SPATIAL VARIATIONS OF IDLE LAND IN TULSA, OKLAHOMA

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ABSTRACT

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A generally neglected form of land use, idleness, has become increasingly important during the post World War II years. This study attempts to explain the place to place variation of idle land in a single urban center, Tulsa, Oklahoma.

Current theory indicates that a satisfactory explanation of the location of a particular form of land use is unlikely when using a single cause-effect approach. Thus eleven variables were hypothesized to explain the distribution of idle land, and a stepwise multiple regression format was designed to measure their statistical significance.

Initially, the eleven variables were grouped into three separate equations on the basis of their origin. These were noted as the Social, Accessibility, and Institutional models. However, tests proved these models to be generally unsatisfactory and they were subsequently combined into a final model, reduced by the stepwise deletion process to

$$Y = a + b_3Ni + b_4Ci + b_5W_i + \log_e b_7E_i + \log_e b_8B_i + b_{10}S_i + e$$

where

N is the distance to the nearest non-white area.

C is the distance to the nearest shopping center.

W is the distance to the median point of employment for the city.

E is the distance to the nearest elementary school.

B is the distance to the nearest area of blight.

Z is the predominant type of zoning per sample area.

and a, $b_4, \ldots, b_{10}$ are empirically determined parameters, i = 1, 2,..., 100, and e is the random error term.

The test of this model yielded a multiple correlation coefficient of 0.82, indicating that 82 percent of the place to place variation of idle land in Tulsa can be explained by the included variables.

It is suggested that the results of this study show that the explanation of idle land variation within a complex system of variables can be simplified by the recognition of process models. The use of such models may ultimately allow a predictive formulation for idle land variation to be erected with a relatively small number of variables.

ACKNOWLEDGEMENT

In completing a research project of this type it is necessary to depend upon the guidance and cooperation of many individuals. Thanks are extended to C. Larry Tompkins and the members of the Tulsa Metropolitan Planning Commission for their vital assistance in the formulation of variables and the collection of data. Dr. Michael C. Roberts contributed greatly with advice and criticisms throughout the course of the study, as did Dr. J. J. Hidore and my other colleagues at Oklahoma State University.

A special thanks is due to Dr. Donald Blome, who supervised the preparation of this thesis. It was he who first introduced me to the techniques of statistical geography employed in this study.

Two research facilities at Oklahoma State University made immeasurable contributions to my work. The Research Foundation made available funds necessary for the conduct of field research, and the Computer Center provided six hours of computer time for the analysis of the data.

Finally, I wish to express my sincere gratitude to my family, whose sacrifices over the past few years are gratefully acknowledged.

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CHAPTER I

INTRODUCTION

Many gaps exist in our knowledge of urban growth processes, let alone the spatial aspects of these same processes. This thesis concentrates on one of these gaps heretofore almost completely overlooked in urban land use theory -- idle land. An implicit assumption has been made in urban literature that all urban land is, in fact, allocated to industrial, commercial, and residential uses. This, however, is not the case. Idleness, as a form of land use, has become increasingly widespread in the United States during the post-World War II years. The rapid expansion of urban centers during this period has brought about considerable change in urban land use, particularly in the rural-urban fringe. During the past decade alone, more than a million acres per year have been transferred from agricultural to non-agricultural uses in urban fringe areas of the United States.[1]

Theoretically, the reallocation process of land from agriculture to urban use is a smooth one. Land shifts from one use "A" to another "B" when the use of "B" will provide a higher economic rent on the land than will use "A". In Figure 1.1, the triangles COP' and DOR describe the competition between two types of land use. The lines CP' and DR

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[1]Charles Press and Clarence Hein, Farmers and Urban Expansion, a Study of a Michigan Township, U. S. Department of Agr. Pub. ERS-59 (Washington, D. C., May, 1962), p. 1.

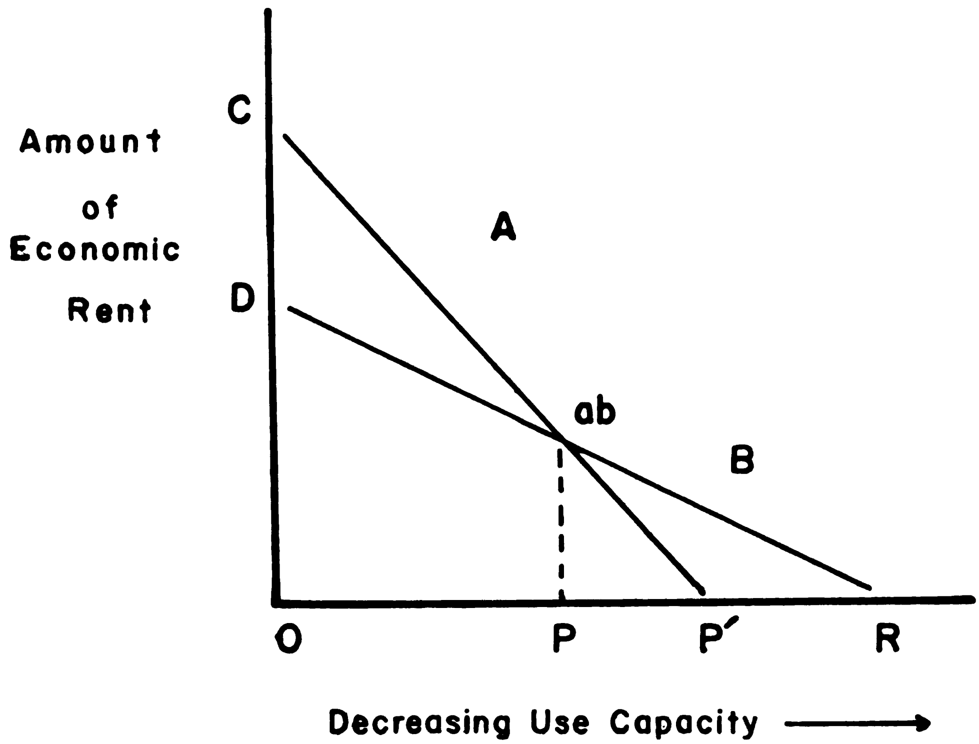
Amount
of
Economic
Rent
C
D
A
ab
B
O
P
P′
R
Decreasing Use Capacity

Figure 1.1

represent the amount of economic rent derived from the two types of land use as an urban front advances over time. The point, ab, at which the two triangles intersect, represents the margin of transference. At this point, P, increasing costs brought about by the advance of the urban front have reduced the amount of economic rent from use "A" to the point that it becomes more profitable to shift to use "B" than to continue with use "A". However, in reality the system does not work quite this smoothly. It is now recognized that another stage, idleness, often enters the transitional process. Thus, instead of a smoothly flowing system from agricultural to urban use, we have a tripartite framework: agriculture to idleness to urban.

Map inspection indicates that the patterns created by idle land upon a landscape are not significantly different from those of other forms of land use (Figure 1.2). Thus, this research builds upon the results of previous studies of land use contained in the following review of the literature.

THE THEORETICAL LITERATURE

Because of the complexity of the formal analysis of the problems of urban growth, the body of current theory dealing with urban expansion is far from comprehensive. Therefore, this review cannot be considered as complete, nor is the sequence of citation necessarily chronological or presented by discipline.

A theory, as defined by Bergmann is:

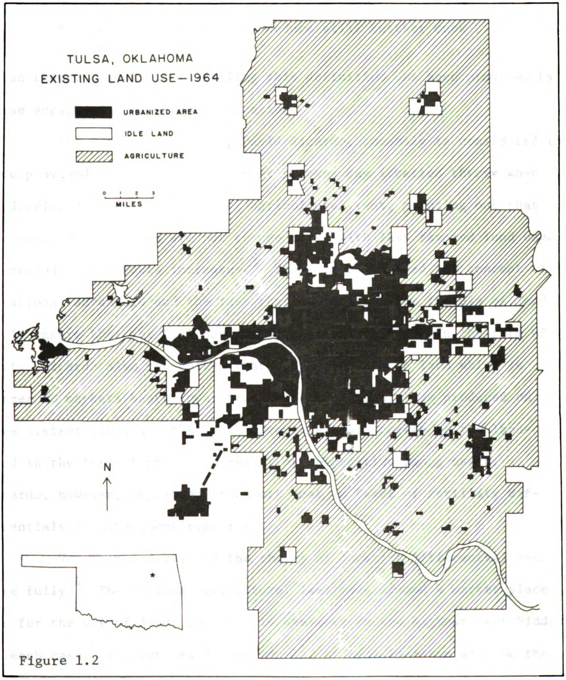
TULSA, OKLAHOMA
EXISTING LAND USE—1964
URBANIZED AREA
IDLE LAND
AGRICULTURE
0 1 2 3
MILES
N

Figure 1.2

> ... a group of laws deductively connected ... from which others, usually a large number, have actually been deduced and from which one expects to deduce still further ones ...[2]

Urban theory closest to fulfilling this definition has been provided by those engaged in the study of location.

The English economist, David Ricardo, commonly is considered to have provided the foundation of most present day location theory when he developed a general theory of agricultural rent, pointing out that the most fertile lands are put to use first with less favored land used as demand for products increases.[3] Thus, he recognized the concept of locational advantage and the idea that competition for the use of land would insure that the full advantage go to the landlord in the form of rent. Ricardo also recognized that crops produced on land which is nearer to markets bears lower transport costs than those produced on more distant land, and that this advantage also accrues to the landlord in the form of rent as a result of competition among users. Ricardo, however, neglected transport cost in favor of fertility differentials in subsequent research.

Von Thunen developed the theory of location differential rent more fully.[4] The various agricultural land uses around a market place bid for the use of land; and land is assigned to the highest rent bidder in each case. The rent each crop can bid at each location will be the

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[2]Gustav Bergmann, The Philosophy of Science (Madison, The University of Wisconsin Press, 1958), p. 181.

[3]David Ricardo, On the Principles of Economic Policy and Taxation, 1817.

[4]Johann H. von Thunen, Der Isolierte Staat in Beziehung auf Land-Wirtschaft un Nationalökonomie (Hamburg, 1st Vol., 1826).

savings in transportation of its product that that site affords in contrast with a more distant site. The most distant land in cultivation yields no savings in transportation, and, consequently, there will be no rent at that location. Viewed another way, the rent at any location is equal to the net revenue or value of product minus transportation costs. This approach has recently been fully and formally developed by Dunn,[5] Isard,[6] and Alonso.[7]

In 1903, Hurd outlined a hypothesis for urban land which closely resembles that of von Thunen's for agriculture.

> As a city grows, more remote and hence inferior land must be utilized and the desirability between the two grades produces economic rent in locations of the first grade, but not in those of the second. As land of a still more remote and inferior grade comes into use, ground rent is forced still higher in land of the first grade, rises in land of the second grade, but not in land of the third grade and so on. Any utility may compete for any location within a city and all land goes to the highest bidder ... practically all land within a city earns some economic rent, though it may be small, the final contrast being with the cities rentless and, hence, strictly speaking, valueless circumference.[8]

He summarizes:

> Since value depends on economic rent, and rent on location, and location on convenience, and convenience on nearness, we may eliminate the intermediate steps and say that value depends on nearness.

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[5]Edgar S. Dunn, Jr., The Location of Agricultural Production, (Gainsville: The University of Florida Press, 1954).

[6]Walter Isard, Location and Space Economy: A General Theory Related to Industrial Market Areas, Land Use, Trade, and Urban Structure (Cambridge: The M. I. T. Press, 1956).

[7]William Alonso, Location and Land Use, Toward a General Theory of Land Rent (Cambridge: Harvard University Press, 1965).

[8]R. M. Hurd, Principles of City Land Values (New York: The Record and Guide, 1903), pp. 11-13.

Hurd, however, does not consider the size of the site, and avoids the problems of residential land by saying that residential land values are socially and not economically derived.

With the advent of formalized city planning during the 1920's, there arose a voluminous literature concerning the form of urban land use. The principal tenets of this literature were developed by Haig. His hypothesis does not appear to differ much in terms of mechanics from that of Hurd:

> Rent appears as the charge which the owner of a relatively accessible site can impose because of the savings in transport-costs which the use of his site makes possible.[9]

However, there is an innovation in Haig's work in its' strong statement of the complementarity of rent and transport costs. Transportation is a device to overcome the "friction of space". The more accessible the site, the less the friction. But, "while transportation overcomes friction, site rentals and transport costs represent the cost of what friction remains." Thus, the user of a site pays as the "cost of friction" transportation costs and rent, which is "the savings in transport cost." But the complementarity of rent and transport costs is limited:

> The sum of the two items, the cost of friction, is not constant, however. On the contrary, it varies with the site. Theoretically the perfect site for the activity is that which furnishes the desired degree of accessibility at lowest cost of friction.[10]

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[9]Robert M. Haig, "Toward an Understanding of the Metropolis," Quarterly Journal of Economics, (Vol. 40, 1926), p. 422.

[10]Ibid, p. 423.

An interesting conclusion results from this view:

> ... the layout of the metropolis ... tends to be determined by a principle which may be termed the minimizing of the cost of friction.

Or, as it was later restated by Ratcliff:

> ... the perfect land market would produce a pattern of land uses in a community which would result in the minimum aggregate costs, the advantages of the more convenient sites are reduced.[11]

Wendt takes issue with the Haig-Ratcliff hypothesis.[12] His remarks are directed primarily to many of the simplifying assumptions of Haig, among them that of a single center to the city and the importance of transport costs. He offers a theoretical model which, in turn, is questioned by Alonso who feels it lacks precision, consisting of poorly defined variables.[13]

Wingo has combined Haig's theoretical analysis of traffic flow with that of his own into an explicit mathematical model of the residential land market.[14] Rents and transport costs are viewed as comlementary.[15] Transport costs, however, include the value of commuting

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[11]Richard U. Ratcliff, Urban Land Economics (New York: McGraw-Hill, 1949), p. 385.

[12]Paul F. Wendt, "Theory of Urban Land Values", Journal of Land Value Trends and "Urban Land Value Trends", The Appraisal Journal, 26 (1958), pp. 254-269.

[13]Alonso, p. 14.

[14]Lowden Wingo, Jr., Transportation and Urban Land (Washington: Resources for the Future, 1961).

[15]Complementary as used here means substitution of transport costs for rents.

time in dollars, determined by the marginal value of leisure time. However, no allowance is made for the liking or disliking of the travel situation. Thus Wingo's analysis supports Haig's view of the complementarity of rent and transport costs in the urban case, and parallels closely Von Thunen's agricultural model.

Alonso challenges the premises upon which Haig's hypothesis of minimum aggregate costs is based. He states:

> The minimum cost of friction hypothesis is not valid when it is interpreted strictly in economic terms. When it is stated so that the costs of friction include disutility, it is undefinable and untestable. There is, moreover, a fundamental objection to its use as a guide for urban planning. The logic that would have the minimizing of costs of friction be a planning objective is faulty ... The minimizing of a certain type of costs would be a valid approach only if all other costs and revenues (economic and psychological) remain constant. For instance, in the extreme use, a city could maximize its cost of friction by crowding all residences as tightly about the center of a city as physically possible and by forbidding all commercial and industrial development. Thus reducing to zero all costs of friction of this sector. Such a solution, of course, would be absurd.[16]

Instead, Alonso proposes a general model of land rents based on a multiple regression equation

$$pg = a + by - ct$$

Where

pg is the dependent variable and is obtained by multiplying the quantity of land per family (g) by the price of land per square foot (p) for each census tract.
y is income, using the median family income per census tract.
t is distance, measured in miles in a straight line from the center of a city.

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[16]Alonso, p. 105.

and a, b, and c are estimated parameters.[17]

The advantage of such a model, Alonso maintains, is its simplicity and testability. In support of his thesis he offers an empirical test using Philadelphia as a study base. The relationship tested, as indicated by the equation above, states that the expenditure for land by a family is determined by their income and their distance from the center of the city.

The hypothesis of minimum costs of friction also appears in the literature of human ecology, but in a modified form. Quinn states a generalized "hypothesis of minimum costs":

> Ecological units tend to distribute themselves throughout an area so that the total costs of gaining maximum satisfaction in adjusting population to environment (including other men) are reduced to the minimum ... as used in this hypothesis the cost has a very broad meaning. It includes much more than economic costs. Negatively it includes dangers encountered and disagreeable experiences undergone. It embraces whatever of value is given up or is enjoyed in lesser degree in obtaining any given pattern of adjustment.[18]

This broad statement explicitly denies the work of Ratcliff. However, ecological theory as stated above cannot be proved or disproved because of its broad scope.

In one of the classical works in the field of human ecology, Park and Burgess state:

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[17] Ibid, p. 168.

[18] James A. Quinn, Human Ecology (New York: Prentice-Hall, Inc. (1952), p. 282.

> Land values are the chief determining influence in the segregation of local areas and in the determination of the uses to which an area is put.[19]

Land values are viewed as a result of a bidding process by potential users, with the land values, in turn, determining the location of land uses in the city. Moreover, human ecologists are greatly interested in residential location. As stated by Hawley:

> Familial units are distributed with references to land values, the locations of other types of units, and the time and cost of transportation to centers of activity ... the influences of the three factors are combined in a single measure, namely, rental value for residential use.[20]

Hawley summarizes a generally held hypothesis of land values in relation to residential location:

> The residential property on high priced land is usually in a deteriorated condition, for since it is close to business and industrial areas it is being held speculatively in anticipation of its acquisition by more intensive and therefore more remunerative land use. In view of that probability owners of such property are not disposed to spend heavily for maintenance or to engage in new residential construction. Hence, the property can command a relatively low rent for family use. Moreover its proximity to various objectionable uses and its distance from family amenities also contribute to lower residential values. Its accessibility, however, tends to counter the depressing effects on rents of deterioration and nearness to undesirable conditions. Conversely, new residential structures appear on low-value lands, lands that have few if any alternative uses. Since the buildings are newer and presumably better equipped for family use than

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[19] Robert E. Park and Ernest W. Burgess, The City (Chicago: University of Chicago Press, 1925), p. 203.

[20] Amos H. Hawley, Human Ecology (New York: Ronald Press, 1950), pp. 280-281.

> those found on high priced land, they can command higher rent. Their protection by distance from objectionable land uses and their access to the services and utilities family life requires also favor a high rental charge. But again the tendency to high rental valuation is minimized somewhat by the lowered general accessibility to places of employment and specialized service that greater distance involves. Thus while land values in the main grade downward with distance from concentrations of associated units, rental values for residential property tend to vary inversely with land values.

Thus, the paradox of low income families living on high priced land while wealthier families live on cheaper land, is explained by Hawley in terms of progress over time in a growing city.

Firey presents a two-fold hypothesis.[21] First, he ascribes to space not only an impeditive quality but also an additional property, "that of being at times a symbol for certain cultural values that have become associated with a certain spatial area." Second, he hypothesizes that locational activities are "not merely economizing agents, but may also bear sentiments which can significantly influence the locational process." He supports his hypothesis by referring to a study of land use in Boston.

Christaller's central place theory, or more descriptively his multivariable hypothesis concerning the spatial distribution of urban settlements, is perhaps the greatest contribution thus far to urban theory. Briefly, the theory states that service centers are evenly spaced, and that their neighborhoods are hexagonal in shape.[22]

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[21]Walter Firey, "Sentiment and Symbolism as Ecological Variables" American Sociological Review, (1945), pp. 140-148.

[22]Walter Christaller, Central Places in Southern Germany, translated by Carlisle W. Baskin (Prentice-Hall, Inc., New Jersey, 1966).

Christaller's theory has been generalized by Lösch to show that a complete economic landscape can be created based on a concept of hierarchies.[23] He postulates that Christaller's marketing, traffic, and separation principles are special cases of a whole series of feasible systems of central places and trade areas, called the "economic landscape", which is characterized by six densely-developed and six sparsely-developed sectors radiating from the metropolis.

But neither Christaller nor Lösch were concerned with generation of spatial distributions. Their theories present possible steady-state equilibrium systems, not the dynamic sequence by which the states might be generated. Berry and Garrison showed how the theory applies to the arrangement of business centers within cities.[24] Their contribution has led to numerous works concerning the internal business structure of cities.

Harris and Ullman contributed toward urban theory in formulating their multiple-nuclei hypothesis of urban growth.[25] According to this hypothesis several points within or near a city, in addition to the CBD, draw traffic and stimulate development around them nearly as much as does the CBD. They put forth as examples of such nuclei big scale

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[23] August Lösch, The Economics of Location (New Haven: Yale University Press, 1954).

[24] Brian J. L. Berry and William L. Garrison, "The Functional Bases of the Central-Place Hierarchy", Economic Geography, XXIV, (1958), pp. 145-154.

[25] Chauncy Harris and Edward Ullman, "The Nature of Cities," Annals of the American Academy of Political and Social Science, CCXLII (1945), pp. 7-17.

industrial installations, large public institutions, government office centers, and major military establishments.

Colby[26] offers "... a dynamic explanation of urban development."[27] According to Colby's theory the patterns of a city at any given moment is the result of the workings of two great forces: centripetal and centrifugal. The concept is that centripetal forces lure residents and businesses into a city from without by the advantages of being in town. Moreover, within the city itself both people and businesses are drawn towards the CBD because of the accessibility of the central point customers, labor and institutions. Centrifugal forces, on the other hand, drive people and businesses out of the CBD into the suburbs in response to a yearning for open space, lower rents, and the desire to escape congestion.

REVIEW OF OTHER PERTINENT LITERATURE

Hansen, in an examination of residential development patterns, has illustrated that accessibility and the availability of vacant developable land can be used as the basis of a residential land use model.[29] He suggests his model as a method for determining accessibility patterns within metropolitan areas.

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[26] C. C. Colby, Centrifugal and Centripetal Forces in Urban Geography", Annals of the Association of American Geographers, XXII (1933), pp. 1-20.

[27] J. W. Alexander, Economic Geography (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964), p. 585.

[28] Walter G. Hansen, "How Accessibility Shapes Land Use," Journal of the Institute of American Planners, XXV (1959), p. 74.

Harvey and Clark have contributed by providing one of the most realistic attempts at defining urban sprawl.[29] Their basic attitude is that peripheral growth is too often incorrectly described, and implicitly classed as a detriment to society. They list a number of causal factors which they feel are responsible for urban sprawl. They conclude, "sprawl occurs, in fact, because it is economical in terms of the alternatives available to the occupants."[30]

Clawson concludes that cities are currently occupying about twice as much land as they are using effectively. He attempts to explain the causal processes involved in urban sprawl and arrives at the conclusion that six controls need to be imposed to minimize sprawl: (1) effective market reporting of transactions in suburban land, (2) demand and outlook studies, (3) urban planning as a stabilizing force (he feels urban planning, through subdivision and zoning, is now an unsettling force), (4) revision of local real estate tax policies, (5) public acquisition of vacant land needed for public purposes, and (6) a more purposeful and coordinated use of public services, such as roads, water lines, and trunk sewers.[31]

Chapin and Weiss developed a multiple regression model designed as a predictor for land development.[32] Their study is of major import-

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[29] P. O. Harvey and W. A. Clark, "The Nature and Economics of Urban Sprawl", Land Economics, XLI (1965), pp. 3-4.

[30] Ibid, p. 9.

[31] Marion Clawson, "Urban Sprawl and Speculation in Suburban Land", Land Economics, XXXVIV (1962), pp. 99-111.

[32] Stuart F. Chapin, Jr. and Shirley F. Weiss, Factors Influencing Land Development (Institute for Research in Social Science, Chapel Hill: University of North Carolina Press, 1962).

ance in light of this study as many of their variables have been incorporated into the derived model. After testing several mixes of independent variables, Chapin and Weiss arrive at a final model consisting of fourteen significant variables which are effective in explaining residential land development. The results of the regression analysis played an essential role in the evaluation of inputs for the next phase of their research, the construction of a synthetic forecasting model of land development. In its most elemental form, the model starts with "raw materials" of land development, and, following rules concerning the way land development is to occur which came out of the analytic part of the research, utilizes a high speed computer to generate a physical pattern of growth on the terrain. This model can build new cities from some point of beginning, say from a crossroads, or it can start with a city of an intermediate stage of development. Since the model is dynamic in nature, it "builds" cities in parts, and each stage of the computer program corresponds to a certain stage of the cities development. The function of the model is to distribute households which in effect are in search of unoccupied terrain to occupy. The way the households decide where to locate is determined by reference to the measures of attractiveness which have been found significant in the multiple regression analysis. Essentially the process is as follows: A grid system of squares is developed. The computer examines each grid square, notes its measures of attractiveness, and decides by a correspondingly biased randomizing procedure whether or not the available unit of development goes there. The land is reassessed again and again through "N" passes of the computer until a predetermined forecast date is reached.

The theme underlying the majority of the works mentioned above is the "friction of distance" concept or, more precisely, the roles that distance and accessibility play in locational decision making processes. Moreover, most concern seems to be given to location with respect to the CBD. Other studies, however, such as the one by Chapin and Weiss, indicate that accessibility to the CBD, in itself, does not provide an adequate explanation for many locational problems.[33] Both Knos[34] and Marble[35] point this out in their studies relating land values to distance from major business centers in addition to the CBD. Furthermore, Yeates, in a study of Chicago land values which is closely related to this thesis, found it necessary to develop a model consisting of six variables in order to get significant results.[36] The present research attempts to build upon the work of these authors in explaining the distribution of a particular type of land use, idle land.

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[33] Ibid.

[34] Duane S. Knos, Distribution of Land Values in Topeka, Kansas (Center for Research in Business, The University of Kansas, May, 1962).

[35] W. L. Garrison, D. F. Marble, et al., Studies of Highway Improvement and Geographic Change (Seattle, 1959).

[36] Maurice H. Yeates, "Some Factors Affecting the Spatial Distribution of Chicago Land Values, 1910-1960", Economic Geography, Vol. 41 (January, 1965), pp. 57-85.

CHAPTER II

IDLE LAND IN TULSA, OKLAHOMA

While the existence of idle land has been widely recognized, as yet little is known about the reasons for the spatial variability of its occurrence. It is hypothesized here at a rather broad level of generalization that idle land is the result of many processes which are the results of many decisions and implementing actions of both a public and private nature. The research introduced here will deal with the "effects" of these decisions and actions, i.e., it focuses on the results of decisions as they can be observed in physical terms. No attempt is made to include in the analysis the decision variables, that is, how political and social factors affect decisions and thus set the limits on the scope of land-use decisions. Moreover, the primary attention is directed toward measuring the effects of the variables, to determine whether the effect is strong in explaining the pattern of idle land within the boundaries of a single urban center, Tulsa, Oklahoma.

Clawson, in writing about the problems of sprawl and speculation, defines idle land as "land within the suburban zone...(which) ...for the most part is not used for any economic output until it is actually developed for urban usage.[1] This basic definition is accepted

[1] Marion Clawson, "Urban Sprawl and Speculation in Suburban Land," Land Economics, XXXVIII (1962), p. 106.

in this study with the following modifications: first, Clawson fails to differentiate between idle land and "unused space". Current urban planning terminology defines unused space as "land which is not suitable for development, i.e., land covered by water, unsuitable slope or soil conditions, etc."[2] It follows that idle land, as operationalized here, should not include "unused space." Secondly, due to the dynamic nature of land allocation processes, it is necessary that a time dimension be added to the definition in order to reduce the danger of accepting fallow agricultural land as idle land. This was accomplished by comparing 1965 aerial photographs with existing 1964 land use maps. Any land appearing to be idle which was not consistent on both sets of data was checked in the field to substantiate the idle status.

Economists argue that land as defined above may indeed be in a state of use. The owner of such land may be holding it in expectation of maximizing marginal revenues over some unspecified period of time. In the interim period, the rent from land held in speculation is equal to the difference between waiting costs, principal, interest and taxes, and the final liquidation price. Thus, at the time of liquidation, the rent will have been paid and this form of economic use terminated. Whether or not the land is economically idle does not detract from the fact that it is allocated to a physically idle state, i.e., there is no apparent use. The problem here is one of explaining the spatial distribution of its occurrence.

The ultimate aim of the study is the construction of a model

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[2]Interview with C. Larry Tompkins, Chief, Long Range Planning Division, Tulsa Metropolitan Planning Commission, Tulsa, Oklahoma, November 16, 1965.

that will account for the spatial variation of idle land in Tulsa, Oklahoma. The problem necessarily involves selecting those variables which have spatial distributions that can be used to explain the pattern of the dependent variable, idle land.

The following method was used to operationalize idle land (Y):

(Y) is the amount of idle land per analysis zone, expressed in square feet.

Tulsa, Oklahoma, part of a Standard Metropolitan Statistical Area of 418,989 residents in 1960, was selected as the site of the study because preliminary field work showed that it was undergoing the rapid growth and coincident problems of growth, including idle land, common to many American cities.[3] Further, the modern master data file system of the Tulsa Metropolitan Planning Commission greatly enhanced the gathering and collation of data. It should be pointed out, however, that all of the data analyzed here could have been collected in the field or from aerial photographs and maps. Thus the replication of the study in other urban areas does not necessarily depend upon common storage of data by planning commissions.

In addition to the data made available by the Tulsa Planning Commission, aerial photographs were collected and compared with existing land use maps. From these sources, a general distribution of idle land was plotted and field checked for accuracy. The field traverses were also intended as a method of observing general geographic features concerning the location of the idle land, because many factors that are

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[3] U. S. Bureau of the Census, Nineteenth Census of the United States: (1960, Population).

not measured by the selected variables may, in fact, play an important part in understanding some of the variations in numerical data. A further purpose was to eliminate any land which appeared to be idle on the photographs, but which, in reality, was fallow agricultural land or land undergoing development.

Additional field work was undertaken in the form of interviews designed to aid in operationalizing the definition of idle land presented above, and to determine the most appropriate method of measurement for the selected variables.

There are several parcels of idle land in the study area. Hence, in an effort to minimize cost and time in the collection of data, a sampling design was used to collect a representative areal sample of the dependent variable, idle land. The nature of the problem indicated that the standard areal sampling methods recommended by such scholars as Quenoville,[4] Krumbein,[5] and Berry[6] were not completely appropriate and would require some modification because of the shape of the city and the unequal size of the "analysis zones" used for data collection. The Tulsa Metropolitan Planning Commission has divided the city into a number of "analysis zones" used for simplification of data collection and storage. These zones are rather arbitrarily defined and are not all of equal areal extent. Thus the 416 analysis zones of the study area

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[4]M. H. Quenoville, "Problems in Plane Sampling", An. Math. Statistics (Vol. 20, 1949), pp. 355-357.

[5]W. C. Krumbein, "Experimental Design in the Earth Sciences", Transactions, American Geographical Union (Vol. 36, 1965), pp. 575-587.

[6]Brian J. L. Berry, Sampling, Coding and Storing Flood Plain Data, Agriculture Handbook No. 237 (Washington: U. S. Department of Agriculture, 1962).

were stratified to insure that all sections of the metropolitan area were equally represented and a stratified random sample was adopted. The selection of the sample size was based on methods recommended by Gregory in which the formula for the standard error ($S.E. = \frac{\hat{\sigma}}{\sqrt{N}}$) is used to determine sample size for specified probability levels.[7] In this case a twenty-five percent sample consisting of 104 analysis zones was calculated as most appropriate at the 95 percent confidence level. A table of random numbers was used for a proportionate selection of those zones to be included in the analysis. Finally, because not all zones are the same size, the following formula was used to standardize the data.

$$y = (100 - \frac{\bar{x}}{x})\ (Ya) - Ya$$

Where

y is the adjusted idle land (sq. ft.)

Ya is idle land (sq. ft.)

x is the size of analysis zone (sq. ft.)

$\bar{x}$ is the $\bar{x}$ size of all analysis zones (sq. ft.)

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[7] S. Gregory, Statistical Methods and the Geographer (London: Longmans, Green, and Co. Ltd., 1963), pp. 84-85.

CHAPTER III

THE PREDICTOR VARIABLES

The hypothesis advanced in Chapter II that idle land is the result of many processes would be applicable to any study involving the spatial distribution of a cultural phenomena. It is the role of the cultural geographer to separate the crucial processes from the unimportant. This chapter presents those variables which are hypothesized as "explaining" the distribution of idle land.

The operational definitions and the rationalization for the use of the selected variables are presented in three sections in accordance with their derivation. The sections are:

a. Accessibility variables

b. Social variables

c. Institutional variables

It is recognized that the separation of variables into groups of similar characteristics and process backgrounds is sometimes a difficult problem because of the absence of precise definitions. However, it is felt that the breaking down of the variables into such groupings will be of value to those engaged in subsequent research in urban location problems, especially in the selection of variables. Thus, they are presented here without reservation.

NOTATION

The following list is the notation used to identify the variables used in this study.

Accessibility Variables:

1.	Distance to the nearest major street system.	S
2.	Distance to the median point of employment.	W
3.	Distance to the CBD.	H
4.	Distance to the nearest convenience shopping center.	C
5.	Distance to the nearest elementary school.	E

Social Variables:

1.	Proximity to the nearest area of blight.	B
2.	Proximity to the nearest non-white area.	N

Institutional Variables:

1.	Assessed valuation.	V
2.	Distance to the nearest available water main.	Wa
3.	Distance to the nearest available sewage main.	Sw
4.	Zoning.	Z

ACCESSIBILITY VARIABLES

The first set of predictor variables hypothesized are based on accessibility factors. Accessibility is generally considered by location theorists to be a major factor in determining to what use a segment of earth space will be allocated. Thunen was among the first to point out the significance of accessibility in his general theory of agricultural location.[1] Thunen's work directly stimulated Weber to develop a general theory of industrial location, again reflected in accessibility and the cost-distance minimization concept.[2] Moreover,

[1]Johann von Thunen, Der Isolierte Staat in Beziehung auf Landwirtschaft and Nationalökonome (Hamburg: 1826).

[2]Alfred Weber, Theory of the Location of Industries, trans. by Carl J. Friedrich (Chicago: 1929).

the more refined analysis of location put forth today has not materially altered this approach. Isard states that three of the factors which determine land use in an urbanizing area are "(1) effective distance from the core (CBD); (2) accessibility of the site to potential customers; and ... (3) proximity to land devoted to an individual use or set of uses which are complimentary in terms of both attracting potential customers and cutting costs...."[3] Alonso, in his discussion of individual preferences, agrees. He states:

> We assume that, all other things being equal, a rational individual will prefer a more accessible location to a less accessible one. If "t" represents the distance from the center of a city, and thus the distance the individual must commute to the principal place of shopping, amusement, and employment, we must say that accessibility decreases as "t" increases. In other words, the individual would prefer "t" to be smaller rather than larger, so that "t" may be thought of as a good with negative utility. Increases in "t" produce dissatisfaction.[4]

Because of this evidence, the following variables are hypothesized:

1. Accessibility of the nearest element of a major street system (S): It has been observed that not only access but type of access is important as a location criterion. Dansereau found that in 1948, three years prior to the opening of the Pennsylvania Turnpike, U. S. 22 through

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[3]Walter Isard, Location and Space-Economy: A General Theory Relating to Industrial Market Areas, Land Area, Trade and Urban Structure (Cambridge: The M.I.T. Press, 1956), p. 200.

[4]William Alonso, Location and Land Use, Toward a General Theory of Land Rent (Cambridge: Harvard University Press, 1965), p. 26.

Monroeville carried a daily average of 4,784 vehicles. By 1957, after the completion of the turnpike, the daily average had reached 16,453 vehicles and was a major factor in the decision to locate a large shopping center on a 38 acre unimproved plot nearby.[5] He found further that, following the construction of the highway, the value of abutting properties showed an increase of 526 percent as compared to the increase of 320 percent for all other properties over a nine year period. Planners have long been aware of the stimulation a new major access artery will provide to the growth of a community. Thus, with this evidence indicating the possible importance of type of access, it is hypothesized that the further a parcel of land is located away from a major access system, the greater the probability that the land will not be developed.

Operationally defined, (S) is the distance, measured from the center of population of each analysis zone, along the nearest collector street to the closest state or federal highway, major street or county highway, expressway or turnpike. The data is expressed numerically to the nearest 0.1 mile (figure 3.1).

2. Accessibility to work areas (W): According to Foley, the most important single type of trip made by an urban dweller is the "journey to work".[6] The results of seven origin-destination studies show that

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[5]Kirk H. Dansereau, "Some Implications of Modern Highways for Community Ecology", Studies in Human Ecology, George A. Theodorson (ED.), (New York: Row, Peterson and Co., 1961), p. 177.

[6]Donald L. Foley, "Urban Daytime Population: A Field for Demographic-Ecological Analysis", Social Forces, XXXII (1961), pp. 323-330.

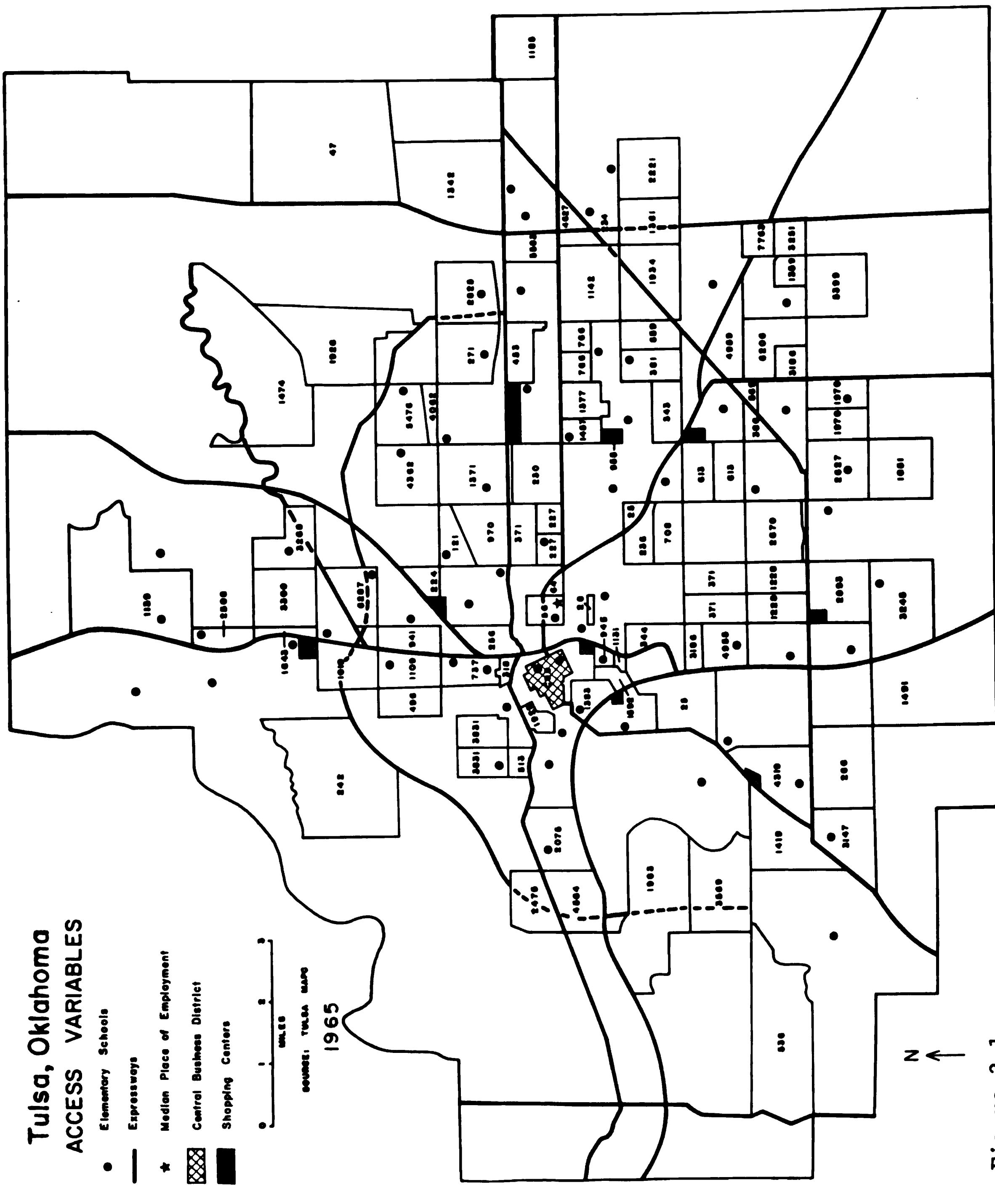
Tulsa, Oklahoma
ACCESS VARIABLES
Elementary Schools
Expressways
Median Place of Employment
Central Business District
Shopping Centers
1965
N

Figure 3.1

roughly two out of every five trips from home are to work. Carroll has hypothesized that "each worker seeks to minimize distance from home to work..."[7] Moreover, Chapin and Weiss found that accessibility to work areas held second position among a mix of eight variables explaining total land in urban use in their study of factors influencing land development.[8] With the support of this evidence, it is hypothesized that as distance increases from the median point of employment of a city, the greater the probability that the land will remain undeveloped.

Operationally defined, (W) is the distance along the most direct available route from the population center of each analysis zone to the median point of employment for the city of Tulsa (figure 3.1). The data is recorded numerically to the nearest 0.1 mile. The median point is used as a measure of central tendency because, as demonstrated by Hart, a single typical value or point can be used to describe an entire mass of areal data.[9] The median is defined statistically as the value of the middle item when all items are arranged according to size. Thus, equal numbers of items have values greater than and smaller than the median

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[7]Douglas J. Carroll, Jr., Home Work Relationships of Industrial Employees: An Investigation of Relationships of Living and Working Places for Industrial Employees with Attention to Implications for Industrial Siting and City Planning, (Unpublished Doctoral Dissertation, Department of Sociology, Harvard University, 1950), p. 150.

[8]Stuart F. Chapin and Shirley F. Weiss, Factors Influencing Land Development, Institute for Research in Social Science (Chapel Hill: University of North Carolina Press, 1962), p. 17.

[9]John Fraser Hart, "Central Tendency in Areal Distributions", Economic Geography, 30 (1954), pp. 48-59.

value. The median point of employment for Tulsa was found by following the techniques described by Hart.[10]

3. Accessibility to the high value corner (H): Urban geographers and planners have long considered the high value, or 100 percent corner, as the point upon which the organization of the city is focused. Moreover, this point normally is located in the center of the Central Business District, the economic heart of nearly every city. Further, according to Carroll, this central district is "generally the greatest single point of employment concentration".[11] Thus, it is hypothesized that the farther a unit of land lies from the high value corner, the greater the probability that the land will remain undeveloped.

Operationally defined, (H) is the road distance measured from the center of population of each analysis zone to the high value corner in the CBD, expressed to the nearest 0.1 mile (figure 3.1).

4. Accessibility to the nearest convenience shopping area (C): For the purposes of this study a "convenience shopping area" is "a group of commercial establishments, planned, developed, owned and managed as a unit, with off-street parking provided on the property ... and related in location, size ... and type of shops to the trade area that the unit serves ... generally in an outlying or suburban area."[12] It is recognized that operationalizing the above definition is, in effect

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[10] Ibid, p. 54.

[11] Carroll, p. 208.

[12] J. Ross McKeever, Shopping Centers Restudied, Urban Land Institute Technical Bulletin No. 30 (February, 1957), p. 6.

ignoring other interaction foci, particularly shopping strips along major road systems. This is done intentionally because it is felt that while shopping strips have a certain measure of attractiveness, they could not be weighed equally with shopping centers in terms of consumer drawing power.

While it is true that CBD's grow as cities grow, it also is true that they grow less rapidly than cities as a whole. That is, in growing cities, outlying business districts increase areally at a faster rate than does the CBD.[13] Thus with the coming of modern transportation networks, the shopping center has captured an increasing share of the market. The objective of shopping centers is to provide outlying areas with the advantages of the CBD without incorporating the disadvantages. While the literature contains numerous articles concerning the locational aspects of shopping centers, there appears to be little in the way of analysis concerning their impact on regional urban growth following construction. Nevertheless, field observations indicate a possible relationship between the establishment of shopping centers and changes in abutting land use. Thus, it is hypothesized that as distance increases between sites of potential development and convenience shopping centers, the probability that development will occur decreases.

Operationally defined, (C) is the distance from the population center of each analysis zone along the most direct access route to the nearest convenience shopping center, expressed to the nearest 0.1 mile (figure 3.1).

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[13] John W. Alexander, Economic Geography, (New Jersey: Prentice-Hall, Inc., 1964), p. 578.

5. Accessibility of the nearest Elementary School (E): Planners consider the proximity of schools to be a major variable in several aspects of land use analysis. Hansen shows the relative importance of various types of trips in the following statement:[14]

> These studies indicate decreases in the exponent (exponential function of distance in gravity or potential models) as trips become more important, i.e., school 2.0+, shopping trips 2.0, social trips 1.1, work trips 0.9. In as much as distance appears in the denominator of the gravity model, a decrease in the exponent means that distance becomes a less restrictive factor.

With this evidence in mind, it is hypothesized that the greater the distance a parcel of land is located away from a school, the less the likelihood that the land will be developed.

Operationally defined, (E) is the distance from the population center of each analysis zone along the most direct route to the nearest elementary school, expressed to the nearest 0.1 mile (figure 3.1).

THE SOCIAL VARIABLES

While the accessibility factors hypothesized in the previous section are thought to be important, it appears that they do not fully provide an answer to the posed problem. There are certain social factors of location which also must be considered. It is to emphasize the importance of these social factors that the following variables are hypothesized.

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[14] Walter G. Hansen, "How Accessibility Shapes Land Use", Journal of the Institute of American Planners, XXV (1959), p. 74.

1. Proximity to blighted areas (B): Blight, as used here, refers to the noticeable deterioration of property. The influence of urban or suburban blight upon land values and development is widely recognized. Park and Burgess were perhaps the first authors to illustrate this concept in their "concentric ring" hypothesis concerning the growth of cities.[15] They demonstrated that a general decline of land values occurs in slum or blighted areas located near the core of the city. Cornick found that premature subdivisions, meaning those developed in excess of market demand, often result in suburban blight and depressed land values.[16] Further, in a study of the Lansing - East Lansing, Michigan rural-urban fringe, it was observed that suburban blight had a general arresting influence on the development of proximate land.[17] Thus, it is hypothesized that the closer a tract lies to a blighted area, the greater the probability it will be idle.

Operationally defined, (B) is the distance from the population center of each analysis zone to the nearest zone having 50 percent or more of its buildings suffering from conditions of blight (figure 3.2).

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[15] Robert E. Park and Ernest W. Burgess (Eds.), The City (Chicago: University of Chicago Press, 1925), p. 203.

[16] Philip H. Cornick, Premature Subdivision and Its Consequences (New York: Columbia University Institute of Public Administration, 1938).

[17] Robert C. Brown, "Farmers and Land Re-allocation in the Rural Urban Fringe," Proceedings, Oklahoma Academy of Science, XLVI (1966), p. 186.

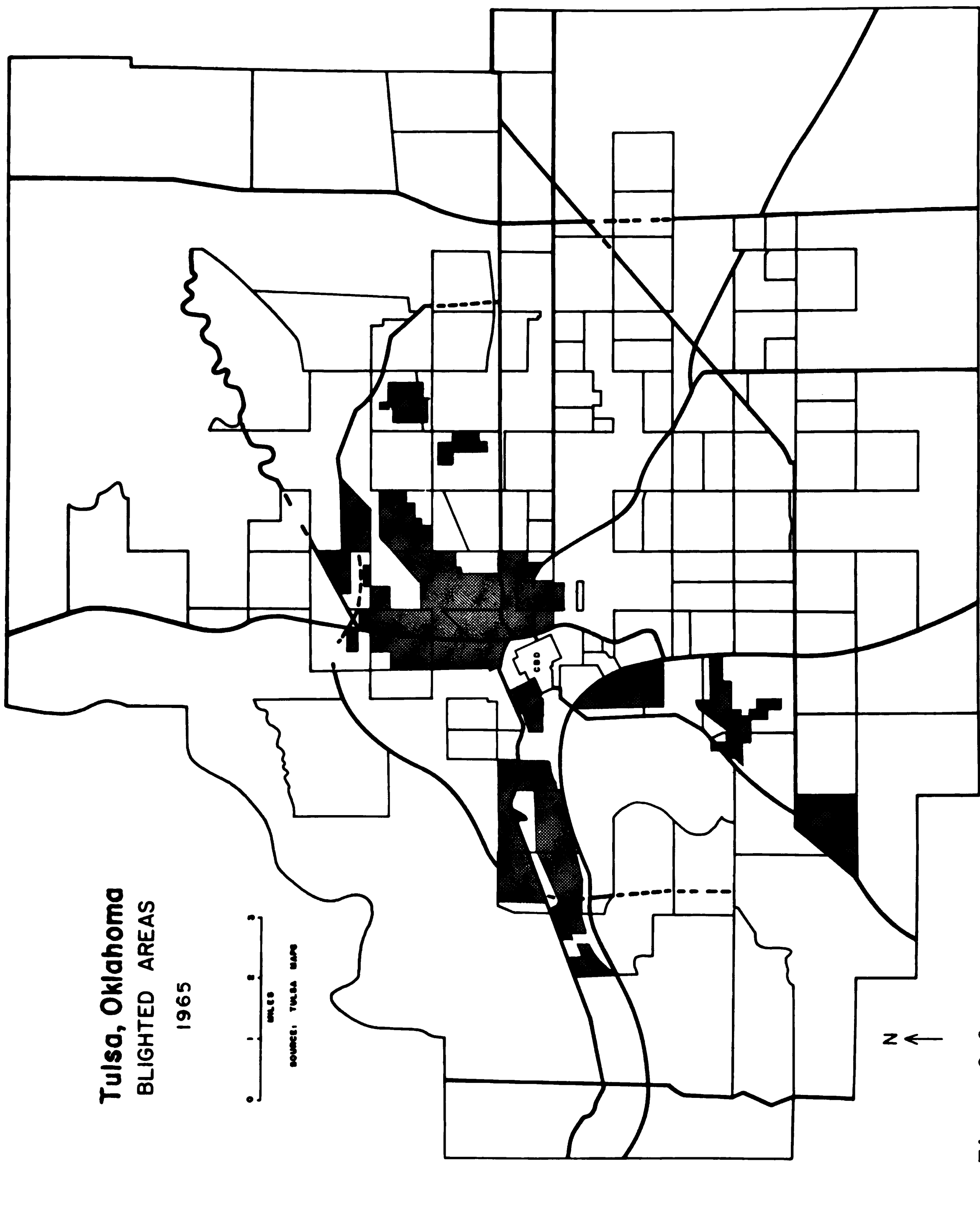
Tulsa, Oklahoma
BLIGHTED AREAS
1965
0 1 2 3
MILES
SOURCE: TULSA MAPS
CBD
N

Figure 3.2

A clarifying paragraph is warranted here. The 50 percent blighted dwelling figure chosen as a lower limit in the operationalization of this variable was an arbitrary one based primarily upon the availability of data. The Tulsa Planning Commission has a projected community renewal program for which this data has been collected in the field. A hierarchy of project areas has been set up for implementation and only analysis zones with 50 percent or more blighted buildings are included in the data tabulation.

2. Proximity to non-white areas (N): An historical review of land use maps for the Tulsa Metropolitan area indicates a striking rate of urban growth over the past 20 years (figure 3.3). However, there are two suburban sections of the city in which growth seems to have become stagnated. Both of these areas are suburban non-white centers of population surrounded by varying expanses of idle land. It is hypothesized that there is a measurable relationship between the distribution of idle land and the location of these non-white areas. Most fringe development is financed and developed for whites who are not willing to locate near non-white centers. Thus, it is hypothesized that as proximity to non-white neighborhoods increase, land allocated to idle use increases.

Operationally defined, (N) is the road distance from the population centers of each analysis zone to the nearest zone having 10 percent or more non-white population (figure 3.4).

The 10 percent criteria was chosen after a reasoned appraisal of the data. Empirical observation indicates that the percentage of non-whites per zone is either extremely low or extremely high. This was evidenced by the fact that no zone fell into the area of 20 to 75

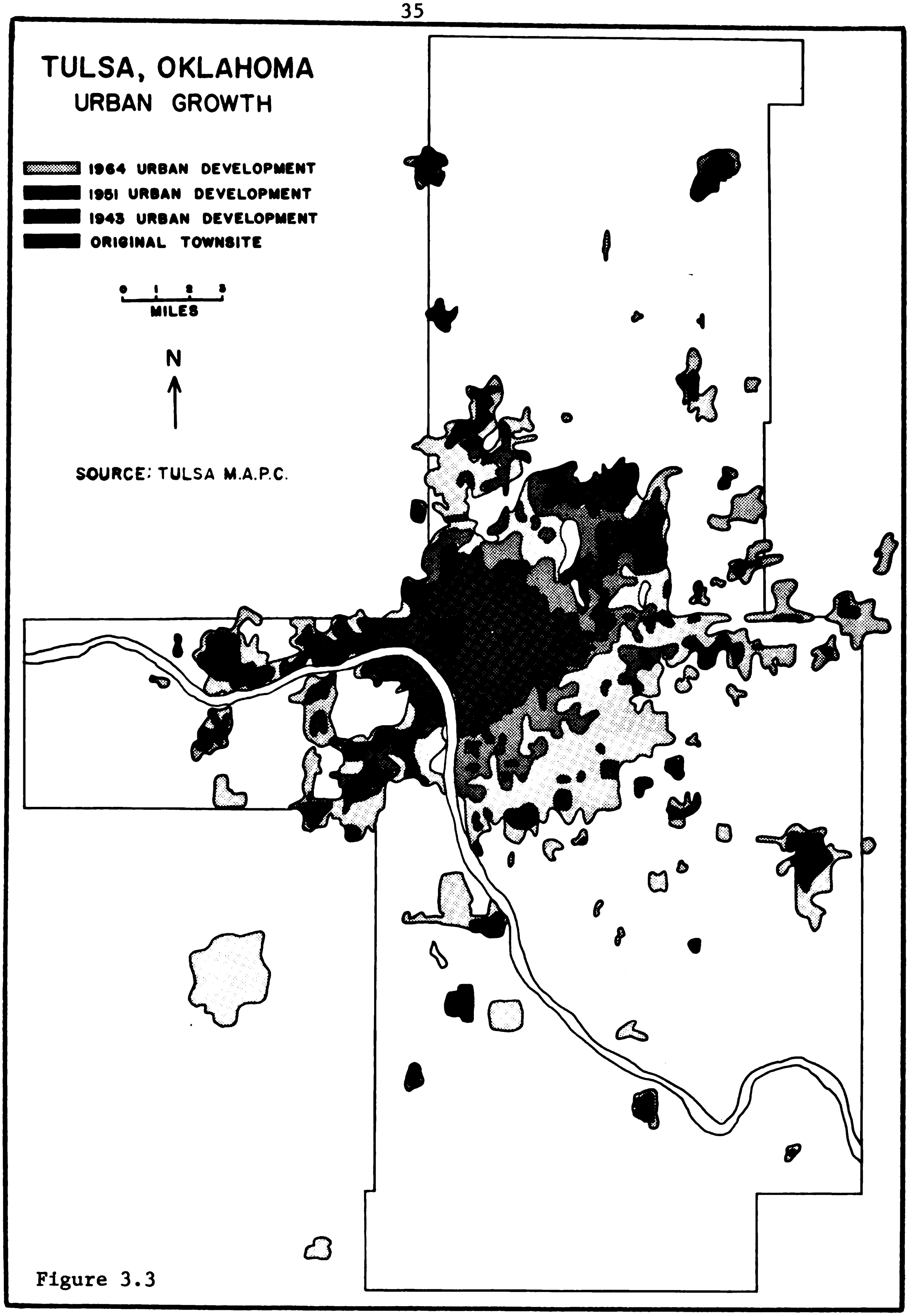
TULSA, OKLAHOMA
URBAN GROWTH
1964 URBAN DEVELOPMENT
1951 URBAN DEVELOPMENT
1943 URBAN DEVELOPMENT
ORIGINAL TOWNSITE
0 1 2 3
MILES
N
SOURCE: TULSA M.A.P.C.

Figure 3.3

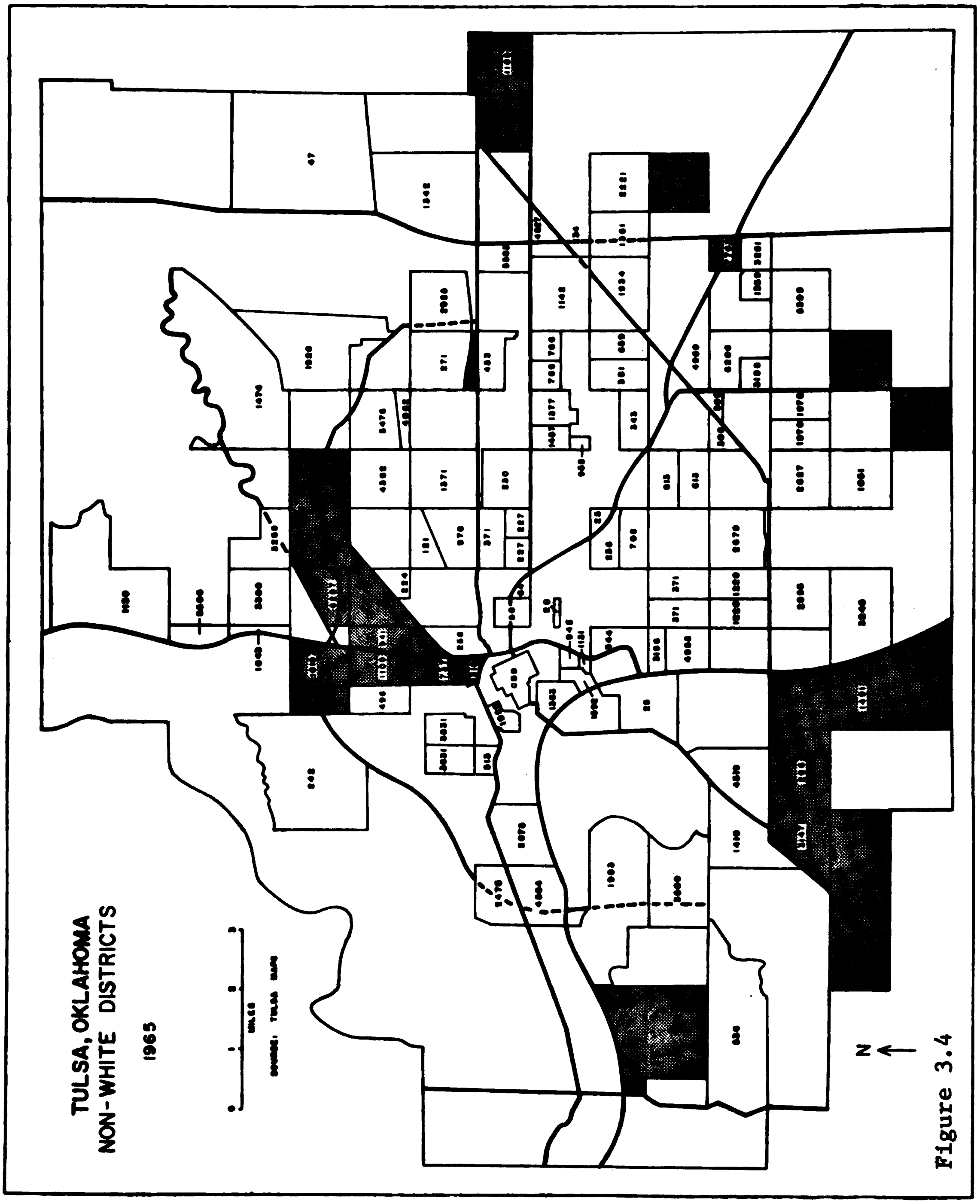
TULSA, OKLAHOMA
NON-WHITE DISTRICTS
1965
MILES
SOURCE: TULSA MAPS
N

Figure 3.4

percent non-white, all were either higher or lower. However, a minimum non-white percentage of 75 percent would exclude those areas currently in transition. Thus the data were scanned for a logical point at which the transitional zones might be defined. The 10 percent figure was determined to be the most representative.

INSTITUTIONAL VARIABLES

The final set of variables included in the study are those relating to zoning, taxes, and the availability of services. Evidence is present for each variable indicating the need for their inclusion in the analysis.

1. Assessed value (B): Much has been written about the effect of taxes on development and land use in urbanizing areas. It is generally accepted in the literature that one of the outgrowths of current tax policies is an increase in land speculation.[18] That is, taxes generally are higher on improvements than on idle land, encouraging the owner to hold the land in the face of rising land values in expectation of maximizing revenues upon liquidation at a later date. It follows, then, that a variable measuring the influence of taxation on the distribution of idle land should be included in this study. Since taxes and assessed valuation differ only by a constant, the millage rate, assessed valuation and not the tax itself is used in this analysis. However, the millage

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[18] Marion Clawson, "Urban Sprawl and Speculation in Suburban Land," Land Economics, XXXVIV (1962), p. 104.

rate may be constant only for designated areas and may, in effect, have a spatial pattern of its own reflecting the attitudes of dwellers within individual school districts. It is hypothesized that assessed valuations and the resultant higher taxes induce re-allocation of land from rural to urban uses at rates in excess of demand. Thus, as assessed valuation and taxes increase, the place to place variation in idle land increases.

Operationally defined (V) is the current assessed valuation of each analysis zone expressed as dollars per acre (Figure 3.5).

2. The availability of water (Wa): The Tulsa Metropolitan Planning Commission weighs heavily the availability of urban water services on their factor sheet concerning land development criteria.[19] Their field observations indicate a strong relationship between the availability of this service and fringe development. It is hypothesized that as trunk-water mains become accessible, the probability of land remaining idle decreases.

Operationally defined (Wa) is the "digging" distance from the population center of each analysis zone to the nearest available water trunk system, expressed in linear feet (Figure 3.6).

3. The availability of sewage lines (Sw): The argument presented above for water is also appropriate for sewage services. Further, the city

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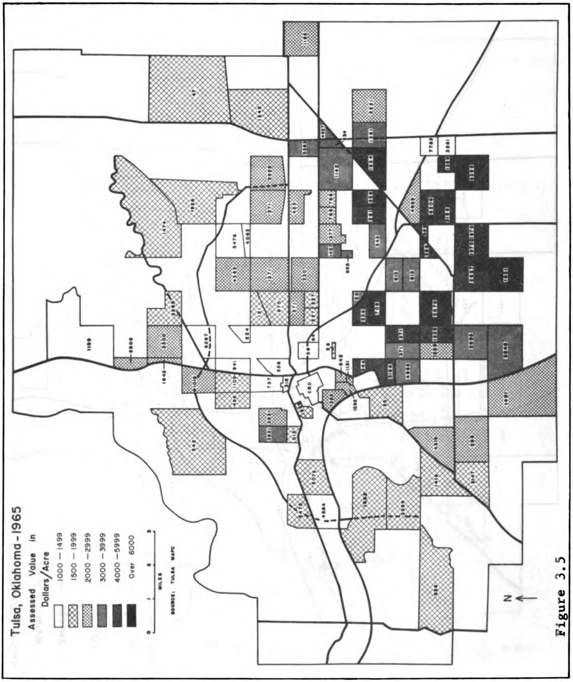
[19]Interview with C. Larry Tompkins, Chief, Long Range Planning Division, Tulsa Metropolitan Planning Commission, Tulsa, Oklahoma, November 16, 1965.



Tulsa, Oklahoma - 1965
Assessed Value in Dollars/Acre
1000 — 1499
1500 — 1999
2000 — 2999
3000 — 3999
4000 — 5999
Over 6000
MILES
SOURCE: TULSA MAPC
CBD
N

Figure 3.5

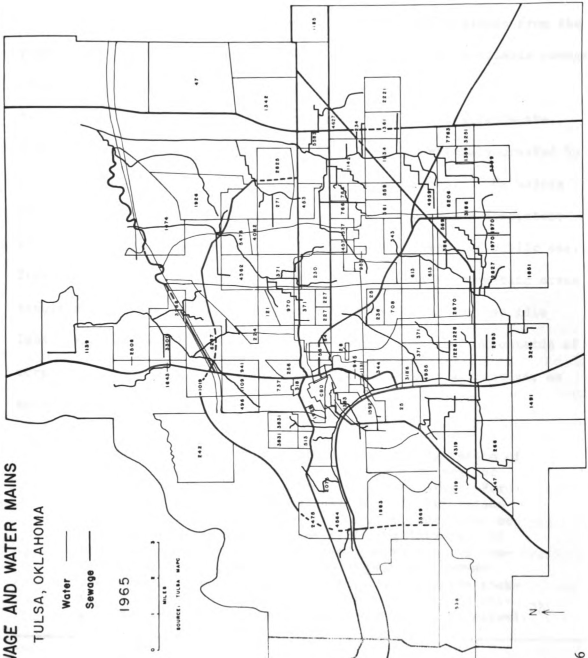

SEWAGE AND WATER MAINS
TULSA, OKLAHOMA
Water
Sewage
1965
MILES
SOURCE: TULSA MAPC
CBD
N

Figure 3.6

zoning code severely restricts the density of structures in areas not serviced by sewage facilities.[20]

Operationally defined, (Sw) is the "digging" distance from the population center of each analysis zone to the nearest available sewage trunk line, expressed in linear feet (figure 3.6).

4. Zoning protection (Z): Clawson states that zoning affects the distribution of land uses, primarily because of uncertainty created by changes brought about by political and other pressures.[21] He points out that even the courts do not always accept land values consistent with zoning regulations when private land is condemmed for public use. Thus, an imbalance is created in the attractiveness of competing areas resulting in urban sprawl; and sprawl, by definition, implies idle land. Further, differences in land use controls inside and outside of corporate limits make the lesser controlled area more attractive, as noted by Harvey and Clark:

> Perhaps the major problem with respect to regulation of land use in sprawl is that a regulatory body may not have control over an entire housing market area. For example, city zoning and land use controls may extend only to the corporate limits or, at best, one, two, or three miles depending upon the state regulations. If the standards of building and land use within the controlled area are greatly more stringent than common practices in the building industry, the standards themselves may impel the development of housing units outside the controlled area and these contribute to sprawl.[22]

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[20]Tulsa Metropolitan Planning Commission, Zoning and Property Restrictions (May, 1964).

[21]Clawson, pp. 101-102.

[22]R. D. Harvey and W. A. V. Clark, "The Nature and Economics of Urban Sprawl", Land Economics, XLI (1965), pp. 3-4.

Thus, it is hypothesized that ineffective zoning policies result in greater frequency of idle land than do effective zoning policies.

Operationally defined, (Z) is graded restrictions in use permitted in each analysis zone ranging from weak to strong controls expressed by the following scale (Figure 3.7).

1. = Single family residential, 13,500 sq. ft. minimum.
2. = Single family residential, 9,000 sq. ft. minimum.
3. = Single family residential, 7,000 sq. ft. minimum.
4. = Multiple dwellings.
5. = Restricted apartments (35 ft. height limitation).
6. = General apartments.
7. = Commercial.
8. = Industrial.

It is noted that this variable consists of ordered data, while all other variables are expressed numerically. It is recognized that by expressing the variable in ordered form, tests of significance are rendered unreliable and the beta value becomes meaningless because the data are not normally distributed. However, due to the non-continuous nature of this variable, it was necessary to resort to ordered data if it was to be included in the mix.

The number of variables selected as predictors may seem rather large. It is emphasized, however, that the selection of these variables does not represent a haphazard "shotgun approach", but rather are those which have been found to be significant in related studies concerning land use behavior.[23] The degree to which they are spatially associated with the dependent variable and thereby provide a satisfactory explanation of the areal variation of idle land will be revealed by the subsequent statistical analysis.

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[23] Chapin and Weiss.

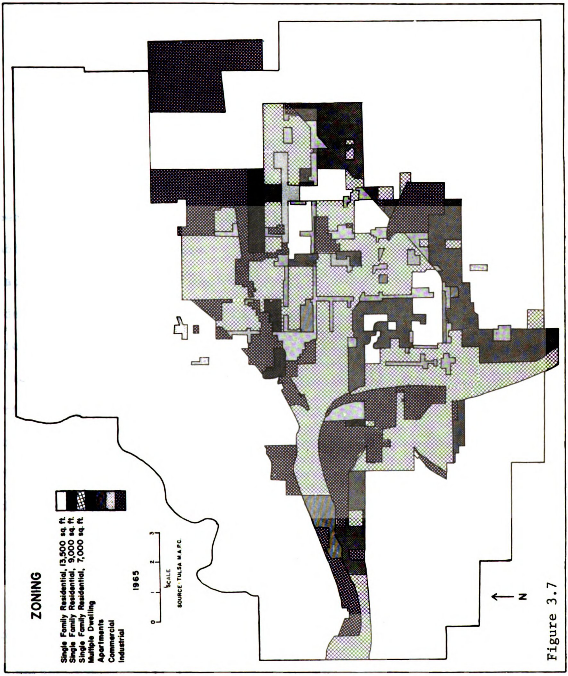
ZONING
Single Family Residential, 13,500 sq. ft.
Single Family Residential, 9,000 sq. ft.
Single Family Residential, 7,000 sq. ft.
Multiple Dwelling
Apartments
Commercial
Industrial
1965
0 1 2 3
SCALE
SOURCE: TULSA M.A.P.C.
N

Figure 3.7

CHAPTER IV

AN EMPIRICAL TEST OF THE MODELS

Empirical studies, such as this one, have the capability of specifying and testing the relationships existing among the observable phenomena in question. Hence, those multivariate techniques that permit simultaneous handling of many variables can be of considerable value in research of this type. This study will be one which attempts to handle the explanation of the spatial variation of idle land in a multivariate framework. The amount of unexplained variation in the dependent variable (idle land) will be indicative not only of the usefulness of the operational definitions used in this study, but also for the relative importance of variables chosen and those which have been neglected.

IDLE LAND AND THE ACCESSIBILITY VARIABLES

In order to systematize the discussion, this section and those that follow will be broken into two parts, one dealing with the hypothesis structure and the other with the results of the linear relationships between the dependent and predictor variables.

HYPOTHESIS STRUCTURE

A fundamental part of this research is the attempt to gain greater discrimination in the use of predictor variables as means of explaining the location of idle land, for it is possible that collinearity exists between some of them. Several variables may measure an attribute of a system in a similar way, and, in some cases, the hypothesis suggested here will cover more than one variable. The presence of idle land is related:

1. directly with the distance to the CBD(H) and distance to the nearest major shopping center (C). These variables are measures of the importance of location with respect to consumer shopping habits. Closeness to shopping areas reduces the time required for shopping trips.

2. directly to distance from a major access route (S). Closeness to an access route reduces the friction of distance and thus the travel time required for trips of all types.

3. directly to distance from place of employment. According to Carroll, workers spend more time in trips from home to work than any other type.[1]

4. directly to distance from elementary schools. Closeness to schools relieves the need for the transportation of children, thus reducing the number of trips a family must make every day.

Thus a general hypothesis can be stated as follows: The closer a unit of land is located with respect to the presence of the above variables, the less likely the occurrence of idle land.

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[1]Douglas J. Carroll, Jr., Home-Work Relationships of Industrial Employees: An Investigation of Relationships of Living and Working Places for Industrial Employees with Attention to Implications for Industrial Siting and Planning, (Unpublished Doctoral Dissertation, Department of Sociology, Harvard University, 1950).

LINEAR RELATIONSHIPS[2]

1. Table 4.1 shows that the simple correlation coefficients for both distance from the CBD and distance from the nearest shopping center are positive and significant at the five percent confidence level. In a study of this nature that involves the description of relationships not previously tested, the statistical significance of a coefficient as against its "physical significance" might be different. However, this is a subject that is exceedingly complex and for this research the statistical significance will be the only guideline.

2. Distance from a major access route is also positive and significant at the 5 percent level as evidenced by the simple correlation coefficient (*r*) of 0.2189.[3] However, the effect of this variable is not as strong as anticipated.

3. Distance from place of employment is the measure within this section that best explains the distribution of idle land. The farther land is located from the median point of employment, the more likely some of it will be idle. This statement is supported by the *r* of 0.5663.

4. Of the four variables hypothesized in this section, only distance to the nearest elementary school failed to be statistically significant. While positive, the *r* of 0.1203 fell considerably short of

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[2]The figures used in this section refer to the hypothesis structure (above) and the results of the linear equations will be discussed under these figures.

[3]Hereafter the simple correlation coefficient will be represented by the symbol *r*.

TABLE 4.1

RELATIONS BETWEEN IDLE LAND AND THE ACCESSIBILITY VARIABLES

		r
1.	Distance to the Central Business District	0.3999*
2.	Distance to the nearest shopping center	0.4398*
3.	Distance to the median point of employment	0.5663*
4.	Distance to the nearest major access route	0.2189*
5.	Distance to the nearest elementary school	0.1203

*Significant at the 5% level

significance at the 5 percent level. This result was contrary to our hypothesis and seems to be inconsistent with the theoretical structure and evidence stated in Chapters I and III. Further examination of this variable is warranted in subsequent research.

IDLE LAND AND THE SOCIAL VARIABLES

HYPOTHESIS STRUCTURE

The relationship between idle land and the two social variables can be stated as: Idle land is negatively associated with distance from non-white population centers (N) and distance from areas of blight (B). These hypotheses are based on the reasoning that closeness to such socially undesirable areas retards land development. Both variables are designed to measure this relationship.

LINEAR RELATIONSHIPS

The "non-white center" distance variable is the one which best explains idle land variation, as evidenced by a negative correlation coefficient $\underline{r}$ of -0.2586 (Table 4.2). The other variable, distance to the nearest blighted area, is not significant, and shows a reverse relationship from the one hypothesized.

IDLE LAND AND THE INSTITUTIONAL VARIABLES

HYPOTHESIS STRUCTURE

The distribution of idle land is related:

1. directly with assessed value (V). Assessed evaluation measures the importance of tax structures on land use. The higher the assessed

TABLE 4.2

RELATIONS BETWEEN IDLE LAND AND THE SOCIAL VARIABLES

		r
1.	Distance to the nearest non-white center	-0.2586*
2.	Distance to the nearest blighted area	0.0769

*Significant at the 5% level

evaluation, the higher the taxes and thus more idle land.

2. directly with distance from the nearest sewage main (Sw) and distance from the nearest water main (Wa). The extension of these urban services into an area speeds development and reduces idle land.

3. directly with zoning (Z). Zoning contributes to urban sprawl by imbalancing the attractiveness of competing areas, and sprawl, by definition, implies idle land.

LINEAR RELATIONSHIPS

1. Assessed value is not significant and has a reverse relationship from that hypothesized (Table 4.3). Oklahoma land taxes are among the lowest in the nation, thus, this result should not be over generalized to other more heavily taxed parts of the country. Further, these results may be a reflection of the acceptance of assessed value as a substitute for taxes. This result does, however, indicate that there may have been an over tendency among researchers in the past to place the blame for inefficient land allocation on present tax structures.

2. Variables Sw and Wa are both positively related to idle land in the manner hypothesized. However, only distance from the nearest water main proved to be significant at the 5 percent level. On the other hand, distance from the nearest sewage main is very nearly significant and these results imply that such facilities have an important predictive role to play in the explanation of idle land variation.

3. The zoning variable proves to be the most significant of this set

TABLE 4.3

RELATIONS BETWEEN IDLE LAND AND THE INSTITUTIONAL VARIABLES

		r
1.	Assessed value	-0.0389
2.	Distance from nearest sewage main	0.1592
3.	Predominant zoning type	0.4863*
4.	Distance from nearest water main	0.2706*

*Significant at the 5% level

with a positive simple correlation coefficient r of 0.4863. This may be explained by the fact that this variable is the one which best measures the positive impact of industry on idle land variation.

TRANSFORMATION OF THE DATA

All of the variables were tested for linearity by the use of scattergrams and for normality by the use of fractile diagrams.[4] The following variables were transformed by use of logarithms:

assessed value
distance to the nearest major access route
distance to the nearest elementary school
distance to the nearest blighted area
distance to the nearest urban sewage main
distance to the nearest urban water main

THE MULTIVARIATE PROCESS MODELS

The groups of variables analyzed above will now be used as the basis for the construction of a series of models. Amorocho and Hart[5] and Roberts[6] have used parametric models as an approach toward seeking the understanding of physical systems. The following extract from Amorocho and Hart was originally designed for their

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[4]A. Hald, Statistical Theory with Engineering Applications (New York: John Wiley and Sons, 1952), pp. 119-158.

[5]J. Amorocho and W. E. Hart, "Critique of Current Methods in Hydrologic Systems Investigation", Trans. Int. Geography Union, Vol. 45 (1964), pp. 307-321.

[6]Michael C. Roberts, The Spatial Variation of Slopes and Associated Climatic and Watershed Variables (Unpublished Ph.D. Dissertation, University of Iowa, Iowa City, 1966).

discussion of hydrologic systems, yet it applies equally as well to cultural geography:

> The methods of correlation analysis are powerful tools when applied to the test of well defined hypotheses in many fields of physical hydrology. They also have legitimate applications when the purpose of the analysis is to evaluate physical parameters in the experimental study of systems that are well defined by functional relationships obtained independently (p. 311).

The functional relationships in the present work are set forth earlier in this chapter.

The approach of Amorocho and Hart is adopted here for the description of a cultural system. These models will permit the part played by different variables to be examined with regards to their statistical significance in explaining the variation in the criterion variable. Further, the existence of collinearity between some of the variables has already been mentioned, but it is necessary in this part of the analysis to specify which variables are involved. The actual plan of the analysis is shown in Appendix A.

THE MODELS

The models developed from the total hypothesized variable mix can be listed as follows:

1. The Accessibility Model
2. The Social Model
3. The Institutional Model

Each of the models will be discussed in turn.

Accessibility model: The variables incorporated are those that deal specifically with the accessibility of places. The general hypotheses for this set of variables states that as accessibility increases with regard to schools, shopping areas, and places of employment, the probability that idle land will exist decreases. Land adjacent to a shopping center or school would be much less likely to remain idle than land located farther away. Symbolically stated, the model reads

$$Ii = a + b_1Hi + b_2Ci + b_3Wi + b_4Si + b_5Ei + e$$

Where

I is the transformed square footage of idle land per analysis zone.

H is the distance from the population center of the ith analysis zone to the high value corner in the CBD, expressed to the nearest 0.1 mile.

C is the distance from the population center of the ith analysis zone to the nearest shopping center, expressed to the nearest 0.1 mile.

W is the distance from the population center of the ith analysis zone to the median point of employment for the city, expressed to the nearest 0.1 mile.

S is the distance from the ith analysis zone along the nearest collector street to the closest state or federal highway, major street or county highway, expressway or turnpike, expressed to the nearest 0.1 mile.

and a, b_1, ..., b_5 are emperically determined parameters, i = 1, 2, ... , 100, and e is the random error term.

However, since quadratic transformations were used for the variables Hi and Si in order to meet the assumptions of the model, the equation is altered to

$$Ii = a + b_1(Hi)^2 + b_2Ci + b_3Wi + b_4(Si)^2 + b_5Ei + e$$

The step-wise procedure is illustrated with respect to the multiple correlation coefficients (Table 4.4). In Step 1, the work place variable, b_3W, is introduced because it has the highest partial correlation coefficient (0.57), of the five variables considered. At this point, the partial correlation of 0.57 indicates that 57 percent of the variation in the distribution of idle land is explained by distance from the median point of employment for the city.

In Step 2, b_5E, distance from schools, enters as the next most important variable with a partial correlation of 0.15. The multiple correlation coefficient (R) is now 0.59 or an increase of about 2 percent over Step 1.[7] In the final step, after all of the variables have been entered, the equation yields an R of 0.65, indicating that 65 percent of the variation of idle land can be "explained" by the five independent variables.

Table 4.5 shows the simple correlation coefficients for the five independent variables. Note that the distance from the median place of employment variable appears to be rather highly inter-correlated with the distance from the CBD variable. This is due to the fact that the two points are located in fairly close proximity to one another within the city. However, it intuitively appears that both variables should be included in the equation because of their different characteristics. While it is recognized that the CBD is a major area of employment, it is also understood that there are numerous other motivations behind trips to the CBD, such as entertainment, professional

[7]Hereafter the multiple correlation coefficients will be represented by the symbol R.

TABLE 4.4

STEP-WISE PROCEDURAL MODEL FOR ACCESSIBILITY VARIABLES

	Variable	Partial Corr. Coefficient	Standard Error	R
Step 1	b_3Wi	0.57	79.83	0.56630
Step 2	b_5Ei	0.15	0.01	0.58538
Step 3	b_1Hi	-0.39	128.34	0.61888
Step 4	b_2Ci	0.18	175.06	0.63508
Step 5	b_6Hi*	-0.53	32.08	0.64441
Step 6	b_1Hi(removed)			0.64403
Step 7	b_9Si**	0.09	0.00000	0.64945

$$I = -983.28 + 42036b_2 + 698.57b_3 + 0.00000b_4 + 0.039b_5$$

*b_6Hi is the quadratic of b_1Hi.

**b_9Si is the quadratic of b_4Si.

TABLE 4.5

SIMPLE CORRELATION MATRIX

	Idle Land	CBD	Shopping Centers	Employment	Access	School
Idle Land	-	0.40*	0.44*	0.57*	0.22*	0.12
CBD		-	0.57	0.82	0.23	0.23
Shopping Center			-	0.61	0.23	0.00
Employment				-	0.21	-0.05
Access					-	0.12
School						-

*Significant at the 5% level

visits, and shopping. Further, most trips to the CBD are simply people going to the other side of town.

The analysis of the equation indicates a significant association between the variable mix and the dependent variable -- idle land. However, it should be noted that the addition of the access variable (Si) to the mix had little impact on the explanation and might warrant removal from the mix. The reason for the ineffectiveness of this variable is not known. However, this result is contrary to our hypothesis which is based upon current theory, and thus deserves attention in subsequent research. The final model is

$$I = -983.29 - 36.02b_1 + 420.36b_2 + 698.57b_3 + 0.00001b_4 + 0.039b_5$$

Social model: The social model is one which measures the relationship of purely social phenomena to land use decisions. The variables included here are distance from non-white and blighted areas. Both variables are hypothesized to be negatively associated with idle land. Thus, because of social disbenefits, the nearer land is located to such centers, the more likely it will be idle. Of the three models examined, the social model, while significant, appears to be the least important in terms of explaining variation in the criterion variable. The model is

$$Ii = a + b_1Ni + b_2Bi + e$$

Where

I is the square footage of idle land per analysis zone.

N is the distance from the population center of the ith analysis zone to the nearest non-white area, expressed to the nearest 0.1 mile.

B is the distance from the population center of the ith analysis zone to the nearest blighted area, expressed to the nearest 0.1 mile.

and a, b_1, and b_2 are empirically determined parameters, e is the random error term, and i = 1, ..., 100.

Once again, however, a quadratic transformation changes the equation to

$$Ii = a + b_1(Ni)^2 + b_2Bi + e$$

Table 4.6 indicates that the step-wise procedure resulted in an <u>R</u> of 0.36, showing that while there appears to be a significant relationship between the independent variables and the criterion variable, it is at best a rather weak one. The correlation matrix (Table 4.7) substantiates this analysis, showing a weak, but nevertheless statistically significant, correlation between the non-white variable and idle land. Although the blight variable did not prove to be significant, it did make a notable improvement in the <u>R</u>, and thus was retained for the final mix.

The equation is

$$I = 1152.56 - 0.0001b_1 + 0.05702b_2$$

The Institutional model: The variables included in this model are those which attempt to measure the relationship of institutional decisions to land use. For example, what effect does the extension of urban water facilities have on land use? The hypothesis suggests that such an extension would result in a reduction of idle land. Another hypothesis is that any increase in assessed value on

TABLE 4.6

STEP-WISE PROCEDURAL MODEL FOR SOCIAL VARIABLES

	Variable	Partial Corr.	Stand. Error	R
Step 1	b_3Ni*	-0.23	0.0000	0.25858
Step 2	b_2Bi	0.19	0.0148	0.35953

$$I = 1152.56 - 0.0001b_1 + 0.05702b_2$$

*Variable b_3Ni is a quadratic of b_1Ni.

TABLE 4.7

SIMPLE CORRELATION MATRIX

	Idle Land	Non-White	Blight
Idle Land	-	-0.20*	0.08
Non-White		-	0.02
Blight			-

*Significant at the 5% level

property would result in an increase in idle land. The equation is as follows

$$Ii = a + b_1Vi + b_2Swi + b_3Zi + b_4Wai + e$$

Where

I is the square footage of idle land per analysis zone (log e).

V is the assessed value at the ith place, by analysis zone (log e).

Sw is the distance from the ith analysis zone to the nearest urban sewage main, expressed to the nearest 0.1 mile (log e).

Z is the predominent zoning type of the ith analysis zone, expressed in ordered form from 1 to 10.

Wa is the distance from the population center of the ith analysis zone to the nearest urban water main, expressed to the nearest 0.1 mile (log e).

and a, b_1, ..., b_4 are empirically determined parameters, i = 1, 2, ..., 100, and e is the random error term.

A quadratic fit of the zoning variable (Z) changed the above equation to

$$Ii = a + b_1Vi + b_2Swi + b_3(Zi)^2 + b_4Wai + e$$

Table 4.8 shows that the application of this model yields statistically significant results. The multiple correlation coefficient (R) of 0.66 indicates that the relationship between the institutional variables is well within the bounds of statistical significance. The equation is

$$I = -846.18 + 92.89b_1 + 0.65045b_2 + 39.34b_3 + 0.22211b_4$$

TABLE 4.8

STEP-WISE PROCEDURAL MODEL FOR INSTITUTIONAL VARIABLES

	Variable	Partial Corr.	Stand. Error	R
Step 1	b_7Zi	0.49	6.12	0.48627
Step 2	b_4Wai	0.32	0.03	0.58027
Step 3	b_2Swi	0.19	0.07	0.63308
Step 4	b_1Vi	0.09	76.87	0.66173

$$I = -846.18 + 92.89b_1 + 0.65045b_2 + 39.34b_3 + 0.22211b_4$$

*b_7Zi is the quadratic of b_3Zi.

TABLE 4.9

SIMPLE CORRELATION MATRIX

	Idle Land	Assessed Value	Sewage	Zoning	Water
Idle Land	-	-0.04	0.16	0.48*	0.27*
Assessed Value		-	-0.10	-0.08	-0.06
Sewage			-	-0.14	0.55
Zoning				-	-0.11
Water					-

*Significant at the 5% level

The results and the value of the three process models is that they show, as individuals, that they provide only a partial explanation of the variation of idle land. When these process variables are combined into a "final" model, however, it is reasonable to expect somewhat better reliability in terms of "explaining" this distribution.

THE COMBINATORIAL MODEL

It has been demonstrated that variation of idle land can only be partially explained on the basis of the process models alone. Thus, it is necessary to combine these models into a Combinatorial model in hope of increasing the amount of "explanation".

VARIABLES SELECTED FOR THE FINAL MODEL

Because of the selective nature of the step-wise procedure, and because one can never be sure how a variable will react when in association with other variables, all eleven of the original hypothesized variables will be included in the initial model, even though the weakness of some of them has been previously demonstrated.

The variables are

1. distance to the CBD (H)
2. assessed value (V)
3. distance to the nearest non-white zone (N)
4. distance to the nearest shopping center (C)
5. distance to the median point of employment (W)
6. distance to the nearest major access route (S)
7. distance to the nearest elementary school (E)
8. distance to the nearest area of blight (B)
9. distance to the nearest urban sewage main (Sw)
10. zoning (Z)
11. distance to the nearest urban water main (Wa)

The links between these factors and place to place variation of idle land, if not always explicit, is at least apparent. While it is not necessary to repeat the hypotheses once again, some general observations are in order.

The fact that idle land is closely related to distance from places of work, schools, entertainment, and shopping facilities is a strong indication of the importance of the social and economic costs of this distance. Moreover, the availability of urban services seems to play an important role in land use decisions. These variables will be examined in the following section.

THE STEP-WISE PROCEDURE FOR THE FINAL MODEL

For the sake of convenience, all eleven variables are regarded as part of the Combinatorial model. The equation is

$$Ii = a + b_1Hi + b_2Vi + b_3Ni + b_4Ci + b_5Wi + b_6Si + b_7Ei + b_8Bi + b_9Swi + b_{10}Zi + b_{11}Wai + e$$

Where

I is the square footage of idle land per analysis zone.

H is the distance from the population center of the ith analysis zone to the high value corner in the Central Business District, expressed to the nearest 0.1 mile.

V is the assessed value at the ith place by analysis zone ($\log_e$).

N is the distance from the population center of the ith analysis zone to the nearest non-white area, expressed to the nearest 0.1 mile.

C is the distance from the population center of the ith analysis zone to the nearest non-white area, expressed to the nearest 0.1 mile.

W is the distance from the population center of the ith analysis zone to the median point of employment for the city, expressed to the nearest 0.1 mile.

S is the distance from the ith analysis zone along the nearest collector street to the closest state or federal highway, major street or county highway, expressway, or turnpike, expressed to the nearest 0.1 mile ($\log_e$).

E is the distance from the population center of the ith analysis zone to the nearest elementary school expressed to the nearest 0.1 mile ($\log_e$).

B is the distance from the population center of the ith analysis zone to the nearest area of blight, expressed to the nearest 0.1 mile ($\log_e$).

Sw is the distance from the ith analysis zone to the nearest urban sewage main, expressed to the nearest 0.1 mile ($\log_e$).

Z is the predominent zoning type of the ith analysis zone, expressed in ordered form from 1 to 10.

Wa is the distance from the population center of the ith analysis zone to the nearest urban water main, expressed to the nearest 0.1 mile ($\log_e$).

and a, b_1, ..., b_{11} are empirically determined parameters, i = 1, 2, ..., 100, and e is the random error term. Quadratic transformations changed the equation to

$$Ii = a + b_1Hi + b_2(Vi)^2 + b_3(Ni)^2 + b_4Ci + b_5Wi + b_6Si + b_7Ei + b_8Bi + b_9(Swi)^2 + b_{10}(Zi)^2 + b_{11}Wai + e$$

The results of the step-wise regression are illustrated by Table 4.10. The CBD variable (b_1Hi) was omitted from the mix since an inter-correlation of 0.82 with the employment variable was too large for the program to justify the presence of both variables. The CBD variable was the weaker of the two, and, thus, it was deleted.

TABLE 4.10

STEP-WISE PROCEDURE OF THE COMBINATORIAL MODEL

Variable	Partial Corr.	Stand. Error	R
Step 1 $b_5 Wi$	0.57	79.83	0.57
Step 2 $b_{10} Zi$	0.39	5.23	0.68
Step 3 $b_3 Ni$	-0.21	0.00	0.71
Step 4 $b_7 Ei$	0.18	0.01	0.73
Step 5 $b_8 Bi$	-0.33	0.01	0.78
Step 6 $b_4 Ci$	0.21	137.99	0.80
Step 7 $b_9 Swi$	-0.22	0.00	0.82
Step 8 $b_2 Vi$	0.15	0.00	0.83
Step 9 $b_6 Si$	0.12	0.02	0.84
Step 10 $b_{11} Wai$	0.09	50.09	0.85

$$I = -4093.31 + 0.00002b_2 + 0.00001b_3 + 552.55b_4 + 488.27b_5 + 0.04618b_6 + 0.06030b_7 - 0.05789b_8 + 0.00001b_9 + 17.22366b_{10} - 0.05357b_{11}$$

The model is

$$I = -4093.31 + 0.00002b_2 + 0.00001b_3 + 552.55b_4 + 488.27b_5 + 0.04618b_6 + 0.0603b_7 - 0.5789b_8 + 0.00001b_9 + 17.22366b_{10} - 0.05357b_{11}$$

At this point it appears useful to see whether the rather large number of eleven variables can be reduced to a smaller number without significant loss of power in terms of explanation. It is pointed out that the goal here is not necessarily to maximize the amount of "explanation" (R), but to determine the more important variables, while maintaining significant "explanation". Table 4.11 indicates the effect of deleting one variable per run of the regression equation, while Table 4.12 shows which variable was eliminated.

A fundamental problem of this analysis arises when attention is focused upon the question of where the elimination process should be stopped. One possibility is to test to see if a significant difference exists between the first R and the remaining ones. However, this statistical discrimination is not regarded as the solution in the present problem, because it is believed that the physical meaning of the variables must be taken into consideration. If R^2 differences between the models are examined, it will be seen that between the complete model and three deletions, the drop in explanation is 5 percentage points; while the drop is 8 percentage points with four deletions, and 11 percentage points with five deletions. At six deletions the drop is 19 percentage points and at seven deletions the difference from the complete model is 27 percentage points. The choice to be made rests with the four and five deletion models since the removal of one variable from the five

TABLE 4.11

COMBINATORIAL MODEL - ELIMINATION SEQUENCE

	R^2	R
All Variables	.72	.85
One Deletion	.71	.84
Two Deletions	.69	.83
Three Deletions	.67	.82
Four Deletions	.64	.80
Five Deletions	.61	.78
Six Deletions	.53	.73
Seven Deletions	.45	.68

TABLE 4.12

IDENTIFICATION OF ELIMINATED VARIABLES IN ORDER OF REMOVAL

All Variables	
One deletion	distance to water main
Two deletions	distance to access route
Three deletions	assessed value
Four deletions	distance to sewage main
Five deletions	distance to shopping center
Six deletions	distance to blight
Seven deletions	distance to school

deletion to the six deletion model results in drop of 8 percentage points in terms of $\underline{R}^2$, a much greater difference than that for any other variable deletion.

There is no hard and fast rule to follow here which will aid in deciding whether the fourth or fifth deletion model should be selected. Thus the choice becomes largely a matter of deciding whether to reduce the complexity of the model or to retain the more significant explanation. However, the simple correlation analysis presented in tables 4.5 to 4.6 indicates that the fifth variable to be deleted, distance to the nearest shopping center, is significantly related to idle land. Thus it is decided to retain this variable in the mix, selecting the four deletion model as final. This model can be expressed as

$$\begin{aligned} Y = {} & -1848.0154 - 0.00001b_3\ (N) + 363.0089b_4\ (C) + \\ & 468.1075b_5\ (W) + 0.0496b_7\ (\log E) + 0.0499b_8\ (\log B) \\ & 30.1981b_{10}\ (Z) \end{aligned}$$

AN EXAMINATION OF THE RESIDUAL BEHAVIOR IN THE FINAL MODEL

In addition to the final model, residuals from regression should be examined as outlined by Thomas.[8] Residual maps are constructed in order to portray the spatial variation of the amount of explanation given by the regression model, thus making the results more explicit. Further, these residual maps can be the basis for the formulation of new hypotheses.

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[8] E. N. Thomas, Maps of Residuals from Regression: Their Characteristics and Uses in Geographic Research (Iowa City, University of Iowa: Department of Geography, Mono. No. 2, 1960).

The map constructed here is of the form Yc - Y/Syc used by Roberts and Rummage.[9] Following this procedure, the positive values are those which are underpredicted, whereas the negative values are overpredicted.

The residuals resulting from the final equation are shown in Figure 4.1. The residuals are rather difficult to examine because of the lack of any really distinguishable pattern. Some observations are in order, however.

The section of the city in which the equation generally seems to be the least effective is the southwestern quadrant. While both underprediction and overprediction are found here, the behavior of the residuals for two analysis zones stand out over the others in their obvious underprediction. Underprediction indicates that the final model is inadequately computing the presence of idle land. Existing land use maps and field observations indicate two possibly significant factors which might help in explaining these deviations. First, this entire section of the study zone is separated from the city proper by the Arkansas River. The influence of this physical barrier on land use in general and idle land in particular has interesting implications which are not measured by the final equation. For example, it is possible that a relationship exists between accessibility to bridges and idle land. Secondly, this section of the city is largely industrial, indicating the possibility that the variables chosen did not adequately account for industrial influence on idle land.

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[9] Michael C. Roberts and Kennard W. Rummage, "The Spatial Variations of Urban Left-Wing Voting in England and Wales in 1951", Annals of the Association of American Geographers (Vol. 55, March, 1965), p. 170.

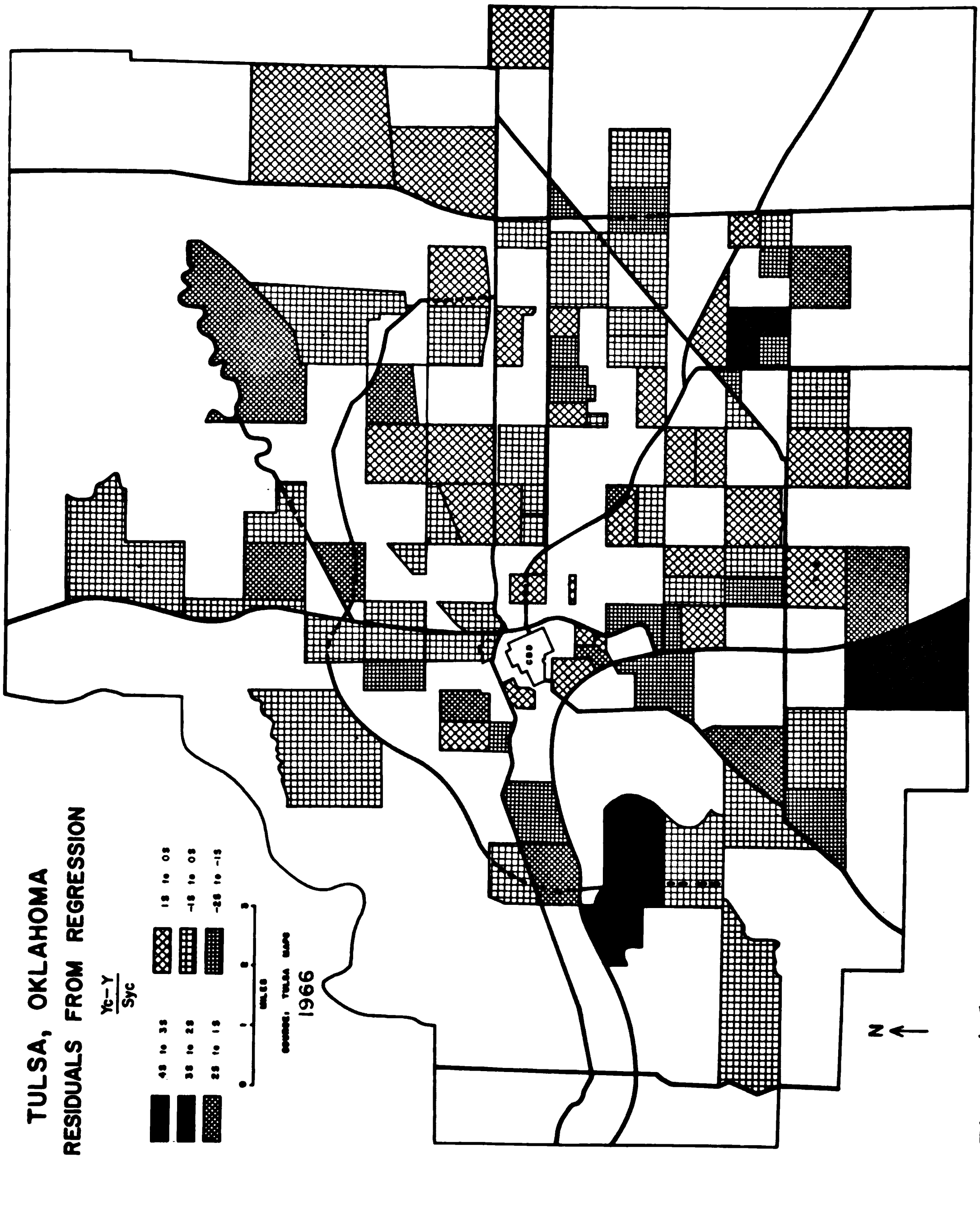

Figure 4.1

The rest of the study area is relatively well predicted, with the only observable pattern being the general overprediction of the zones to the north of the CBD. A factor that may be of importance here is that the rate of growth in the northern sectors of the city is considerably less than to the south and southeast. This is due to topographic features, plus a problem of land ownership stemming from old Indian reservation lands.

A poorly predicted zone in the southeastern quadrant presents an anomaly which is difficult to explain. This zone lies in an area which has been undergoing rather rapid growth since the establishment of a new freeway system in 1964, but which also is adjacent to a predominently Negro suburb. The most obvious explanation is the location of the zone with respect to the Negro district. However, this should have been accounted for by the non-white (N) variable in the equation, since the variable seems to have proven significant in the other sectors in the city. Thus, at present there is no satisfactory explanation for the underprediction of this zone.

The deviant cases mentioned above generate questions which must be answered by future studies. An attempt has been made here to find plausible explanations for some of these deviations, but whether or not there are any underlying regularities among them cannot be stated. One of the more interesting problems posed is the relationships of accessibility to bridges or tunnels to type of land use.

CHAPTER V

CONCLUSION

Place to place variation of idle land within Tulsa, Oklahoma, is the result of many factors about which there are varying degrees of *a priori* knowledge. This study has isolated some of the major variables; and its success is shown by the amount of explanation that is yielded by the final model.

Isard's notion that land use within an urban area can be explained by:

> (1) effective distance from the core (CBD); (2) accessibility of the site to potential customers; and... (3) proximity to land devoted to an individual use or set of uses which are complementary in terms of both attracting potential customers and cutting costs...[1]

is in fact the concept behind which the bulk of this study is formulated.

The processes that are acting upon land use, and idle land in particular, are considered to be so closely related and responsive to changes in any one variable that a land use pattern will quickly readjust after a change. This is an important concept, because it may allow predictions to be formulated concerning the impact of the construction, for example, of a shopping center on present land use patterns. If the

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[1]Walter Isard, *Location and Space - Economy: A General Theory Relating to Industrial Market Areas, Land Area, Trade and Urban Structure* (Cambridge: The M. I. T. Press, 1956), p. 26.

equations are predictive, their reliability will be reflected by the significance of the multiple correlation coefficient for each model.

Of the three models tested independently, the accessibility and institutional models show the best results with multiple correlation coefficients (*R*) of 0.65 and 0.66 respectively. The social model, while significant, was rather weak in explanation with an *R* of 0.36. Thus the problem of adequate hypothesis formulation is well illustrated, showing the need for the expansion of the three types. This was accomplished in the combinatorial model with a total mix of eleven variables yielding an *R* of 0.85.

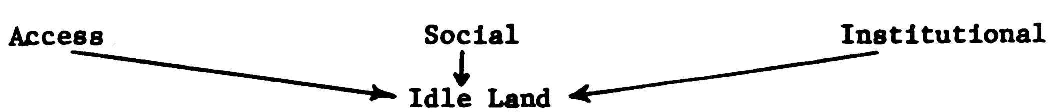
The final model included at least one variable from each of the three independent process models. This indicates that in an adequate explanation of the place to place variation of idle land, the three process models must be combined.

This study, by showing the value of these variables, indicates that more research must be conducted in order that operational definitions can be refined and the theoretical constructs of the spatial variables in land use study can be systematized.

The variables retained in the final model were:

Distance to the nearest non-white center.
Distance to the nearest shopping center.
Distance to the median point of employment.
Distance to the nearest elementary school.
Distance to the nearest area of blight.
Zoning.

These variables can be summarized as follows:



This grouping of variables reflects the major inputs into a land use analysis system. The accessibility variables indicate the role that friction of distance plays on human trip decisions, i.e., how far is a person willing to travel to work, etc.

The social variables provide a measure of human biases, i.e., what is the reaction to social disbenefits; and the institutional variables attempt to indicate the importance played by the extension of governmental decisions and actions on land use behavior.

It is suggested that the results of this study show that the explanation of idle land variation within a complex system of variables can be simplified by the recognition of process models. The use of these models permits a formula explaining idle land variation to be erected with a relatively small number of variables. However, it must be pointed out that any attempt to generalize the model beyond the present study area is not warranted on the basis of the current research alone. In reality this study represents a sample of one and the process would have to be repeated, showing similar results, in several other cities before a general acceptance of the model could be suggested. Further, if the model has any predictive utility, even for Tulsa, it should be able to tell where idle land should theoretically occur rather than where it actually occurs. Whether or not such predictive ability exists can be determined in subsequent research by applying a chi-square goodness of fit test to the model. Thus, the value of the model at present is that it portrays those variables that best explain the place to place variation of existing idle land in Tulsa.

Finally, although the model is essentially a static one and idle land is quite dynamic, the work of Yeates in explaining Chicago land value distributions has shown that variables of the type chosen here, while varying in importance, tend to remain significant over time.[2]

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[2]Maurice Yeates, "Some Factors Affecting the Spatial Distribution of Chicago Land Values, 1910-1960," Economic Geography, Vol. 41 (January, 1965), pp. 57-85.

APPENDIX A: THE PLAN OF THE ANALYSIS

The plan of the analysis is shown in Figure A.1, which is a flow chart of the general process of the analytical procedure. This flow chart is a great simplification of reality. Each model has a different number of independent variables, and, as a corollary, the number of significant variables deleted from the models also vary in number. The so-called variable reduction model is the one in which all the abstracted variables are in one equation; and this equation is then checked for the part played by the different components. A step-wise multiple regression program with variable transformations is used to analyze the variable mix, listing the variables, step by step, in the order of their statistical significance.[1] The computer scans the mix, selects the most significant variable (in terms of partial correlation coefficients) and computes the initial equation as Step 1. The partial correlation coefficients of the remaining variables are then scanned again and the variable with the highest score is selected and a new equation is computed by adding the weight of the new variable to the first (Step 2). The process continues until all significant variables are included in the final equation or until there is a significant difference in the amount of explanation between regression coefficients of the first compared to the last

[1]The step-wise regression computations were performed with the ERM-PR3 computer program with variable transformations on an IBM 7040 computer.

model. A similar approach to the solution of multivariate problems was used by Wolpert in his study of decision processes.[2]

A further word is required here concerning the nature of the adopted program. Variable transformations are available for a variety of purposes. Because scattergrams indicate a lack of linearity in some of the data, quadratic transformations are introduced for all variables. The computer then selects either a second or third degree polynomial curve depending upon which provides the best fit for the data. Thus the resultant regression models may include either linear or curvilinear elements.

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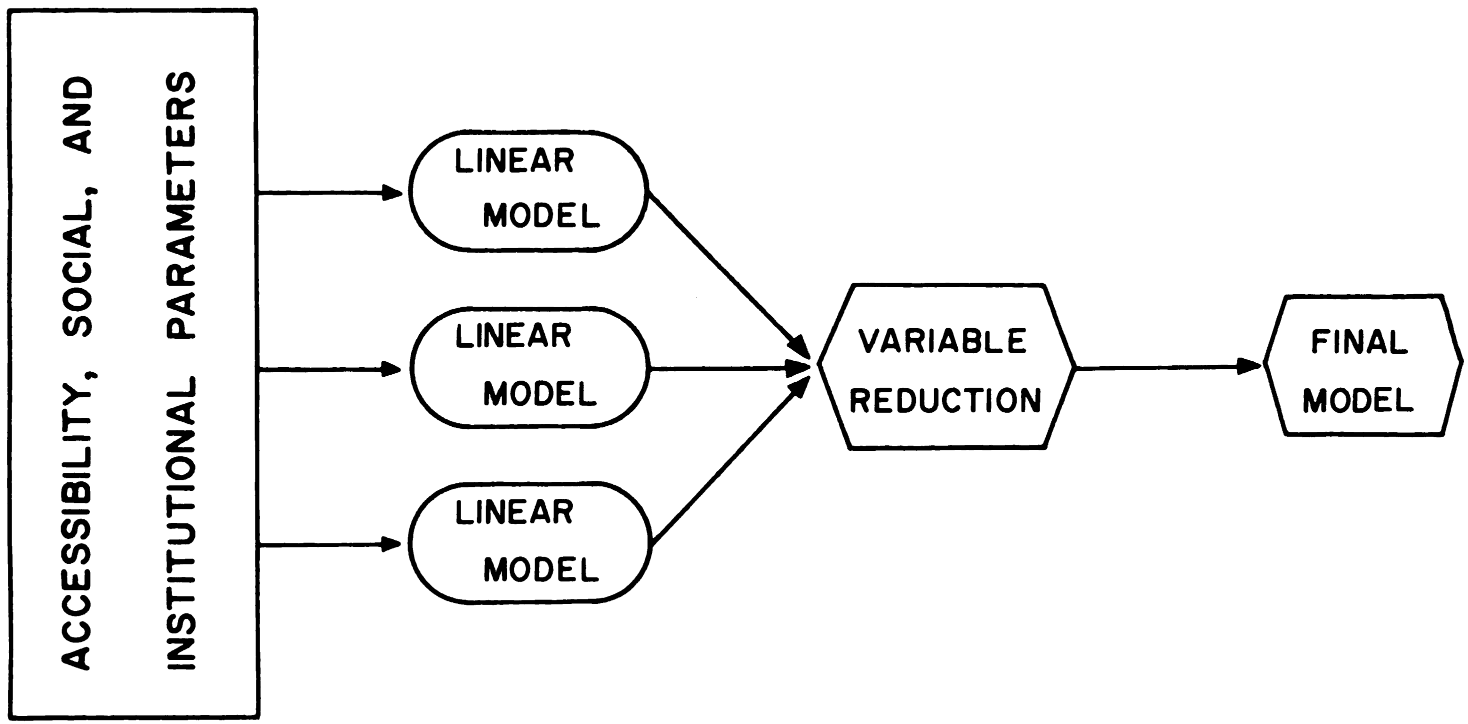
[2]Julian Wolpert, "The Decision Process in Spatial Context," Annals of the Association of American Geographers (Vol. 54, 1964), pp. 537-558.



Flow Chart Illustrating the Selection of the Final Model

Figure A.1

APPENDIX B: THE STEP-WISE DELETION PROCESS

A word is needed here to clarify what took place in Step 6 of the program where variable b_1H was removed from the mix. In Step 5, b_6H, which is the quadratic of b_1H, was drawn into the equation. The program then scanned the previous steps and determined that after b_6H had been added, b_1H made a negligible contribution. Then b_1H was removed and the program continued. This procedure is built into the program to avoid the problem of collinearity.

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