SPATIAL STRUCTURE OF LAND VALUES IN NAIROBI, KENYA

by

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Introduction

General Background — The City of Nairobi is situated at a point where the densely populated agricultural Central Highlands of Kenya merge into the extensive Athi Plains at just above 5,000 feet above sea level. Although founded as a Kenya-Uganda railway encampment some seventy years ago, the City has grown as a national capital to become the largest centre in the urban system of Kenya. A post-industrial and colonially-generated city, Nairobi has become the hub and core area of the country, a focal point for communication networks and the national nuclei for Kenya's economic, social and political organisations (Fig. 1).

According to the 1969 census, Nairobi's population stood at about half-million people compared with a figure of 266,795 in 1962. Of the half-million inhabitants, an overwhelming majority (83.04%) are Africans while the rest comprise Asians (13.19%) and Europeans (3.77%).

One of the prominent features of the occupation of land in Nairobi has been the separation of the races. Distinct African, Asian and European residential sectors, each with distinct environmental and amenity standards, tend to radiate from just outside the central business district toward the periphery. In the low and poorly drained Eastlands are the Africans residential areas; the Asians concentrate in the east and north-east at Eastleigh, Pangani, Parklands and Highridge; while the more elevated lands with panoramic views to the west and north-west were mainly for European residency. There are several factors that may account for such residential segregation.

In the early period of settlement, it was the colonial policy of the government to reserve certain areas for certain racial groups. Asians, for example, were excluded from the areas of the city on sanitary grounds. Although this policy was later rejected in 1923 by the British government, other effective means for retaining racial separation were applied. For instance, covenants in matters of land transactions which restricted the freedom of assigning or subletting to other persons were very common. The African who could not even afford to purchase an urban site (because of his extremely low income) was throughout the colonial period discouraged from settling in the urban area and his residence in the city was regarded as an essentially temporary phenomenon. In fact, the early urban settlement of Africans was brought about by the necessity to 'stabilize' his working life primarily for the benefit of a European colonialislist. Each ethnic group has tended to retain links with its traditional homeland and thus preventing real social integration from developing. The situation however has been gradually changing since about 1960 as more and more Africans acquire property in and around the City, as landlessness among Africans mitigate permanent urban residency, and as more European and Asian groups regard themselves as forming an integral part of the Kenyan

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1 S. S. YAHYA, The changing patterns of land use and land values in suburban Nairobi, Monograph, Department of Land Development University of Nairobi 1969.
community. But in spite of the dramatic changes which have occurred since independence (1963), the evolved residential homogeneity in three separate communities remains essentially the same – a condition that is reflected in the following account of the spatial structure of land values in a period just before Kenya’s independence.
The Underlying Theory

The development of the basic theory of urban land values and uses is normally attributed to the works of Hurd, Haig, Marshall and Alonso. The primary tenets of the theory revolve around the concept of economic rent which may be summarised as follows.

An urban activity is capable of deriving utility from a given site. The derivable utility is reflected in the amount of rent an activity is willing to pay for use of the urban site so that utility is directly related to the amount of rent. "In the long run, competition in the urban land market for the use of available sites results in the occupation of each site by the 'highest and best' use, which is the use able to derive the greatest utility from the site and which is, therefore, willing to pay most to occupy it."

The result is an orderly pattern of land uses in which rents are maximized and all activities optimally located.

One of the most important factors influencing the amount of rent paid for a site is the location of the site relative to other uses. For many commercial types of land use the most desirable locational property of an urban site is centrality. Maximum centrality occurs at the most accessible point, usually the city center, where transport routes converge. The less central, and therefore, less accessible, the site is, the greater the transport inputs incurred and the lower the returns. Assuming that site rents represent a saving in transport cost, the pattern of urban rents is essentially a function of transport cost whereby savings in transport cost can be traded off for extra rent payment to ensure the use of a particular site.

Therefore, those activities which enjoy the greatest benefits from occupying accessible locations will have greater surpluses available with which to bid for land. Consequently, sites in the urban area are not merely occupied by activities which can pay most for their use,

Purpose of the Study —. The need to study the spatial patterns of urban land values has been long recognized by many scholars including city planners. It is clear that an understanding of the patterns and processes of variations in land values is essential to an explanation of the structure of cities in guiding policy decisions directing city growth and development.

Several attempts have been made to clarify the relationships which exist among land values and other physical, social and economic variables in the city. But the majority of the articles have mainly dealt with western cities. To the author's knowledge, no detailed studies of land values have been made in any African cities. It would, therefore, appear that "the time is now ripe to extend both theory and the empirical research to the cities of the developing countries to see whether their generality extends to cases other than those for which they were devised".

Apart from the use by the Nairobi City Planners this study was originally conceived in that spirit. The primary purpose of this paper therefore, is to present some empirical findings from Nairobi in the light of western-based theories of the spatial structure of urban land values.

B. J. GARNER, op. cit.
but more specifically, by those activities which are able to derive the greatest positive transport advantages from the use of a given piece of land. When rents are viewed in this framework they will be represented by land values, which in turn can be considered as a direct reflection of differences in intra-urban accessibility. Thus, high land values will be associated with highly accessible locations and vice versa.  

It is from this sort of argument that scholars hypothesize an inverse relationship obtaining between land values and distance from city center (Fig. 2), or from any other important 'center' within the urban area — such as a shopping centre, transport depot, a school, etc. A similar hypothesis is proposed and tested in this paper for Nairobi.

Data

The most suitable data for this type of study would be perhaps market values of real state land market situation. In fact, some scholars12 have made a commendable effort in obtaining such information. But, as in some other studies13, the author found it necessary for various reasons to use the assessed values from the City Council Valuation Rolls. Firstly, the Rolls are readily accessible to the public; secondly the author was particularly interested in producing a map of land values based on all available information covering the entire city as opposed to one based on a sample; and thirdly, it was felt that assessed valuation is not too sensitive to short-run market fluctuations and somehow may reflect 'stable' conditions in the city. This last point was considered important at this time when one takes into account the panicky selling of property that dominated the market during the few years before and after Kenya's independence which had a major effect of generally very low prices for a fast sale. At the time of writing, very inflated market prices have been the trend for the last three years as a result of a 'sudden' property demand in a limited supply situation. Such a market condition was by no means exaggerated by the following local advertisement of a real-estate agent:

"The Christmas Holiday and the end of yet another year gives one time to reflect on the property market. Houses are getting very scarce, land difficult to find and rents and building costs rising every day. Why not buy a place of your own while we still have something special to offer?"  

Of course one realizes that there is some degree of subjectivity on the part of the valuer in the assessment process, but assuming that some uniform criteria are applied throughout the city, this element of subjectivity should not necessarily introduce a very serious bias in the data.

Notwithstanding those remarks, there is no doubt that a very strong correlation exists between market and assessed values such that there is a high probability that one would get essentially the same pattern and arrive at similar conclusions regardless of the measurement used.

However, one weakness in the data lies in the lack of temporal uniformity in that some sections of the city were assessed in 1959 while others in 1960 and 1961. But this element does not appear to seriously affect the analysis or its outcome. Although quite a formidable task, all the available assessed values and acreages for individual plots of varying sizes and shapes were collected. The value per acre for larger areas of the size of a block15 were calculated. These figures provided the raw material for construction of the map and subsequent analysis in this paper.

Configuration of the Value Surface

Morphologically, the spatial structure of land value surface exhibits at least three elements common to most cities.16

1. Land values reach a grand peak in the center of the city and decrease by varying gradients outward toward the periphery.

2. Land values are higher along the major traffic arteries than in the areas away from them.

3. Local peaks of higher value than the general level at a given distance from the city center occur at intersections of the major traffic routes.

An examination of Fig. 3 reveals that configuration of the value surface in Nairobi is no exception to the above observations. It can be seen that the highest land values (over a million

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15 The definition of a 'block' is very imprecise in terms of size. Some are larger than others depending on the convenience of calculations and map drawing. But any 'block' contains several contiguous plots bounded by streets including natural boundaries such as streams.
shillings = £ 50,000) are found in the area enclosed by Uhuru Highway, Haile Selassie Avenue and Grogan Road – an area consisting of the Central Business District (CBD). Within the CBD, grand peaks are reached near the intersections of Government Road–Kenyatta Avenue, and also around the intersection of Bazaar Street and Government Road where values reach over five million shillings per acre. Immediately to the west and south-west of this central high value plateau is a sharp escarpment where the value suddenly drops from a million to eighty thousand shillings per acre on the other side of Uhuru Highway – a very short distance of less than a mile from city centre. Outward from here, the surface slopes down very gently to the periphery of the western half and south-western sector where values fall to as low as twenty thousand shillings per acre.

A sector of gradual diminution of values lies roughly between Fort Hall and Mombasa roads to the north and south respectively, and outward to the end of Jogoo Road – approximately five miles from city center. The surface in this sector is generally at higher elevation than in the western and south-western sectors. Here the value surface descends from a million at the edge of the CBD to about forty thousand shillings at the periphery. This area covers all the industrial zone and also the densely populated sections of the city to the north of the industrial area. Elevation of the surface in the remaining sector (to the nord and north-west) lies between the other two extremes. From the edge of the CBD, the values gradually diminish outward to values as low as ten thousand shillings in places almost six miles away from city center. This sector is marked by a continuation of the central functions (near the CBD) which merges into an area of medium population density on to the lightly populated area providing first class residences at the periphery in Muthaiga. Although not clearly visible on the map, elongations of higher values are evident along the major highways (named on the map) leading in and out of the city than in places removed from these arteries. There are localized secondary peaks (Shs. 140,000 and over) in nearly all the major shopping centers such as Westlands, Lavington, Adams Arcade, Parklands, etc. Here again, values seem to fall off from these centers more rapidly than other areas in general. The progressively declining surface is also punctuated by occasional depressions as shown by hatchured contours on the map. A quick check on some of these showed that most of

\[ \text{Fig. 3} \]
them are mostly undeveloped land with very poorly drained soils, or steep slopes.
It is quite clear from the above that: 1) land values generally fall with distance from city center or other commercial nodes; 2) the gradients are not uniform in every direction; 3) elongations of higher values extend along major highways, and 4) there are more than just accessibility variables associated with the variation of the value surface.

Testing of Hypotheses

(a) Value-distance Relationship —. In view of the above remarks, it would appear that a host of hypotheses can be proposed and tested for a fuller understanding of the spatial variation in land values. Indeed an inspection of the literature reveals that a large number of variables have been examined in the effort to gain a higher degree of explanation for the spatial variation in value surface. Apart from those associated with accessibility (distance measures to various nodes), physical variables such as elevation of land and sociological variables such as ethnic composition, population density, etc. have been incorporated into explanatory models. Although they form an important consideration in empirical investigations, it is quite evident that many of these variables add sometimes insignificantly to the explanatory power of the final models. Since this is an exploratory case study, it was found necessary to first examine the relationships among land values, distance and population density.

A stratified random sample (stratified according to census divisions) of 150 scores was drawn using random number tables. Straight-line distances were measured from the approximate city center to the selected points on the map. From the scatter diagram (Fig. 4A) it can be observed that some relationship exists between the collected land values and distance from city center. In order to establish the extent of this relationship, a simple regression analysis of the type: \( \log y = \log a + b \log x \) was employed. The resulting correlation coefficient, \( r = 0.824 \), is very significant at .01 level. The simple model provides a remarkably high degree of explanation of the total variation in the value surface for the overall city as indicated by the coefficient of determination, \( r^2 = 67.9\% \).

(b) Residuals from Regression —. Even with such encouraging results, it seemed important to assess the predictive performance of the model with a view to speculate as to what other factors may be associated with spatial variation of land values. This was accomplished by calculating the differences between the actual and the theoretical or estimated \( y \)-values – the residuals from regression. To simplify the examination of the residuals, a map was drawn based upon over-and under-estimation of the dependent variable, \( y \) (Fig. 5). The spatial pattern which emerges is interestingly arranged according to sectors which have been historically racially segregated. On the one side is the area which has been predominantly European settled until the post-independence period during which a number of Africans and Asians have bought out and occupied former European homes. Nearly all the values in this sector were over-estimated. In other words, the actual values were less than the predicted values and hence negative residuals. On the other extreme is the all-African settled area in which most values are under-estimated. Somewhere in between lies the Asian sector in which a mix of the positive and negative residuals are almost equally distributed.

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18 M. T. Daly, op. cit.
19 where \( y = \) land values per acre in K£.
\( x = \) distance units from city center.
21 E. N. Thomas, Maps of residuals from regression; their characteristics and uses in geographical research, Monograph 2, Dept. of Geography State University of Iowa 1960.
with the given logarithmic equations as well as a means of compressing the values for reasonableness-size diagrams. Since the scatters in diagrams B, C, D are components of Fig. 4A, it is to be expected that each of these graphs should exhibit a negative correlation between land values and distance which is clearly indicated. It is also apparent that the elevation and gradients appear to differ from sector to sector. But special mention must be made of an outstanding characteristic in the European sector (Fig. 4C) that very low elevations and gradient are conspicuously evident when compared with the others. It is particularly puzzling when one considers that this sector is the best provided for in terms of infrastructure and has the highest amenity standards. As footnoted earlier, occurrence of comparatively low values right up to near the CBD is a rather peculiar phenomenon. Indeed, one cannot help to wonder whether or not a deliberate attempt had been made to under- or over-value certain properties on a racial basis. It is an interesting observation that will not be laboured at this juncture. Instead, we shall proceed with a statistical analysis designed to ascertain the differences among the slopes and elevations in the various sectors.

From the sample, new regression equations were computed for each of the sectors as given in Fig. 4. Testing of the differences among the equation parameters consists of finding the solution to the proposition that there is no difference among the a's and the corresponding b's in the equations: i.e. to verify the hypothesis that the elevations (a's) and the corresponding slopes (b's) are equal.

The relevant test22 is based upon a statistical comparison of the sum of the unexplained variation in the series of the regression equations, and the sum of the unexplained variation calculated from the pooled sums of squares and products among the regression equations. The resulting ratio is compared with the tabled F-value entering the appropriate degrees of freedom. The hypothesis of equality among the corresponding parameters is accepted if the calculated ratio is less than the tabled value, and rejected accordingly.

Two runs of the test were carried out – one in which all the four sectors were included, and the other excluded the industrial-CBD area. The results in both runs culminated in the rejection of the hypothesis of equality among the slopes and elevations.23 This means that the value surfaces in those sectors differ significantly one from the other. It could also imply that although there is significant relationship between value and distance, this relationship differs markedly from sector to sector.

(c) Value-distance-density Relationship —. The above analysis has established the existence of sectoral variation in the value surface – sectors that have been racially segregated. But before one can infer that racial segregation has influenced variation in the value surface, it seemed worthwhile to investigate the role of another factor which is generally included in this type of study and one which apparently varies in a similar spatial pattern in the City, namely, population density. For example, the African sector is the most densely populated area; the Asians generally live in medium density areas, while the lowest densities are to be found in the former European areas. Thus, we are concerned with two simple questions: 1) Does population density play a significant role in explaining variation in the value surface? 2) Would the density factor eliminate the element of sectoral arrangement of the unexplained variation?

The data on population density are given by census divisions, thus giving rise to what is known as a change in scale of analysis. This ‘problem of scale’ dictated the generation of a new set of raw data for use in this section of the analysis. To obtain a more representative valuation for each census division, an arithmetic average of land values was calculated in preference to drawing a sample based on an observation per census division. Distances were measured from the same center as before to the approximate divisional center. With this set and population density, a logarithmic transformation was carried out and the data subjected to a multiple correlation analysis.

22 This is essentially a covariance procedure, but the test of normality and homogeneous variance which normally precedes this one, was omitted considering that the F-test here is usually insensitive to moderate departures from homogeneous variance. The test is detailed by K. W. MEINKEN, The demand and price structure for oats, barley and sorghum grains, U.S.D.A. Tech. Bull. 1080, Washington D.C. 1953. For covariance analysis see G.W. SNEDECOR & W.G. COCHRAN, Statistical methods, Ames Iowa State University Press 1967, ch. 14.

23 The calculated F-ratios: 19.51 and 8.82 were significantly larger than the tabled ratios of 2.16 and 2.45 for both runs given the degrees of freedom as 146, 6 and 123, respectively, H. ARKIN & R. R. COLTON, Tables for statisticians, New York Barnes and Noble Inc. 1963, p. 124.
The resulting multiple coefficient of determination, $R^2 = 0.738$, is also significant at .01 level—meaning that about 74% of the total variation in the value surface is explained by the two variables. But we are still faced with the question of whether the increase in the amount of explained variation resulting from introduction of the variable, density, is significant or not. This led to an examination of the coefficient of partial determination in the correlation matrix. Using the $t$-test, it was found that the relative importance of density in explaining spatial variation of land values is significant at .05 but not at .01 level.24 Thus, in response to the first question, we may conclude that the use of population density has explained a fairly significantly larger amount of variation in the value surface. We should also note that the level of explanation achieved by use of the two variables, compares favourably with those experienced in other studies of the western cities in which more than two variables had been incorporated into similar statistical models.25

Turning to the second question, the residuals from the multiple regression were examined (inset map in Fig. 5). We find that when the two maps are compared, their spatial patterns are essentially similar. This means that despite the significant rise in the level of explanation, the density component in the model did not eliminate the sectoral arrangement of the unexplained variation in the value surface. Consequently, and since the sectors are spatially arranged according to ethnic groups, it may be inferred that racial segregation could have had a powerful influence on land valuation in Nairobi City.

**Conclusion**

The outcome of this investigation does suggest several important points. Firstly, it has been demonstrated that very significant regularity exists between land values and distance as hypothesized in the western-based theory, and that population density plays a minor, though significant, role in variation of the value surface. Such a finding in Nairobi compares favourably with those in the western cities which have evolved under a different set of circumstances and under a different cultural environment. As already noted, the level of explanation achieved by use of the two variables, compares favourably with those in the western cities which have evolved under a different set of circumstances and under a different cultural environment. As already noted, the level of explanation achieved by use of the two variables, compares favourably with those in the western cities which have evolved under a different set of circumstances and under a different cultural environment.

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24 When degrees of freedom, $n = 23$, a value of $t = 2.616$ is beyond the .05 level but just below the .01 level, F. E. CROXTON & D. J. COWDEN, Applied general statistics, Englewood-Cliffs N.J. Prentice Hall Inc., 1955, p. 734 and 727.

25 The outcome of the studies in: Seattle by W. R. SEYFRIED (The centrality of urban land values, *Land Economics* 39 (1963), p. 275–285), $R^2 = 0.64$; New Castle by M. T. DALY, $R^2 = 0.86$; Topeka by D. S. KNOS, $R^2 = 0.78$, all of which contrast markedly with the poor results achieved by M. YEATES in Chicago where $R^2 = 0.18$ and was raised to $R^2 = 0.51$ when a sectoral component was added.
achieved is very much in keeping with others in those cities where even more variables had been included in statistical models similar to the one used in this paper. Secondly, it is not common to expect deviations from hypothesized relationships which are reflective of an important local influence such as a probable colonial attitude – a situation that appears to manifest itself in the occurrence of distinct elevations and gradients as well as unexplained variation of the value surface spatially arranged according to sectors which are known to have been racially segregated. Thus, whereas racial composition has not proved an important variable (although suspected and tested) in western cities, it would seem to be a fairly powerful factor in Nairobi and perhaps may be characteristic of other non-western former colonial cities. Thirdly, the results may serve to dispel some of the fears and pessimistic attitudes that have been expressed over the use of western-generated concepts and analytical techniques in studying African cities such as Nairobi. Nevertheless, as Yahya stresses, great caution must be exercised in any scholarly undertakings in our areas, the automatic transplantation of western-based notions to non-western case studies is a dangerous procedure.

There is yet a word for the City authority. Configuration of land value surface generally exposed areas of relatively cheap land – mainly in the periphery of the City. But the question of availability is another matter. Nairobi is situated between the valuable Game Park to the south, the international airport to the east, and the heavily populated areas of Kiambu district to the north and northwest. It would appear from this that a logical expansion of the City must be in the direction of north-east and south-west where the land is cheap and very sparsely inhabited. Upon the realisation of the increasing demands for city functions by the rapidly growing urban population (especially housing and related uses), the need for City Authority to secure land in such potential areas for expansion should not be overemphasized. Admittedly, this study has not been exhaustive. Neither is the correlation technique the most powerful tool of analysis however appropriate and suggestive it may be. Indeed, the inclusion of a broader base of accessibility measurements (e.g. distance to shopping centers, to major streets, etc.), site characteristics (e.g. plot size, elevation, improvements, etc.), and other sociological variables, might have led to a larger degree of explanation of the spatial structure of urban land values. Would better results be achieved if such other variables were examined through the use of more refined tools of analysis? Now that the new post-independence valuation (1970) has just been published, are there important changes in the spatial behaviour of land values? Would similar conclusions obtain if the newly annexed city suburbs were included? Would similar findings prevail in other African cities? In Alonso's words, "there is the need to test the quality and scope of the (existing) theories to see whether they fit cases for which they were not designed," (1964). This plea has been only partially met in this presentation. Efforts directed to finding solutions to the questions raised and many other relevant problems, would be a promising avenue for future research in this area.