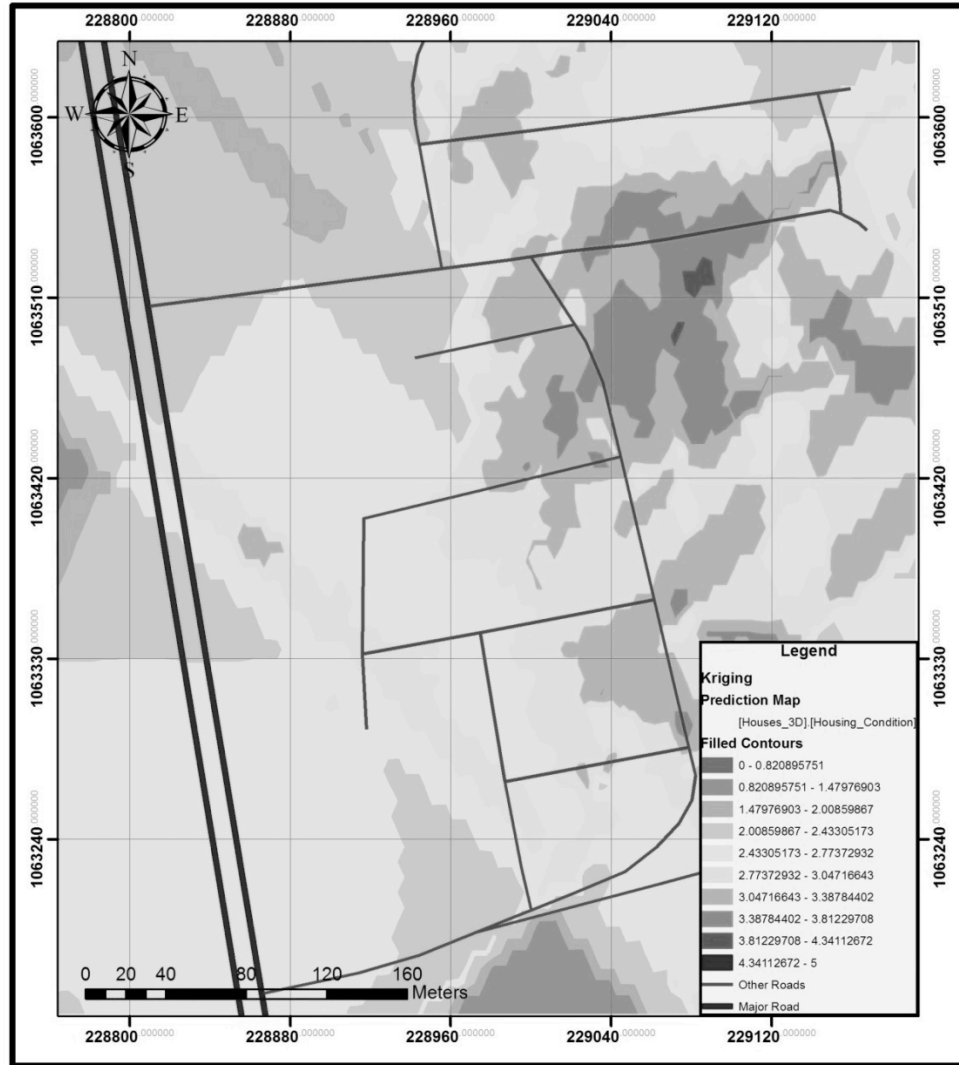


Figure 7: Kriging of Building Conditions for Oduoye Quarters

Spatial result presented in Figure 7 indicates that houses that are located within the filled contours value of 4.3 – 5 are better in terms of their conditions where as those that are located within the range of 0 – 0.8 filled contour value are poor in terms of their conditions.

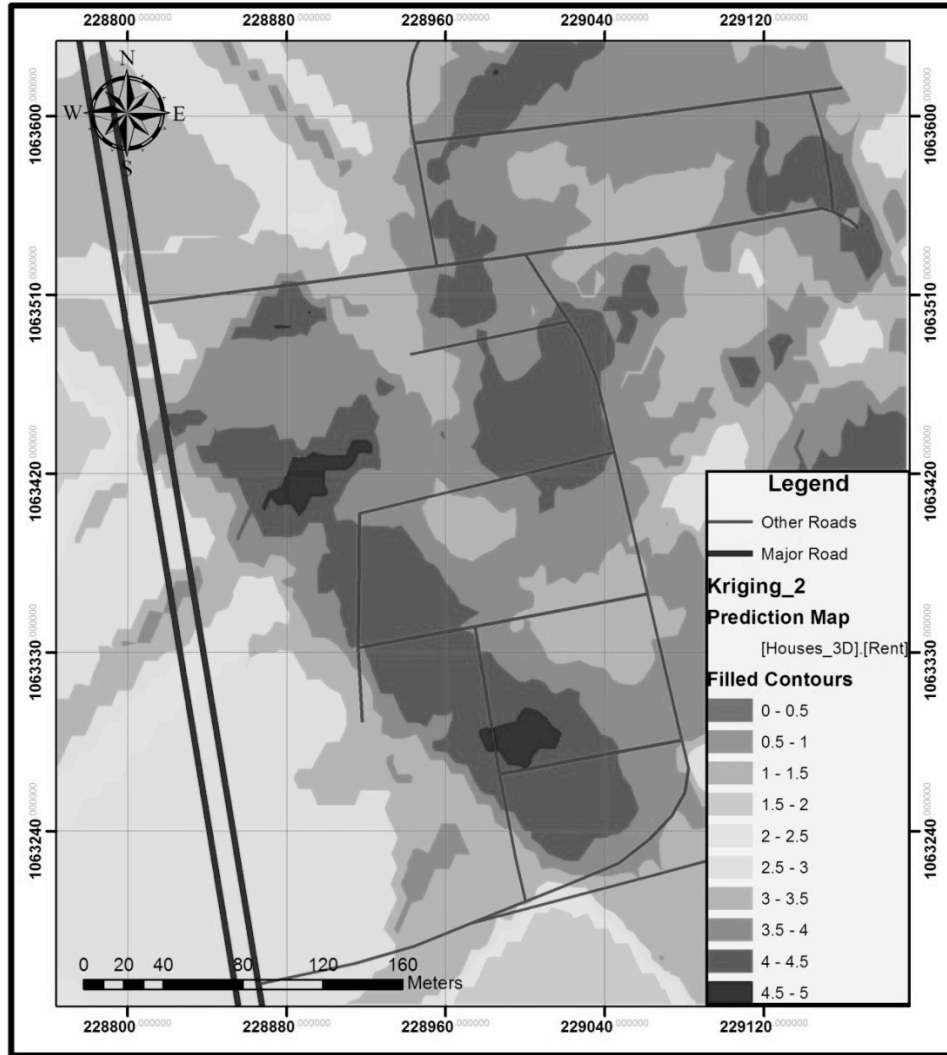


Figure 8: Kriging of Rental Value for Oduoye Quarters

Figure 8 revealed that houses that are located within the range of filled contour value of 4.5 – 5 command highest rent in Oduoye Quarters likewise those houses that are located within the range of filled contour value of 0 – 0.5 command lowest rental value.

Comparing Figure 7 and Figure 8, it can be visualized that there is not strong relationship between the areas with highest rental value and those with the better building conditions. This spatial analysis in conformity with the correlation analysis earlier explained.

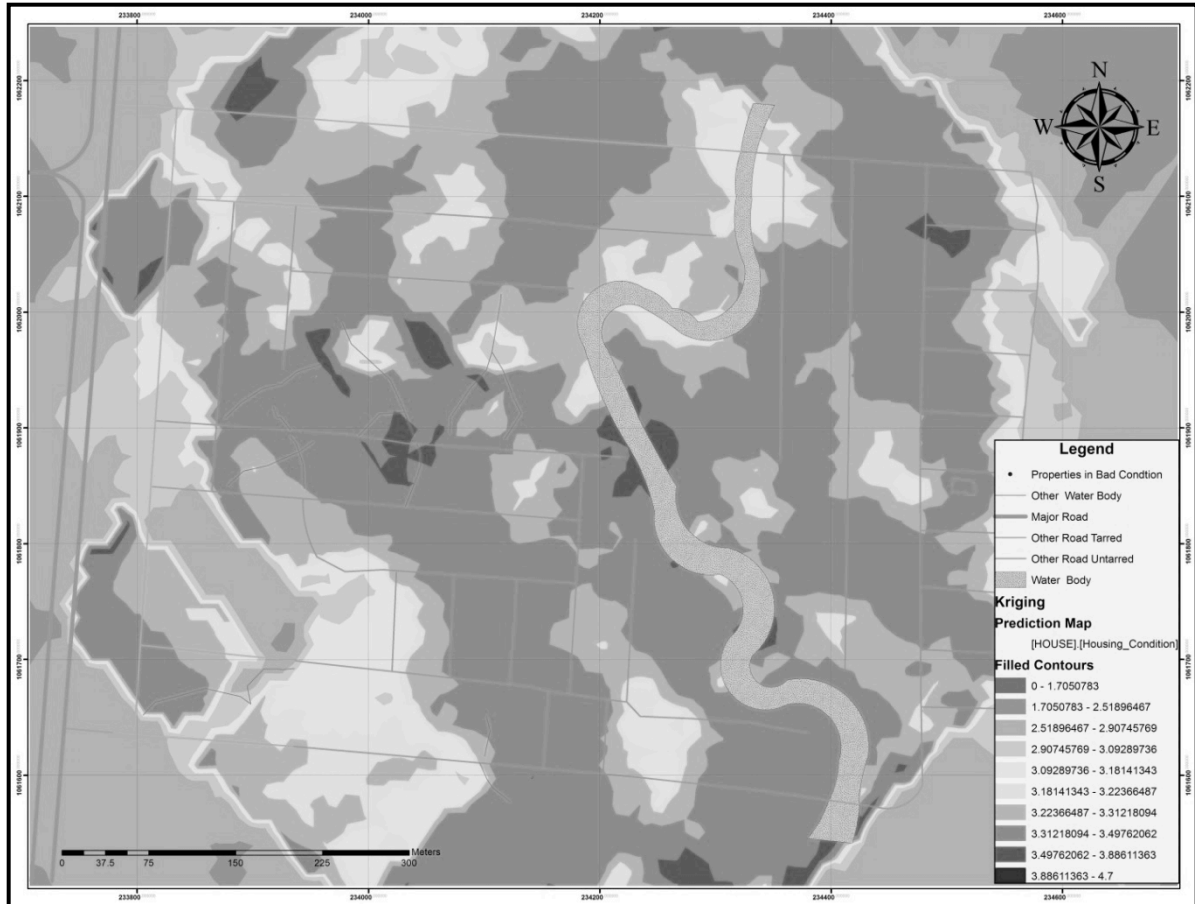


Figure 9: Kriging of Building Condition for M. I. Wushishi Housing Estate

Spatial result presented in Figure 9 indicate that houses that are located within the filled contours value of 3.8 – 4.7 are better in terms of their conditions were as those that are located within the range of 0 – 1.7 filled contour value are poor in terms of their conditions.

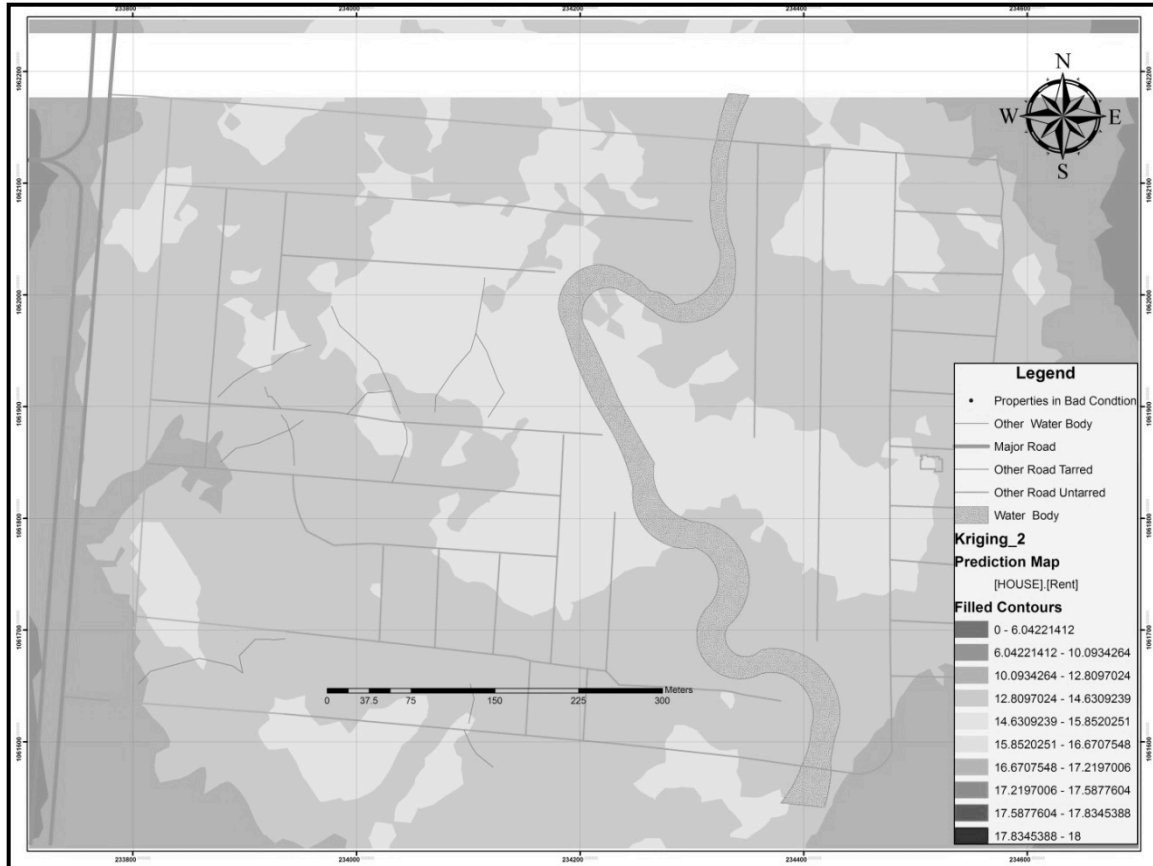


Figure 10: Kriging of Rental Value for M. I. Wushishi Housing Estate

Figure 10 revealed that houses that are located within the range of filled contour value of 17.8 – 18 command highest rent in M. I. Wushishi Housing Estate likewise those houses that are located within the range of filled contour value of 0 – 6.0 command lowest rental value.

Comparing Figure 9 and Figure 10, it can be visualized that there is not strong relationship between the areas with highest rental value and those with the better building conditions. This spatial analysis is conformity with the correlation analysis earlier explained.

## CONCLUSION

The study reveals that building conditions has weak relationship with rental values in the housing estates. The correlation between the building condition and rental value variables is -0.235, 0.110 and -0.049 for Bosso estate, M. I. Wushishi housing estate and Oduoye quarters respectively. The Kriging and spatial autocorrelation analysis revealed that there is not strong relationship between the areas with highest rental value and those with the better building conditions. Therefore it cannot be concluded that the buildings with better conditions command higher rent in the housing estates.

## RECOMMENDATION

There is no doubt that GIS is a powerful tool is solving spatial and related problems. Therefore, GIS can play a better role in real estates research. Consequently, the following recommendations are put forward:

- i. That, real estate professionals are encouraged to organize seminars, workshops, conferences and public lectures on the application of GIS in real estate practice.

- ii. Geo-statistical tools should be an instrument for measuring and monitoring of residential property development.
- iii. Application of GIS in real estate research needs to be encouraged in academic environments
- iv. GIS hardware and software usage should be critically enhanced by both the government and real estate firms.

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