1975

Land Use Patterns In Occidental And Non-occidental Central Business Districts

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LAND USE PATTERNS IN OCCIDENTAL AND NON-OCCIDENTAL CENTRAL BUSINESS DISTRICTS

by

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Submitted in partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

Faculty of Graduate Studies

The University of Western Ontario

London, Canada

September 1974

ABSTRACT

This study compares Occidental and Non-Occidental land use patterns in Central Business Districts (CBDs). Each land use is treated separately as a distribution of points. The Occidental studies are synthesized and common processes are recorded. There are six common processes: a general accessibility process; an accessibility to principal arteries process; an attractiveness of a particular resource process; a mutual affinity process; a mutual disaffinity process and a random process. Each process results in a land use pattern although the clustered pattern predominates. Using a typology of Occidental land use patterns an assessment of the similarity of Non-Occidental CBDs is made.

A methodology to describe patterns using geostatistical measures is outlined.

Land rent is compared for three case studies; London (the Occidental case), Guatemala and Bogotá (the two Non-Occidental cases). While in most Occidental studies a cone of land values can be expected, in Guatemala a second peak occurs. This second node is described in other Non-Occidental literature and so a revised rent model for Non-Occidental CBDs is formulated.

For Guatemala the detailed land use information has also a binary measure of the quality of use. The better quality businesses occur around the Peak Land Value Intersection (PLVI) and the poorer quality

businesses are around the second node of the revised rent model. This second node is the area of the native bazaar, the focus of the majority cultures trade. It is often the area of greatest pedestrian densities. These observations concur with statements made in the sparse Non-Occidental CBD literature.

When the three case studies are compared (without quality of use information) there is an overall similarity of pattern with some important differences. Land uses with a central clustered pattern tend to be the same in both types of CBD. They respond therefore to central clustering processes. The periphery tends to be less well differentiated in the Non-Occidental CBD possibly because the private automobile is less widely used. There are two types of land use which occur more centrally in the Non-Occidental CBD than expected from Occidental experience. The first type are industrial and related uses with important extra-national connections enabling them to pay higher rents. The second are consumer product industries oriented to the PLVI taking the place of 'off the peg' goods.

There are no consistent peripheral clusters or linear patterns in the Non-Occidental CBD. Random patterns do not exist in any of the case studies and regular patterns are not common.

The Non-Occidental CBD is in many cases binodal. The area around the PLVI is oriented to Occidental business practice and the wealthy minority cultural group. The area of the Bazaar forms a second focus, oriented to the majority culture, the indigenous group. Cheaper and often different types of goods are sold in this second area. Apart from these central foci the peripheral areas are less well differentiated than the Occidental CBD yet possess the same types of uses.

ACKNOWLEDGEMENTS

I am pleased to acknowledge the help of the following people in the completion of this dissertation. Doctor H. W. Taylor's expertise in Latin American studies was invaluable both in preparation for field work and in the interpretation of the results of this dissertation. He was my chief source of direction and advice on all matters relating to the dissertation. I greatly appreciate that he was always available for consultation even at the shortest notice and gave close attention to all the matters I brought to him. Dr. M. F. Goodchild assisted me chiefly in the mathematical and programming aspects of the dissertation and I am grateful for the quality of his instruction. Dr. D. G. Janelle made useful criticisms of the structure and presentation of the early drafts.

I was supported financially while completing the dissertation by the Department of Geography at the University of Western Ontario. The support came from Teaching Assistantship appointments and an appointment as Instructor. I am also grateful for the support provided through the Ontario Graduate Fellowship. The award of a travel grant from the Department of Geography helped me to travel to Central and South America.

Through discussions in seminars and other informal meetings almost every faculty member in the Department of Geography has contributed to this dissertation. In addition the staff in the Map Library, in the Cartographic Section, friends and colleagues in the graduate school have all been helpful and have been a stimulus in this work.

I would like to thank the officials and the technical staff in the Census Department in the City of Guatemala and in the Centre for Systematization and Technical Services in Bogotá who provided the detailed land use information. I would like to thank Victor Tejada for his help while I was in Bogota. There are many other people in Planning Departments, Government Offices, embassies and businesses who gave help and provided me with information.

I would like to thank the many friends whom I knew in London, Ontario. Their contribution is less direct but no less important. I would like to thank Anne Donovan for her typing and help in the reproduction of this dissertation. Finally I would like to thank Phyllis who was involved throughout in encouraging and helping me in the work, particularly in the final stages of production and organization.

I alone am responsible for any errors which may occur.

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CHAPTER I

INTRODUCTION

The theories, hypotheses, concepts, or models of the Central Business District (CBD) are Occidental ones. The models are usually of European or North American CBDs and although there are studies of Non-Occidental CBDs none of them make direct comparison between these two situations where tradition, culture and economy would seem to be very different. This study is concerned with the well defined subsection of the city known as the CBD[1] and with some of its complex interrelationships. The Occidental and Non-Occidental CBDs are compared by studying differences in their distribution and pattern of land use.

In a review of the literature on the CBD in 1960 Murphy posed nine areas needing further study (Murphy, R.E., 1960, p. 482) but he did not mention the Non-Occidental CBD nor has it received much attention since. Comments by Alonso (Alonso, W., 1964, p. 165) and Bellett (Bellett, J., 1969, p. 1) suggest that it is time to extend Occidental models to the Non-Occidental city. The literature does contain land use comparisons for different CBDs but they are usually for one nation and one cultural area. There are no studies which make direct comparisons in different cultural areas.

[1] Thompson, R.W., 1972, p. 72 demonstrates that it is valid to consider the CBD as an individual element in the city.

In this spirit an attempt is made here to examine the CBD in different cultural areas. For convenience the terms Occidental and Non-Occidental are used but it is difficult to assign CBDs to these classes in an unequivocal way. The concern is not to classify CBDs by cultural characteristics but to make a simple division which reflects the different levels of automobile use, the different levels of economic development, the different consumption patterns and the different ethnic composition of the populations. The countries of Western Europe, the United States, Canada, Australia, New Zealand and South Africa are here called Occidental, while the countries of Central and South America, Central and Northern Africa and the countries of South Asia are termed Non-Occidental. The literature quoted in this study and the case studies chosen for detailed analysis reflect this division.

Since there is no single and generally accepted Occidental CBD model it is not possible to turn to one model to apply to the Non-Occidental CBD. If, however, the CBD models have the components: causal mechanisms, patterns (or ordered distributions) which these mechanisms generate and land uses which fit these patterns, then there is agreement that there are commonalities at all three levels even though the agreement is not total.[1] Because there is not total agreement as to the commonalities which exist in the Occidental CBD and because there are a number of CBD models and many case studies, this study will first define the important mechanisms which operate to arrange the land uses spatially; it will then comment on the patterns which are expected

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[1] It is recognized that there is an extensive literature which deals with associations and mixes of land uses rather than the spatial arrangement of individual uses. The latter is the focus of this study for reasons given in pages 23-24.

as a result of these mechanisms and it will consider which land uses adopt which patterns. This will all be based on literature for the Occidental CBD. Once completed it will show the degree of consensus for Occidental CBDs and will provide a base for comparison with land use patterns in the Non-Occidental CBD.

Harvey opened a publication by stating:

> A traditional aim of geographical research is to describe the spatial pattern of objects or events and to explain that pattern by way of the causal mechanisms which have generated it. This implies some way of deducing spatial patterns from a knowledge of temporal processes... (Harvey, D. W., 1968, p. 71).

The knowledge of the causal mechanisms at work in the CBD is derived from the comments by a number of authors in the Occidental literature which will be reviewed later.

It is recognized that these mechanisms operate in time to produce patterns. In all of the case studies used here, it is assumed that the processes and influences have worked themselves out to produce a mature mosaic of land uses in the CBD. This study is not concerned directly with the time dimension and, therefore, it provides no direct evidence of the operative processes; instead it is a comparative study of land use patterns within the CBD and for CBDs in different parts of the world. It is the Occidental processes and patterns which are best understood. If the patterns in the Occidental and Non-Occidental CBD are the same then this is an indication that the processes operating are also the same. The degree of difference in comparing the two types of CBD is taken as a measure of the applicability of the Occidental CBD models.

Some Important CBD Mechanisms

The processes and patterns of the CBD are recognized mainly for North America, Europe, South Africa, Australia and New Zealand. Hartenstein and Staack (Hartenstein, W. and Staack, G., 1967, p. 42) and Getis and Getis (Getis, A., and Getis, J. M., 1968, p. 322) show that in the CBDs of a number of cities the total mix of land uses is very similar. This is also a covert assumption in the presentation made by Murphy, Vance and Epstein (Murphy, R.E., Vance, J.E. and Epstein, B.J., 1955, p. 21). While the total mix is similar there is also a good amount of agreement that the internal structure of the CBD and the patterns of individual land uses are also similar. The agreement is such that terms are coined which apply to areas smaller in extent than the whole CBD yet larger than individual land uses. The terms most in current use are core, hard core, frame and periphery. These terms have loose definitions yet they reflect the need to differentiate between the center of the CBD and the periphery.

The Distinction Between Center and Periphery

The great difference between the center and the periphery is shown in the structure of a number of independent variables often mentioned in CBD studies. Land rent is a fundamental variable in the CBD and is recognized by most authors as an important influence on land use. Rents or a common surrogate, assessed land values, are highest in the CBD center and decline steeply to the periphery. Central locations are more valuable and they are associated with large pedestrian densities. Land is more intensively used in the center and building heights are greater

(Campbell, N., 1969, pp. 25-40).[1] The variables are obviously not independent of one another but they are important influences on the arrangement of land use and their gross central/peripheral differentiation is recognized in most Occidental studies and is seen to influence the CBD land use structure.

Concentric Rings

Garner presents a more refined rationale for a center/periphery differentiation in his concentric arrangement of land use based on land rent (Garner, B.J., 1966, p. 112). He shows that land rents in the CBD define a cone around the most accessible point, the peak land value intersection (PLVI). He argues that the location of a land use type is determined by its threshold size which in turn determines the rent which the land use type can bid for a site. The result should be a concentric arrangement of land uses from the PLVI with the highest rent paying land use in the center and the lowest on the periphery. If accessibility to the whole city is important then the land uses should be arranged in concentric rings according to Garner's reasoning.

The influence of accessibility and the theoretical concentric ring arrangements are important in much of the empirical literature. The concentric ring concept influences the form of most analyses and almost all studies of the internal CBD arrangement of land uses expect these patterns to occur. E. Jurkat, quoted in Rannels' review of the CBD analyses (Rannels, J., 1961, p. 23), defines a core, a fringe and a belt and names the characteristics of each area. Murphy and Vance describe

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[1] A number of authors use some or all of these measures to delimit the CBD (Murphy, R.E., and Vance, J.E., 1963; Davies, D.H., 1965).

the CBD as a region having:

> ... the normal regional qualities - a core where the definitive qualities reach their greatest intensity with zonal and mostly impermanent boundaries (Murphy, R.E. and Vance, J.E., 1954, p. 419).

The later analysis by Murphy, Vance and Epstein of the internal structure of the CBD looked for concentric ring arrangements and described the proportion of land uses in each concentric zone (Murphy, R.E., Vance, J.E. and Epstein, B.J., 1955). All of the studies just mentioned recognize that concentric patterns of land use occur in the CBD.

Horwood and Boyce divide the CBD into two broad areas which they call the core and the frame (Horwood, E.M. and Boyce, R.R., 1959). The concentric ring pattern is still important in their work since the frame surrounds the core. Building heights are greatest in the core and lowest in the frame. Retail productivity per square foot, pedestrian density and land value all decline from center to periphery, but the decline is characterized as a dichotomous relationship between the core and frame, rather than a transitional change as it is in the work by Murphy, Vance and Epstein. The land uses are expected to have a basic concentric division by Horwood and Boyce but instead of a number of concentric bands only two major ones, the core and frame, are described. Their characteristics are outlined in Tables I, II, compared in Table III and diagrammed in Figure 1. The addition to the statement made by Murphy, Vance and Epstein is that in either the core or frame, land uses can be clustered, dispersed or distributed in zones. Both Murphy et al and Horwood and Boyce are concerned with causal mechanisms operating on groups of land uses. The patterns of individual land uses are in most cases unclear.

Clusters

Horwood and Boyce recognize some clusters in both the most central area, the core, and the peripheral area, the frame.[1] The frame contains nodes which "... may be concentrated in a single area, diffused in several clusters or partially dispersed" (Horwood, E. M. and Boyce, R. R., 1959, p. 21). Nodes are clearly illustrated in their model (Figure I). The land uses appear to cluster due to their mutual affinity or their attraction to a particular location in the CBD. The reasons are not made clear even though the patterns are recognized. Mechanisms forming clusters are better described by R. L. Davies and by A. and J. Getis-but these will be dealt with later in the next section on complex arrangements.

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[1] Diamond recognizes clusters in the core in his study of Glasgow in Scotland (Diamond, D. R., 1960, pp. 523-524).

TABLE I

General Properties of the CBD Core*

Property	Definition	General Characteristics
Intensive land use	Area of most intensive land use and highest concentration of social and economic activities within metropolitan complex	Multistoried buildings Highest retail productivity per unit ground area Land use characterized by offices, retail sales, consumer services, hotels, theaters, and banks
Extended	Area of highest buildings within metropolitan complex	Easily distinguishable by aerial observation Elevator personnel linkages Grows vertically, rather than horizontally
Limited horizontal scale	Horizontal dimensions limited by walking distance scale	Greatest horizontal dimension rarely more than 1 mile Geared to walking scale
Limited horizontal	Horizontal movement minor and not significantly affected by metropolitan population distribution	Very gradual horizontal change Zones of assimilation and discard limited to a few blocks over long periods of time
Concentrated daytime	Area of greatest concentration of daytime population within metropolitan complex	Location of highest concentration of foot traffic Absence of permanent residential population
Focus of	Single area of convergence of city mass transit system	Major mass transit interchange location for entire city
Center of specialized functions	Focus of headquarters offices for business, government, and industrial activities	Extensive use of office space for executive and policy making functions Center of specialized professional and business services
Internally conditioned boundaries	Excluding natural barriers, CBD boundaries confined only by pedestrian scale of distance	Pedestrian and personnel linkages between establishments govern horizontal expansion Dependency on mass transit inhibits lateral expansion

* Horwood, R. and Boyce, E., 1959, p. 16.

TABLE II

General Properties of the CBD Frame*

Property	Definition	General Characteristics
Semi-intensive land use	Area of most intensive non-retail land use outside CBD core	Building height geared to walk-up scale Site only partially built on
Prominent functional subregions	Area of observable nodes land utilization surrounding CBD core	Sub-foci characterized mainly by wholesaling with stocks, warehousing, off-street parking, automobile sales and services, multifamily dwellings, intercity transportation terminals and facilities, light manufacturing, and some institutional uses
Extended horizontal scale	Horizontal scale geared to accommodation of motor vehicles and to handling of goods	Most establishments have off-street parking and docking facilities Movements between establishments vehicular
Unlinked	Activity nodes essentially linked to areas outside CBD frame, except transportation terminals	Important establishments linkages to CBD core (e.g. intercity transportation terminals, warehousing) and to outlying urban regions (e.g. wholesale distribution to suburban shopping areas and to service industries)
Externally	Boundaries affected by natural barriers and presence of large homogeneous areas with distinguishable internal linkages (e.g. residential areas with schools, shopping, and community facilities)	Commercial uses generally limited to flat land Growth tends to extend into areas of dilapidated housing CBD frame uses fill in interstices of central focus of highway and rail transportation routes

* Horwood, R. and Boyce, E., 1959, p. 20.

TABLE III

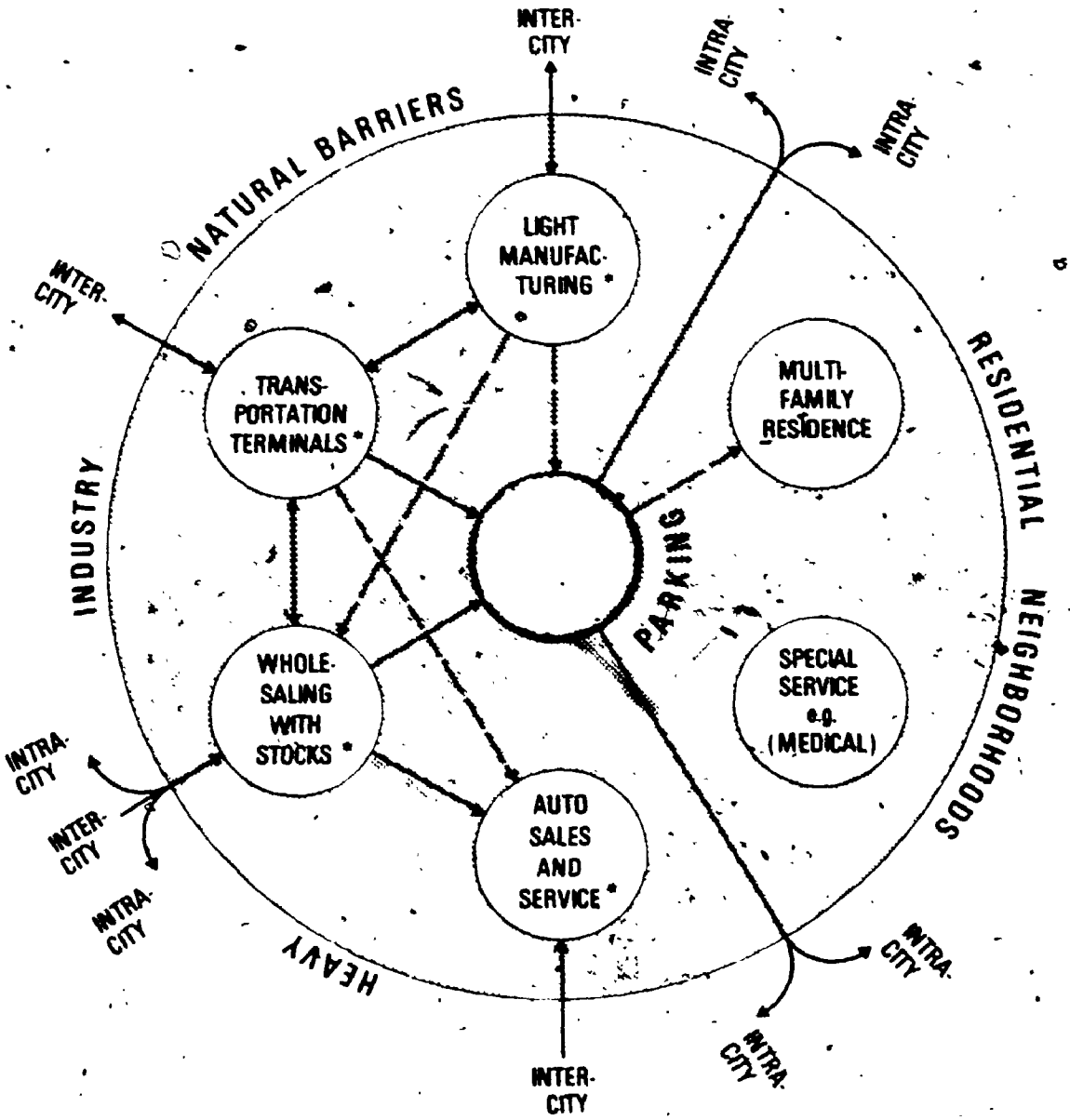
Primary Differences Between CBD Core and CBD Frame*

Factor	Primary Characteristics In CBD Core	In CBD Frame
Land Utilization	Intensive	Semi-intensive
Site Utilization	Fully built on	Partially built on
Building Types	Similar	Dissimilar
Growth	Upward	Outward
Business Linkages	Internal	External
Parking Space	Very limited	Generally adequate
Transportation Mode	Pedestrian	Vehicular
Transportation Focus	Intracity	Intercity
Boundary Determinants	Internal factors	External factors

* Horwood, R. and Boyce, E., 1959, p. 22.

The CBD Core – Frame Concept

Schematic Diagram with Selected Functional Centers and Principal Goods Flows



Source: Harwood, E.M. and Boyce, R.R. 1959, P.21.

Figure I

Complex Arrangements

D. H. Davies applies the Murphy and Vance technique to Capetown but he gives a better explanation of the causal mechanisms at work. He recognizes that rings, sectors and multiple nuclei can occur in the CBD just as Burgess (Burgess, E. W., 1925), Hoyt (Hoyt, H., 1939) and Harris and Ullman (Harris, C. D. and Ullman, E. L., 1945) show them to exist for the whole city. Concentric rings, clusters and strings are all meaningful CBD patterns and he links these three CBD land use patterns to location in relation to accessibility, to location in relation to the availability of businesses linkages, and to location in relation to arteries entering the CBD respectively (Davies, D. H., 1965, p. 204). His work makes an important addition to understanding CBD land use patterns and it deals with the pattern of the individual land use.

R. L. Davies also deals with the individual land use and takes the understanding of the CBD land use patterns even further. Covering some of the same ground as D. H. Davies he develops a very similar but a more comprehensive model of retail distribution (Davies, R. L., 1972a, pp. 59-80 and Davies, R. L., 1972b, pp. 1-32). He suggests that the rings, sectors and multiple nuclei, the three concepts already mentioned above, should not be "... viewed as separate alternatives for describing any one pattern of land use but as contributing methodologies for understanding different aspects of the same situation" (Davies, R. L., 1972a, p. 70). He recognizes three components in his model of the CBD;

> ... broad zonal differences in types of shops, based on the structural variations in threshold values for nucleated facilities noted by Garner, this pattern arises in shops competing for the most central position of all and relates to the general surface of accessibility. Cutting across this pattern there will be embryonic ribbon characteristics along the

> major axial roads... A third component superimposed on both nucleated and ribbon patterns will comprise clusters or large areas of highly specialized retail functions which respond to particular advantages of site and unique conditions of accessibility...

The last type has two subdivisions; they may be distinctly similar in lines of trade; or they may be similar "... in the level of quality image, the mode of retail organization or the specialized clientele which it serves" (Davies, R. L., 1972a, pp. 74-75). The three components are generated by the three notions of general, arterial and special resource accessibility conditions (Davies, R. L., 1972b, p. 6).

R. L. Davies' model is a synthesis of much of the content of the models which precede it. It is a useful expression of three causal mechanisms which affect the CBD structure and the kinds of patterns associated with each one. There are three mechanisms and patterns:

1. Resulting from competition for the most central and most accessible location at the PLVI are concentric ring patterns;

2. Resulting from accessibility due to a principal artery are linear patterns. This can be along any major artery in the CBD periphery;

3. Resulting from the attractiveness of a particular resource are nodal patterns. The attractiveness can be due to the characteristics of the area itself or an affinity between land uses themselves.

These three types are not mutually exclusive, they overlap and together they make up R. L. Davies' model. The model if further complicated by quality of use considerations which influence the patterns. A land use may be expected to have a concentric ring pattern but this may be obscured by arterial or special resource accessibility mechanisms.

Any pattern may be obscured by influence due to the other two mechanisms and all patterns in turn can be influenced by quality considerations. The result is a very complex model to describe the structure of the CBD. The more complex model may come closer to describing empirical reality as it is found in Coventry but the average characteristics of each land use are no longer considered.

The outline of the literature so far follows the development made in CBD land use analysis. The study of Getis and Getis should be added, for although it is a preliminary study, it is conceptually important since it defines another mechanism operating in the CBD (Getis, A. and Getis, J. M., 1967). They allow that certain stores in the mix of uses in the CBD may be more affinitive than would be expected by chance alone. This mechanism is a part of the third component in R. L. Davies' model (page 13). The affinity mechanism is not influenced by the resources in the environment although uses which are affines may appear to be oriented to some physical location. Land uses can be mutually affinitive for comparative shopping reasons, for ease of intercommunication, as D. H. Davies suggests, or for prestige or image reasons, all of which need not be influenced by the physical environment but may be a creation of the land uses themselves. The influence due to environment and the influence due to other land uses is difficult to separate without a questionnaire and is not attempted in this study.

Getis and Getis help to clarify two other mechanisms which are not clearly stated in R. L. Davies' work. While land uses may attract one another they may also repel, and land uses which repel their own type will tend to be regularly spaced. The second dispersed pattern is the random distribution which is the product of chance alone. These two

extra mechanisms with their associated patterns need to be added to those described by R. L. Davies.

There are then six important mechanisms in the Occidental literature. Each mechanism produces a particular land use pattern. The concentric influence is recognized in the earliest of studies, it is related to general accessibility to the whole city, to rent, pedestrian densities and intensity of use. The influence of the principal arteries, land use affinities, land use repulsions, and chance processes are recognized more recently. The enhanced access along principal arteries is used to explain linear patterns. Affinity explains some clustered patterns, either as mutual affinity (land use A with A) or non-mutual affinity (land use A with B). Clusters can also be due to the attractiveness of a resource which has a particular location in the CBD, for example, a cross roads, the port, the station or market. Dispersed patterns may be due to repulsion processes where the distribution is regular or by chance processes where it is random.

From this point some studies go on to describe aggregates of land uses; they consider the types of associations or mixes often using multivariate techniques. Other studies continue with the individual land use but, as in R. L. Davies' study, complicate the descriptions by considering the overlapping effect of the different mechanisms. The mechanisms do, of course, overlap but there is much to be learned from a comparison of the patterns of individual land uses in more than one study area. This is the point of departure of this study.

The important processes outlined above are expected to produce certain idealized but recognizable patterns. Using a number of CBD

studies it should be possible to isolate consistent land use patterns and compare them to the idealized patterns. The degree to which the two patterns are similar is a measure of the importance of that mechanism on its distribution. This methodology avoids much of the complication of R. L. Davies' model and helps to isolate consistent CBD land use patterns. When applied to the Occidental CBD first it provides a useful base from which to compare the Non-Occidental patterns.

A Typology of CBD Patterns

The ability to recognize and describe the pattern of a land use depends upon the number of processes, causal mechanisms or influences which are known to operate and it depends upon the vocabulary of patterns available. In the foregoing review of the CBD literature the number of processes, mechanisms and influences are few as are the number of different patterns which are expected to occur. It is possible therefore to construct a simple typology of patterns for the CBD.

The typology is not an integrated theoretical arrangement of patterns[1] but a compromise between the conceptual, the empirical and the methodological. The typology will be constructed first and following this, land uses are added to it which are consistently described with the same pattern in the literature. In this way it is possible to synthesize all the Occidental models of CBD land use structure. As is already mentioned, the consistency of the pattern/land use relationship is a measure of the consistency of the Occidental CBD land use structure. The causal mechanisms which generate the patterns are already outlined.

[1] This study, for example, uses patterns described by Horwood and Boyce. R. L. Davies did not integrate the Horwood and Boyce concept into his theoretical approach to the CBD (Davies, R. L., 1972a, p. 72).

Once the assignments are made for the Occidental CBD it will be possible to assess the similarity or dissimilarity of the Non-Occidental CBD.

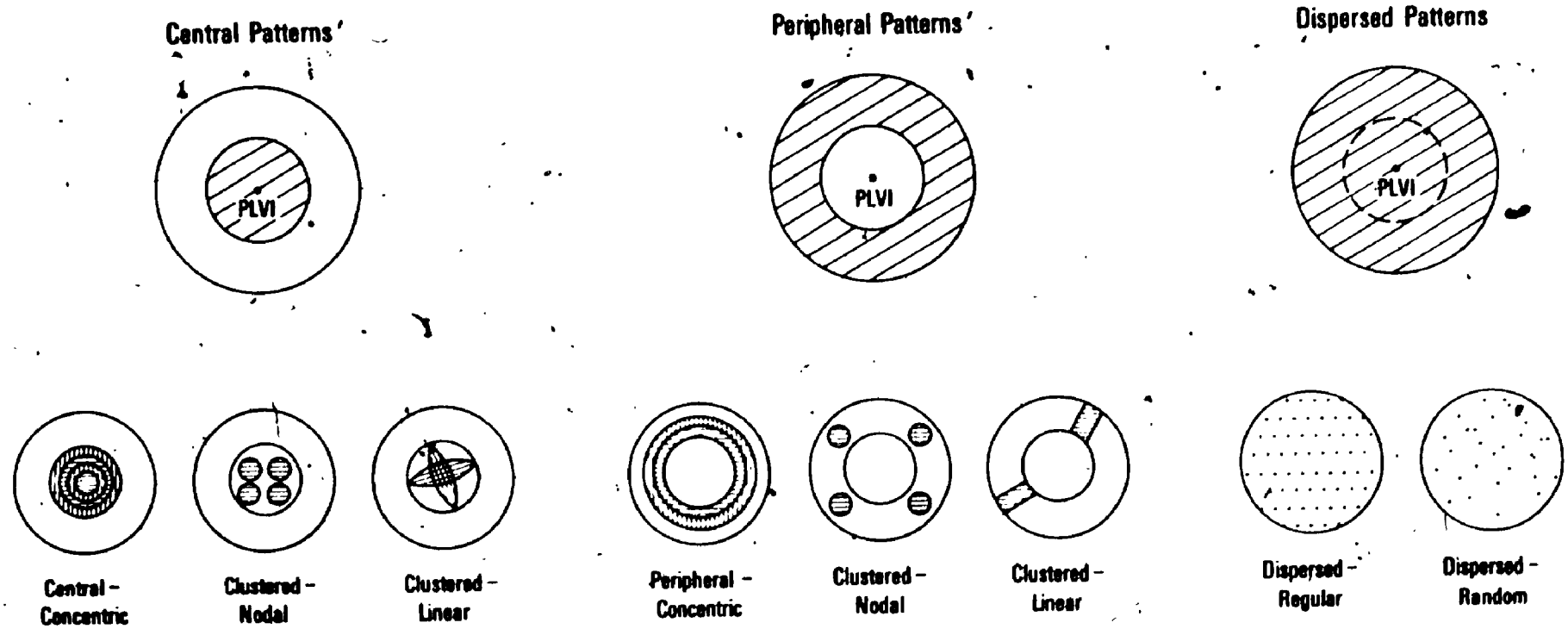
The typology recognizes three broad types of patterns: central, peripheral and dispersed. The use of central and peripheral is for simplicity of presentation and the methodology outlined in Chapter II can recognize intermediate patterns. The patterns in the typology are shown in Figure II.

The PLVI is the most important center in the CBD. In the foregoing review and in Chapter III some mechanisms which decline from the PLVI are mentioned. The decline in general accessibility measured by intensity of use, land rent and pedestrian traffic is an important influence in the CBD. The rent, intensity of use and pedestrian density are always considered much higher in the center than in the periphery. This differentiation is preserved in this typology. Patterns which are central are considered separate to those which are peripheral. Unlike the dichotomy of Horwood and Boyce's model, it is recognized that patterns which are intermediate between these two areas are possible.

Where general accessibility is not so important but is replaced by strong affinity between land uses of the same type or where access to the resources of a particular area is important then clustered-nodal patterns can be expected. These clustered-nodal patterns can be either central or peripheral for they may be influenced in addition by the general accessibility factor previously mentioned. (It may be difficult to differentiate between the most central of the concentric patterns and a clustered-nodal pattern close to the PLVI.) Once again patterns intermediate between the center and periphery are possible.

The next pattern recognized is the clustered pattern which is

Diagram of CBD Patterns



' Patterns which are intermediate between centre and periphery are not shown.

Figure II

linear. Here accessibility to an artery is important. This type of pattern may be central or peripheral or again may have an intermediate position.

All of the patterns so far described are derived from the CBD literature. A third type of pattern has its origin more in the mathematical literature (see Chapter II). This is the dispersed pattern. The dispersed pattern is noted by R. L. Davies but it is not an integrated part of his model. Getis and Getis recognize the possibility of random patterns but again they are not a distinct part of a model. The dispersed patterns can have two forms. They can be regularly spaced and therefore are a response to a mutual disaffinity mechanism, or they can be randomly spaced and therefore locate by chance alone.

Land Uses Assigned to the Typology

From the literature on the CBD it is possible to assign certain land uses to particular areas in the typology. Less detailed studies may simply describe a land use as being central, peripheral or dispersed. The more sophisticated studies describe the processes and patterns more precisely. In assigning uses to the typology it is possible to assign them to a general location or to a specific location depending upon the detail of the description which the literature provides.

The sophistication of the pattern recognizing techniques of each study in the literature varies considerably. At the most simple, descriptions are verbal or in the form of maps. Murphy, Vance and Epstein (Murphy, R. E., Vance, J. E. and Epstein, B. J., 1955, p. 26) use a methodology with a concentric ring bias. Land use percentages are estimated for one hundred yard zones radiating from the PLVI.

D. H. Davies, (1965), p. 31 points to a flaw in the analysis for, with the concentric ring as the spatial unit, no other pattern but concentric ring patterns can be recognized and even some of these may be invalid, e.g. where there are arcs and not full belts. Getis and Getis use only one hundred yards on one side of the street on either side of the PLVI of thirteen United States cities. R. L. Davies deals only with retail land uses and Hartenstein and Staack use grid squares which do not give a detailed description of land use patterns (Hartenstein, W. and Staack, G., 1967). D. H. Davies uses a method which does not allow easy comparison between one CBD and another because he defines and maps complex shapes using isolines. R. L. Davies uses the most sophisticated mathematical approach and he draws on a wide range of geostatistical measures like those applied to the case studies of this dissertation (see Chapter II). There are other studies of the mix of uses rather than the pattern of individual uses and these will be discussed later.

The assignment of land uses to places in the typology is based on only six authors. These authors are chosen because they use a detailed classification of land uses although naturally differences can be expected because the studies are independent. Some studies for example include, while others exclude, industrial uses. The authors can also differ in the way land uses are represented. Some authors use points and others areas but in all six cases the units are discrete and are not accumulated so that separate spatial patterns can be defined. Some of the six analyses are for the ground floor only, others aggregate all floors together and others describe each floor separately. Where possible cross-comparisons between the literature and this dissertation are for ground floor patterns only. Often in the six studies different

criteria are used to draw the boundary but since this study is of internal CBD patterns the boundary definitions are less important.

A number of other studies accumulate land use information for a statistical unit such as the city block, the block front or some other aggregating unit. Studies using these methods are less useful because the information on individual patterns is lost and they deal with the patterns of aggregates of land uses. Studies of this type, whether they use geostatistical or multivariate methodologies are not used in assigning uses to the typology but some of the general patterns which they describe will be commented upon later.

Murphy, Vance and Epstein (Murphy, R. E., Vance, J. E. and Epstein, B. J., 1955), Horwood and Boyce (Horwood, E. M. and Boyce, R. R., 1959), Scott (Scott, P., 1959), D. H. Davies (Davies, D. H., 1965), R. L. Davies (Davies, R. L., 1972), and Carter and Rowley (Carter, H. and Rowley, G., 1966) are the principal authors used here. The first four particularly are interested in universalities of patterns despite the unique properties of individual cities. A synthesis of the results of all of these authors already shows strong similarities and this despite the differences in the classifications and the types of analyses which they use. The center/periphery differentiation dominates otherwise the emphasis in their works, as in much of geography, is upon clustered patterns which are most easily recognized. The dispersed category particularly is a neglected one. In addition R. L. Davies and Scott are only interested in retail uses and produce no results for industry. Despite these qualifications there is clear evidence of order in the Occidental city.

The land uses are assigned to the parts of the typology in

Table IV. This figure is a summary of the consistency of pattern for each land use. The land uses can be assigned with confidence, in most cases, to the broad areas of the typology. The figure shows those which have a definite designation and separates those which are to some degree questionable. A land use may be described with a given pattern by any of the above authors. When the authors agree totally on the pattern associated with a land use then it occurs in column two (land uses of consistently the same pattern). Consistent land uses are always agreed upon by at least two and usually three or four authors. Where one or more authors are not totally agreed on the pattern associated with a land use then it is recorded in column three (land uses of questionable consistency of pattern). Land uses can be questionable either because the authors disagree or because differences in classification makes accurate comparison difficult.

The central-clustered uses are all pedestrian oriented types with what R. L. Davies would describe as a large number of customers or what Garner describes as high thresholds. Of the uses which are listed as questionable in this section all are recognized as having a center focus although for each one some author differs from the others in describing the use as dispersed. For this reason its location in the typology is questioned. Cafes, of all of these uses, have the lowest threshold and only banks have ever been described as linear.

An important peripheral category is formed by those uses which are clustered, for these uses have either a mutual affinity or are attracted to some resource offered by the specific area in which they locate. Those which are linear rather than nodal are likely influenced by the presence of an artery and the resource is the road itself. Most

TABLE IV

Land Uses Assigned to CBD Patterns

Pattern		Land Uses of Consistently the Same Pattern	Land Uses of Questionable Consistency of Pattern
Central	Concentric Clustered Nodal	Department Stores Variety Shoes Clothing and Women's Clothing[1] Specialty Foods[2]	Hotels Banks Theaters Cafes Vacancy
	Clustered Linear		Banks
Peripheral	Concentric		Banks Parking Wholesaling* Public Government Organizational Transportation Industrial* Residential* Cafes and Restaurants Shipping
	Clustered Nodal	Furniture Office Supply Furniture and Equipment Professions[3] Auto Sales	
	Clustered Linear		Furniture Auto Sales General Food
Dispersed	Regular Random	Service Trades/ Personal Services Hotels, Cinemas and Entertainment	Food Hotels Cinemas Vacancy Books

TABLE IV (Continued)

Pattern	Land Uses of Consistently the Same Pattern	Land Uses of Questionable Consistency of Pattern
	Miscellaneous Retailing General Trades Catering/Eating Places	General Shopping

[1]Men's clothing in a few studies is central but it is closer to the edge of the center than women's wear.

[2]Food where it loses its speciality qualifier becomes more peripheral and some authors suggest that it is more dispersed.

[3]Johnson in his study on Melbourne states that medical offices are clustered (Johnson, R. J., 1968a, p. 189).

[4]Davies, R. L. has garages and repairs under personal services which he shows to be peripheral.

*Diamond in his study in Glasgow agrees with these designations but notes that Industry and Wholesaling are peripheral but not totally non-central (Diamond, D. R., 1960, p. 528).

of the peripheral uses Horwood and Boyce suggest are large space users with a vehicle rather than a pedestrian orientation. The professions, where they are in the periphery, are likely site-image oriented but they are not great space users. Auto sales and furniture sales are described as linear uses by two authors.

Certain other uses are described as peripheral but do not cluster like those above. They may be peripheral in rings or have no form except that they are not central.

A number of uses have an intermediate position between the center and the periphery. Although there is some disagreement a few authors have described household goods and service in this way while others say they are more dispersed.

As has been mentioned most studies are oriented toward defining clusters and do not recognize a dispersed pattern per se. It then becomes the residual category of as yet unexplainable uses. This is an unsatisfactory description of some uses for it may be that certain uses are not associated with any of the above structuring processes but transcends them all. This typology goes further in at least recognizing those which are maximally spaced and those seemingly located by chance alone. This last category is likely to contain those uses which need more examination and it is hoped that identification will be a stimulus to further research.

The pattern associated with each land use is fairly constant from study to study. This is particularly true for the broad central versus periphery differentiation which also dominates the theoretical literature. The method used to define patterns is much less constant and different methodologies are capable of finer descriptions than others.

Some descriptions are simply verbal, whereas others are precise and mathematical. The studies in the literature do not differentiate between central patterns which are concentric and those which are clustered nodal nor do they distinguish between dispersed uses which are regular and those which are random. There are no uses which are consistently described as central-clustered-linear. The peripheral-concentric uses are all questionable as are the peripheral-clustered-linear uses. Certain patterns in the CBD are much more significant than others as this assignment of uses show.

The study, then, is based on the recognition of patterns which are closely related to these processes described in the literature. It has an empirical orientation avoiding the problem of matching empirical results with narrow theoretical premises. It draws upon a number of unintegrated explanations which are made in the combined theoretical and empirical literature.

In addition to the essentially geostatistical works mentioned above which deal with the spatial pattern of individual land uses, there is a considerable body of literature which uses multivariate analyses and provides useful results particularly with regard to the mix and the associations of land uses in the CBD. Although the multivariate work does not provide detailed statements of individual patterns many of the associations are interesting and worthy of mention.

Studies of Land Use Associations

Most analyses of the association between land uses are of the multivariate types and include factorial, principal components and various kinds of cluster analyses. Goddard (Goddard, P., 1968, pp. 70-71), who

uses this type of technique criticizes D. H. Davies and his study based on discrete areal units, and criticizes the family of point pattern analyses in general by saying the results are difficult to compare for more than a few cases. While this is true, multivariate analyses fail to describe the pattern of individual land use except in a gross sense and they may 'miss' completely dispersed patterns (see Chapter II, p. 32). It is difficult to make exact comparisons since the former describe spatial patterns and the latter describe mixes or associations of land uses. Similar land use patterns where they occur in the same part of the CBD must mean that the uses are mixed or associated. Further detailed comparison is difficult to make since so much information on the distribution of a land use is lost in multivariate analysis. It would not be easy to say whether associated uses are clustered, associated and linear, or associated and dispersed. It is only possible to describe gross patterns of associated land uses. Despite these difficulties it is still worth considering some multivariate results to see which broad associations and which broad patterns do occur. Even though an understanding of individual land use patterns is a useful, if not a necessary, first step in CBD analysis it is not one that is usually taken before a multivariate analysis begins.

Notwithstanding this qualification on their comparability certain parallel results of the two methodologies are worthy of note. Wholesaling is commonly associated with a number of other land use types which are usually peripheral, rather than forming a cluster by itself.[1] In Whipple's study of Melbourne, wholesaling is associated with public

[1] Goddard, P., 1968, p. 72; Davies, D. H., 1965, pp. 58-59; Whipple, R. T. M., 1967, p. 11 (refer to groups 4, 5, 6, 7, 8 and 9 in the appendix).

use, parking, government industry, education and motor vehicle sales, all of which are peripheral uses.[1] The land uses associated in two of Whipple's other clusters confirm the grouping of some of the central and clustered uses in the typology. Shipping and insurance are significantly related in the study of offices in London by Goddard and he also noted a finance association in the grouping between insurance and banking, and banking and other finance. The textile industry is, he comments, the only industry which is clustered of itself (Goddard, P., 1968, p. 72).

Although textile uses are the only industrial category which are clustered it is a feature of the multivariate literature that most commercial and service uses are described as clustered with their own type. This adds further justification to a geostatistical analysis to find the type and the degree of clustering, for a multivariate technique is ill-suited to highlighting such clusters.. The Getis and Getis study at first does not seem to substantiate this clustering of like uses but their work may have some serious methodological short comings (the study is only an exploratory one to test a method of analysis, see p. 18). R. L. Davies in his criticism of the study points out that the boundary of their study only encompasses the first ring in Garner's hierarchy of uses. The first ring is the clothing ring and it is interesting that it is clothing which is the only significantly associated use in the Getis study. R. L. Davies applies the Getis and Getis methodology to the whole CBD. Coventry is a much larger area and for seven broad categories of

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[1] Whipple, R. T. M., 1967, p. 11 (refer to groups 4, 5, 6, 7, 8 and 9 in the appendix).

land use he found that self-association were the most significant (Davies, R. L., 1972b, p. 30). R. L. Davies shows, despite the preliminary Getis and Getis findings, that self-clusters are important to the CBD.

Griffin and Preston (Griffin, D. W. and Preston, R. E., 1966 and Preston, R. E., 1968) worked on the area which surrounds the CBD. By some definitions (other than the Murphy and Vance delimitation (Murphy, R. E. and Vance, J. E., 1954) the area which they define as the transition zone would include parts of the CBD periphery. It is notable that all of the land uses which they mention are peripheral in the typology as might be expected.

The analyses of the mixes of CBD land uses tend to confirm the descriptions of individual patterns and therefore the arrangement of land uses in relation to the typology.

The typology used in this study is a summary measure of the state of the Occidental literature. The division between center and periphery is the one which is commented upon most but there are some references to other patterns. The next chapter outlines a statistical method of pattern recognition which is more comprehensive than any used before in CBD analysis. This methodology will be applied to three case studies. The first is the CBD of the city of London in Ontario. It is taken as a representative Occidental CBD for which detailed locational information is available and it will be used as a test of the methodology. Guatemala and Bogotá are analyzed next as Non-Occidental CBDs. Before the analysis of London, Ontario and after the review of the methodology some potentially explanatory variables will be described for all three case studies. The culmination of the dissertation is a set of comments upon the

commonalities and differences of pattern for the Occidental and Non-Occidental CBD and an assessment of the potential use of Occidental CBD models.

CHAPTER II

SYSTEMATIC PATTERN RECOGNITION

The purpose of this chapter is to outline a useful and systematic method to test for the occurrence of the patterns and, by inference, the processes outlined in the typology in the last chapter.

A general category of descriptive spatial statistics is outlined by Bachi (Bachi, R., 1963), Warntz and Neft (Warntz, W. and Neft, D., 1960), Neft (Neft, D., 1966), and Shachar (Shachar, A., 1967) among others. Another set of inferential statistics is outlined by Rogers (Rogers, A., 1969), King (King, L. J., 1969) and Clark and Evans (Clark, P. J. and Evans, F. C., 1954). Added to the descriptive statistics these inferential statistics define separate spatial properties and provide a useful package for CBD pattern analysis. The descriptions are largely based on statistical averages and closely match the typology in Chapter I to provide a better descriptive analysis of individual land uses than has previously occurred in the literature.

The typology is a useful synthesis of currently known CBD processes and patterns. The accuracy of the land use assignments to the typology depends upon the descriptive quality of the methodology used in each analysis. All of the six studies previously mentioned which contributed to the assignments use geostatistical measures, mainly the relatively simple measure of mean center and dispersion. In Chapter I

there are some general criticisms of CBD analysis; others are presented next, before the description of the details of the methodology used here.

Most studies based on the collection of data for an areal statistical unit have shortcomings. Data on the individual building's land use is accumulated to some larger unit whether it be grid, city block or block front. The grid studies have the problem of deciding upon the optimal grid size for the mix and distribution of CBD land uses since each land use is both a different quantity and a different distribution. The grid could therefore be optimal for one land use but poor for another. Because the CBD, in North America at least, is laid out in a grid system of streets some studies use simply the city block as the unit of data collection. Use of this unit ignores the great differences that can exist between two opposite sides of a block. There are inherent problems based on this areal unit and there is a considerable loss of information. Streets functionally unite the sides of the blocks which face onto them and so some studies use block fronts as the statistical unit (Campbell, N., 1969).

Apart from the unit of data collection, the type of analysis the data is subjected to will, of course, determine the type of descriptions possible. There are two quite different sets of techniques. The interest here is on the pattern of individual land uses based on the processes in the typology so the study concentrates on a set known as geostatistics. The second set is the multivariate analysis set in CBD analysis and includes factor analysis, principal component analysis and various types of cluster analysis. Multivariate analysis is based on the mix or association of uses in some spatial unit. The analysis of the association of land uses is used to group the spatial units into clusters,

which if they are contiguous form regions. The set of techniques can be useful in defining inner CBD regions but there are problems not encountered in the use of geostatistical techniques. Both the problems of multivariate analysis and the properties of geostatistical techniques help to justify the choice made in this study.

There are a number of reasons for choosing geostatistical rather than multivariate types of analysis. In most multivariate analyses of the CBD each city block, block front or other statistical unit is described by the quantity of each land use or area of each land uses that it contains. The statistical units are associated or unassociated depending upon the similarity of the land use mixes within an areal unit. The degree of association of one unit with another unit is calculated using the correlation coefficient in factor analysis and principal component analysis and using an index of association in most cluster analyses. The complexity of interrelationships in the original data matrix is reduced to a few factors, components or levels of association which are relatively simple measures. These measures form a matrix of associations for every unit with every other unit. The matrix can then be used to define clusters of the units, each cluster having a precise measure of association (variously defined depending upon the technique). The techniques are useful in spatial analysis in that where the units are spatially contiguous they define regions which have a measure of cohesion associated with them but they are not useful as a tool to describe individual land use patterns and so are not used here. A detailed review of factor analysis and principal component analysis is found in King, L. J., 1969, pp. 184-193 and pp. 164-184 respectively.

Many forms of cluster analysis are discussed in Sokal, R. R. and Sneath, P. H. A., 1963.

More fundamentally there are problems associated with the use of the product moment correlation coefficient in studies concerned with spatial contiguity. Harvey states that the product moment correlation coefficient seems inappropriate for regionalization:

> Since the aim of such regionalization is to produce contiguous regions which are internally relatively homogeneous, it seems almost certain that this condition of independence in the observations will be violated (Harvey, D., 1969, p. 127).

The product moment correlation coefficient is the basis for factor analysis, principal component analysis and multiple regression analysis. Factor analysis is further criticized because it only rewrites the original data in another form which may or may not be interpretable (Johnston, R. J., 1968; p. 577). In addition, in comparative studies a synthesis of results of several factor analyses is difficult if not practically impossible (Harvey, D., 1969, p. 347, quoting Miller and Kahn, 1962, p. 295).

Harvey states that the various types of clustering, linking and grouping techniques face similar difficulties of application (Harvey, D., 1969, p. 347). There is no method to decide which resulting classification is best (Johnston, R. J., 1968, p. 586) for the application of different techniques can produce different, and often very different, results. Johnston quotes Rao in stating "No formal rules can be laid down for the finding of clusters because a cluster is not a well defined term" (Rao in Johnston, R. J., 1968b, p. 576).

In multivariate analyses the pattern of individual land uses

are not considered separately but are lost as a part of the mix of uses making up each statistical unit.[1] As a result multivariate analyses seem to ignore the fact that the processes in the CBD operate on individual land uses first. The classifications or regionalizations from multivariate analysis have a tenuous connection with CBD processes. At best a set of land uses would be distributed in exactly the same way as a result of the influence of a process or processes which is common to them all. The process and pattern could then be paired. However, this result is most unlikely and a comparison of actual patterns with ideal land use patterns resulting from known processes cannot be made in this kind of analysis. A primary knowledge of individual patterns and a description of their similarity with certain idealized patterns seem a useful way to describe, first, the different spatial characteristics of land uses and second, the structure of the CBD. This is the method used to construct the typology in Chapter I, and it is also the method used to compare Occidental and Non-Occidental patterns: Geostatistical rather than multivariate techniques provide the tool for pattern description used in this study.

Two geostatistical studies of the CBD lose information, one by accumulating the land uses to the city block unit (Thompson, R. W., 1972) and the other by systematically defining spatial clusters which cannot be easily compared either from land use to land use or from CBD to CBD (Davies, D. H., 1965). Thompson uses the block front as an areal unit and calculates the proportion of the area given over to a particular land

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[1] Alexander recently uses information analysis in an interesting study of the CBD of Perth, Western Australia but it is subject to these same observations (Alexander, I. C., 1972).

use in each block. He develops indices of segregation and compactness to define CBD regions but his results are not comparable in detail with this study since his land use data is accumulated in the statistics and further submerged in a regression analysis for twelve British cities (Thompson, R. W., 1972, pp. 69-94). Davies' study uses data on the area covered by each land use unit (Davies, D. H., 1965). He describes the shape of the distribution of each land use. The shapes are varied, based on isovalue lines defined using measures of the percentage area and percentage distance from the center of gravity (Davies, D. H., 1965, pp. 41-43). Each shape is unique and comparisons with other shapes are difficult.

Davies states that:

> ... The clusters delimited on the basis of areal measurements would not present a spatial pattern grossly different from that obtained by means of establishment counts (Davies, D. H., 1960, p. 40).

This is a useful observation because this study uses point and not areal information.[1] He also found that the mean centers of the clusters for areas and points are very close together. The cumulative percentage of points in a cluster, if the land uses are represented as points, corresponds quite well with the cumulative percentage of area in the cluster, if the land uses are represented as areas. The cumulative percentage of points in the cluster underestimates the area somewhat especially between the 45th and 75th percentiles value (Davies, D. H., 1960, p. 40 and Fig. 14) but these observations suggest that a study of land uses as points is a valid substitute for land uses as areas.

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[1] Areal information is not consistently available for London, Guatemala and Bogotá and so point location information is used.

The Boundary and the Scale

The boundary and the scale are interrelated and are important in the description of patterns. The CBD as a spatial sub-unit in the city-wide system is the result of city-wide processes. The internal CBD, the focus of this study, is the result of CBD-wide processes which spatially differentiate the land uses. The CBD boundary has received considerable attention in the literature. In the three case studies in this dissertation it is assumed that the boundary is defined large enough to encompass the aggregate of processes and patterns of interest in this study.[1] The assumption is intuitive based on other CBD studies and where the definition is erroneous the boundary is likely too large and so patterns would be over-clustered as Figure IIIA illustrates. This tendency can be negated by describing patterns in relative rather than absolute terms, as will be seen later. To identify the parts of the CBD spatial system it is necessary to define land uses in enough detail so that the land use sub-systems making up the whole CBD are identified. In each of the three case studies the land uses are more detailed than in most published CBD analyses.

When the boundary is defined and the uses finely differentiated, their pattern should then represent spatial sub-systems which are the result of CBD internal processes. It is recognized that there are uses

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[1] The boundary in all three case studies is defined by the planners in the respective cities. The five percent of the PLVI value which Murphy and Vance said corresponded closely to the edge of the CBD (Murphy, R. E. and Vance, J. E., 1954, p. 426) is shown for Maps I, II and III and it approximates the area defined in the field. In Guatemala this is not the case but the CBD is considered large enough intuitively to allow the study of the internal structure of the CBD. It seems from the Guatemala example that the five percent value does not always approximate the Non-Occidental CBD boundary.

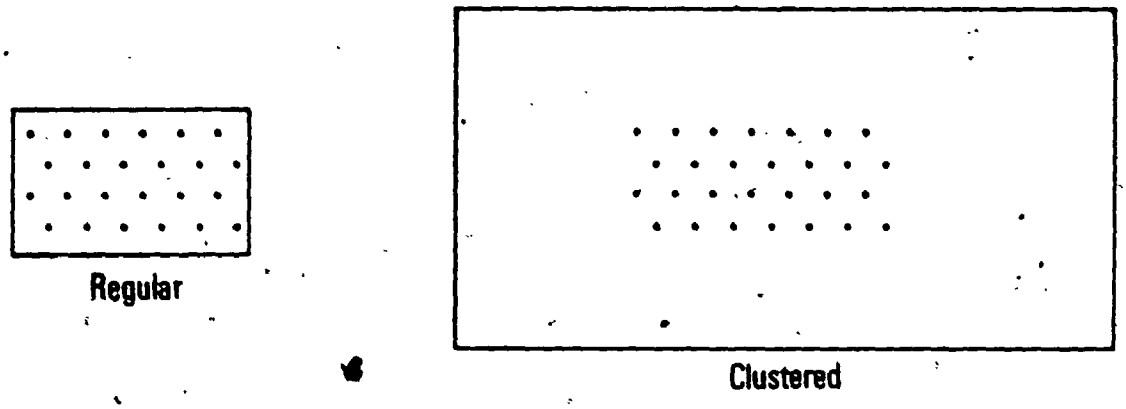

Figure IIIA

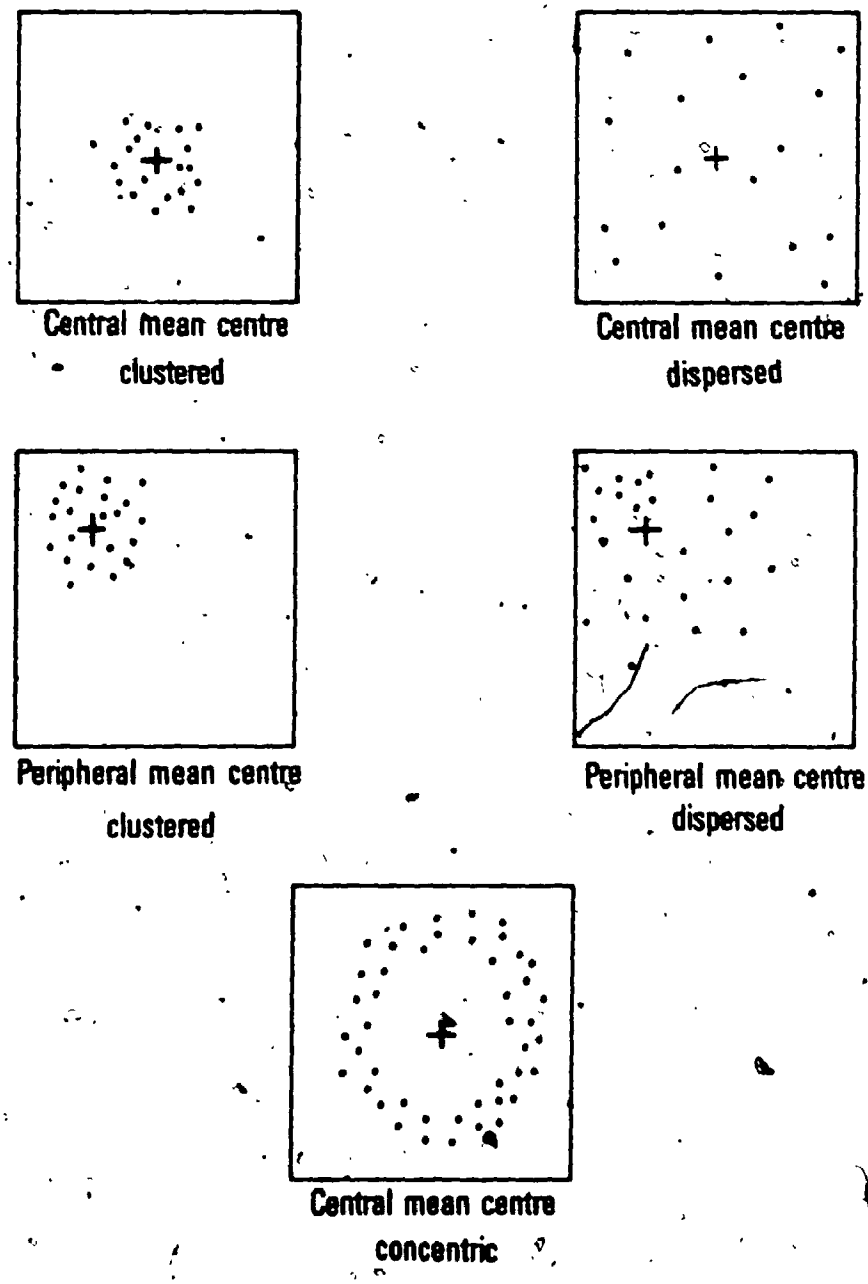

Figure IIIB

whose arrangement is the result of outside influences for few systems, in the social sciences at least, are remotely closed. The regular or random uses may be non-CBD in character. It is difficult to say more than that they may be non-CBD but they do contrast with those other clustered, linear and concentric patterns which are linked with a spatial process in the literature. To say that they locate by chance, or are maximally spaced seems unsatisfactory given influences like the extreme gradients in land values or pedestrian density in the CBD. It can only be concluded that intuitively, dispersed, random or regular (particularly random uses) operate according to a process which has a larger boundary.

> It has been generally agreed (although not always observed in practice) that different processes become significant to our understanding of spatial patterns at different scales. For the most part, however, we have no measure of the scale at which a particular process has most to contribute to the formation of a spatial pattern and our notions regarding the scale problem remain intuitively rather than empirically based (Harvey, D. W., 1968, p. 72).

Random and regular patterns seem at odds with the general accessibility mechanism, the mutual affinity mechanism or the attractiveness of a physical resource but instead of a spatial explanation based on scale the explanation may lie in some other non-geometric influence on the land use. Diamond points out (Diamond, D. R., 1960, p. 528) some influences of history in Glasgow. The influence of zoning has been noted by Weaver (Weaver, D. C., 1969, p. 410) and R. L. Davies has a model with an important cross classification based on the quality of the business. All of these influences are mentioned to explain deviations from the expected patterns. All of these and more have an effect on the interpretations of patterns and while they can be raised to explain anomalies

it is also possible that they can lead to misinterpretations of some patterns. It is possible to avoid error by comparing patterns for different cities for the same land use so as to isolate patterns which are the same despite local influences. Although many authors raise 'local influences' to explain aberations of expected patterns there is considerable evidence of common pattern (as noted in Chapter I) and it is difficult to assess what is truly 'local'. The design of the analysis in this dissertation is such that it is possible to isolate land use patterns produced by known CBD mechanisms which are typical of CBDs.

Comparisons are difficult between cities of different sizes, of different sized CBDs, or of different quantities for each land use. Some statistics can be compared directly despite these differences, while others can be compared at an ordinal rather than interval scale when the uses are ranked for a statistic rather than compared by absolute value. Some degree of comparison is always possible but an attempt is made here to preserve as much information as possible while making comparisons. The actual statistics to be used, their properties and the method of comparison follows.

Basic Data Description

In the analysis the CBD of London, Guatemala and Bogotá are assumed to be a homogeneous plane. Murphy and Vance point out that the CBDs are mostly built on flat sites (Murphy, R. E. and Vance, J. E., 1954, p. 335, Figs. 2, 5) and this is true of all three study areas (in Bogotá there is a gradient for a small peripheral proportion of the CBD). A land use is treated as a point on this planar surface. This point is located on the map at the front of the business where it meets the street

although a very few uses are interior in the block. Inaccuracy occurs in the study by assigning a land use to a point, that point being usually at the street front but this is not serious considering the total area of the CBD.

Land uses are sorted so that each has N individuals of equal weight described by cartesian co-ordinates. Each land use is analyzed separately for each of the three case studies in turn. The statistics are of two types. Descriptive statistics are only affected by the border in that it defines the limits of the distribution. Inferential statistics are affected by the border because the density of points per unit area is used in the calculation. Although the second group are correctly called inferential statistics they are not used for inference in this study. In all case studies the data is for whole populations and not samples so that the inferential statistics are used only in a descriptive role. The patterns which are outlined next are the average characteristics of the spatial distribution of each set of land uses represented as points.

The Points of Focus

The focus of a land use distribution is important. Land uses which are peripherally focused, like automobile sales in the Occidental literature, are quite different to centrally focused uses like shoe stores. The importance of the center is shown by the frequency of use of the PLVI in the literature and the comparison of its location with the distribution of the land uses. The PLVI is the most accessible intersection of the CBD and as a consequence around it rents, intensity of use and pedestrian densities are highest. The relationship between the

location of the PLVI and the point of focus of the land use is taken as a measure of the importance of general accessibility to that land use. It is also counted as a measure of its ability to pay rent and its orientation to pedestrians rather than vehicles. Land uses distributed close to the PLVI pay high rents and are in the center of heavy pedestrian traffic, those in the periphery are not. The point of focus can also be used to measure a property of the mutual affinity mechanism. Where land uses are clustered through mutual affinity the point of focus describes the center of their cluster.

The measure of focus in this study is a common one, the mean center. It is the balance point or center of gravity of the distribution and is described as follows:

$$\bar{X} = \sum_{i=1}^{N} \frac{X_i}{N} \quad , \quad \bar{Y} = \sum_{i=1}^{N} \frac{Y_i}{N}$$

where X and Y are the cartesian co-ordinates of each point i, and N is the total number of points for each land use.

The mean center is "the point on the plane from which the sum of squares of the distances to the point of the distribution is minimal" (Shachar, A., 1966, pp. 199-200).

Dispersion

The relationship between accessibility and the pattern cannot be described by the point of focus alone but when a measure of dispersion is used central and clustered uses can be differentiated from peripheral

uses. Two mean centers (points of focus) could have the same focus but one be clustered and the other dispersed, indeed one might be tightly concentrated round the PLVI and the other completely in the periphery. There is some difficulty in distinguishing a pattern which is dispersed throughout the central area and those which are peripheral and non central. However the statistics are useful in that they distinguish relative degrees of clusteredness and peripheralness and so help to describe a pattern's relationship to the accessibility mechanism. The statistic also describes peripheral clusters where a mutual affinity or an affinity for a characteristic of the physical environment is important. The pattern with a peripheral mean center but a dispersed distribution has no explanation in the literature unless it is a non CBD activity or is the result of a random process.

The measure of dispersion allows many of the patterns in the typology to be recognized but it does not allow a differentiation between certain clustering processes. Clustered patterns can have a number of interpretations. Peripheral clusters can be clustered due to the influence of an environmental characteristic; what R. L. Davies calls resource accessibility. There may be warehouses, garages or other land uses associated with a port, river or an important artery. Land uses can also be clustered with respect to one another and without regard to the environment. Getis and Getis call this mutual affinity. Clothing stores are mutually affinitive because each generates custom for the other. Certain professions are affinitive requiring close personal contact. Only those land uses in the center of the CBD and close to the PLVI can, in addition to resource accessibility and mutual affinity, be influenced by general accessibility to the whole city. General accessibility declines,

like assessed land value, intensity of use and pedestrian density, from the PLVI. It is not possible in this study to untangle these three closely related influences on pattern except to recognize that each one produces a clustered pattern. In general, resource accessibility relates to a process focused on a specific part of the CBD environment whereas mutual affinity is related to a process involving the individual land use itself, and general accessibility is related to the overall decline in the value of the land from the peak land value intersection. It is not possible to differentiate between these influences without reference to additional information about the more detailed individual decisions which influence the choice of sites.

The measure of dispersion also allows peripherally oriented patterns to be recognized. The degree to which patterns are exclusively central or exclusively peripheral has no measure. This causes some problem in interpreting concentric ring uses for it is not possible to describe them as peripheral-non-central, only that they are peripherally oriented.

The measure of dispersion used here is the mean distance to the mean center which is calculated as follows:

$$\text{mean distance to the mean center} = \frac{\sum_{i=1}^{N} ((X_i-\bar{X})^2 + (Y_i-\bar{Y})^2)^{1/2}}{N}$$

where $\bar{X}$ is the mean value of the X co-ordinates and $\bar{Y}$ is the mean value of the Y co-ordinates.

Focus and Dispersion Combined

The importance of a central/peripheral and clustered/dispersed differentiation of patterns is noted in Chapter I. There is a great difference between clustered and dispersed, central uses and between clustered and dispersed, peripheral uses. It is useful to combine the two statistics to make four categories. The center in most CBD studies is taken as the PLVI. Focus, or the position of the mean center of the distribution, can be reckoned in relation to the PLVI. A scattergram with two axes; the mean distance to the mean center, and the distance from the mean center to the PLVI represents dispersion and focus at the same time (see Figure IV).

The uses which occur in Sections A and B already have a place in the typology and the mechanisms which generate them are described in the literature. Land uses in A and B are the clustered uses; clustered either with members of their own type, or clustered with respect to some property of the location. The two may even operate together. The uses in A may also locate with respect to general accessibility which produces highest land value, intensity of use and pedestrian density in the center. Uses in B shun the central area but instead of an arrangement in a ring they are influenced by a mutual affinity mechanism or some special resource influence and form a cluster in a specific area in the periphery.

Uses in Section B are clearly not concentrically belted from the PLVI. The belted property is difficult to isolate, and this study is only partially successful in doing so. Belted uses should form a progression from Section A to C with an increasing dispersion but constantly central mean centers. Such an arrangement would signify increasingly dispersed uses but unfortunately they need not be in neat belts. They are

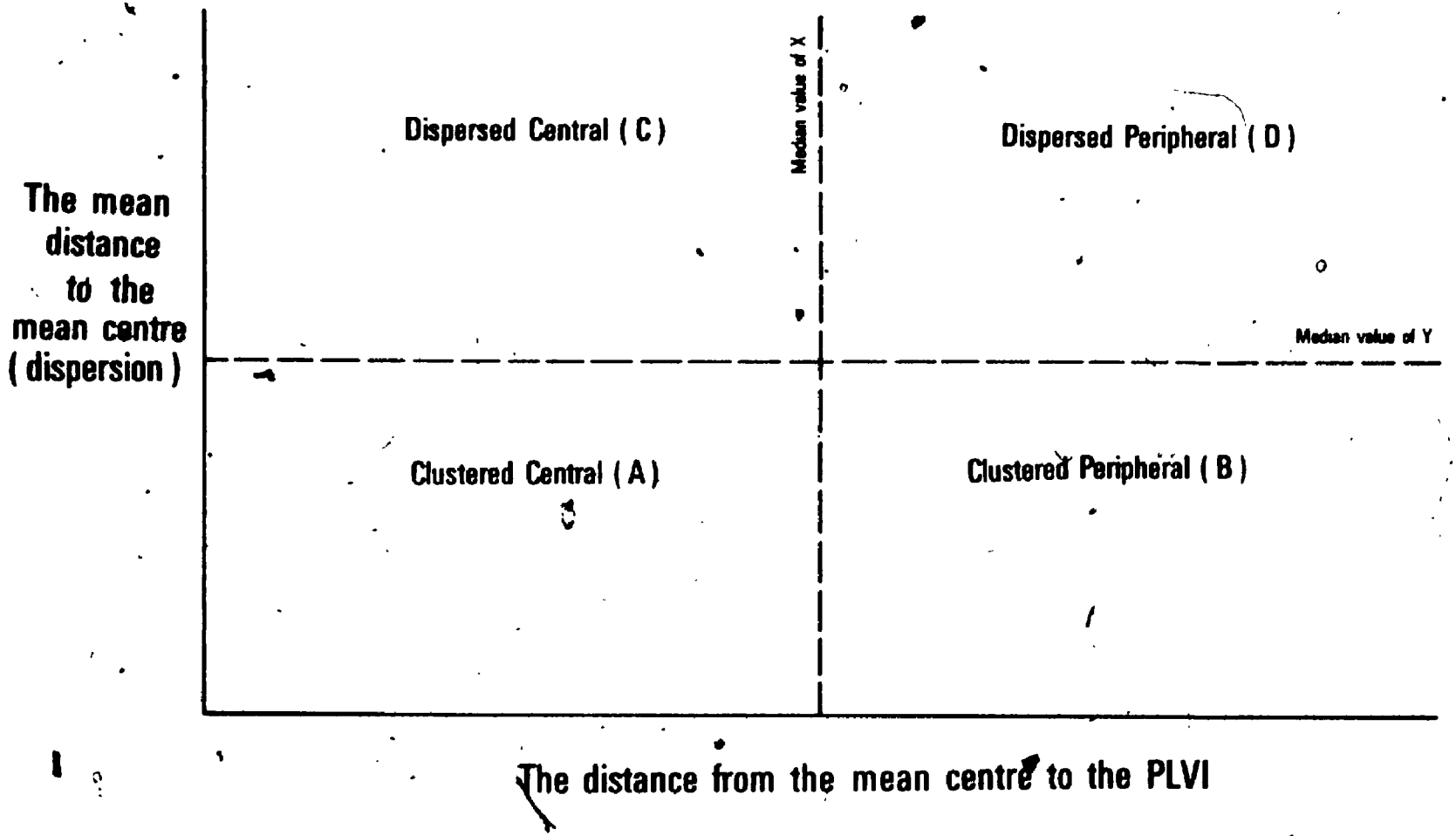
Dispersed Central (C)
Median value of X
Dispersed Peripheral (D)
The mean distance to the mean centre (dispersion)
Median value of Y
Clustered Central (A)
Clustered Peripheral (B)
The distance from the mean centre to the PLVI

Figure IV

increasingly dispersed in the aggregates but individual land uses could be central as well as peripheral. So it is difficult to decide if the uses in A and C are belted and the belted property cannot be isolated with the same precision as the other patterns in the typology. Uses in A do have a central orientation and those in C a peripheral orientation particularly where the value of dispersion is at the respective extremes, but this is only a crude measure of beltedness and the demand for an accessible location. Uses in B and D clearly do not have the concentric belted quality.

The uses in Section D are likely non-CBD uses since they do not have a central focus and are in addition dispersed. Land uses in D are likely to be distributed across the border and outside the CBD area. Like the uses in Section C they form a dispersed category and may be distributed in the CBD according to a mutual disaffinity or a random process.

The division into four sections is not an absolute one. This should be borne in mind when CBDs are compared. The median division could be ignored and the actual location of each land use in the scattergram could be used. It is felt that the division about the median is of practical value since each city has a different size, the land users are each of different quantities both within and between cities; and the boundaries are of different shapes. Because of this variation between cities the four sections are useful as a partition of the land uses into relative locations in the scattergram which have properties described in the typology. Land uses with the same description and the same properties can be compared for different cities.

The scattergram helps to isolate some of the patterns which are a part of the typology, particularly the clustered, central and clustered,

peripheral parts (Sections A and B). The use of a number of other statistics at this stage such as the oblongity and orientation statistics makes further isolation of important CBD patterns possible.

Shape

Both clustered and dispersed patterns may have a variety of shapes. Linear shapes, since they reflect the importance of access to a main artery, are particularly important. R. L. Davies and a number of authors link linear patterns with the arterial accessibility mechanism which draws particular land uses to important arteries. The measure of shape is particularly important for the more clustered uses and helps to distinguish between the patterns in Figure VA. The oblongity statistic (Waterman, S., 1972) differentiates circular or nodal patterns from those which are linear. Both patterns occur in the typology. The linear shapes, coincident with an artery are no doubt influenced by that special linear resource. This separates nodal clustered patterns, influenced either by a point or small area resource or by mutual affinity considerations. The oblongity statistic measures the relationship between the variance about the principal or long axis and the orthogonal short axis of the distribution.

$$\text{Oblongity} = \frac{\sigma_u^2 - \sigma_v^2}{\sigma_u^2 + \sigma_v^2}$$

where σ_u^2 is the variance about the long axis and σ_v^2 is the variance about the short axis.

$$\sigma_u^2 = \frac{\cos^2\alpha \sum x_i'^2}{N} + \frac{\sin^2\alpha \sum Y_i'^2}{N} - + \frac{2 \cos\alpha \sin \sum X_i' Y_i'}{N}$$

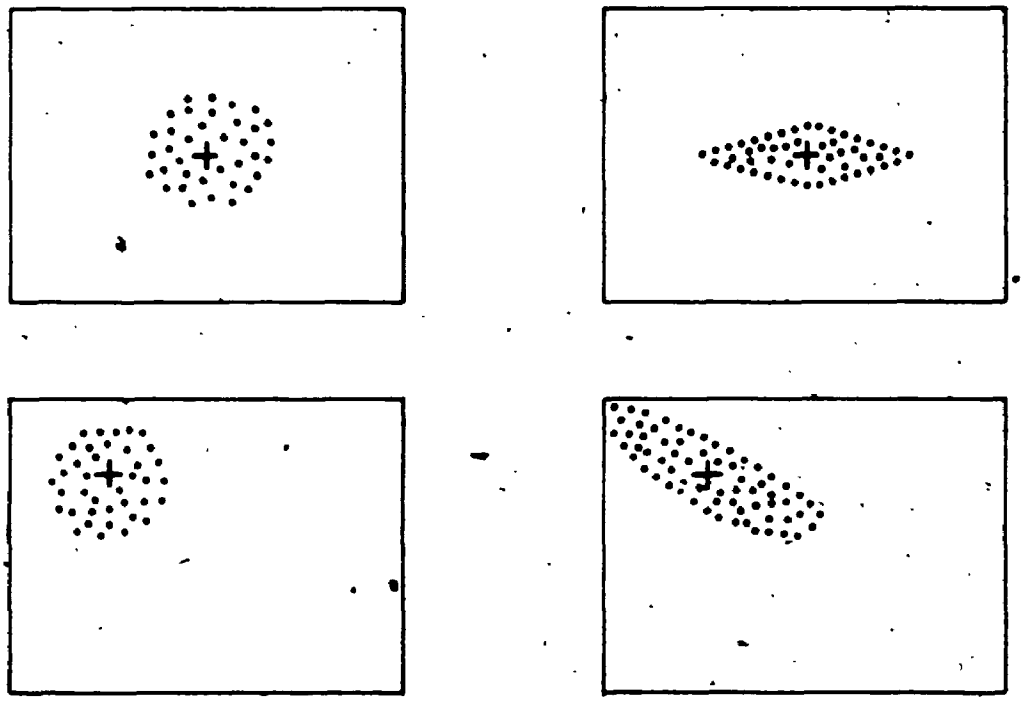

Figure VA

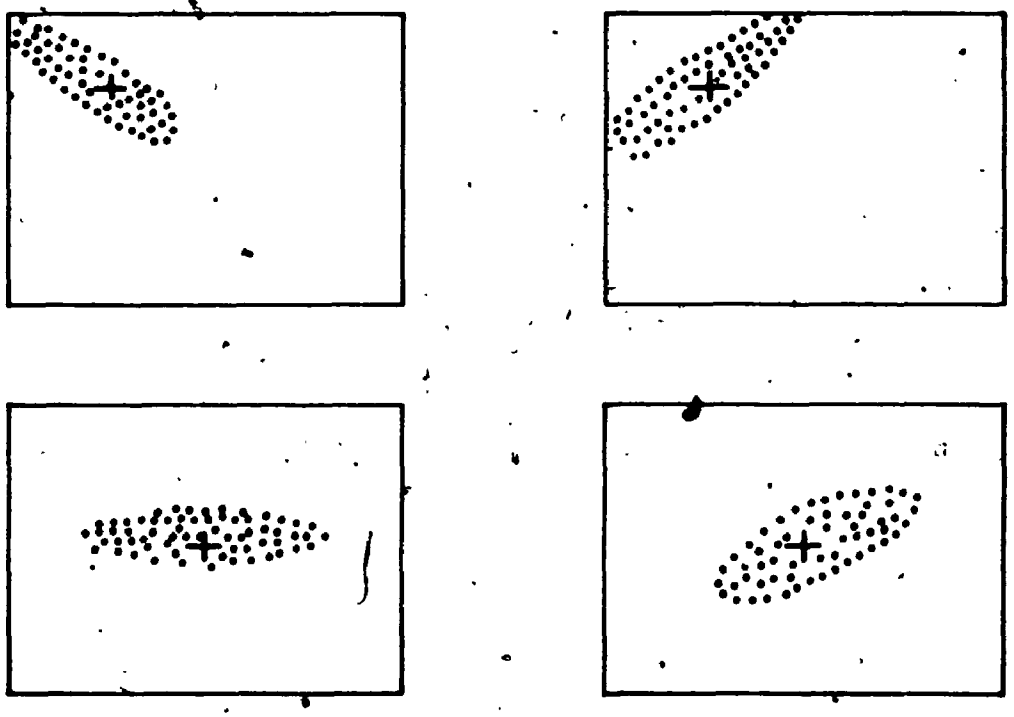

Figure VB

and

$$\sigma_v^2 = \frac{\cos^2\alpha \sum Y_i'^2}{N} + \frac{\sin^2\alpha \sum X_i'^2}{N} + \frac{2\cos\alpha \sin\alpha \sum X_i' Y_i'}{N}$$

where α is the orientation of the principal axis in relation to the cartesian co-ordinate system. X_i' and Y_i' are the distances on the x and y co-ordinates respectively, from the point X_i, Y_i to the mean center.

Oblongity varies between 0.0 for a circular distribution and 1.0 for a straight line.

Orientation

Where a distribution is clustered and particularly where it is linear then the orientation is a useful descriptive measure. Linear-clustered patterns are likely influenced by principal arteries. With this measure it is possible to compare the orientations. In block pattern CBDs the distributions may be linear along one set of streets, or the cross-streets, or may compromise between both. Whatever pattern, the orientation adds useful information on CBD structure. It differentiates between the patterns in Figure VB. The orientation is measured by the angle α, the angle between the principal axis (which maximizes the variance) and the artesian co-ordinate system. It is defined as follows:

$$\alpha = 1/2 \tan^{-1} \left(\frac{2 \sum X_i' Y_i'}{\sum X_i'^2 - \sum Y_i'^2} \right)$$

The measure can be converted from radians to degrees.

$$\alpha \text{ (in degrees)} = \frac{180}{\pi} \alpha \text{ (in radians)}$$

The inferential statistics[1] both confirm some of the patterns already observed and help to isolate the two dispersed types in the typology, i.e. the random and regular patterns. The measure of dispersion is a measure of the clusteredness of the whole land use distribution whereas the nearest neighbor statistic isolates smaller clusters. The nearest neighbor statistic will confirm the clusteredness of the whole group or will highlight small clusters of two or more. This aspect of the statistic is useful as a check for land uses already in Sections A and B. Where the uses are already in C and D, i.e. they are dispersed uses, the nearest neighbor technique differentiates between those which are maximally or regularly spaced by the mutual disaffinity mechanism and those which are spaced by a chance process and have a random distribution. The patterns in Figure VI can be differentiated.

These patterns are described by the R statistic and by the normal deviate. Definition of the boundary is important for this statistic since the density of points is used in the calculation.

Distances between each point and its nearest neighbor are measured in a data set of size N. If a point is closer to the boundary than to its nearest neighbor it is deleted from the calculation. The distances are independent of direction and form a set of N paired distance measures. They are compared to a theoretic randomly distributed population of the same size. For the set of randomly distributed points the mean distance between pairs of nearest neighbors $\bar{r}_E$ is calculated as follows:

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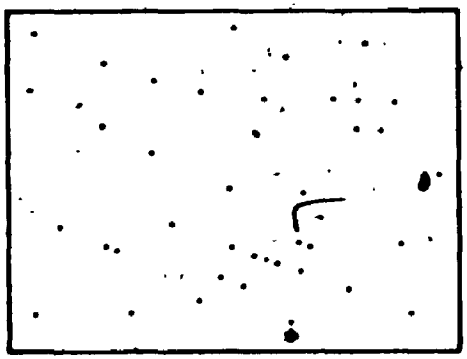
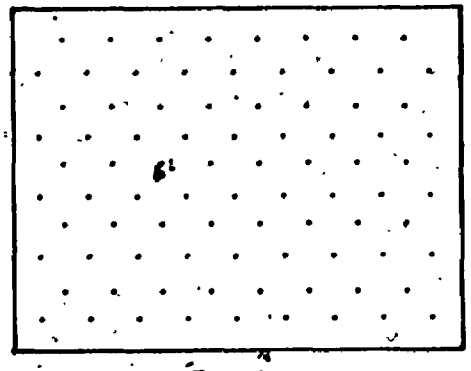
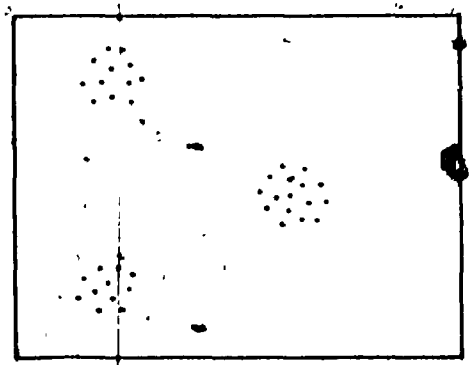
[1] Inferential statistics are used descriptively in this study and not for inference.



Random



Regular



A cluster or clusters

Figure VI

$$\bar{r}_E = 1.0/(2\lambda^{1/2})$$

where λ is the density of the points (King, L. J., 1969, pp. 99-100).

The R statistic (King, L. J., 1969, p. 100) is based on a comparison of the mean of the actual distances $\bar{r}_A$ and the mean of the random distances $\bar{r}_E$

$$R = \frac{\bar{r}_A}{\bar{r}_E}$$

The statistic has a range $0.0 \leq R \leq 2.1419$. The distribution being tested is random where R = 1.0, more clustered as it approaches 0.0 (when all points have the same locus) and more regular as R approaches 2.1419 (when points are distributed in a maximally spaced hexagonal pattern).

While the R statistic is presented for the London case study the normal deviate, a similar statistic, is preferred because it incorporates a measure of statistical significance. The normal deviate is calculated as follows:

$$N.D. = \sqrt{2\chi^2} - \sqrt{2N-1}$$

The calculation of χ^2 and N is based on Thompson's statistic (Thompson, H.R., 1956, for elaboration see Appendix V).

The normal deviate has a mean of 0.0 and a standard deviation of 1.0. The value ±1.96 is at the 95% confidence so that values above +1.96 are regular and those below -1.96 are clustered. The value ±1.96 corresponds to 0.05 percent probability in the χ^2 table. The normal deviate should be used for values of N greater than thirty but all the statistics are calculated for populations of five or more in this study. The use of the statistic for small numbers of points invalidates the

test of significante but the statistic is used only as a descriptive measure to rank the land uses. The normal deviate is used because it is a better measure for large populations and the normal deviates in rank order are very similar to the R statistic even when small populations are included (compare Appendix IV with Table X).

The dissertation now proceeds to an analysis of three case studies, namely London, Guatemala and Bogotá. In Chapter IV, which follows, data on some important explanatory variables is discussed. It is mentioned on page 56 that land rent, measured in most studies as assessed land value, is of central importance as an influence upon land use in Occidental CBDs. This information has been acquired for London, Guatemala and Bogotá. It is the only measure of its kind obtainable for all three cities and some common land value surface characteristics are evident.

In the succeeding three chapters (IV, V, and VI) each case study is described. The information in the scattergram, the measures of shape and orientation as well as the normal deviate statistic are arranged so that comparisons can be made between CBDs. The statistics are divided into four quartiles and comparisons are based on these quartiles. The problems of comparing these relative values are already discussed and should be borne in mind.

In Chapter VII the methodology is assessed but more importantly the descriptions which it provides are used to test for similarities between London as an Occidental case, and Bogotá and Guatemala as Non-Occidental cases. The methodology just outlined helps describe land use patterns in relation to the processes in the typology. It should be possible to compare Non-Occidental patterns, described by the same

measures, and to assess if they conform to the patterns and processes expected from analyses of Occidental CBDs. The comparison is made using the London CBD and the Occidental literature summarized in the typology on the one hand, and the Bogotá and Guatemala CBDs and the Non-Occidental literature on the other.

CHAPTER III

LAND VALUE AS AN INFLUENCE ON LAND USE

This chapter deals with the only independent variables which are measured for each of the case studies. Land values and pedestrian density are treated as related independent variables which influence land use. Emphasis is on land value since it is considered an important influence on land use by most authors and is included in their studies of the CBD. It is also the only independent variable which is measured for all the case studies. Murphy and Vance discuss its usefulness (Murphy, R. E. and Vance, J. E., 1954, p. 424). Diamond discusses it for Glasgow (Diamond, D. R., 1960, p. 531) and D. H. Davies for Capetown (Davies, D. H., 1960, pp. 15-16). Carter and Rowley have a map of ratable values for Cardiff (Carter, H. and Rowley, G., 1966, p. 125). Each author expects a correspondence between land use and land value. This expectation no doubt is influenced by some observed empirical regularities in land value, some observed correspondence between land value and land use and some theoretical statements that are made.

Alonso and Garner are authors of important theoretical statements as to the relationship of land use and land rent. The PLVI is the most central point in the city. It is therefore the most accessible point for the city as a whole. Accessibility influences the rent which a land use is willing to pay for its site. Those requiring and able to pay for

the most accessible site locate at the PLVI, having outbid other competitors in the free market situation.

The ability to pay for the site is expressed in the bid rent curve. This is a curve expressing the relationship between rent and distance from the PLVI. The PLVI as has been noted is the most accessible point and commands the highest rent. Businesses with the steepest bid rent curves locate at the center being surrounded by the next steepest curve and so on. Alonso showed this relationship when he improved upon the application of Von Thunen's principles to the whole city. The bid rent curve for a land use is the summary measure of all of the economic influences particularly volume of sales, operating costs and area of intensive land use.

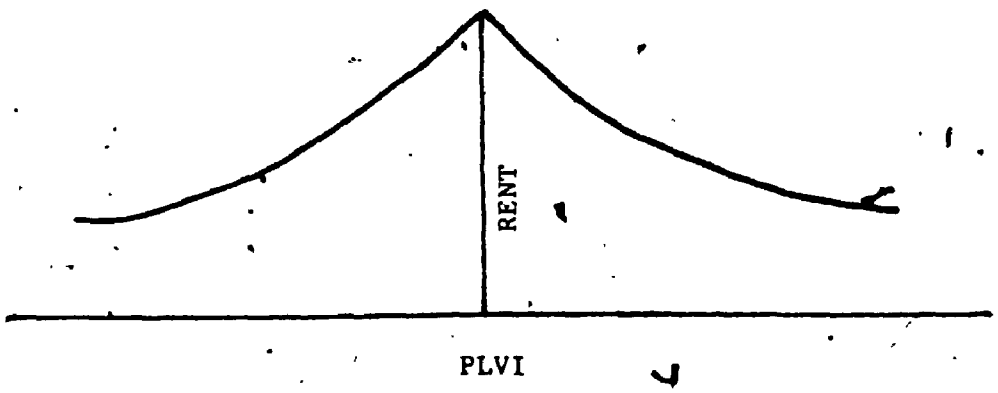
> The locations are determined by assigning to each successive user of land the location available nearest the centre of the city after assignment of land quantities to the higher and more central businesses (Alonso, W., 1972, p. 116).

The result of this work is a concentric ring arrangement determined by the model's very strict assumptions, however, Alonso points out that new arrangements would result by adding other influences.

Alonso's model is a whole city model and has been only very briefly discussed here. Garner deals only with retail land uses and gives a useful theoretical addition to the understanding of the CBD. He notes two influences upon a retail business type, one macro and the other micro, which affect its ability to pay rent. The macro influence is the aggregate transport costs to the consumer and the micro influence is the local concentration of shoppers. The more central in the CBD the land use is located, the greater will be the savings in aggregate transport costs to the consumer. This saving is related to threshold size since the threshold

defines the number of consumers (or sales volume) required to support a land use. The department store with the higher threshold derives its customer support from the whole city. It would not locate in a neighborhood business district for although rent would be cheaper there the aggregate transport costs would be greater. Each land use has a different threshold size and consequently number of customers or volume of sales required to support it. Each will have a different aggregate transport cost and therefore a different rent which it can afford to pay. The land uses then, Garner argues, will arrange themselves concentrically with the "highest and best" use in the center surrounded concentrically by each successive use in the hierarchy (Garner, B.J., 1966, p. 107).

There are a large number of assumptions in these theoretical statements. Each land use is expected to locate like other members of the same land use type. Their volume of sales should, therefore, change only in proportion to their floor area. Quality considerations are not incorporated, neither are any geographic influences such as street pattern, zoning influences, barriers and many others. The descriptions are for a static equilibrium state. The rent declines uniformly from the PLVI, reflecting the decreasing access to the whole city, the decreasing number of shoppers and therefore a decreasing volume of sales. The PLVI is at the center of a 'cone' of rent costs as follows:



In summary each land use is expected to give way to another depending upon its ability to pay rent. The highest rent payer will be in the center, the lowest on the periphery. The highest rent paying type uses all the space it requires in the most central portion before the next lowest rent payer follows in a concentric belt.

In the empirical studies most authors give some consideration to surrogates for rent since this is usually confidential information and difficult to obtain. The most common surrogate is assessed land value which although it is slower to react to the market situation is widely used because it is relatively easily obtained.

Knos showed that the assessed land value surface is cone shaped for the whole city (Knos, D.S., 1968, p. 270). The surface has also been identified in the CBD although sometimes imprecisely. Rannells, for example, notes that the highest land value is found in the center of the retail shopping district in New York at which point the pedestrian traffic is also heaviest (Rannells, J., 1961, p. 19). He states that assessed valuations give a gross measure of relative importance of locations within the CBD. Larry Smith also notes the change in land value and associated land uses (Smith, L., 1961, p. 38). Murphy and Vance give better expression to the land value surface when they say that various measures of intensity ordinarily decline (from the PLVI) toward the edges of the city although more sharply in some directions than in others (Murphy, R.E. and Vance, J.E., 1954, p. 418). Murphy and Vance, as well as Davies for Capetown, show that the five percent land value line approximated the CBD boundary defined by the Murphy, Vance height and intensity indices (Murphy, R.E. and Vance, J.E., 1954, p. 425-526; Davies, D.H., 1960, p. 16).

Actual maps of the land value appear in a number of studies.

London, Ontario shows a decline to the CBD edge with an elongation on the principal artery (see Map I, first produced in an MA thesis, Campbell, 1969, p. 32A). Davies (Davies, D.H., 1960, Figure 18) for Capetown again demonstrates that the surface of land values has a rough conical form. Carter reproduced a map of rate indices in his book (Carter, H., 1972, p. 199) which again shows a decline from the PLVI. The identification of the land value surface is more precise in some studies than others but it is generally agreed that it is an important influence on land use.

Apart from the general conical form of land values there are a number of other constant characteristics. The PLVI is not central to the CBD as defined by the Murphy-Vance index but is offset toward the area where the isovalue lines are steepest. Murphy and Vance call this area "the zone of discard" and the opposite side of the CBD "the zone of assimilation". If the land values have a steep gradient toward the zone of discard they have a gentle one toward the zone of assimilation (Murphy, R.E. and Vance, J.E. and Epstein, B.J., 1955, pp. 42-44). These features are common to a number of CBD's and are not influenced by topographic features since the CBD is generally characterized by a flat site and in North America, at least, a regular grid system of streets. It exists on what is almost an isotropic plane. The CBD seems to grow away from the PLVI in the direction of, and beyond, the geographic center[1] (Diamond, D. R., 1960, p. 533). The growth of the CBD is incremental but the PLVI leaps from one intersection to the next with growth through time, lagging behind the geographic center (Murphy, R.E., Vance, J.E. and Epstein, B.J.,

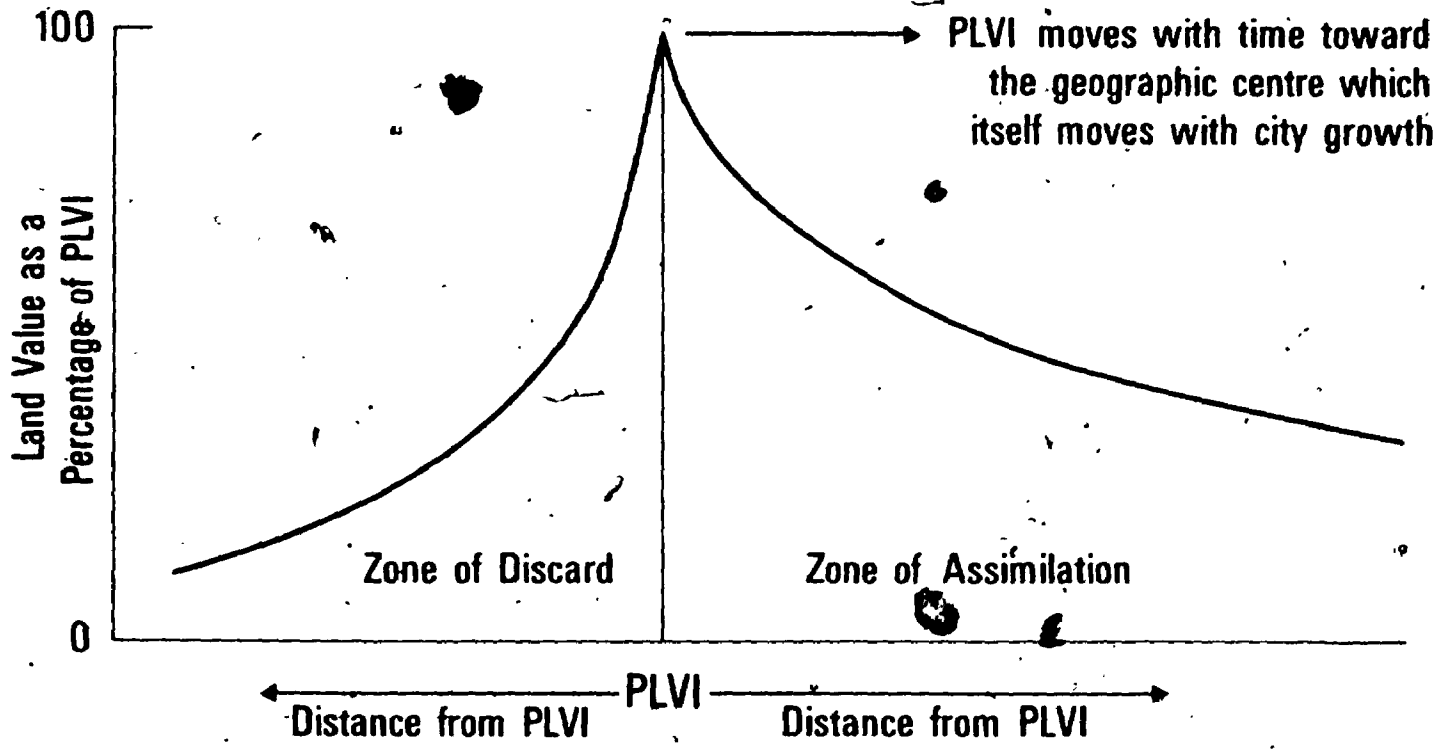
[1] Bowden, J.J., 1971, p. 130 notes a constant movement of the geographic center south for seventeen years to 1906 for San Francisco. Between 1906 and 1931 it moves 200 yards west. It shifts most markedly at fifteen yards per year in its early years.

1955, p. 44). Figure VII summarizes the common land value features.

London is selected to represent the Occidental city in this dissertation. The remarks made so far in the chapter refer to Occidental CBDs and apply very well to London as has already been mentioned. The PLVI is at Dundas and Richmond Streets' intersection (Map I). The land value gradient is steeper toward the river in the west which was once the old banking district and the location of the PLVI itself (Simmons, A. J., 1961). This is now, from personal observation, the zone of discard. Yeung shows that the values declined in the center and west between 1961 and 1965 whereas parts of the north and southeast increased (Yeung, Y. M., 1966, p. 70 ff.). The PLVI is moving west and possibly northwest and it is in that direction that the zone of assimilation is to be found.

Gautemala and Bogotá are the Non-Occidental representatives. They are characterized by an entrepreneurial class which is not of the same ethnic group as the mass of the people. The bicultural nature of the CBD is notable in a number of cities but it seems to be reflected even in the land value surface in Guatemala. The area of highest land values is opposite the National Palace in what is a European or Spanish oriented part of the city, reflected (as will be seen later) in the land use quality and also in the culture of pedestrians on the street. The values from the PLVI remain high along the two arteries Avenida 6 and 7 (Map II). The values decline from a maximum of one hundred and seventy Quetzals to a low point of one hundred and thirty in Avenida 6. At Calle 18, which is perpendicular to the Avenidas, the values rise once more so that on some blocks the value is 83 percent of the peak value, a very unusual situation given its distance from the peak. Calle 18 represents almost a second but minor peak; its character, from personal

The Structure of CBD Land Values[1]



PLVI = Peak land value intersection

1. As described in the CBD literature

Figure VII

observation, is a bustling street with small businesses catering to the Indian and mestizo population. It contrasts with the area around the PLVI and has the character of a native bazaar. This duality is noted in other cities but its expression in the structure of land values is not shown before. The PLVI is well to the north of the CBD but no evidence exists to aid in the definition of its movements or the zones of assimilation and discard.

There is no second peak in Bogotá (Map III); like London it follows the observations made in the literature for North America. The entrepreneurial class may be of the same proportions as Guatemala but, and again from personal observations in the field, the city has a highly developed character which outwardly at least is similar in appearance to European and North American CBDs. There is no area which has the character of a bazaar. The PLVI is, like all three cities, offset to one side of the CBD, and the high values are extended toward the north. This is toward the area of high social stratification and away from the area of lowest stratification in the south.[1] This may be an indication of the direction of the zone of assimilation (north) and the zone of discard (south). It seems likely that the PLVI is moving out of the south toward the north and now is located at the junction of Avenida Jimenez and Carrera 7. Two major arteries Carreras 7 and 10, and to a lesser extent 14, form elongated land value ridges running from south to north.

In the land value maps of all three cities the PLVI (or 100 percent location) is marked. Isovalues for 75, 50, 25 and 5 percent are

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[1] Map opposite p. 172 of the Boletin Mensual De Estadistica 1970, #229, Departamento Administrativo Nacional De Estadistica (DANE).

drawn to show the form of the value surface. In Guatemala the 5 percent value does not occur within the CBD. Although the 5 percent value is shown by Murphy and Vance to approximate the outer margin of the Occidental CBD nevertheless it is felt that the CBD in Guatemala is generously defined.[1]

The Bogotá land values are for one front on each block. In Guatemala they are for two adjacent sides of a block. The London land values are the mean value of each property for each block front. In each case the values are per unit area. The PLVI in each case is given the value of the highest adjacent block front.

The London and Bogotá value surfaces accord with the literature. Guatemala may be explained by the ethnic influences in the CBD. Whether or not this is a satisfying explanation, the land value surface is an important description of the CBD space and it is clearly recognized as such by most authors. The surface for these three case studies should be borne in mind when the analysis of the land uses is conducted. This is the only independent intensity measure which could be obtained for all three cities.

While land value is a surrogate for land rent it might also be considered a surrogate for other intensity measures which, as Murphy and Vance indicate, ordinarily decline from the PLVI (Murphy, R. E. and Vance, J. E., 1954, p. 418). Daytime population, pedestrian counts, traffic flows, intensity of use and building height are all suggested in the same work. D. H. Davies has a long list which also includes shop rent index, trade index, block front volume of sales, etc. (Davies, D. H.,

[1] The five percent value line is not useful to define the limits of the Guatemala CBD. It may be useful only in Occidental CBDs.

1960, p. 15, footnote 1). Volume of sales would be a useful intensity of use measure although this is not available. It is possible, however, to give pedestrian densities for London (see Map IV) and while the data is incomplete it conforms closely to the land value. For Bogota information exists on the number of sidewalk vendors per block front. These are itinerant merchants who sell shoe laces, watch straps, candies, etc. on the sidewalk to passing pedestrians. Their numbers are treated as an index of pedestrian concentration. To produce a surface a potential program is used with a self potential of 0.0. The surface of pedestrian potential again corresponds very closely to the land value surface (see Map V).

These two measures, with no pedestrian data for Guatemala unfortunately, are the only intensity of use measures for the three cities. They both decline from the PLVI, more steeply in one direction than the other. They should be borne in mind in the land use analysis which follows. The land uses are for the ground floor only. Where two or more land uses of the same type have the same address then only one is used. In Guatemala land uses in the market are deleted because they could not be accurately located. The CBD boundaries are defined by the planners in the field and the land use classifications are recorded in Appendices I, II and III for London, Guatemala and Bogota respectively.[1]

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[1] The clarification in Appendixes I, II and III can be folded out and should be used to interpret the codes used in the maps and text which follows.

CHAPTER IV

THE CBD OF LONDON, ONTARIO

The Occidental literature has been culled for regularities of pattern among the land uses in the CBD. These are organized not by theoretical structure alone but by a combination of theory, empirical results and techniques of pattern recognition. The result is a set of patterns which are important in CBD analysis and a set of land uses which are consistently associated with each pattern. This typology characterises the Occidental CBD since it is a synthesis of statements about that CBD. This is the base from which the Non-Occidental CBD's are examined for similarities or differences. It is also the base from which London is examined both to test the analytical tools used in this dissertation and to provide a case study which can be directly compared with the other Non-Occidental case studies since the same statistics are used.

The package of pattern describing statistics reviewed in Chapter II is more comprehensive than in any previous study of the CBD. The package has a bias toward the clustered uses and succeeds in identifying these best of all. Belted uses are least well described but apart from these two types, the analysis differentiates between clustered-linear, clustered-nodal, peripheral-oriented, central-oriented, random and regular types. The actual statistics used to identify each pattern are already described in Chapter II. In this chapter the statistical package is applied to London, Ontario which has a population of approximately 200,000 people.

London, Data Characteristics

The boundary of the London CBD is a modification of one used by Yeung in a commercial study of the city (Yeung, Y.M. 1966). Each Land use population is delimited by this boundary. Two important barriers define the south and the west, namely, the railway tracks and the river. In the north a park forms a partial barrier in that direction but the east is quite open.

Each land use is represented by a series of points on the edge of the block. The location of each point is defined by Cartesian co-ordinates which are converted from the street addresses. In 1966 a survey of the CBD was undertaken and each land use type and its address was recorded. The streets in London form a grid pattern with roughly an east-west and north-south orientation. It is found that parallel block fronts have similar addresses and there is no overlap between one block front and the next one along the street no matter which street is examined. Because of this a maximum and minimum address for each east-west oriented block front bounded by the same two north-south streets could be established. Since the beginning and end of each block has a maximum and minimum address similar to those blocks which parallel it then it can be assumed that the street address system is itself a regular co-ordinate system. These addresses can be converted to a cartesian system by assigning the beginning and end of each block front an X and Y value on the Cartesian system and recalculating the position of each old address on the straight line between these two points. Some inaccuracy is inevitable in using this method but the increased information and savings in field work time seem to justify it. The values in each table are in one hundredths of an inch on the original base map and can be transformed, getting one

hundredth of an inch equal to 0.6025 meters.

The classification system used for London is the one contained in the Standard Land Use Coding System (Urban Renewal Administration Housing and Home Finance Agency and Bureau of Public Roads, Department of Commerce, 1965) and the relevant uses are listed in Appendix I.[1] The set of Cartesian co-ordinates are sorted by land use and each use is analyzed separately using the statistical package described in Chapter II. The analysis for all of the three case studies is only for the ground floor land uses.

Foci of the Distributions

The focus of the London CBD is the intersection of Dundas and Richmond Streets. This is also the PLVI and from this same intersection the land values and pedestrian densities decline (see Maps I and IV). The decline is steeper toward the west (the "zone of discard") than toward the east (the "zone of assimilation"). The mean center, or center of gravity of the distribution, is an important measure of focus. The mean centers are consistently to the east of the PLVI reinforcing the notion that the "zone of assimilation" is in that direction (see Map VI). This adds evidence to Murphy, Vance and Epstein's suggestion that the PLVI lags behind the functional center of the CBD (Murphy, R.E., Vance, J.E. and Epstein, B.J., 1955, p. 24).[2] The functional center of the

[1] In the Appendix the full numerical notation for each land use is used but in the Text, Tables and Maps the notation is abbreviated to the first four digits, e.g. 2210 rather than 2210-3914.

[2] Weaver modifies these findings when he up dates the Murphy, Vance and Epstein study (Weaver, D.C., 1969, p. 410).

London CBD appears from the mean center information to be almost half a block east of the PLVI.[1]

The central and peripheral CBD uses are already differentiated by their mean centers distance from the PLVI (Table V). Most of the central uses in the typology are below the median value in the lower quartiles for this statistic. The peripheral uses include professional types (6511, Map XIII and 6591), vehicle oriented types (4114, Map IX; 5100, Map X, 6411 and 6370) and there are a number of service oriented uses (6251, 6920, 6121 and 6310). The arrangement conforms very well to the assignments in the typology but there are a number of anomalies.

Dispersion of the Distribution

The automobile parking (4600, Map X) and industrial uses (2210, Map IX) are examples of anomalies and show the need for a measure of dispersion. The two uses have a central focus yet intuitively and by the assignments to the typology should be peripherally oriented, i.e. dispersed around the mean center. The properties of the measure of dispersion are already outlined. The measure is useful in differentiating clustered and dispersed uses, for these two different types may have the same mean center. Table VI shows that the two anomalous uses mentioned above are dispersed and therefore peripherally oriented. Shoe stores and women's wear sales (5660, Map XII and 5620, Map XI), as examples, are clustered and are already central in Table V. Physicians' services and movie theatres (6511, Map XIII and 7212, Map XIV) are clustered in Table VI and yet are peripheral in Table V. The combination of these two

[1] Recently considerable investment has been made in the east of the CBD so that the patterns may be changing.

TABLE V

London
Ranked Distance From the Mean Center to the PLVI

Value	Land Use		Value	Land Use	
867	6511		207	9400	
692	4114		206	2210	
640	6220		197	6700	
578	6370		195	6520	
484	6920		193	5620	
465	5931	Upper	173	6711	Lower
445	6591	Quartile	170	5630	Middle
385	5950		168	6231	Quartile
338	6251		167	6232	
336	6151		164	5610	
304	6310		159	5670	
289	6121		132	6111	
288	4711		125	5941	
278	7620		106	5660	
272	6411		96	5820	
261	1210		95	5400	
255	5100		78	5300	
245	5990	Upper	73	5810	Lower
241	1300	Middle	73	5500	Quartile
238	6611	Quartile	64	6491	
234	5910		55	6991	
233	7212		55	4600	
229	7219		32	5970	
214	1100		32	5711	
208	6200	Median Value			

TABLE VI

London
Ranked Mean Distance to the Mean Center

Value	Land Use		Value	Land Use	
793.9	1100		398.3	5711	
750.4	6611		388.3	4114	
680.2	1210		386.2	5300	
648.8	5500		382.7	5810	
647.7	6711		381.3	1300	
565.9	6991	Upper	362.8	5630	Lower
561.9	4600	Quartile	358.5	5670	Middle
548.3	7620		347.8	6370	Quartile
548.0	6310		328.8	7219	
531.2	2210		327.7	5950	
525.3	6151		325.8	5910	
512.0	6700		323.2	6591	
511.9	6231		321.3	5820	
503.2	6232		306.1	5970	
485.4	6121		302.3	5610	
481.5	6210		298.1	5400	
468.0	6520		271.8	6920	
465.3	5941	Upper	270.2	6111	Lower
454.8	6491	Middle	266.7	5931	Quartile
454.3	9400	Quartile	250.0	5620	
435.7	6411		212.0	6511	
419.4	5100		209.6	6251	
417.7	4711		204.0	7212	
410.1	6220		170.6	5660	
400.6	5990	Median Value			

measures, focus and dispersion, helps to further differentiate the land uses.

The Scattergram

Focus on the X axis is related to dispersion on the Y axis (see Figure VIII). Focus is measured as distance of the mean center of the land use from the PLVI. Dispersion is measured as mean distance to the mean center of the distribution. The graph can be divided into four useful sections (A, B, C and D) by the median values of the abscissa and ordinate. Distance on the axes is in fractions of the median value. Section A uses are central and clustered and are those expected to be central CBD or "core" uses as outlined in the literature. Section B contains the peripheral-clustered uses; the expected specialized sub-foci of the frame that Horwood and Boyce, among others, describe. Sections C and D are dispersed and are more difficult to interpret. Distinctions, for example, between peripheral-non-central and dispersed (whether regularly or randomly) would be difficult to make since both may have a central mean and a large dispersion. The problem is not as marked in Section D where there is a peripheral mean center. Intuitively, land uses with this description seem to be non-CBD in character since they have neither the central orientation of Sections A and C, nor the clusteredness of Section B.

The actual land uses which belong to each pattern are shown in Table VII and a diagram of the nature of the distribution accompanies each section. The uses are listed in order of their conformity to the characteristics of each section, so that for Section A the most central and most clustered uses are listed first and the least clustered, least central last.

The Focus and Dispersion of London Land Uses

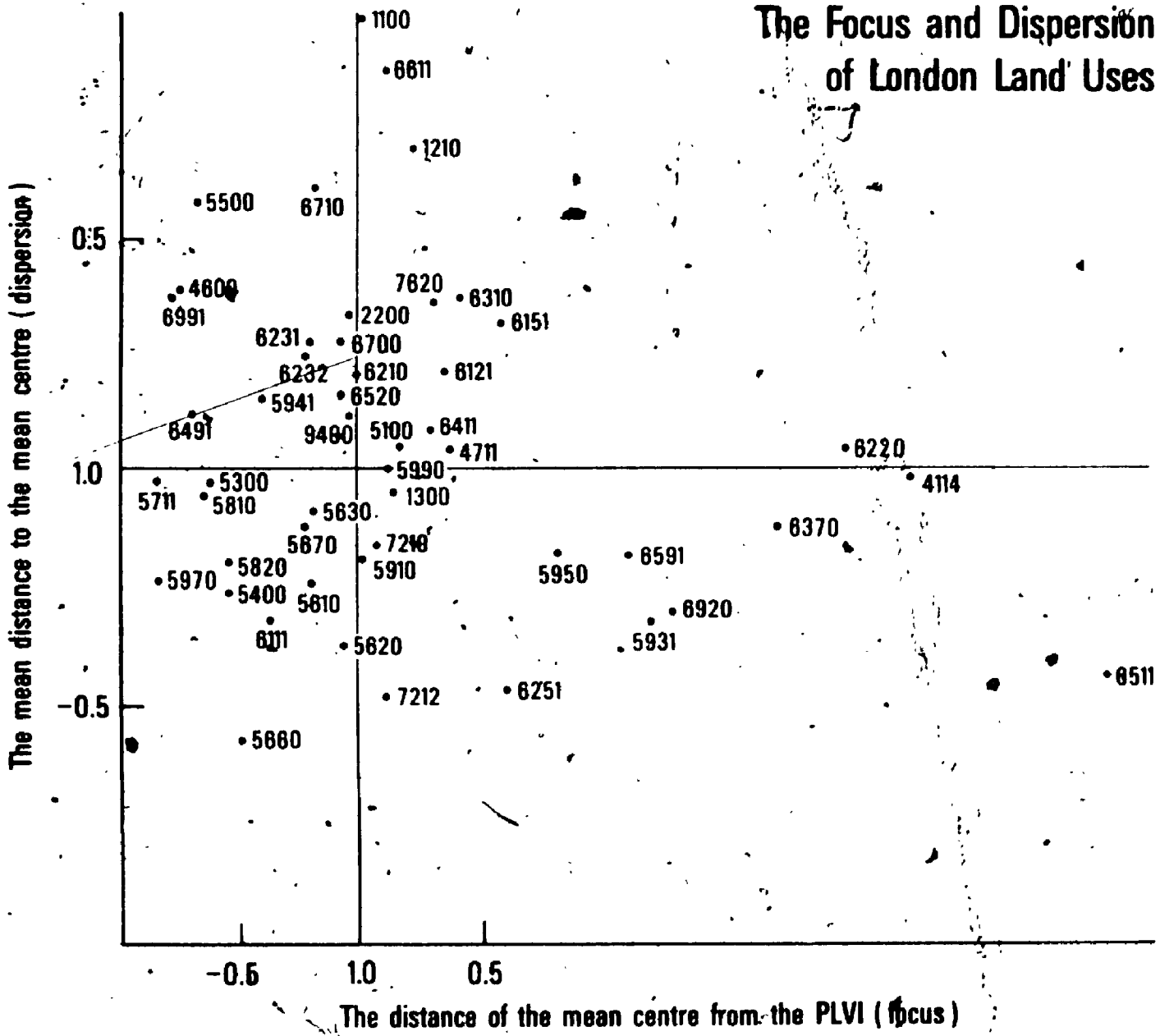


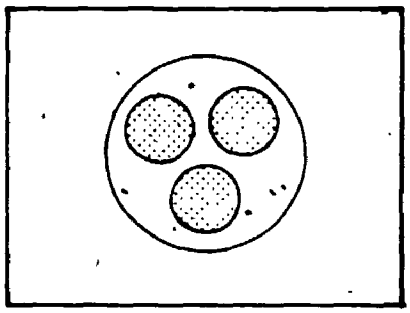
Figure VIII

TABLE VII

London
Scattergram Allocations

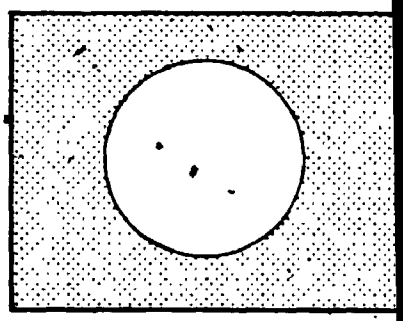
Section A: Central-Clustered

5660
6111
5610
5620
5400
5970
5820
5670
5630
5810
5300
5711



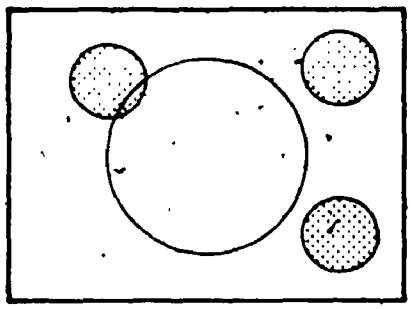
Section C: Central-Dispersed

5500
6711
4600
6991
2210
6231
6700
6232
6210
6520
9400
5941
6491



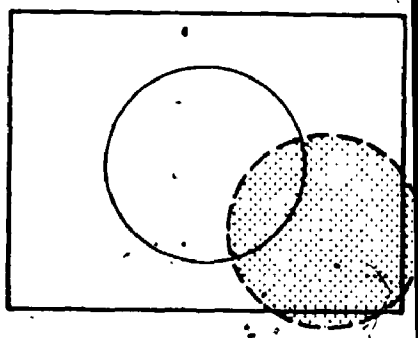
Section B: Peripheral-Clustered

6511
4114
6370
6920
5931
6591
5950
6251
7212
5910
7219
1300
5990



Section D: Peripheral-Dispersed

1100
6611
1210
6310
7620
6151
6121
6220
6411
4711
5100



The uses in A are clearly characteristic of the CBD core area. All of the uses in this section are less than 140 meters from the PLVI and their dispersions are less than 280 meters. All of the consistent central uses are confirmed except "variety" which does not exist as a class in London. Many of the questionable central uses in the typology are central-clustered in London, these include banks (6111), drinking places (5820) and eating places (5810, Map XII). Shoes (5660, Map XII) are a tight central cluster. Men's and Boys' wear (5610, Map XI) are more dispersed than Women's wear (5620, Map XI) suggesting that there is a stronger peripheral influence in men's and boys' clothing even though it is a central clustered type. Banks (6111), food (5400), jewellry (5970) and the other most central clustered types. Food in London is mainly of the specialty type and as such is central-clustered in the occidental city. Department stores and dry goods (5300) are not as central as in most CBD's because of the central position of a modern mall.[1] Section B contains the uses with a peripheral orientation but which are also clustered as a group. The division into sections is arbitrary, based on the median values and it should be noted that the last three uses, movies (7212, Map XIV), drug stores (5910) and other entertainment (7219) are on the edge of the central area. These three uses and sports goods (5950) are transitional commercial types. The conformity between this section and the typology is less well marked than for Section A. It is notable, however, that warehousing (6370), physicians (6511, Map XIII), other professional services (6591) and transport terminals (4114, Map IX) are

[1] It should be noted that three sides of the mall block and all of the market building block are owned as a unit, have totalled assessed land values. The land uses could not be given precise street locations. For these reasons the block and part of a block are treated as single units and classified as one land use.

exactly the sub-foci envisaged by Horwood and Boyce (see Figure I). Multiple family residences (1210, Map VII), industry (2210, Map IX) and auto sales (5500) do not occur in Section C and so are not as differentiated for London as Horwood and Boyce expect. Legal services (6520), as a professional type, are more dispersed and central than expected. From the arrangement in the typology furniture is also expected in Section C but it is represented only by antiques and second hand sales (5931); the main furniture category (5711) is in the center in Section A.

This method of analysis is more sensitive to defining sub-foci than a multivariate technique which is applied to the same data in another study (Campbell, N., 1969).

Sections C and D are difficult to interpret at this stage because the scattergram does not differentiate clearly those uses which are regular, random or occur in peripheral belts. Other statistics will aid in isolating some of these patterns but group C could contain any of these. It is important to recognize peripheral-non-central because of the importance attached in the literature to the land value surface in the core. The first seven uses listed in Section C have mean distances so large that they are likely peripheral, of these parking (4600, Map X), government (6700) and executive, legislative and judicial (6710) uses conform to the typology. The last two listed uses, book stores (5941) and repair services (6491) are close to the median value and are not uses of the extreme periphery but are likely found in both central and peripheral areas. Many of the other uses are of the service type and they are spread over the whole CBD (see 6991, Map XIII). The use of further statistics may help to further define their patterns.

Uses in Section D are dispersed and have mean centers which are

peripherally oriented. The top right section of the gradiant is avoided largely for geometrical reasons and uses are oriented to either Sections B or C. Photographic sales is oriented to the peripheral-clustered section. Households (1100, Map VII) and group quarters (1210, Map VII) are central-dispersed in orientation with a dispersion so large that they are likely a peripheral use. Of the other uses parks (7620), business services (6310), real estate (6151) and credit services are most characteristic of the section. These are perhaps uses which have a pattern in an area wider than the CBD. They are not a group in Preston's work on the transition zone which suggests they are a dispersed category. Further statistics may reveal more of their character. This category likely contains the most foot loose uses but their exclusiveness to the periphery will require further study.

The Shape of the Distributions[1]

The scattergram has gone some way toward differentiating the land use patterns. It is particularly useful in isolating clustered patterns. The oblongity statistic gives useful additional information on these clustered patterns since it is a measure of shape. The measure differentiates between circular (nodal) clusters and linear clusters (see

[1]The following land uses are deleted from the analysis because their populations are five or less and computational difficulties can occur:

Transport terminals	(4114)
Antiques	(5931)
Sports shops	(5950)
Real estate	(6151)
Photography	(6220)
Repair services	(6491)
Other Professional	(6591)
Building and construction services	(6611)
Charity	(6920)
Other entertainment	(7219)
Parks	(7620)

Table VIII). Following this the alpha statistic is useful where linear statistics exist, for it describes the orientation of the distribution.

In general the distributions tend to be linear rather than circular. The rectangular study area and the importance of the Dundas Street artery are no doubt influences which produce the linear shapes. Both assessed land values and pedestrian densities are elongated along this artery (Maps I and IV), so that it is difficult to distinguish between general accessibility, in relation to the assessed land value and pedestrian density, and resource accessibility in relation to the Dundas artery. Shoe sales (5660, Map XII), and women's wear sales (5620, Map XI) are most linear and related to Dundas Street. Jewellry (5970) and eating places (5820) are less linear but are again oriented to Dundas Street. Banks (6111), Men's and Boys' wear (5610, Map XI), Women's accessories (5630) and most of the other uses in Section A have a circular distribution shape.

In Section B there are more linear uses. Warehousing (6370) and drug stores (5910) are most linear and the following uses are less so, physicians (6511, Map XIII), movie theaters (7212, Map XIV), hotels (1300, Map VIII) and other retail sales (5990).

The Orientation of the Distributions

Orientation is significant mainly for linear uses and only the most linear are shown in Map VI. All of the orientations are listed in Table IX. The north of east and south of west orientation dominates so much that the CBD can be described as having a 'grain'. This orientation and the presence of so many mean centers in the east and north of east suggests that the CBD is growing in that direction. The influence of the

TABLE VIII

London
Ranked Values of Oblongity

Value			Value		
0.2621	5610	Circular	0.6581	6511	
0.3034	2210		0.6582	6591*	
0.3375	5630		0.6612	5970	
0.3690	5941		0.6872	6232	
0.3760	4600		0.6971	6310	
0.4093	5100	Upper	0.6985	1300	Lower
0.4433	5500	Quartile	0.7065	5990	Middle
0.4525	6210		0.7073	5910	Quartile
0.4612	5670		0.7509	6991	
0.4793	5400		0.7593	6611*	
0.4941	1210		0.7696	6711	
0.5165	6111		0.7772	4114*	
0.5201	4711		0.8164	6370	
0.5307	5300		0.8350	5620	
0.5681	6251		0.8698	5660	
0.5692	5711		0.8908	6151*	
0.5751	5810		0.8909	7219*	
0.5766	6700	Upper	0.9178	6411	Lower
0.5774	1100	Middle	0.9638	6920*	Quartile
0.5779	6121	Quartile	0.9708	6491*	
0.6087	6231		0.9732	6220	
0.6277	6520		0.9994	5931*	
0.6315	9400		0.9998	7620*	
0.6330	5820		1.0000	5950*	Linear
0.6368	7212	Median Value			

* Land Uses with Five or Less Individuals

2 3

OF/DE

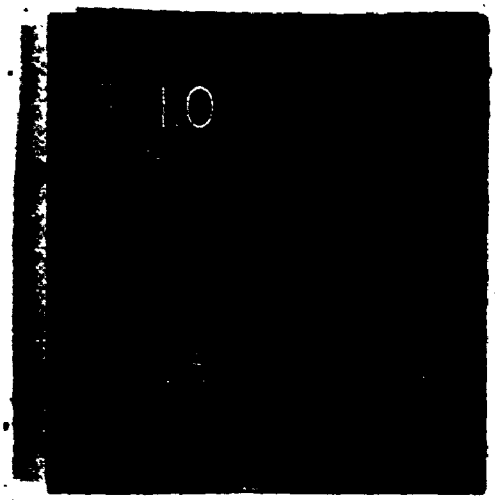


TABLE IX

London
Ranked Values of Alpha (in degrees)

Value	Land Use	
55°49	5620	
34°42	5950*	
32°33	5931*	
30°18	7219*	
27°03	7212	
26°43	6700	Upper
26°32	6210	Quartile
23°28	6611*	
21°41	6520	
21°32	4114*	
20°34	5630	
17°49	5400	
15°57	5941	
15°43	5990	
12°03	7620*	
12°47	5910	
11°58	6511	
11°53	1100	Upper
10°21	6220*	Middle
9°61	5711	Quartile
9°21	6370	
9°06	2210	
9°01	6231	
7°22	6121	
6°26	5810	Median Value
6°26	6111	
6°19	9400	
6°07	1300	
4°03	5660	
4°02	6491*	
3°40	6310	Lower
2°55	5820	Middle
1°52	1210	Quartile
0°21	6711	
0°13	6411	
-0°04	5970	
-1°30	5300	
-4°10	6991	
-5°22	4600	
-5°31	5670	
-6°20	6151*	
-6°56	5610	
-7°20	6232	Lower
-8°09	5500	Quartile
-17°48	6591*	
-19°05	6920*	
-23°16	4711	
-44°25	6251	
-56°21	5100	

* Land Uses with Five or Less Individuals

Dundas Street east-west axis is illustrated by the number of distributions which parallel it or are offset only by a few degrees from it. All of the land uses with the opposite (north-west/south-east) orientation are interestingly peripheral uses. Only the orientations of the most clustered-linear land uses (i.e. those in Sections A and B) are shown in Map VI. Only "transport terminals" (4114, Map VII) has an orientation to a peripheral street.

Clustered, Random and Regular Distributions

Inferential statistics are used as a final test of the clustered and dispersed patterns and as a method to isolate from the dispersed set those which are random and those which are regular. The inferential statistic involves a test with a random distribution. The normal deviate is preferred here over the R statistic because it incorporates a test of significance. The R statistic is listed in Appendix IV for a comparison with the normal deviate and as a check for small populations. Only the normal deviate is used in the text. Clusters occur where the normal deviate has a value less than -1.96 or where the R statistic approaches 0.0. A number of land uses are deleted from the analysis because their populations are small (five or less) and they cause computational problems. These uses are listed on page 77.

The ranked values of the normal deviate (Table X) shows that most land uses tend toward clusteredness and no uses are regularly spaced although a number are random. There are no uses in London's CBD which are maximally spaced in relation to their fellow uses. This is evidence that the CBD serves the whole city since no uses are spaced so as to serve the internal CBD area.

TABLE X

London
Ranked Normal Deviate

Value	Land Use			Value	Land Use	
0.2227	6210*	R		2.399	6711	
0.6115	6151*	A		2.512	5931*	
0.7002	1300	N		2.538	7212	
1.000	4114*	D		2.646	6591*	
1.000	6920*	O		2.716	5400	
1.000	6220*	M	Upper	2.882	6251	Lower
1.000	7620*		Quartile	3.055	5660	Middle
1.000	5950*			3.112	5610	Quartile
1.000	6611*			3.178	6111	
1.348	5910			3.008	6121	
1.368	5941			3.612	6520	
1.463	6991*			3.728	5711	
1.570	6310			3.733	5970	
1.620	5820			3.737	5670	
1.647	7219*			3.968	5810	
1.696	5300			4.012	4600	
1.737	6700			4.045	6370	
1.782	6491			4.349	5100	Lower
1.830	5500		Upper	4.370	5620	Quartile
1.944	6232		Middle	4.462	2210	
			Quartile	4.663	6511	
2.000	5630			4.750	5990	
2.005	4711			4.975	1210	
2.021	6231			8.034	1100	Clustered
2.097	6411					
2.116	9400		Median Value			

* Land Uses with Five or Less Individuals

The normal deviate confirms the arrangement of land uses in the four quadrants remarkably well, Figure IX shows that most uses in Sections A and B tend to be clustered and most in C and D tend toward randomness, or are at least only marginally clustered. The few exceptions will be discussed next.

The following uses in Sections A and B of the scattergram are more dispersed by the normal deviate than expected. These uses are, women's accessories (5630), department and dry good stores (5300) and drinking places (5820). Hotels (1300, Map VIII), other entertainment (5910) and drug stores in B are also more dispersed than expected. These uses obviously are dispersed throughout the CBD although they have a center orientation. Very few of the clustered uses in A and B are questioned by the normal deviate test and so the arrangements in the typology are confirmed once again.

When the normal deviate is applied to the dispersed categories, Sections C and D, the number of questioned uses is larger. There are a good number of uses less than -1.96 and therefore clustered. The normal deviate is based on the distance between a point and its nearest neighbor. The fact that land uses occur in Sections C and D and yet are clustered means that there are small clusters at least of pairs of points. It may be that there are belts of peripheral uses since they are clustered by the normal deviate yet dispersed by the mean distance to the mean center. The uses which are questioned in these two sections are likely peripheral agglomerations of like uses whether they are belts or not. The questioned uses are households (1100, see Map VII), group quarters (1210, see Map VII), car parks (4600, see Map X), industries (2210, Map IX) and wholesaling (5100, Map X). All of these are peripheral concentric types in

Figure IX

London
Scattergram and Normal Deviate

Section A	Section B	Section C	Section D	Value
	5990 6511	2210	1100 1210	-8.00
5620 5810	6370	4600	5100	
5670 5970 5711		6520	6121	-3.612
6111 5610 5660 5400	6251			
	6591* 7212 5931*	6711		2.399
5630		9400 6231	6411 4711	-1.96
5300		6232 5500 6491* 6700		
5820	7219*	6991 5941	6310	
	5910 5950*		6611*	

Figure IX cont.

Section A	Section B	Section C	Section D	Value
			7620*	
			6220*	
	6920*			
	4114*			
	1300			
			6151*	
		6210		

* Land Uses with Five or Less Individuals

the typology and they seem to be confirmed by these statistics. The remaining questioned uses are much less dispersed and are likely transitional between center and periphery having some mutual affinity, these are legal services (6520) and credit services (6121).

The normal deviate isolates some random uses and these occur mainly in Sections C and D as expected. The random uses are mainly service types or public services which have planned locations and do not locate by the normal market forces. The following uses in Section C and D are only marginally clustered and can readily be added to the random set, these are, executive, legislative and judicial functions (6711), vacant (9400), beauty services (6231), auto repair (6411), and communications and utilities (4700). Since these uses appear to locate randomly these are the uses most requiring further study.

The uses which are confirmed in their position in the scattergram by the normal deviate statistic are not listed but appear in their appropriate positions in Table VII. These are the bulk of the uses and only the land uses which the normal deviate helps to further define are mentioned above. Some overall aspects of the London CBD land use structure are notable. The first is the primacy of clusteredness. Few uses are random and none are regularly spaced in this CBD. Secondly, there is evidence of a 'grain' in the CBD since most uses are oriented in the same direction. Most mean centers, particularly the commercial-retail type, are located on the zone of assimilation side of the PLVI.

Where the uses are central-clustered and therefore in Section A, the clusteredness may be due to mutual affinity, general accessibility in relation to the surface of land value and pedestrian density, or for London a good number of central distributions are linear and so may be

influenced by the Dundas Street artery. It is not possible within the bounds of this study to isolate the effect due to each influence. The central-clustered uses are in close conformity with the assignments in the typology. The conformity is largely confirmed by the use of the normal deviate statistic.

While the peripheral-clustered uses are not in total conformity with the typology, many are, nevertheless, the foci expected by Horwood and Boyce. Where a land use has a different orientation to the general grain, it is usually a peripheral-clustered use. The peripheral clusters are not as linear as the more central types and there is no peripheral artery which exerts a strong influence except York Street on the transport terminals.

The dispersed patterns also conform very well to the typology. There is evidence of two types. One is dispersed in some random or almost random pattern and the other is dispersed but clustered in smaller groups. The first type requires further study but includes public institutions which may not reflect common market influences. The second type follows the assignments in the typology for peripheral uses.

With the exceptions already noted the CBD of London is representative of the Occidental type.

The next two chapters contain the analyses of Guatemala and Bogotá. The chapters follow the same structure as the current one and the statistics are the same. Much of the details relating to the methodology that occurs in this chapter will be deleted as unnecessary and emphasis placed on the actual results. The comparison of the three chapters is reserved until Chapter VII and takes place after some literature on the Non-Occidental CBD is reviewed.

CHAPTER V

THE CBD OF GUATEMALA CITY, GUATEMALA

It is not the aim of this study to define the essential economic and cultural differences between the Occidental and the Non-Occidental world. It is easy to appreciate however that the CBD of Guatemala of all the three case studies best represents the Non-Occidental world. The number of Indians and mestizos is much higher in the Guatemala CBD than in Bogota. From personal observation there seem to be areas of Indian and mestizo pedestrian concentration and other areas of Occidental concentrations. It is likely that the businesses can be similarly differentiated if not by the ethnic origin of the owner than by the ethnic group to which the business is oriented. The differentiation among western goods, capital intensive businesses and those which trade in native goods is an obvious and simple one but the total economic and cultural background to the businesses is complex and will not be much commented upon. This study concentrates on the physical patterns produced in this different environment and compares them to the patterns which are observed in the Occidental world.

It is expected that there will be a difference in the Occidental, Non-Occidental CBD land use patterns just as there is a difference in both the land value surface and the ethnic composition of entrepreneur and customer. Some of the known and recorded patterns in the Non-Occidental CBD are reviewed in Chapter VII. This chapter concentrates on a detailed geostatistical analysis of Guatemala.

Data Characteristics

The classification of land use is not the same for Guatemala and London but it is very similar for Guatemala and Bogotá. (For comparison of all three sets see Appendices I, II and III). When Guatemala categories are accumulated they compare very closely to categories for Bogotá. This chapter has two sections. In the first land uses are analysed at their most detailed for Guatemala. In the second the land uses are accumulated so that they are comparable to Bogotá classes, paralleling them as closely as possible.

The boundary of the CBD is defined by the city planning department. The land use information is from the census department for 1965.[1] The information is for city zones 1, 4 and 9 which correspond to the CBD definition. The land use list was checked against master sheets in Guatemala so that all land uses are accounted for.

The address system in Guatemala, like Bogotá, is systematic and very useful for the urban geographer. An address is divided into the street, the avenue and the number of the premises. The streets and avenues are orthogonal to one another (except in zone 4, see Map II). The address of the business is the percentage distance between the intersections, even for one side of the street, odd for the other.[2] For Guatemala the locations of each land use are plotted on maps and digitized to be described by X and Y Cartesian co-ordinates. Once again the digitizer units are used. The figures in each table are in units of one hundredth of an inch and each unit is equal to 1.98 meters. Locations in the

[1] Censos Economicos, 1965, Departamento de Censos y Encuestas, Dirección General de Estadística, Ministerio de Economica, Republica de Guatemala.

[2] This same system is used in Bogotá.

markets are deleted because either they could not be accurately located or else the points would have to be made co-incident which leads to computional problems. For the same reasons any point co-incident with another member of the same population is deleted. Although all market locations are deleted they are important foci in the city and so are shown in each base map.

The detailed classification of Guatemala is analysed first. Alpha, oblongity and the inferential statistics are only generated for the accumulated classes in section II, and section I is concerned only with the mean center and dispersion measures (for time and cost reasons).

The Detailed Land Use Analysis

Data Characteristics

The classes are at their most detailed in this section and the three broad categories of business, industry, commerce and service can exist in two forms. The two forms are con contabilidad or sin contabilidad which are translated as with and without an auditor respectively. The result is six broad categories of business so that industry, for example, can be con contabilidad or sin contabilidad in its two forms. Those businesses with an auditor are generally of a high capital input; they are a part of the international business world; keep accurate records and pay government taxes. The businesses without an auditor are generally Indian and mestizo oriented; they are not regular tax payers and generally have only a loose tie with official institutions. These two types can be conceptualized as the western, neo-colonial type of business and the indigenously oriented, bazaar type respectively. This definition is from the field and there is no further documentation; however, it is a useful surrogate for quality

and cultural orientation although unfortunately it has only a binary division.

The six categories are studied separately in this section. The location of each land use is recorded using Cartesian co-ordinates and each land use is analysed in two sets divided by the sin and con differentiations.

Foci of the Distributions

The PLVI in the CBD of Guatemala City is well to the north end close to the National Palace at the intersection of Avenida 6 and Calle 8. From personal observation it is an Occidental oriented area and contains stores selling international products. There is an important second peak at the intersection of Avenida 6 and Calle 18. The area around the second peak, along Calle 18, Avenida Bolivar and the markets are Indian and mestizo oriented in the goods sold and a larger proportion of the pedestrians are Non-Occidental.

There is a marked difference in the orientation of the mean centers for each of the six broad categories (see Maps XV, XVI, XVII, XVIII, XIX and XX). The sin contabilidad uses notably are focused as a group toward the south and west. This is the area of greatest mestizo and Indian activity. The con contabilidad uses by contrast are centrally oriented, closer to the PLVI but between it and Calle 18. The focus on the PLVI is particularly true of commerce and services but industries con contabilidad are more south and east oriented.

While there is a marked difference in the sin and con contabilidad orientations it is difficult to make detailed comparisons with the London and Occidental CBD's since a quality differentiation is usually not

available. However, neither the Occidental literature nor the London results indicate the marked shift in focus that can be observed here. The dual definition of each land use; these differences in the orientation of the mean centers; the second peak in land value and the observed difference in ethnic background of the pedestrians suggests that the structure of Guatemala is different to that of the Occidental CBD.

The Scattergram

The scattergram is constructed as before (see Figure X). The commercial con contabilidad uses taken alone have a positive linear relationship so that as distance from the PLVI increases so does dispersion. Commercial con contabilidad uses which seek the highest value sites also seek their own kind. Sports goods, toys and ornaments (61193), optical goods (61295), records (61241), and perfumes and cosmetics (61222) are most central and clustered while insecticides, fungicides and fertilizer sales (61225), supermarkets (61218), gas stations (61270) and general tin plate articles (61257) are more peripheral and dispersed. This conforms in general terms with the arrangements in the typology posed in Chapter I. As the commercial sin contabilidad and the services and industries of both sin and con contabilidad types are added, this linear relationship becomes less clear.

The land uses in sections A, B, C and D of the scattergram are listed in Table XI. The numbers of land uses for each of the six categories in each of the four sections are as follows:

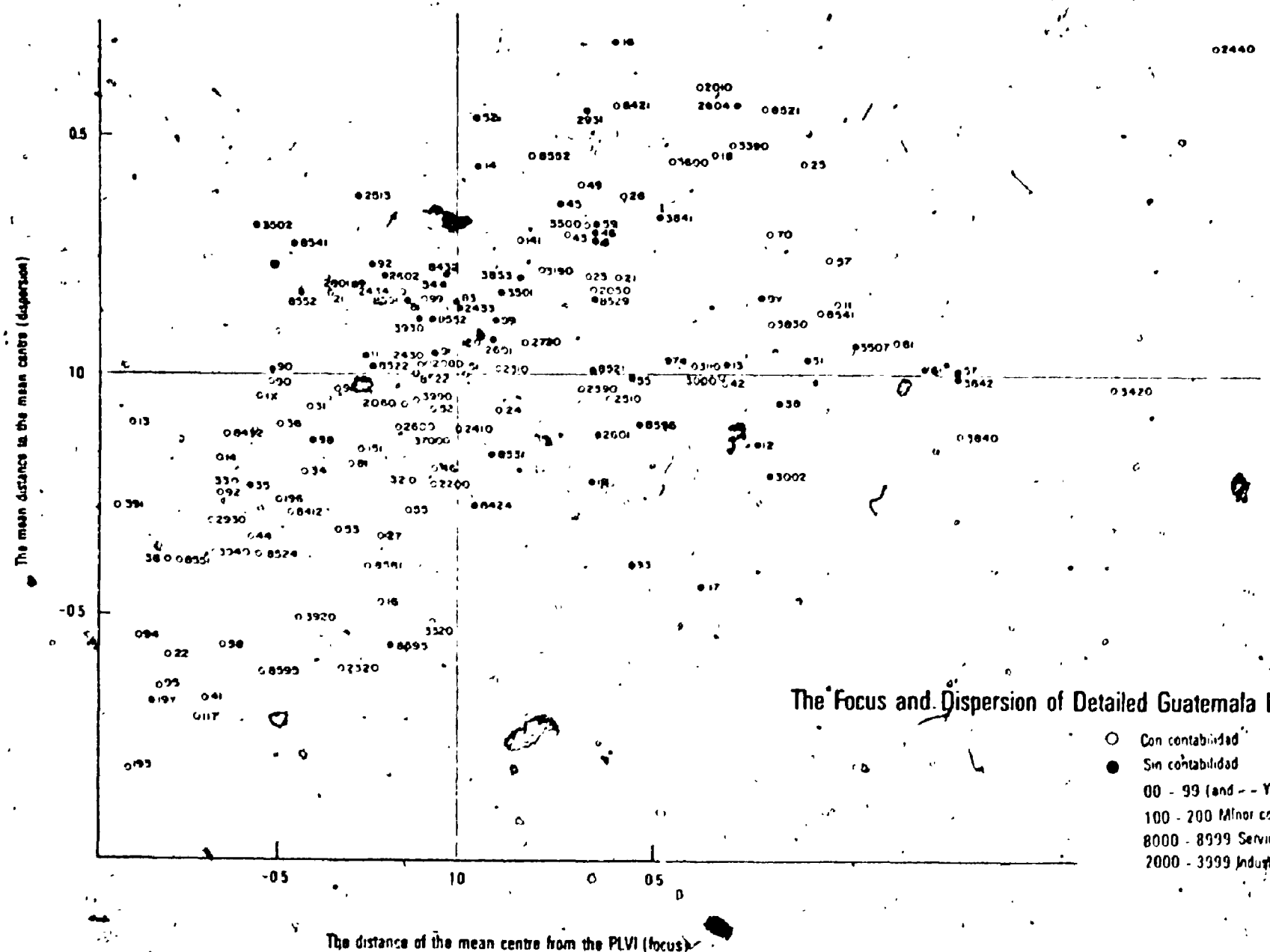

0.5
10
-05
-05
10
0
05
The mean distance to the mean centre (dispersion)
The distance of the mean centre from the PLVI (focus)
The Focus and Dispersion of Detailed Guatemala Land Uses
Con contabilidad
Sin contabilidad
00 - 99 (and - - Y) Major commerce
100 - 200 Minor commerce
8000 - 8999 Service
2000 - 3999 Industry

TABLE XI

Guatemala, (Detailed Land Uses) Scattergram Allocations

Section A

61193 c	61235 s
61117 c	61292 c
61194 s	61233 c
61241 c	61214 c
61295 c	61234 c
61222 c	8432 c
61294 c	61213 c
61298 c	61255 c
8595 c	61232 c
2320 c	61281 c
8595 s	61151 c
3920 c	61298 c
61238 c	61236 c
8551 c	61231 c
3940 c	6121X c
8524 c	61290 c
61244 c	61291 c
2930 c	2060 c
61391 c	2600 c
3320 c	3700 c
61216 c	61246 c
8561 c	2200 c
61227 c	3990 c
61253 c	61252 c
8412 c	8522 c
61196 c	2410 c

Section B

61217 s	8596 c
61233 s	2601 c
3420 c	61219 s
3840 c	8424 s
3002 c	8531 s
61212 s	2510 c
3842 s	2510 c
61238 s	61255 s
61242 c	2590 c
3000 c	61224 c
	61251 c

s = sin contabilidad

c = con contabilidad

Section C

3502 s	61234 s
2513 s	61299 c
8541 s	61281 s
8552 s	3930 s
2801 s	61211 s
61221 c	61290 s
2434 s	8552 s
61292 s	61283 s
2602 s	61291 s
8591 c	2430 c
8432 s	8322 s
	2080 c

Section D

2440 c	61252 s
61143 c	61245 s
8521 c	61259 s
2010 c	61246 s
2604 s	61215 s
3390 c	61243 c
61223 c	3500 c
61216 s	61221 c
61218 s	61223 c
8421 c	2050 c
3600 c	8529 c
61270 c	61213 s
61257 c	3110 c
2931 s	61297 s
61226 c	3190 c
3841 s	61141 c
61211 c	61214 s
8341 c	8521 s
61261 c	3853 s
3507 c	3501 s
61261 s	2433 s
61257 s	61299 s
61251 s	2720 c
3830 c	8521 s
6129Y s	2601 s
61249 c	61212 c
8552 c	2310 c

Scattergram Section	CCC	CSC	SCC	SSC	ICC	ISC	TOTAL	
A	30	03	07	01	11	00	52	central-clustered
B	03	07	00	03	07	02	22	peripheral-clustered
C	02	07	00	06	02	06	23	central-dispersed
D	13	14	04	02	10	09	52	peripheral-dispersed
Total	48	31	11	12	30	17	149	total land uses

CCC = Commerce con contabilidad

CSC = Commerce sin contabilidad

Industries and services are similarly divided

Section A

Thirty of the fifty-two clustered and central uses are commercial con contabilidad uses (for example 61232 and 61234, Map XX). Most of the services con contabilidad are also in this section (seven of the eleven [see for example 8522, Map XXIII]). All of the industries in Section A are con types and are characterized by either customer orientation or they require high level skills and are capital intensive businesses (for example, 2600 and 3920, Map XXV and Map XXVI respectively). All the central-clustered uses in the typology also occur in Guatemala but the industrial uses in this section are marked anomalies when judged by the occidental modes. Also with an anomalous central position are the two import and export uses (61117 and 61196).

Section B

Because of the median value on the X axis of the scattergram

and because all of the mean centers (except four) are south of the PLVI it can be assumed that the clustered uses in this section are around Calle 18 and the area of the markets. In composition this is an area where the sin contabilidad commercial uses are more important (see 61212, Map XXII), although equally important are the con industrial uses. It is evident that this area could be a second core, or the area of the Indian and mestizo bazaar. The land values reach a second peak in this area. The pedestrians are mainly mestizo and Indian rather than the Occidental type who frequent the area closer to the PVLI. From personal observation the area is a bustling one like the PLVI area but separated from it by a quieter zone.

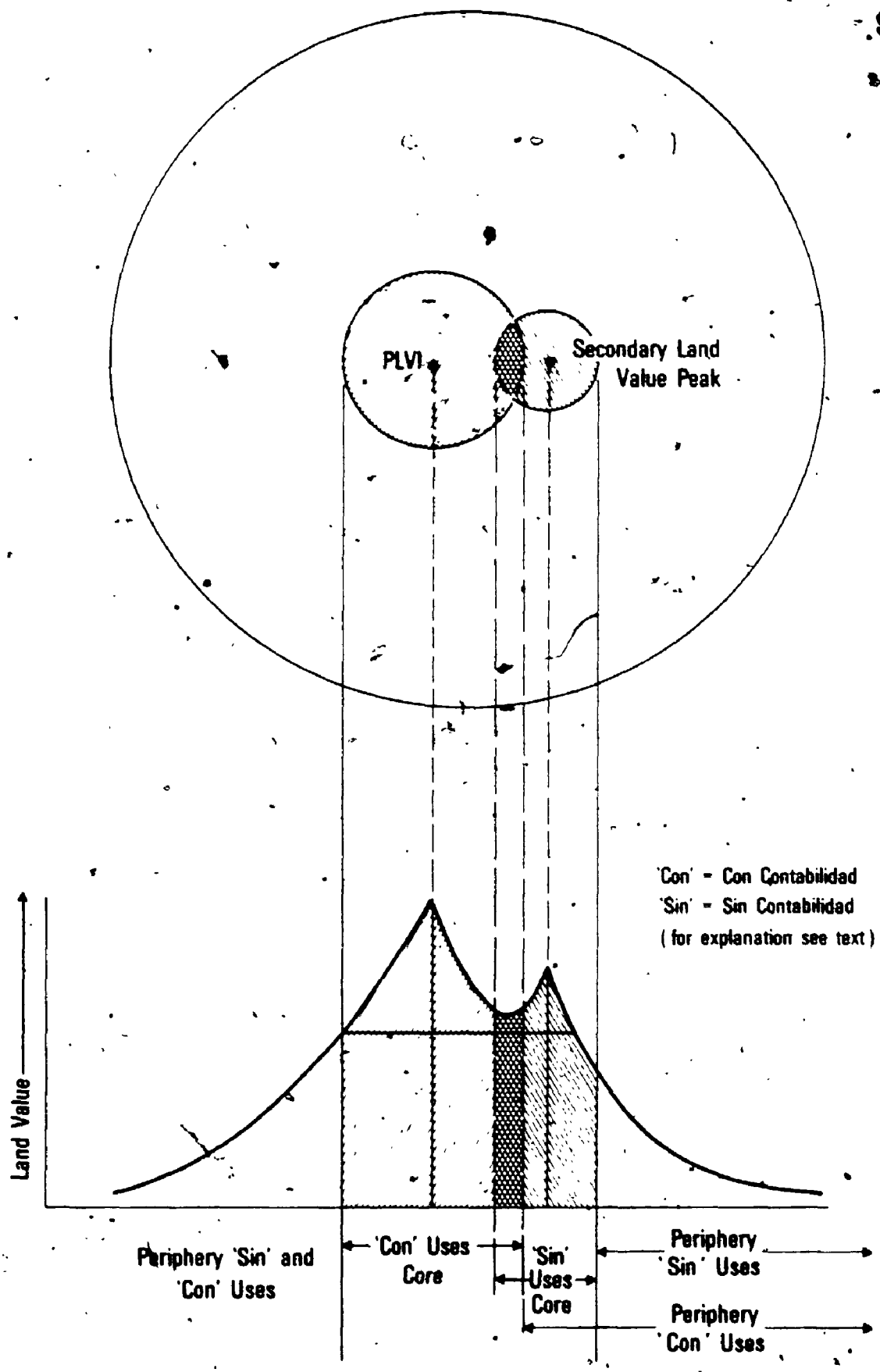
The land uses in Section B are not center-CBD Occidental nor are they particularly peripheral-clustered Occidental types. They are businesses selling Indian and mestizo oriented goods, such as beer and soft drinks (61217), sweets and candies (61212), thread, cloth and fabrics (61233), other minor foods (61219), candles and soap (61224), ironware sales (61251), or businesses which may have Indian and mestizo entrepreneurs such as various domestic articles (61255), woodworking industry (2510), bread and produets (61216), other cork and wood articles manufacture (2590), and shoe manufacture other than plastic (2410). A full list occurs in Table XI. These uses could constitute an Indian and mestizo oriented 'core' region - a native bazaar area. There are, however, many con contabilidad industries in the same area including tire retreads (3002), auto repairs (3840), metal furniture manufacture (2601), etc. In the Occidental CBD context these are uses of the periphery and yet they successfully compete for what could be considered Indian and mestizo central area space. Because of these

Occidental/Non-Occidental land use differences and the double peak in land values a modification of the model already discussed in Chapter II (p. 56) suggests itself and is diagrammed in Figure XI. The figure shows the main and dominant central area typical of the descriptions in the occidental literature and very similar to the arrangement of land uses in the typology (compare Tables XI, Section A, and IV). The second peak and smaller 'central' area, is south of the major core and has within its area some of the peripheral uses associated with the 'main' core. This accounts for the presence of industry con contabilidad in the same area as commercial sin contabilidad. The diagram accounts for the native oriented 'central' area, its commercial sin contabilidad uses and its location in relation to the land use surface and 'main' central area.

The central and peripheral-dispersed uses (Sections C and D respectively) are simply interspersed in the peripheral area. The industrial con contabilidad uses may locate in the secondary central area but otherwise share the periphery with the sin contabilidad uses.

Section C

The sin contabilidad uses predominate in this section. Because of the great mean distance to the mean center these are likely peripherally oriented uses. Eight of the twenty-three uses are industrial and most are sin contabilidad types (see, for example, 2602, 3930, Map XXVI and Map XXVII). The sin contabilidad types in this section include books, magazines and periodicals (61292), tailors and seamstresses (2434), cafes and tea shops (8522, Map XXIV), and women's and children's clothing (61234, Map XXII). These uses would be central-clustered in the Occidental CBD yet each is dispersed here, however each one in its con contabilidad form



A Tentative Non-Occidental CBD Land Use Model

Figure XI

is in Section A (except tailors and seamstresses which does not exist in that form).

Section D

This section has most industrial uses of the sin contabilidad type (for example, 2602, Map XXVI) and is second only to Section A for industrial con contabilidad (3600, Map XXV). The uses in this section are also listed in Table XI. The automobile oriented uses are important as are basic metal industries. Furniture, hardware and uses associated with building are here also. There are a number of uses associated with food and some service industries (8541, Map XXIV). The surprise in terms of the Occidental typology in the section is the restaurant and drinking places categoty (8521) which is a con contabilidad type. Its location can possibly be explained by the high quality nature of zones 4 and 9 where many of the embassies are located.

This detailed analysis exhibits a number of inconsistencies in comparison to the Occidental CBD models and the land use arrangements in the typology. The first difference is the presence of skill-using, capital intensive industries in the most central area. This indicates a change in the ordered arrangement of land uses in relation to the general accessibility mechanism. Industries of this type have an increased ability to pay rent compared to their equivalent position in the Occidental CBD. In Garner's terms, their bid rent curve has steepened. The second difference, already noted in Chapter II is the curious second peak in land values. This second peak is complemented by the observed difference in the ethnic composition of the pedestrians on certain streets. The sin and con contabilidad division allows an analysis of the land use with a culture

orientation and a quality measure added. The addition is based on the assumption that the sin and con dichotomy reflects the differences in the two cultures and/or the difference in quality associated with each. The results show that land uses have a different orientation based on these cultural and quality criteria. The Occidental models may not be adequate to explain the differences in the Guatemala CBD and a tentative cultural modification of the rent model in Chapter I is posed (Figure XI). It is recognized that other explanations are possible but this one goes some way to explaining the Guatemala CBD.

The discussion in this section is somewhat parenthetic to the main stream of the dissertation but it is embarked upon because the detailed information is available. Some of the insights gained can be carried through to the main body of this work but direct detailed comparison with London or Bogotá is not possible because information on the quality and customer orientation or a surrogate for them is not available for these cities. Because comparisons cannot easily be made at this level the Guatemala land uses are accumulated to make them directly comparable with the Bogotá uses. The con and sin contabilidad tags are dropped. The next section deals with the same sets of points but grouped in a different way.

THE ACCUMULATED LAND USE ANALYSIS

In this section land uses are accumulated to make them directly comparable with the Bogotá CBD information. The distinction between sin and con contabilidad is dropped so that each land use is now without a quality/culture division. The same statistics are used in the analysis of the accumulated land uses of the Guatemala CBD. The land use classification is shown in Appendix II.

Foci of the Distributions

The bulk of the land uses are focused between the PLVI and the secondary peak in Calle 18. Most of the Occidental center-oriented businesses are focused on the PLVI. These include optical and photographic sales (69, Map XXXV), libraries and bookstores (69, Map XXXVI), watches (67), production distribution and exhibition of films (74) and the sale of fabrics (45). There are in addition some anomalous central functions including the leather industry (09) and printing (08). The land uses most peripherally focused are peripheral in the Occidental literature also. These uses include base metal industries (14), construction of machinery (16, Map XXIX), accessories (46), repair workshops (24, Map XXX), transport and materials and accessories (18) and petrol products (64, Map XXXIV). The locations of the mean centers are shown in Map XXVIII. At this level of pattern analysis there is general accord with the arrangements in the typology.

The Scattergram

Focus (Table XII) and dispersion (Table XIII) are combined to give the scattergram (Figure XII). As in the detailed analysis in the first part of this chapter, there is a positive linear arrangement of land uses in the scattergram, suggesting that as land uses are focused farther from the PLVI they are more dispersed. The scattergram is divided into four sections based on the median values as before. The membership of each section is shown in Table XIV.

If Guatemala is similar to the Occidental city then the uses in each section should correspond to those arranged in the typology and those found for London in the last chapter. In Section A almost all the central-

TABLE XII

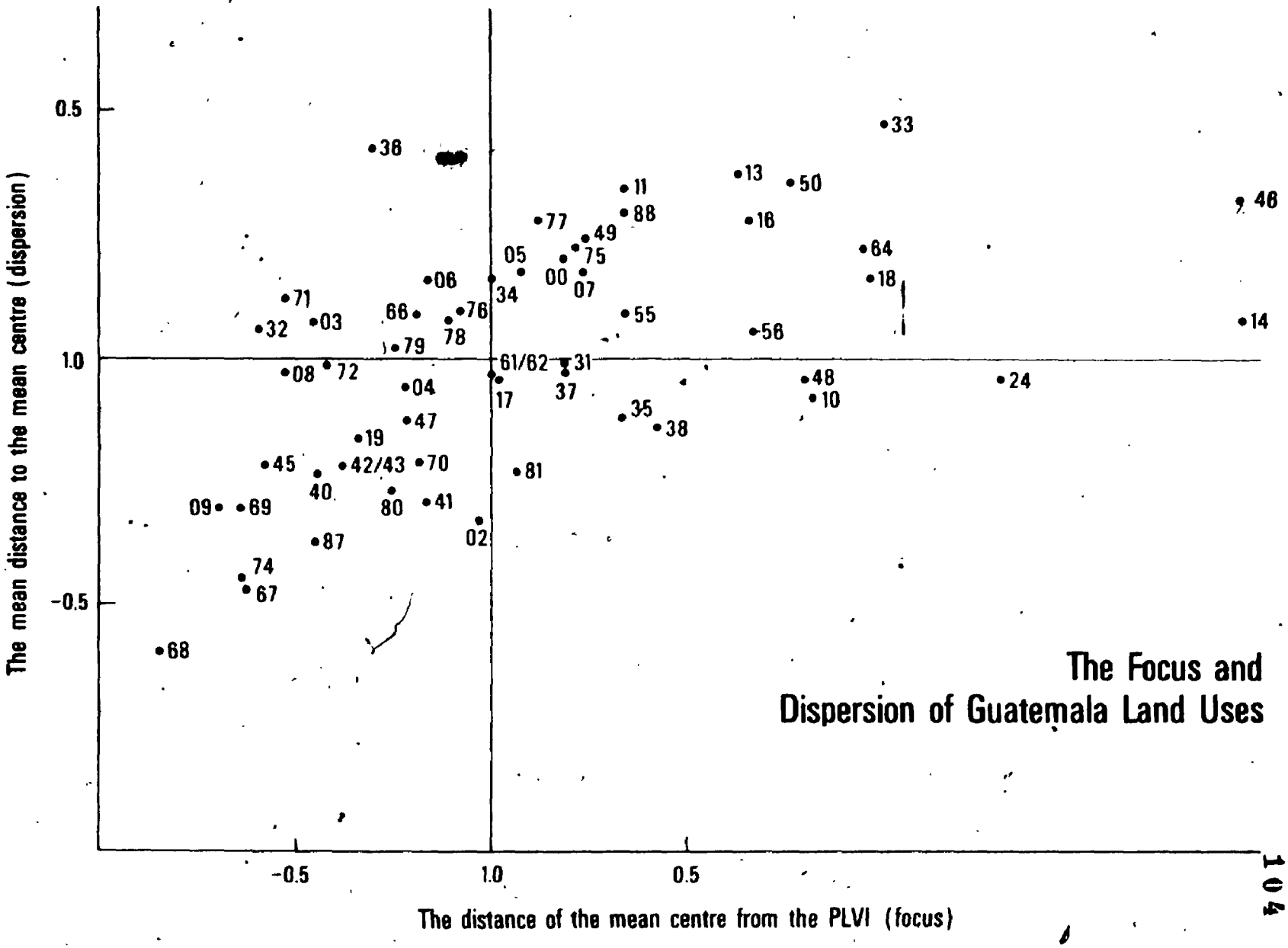
Guatemala (Accumulated Land Uses)
Ranked Distance From the Mean Center to the PLVI

Value	Land Use		Value	Land Use	
1380	14		475	61/62	
1155	46		460	02	
1090	24		435	76	
950	33		420	78	
930	18		395	06	
920	64		392	41	
860	10	Upper	385	70	Lower
850	48	Quartile	380	66	Middle
835	50		371	47	Quartile
792	56		362	04	
791	16		355	79	
775	13		350	80	
672	38		340	36	
640	88		310	19	
635	55		290	42/43	
635	11		275	72	
630	35		260	40	
587	49		258	03	
585	07		250	87	
580	75	Upper	232	71	
560	31	Middle	220	08	Lower
560	00	Quartile	200	45	Quartile
555	37		195	32	
540	77		175	67	
510	05		170	74	
505	81		170	69	
480	17		150	09	
475	34	Median	155	68	
		Value			

TABLE XIII

Guatemala (Accumulated Land Uses)
Ranked Mean Distance to the Mean Center

Value	Land Use		Value	Land Use	
867.2	33		576.1	31	
832.4	36		573.4	72	
818.4	13		569.3	08	
790.7	50		569.1	37	
785.0	11		560.5	75	
760.6	88		560.3	61/62	
750.2	77	Upper	559.6	17	Lower
744.3	10	Quartile	556.8	24	Middle
733.2	46		552.4	48	Quartile
727.0	49		546.8	04	
708.9	64		537.3	10	
707.2	00		500.0	38	
685.6	07		485.6	19	
684.0	05		477.1	35	
678.8	34		456.0	70	
677.5	18		455.7	45	
676.1	06		452.7	42/43	
653.9	71		448.8	81	
642.1	47		440.6	40	
636.8	76	Upper	424.8	80	
636.0	55	Middle	408.7	41	Lower
635.2	66	Quartile	407.8	09	Quartile
629.7	03		401.1	69	
628.1	78		391.3	02	
621.8	14		369.4	87	
619.7	32		321.5	74	
609.8	56		305.0	67	
593.7	79	Median Value	231.9	68	



The Focus and Dispersion of Guatemala Land Uses

Figure XII

TABLE XIV

Guatemala (Accumulated Land Uses)
Scattergram Allocations

Section A	Section C
68	36
67	71
74	32
09	03
69	06
87	34
45	76
40	66
42/43	79
80	78
41	
02	
70	Section D
19	
08	46
72	33
47	14
04	50
61/62	64
	18
	13
Section B	16
	11
38	88
24	56
48	49
10	77
35	75
81	00
37	07
31	55
17	05
	61/62

clustered uses in the typology are represented. The exceptions are, first, vacancy, which is not represented at all as a class in Guatemala. In addition there are those which occur in another place in the typology. Specialty foods are consistently central-clustered uses in the typology. This use is approximated in Guatemala by special groceries (35) but instead it is peripheral-clustered. The fact that special groceries is offset into Section B in Guatemala may be due to the cultural/quality differences peculiar to this CBD (already discussed) but this cannot be substantiated using the information in this section alone. Most of the land uses expected to be in Section A are in fact there (see Maps XXXII, XXXIII), but there are some additional central-clustered uses.

The following uses are not central-clustered when judged by the assignments in the typology, importers and exporters (87, Map XXXVIII), rubber industry (09), diverse manufacturing (19), sale of accessories (47), tobacco industry (02), shoe and clothing manufacture (04) and printing (08). Some of these (02 and 09) can be discounted because the populations are small, the others illustrate that the system of land uses is different in the Guatemalan CBD. Importers and exporters, the sale of accessories, the tobacco industry and printing may represent the importance of the links outside of Guatemala. Leather industry (09), diverse manufacturing (19) and shoe and clothing manufacture (04) are alike in that they are customer oriented and use, most likely, local materials and labor. Various colleagues and personal observations confirm that small industries, often in back rooms, can exist in the heart of the CBD in Non-Occidental cities operated often by native people. These small businesses are oriented to the mass consumer and take the place of the brand name consumer goods which occur in the Occidental world.

There is some difference in the uses which are now in Section B compared to those which occurred in the detailed analysis. There is some evidence of the bazaar but it is diminished. Uses which reflect an Indian and mestizo orientation are the various food uses (31, Map XXX and 35), the refreshment places (37 and 38, Map XXX) and personal services (8. Map XXXVIII). All are clustered close to Calle 18 and the secondary peak interaction. These uses in the Occidental CBD are more central. The other uses in Section B are typically peripheral in the Occidental CBD, they are vehicle oriented and usually large space uses (10, 17 Map XXIX, 48 Map XXXIII; 24 Map XXX and 37 Map XXXI).

Sections C and D contain the dispersed uses. In C are the commercial uses which do not cluster, most of which are food oriented but also included are florists (71), laundries (78), recreation services (76, Map XXXVI), hairdresser and beauty services (79, Map XXXVII), drug stores (66, Map XXXV) and furniture and accessory manufacture (06). Section D contains most of the industrial uses as expected. Also in D are a number of transport oriented uses (14, 18, 46, 55, Map XXXIV and 64, Map XXXIV) which are more typically peripheral-clustered in the Occidental CBD and in fact in the scattergram are close to Section B.

The Shape of the Distributions

Because of the elongated nature of the Guatemala CBD there is an overall tendency for the distributions to be linear but to allow comparison between CBD's this tendency can be negated by a rank ordering of the land uses. The uses are ranked according to their oblongity value and appear in Table XV.

The shape of the distribution is most useful for clustered types,

TABLE XV

Guatemala (Accumulated Land Uses)
Ranked Values of Oblongity

Value	Land Use		Value	Land Use	
0.2770	68	Circular	0.7171	34	
0.3207	74		0.7272	35	
0.5046	77		0.7396	18	
0.5291	38		0.7416	45	
0.5493	42/43		0.7449	55	
0.5663	67	Upper	0.7555	37	Lower
0.5709	47	Quartile	0.7619	16	Middle
0.5760	32		0.7685	70	Quartile
0.5949	04		0.7728	76	
0.6090	19		0.7784	02	
0.6262	08		0.7788	00	
0.6353	69		0.7869	64	
0.6364	07		0.8074	60	
0.6388	06		0.8247	61/62	
0.6661	56		0.8338	24	
0.6670	75		0.8383	66	
0.6690	09		0.8537	36	
0.6722	41		0.8543	14	
0.6767	10	Upper	0.8704	50	Lower
0.6823	72	Middle	0.8987	13	Quartile
0.6823	80	Quartile	0.9002	49	
0.6827	87		0.9094	11	
0.6848	31		0.9314	03	
0.6957	81		0.9394	88	
0.7080	17		0.9337	71	
0.7096	05		0.9435	48	
0.7118	79		0.9833	46	
0.7167	78	Median Value	0.9847	33	Linear

i.e. those in Sections A and B. Like London most uses are circular where they are central-clustered and to some extent linear where they are peripheral-clustered. Using the extreme quartiles of the ranked oblongity statistic no uses in Section A are linear although nine are circular and one use in Section B is circular and two are linear. The number of linear uses in B is too small to conclude that peripheral-clustered uses are usually linear. Most of the linear uses are dispersed including two of the three uses mentioned in the typology. These two uses are general foods (represented by 36 and 33) and vehicle sales (represented by 46 and 48, Map XXXIII). Furniture is not as linear in Guatemala.

The Orientation of the Distributions

While the orientation of the principal axis of the distribution is most relevant where the distribution is linear it is also worth noting the orientation of the axes in total (see Table XVI). The main grain of the axes is offset from the main street orientation just as they are in London. In Guatemala the influence of the markets in the north-east and south-west no doubt causes some of the re-orientation, for the markets are important pedestrian and commercial foci. The uses most skewed by the influence of the markets are the central-clustered commercial types for the most part. Those uses which run contrary to the grain are chiefly peripheral types. Again both of these features are similar to those observed in London. As in London only the linear uses in the lower quartile of the oblongity table are shown with their alpha orientation in Map XXVII.

TABLE XVI

Guatemala (Accumulated Land Uses)
Ranked Values of Alpha (in degrees)

Value	Land Use		Value	Land Use	
+44.30	36		-7.741	61/62	
+5.223	48		-8.491	17	
+4.277	32		-8.771	08	
+4.091	49		-9.248	81	
+1.606	78		-9.305	04	
+0.8682	11	Upper	-9.918	24	Lower
+0.8631	87	Quartile	-9.952	34	Middle
+0.8250	33		-10.37	42/43	Quartile
+0.1715	71		-10.53	72	
+0.1037	88		-10.98	40	
-0.6423	18		-11.11	74	
-1.820	14		-11.40	75	
-2.187	46		-12.44	03	
-2.240	56		-12.47	69	
-2.878	64		-12.78	55	
-2.922	66		-13.54	07	
-3.694	76		-13.79	35	
-4.139	00		-13.80	80	
-4.331	05		-14.03	41	
-5.654	06	Upper	-14.06	45	Lower
-5.695	13	Middle	-15.08	38	Quartile
-5.771	68	Quartile	-15.56	77	
-5.892	37		-15.61	67	
-6.014	50		-17.08	31	
-6.610	10		-21.31	19	
-6.712	79		-26.85	02	
-6.939	47		-30.25	70	
-7.321	16	Median Value	-33.22	09	

Clustered, Random and Regular Distributions

The normal deviate when used as a check (Table XVII and Figure XIII) confirms most of the central-clustered uses of Section A but the uses in B are less strongly clustered than they are for London. There is not much difference in the highest negative normal deviate values between Sections B, C and D whereas in London the uses in B are much more clustered than in Sections C and D. Strong peripheral clustered, therefore, are not as common in Guatemala.

All of the central-clustered uses in the typology are confirmed, including women's and children's wear (42/43, Map XXXII), cloth, clothing and footwear (41, Map XXXII), minor department stores (40, Map XXXI) and fabric sales (45, Map XXXIII). Many of these distributions have strong secondary concentrations along Calle 18 and Avenida Bolivar or the area described as the bazaar in the detailed analysis. These are additional central-clustered uses to those in the typology. Importers and exporters (87, Map XXXVIII), and the sale of accessories (47) would not occur in the center of an Occidental CBD. In Guatemala these two uses may be a measure of the importance of external relations to the country of Guatemala since they occur in the very center. Another difference is the existence of some industrial uses in the center such as shoe and clothing manufacturers (04) and diverse manufacturing (19). The leather (09) and tobacco industries (02) can be dismissed since they are both marginally clustered by the normal deviate statistic and have small populations.

Section B is quite different from the typology and from the arrangement found in London. Cafes (37, Map XXXI) and beer and soft drinks (38) are peripheral-clustered in Guatemala but are either more concentric or central in the typology. The fact that these two uses are clustered

TABLE XVII

Guatemala (Accumulated Land Uses)
Ranked Normal Deviate

Value	Land Use		Value	Land Use	
+0.2326	07	R	-4.695	31	
-0.8374	34	A	-4.892	18	
-1.501	02	N	-4.919	32	
-1.635	49	D	-5.337	24	
-1.868	14	O	-5.377	06	
		M	-5.421	81	
-2.094	09		-5.431	10	Lower
-2.269	36	Upper	-5.513	11	Middle
-2.299	64	Quartile	-5.955	33	Quartile
-2.300	03		-5.999	19	
-2.566	46		-6.131	87	
-2.739	55		-6.303	88	
-2.741	48		-6.573	08	
-3.187	71		-6.965	70	
-3.320	16		-7.315	72	
-3.364	50		-7.461	69	
-3.429	47		-7.511	79	
-3.477	75		-7.833	67	
-3.503	13		-8.558	66	
-3.523	56		-8.604	00	
-3.896	76		-9.553	37	Lower
-4.047	17	Upper	-9.753	61/62	Quartile
-4.055	35	Middle	-9.885	45	
-4.364	68	Quartile	-11.36	04	
-4.373	77		-11.78	40	
-4.378	74		-12.57	41	
-4.403	80		-13.09	42/43	
-4.562	78		-13.34	38	Clustered
-4.646	05	Median Value			

Figure XIII

Guatemala (Accumulated Land Uses)
Scattergram and Normal Deviate

Section A	Section B	Section C	Section D	Value
	38			-13.34
42/43				-13.0
41				-12.0
40				
04				-11.0
45				
61/62				
	37			-9.0
			00	
		66		-8.0
67				
		79		
69				
72				
70				
08				
			88	
87				-6.0
19				
			33	
			11	
	10			
	81			
		06		
	24			-5.0
		32		
			18	
	31			
			05	
		78		
80				
74				
			77	
68				
	35			
	17			-4.0
		76		
			56	
			13	
47				
			75	
			50	
			16	
		71		-3.0
	48			
55				
46				

Figure XIII cont.

Section A	Section B	Section C	Section D	Value
09		03 36	64 14	-1.96
02		34	49 07	

and peripheral in Guatemala is an indication of the existence of the bazaar area at this level of accumulation. Personal services (81, Map XXXVII) are also clustered in this area but the remaining uses are all large space using types quite typical of the Occidental periphery. (Some examples are given in Maps XXXVIII and XXXIX.) The bazaar area is not as easily differentiated at this level of accumulation without the measure of quality.

All of the random uses (except tobacco manufacture [02]) are in Section D and if those with low negative normal deviate scores are added then most dispersed uses are in Sections C and D. Most peripheral-dispersed types are industrial uses. A number of the central-dispersed types are commercial including bread, biscuits and pastry (36), florists (71) and recreation services (76, Map XXXIV).

Uses in C and D which have a higher negative normal deviate score are likely clustered in small dispersed groups or are arranged in peripheral belts. This is the likely arrangement since they have a large group dispersion, yet a small paired distance. All of the uses in D conform to the peripheral-concentric uses in the typology except fruit and vegetables (33) which may have a pattern influenced by the distribution of the markets. Section C contains many more commercial uses which may be dispersed in both areas or form loose intermediate belts.

In summary, the CBD of Guatemala shows certain similarities when compared to the Occidental CBD. The mean centers are on one side of the PLVI and the same land uses are central-clustered. There is evidence of a 'grain' in the distribution and orientation of the land uses strongly influenced by certain streets and the markets. As in London most central-clustered uses are circular and there is some evidence that the peripheral

uses are linear. While these similarities are notable there are important exceptions.

There are land uses in the most central area of the CBD which never occur in equivalent locations in the Occidental CBD. These land uses are of two types. There is the external relations type of industry or industry related use, such as import and export agencies and the sale of accessories. There are, more importantly, the internally oriented industries which in the absence of chain stores produce consumer oriented goods in their central CBD premises. There is less differentiation of land uses in the periphery so that there are fewer peripheral clusters. This may be due to reduced influence of the private automobile in the non-occidental CBD. Although there are fewer peripheral clusters, there is some evidence of the bazaar already mentioned in the detailed analysis. Many of the central clustered uses have strong concentrations around Calle 18 and certain of the peripheral-clustered uses are bazaar types.

The comparison of the Occidental and Non-Occidental CBD is taken further in Chapter VII. In the next chapter the arrangement of land uses in Bogotá, Colombia is considered.

CHAPTER VI

THE CENTRAL BUSINESS DISTRICT OF BOGOTÁ

Bogotá has a population of 1,697,000 (1964) and so is larger than Guatemala City (577,000 in 1964) and London (200,000 approximately in 1968). The CBD is modern and bustling and does not have a large and obvious Indian and mestizo pedestrian component like Guatemala. Based upon observation, the pedestrians are not segregated into Indian and mestizo dominated and Spanish dominated areas as they are in Guatemala. The land value surface (Map III) has no second peak and in this respect it is also unlike Guatemala. The land values decline from a peak at the intersection of Avenida Jimenez and Carrera 7. The slope is more gentle to the north so that the high values are elongated in this direction, whereas they fall off more steeply to the south. These slopes correspond closely to the revised land value model mentioned in Chapter III. The mean centers are all to the north and west of the PLVI toward what can be called the 'zone of assimilation'.

Bogotá, Data Characteristics

The boundary of the CBD was defined in the field by planners in the Departamento de Planeacion Distrito. The CBD has a fairly flat site but the eastern boundary is easily defined because the slopes increase sharply toward the mountain which dominates the skyline in that direction. In the north and north-west, some parks, the cemetery and an area of re-development partially define the boundary in those directions.

The land use data is from the "Centro Distrital de Sistematizacion" in Bogotá. The information is given on a computer tape and contains the address and land use code of industrial and commercial uses for the central area for the year 1968.

The addressing system used in Bogotá is even more systematic than that for Guatemala. The address is written out in Spanish but it also exists as a code in specific fields. It is not necessary to draw maps of each land use because it is possible to transform the coded addresses to Cartesian co-ordinates directly using a small computer program. The digitizer is not used for Bogotá and the co-ordinates are in millimeter units taken directly from the original base map. The figures in the tables are in millimeters where each millimeter is 2.00 meters.

The land uses now on the Cartesian co-ordinate system are sorted into classes. There are eighty-eight classes in all, but, as before, a number are not represented because their populations are not greater than the arbitrary minimum number required to usefully define a pattern. Where two similar land uses have the same address then one is deleted for computational reasons. The analysis is once again for the ground floor only. The land uses represented in this study are listed in Appendix III. The analysis takes the same form as for London and Guatemala.

Foci of the Distributions

The mean centers are all on one side of the PLVI, to the north and west (Map XXXVIII). This arrangement is similar to that of the other two case studies. The table of ranked distances of the mean center to the PLVI shows most of the commercial retail uses close to the PLVI (Table XVIII). Some examples of the center-focused land uses are, optical,

TABLE XVIII

Bogotá
Ranked Distance From the Mean Center to the PLVI

Value	Land Use		Value	Land Use	
657	05		325	48	
605	14		316	78	
576	56		314	77	
541	85		313	35	
527	63		310	59	
512	24		309	10	
507	33		305	28	
502	18		301	76	Lower
501	81	Upper	298	45	Middle
495	09	Quartile	295	13	Quartile
491	57		293	07	
484	19		289	04	
481	55		287	87	
464	01		286	36	
463	11		284	82	
454	46		280	74	
454	29		280	40	
452	34		275	39	
445	00		266	70	
444	60		260	75	
430	64		258	66	
429	03		244	44	
427	17		223	61	
421	21		222	80	
419	71		220	62	
413	51		207	30	
412	16		203	22	
410	06		195	84	
407	47	Upper	194	08	
405	38	Middle	190	88	
399	15	Quartile	179	83	Lower
395	31		178	73	Quartile
393	27		177	53	
389	12		173	43	
379	65		173.17	42	
374	32		167	25	
355	52		151	41	
353	20		143	69	
347	50		131	67	
332	23		124	68	
329	26		85	72	
326	79	Median Value			

photos (68, Map XLX), watches (67, Map LXL), other merchandise (72), libraries and bookstores (69) and cloth, clothes and footwear (41, Map XLII). The most peripheral uses are industrial or large space using land uses and include wood and cork industry (05), base metal (14, Map XXXIX), wood sales (56, Map XLVI), vaults and warehouses (85, Map XLXII) and repair workshops. These uses are all consistent with the results for Guatemala and London as well as the assignments to the typology. The use of the measure of dispersion adds more descriptive power.

Dispersion of the Distribution

The dispersion is measured by the mean distance to the mean center (see Table XIX). Many of the most clustered land uses are also closest to the PLVI. The most clustered uses are optical, photos (68, Map XLX), women's clothing (42, XLIII), other foods (39) and wood sales (56, Map XLVI). The most dispersed uses tend to be industrial or industry related uses and include petrol and derivatives (12, Map XLIX) and fuel sales (63). The combination of the measure of focus and dispersion gives the scattergram.

The Scattergram

The arrangement of land uses in the scattergram is shown in Figure XIV. Once again, like Guatemala, there is a positive linear relationship between the focus and dispersion. The more distant from the PLVI the focus of the land use then the more dispersed it is likely to be.

Table XX lists those uses which are in Sections A, B, C and D. The clustered and central uses of Section A are again, as in Guatemala,

TABLE XIX

Bogotá
Ranked Mean Distance to the Mean Center

Value	Land Use		Value	Land Use	
686.8	12		422.6	57	
677.3	06		421.6	52	
673.4	64		415.9	74	
651.9	63		407.8	60	
625.1	03		399.7	87	
613.8	71		396.4	26	
613.4	31		393.0	44	
613.3	32		390.6	15	
581.4	34		386.3	40	
575.0	14	Upper	380.3	77	Lower
568.0	24	Quartile	379.8	51	Middle
567.7	46		379.2	65	Quartile
563.5	01		377.7	30	
553.6	07		365.0	85	
551.7	36		363.3	22	
551.2	19		359.7	61	
548.5	79		357.5	53	
548.0	18		357.1	43	
539.1	29		330.8	67	
529.2	00		323.9	75	
525.2	16		321.9	45	
516.7	38		320.2	70	
515.5	05		311.7	69	
514.3	21		309.0	88	
509.9	35		295.0	84	
500.5	10		290.6	83	
497.3	20		284.5	73	
485.1	76		280.9	59	
483.7	09	Upper	270.2	25	
480.3	33	Middle	261.3	62	Lower
479.4	27	Quartile	257.0	55	Quartile
467.7	04		251.2	41	
454.8	23		149.2	47	
453.3	11		142.2	66	
447.7	13		118.7	78	
444.9	08		117.8	81	
441.0	80		92.61	72	
438.7	48		44.46	39	
436.4	50		41.42	42	
435.6	17		30.00	56	
434.6	82		9.763	68	
432.3	28	Median Value			

The Focus and Dispersion of Bogota Land Uses

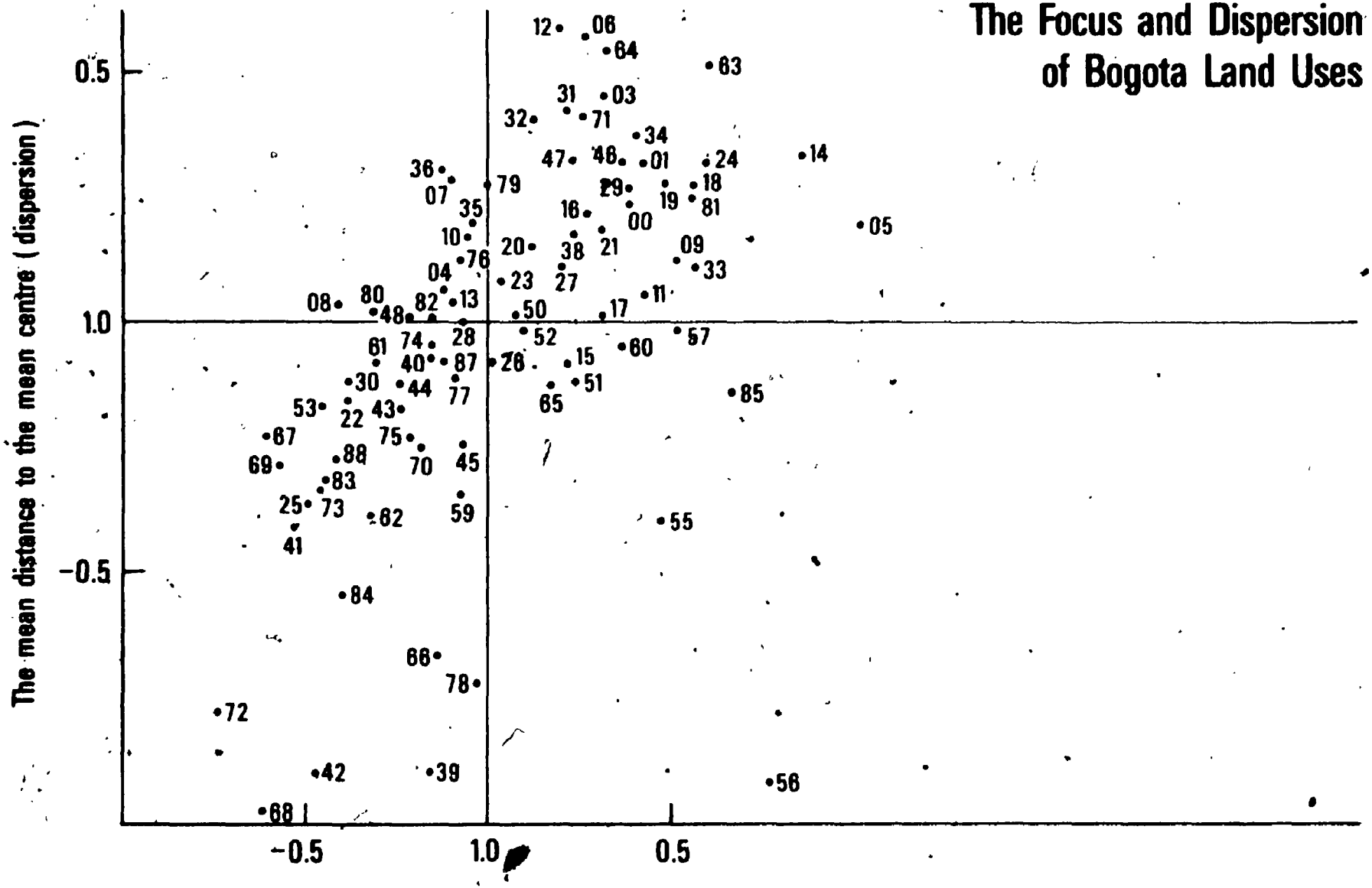


Figure XIV

TABLE XX

Bogotá Scattergram Allocations

Section A	Section B	Section C	Section D
68	56	36	63
42	55	07	06
72	85	35	64
39	57	10	14
78	60	76	05
66	51	04	12
84	65	08	03
41	15	80	34
25	52	48	01
73	26	82	24
62		13	18
83			81
69			19
67			46
88			71
70			31
59			32
45			47
75			29
22			00
53			09
30			33
43			11
44			17
77			21
87			38
40			16
61			79
74			20
28			27
			23
			50

and London, the pedestrian oriented uses, the clothing stores (41, Map XLII; 42, Map XLIII; 43, 44, Map XLIII; 45, Map XLIV), the domestic articles of mass appeal (39, 66, 62, Map XLVIII; 61, Map XLVIII), those uses specialized and selling expensive products (68, Map XLX, 67, 53) and uses depending on pedestrians apart from these named above (73, 83, 84, 88, 75, 69, 77, 39, and perhaps 40 and 72). All of the highly commercial, potentially high rent paying uses are in this section.

The Occidental CBD center is typically a pedestrian area of pedestrian oriented land uses, of intensive use of the land, and of high rents. The same overall arrangement occurs in the Guatemala and Bogotá Non-Occidental cities, but there are a number of anomalies. The anomalies are similar to those already noted for Guatemala. General warehousing (85, Map XLXII), import, export and distribution of merchandize (87, Map XLXIII) and electrical articles for construction (59) are more central and more clustered than would be expected from the typology as occurred in Guatemala. In the Bogotá CBD there are also some industries but they are fewer than in Guatemala. Bird raising (25, Map XLII) is central and clustered and there is a hotel industry (30) which is distinct from the hotels and pensions category (77). Water and sanitary services (22) are also quite central and clustered but these are public services and may not have a pattern which is a response to free market forces. Most of the anomalies in the Bogotá CBD are also common to Guatemala, however, most of the remaining central area patterns are similar for Occidental and Non-Occidental CBD's alike.

Section B contains large space using land uses, that is, they are extensive rather than intensive in their use of the land (see 55, Map XLVI; 56, Map XLVI; and 85, Map XLXII). Most of the uses in this section are concerned with the sale and storage of bulky goods or else they are

industries. There is no sub-focus which could be called a bazaar, nor are the uses in this section strikingly similar to those in the same section in Guatemala.

Only two uses in Section C might be expected from the typology to occur in Section A. These are movie theaters (74, Map XLXI), and fine foods (35). The other land uses in Section C are large space users (10, Map XXXIX) or commercial types which cannot compete for such a central location or are large space users and are expected to be peripheral. Only two food uses occur in Section C (35 and 36) while there are five food related uses in D and only one in A. The remaining uses in C are typical of the CBD peripheral area.

Section D contains almost all of the industrial uses (see land uses in 14 to 25 in Maps XXXIX to XLII respectively). Food uses are also important in this section and laundry and automobile oriented uses also occur as might be expected (see 46, 47, Maps XLIV, XLV). Where the uses are commercial they are usually of bulky products such as industrial, commercial and agricultural equipment and machinery (48), furniture and equipment for restaurants and bars (52, Map XLV), electrical machinery sales (50) and paper, glass and wallpaper (57, Map XLVII).

In general overall structure Bogotá has the same characteristics as the Occidental CBD, especially for the central-clustered uses. The anomalies which are observed in Guatemala, however, are also common to Bogotá although the degree of difference is greater in Guatemala.

The Shape of the Distributions

There is an overall tendency for land uses in the Bogotá CBD to be circular because of the "square" shape of the boundary. When the uses

are ranked and divided into quartiles the central uses are quite mixed in their shapes (see Table XXI). In Section A cloth, clothing and shoes (41, Map XLII), jewellry (67, Map XLX), children's and babies' clothes (43) and general merchandise (40) are all circular whereas women's clothing and articles (42, Map XLIII), optical and precision instruments (68, Map XLX), drugs and biochemicals (66), theatres, radios, and associated services (75) and other merchandize (72) are all linear. The linear uses include a number of automobile oriented uses such as accessories sales (47, Map XLV), fuels (63, Map XLIX), petrol and derivatives (64), agricultural tools, seeds and fertilizers (51) and wood sales (56, Map XLVI), all of which are in Section B and are peripheral-clustered types. The linear and peripheral uses are similar to those in the typology but the sale of automobiles (46, Map XLIV), while it is linear it is in Section D. Banks (88, Map XLXII) which are a central-linear type in the typology are also linear in Bogotá but they are not in the extreme linear quartile.

The Orientation of the Distributions

The orientation of each land use is shown in Table XXII. The overall orientations fall into two groups, based on the general orientation of the rectangular network of streets. The streets are from north-east to south-west and from north-west to south-east approximately. There is some division of land uses by their orientation. Most of the central-clustered uses, particularly the clothing uses, are north to north-east oriented whereas motor vehicle and furniture uses are north-west to south-east. The axes along Carrefas 7, 10 and 14 lead to the high quality residential area in the north, whereas the axis to the west leads to the market and railway station.

TABLE XXI

Bogotá
Ranked Values of Oblongity

Value	Land Use	
0.0413	50	Circular
0.0457	23	
0.0604	15	
0.0676	30	
0.0958	11	
0.0991	74	
0.1040	41	
0.1057	20	
0.1207	33	
0.1273	65	Upper
0.1336	57	Quartile
0.1402	67	
0.1413	55	
0.1487	00	
0.1757	10	
0.1767	16	
0.1793	08	
0.1839	43	
0.1841	07	
0.1889	40	
0.1922	82	
0.1950	59	
0.1988	79	
0.2010	69	
0.2063	87	
0.2238	70	
0.2349	36	
0.2351	17	
0.2363	34	
0.2381	80	Upper
0.2429	38	Middle
0.2482	04	Quartile
0.2540	01	
0.2556	21	
0.2568	31	
0.2577	32	
0.2590	76	
0.2800	78	
0.2813	19	
0.2851	44	
0.2867	25	
0.2980	85	Median Value
0.3004	60	
0.3006	24	
0.3028	29	
0.3090	09	
0.3169	05	
0.3301	26	
0.3339	14	
0.3345	63	
0.3484	13	
0.3762	64	Lower
0.3807	84	Middle
0.3808	52	Quartile
0.3912	81	
0.3925	61	
0.3932	18	
0.4005	12	
0.4070	35	
0.4095	73	
0.4139	77	
0.4163	48	
0.4173	45	
0.4235	22	
0.4369	28	
0.4638	83	
0.4809	88	
0.5034	62	
0.5612	06	
0.5649	03	
0.5670	75	
0.6117	66	Lower
0.6353	53	Quartile
0.6626	27	
0.7283	71	
0.7353	56	
0.7882	46	
0.8203	68	
0.9112	72	
0.9427	42	
0.9738	39	
0.9847	47	
0.9921	51	Linear

TABLE XXII

Bogotá
Ranked Values of Alpha (in degrees)

Value	Land Use		Value	Land Use	
42.00	17		-18.06	72	
34.91	65		-18.14	34	
34.97	23		-18.44	30	
33.82	57		-18.76	40	
31.74	62		-19.46	21	
30.36	11		-19.60	78	
25.07	16		-20.09	85	
24.56	66		-20.11	25	
23.66	47		-20.34	71	
21.52	26	Upper	-21.45	33	Lower
18.65	82	Quartile	-22.40	70	Middle
16.08	42		-22.74	45	Quartile
14.32	43		-23.39	84	
7.886	07		-23.42	36	
5.207	41		-23.51	24	
4.258	00		-23.63	81	
3.334	39		-24.26	80	
2.763	05		-24.67	79	
0.04589	59		-25.20	83	
-2.681	14		-25.38	55	
-3.476	04		-25.81	73	
-3.718	09		-25.85	35	
-4.212	68		-26.64	88	
-6.493	06		-27.48	48	
-10.74	19		-27.69	61	
-11.59	67		-27.99	64	
-11.70	60		-28.48	87	
-11.76	29		-30.41	76	
-12.93	10		-31.49	28	
-13.46	08	Upper	-32.62	18	Lower
-14.15	13	Middle	-32.73	50	Quartile
-14.90	27	Quartile	-32.82	03	
-15.00	15		-33.89	53	
-15.32	01		-33.92	56	
-15.45	69		-34.26	38	
-15.93	63		-34.57	77	
-16.16	12		-37.98	51	
-16.38	75		-38.06	20	
-17.01	32		-39.99	74	
-17.38	44		-42.14	46	
-17.75	31		-43.17	52	
-17.79	22	Median Value			

Clustered, Random and Regular Distributions

London and Guatemala are similar in that there is a tendency toward clusteredness for the land uses. Bogotá is no exception; there are only five random uses, no regular uses and most uses are clustered by the normal deviate statistic (see Table XXIII). The five random uses are all industrial types (see 18, Map XL), three occur in Section D and two in Section C. These uses are dispersed both when they are measured as a group and when they are measured as paired locations. It is notable that in the Occidental literature and in the case study for London the industrial land uses are never random but are peripheral and usually concentric. In Guatemala and Bogotá the random uses are usually industrial uses.

Figure XV arranges land uses according to the four scattergram sections and according to the normal deviate statistic. Once again, as in London and Guatemala, the most clustered uses are in Section A and the most dispersed in Section D. However, unlike London, differences are focused in Section B and in Section C. The difference is most marked in Section B where the land uses do not all have high normal deviate scores. The land uses in C do not have predominantly low normal deviate scores. In the London study the normal deviate scores for Sections A and B are markedly higher than for C and D. At this level of general description the two Non-Occidental CBDs are somewhat different to the Occidental CBD.

There are differences in the detailed composition of the four sections in Figure XV for London and Guatemala and Bogotá. Water and sanitary services (22), bird raising (25, Map XLII), import, export and distribution of merchandise (87) and hotel industry (30) are still quite well clustered. Less well clustered by the normal deviate yet members of Section A are theatres, radios and connected services (75), professional

Figure XV

Bogota
Scattergram and Normal Deviate

Section A	Section B	Section C	Section D	Value
40 77		76 10	31	-31.78 -20.00
41	55		24 47 79	-15.00
73 61 84 83		04		
68 44 45	57		46	-10.00
72 22 67		35	71	
62 66 25 87	52			
69 30			32 33 20	
70 43		82 13 80		
78			50 01 23 21	
	51 65			

Figure XV cont.

Section A	Section B	Section C	Section D	Value
42 39		80	11 12	
88 59	56 26	36		
74 53	60		38 16	-5.00
	81 15		14 17 27 19	
75		28	34 00	
	85		05 06 09 83 64	-1.96
		07 48	29 03 18	

TABLE XXIII

Bogotá
Ranked Normal Deviate

Value	Land Use		Value	Land Use	
-.9288	18	R	-7.269	50	
-1.555	48	A	-7.270	43	
-1.686	03	N	-7.622	70	
-1.741	29	D	-7.836	80	
-1.809	07	O	-7.867	13	
		M	-7.955	82	
-2.295	64		-7.965	30	
-2.497	63		-8.142	20	
-2.904	85		-8.693	33	
-3.006	09		-8.850	69	
-3.113	06	Upper	-8.882	32	Lower
-3.526	05	Quartile	-8.924	52	Middle
-3.695	75		-8.951	87	Quartile
-3.770	00		-9.063	25	
-3.973	34		-9.089	66	
-4.030	28		-9.094	62	
-4.046	15		-9.118	67	
-4.074	81		-9.170	22	
-4.675	19		-9.215	35	
-4.748	27		-9.296	72	
-4.883	17		-9.379	71	
-4.908	14		-9.492	45	
-4.951	60		-9.585	44	
-5.054	53		-9.742	68	
-5.131	16		-9.826	46	
-5.379	74		-9.924	57	
-5.563	38		-10.27	83	
-5.617	26		-10.52	84	Lower
-5.823	56	Upper	-10.82	04	Quartile
-5.888	59	Middle	-11.12	61	
-5.918	36	Quartile	-11.22	73	
-5.935	88		-11.27	41	
-5.998	12		-11.62	79	
-6.042	39		-11.99	47	
-6.133	11		-14.56	55	
-6.244	42		-15.84	24	
-6.366	65		-18.41	10	
-6.621	08		-19.51	31	
-6.729	51		-20.36	77	
-6.739	21		-21.52	40	
-7.005	23		-31.78	76	Clustered
-7.023	01				
-7.186	78	Median Value			

furniture and equipment (53), production, distribution and exhibition of films (74, Map XLXI) and electrical articles for construction (59). These can be either peripheral to the center of the CBD or dispersed in the center. The remaining uses in Section A are confirmed as central-clustered and agree with the assignments to the typology.

Section B has not as many highly clustered uses by the normal deviate as expected. Petrol sales (64, Map XLX), fuels sales (63, Map XLIX), general warehousing (85, Map XLXII), metal products manufacturing (15), personal services (81), other construction articles (60, Map XLVII), wood materials industry (26) and wood sales (56, Map XLVI) have low normal deviate scores and are not well defined clusters. The other uses in this section are confirmed as clusters especially hardware and construction materials (55, Map XLVI), paper, glass and wallpaper (57, Map XLVII), furniture and equipment for restaurants, bars and hotels (52, Map XLV), agricultural tools, seeds and fertilizer (51) and other merchandise (65). Aspects of the furniture sales use are represented here as in the typology. The professions are not a part of the classification and automobile sales are in Section D. Section B does not have well differentiated clusters and only partly matches the assignments in the typology.

There is some correspondence between the peripheral-linear uses which occur in Bogotá and those mentioned in the typology. Section B contains many automobile oriented uses which are clustered by the mean distance to the mean center, and the normal deviate, and they are linear by the oblongity statistic (see, for example, 63 and 64, Map XLIX). Automobile sales and accessories (46, Map XLIV) are dispersed as a group and are in Section D, but by the normal deviate they are clustered and by the oblongity statistic they are linear. Professional furniture and

equipment (53) and domestic electrical goods (62) are quite linear although they are in the central clustered category and are not so peripheral. Bogotá unlike Guatemala confirms some of the linear uses in the typology.

A number of the uses in Section C are confirmed as dispersed, these include two randomly spaced uses: paper and articles manufacture (07) and industrial, commercial and agricultural equipment sales (48). Only loosely clustered and in this section are glass and derivatives sales (28) and bread and biscuits sales (36). The remaining uses in C have some degree of paired clusteredness which may mean they tend toward a concentric peripheral pattern, such uses include recreation services (76), rubber manufacturing and products (10), shoes, clothing and other articles manufacture (04), fine foods, liquor and tobacco sales (35) and vehicle parking (82, Map XLX).

Section D is the dispersed category and a large number of uses, particularly industrial uses are confirmed as dispersed by the normal deviate statistic. All of the land uses in the lower part of the column (Figure XV) are industrial or industry related uses except milk shops (34) and beer and soft drink sales (38). The upper uses in the same column may again be concentrically arranged or have a tendency to some form of paired, or small group clustering. This last category includes uses such as unprepared food and drink (31), repair workshops (24, Map XLI), sale of accessories (47, Map XLV), beauty salons (79) and auto and accessory sales (46, Map XLIV), most of which are peripheral and some are elongated along peripheral streets.

Guatemala and Bogotá share common similarities when compared to London and the typology. The anomalies may represent a different spatial-

structural order for Non-Occidental CBDs. Guatemala, in particular, emphasizes the differences. The next chapter reviews some literature which describes the Non-Occidental CBD and makes some conclusions about the differences with the Occidental CBD. The comparisons are centered on the three case studies which have the same form of analysis and are presented in these last three chapters. The next chapter concentrates on the cross-comparisons between the case studies, the typology and the Non-Occidental literature.

CHAPTER VII

CONCLUSIONS

This final chapter has three sections. First, the scarce literature on Non-Occidental CBDs is explored; second, detailed comparisons of London, Guatemala and Bogotá are made and third, the concluding section compares Occidental and Non-Occidental CBDs using these last two sections and the typology in Chapter I.

Some Non-Occidental CBD Literature

Bellett made an important observation when he recognized the need to include the cultural as well as the economic dimension in explaining the Non-Occidental Central Area retail structure.

> Whilst economic controls which normally assume a dominant role in the western city, are much tempered in less developed areas by social and cultural forces they do nonetheless exist in the oriental urban milieu, albeit much overlain by ethnic and socio-economic unconformities (Bellett, J., 1969, p. 1).

Bellett's study is for Singapore but a number of other authors comment on the need to include cultural influences in understanding Non-Occidental CBDs.

In East Africa de Blij conducted two studies, one in Lourenço Marques and the other in Dar Es Salaam. In both the cultural influence

is emphasized in explaining the land use structure (De Blij, H., 1962, and De Blij, H., 1963). In West Africa, in Lagos, and in Ibadan, Mabogunje emphasizes cultural influence on the overall city structure.

The cultural factor has its expression in the detail of business ownership and business patronage. Mabogunje (Mabogunje, A. L., 1968, pp. 210-212) is the most conceptual in his approach. He notes for Ibadan that the scale of operation of a business is closely related to "the racial complexion of Nigerian trade". Europeans handled eighty-five percent of imports, Levantine and Indian firms ten percent and Africans five percent in 1949. He notes that race is related to the scale of operation and this in turn influences the ability to pay rent which leads to a spatial ordering of businesses in the CBD. Closest to the railway were the European firms in high rise buildings followed to the east by Levantine and Indian two storey businesses and finally followed by single storey African shops. He notes a spatial ordering based on the culture factor yet to the south and north of the CBD are the large space using automobile sales and repair garages quite typical of the pattern in the Occidental CBD. This is supporting evidence for the quotation from Bellett's work mentioned above that the cultural influences rest unconformally upon the economic.

De Blij for both Lourenco Marques and Dar Es Salaam (De Blij, H., 1962, p. 66 ff. and De Blij, H., 1963, p. 48) also notes a cultural differentiation in business ownership and customer patronage. The European influence in Dar Es Salaam is around the Askari Circle which is also the area of highest buildings and highest land values. From the Askari Circle and to the south-west the European domain gives way quite distinctly to Asian and African domains (De Blij, H., 1963, p. 87). The

market divides the CBD in Lourenço Marques. In the north-west is a low quality retail area where most of the customers are African. In the south whites and non-whites are about equally important as buyers. East of the market is the high class retail area where the patronage is mainly white. De Blij's observations on the cultural differentiation of the population are personally observed yet he states that they are essential in an explanation of the arrangement of CBD functions (De Blij, H., 1962, p. 65).

Hamdan's work on the Khartoum CBD is also based on personal observation and again he notes there are separate areas enjoying different cultural patronage. The native market is around the mosque and transport foci in the south while the European sector is around the northern market close to the high class residential suburbs (Hamdan, G., 1960, p. 30).

Another clear expression of cultural influence is in the study of the Dacca CBD by Majid. She notes:

> ... (that goods) instead of falling into one large central core, they fall broadly into two categories: a) The agricultural or food market known as 'Bazar'; b) The shopping centres largely dealing in foreign and locally manufactured goods (Majid, R., 1970, p. 44).

Majid states that the bi-nodal form of the Dacca CBD is similar to many other eastern cities but she gives no references or examples. However the bi-nodal quality is similar to Dar Es Salaam, Lourenço Marques, Khartoum and Ibadan in Africa and Dacca in Asia. Majid's description of the character of the two nodes could apply to a large extent to any of the above cities:

> These two (nodes) can be easily differentiated by the nature of shops, type of commodities sold,

> type of buildings, etc. The indigenous centre ... with their old congested buildings and narrow crooked roads has a shabby look with people living on the upper floors and the rear rooms of shops. They sell local goods and deal with the local dealers... there is a Hawkers market around which even the roads remain packed with temporary stalls... In contrast the new centre... has a modern appearance with its wide roads with paved sidewalks and blocks of buildings, almost entirely occupied by business organizations both horizontally and vertically. Foreign goods and foreign firms are common here. But the sidewalks of even this area are being crowded by hawkers' display (Majid, R., 1970, p. 55).

Mabogunje describes the different economic character of the European center and the native peripheral market area. The former has large scale investment and competition for choice sites but the markets have no investment and the trading is small scale at negligible overhead costs and for little profits (Mabogunje, A. L., 1968, p. 210).

There is not much indication of spatial differentiation in the periphery of any of the Non-Occidental CBDs except that the bazaar is peripheral to the Occidental land use concentration around the PLVI. Majid is more definite and states that there is no prominent differentiation in the periphery as there is in the Occidental CBD (Majid, R., 1970, p. 60).

In each case mentioned above there is a clear cultural influence with a morphological expression. The Non-Occidental CBD is differentiated into separate areas based on the cultures which exist in the city. Most common is the two culture situation where Occidental goods exist in one area around the PLVI and the Non-Occidental goods in another often associated with the bazaar. The ownership and patronage also seems to be divided between these two areas with the wealthy or Occidental owner and customer using the Occidental section of the CBD and

the indigenous Non-Occidental owner and customer using the Non-Occidental section of the CBD (Majid, R., 1970, p. 56; De Blij, H., 1962, p. 65; De Blij, H., 1963, p. 87).

In some Non-Occidental case studies land rent and other measures of intensity of use are influenced by culture. The position of the PLVI is sometimes described in the Non-Occidental literature. In each case the PLVI is in the European or Occidental section of the CBD. The PLVI is still associated in this type of CBD with accessibility and in Dacca it is the focus of bus routes (Majid, R., 1970, p. 60) and in Dar Es Salaam it is described as the focus of vehicular traffic (De Blij, H., 1963, pp. 45-46). In both cities it is associated with the tallest buildings, quality shops and Occidental goods. In Lourenço Marques the PLVI cannot be identified but De Blij equated its position with the 'hub' which is an intersection with the same characteristics as the PLVI.

In Dar Es Salaam there is information on the whole surface of land value and it declines from the PLVI as in the Occidental CBD. There is a suggestion that a second land value peak may be present in the CBD of Nairobi for Kimani notes a second peak in the land value surface. However the study is a city wide one and the land value information is not detailed enough to be certain that a second CBD peak does in fact occur (Kimani, 1972, p. 109).

There is also evidence that two peaks occur in Dacca. The information is scant but the highest land value at the modern 'core' is RS. 1,200,000 per acre. This declines along the street leading to the bazaar areas to RS. 500,000 and increases to RS. 900,000 at the bazaar area (Majid, R., 1970, p. 59). This rise may represent a second peak.

There is clearly some evidence that the cultural influence is

reflected in the land value surface. City-wide accessibility is greatest around the PLVI and it is the center of tallest buildings. The land value declines outward from the peak but on one side it reaches a second peak in the area where the native bazaar is found. Although the tallest buildings are at the first peak as in the Occidental CBD, evidence from De Blij's study of Dar Es Salaam shows it is not necessarily the area of greatest pedestrian density of intensity of use. These last two measures peak around the native bazaar in the Non-Occidental situation in contrast to their PLVI focus in the Occidental CBD.

The mean centers of the land use distributions are on one side of the PLVI in the Non-Occidental CBD where the information is available. In Dar Es Salaam the mean centers are toward the Non-Occidental section of the CBD and away from the European Focus known as the Askari Circle. In Lourenco Marques most mean centers are on one side of the 'hub'. These general mean center positions are consistent with observations in the Occidental CBD but the existence of a Non-Occidental domain means that the concept of 'zone of assimilation' and 'zone of discard' need re-thinking. In the Occidental CBD the mean centers are on one side of the PLVI and this is also the direction of the zone of assimilation. In the Non-Occidental CBD, however, this is the direction of the native domain and De Blij notes that Occidental businesses in the CBD of Dar Es Salaam are expanding in the opposite direction toward the high quality residential area (De Blij, H., 1963, pp. 45-46). Hamdan notes expansion of Occidental businesses into the high quality residential sector in Khartoum (Hamdan, A. L., 1960, p. 30) and Majid describes the same feature for Dacca (Majid, R., 1970, p. 53). The Non-Occidental CBD is like the Occidental one in that the expansion is toward the high quality residential area but unlike

in that the mean centers are all on the opposite side of the PLVI. It may be therefore that the Occidental and Non-Occidental domains exist back to back making the concept of 'zone of assimilation' and 'zone of discard' somewhat redundant in the Non-Occidental situation. For this reason the two zones are omitted from the tentative land value model in Chapter V (see Fig. XI).

The CBD is itself an Occidental feature, yet the structure becomes modified in the Non-Occidental setting. The general accessibility influence in particular is changed; there are two peaks associated with the two cultures. The second and surprising change is the clustering which forms the bazaar. The various qualities of the two nodes are already described but the Non-Occidental CBD is an amalgam of the classic Occidental CBD and the bazaar annex. Business ownership, quality of business, physical characteristics of the building, size of business, origin of goods, etc. all vary. While the PLVI is the focus of Occidental business the bazaar may be focused on a traditional market, a religious center or transport node which is important to the indigenous people.

The bazaar and the Occidental center seem to vary in size depending upon the relative importance of the Occidental and Non-Occidental cultures. In Lagos from Mabogunje's comments the CBD is an Occidental creation and through demolition and fragmentation the Non-Occidental markets have not established themselves as a unit as they have in Ibadan. No doubt there are other examples of CBDs (e.g. Bogotá) where the Non-Occidental structure being described here does not exist for similar kinds of reasons. In Khartoum, in Dar Es Salaam, in Lourenço Marques, in Dacca and in Guatemala the Occidental and indigenous influences are clearly reflected in the CBD structure.

It is clear that some of the differences between Occidental and Non-Occidental CBDs just observed are similar to the results obtained for Guatemala and Bogotá when they are compared to London, Ontario. None of the Non-Occidental literature provides the detail in analysis that is available for Guatemala and Bogotá. It is valuable, then, to use the results of the London analysis and the assignements to the typology to represent the Occidental CBD and the Guatemala and Bogotá results to represent the Non-Occidental CBD. London, as a smaller city, could be untypical of the Occidental CBD but the large amount of consistency with the typology assignments suggests that it is not. The London case study is valuable since it has a detailed description and uses the same techniques as the two Non-Occidental CBD studies. The literature on the Occidental CBD is also used since it provided the typology with its mechanisms and general patterns. The Non-Occidental literature just reviewed is used to supplement and substantiate the understanding of the Guatemala and Bogotá CBDs.

Comparison of London, Guatemala and Bogotá Land Use Patterns

Some of the problems in making comparisons between cities should be noted. First the CBDs are of different sizes and shapes and the land use categories and the numbers in each of the categories are different. The Bogotá and Guatemala classifications are very similar but not the same, and London's is quite different. Despite these problems it is assumed that London usefully represents the Occidental CBD and Bogotá and Guatemala usefully represent the Non-Occidental CBD. The land use detail and the common methodology applied to all three cities provides information and a degree of comparability not obtained before. The methodology

is constructed around Occidental patterns and processes but its Occidental bias is nonetheless useful since the study compares Occidental and Non-Occidental land use patterns. Where the patterns are the same it is inferred that the processes giving rise to them are the same. This comparison should isolate land uses in the Non-Occidental CBD which have unexpected land use patterns and respond to different processes.

This is not a CBD delimitation study so the exact position of the boundary is not so important. It is assumed that the internal CBD processes are circumscribed so that the CBD patterns are enclosed. The data is presented in rank order so that useful comparisons which are independent of the area, shape and numbers in each land use can be made. While rank ordering facilitates comparison of the three case studies, there are inherent difficulties in that the different number of land use classes gives different numbers of ranks. This difficulty is only partly relieved by using medians and quartiles to compare the position of land uses. Description based on the medians are most meaningful where the land uses are at the extremes in the rank order. It is felt that a considerable amount of information can be obtained by comparing positions relative to the median values. The rank ordering has proved useful in this study and there is a very similar arrangement of land uses for many statistics. The comparison of the three cities is a comparison of relative positions for the various statistics with the median used to differentiate between broad categories. The statistics and the division by the median value help to define certain patterns which are produced by a known process in the Occidental CBD.

The Comparison of Scattergrams

A number of important general similarities in the statistical results for the three cities should be mentioned before a more detailed comparison begins. The distribution of points in the scattergram for Guatemala and Bogotá (Figs. XII and XIV) shows a positive relationship between the two axes suggesting that the greater the distance the focus of a land use is from the PLVI then the more dispersed it will be.[1] As a result, sections A and D of the scattergram are well filled in these two cities. London, however, is somewhat different (see Fig. VIII); sectors C and B are of increased importance so that there is obviously better differentiation in the periphery of London than there is in the other two CBDs. The periphery of Non-Occidental CBDs appears to be poorly differentiated as noted by Mabogunje and cited earlier in this chapter and for the Dacca CBD described by Majid (Majid, R., 1970, p. 60).

The original scattergrams are divided into four sections using the median values of each axis so that there are four relative sets of patterns. The median values remain as the bases of Figures XVI and XVII. In these figures the spearate London, Guatemala and Bogotá scattergrams are combined by superimposing the medians and locating each land use for each city in its approximate position in each of the four sections. The combined scattergram is then divided into industrial and non-industrial uses for clarity. London, Guatemala and Bogotá land uses are differentiated by the use of symbols.

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[1] This description is based on a visual and qualitative assessment of the distribution of points in each scattergram and is not a statistical description.

Industrial Uses

Industries (see Figure XVI) are not a feature of the center of Occidental CBDs; as large space users they are not expected to be able to afford the most central sites. For Guatemala and Bogotá certain industries do occur in A although none are heavy industries. Those industries in A are pedestrian oriented including the manufacture of leather and products (09), clothing and footwear (04), printing (08), tobacco (02), and diverse goods (19). Most are clustered (although leather and tobacco ((02) and (09)) are randomly spaced by the normal deviate statistic). None of these centrally occurring uses are common to both Guatemala and Bogotá, and most are likely to be small space users. It is curious that they occur centrally in these Non-Occidental CBDs for in London and in the typology there is no industry or industry related uses in this section. Most industrial and industry related uses do conform to the Occidental models despite these exceptions. Most industries are peripherally oriented and are in sections C and D of the scattergram. Industrial uses constitute most of the random uses.

Non-Industrial Uses

The Non-Occidental uses in Figure XVII are described in this section.

The land uses most typical of the most central part of the Occidental CBD are consistently central-clustered for all three CBDs. These, it is inferred, are uses which either seek the most accessible sites, have a mutual affinity, locate in relation to a central physical resource or locate according to a combination of all three. The uses which locate thus are the clothing types of stores including women's,

Superimposed London, Guatemala, and Bogota Scattergrams

Industrial Uses

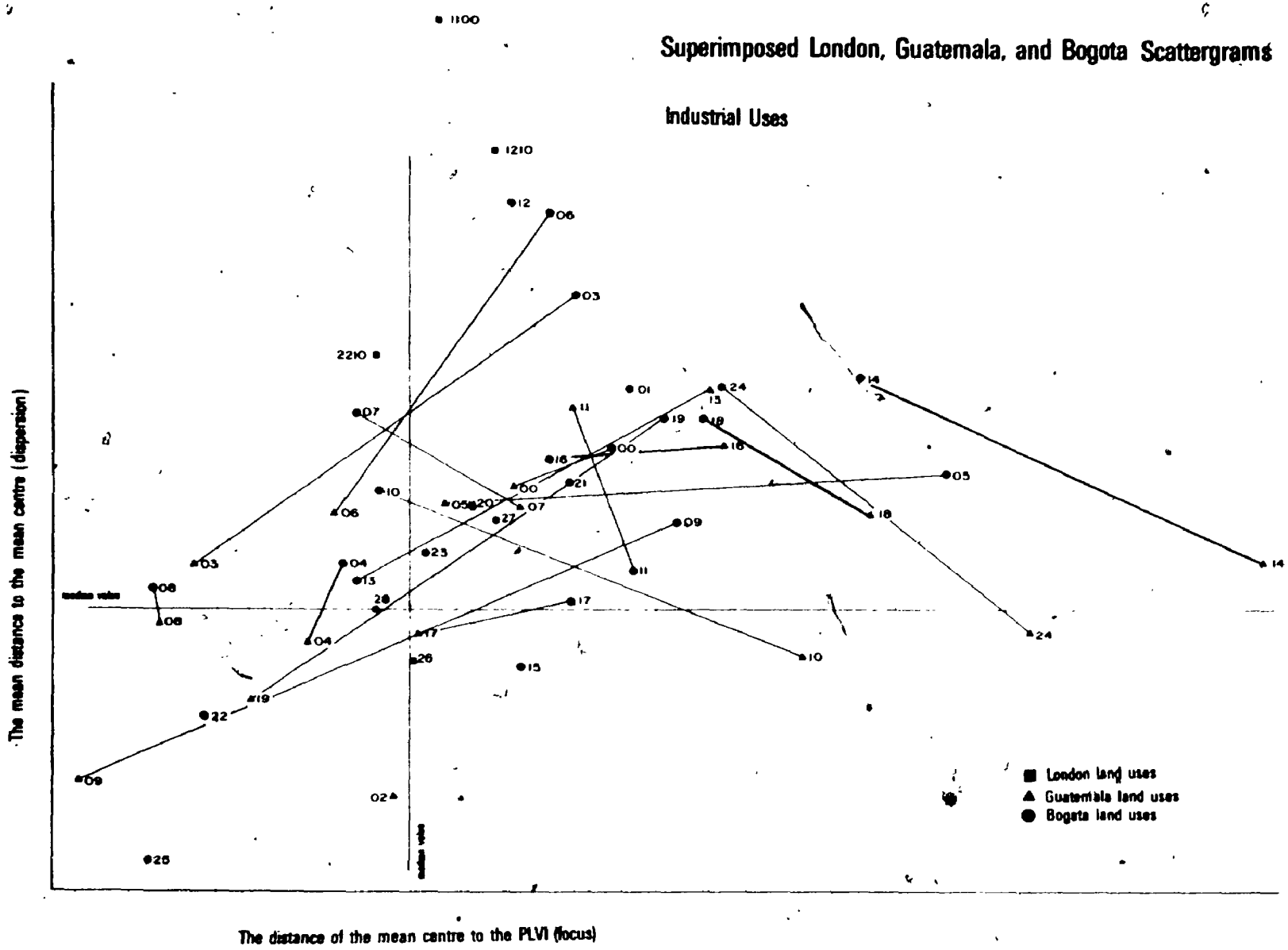

Figure XVI

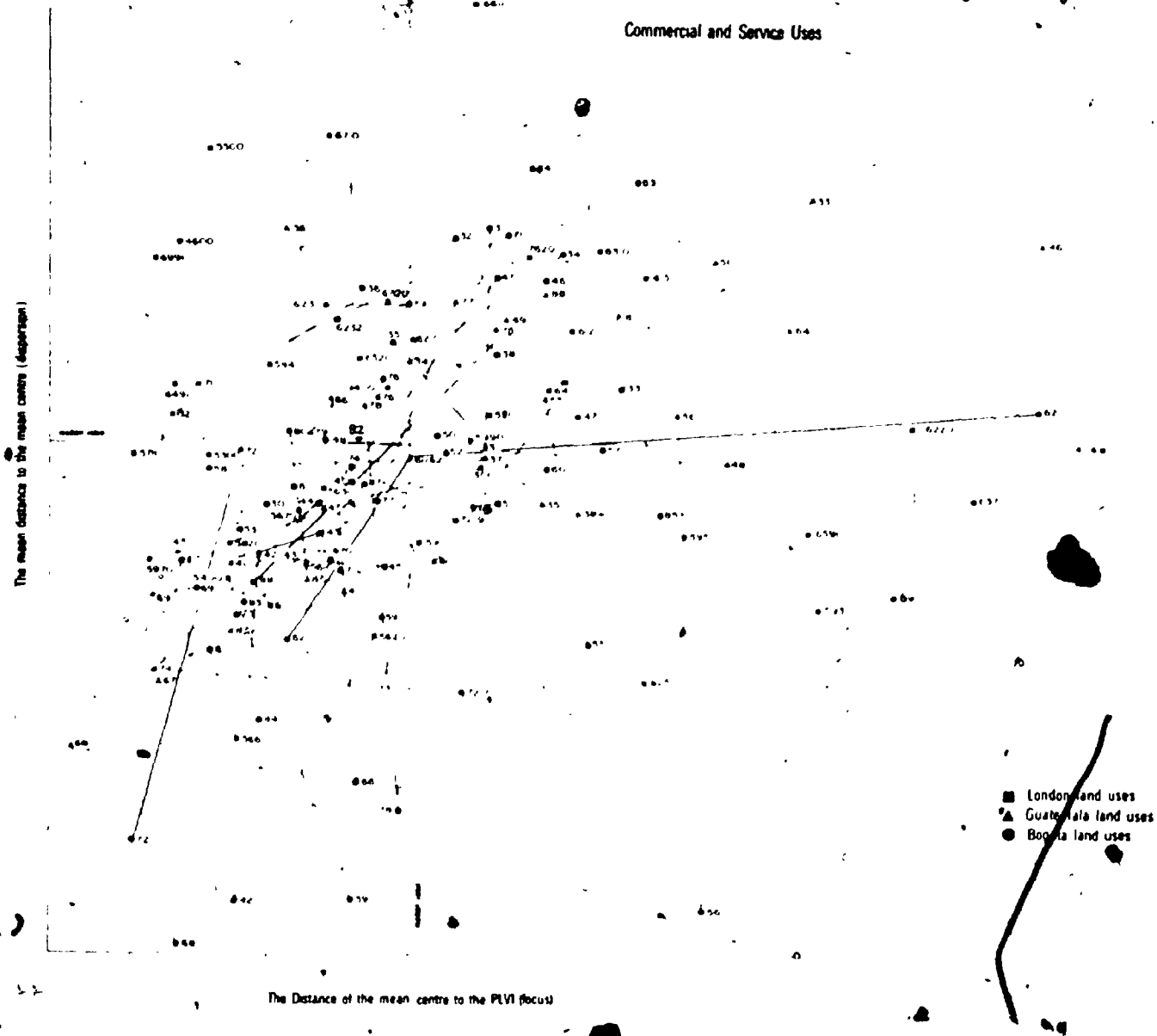
Superimposed London, Guatemala, and Bogota Scattergrams
Commercial and Service Uses
The mean distance to the mean centre (dispersion)
The Distance of the mean centre to the PLVI (focus)
London land uses
Guatemala land uses
Bogota land uses

Figure VII

children's, men's wear and shoes (land uses 41 to 44 and 5300, 5630, 5670, 5660). Clothing accessories also feature consistently in the Central Area in a clustered fashion and jewellry (67 and 5970) is among this group. All of these are consistently clustered central uses in all three CBDs and are also clustered by the normal deviate statistics.

Uses which are members of Section B are those which respond to two of the properties described for A. Peripheral clusters are those which share a mutual affinity and/or are attracted to a physical resource. The third process, the influence of general accessibility, is still important in that the clusters are peripheral but not so dominant that it produces a concentric belted pattern. Membership of Section B is much less consistent for all three CBDs than expected. There are no uses consistently in this group for all three CBDs. Automobile sales (46 and 5500) normally expected in this section are in Section C or D. Land uses associated with automobiles are peripheral-clustered by many descriptions in the Occidental literature yet in these three case studies auto repair and gasoline (64 and 6411) are consistently in Section D. Most other automobile oriented uses are peripheral but only in a few cases are they clustered. Furniture (52, 53, 61, 62 and 5711) is not peripheral-clustered as it is in the assignment to the typology. Professional services (6511 and 6590) are in Section B in London but do not exist as classes in the other two cities. These observations confirm the absence of peripheral differentiation already mentioned in the review of Non-Occidental literature.

Most of the similarities common to all three studies occur in Section A: the central and clustered patterns.

If only Bogotá and Guatemala are compared, a number of additional

consistencies occur. Some of these consistencies are additional central-clustered patterns in Section A, such as, other retail merchants (40), general cloth and clothing stores (45), bookstores (69) and other merchandise (72). These land uses all conform to the typology and its assignments. A number of other Guatemala/Bogotá consistencies do not conform to the typology. Optical and precision instruments (69) and exporters, importers and distributors (87) are of this type. They are also clustered by the normal deviate statistic. In Australia Scott notes import and export functions are on the zone of discard side of the Occidental PLVI (Scott, P., 1959, Fig. 15, p. 309). Here in the Non-Occidental situation the use is more centrally located on the opposite side of the PLVI and this concurs with De Blij's descriptions of Dar Es Salaam (De Blij, H., 1963, Fig. 43, p. 63) and Lourenco Marques (De Blij, H., 1962, Fig. 24, p. 75). These last observations indicate that certain commercial uses like the industrial uses previously mentioned are much more central in the Non-Occidental CBD than would be expected from Occidental experience.

Even when the two Non-Occidental CBDs are considered alone they do not produce consistent clusters in the periphery. It is worth noting that only the London results reflect the peripheral-clustered arrangement made by Horwood and Boyce (see Fig. I).

The peripheral sections C and D have consistencies for Guatemala and Bogotá. The uses which occur in Sections C and D are notably the outer retail types, food and some service types, which have the same pattern in the typology. The industrial uses, already mentioned, are here also. The normal deviate values are lower in Sections C and D than in A or B; this is particularly true of Guatemala. It follows that most

of the random uses are also in this section including the industrial uses already mentioned for Guatemala such as industrial machinery and equipment sales except electrical (49) and in Bogotá agricultural machinery sales (48), washing, disinfectant and cleaning plants (29) and transport materials and accessories construction (18).

Land uses unique in either Bogotá or Guatemala confirm the observations just made. There are various retail land uses which intuitively, and in the Occidental CBD, would be expected to be central and do in fact occur in Section A. There are other unique uses of the industrial and space using type that occur in Section A and so are closer to the center than would be expected from the typology.

In Section B in Bogotá the unique uses are all space using, most have a transport orientation but they are a mixed group and do not conform very well to the typology. Eating and drinking places, the only unique Guatemalan use in B, are equivalent to cafes in London where they are much more central-clustered. Cafes are focused on Calle 18 in Guatemala which is the area of the bazaar.

The unique uses in C and D conform quite well to the typology and they are all either industries, sell bulky materials, or are space using public services.

From this comparison of London with Guatemala and Bogotá there is clear evidence of broad similarity in the following land use patterns: clothing uses for men, women and children, the sale of shoes and accessories to clothing, banks, theatres and other entertainment and hotels. All of these are central and clustered as expected from the typology and its assignments. The peripheral sections also contain uses which are expected by the typology. Most government uses, transport oriented uses,

and those selling bulky goods are peripheral. Industries are in most cases peripheral, and auto sales, although they are not always clustered, are nonetheless peripheral.

Closer inspection reveals certain meaningful exceptions to the typology in the internal structure of Bogotá and Guatemala, especially the latter. The central area, Section A, while it contains some consistencies also contains most anomalies. All of the expected central clustered uses are in this section but there are others also. The other uses are unusual from the Occidental point of view and can be divided into two types. There are manufacturing uses with a retail bias such as leather work, clothing manufacture, tobacco and diverse industries, many are in Guatemala. The second type have a high capital input and reflect the links outside the nation. The import, export and distribution use is in this category, as are wholesaling and storage, optical and precision instruments and the sale of electrical articles for construction. The position of all of these last uses is much more central than would be expected from the typology and the assignments from the Occidental literature. Comparison with the wider literature on the Non-Occidental CBD also supports these observations. The differences which exist is evidence of a difference in the Non-Occidental CBD when compared to the Occidental stereotype. This difference in pattern no doubt reflects a different process which is operative.

There is further evidence of a difference in Occidental and Non-Occidental CBDs in the detailed Guatemala study. Unfortunately, the quality separation implied by the sin and con contabilidad description is not available for the other CBDs. It does, however, show clearly that lower quality land uses are oriented to the native bazaar (located at the

minor peak in land values) and the higher quality land uses are oriented to the PLVI. Some of this clarity is lost when the land uses are accumulated but the detailed study does show a clear distinction in the orientation of land uses by their quality.

A further result of the three empirical studies is that clustered patterns, measured by the normal deviate, are much more common than random patterns and regular patterns do not occur at all. The mutual-disaffinity mechanism producing maximum spacing does not operate in the CBD. Patterns which are the product of a random process are not common. The clustered patterns from the Occidental literature is sometimes the product of a general accessibility mechanism; sometimes a mutual affinity mechanism and sometimes an attraction to a physical resource; each of these mechanisms or any combination are of prime importance in the CBD. This study does not disentangle the three mechanisms completely but it shows which land uses respond most to the clustering processes.

Each CBD appears to have a grain for a great number of the land use distributions have a common orientation. The orientation tends toward the zones of assimilation and discard. Where land uses have a contrary orientation, they are almost always peripheral in their distribution. There appear to be forces at work which influence the orientation of a distribution. In London especially the centrally focused land uses are oriented like the pattern of pedestrian densities.

The importance of the land use anomalies just mentioned is reinforced by (1) the difference in Non-Occidental land value structure, and (2) the emphasis given in the literature to the differentiation in the CBD caused by the presence of (usually) two cultural groups. Land values (counted as a surrogate for general accessibility) declines from the PLVI

in the Occidental CBD rapidly at first but more slowly later; in the form shown in Figure VII. Building heights, pedestrian density and intensity of use all decline from the PLVI reflecting the importance of the general accessibility mechanism.

There is evidence that in the Non-Occidental CBD not one, but two, land value peaks occur. The first node is at the PLVI and the conical shape from this node would, if it existed alone, be completely similar to the Occidental case. Also similar is the clustered location of land uses such as the retailing of clothes and shoes at or around this node. At this point there is no difference between the Occidental and Non-Occidental situation. Even the space using uses and automobile oriented uses such as the industries and automobile and accessory sales are peripheral to this central and most important node. The second node is at a short distance from the first and forms a separate CBD sub-area. This second cone (see Fig. XI) forms an annex to the first. It is the focus of poorer quality land uses not able to compete for more central positions and concentrated because of native activity in this section of the CBD. The detailed Guatemala study gives best evidence for this division but there is other evidence in the accumulated results and in the Non-Occidental literature. If the separate cultures in Non-Occidental countries (usually two distinct cultures; one Occidental in orientation and one indigenous) have a strong influence on the CBD structure, and the literature and findings in this dissertation suggest this is so, then the principal cone is one of Occidental influence and the secondary cone is one based on the indigenous culture. There are numerous statements in the Non-Occidental literature to substantiate this bicultural influence and its manifestation in the CBD structure. Land uses are divided by

business ownership, quality, patronage and size or scale into separate cultural area, one Occidental and centered on the PLVI and the other Non-Occidental and centered on the bazaar.

The separation of cultures in the Non-Occidental CBD means that general accessibility may have to be seen culturally. Land uses may be arranged according to Occidental notions of general accessibility around the PLVI and Non-Occidental notions around the second peak at the bazaar. The Occidental movements are based on the private car, taxi and truck, the Non-Occidental on journey by foot. Both may use the bus but the Occidentals use it for the intra city journey to work or to shop whereas the Non-Occidentals use the bus for journeys to the city edge or to the hinterland and for the transport of goods. The important bus routes for Occidentals focus on the PLVI while for the Non-Occidentals they focus on the markets and bazaars. The bazaar or Non-Occidental center, although it may be near a religious center or public building, is more commonly at a focus of routes or near a bus terminus.

CBDs are themselves Occidental features; the product of an outside culture, it is the focus of the ties of external nations with the interior. The Occidental core area may have located near an indigenous market, perhaps displacing it. Whatever the process is in time the spatial result is an important Occidental center with a more minor indigenous annex on one side, in the periphery. The unexpected central position of some external-trade oriented uses and some industries could be explained by their changed relative competitiveness (for location near the PLVI). The external trade is no doubt important and many external-trade oriented firms are part of the Occidental economic system and so have a high relative competitiveness in the CBD of a developing

country. This seems to give them a more favorable position by the general accessibility mechanism.

The presence of retail oriented manufacturing industry close to the PLVI cannot be explained by an improved relative competitive position because of the industry's orientation to the external-trade economy. These retail oriented industries produce for the internal market. It is proposed that their unexpected central position may be due to an absence of 'off the peg' clothing and consumer goods so that these firms locate more centrally, although not usually on the main streets themselves or on the front of the block. From their central locations they may produce what is almost a consumer service.

Peripheral clusters do not occur consistently in the Non-Occidental CBD. Peripheral clusters are influenced chiefly by the mutual affinity and/or the physical resource attractiveness mechanism. It seems that in the periphery of the Non-Occidental CBD these mechanisms are not as strong. The population do not have the same use of the private automobile as in the Occidental CBD and bus routes focus on the PLVI, so that in the Non-Occidental CBD a specialized node with a bias to one side of the CBD would not be easily accessible to the whole city as it is in the Occidental CBD.

The notion of general accessibility ought to be seen in a two culture context for the Non-Occidental CBD. The mutual affinity and physical resource attractiveness mechanism should be seen in the same way. When the processes affecting land uses are interpreted in this new context they help to explain many of the consistent Non-Occidental anomalies of pattern noted above. It is recognized that other explanations of the anomalies in the Non-Occidental land use patterns are

possible but these interpretations, based upon the four recognized and important CBD mechanisms seem a useful first step. The five original mechanisms can be reduced to four since the mutual disaffinity mechanism producing regular patterns is not present in any CBD so far studied.

The important conclusion to this dissertation needs restatement at this point. It is that the Occidental and Non-Occidental CBDs are very similar in the ground floor establishments point patterns of land uses which they display. The same uses consistently occur in center and periphery. The anomalies of pattern however are significant for in their consistency they indicate that there are differences in the form of the Non-Occidental CBD which show that there are important modifications of the recognized Occidental forces. Chief among these modifications is the change due to the (usually) two cultures acting on the CBD. The majority culture is economically poorer than the majority culture.

This dissertation has looked for patterns which result from recognized CBD processes. There are only five processes: general accessibility; mutual affinity; physical resource attractiveness; randomness and mutually disaffinity. The statistics successfully measure the patterns resulting from all five but there are two short-comings which could be improved. The first is that belted uses, especially those intermediate between center and periphery, are not easily recognized. The second short-coming is that the three separate mechanisms which produce clusters cannot be differentiated. This could only be improved by the use of a questionnaire. This dissertation concentrates on the analysis of a number of cities and many land uses and the use of a questionnaire was not possible.

There is a second order of problems in the dissertation which

are the result of the close process/pattern relationship. None of the CBDs are controlled environments and many mechanisms operate rather than just these important five. The additional mechanisms, although minor, distort the patterns. This dissertation has looked at, for example, the relative degree of circularity or clusteredness rather than absolute circularity or clusteredness. Improvements can perhaps be made by map transformation to correct, for example, an elliptical pedestrian density surface, or by the use of new statistics which are independent of boundary, size of area or land use quantities. Such transformations or new statistics may improve our ability to recognize patterns. There is clearly a need to account for other mechanisms, some of which are shown to be important here, such as land use quality or culture in the Non-Occidental CBD. In future, it should be possible to isolate still further the influences due to each of these mechanisms.

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APPENDIX I

London Land Use Classification

1100	Households units
1210-1290	Group quarters
1300-1590	Hotels
2210-3914	Industries
4114-4291	Transport terminals
4600	Car parking
4711-4923	Communications and utilities
5100-5199	Wholesaling
5300-5399	Department and dry goods
5400-5499	Food sales
5500-5599	Auto retail
5610	Men and Boys' wear
5620	Women's apparel
5630-5650	Women's accessories
5660	Shoes
5670-5690	Custom tailoring
5711-5732	Furniture sales
5810	Eating places
5820	Drinking
5910	Drug stores
5931-5932	Antiques
5941	Books
5950	Sports
5970	Jewellry
5990-5999	Other retail
6111	Banks
6121	Credit Society
6151-6152	Real estate
6210	Personal services
6220	Photographic
6231	Beauty services
6232	Banker services
6251-6253	Apparel repair
6310-6360	Business services
6370-6379	Warehousing
6411	Auto repairs and gasoline
6491-6492	Repair services
6511	Physicians
6520	Legal services
6590-6599	Other professional services
6611-6622	Building and construction
6700-6711	Government
6710-6753	Executive, legislative and judicial services
6920	Charity
6990-6994	Other services
7212	Motion picture theaters
7219	Other Entertainment
7620	Parks
9400	Vacant

APPENDIX II (a)

Guatemala Land Use Classification (Detailed)

2008	Cocoa, chocolate and confectionary manufacturing
2010	Slaughter and processing of meat
2050	Flour and milled products
2060	Bread manufacture
2200	Tobacco industry
2310	Spinning, weaving and finishing of textiles
2320	Fabrics and sewing industry
2410	Shoes (except rubber) industry
2433	Garments (except shoes) manufacture
2440	Articles of textile (except clothing garments)
2510	Wood and cork industry (except furniture)
2513	Saw, workshop and planing etc., in working of wood
2590	Other wood and cork products
2600	Furniture and accessories manufacturing
2601	Metal furniture manufacture and repair
2602	Wooden furniture manufacture and repair
2604	Tapestry workshops
2720	Paper and products
2801	Printing
2930	Leather and skin (except shoes and clothing)
2931	Leather (except footwear and clothing)
3000	Rubber products manufacturing
3002	Rubber coats and ponchos manufacturing
3110	Chemical products
3190	Diverse chemical products
3320	Glass products
3390	Other non-metallic minerals
3420	Non-ferrous metals
3500	Manufacture of metal products (except transport equipment)
3501	Tinsmiths, etc., workshops
3502	Blacksmiths and coppersmiths
3507	Doors, windows and metal products manufacture
3700	Electrical machinery
3830	Automobiles manufacturing
3840	Automobile repairs
3841	Automobile manufacturing and repair
3842	Body shops
3853	Motor bicycles and bicycles
3920	Photographic and optical
3930	Watches
3940	Jewellry
3990	Other industry
61117	Prime agricultural sales
61141	Machinery and materials for industry, commerce, agricultural and vehicle sales
61143	New and used vehicles and accessories
61151	Iron work and electrical tools (large) sales
61193	Sports goods, toys and ornaments

61196	Importers, exporters and representatives
6119Y	Other major commercial services
61211	Live hens and their products
61212	Licquors and sweet sales
61213	Milk and derivatives sales
61214	Meat, fish and hens
61215	Fruit, vegetables and
61216	Bread, biscuits and pastry
61217	Beer and soft drinks
61218	Supermarkets and variety stores
61219	Other minor commerce
6121X	Cigar stores and tobacco shops
61221	Drug store and sale of medicines
61222	Perfumes, cosmetics and beauty products
61223	Veternary products
61224	Candles and soap sales
61225	Insecticides, fungicides, fertilizers and
61226	Paints, varnishes and lacquers
61227	Plastic articles sales
61231	Men's wear
61232	Shoe stores
61233	Thread, cloth and fabric sales
61234	Men's, women's and children's wear
61235	Leather wear
61236	Haberdashery
61238	Native costumes and traditional goods
61241	Record stores
61242	Musical instruments
61243	Ornaments and presents
61244	Electrical goods
61245	Beds, mattresses and pillows
61246	Furniture sales
61249	Other domestic goods
61251	Hardware stores
61252	Glass, pottery and crystal articles
61253	Motors and electrical materials
61255	Various domestic goods
61257	Tin plate articles
61259	Ceramic goods
61261	Auto and motor cycles repairs
61270	Petrol stations
61281	Variety and miscellaneous sales
61283	Garden ware
61290	Florists
61291	Leather skins and furs
61292	New agents and book stores
61294	Articles for transportation including bicycle repairs
61295	Optical, photographic and precision instrument sales
61297	Lime, cement and construction materials
61298	Jewellry and watches
61299	Other minor commerce
6129Y	Bargain stores
8412	Cinemas

8421	Media, television and stereos
8424	Orchestras and musical organizations
8432	Gymnasiums, billiards, etc.
8521	Restaurants and dining places
8522	Cafes, tea shops, etc.
8524	Bars and beverage rooms
8529	Other food and drink establishments
8531	Hotels and lodging places
8541	Laundries and dry cleaners
8551	Barbers and hair dressers
8552	Beauty salons
8561	Photographic studios
8591	Funeral parlours
8595	Automobile parking, washing and lubrication
8596	Charitable services

APPENDIX II (b)

Guatemala Land Use Classification (Accumulated)

0	Mines and quarries exploitation industries
1	Food industries
2	Tobacco industries
3	Textiles industries
4	Shoe clothing and other articles manufacture
5	Wood and cork industry
6	Furniture and accessories manufacture
7	Paper and paper articles manufacture
8	Printers, editors and connected services
9	Leather and leather production industry
10	Rubber industry
11	Chemical products manufacture
12	Gasoline and gasoline products industries
13	Mineral products manufacture
14	Basic metal industries
15	Metal products manufacture
16	Machinery construction
17	Electrical machinery construction
18	Transport materials and accessories construction
19	Diverse manufacturing industries
20	Construction of buildings
21	Electricity and gas services
22	Provision of water and sanitary services
23	Beverage industry
24	Repair workshops
25	Bird raising (aviculture)
26	Manufacture of plastics
27	Wool, cloth and carpet manufacture
28	Manufacture of glass and derivatives
29	Washing disinfecting and cleaning plants
30	Hotel industry
31	Unprepared food and drink sales
32	Meat sales
33	Fruit, vegetables and tubers
34	Milk sales
35	Special grocery, liquor and tobacco sales
36	Bread, biscuits and pastry
37	Cafes
38	Beer and soft drink sales
39	Other grocery sales
40	General merchants sales
41	Cloth, clothing and footwear sales
42	Women's clothing and articles sales
43	Children and infants' clothing and articles sales
44	Shoe and leather articles sales
45	Cloth and general fabric sales
46	Automobiles and accessories sales
47	Accessories sales

48	Agricultural machinery sales
49	Industrial machinery and equipment (except electrical) sales
50	Electrical industrial machinery and equipment sales
51	Agricultural equipment, seeds and fertilizer sales
52	Furniture for restaurants, bars and hotels sales
53	Professional furniture and equipment sales
54	Other machinery sales
55	Hardware and construction materials sales
56	Wood sales
57	Paint, glass and wallpaper sales
58	Bricks, tiles and clay shingles sales
59	Electrical articles for construction sales
60	Other articles for construction sales
61	Furniture, kitchen ware and domestic electrical articles sales
62	Radios and domestic electrical appliances sales
63	Fuel sales
64	Gasoline and gasoline products sales
65	Other undetailed merchandise
66	Drugs and related biochemical sales
67	Jewellry sales
68	Optical, photographic and precision instrument sales
69	Libraries and bookstores sales
70	Leather articles sales
71	Flower sales
72	Other merchandise
73	Rentals
74	Production distribution and exhibition of films
75	Radio, theaters and connected services
76	Recreation services
77	Hotels and lodging places
78	Laundries and dry cleaners
79	Hairdressers and beauty services
80	Photographic
81	Personal services
82	Vehicle parking in general
83	Tourist and advertising services
84	Commercial banks and finance establishments
85	Vaults and warehouses
86	Animal feed sales
87	Import, export and distribution of merchandise
88	Banks and security services

APPENDIX III

Bogota Land Use Classification

0	Mines and quarries exploitation industries
1	Food industries
2	Tobacco industries
3	Textiles industries
4	Shoe clothing and other articles manufacture
5	Wood and cork industry
6	Furniture and accessories manufacture
7	Paper and paper articles manufacture
8	Printers, editors and connected services
9	Leather and leather production industry
10	Rubber industry
11	Chemical products manufacture
12	Gasoline and gasoline products industries
13	Mineral products manufacture
14	Basic metal industries
15	Metal products manufacture
16	Machinery construction
17	Electrical machinery construction
18	Transport materials and accessories construction
19	Diverse manufacturing industries
20	Construction of buildings
21	Electricity and gas services
22	Provision of water and sanitary services
23	Beverage industry
24	Repair workshops
25	Bird raising (aviculture)
26	Manufacture of plastics
27	Wool, cloth and carpet manufacture
28	Manufacture of glass and derivatives
29	Washing disinfecting and cleaning plants
30	Hotel industry
31	Unprepared food and drink sales
32	Meat sales
33	Fruit, vegetables and tubers
34	Milk sales
35	Special grocery, liquor and tobacco sales
36	Bread, biscuits and pastry
37	Cafes
38	Beer and soft drink sales
39	Other grocery sales
40	General merchants sales
41	Cloth, clothing and footwear sales
42	Women's clothing and articles sales
43	Children and infants' clothing and articles sales
44	Shoe and leather articles sales
45	Cloth and general fabric sales
46	Automobiles and accessories sales
47	Accessories sales

48	Agricultural machinery sales
49	Industrial machinery and equipment (except electrical) sales
50	Electrical industrial machinery and equipment sales
51	Agricultural equipment, seeds and fertilizer sales
52	Furniture for restaurants, bars and hotels sales
53	Professional furniture and equipment sales
54	Other machinery sales
55	Hardware and construction materials sales
56	Wood sales
57	Paint, glass and wallpaper sales
58	Bricks, tiles and clay shingles sales
59	Electrical articles for construction sales
60	Other articles for construction sales
61	Furniture, kitchen ware and domestic electrical articles sales
62	Radios and domestic electrical appliances sales
63	Fuel sales
64	Gasoline and gasoline products sales
65	Other undetailed merchandise
66	Drugs and related biochemical sales
67	Jewellry sales
68	Optical, photographic and precision instrument sales
69	Libraries and bookstores sales
70	Leather articles sales
71	Flower sales
72	Other merchandise
73	Rentals
74	Production distribution and exhibition of films
75	Radio, theaters and connected services
76	Recreation services
77	Hotels and lodging places
78	Laundries and dry cleaners
79	Hairdressers and beauty services
80	Photographic
81	Personal services
82	Vehicle parking in general
83	Tourist and advertising services
84	Commercial banks and finance establishments
85	Vaults and warehouses
86	Animal feed sales
87	Import, export and distribution of merchandise
88	Banks and security services

APPENDIX IV

London, Canada

The R Statistic

Value	Land Use	Value	Land Use
[illegible]			
[illegible]	4114	.5169	5820
[illegible]	6920	.5138	6710
[illegible]	6220	.4882	5620
[illegible]	5950	.4827	5990
[illegible]	7620	.4807	6991
[illegible]	6611	.4702	6700
1.322	6151	.4677	6111
1.009	6210	.4604	5660
.7983	1390	.4558	5400
.7121	6310	.4529	5100
.6954	5910	.4258	5970
.6726	5630	.4155	6251
.6578	5500	.4143	7212
.6495	4600	.3963	5610
.6351	6231	.3782	7219
.6218	9400	.3657	1210
.6114	6121	.3453	5670
.5833	5711	.3447	6491
.5805	6411	.3370	2210
.5744	6232	.3327	6520
.5583	5810	.2693	6511
.5568	5941	.2075	1100
.5401	5300	.1295	6370
.5211	4711	.05324	(5931)
		.0000	(6591)

The Uses in brackets were removed due to population < 5.

APPENDIX V

Comments on Nearest Neighbour Analysis

Inferential Statistics

The boundary is more important for these statistics since density and distance between points is used. The statistics are inferential because actual observed distributions of points are compared with two theoretical distributions, the χ^2 and Normal distributions. This comparison allows a judgment as to whether the distribution is more clustered or regular than the random distribution which is the basis of the comparisons. If the points are significantly clustered or regular then it can be inferred that they have an influence upon one another. In a random distribution any point has the same chance of falling upon any sub-area as any other point. Any sub-area of a given size has the same chance of receiving a point as any other sub-area. The placement of any point has not been influenced by any other point.

Distances between each point and its nearest neighbour are measured in a data set of size N. These are independent of direction and form a set of r_N distance measures. These are compared to theoretical randomly distributed population of the same size. The following are the statistics used to compare the two distributions of r_N namely, the actual observed distribution r_A and the theoretically expected random distribution r_E.

A simple ratio of the actual to be expected gives an index of the departure from randomness:

$$R = \frac{\bar{r}_A}{\bar{r}_E}$$

Here the means ($\bar{r}_A$ and $\bar{r}_E$) are compared. The resulting R statistic has the range $0.0 \leq R \leq 2.1491$. The distribution being tested would be random where R = 1.0, more clustered as it approaches 0.0 (when all points are on the same locus) and more regular as R approaches 2.1491 (when it is distributed in a maximally spaced hexagonal pattern).

The statistic is based on a comparison of means, the mean of r_E ($\bar{r}_E$) is compared to the mean of r_A ($\bar{r}_A$). The mean of the expected distribution is based on the poisson series and is $1/2\sqrt{\lambda}$, where λ is the density of original points per unit area. It can be seen that $\sqrt{\lambda}$ converts a square measure to a linear one. Since density is used in the denominator here then the statistic is independent of density itself, and shape and area of the CBD, and to the units of measurement between pairs.

The actual and expected distance measures can be transformed so that tests other than a scale between 0.0 and 2.1491 can be used. Tests with χ^2 and the normal distribution are two of the most common.

CHI Square

The probability that a point is a distance r from its neighbours is given as $2\pi\lambda re^{-\pi r\lambda}dr$.

This function has a poisson distribution and so can be related to χ^2.

The values $2\pi\lambda r$ and $2\pi\lambda r^2$ are distributed as χ^2 with 2 and 2N degrees of freedom respectively. The values $2,\pi$ are constants. λ and r are related to area and to N, the population. The mean value of r(r) can be transformed to $2\pi\lambda\bar{r}_n^2$ and this value is also distributed as χ^2. This value is calculated for the actual population and where it is greater than 0.95 it is over dispersed or regular and where less than

.05 it is under-dispersed or clustered.

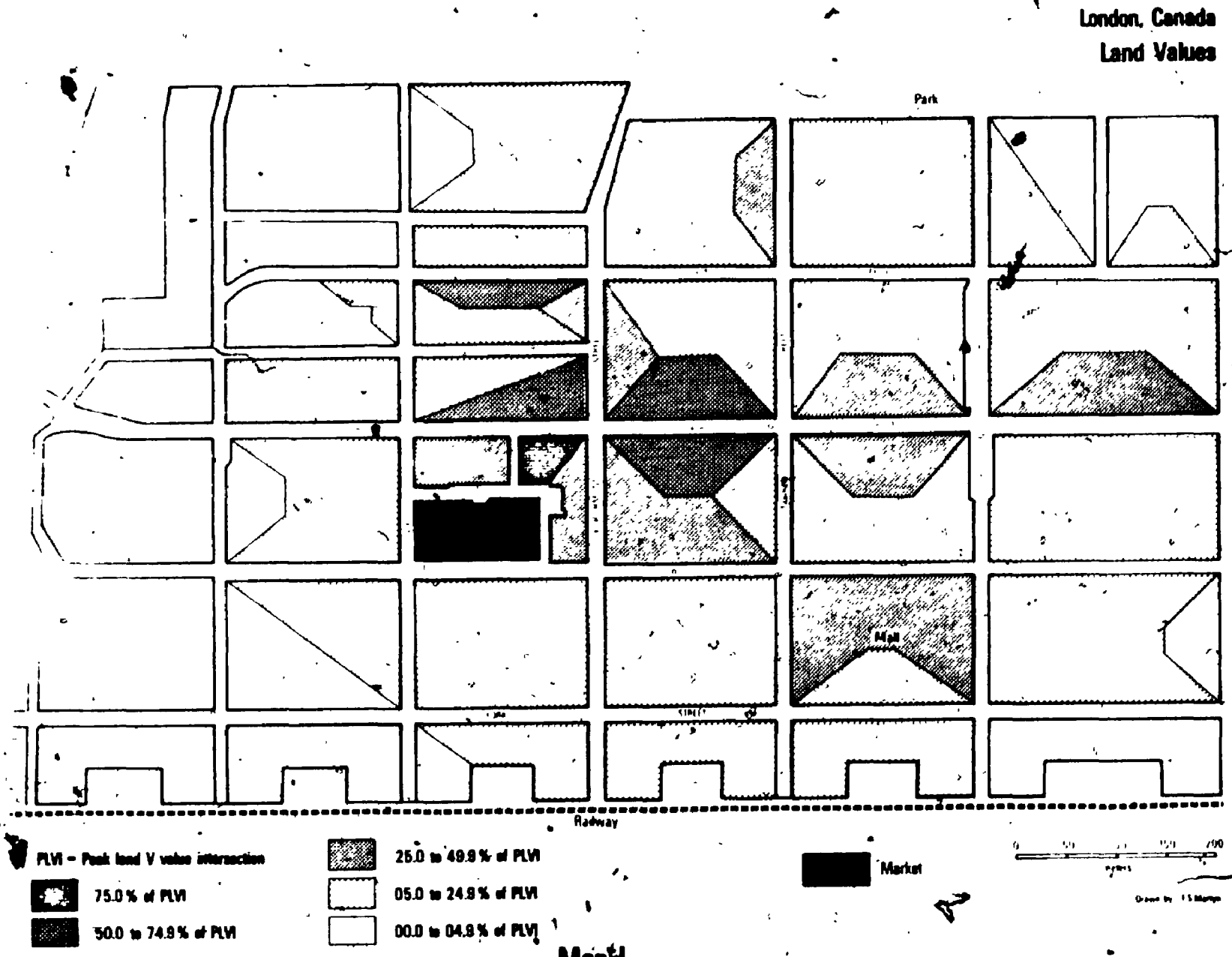
The value $2\pi\lambda r_E^2$ for a random distribution is distributed as χ^2. This value can be plotted for marked cumulative distances of r_E (but has not been for the purposes of this study) and describes and 'S' curve. The actual distances r_A when summed cumulatively by the formula $2\pi\lambda r_A^2$ should correspond to the former curve where the actual pattern is random.

Normal Deviate

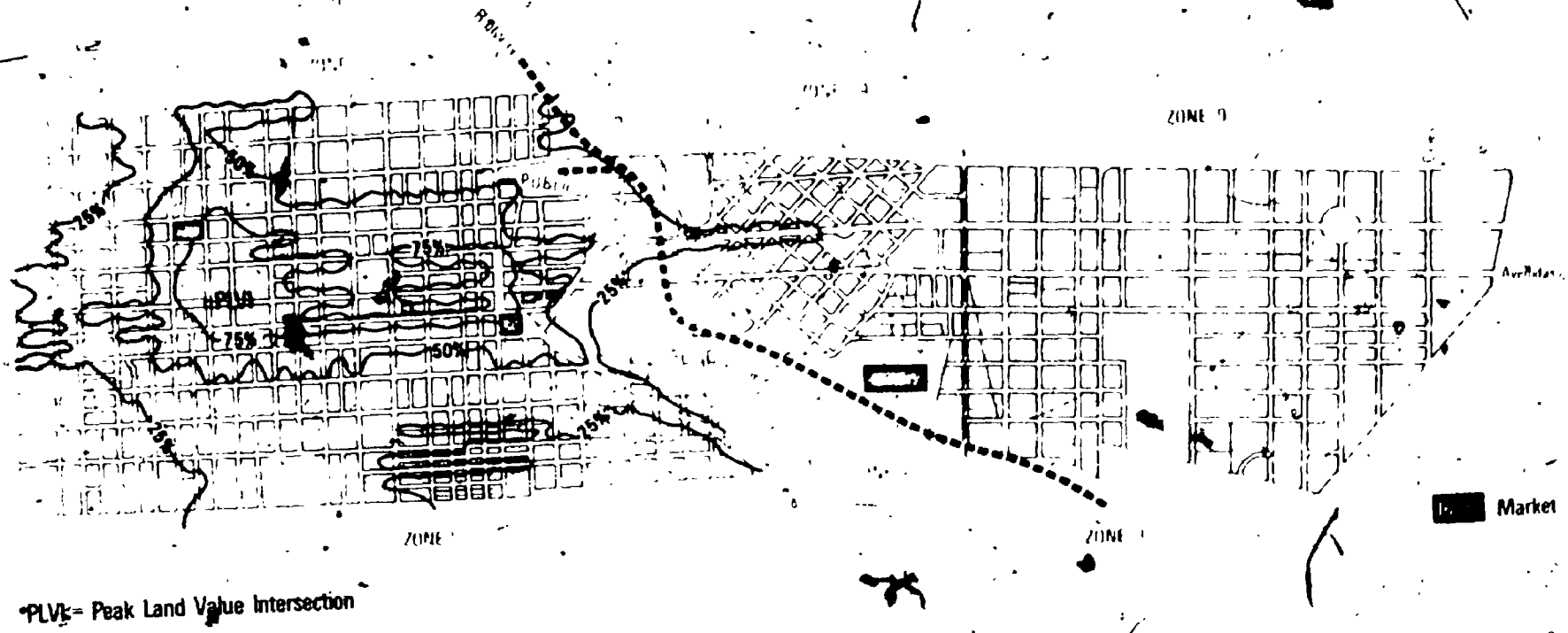
This is calculated using Thompson's statistic and the χ^2 statistic this time is transformed to give the normal deviate. This transformation is

$$N.D. = \sqrt{2\chi^2} - \sqrt{2N-1}$$

and has a mean of 0.0 and standard deviation of 1.0. The values of ±1.96 are at the 95% confidence level so that values above 1.96 are regular and those below -1.96 are clustered. The value +1.96 corresponds to 0.05% probability in the χ^2 table. The normal deviate should be used only for large values of N, but since the statistic describes whole populations in this study (and is not used for inference) it is used for all land use populations.


London, Canada
Land Values
Park
Mall
Railway
PLVI = Peak land V value intersection
75.0 % of PLVI
50.0 to 74.9 % of PLVI
25.0 to 49.9 % of PLVI
05.0 to 24.9 % of PLVI
00.0 to 04.9 % of PLVI
Market
Map H

Land Values – Guatemala City, Guatemala

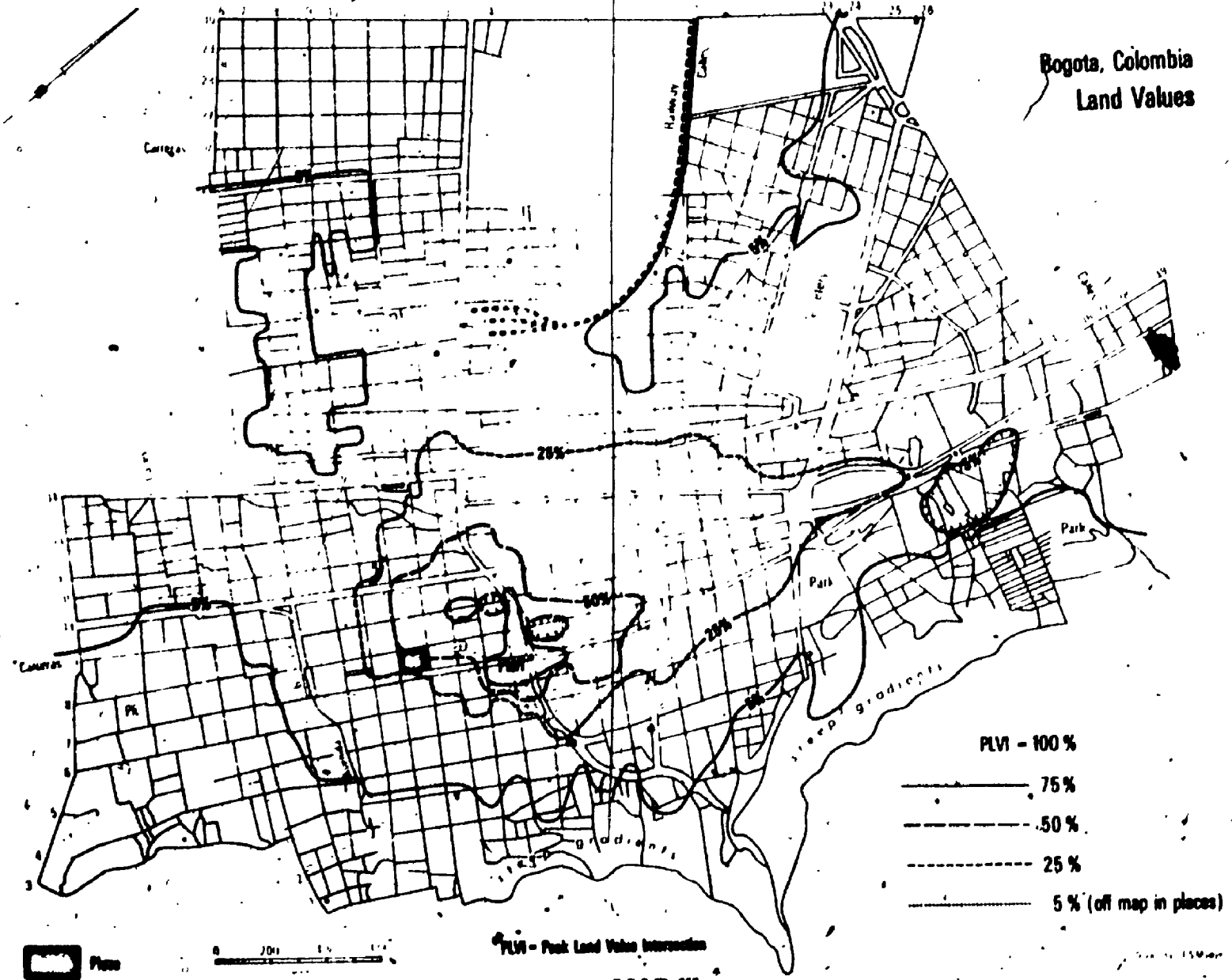


*PLVI = Peak Land Value Intersection

Map II

3 3

OF/DE

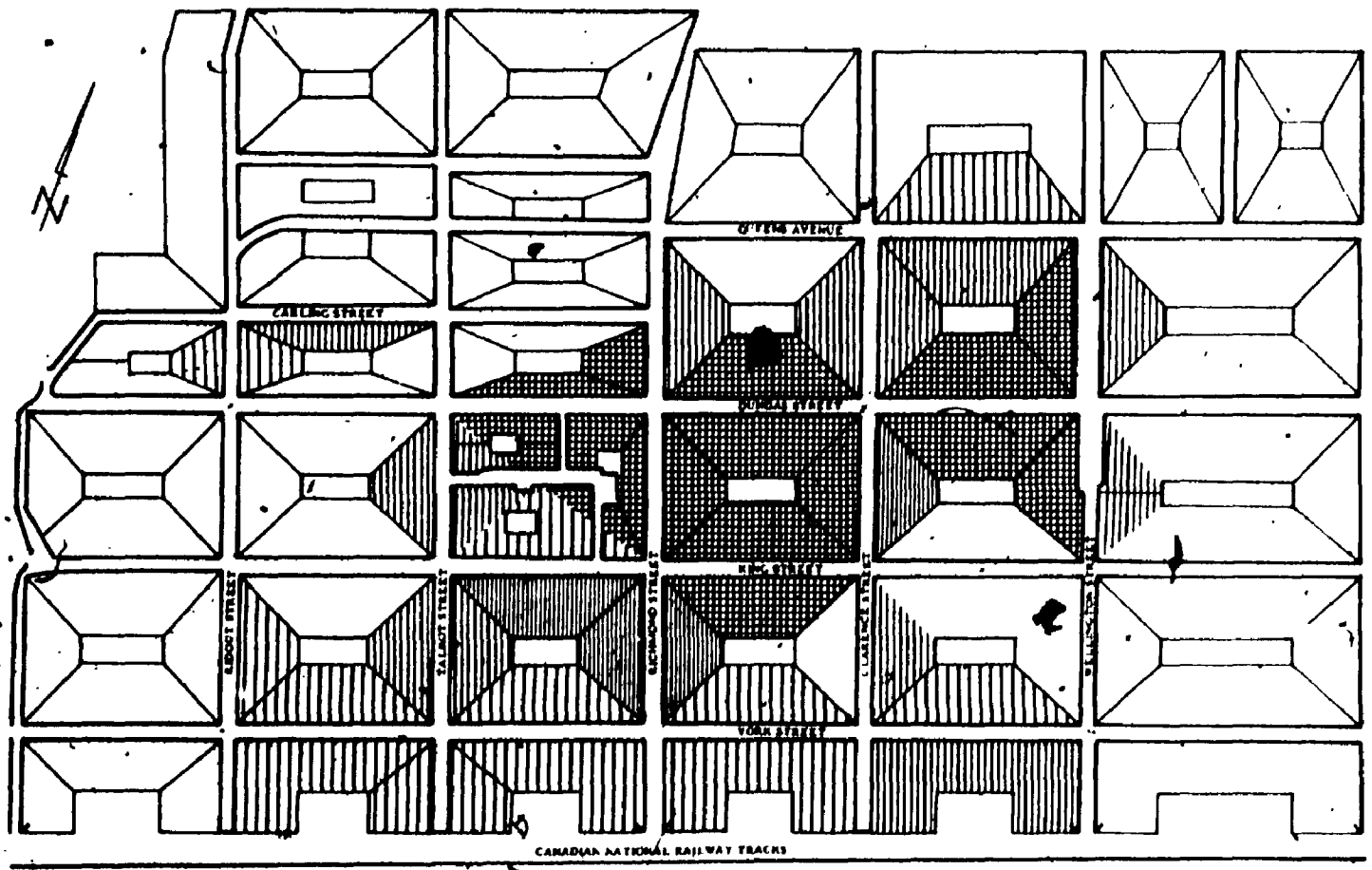

Bogota, Colombia
Land Values
Park
Park
Park
PLVI – 100 %
75 %
50 %
25 %
5 % (off map in places)
Plaza
PLVI - Peak Land Value Intersection

MAP III

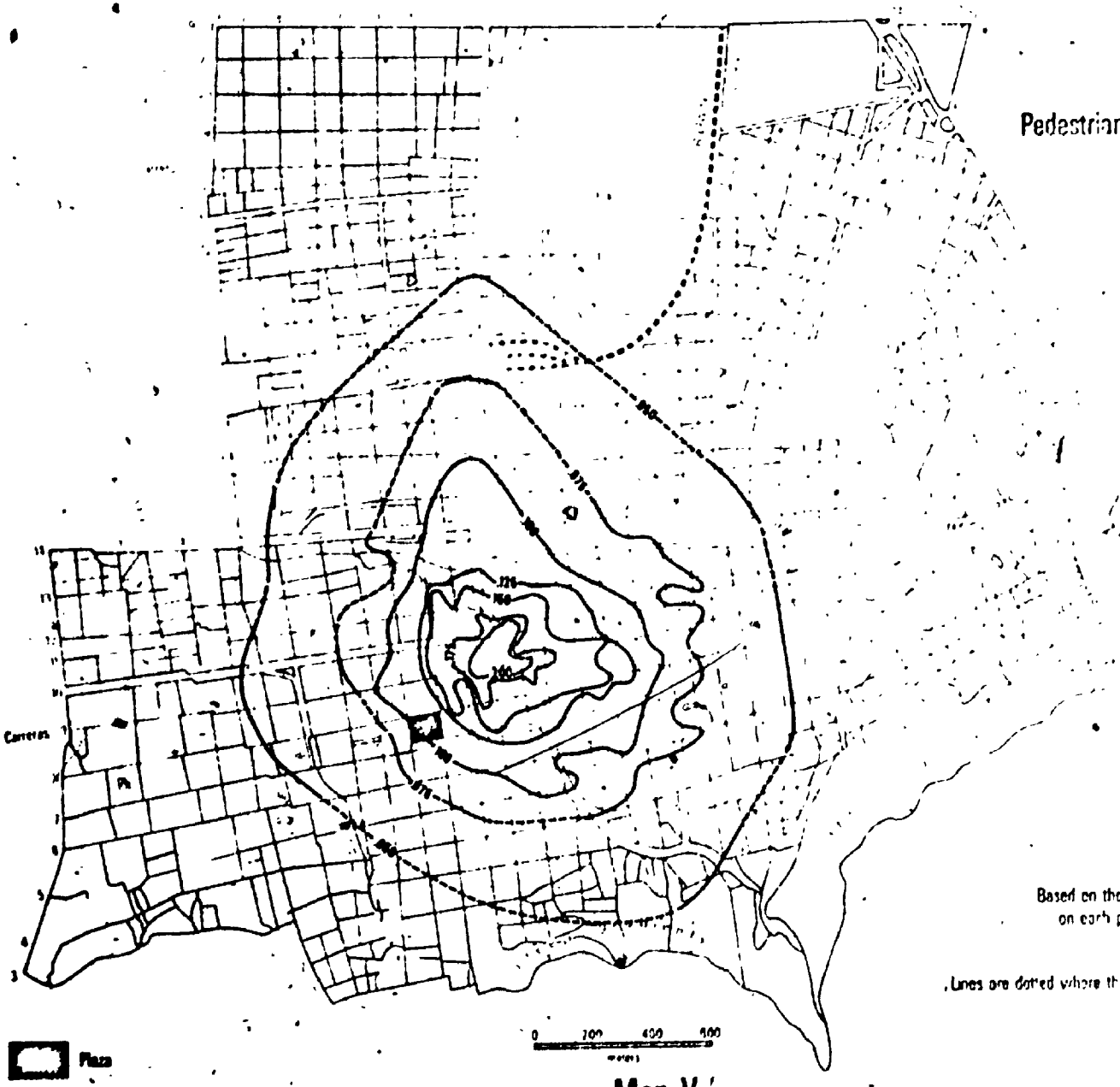
London, Canada

Pedestrian Density

(persons per ½ hour per block front)



MAP IV



Bogota, Colombia

Pedestrian Density Potential

(Self Potential = 0.0)

Based on the number of street vendors on each pair of opposite block fronts.

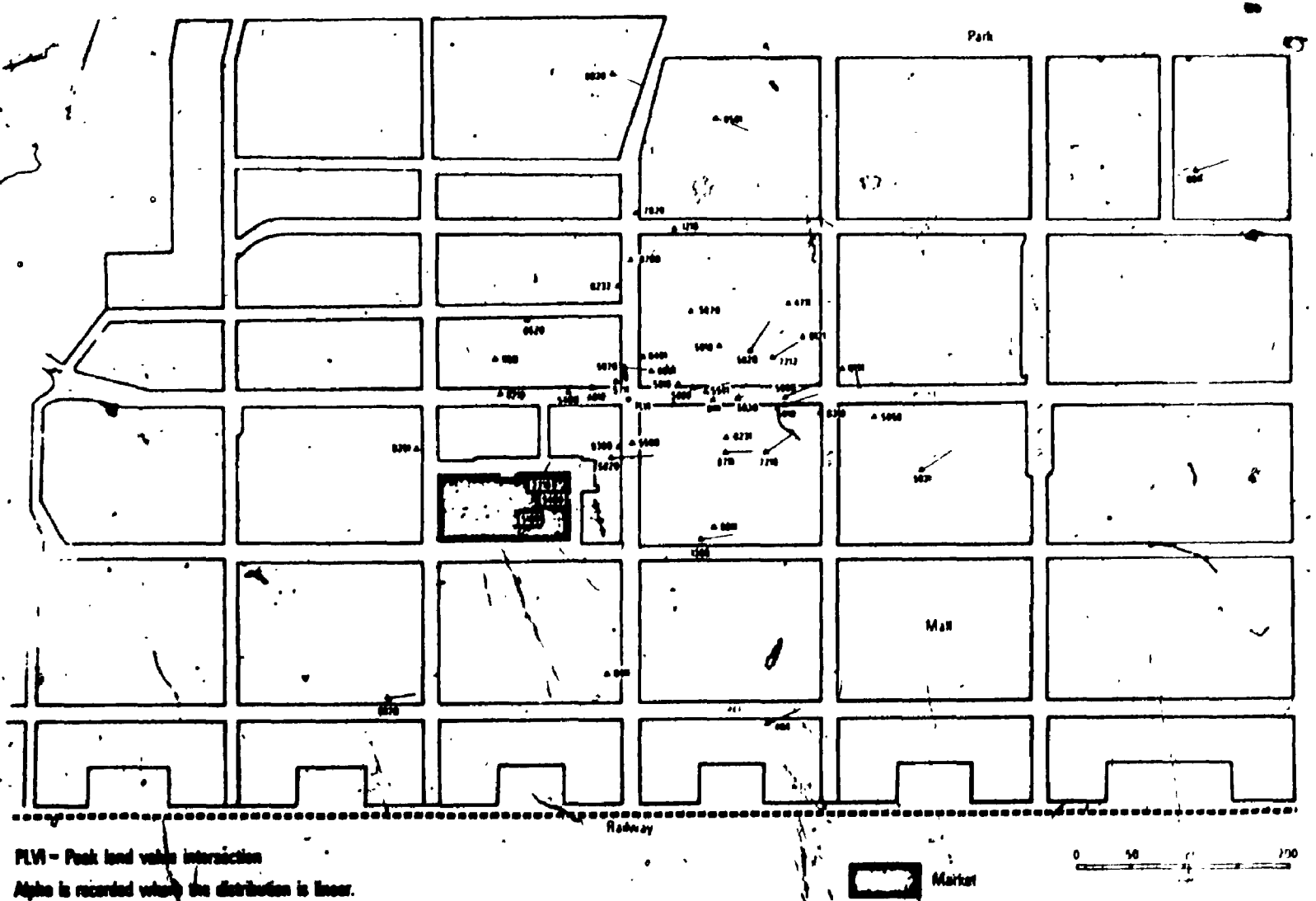
Lines are dotted where there is a lack of information

Map V.

London, Canada

Land Uses

Mean Centres & Alpha Statistics



PLVI – Peak land value intersection

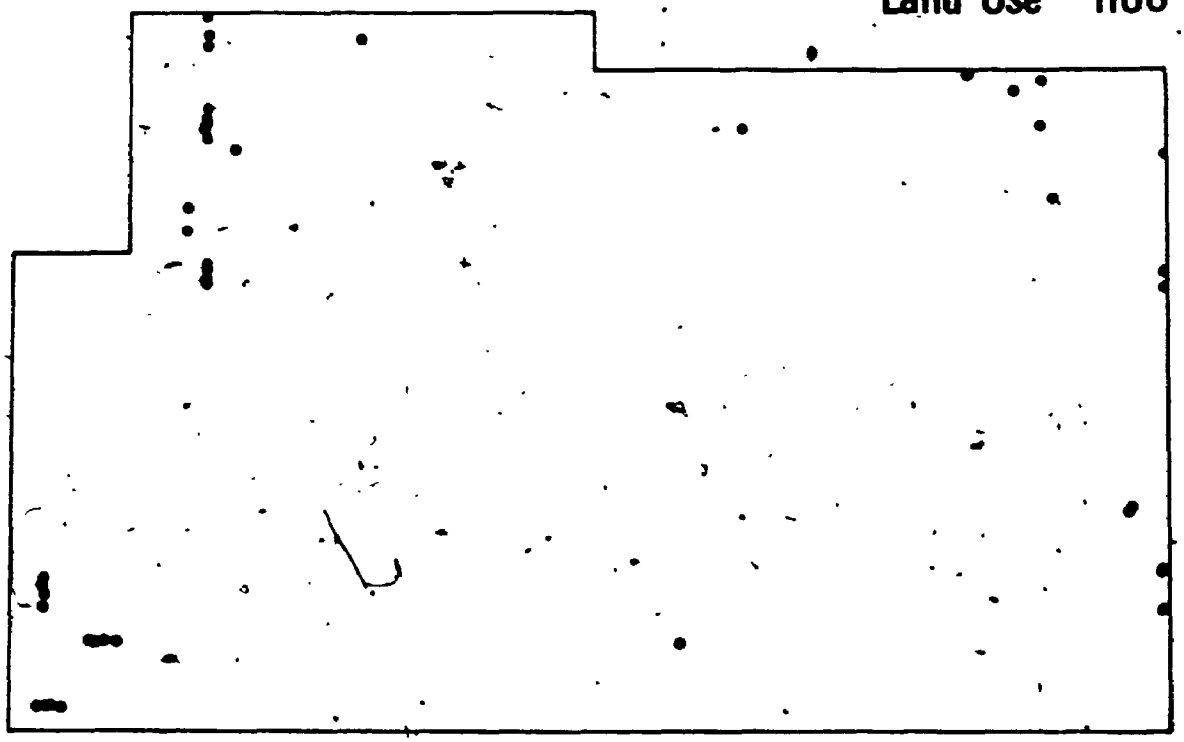
Alpha is recorded where the distribution is linear.

Orientation of the land use distribution.

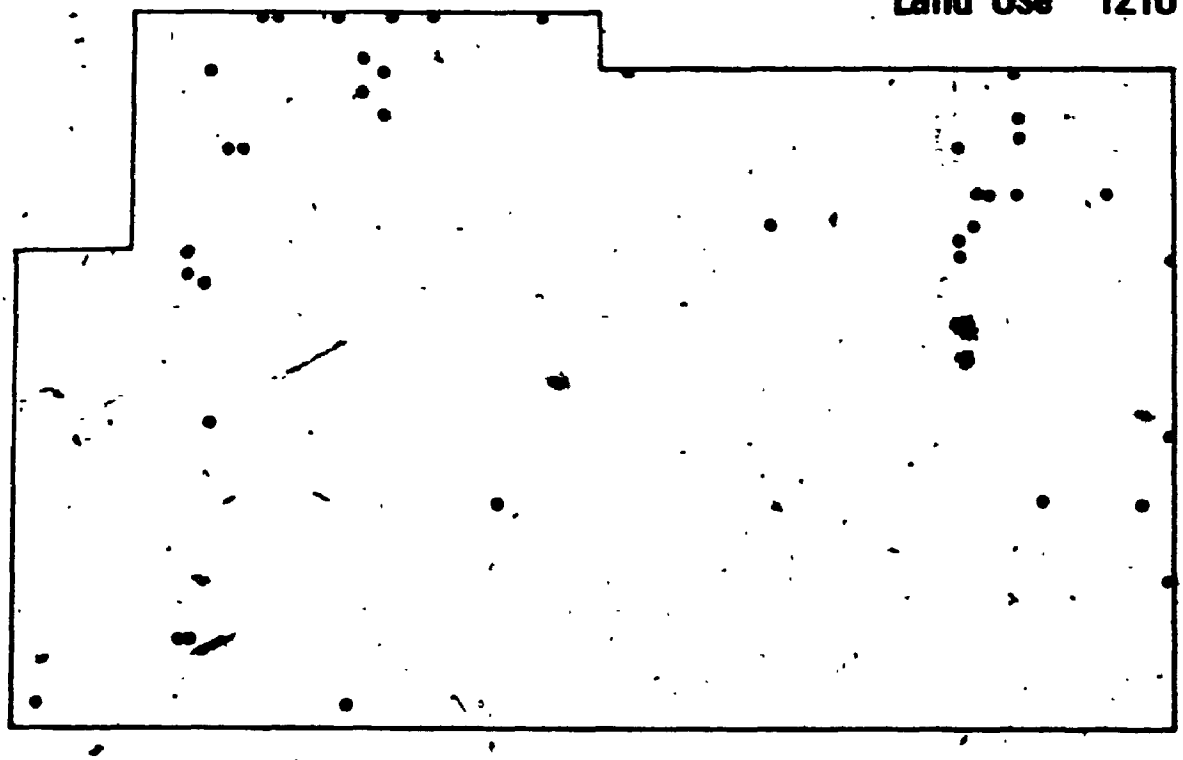
Map VI

London, Canada.

Land Use 1100



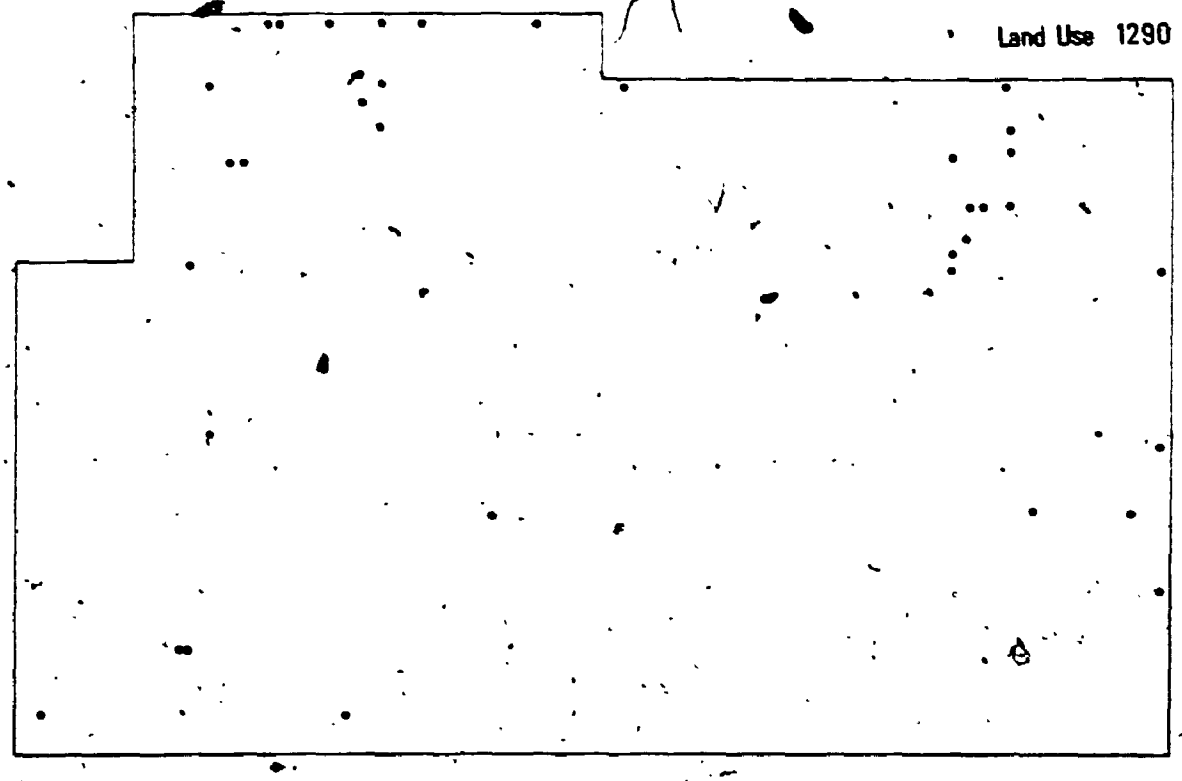
Land Use 1210



Map VII

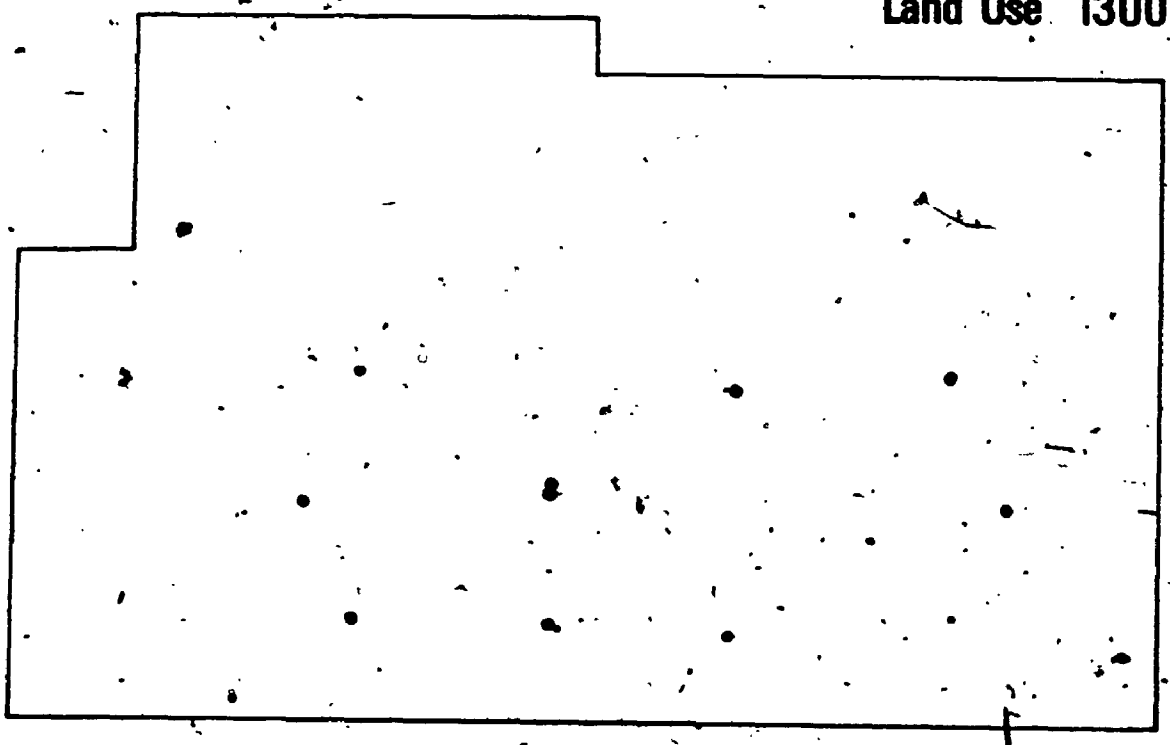
London Canada

Land Use 1290



London, Canada.

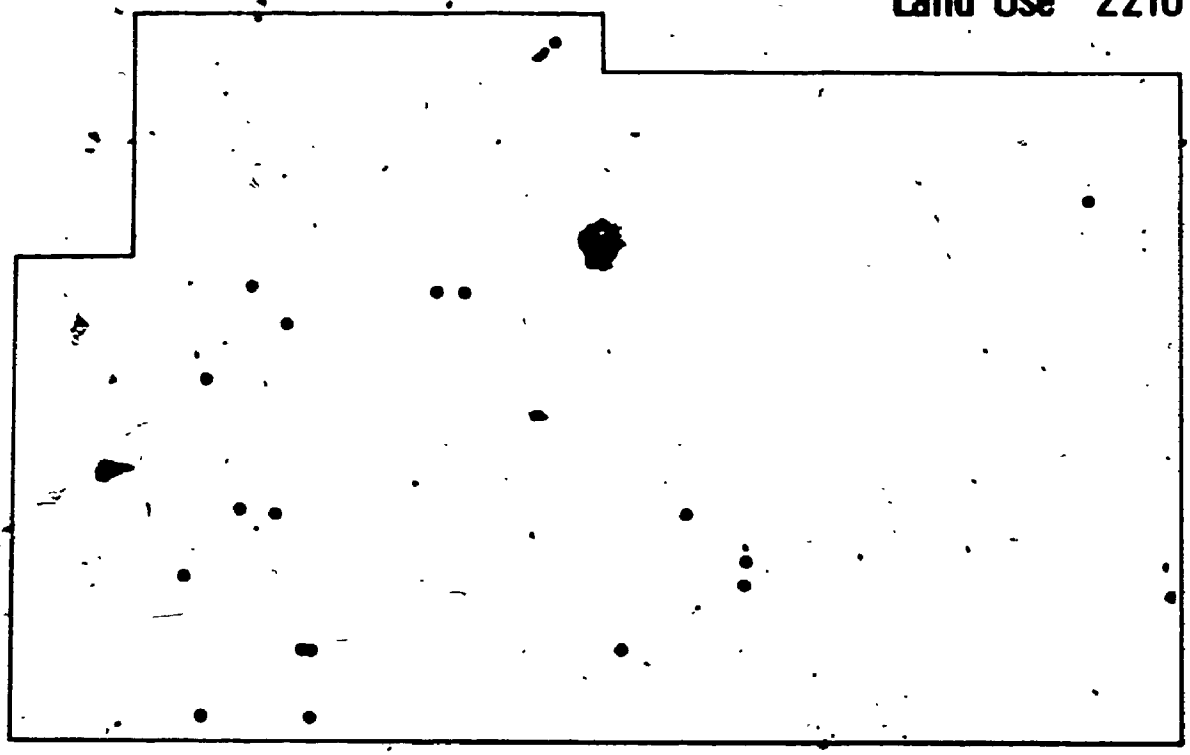
Land Use 1300



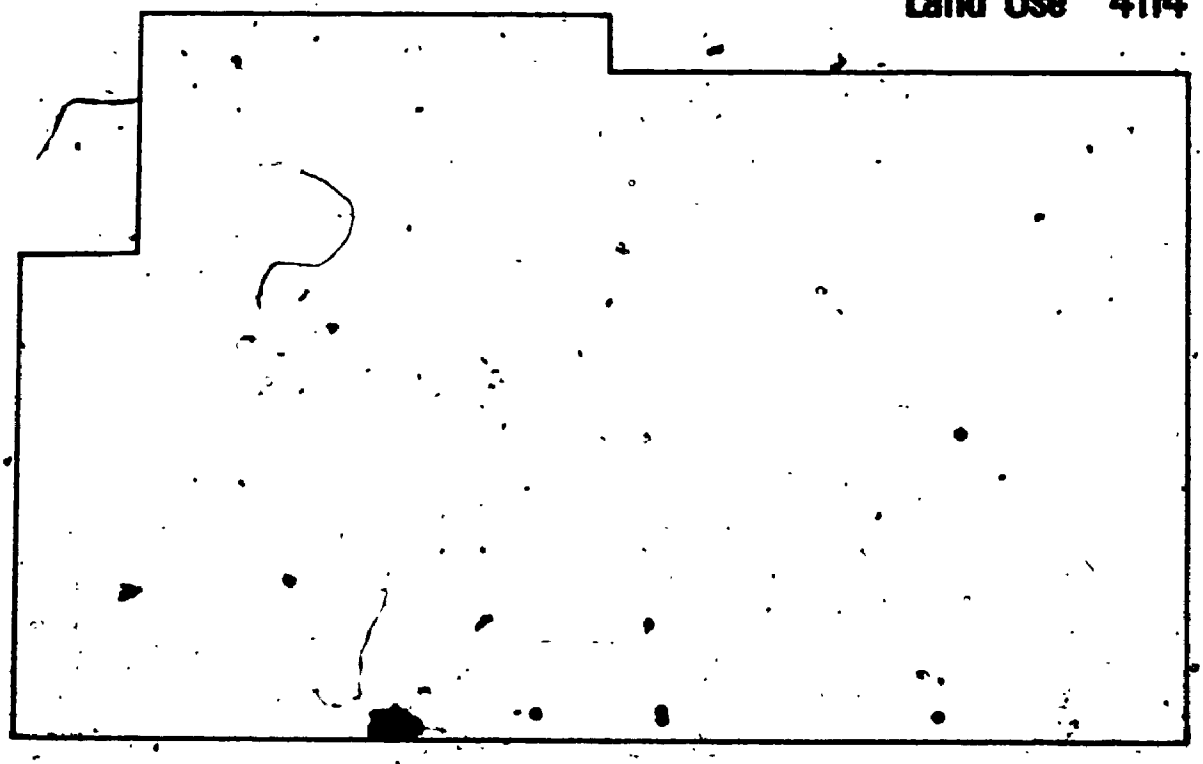
Map VIII

London, Canada.

Land Use 2210



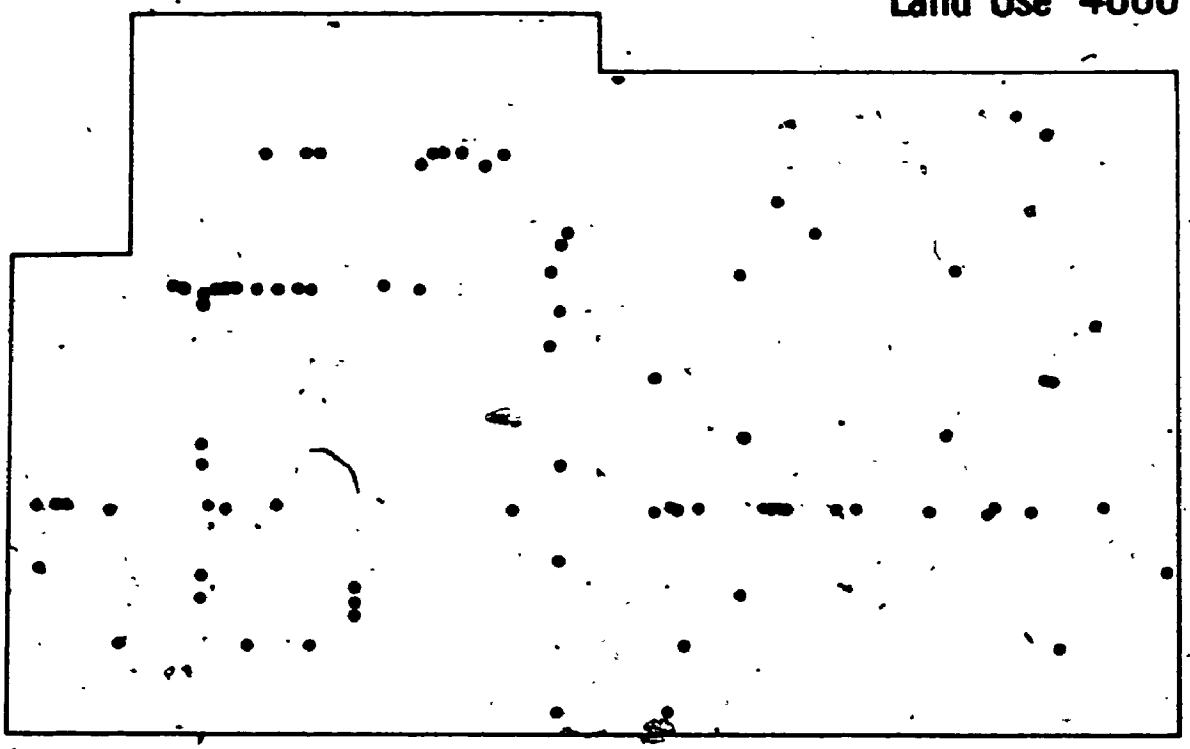
Land Use 4114



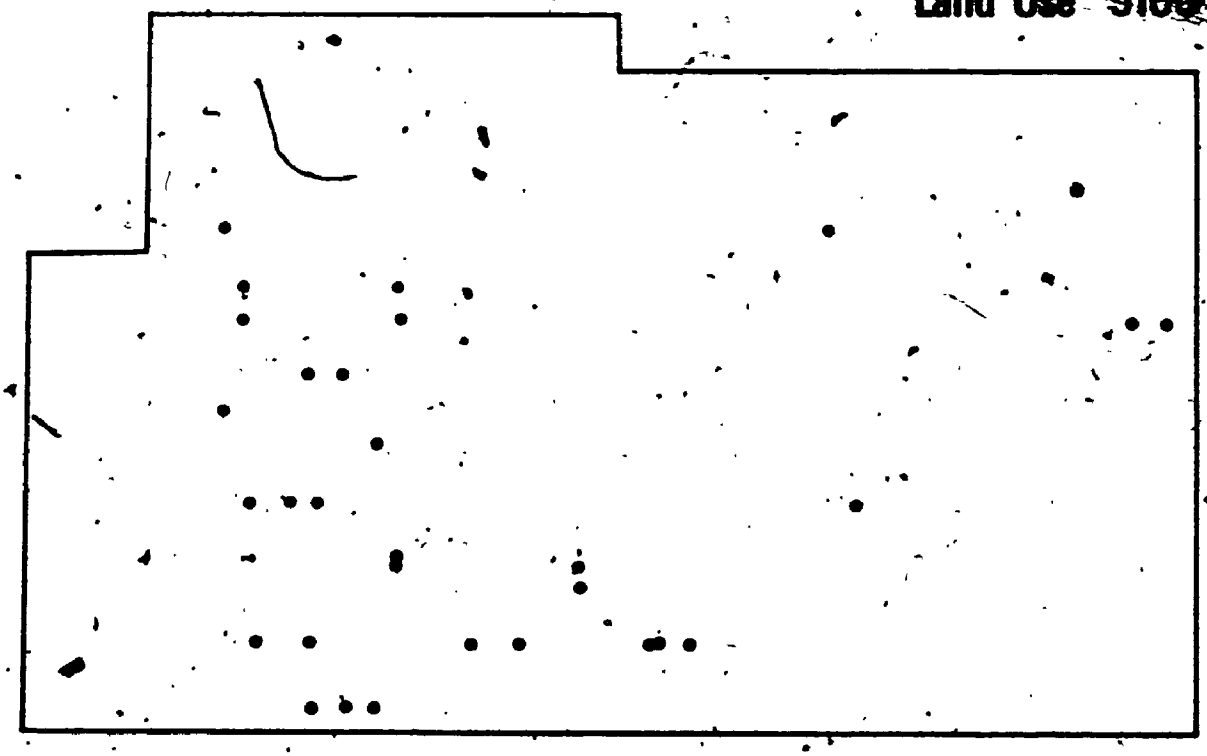
Map IX

London, Canada.

Land Use 4600



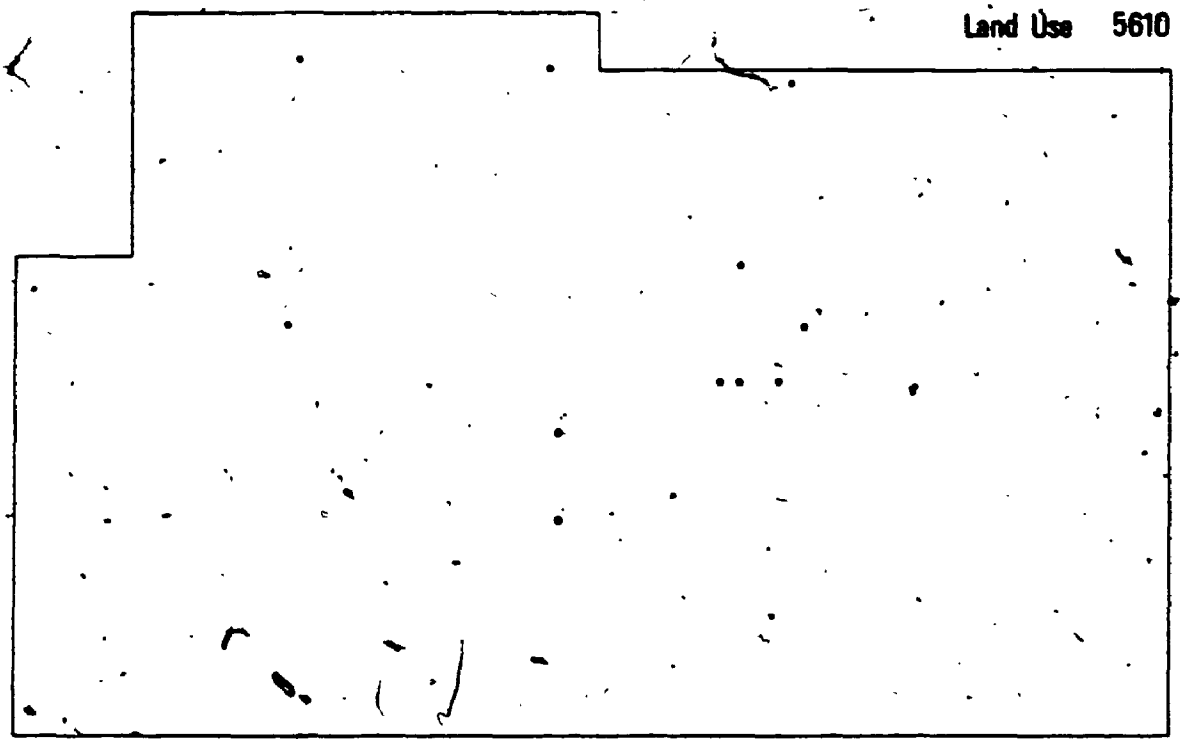
Land Use 5100



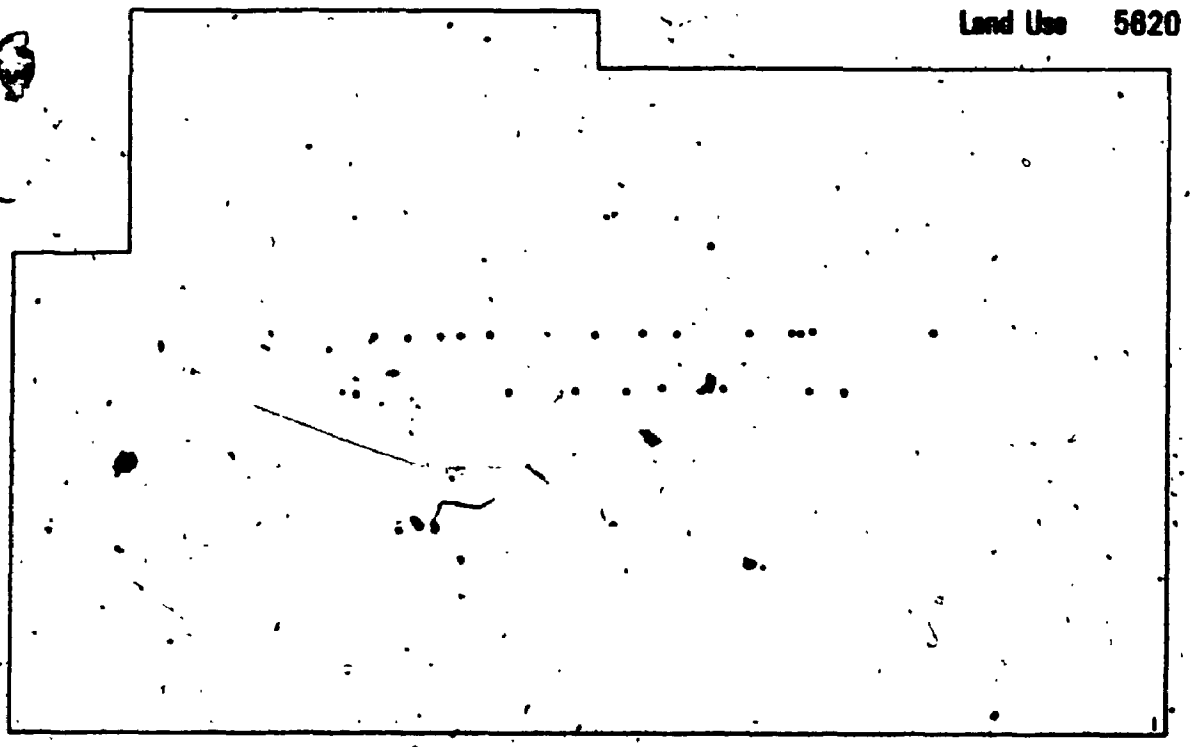
Map X

London, Canada

Land Use 5610



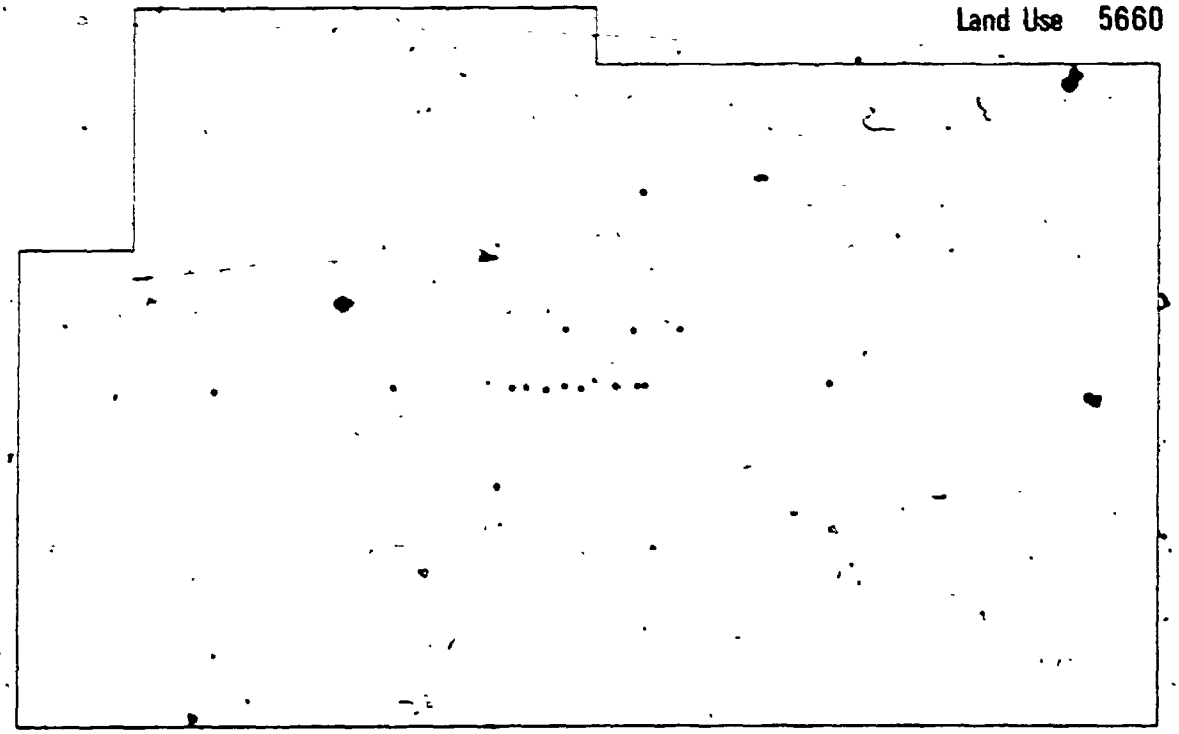
Land Use 5620



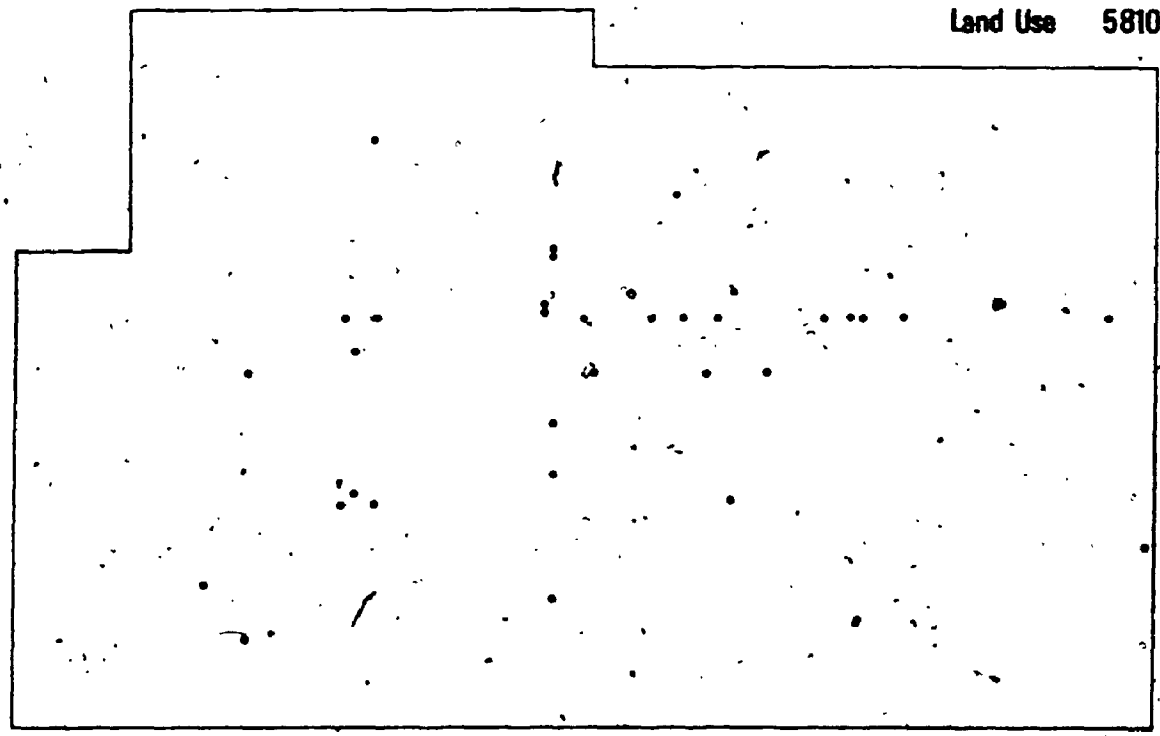
Map XI

London, Canada

Land Use 5660



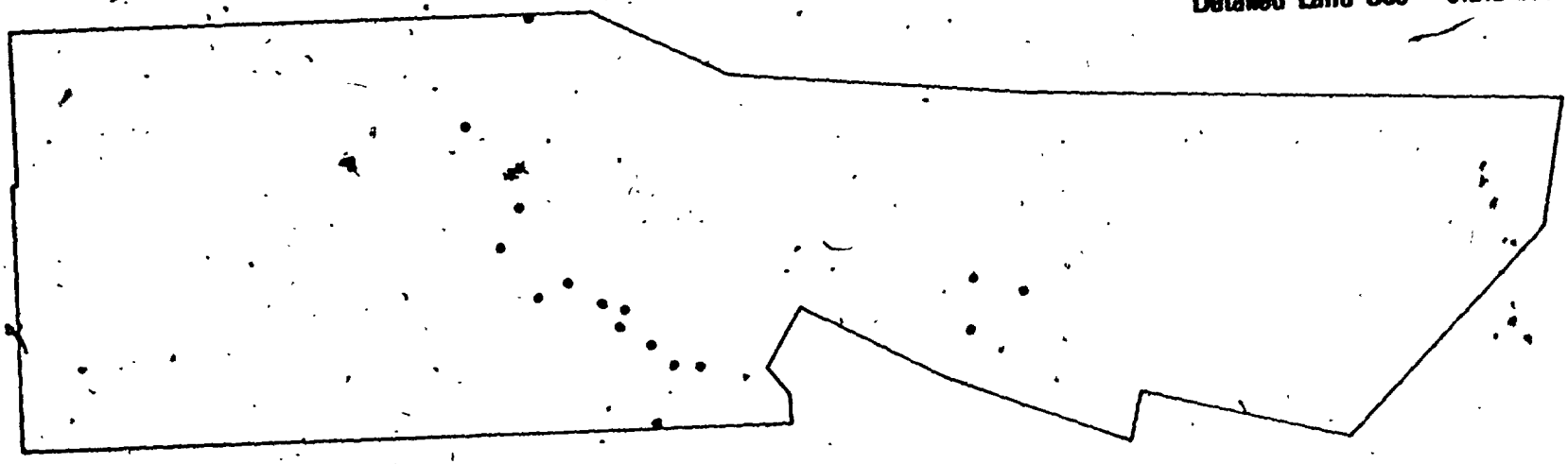
Land Use 5810



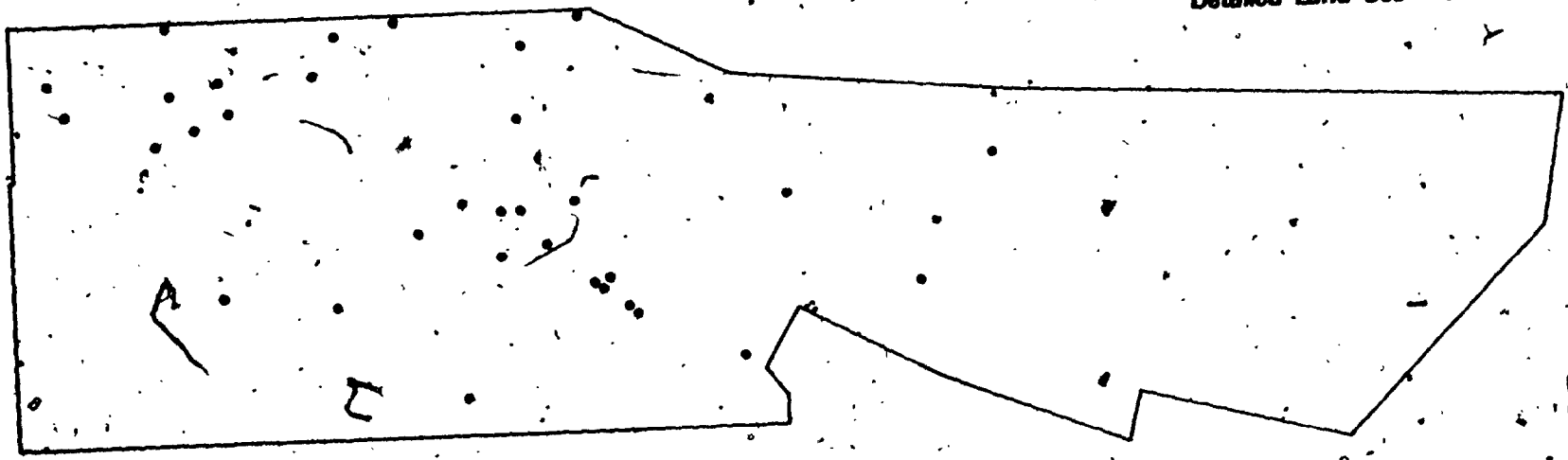
Map XII

Guatemala City.

Detailed Land Use 61212 CSC



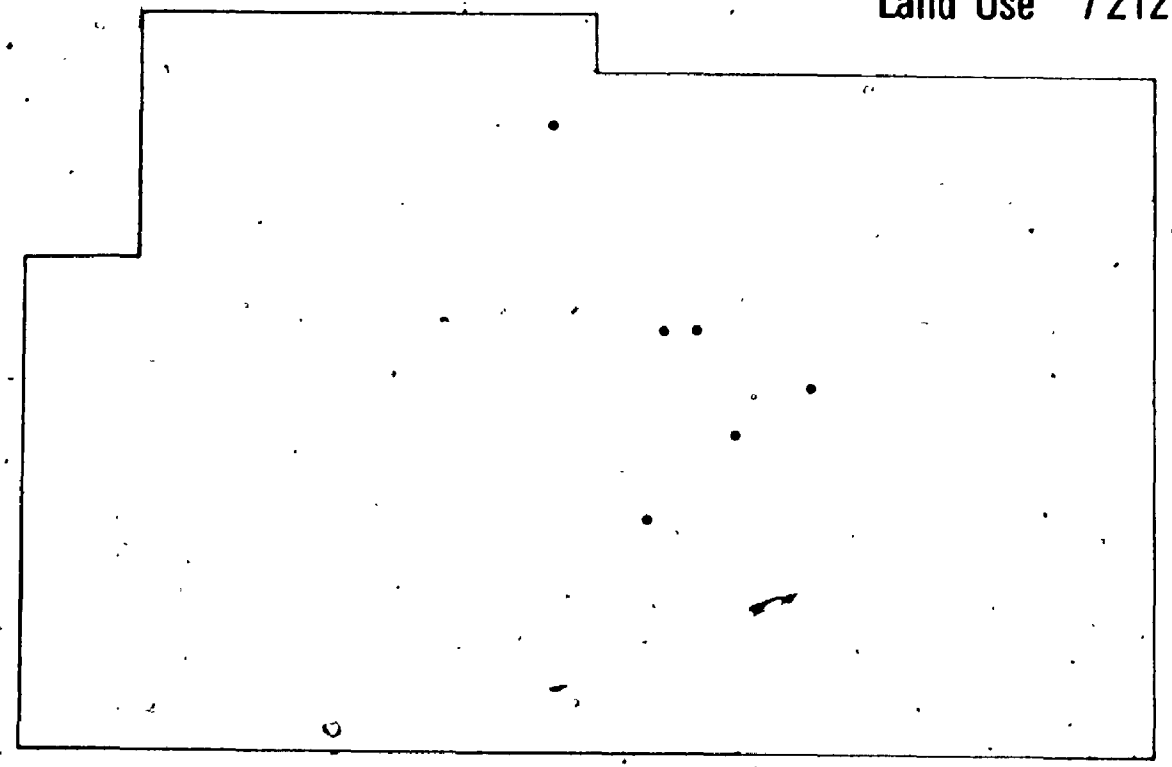
Detailed Land Use 61234 CSC



Map XXII

London, Canada.

Land Use 7212

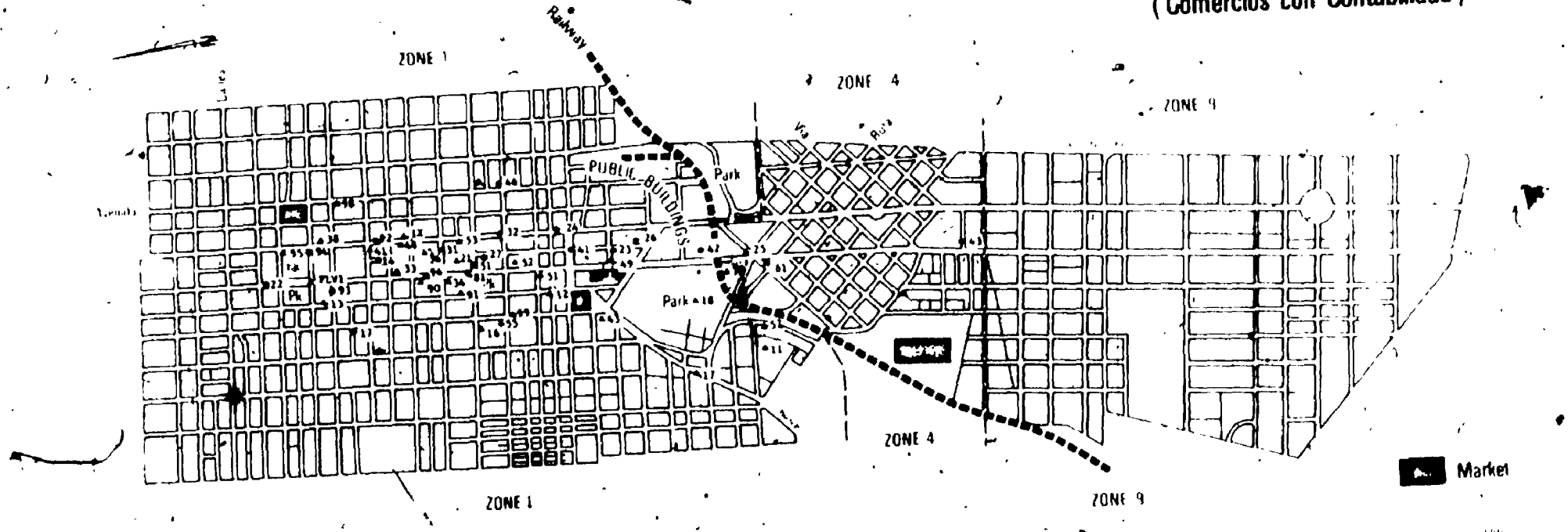


Map XIV

Guatemala City, Guatemala

Mean Centres of CCC Land Uses

(Comercios con Contabilidad)



- Land uses prefixed by 611.
- Land uses prefixed by 612.

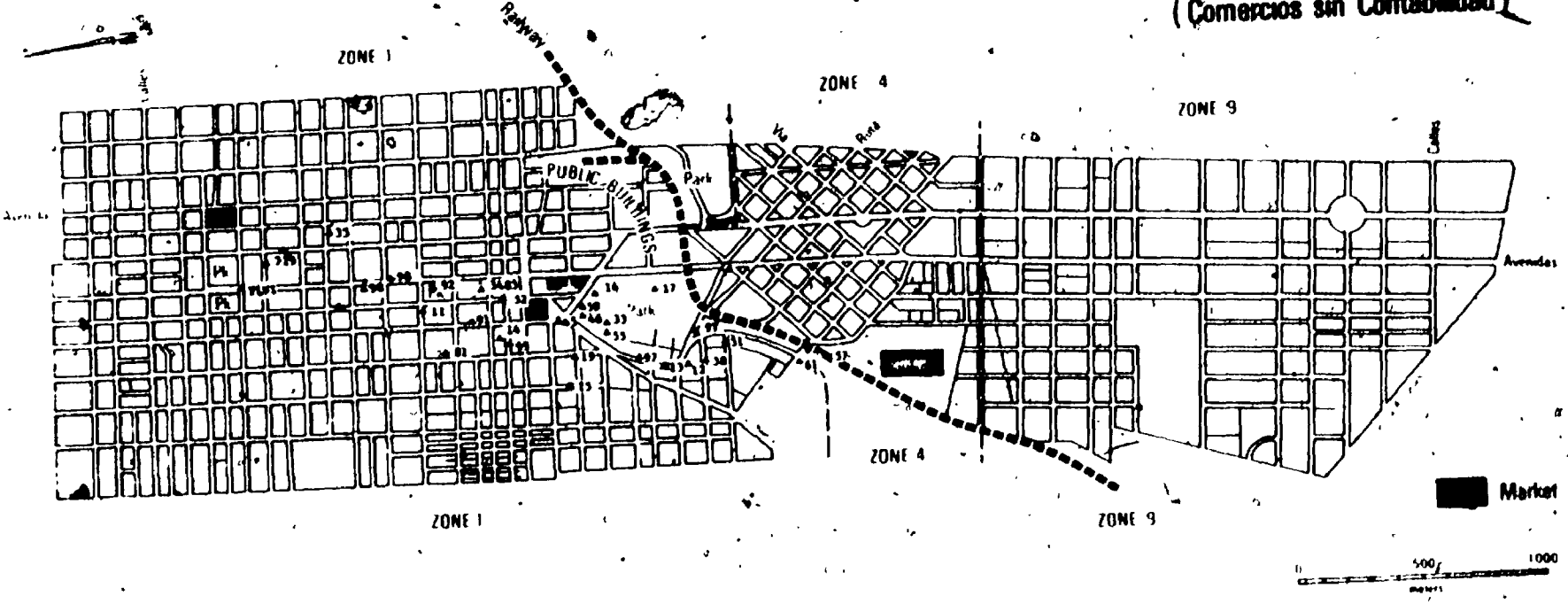
PLVI – Peak land value intersection

Map XV

Guatemala City, Guatemala

Mean Centres of CSC Land Uses

(Comercios sin Contabilidad)



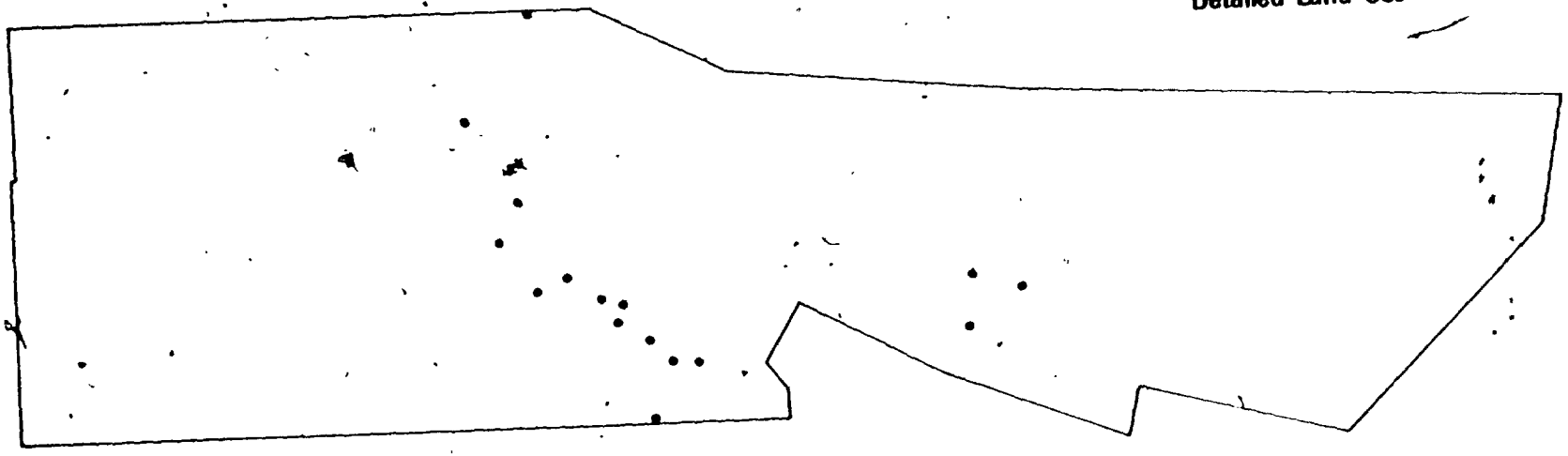
All land uses are profiled by 612.

PLVI – Peak land value intersection.

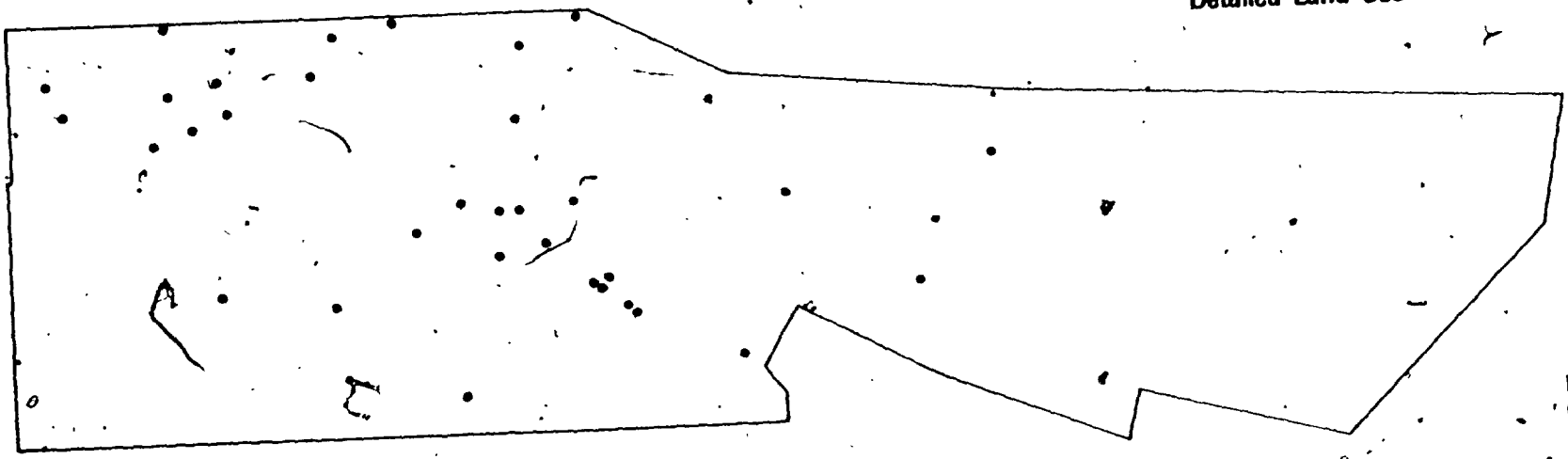
Map XVI

Guatemala City.

Detailed Land Use 61212 CSC



Detailed Land Use 61234 CSC

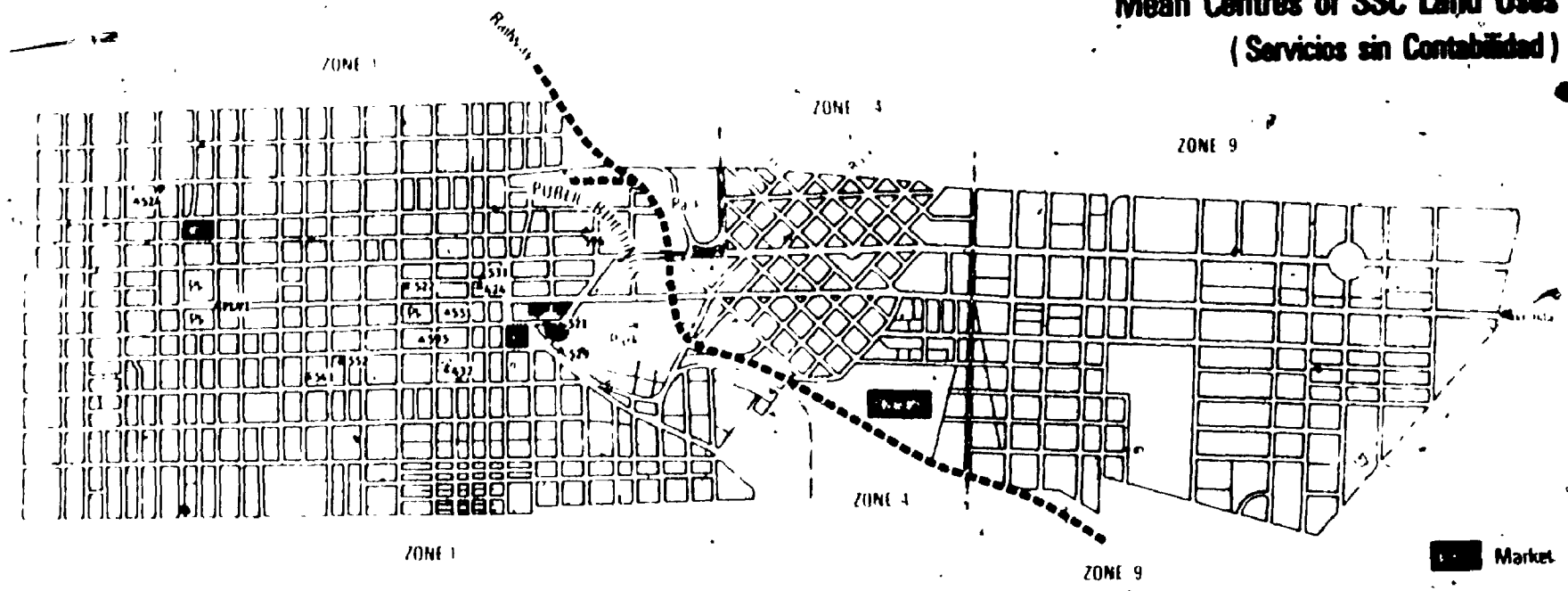


Map XXII

Guatemala City, Guatemala

Mean Centres of SSC Land Uses

(Servicios sin Contabilidad)



All land uses are prefixed by 8.

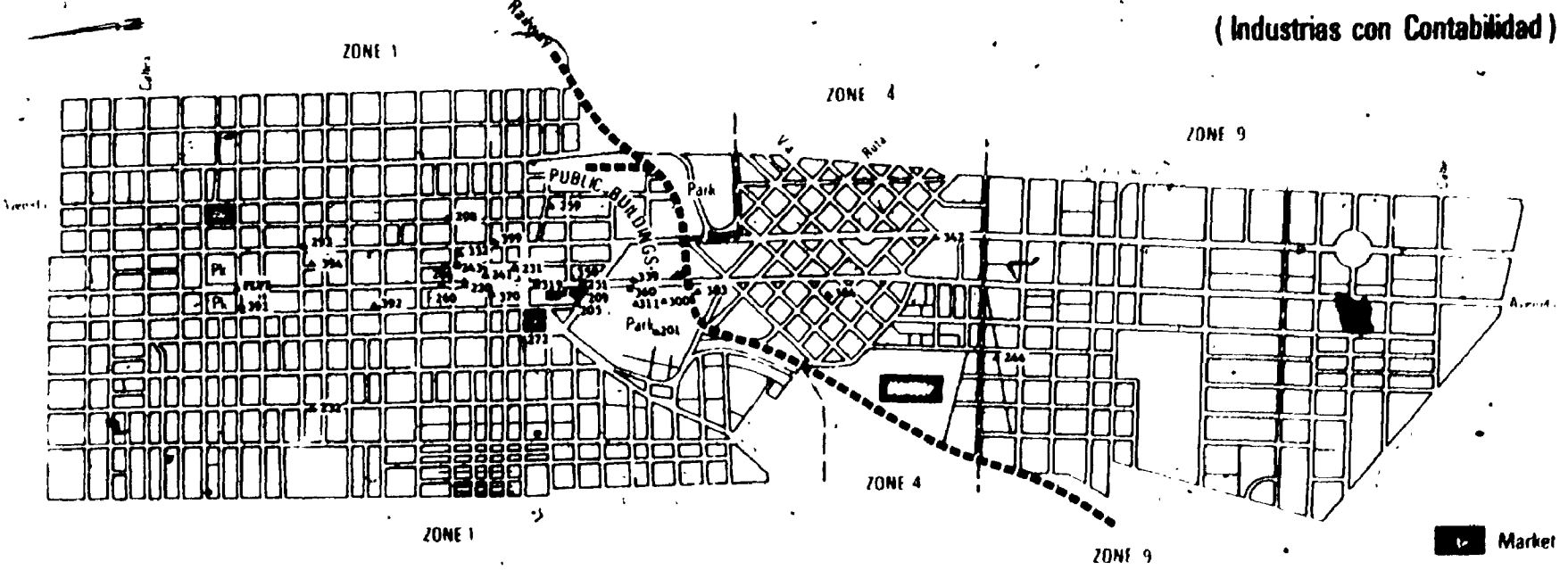
PLVI = Peak land value intersection.

Map XVIII

Guatemala City, Guatemala

Mean Centres of ICC Land Uses

(Industrias con Contabilidad)

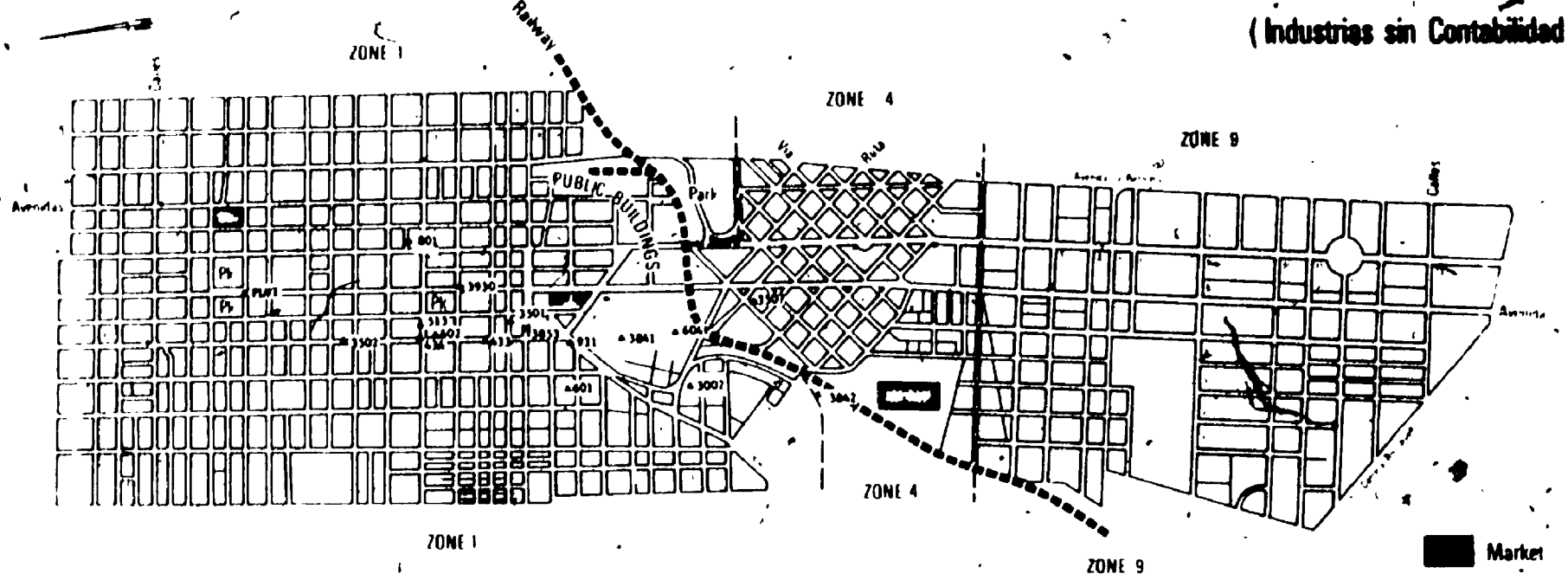


All land uses are suffixed by 0.

PLVI – Peak land value intersection.

Map XIX

Guatemala City, Guatemala
Mean Centres of ISC Land Uses
(Industries sin Contabilidad)



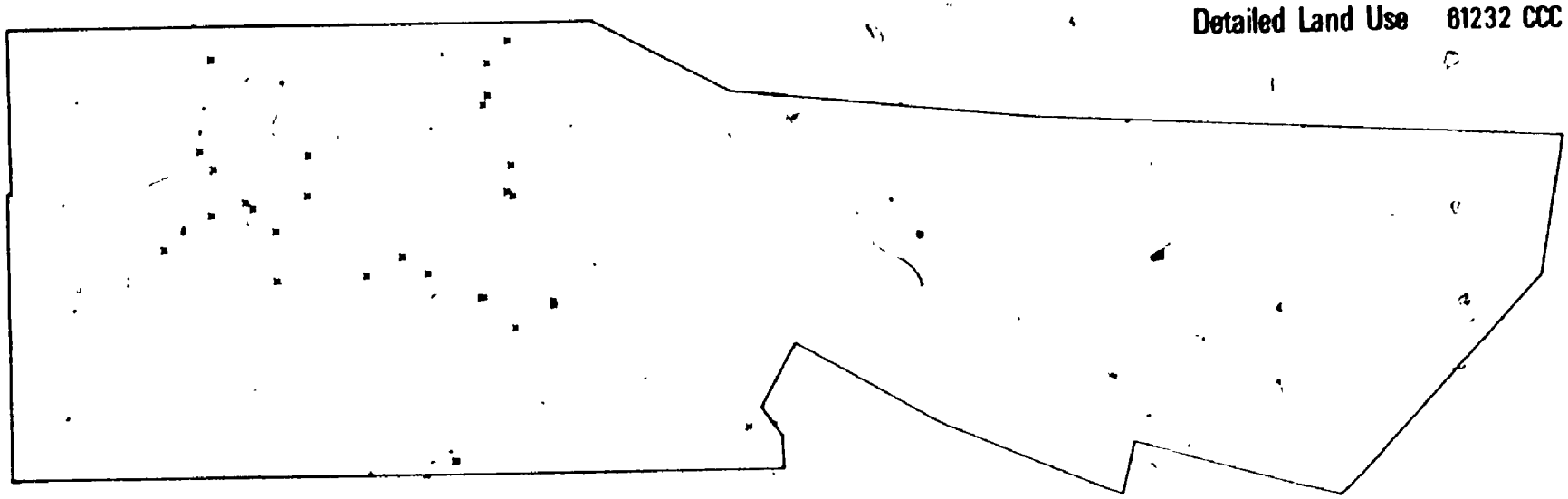
All the 3 digit land uses are prefixed by 2

PLVI – Peak land value intersection.

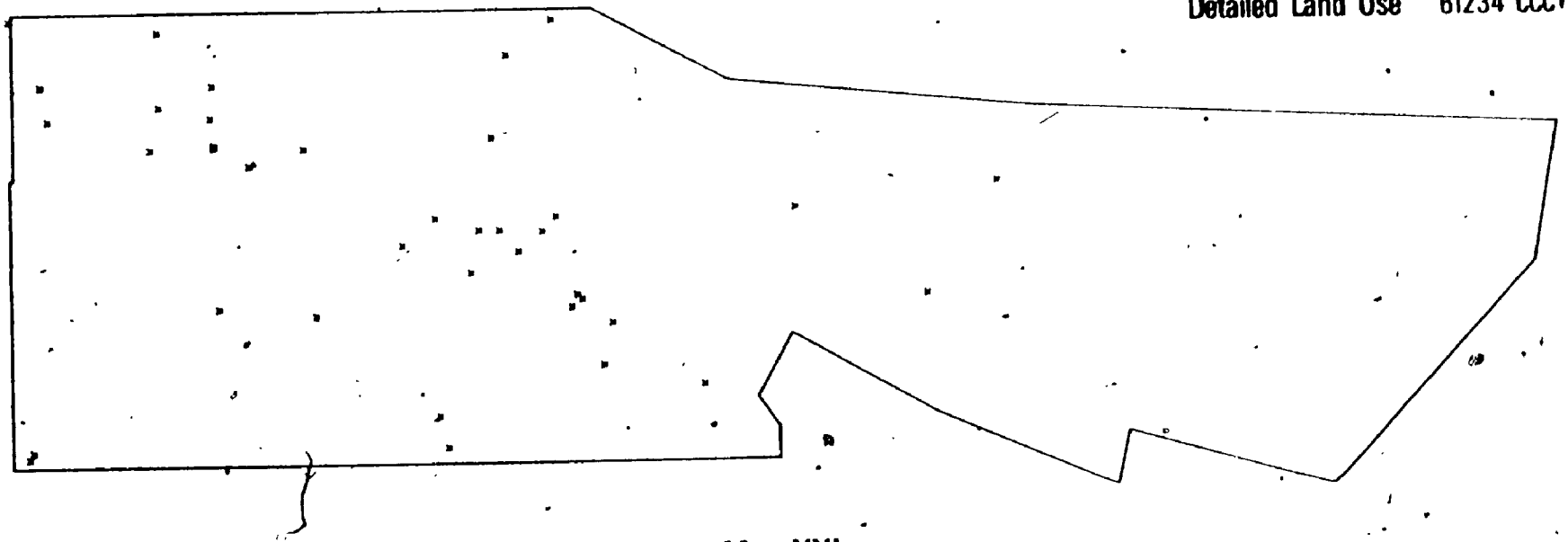
Map XX

Guatemala City.

Detailed Land Use 61232 CCC



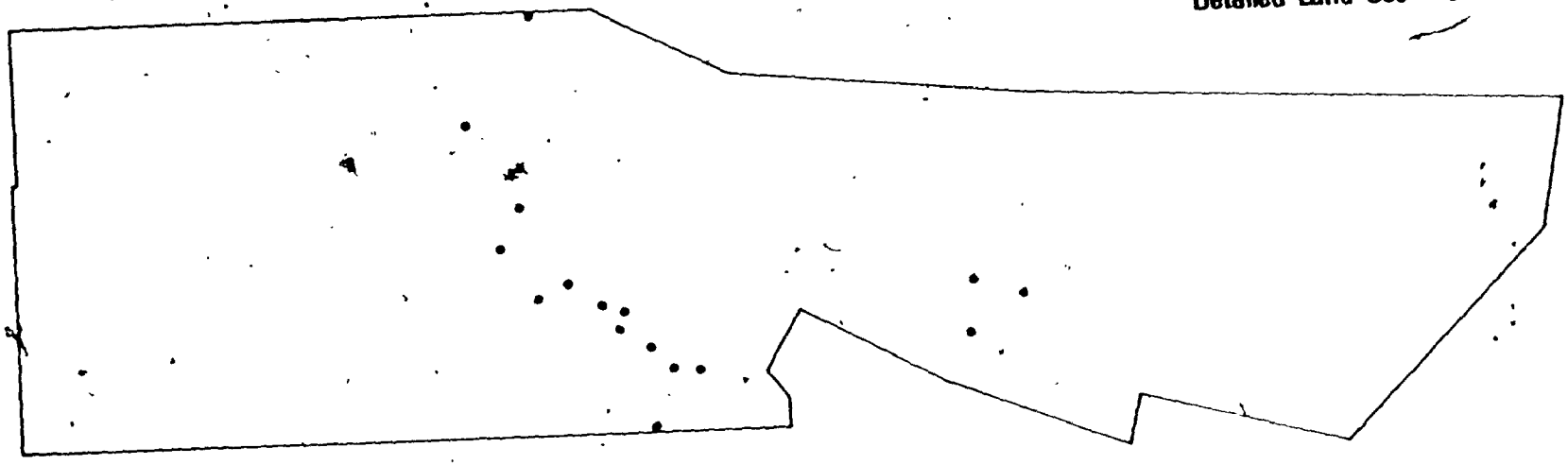
Detailed Land Use 61234 CCC



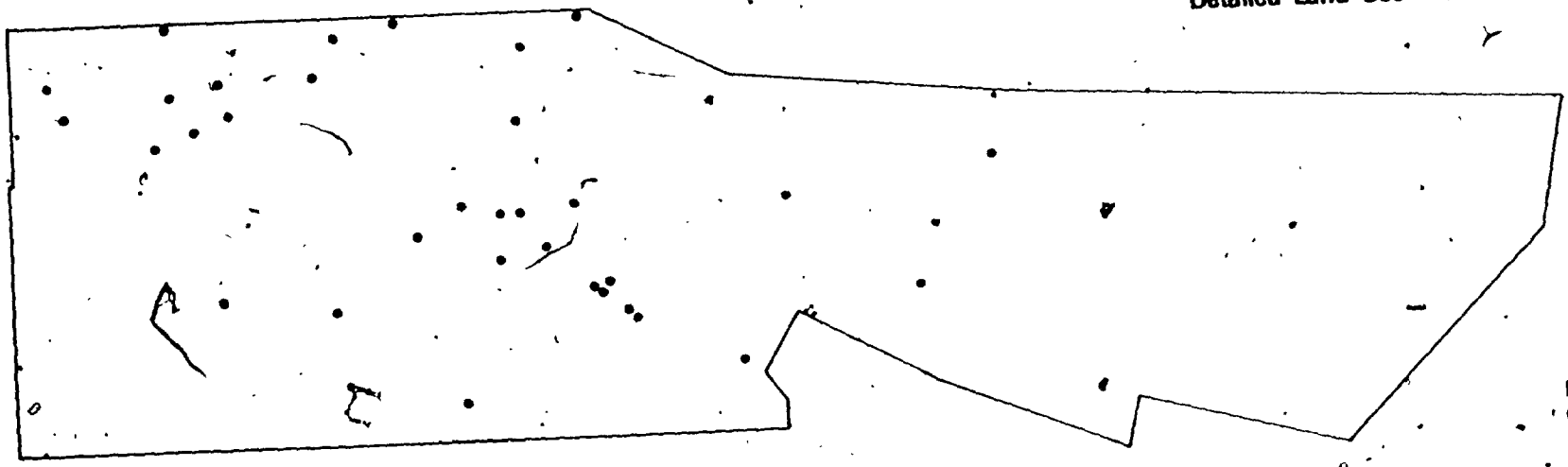
Map XXI

Guatemala City.

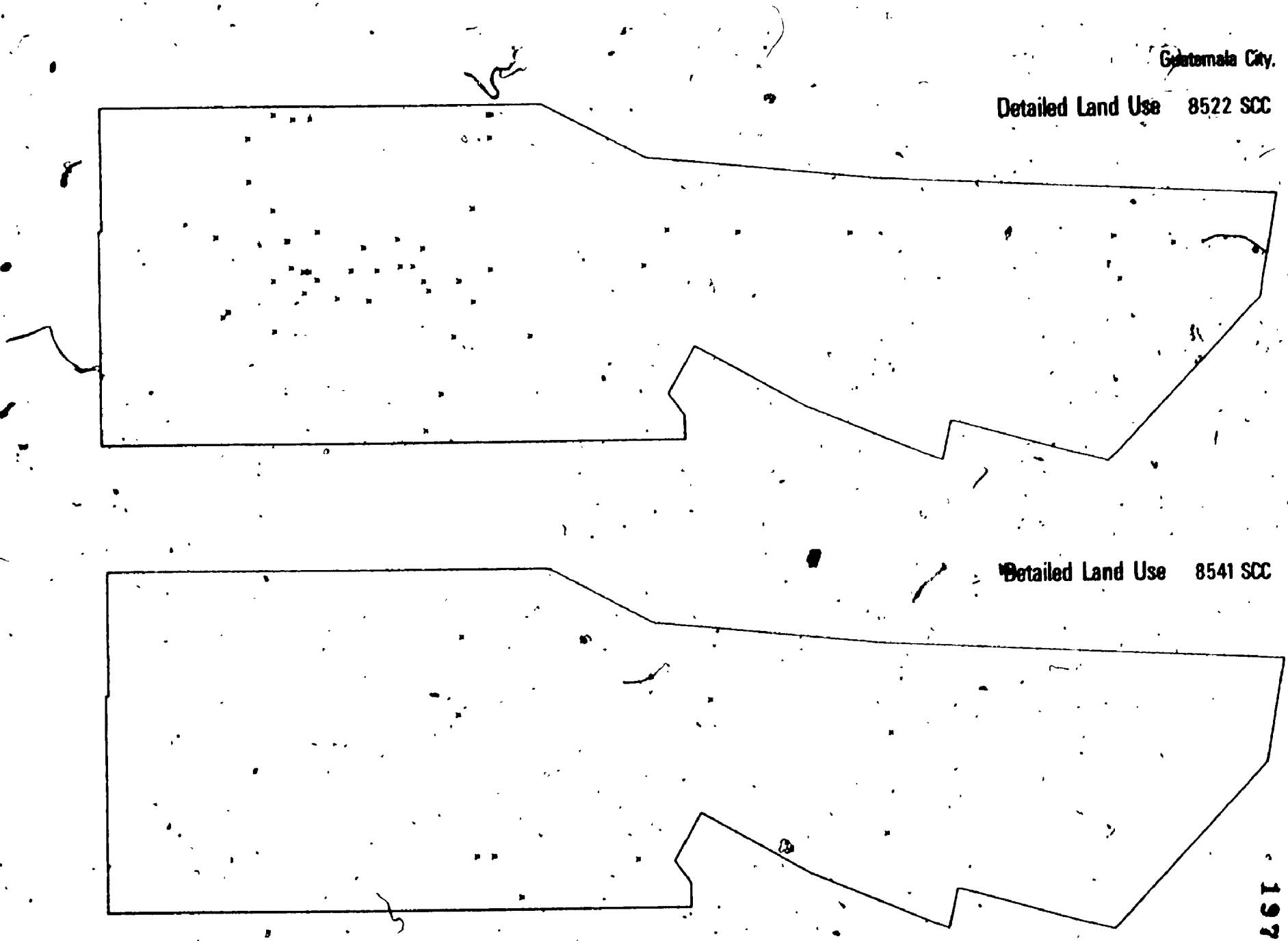
Detailed Land Use 61212 CSC



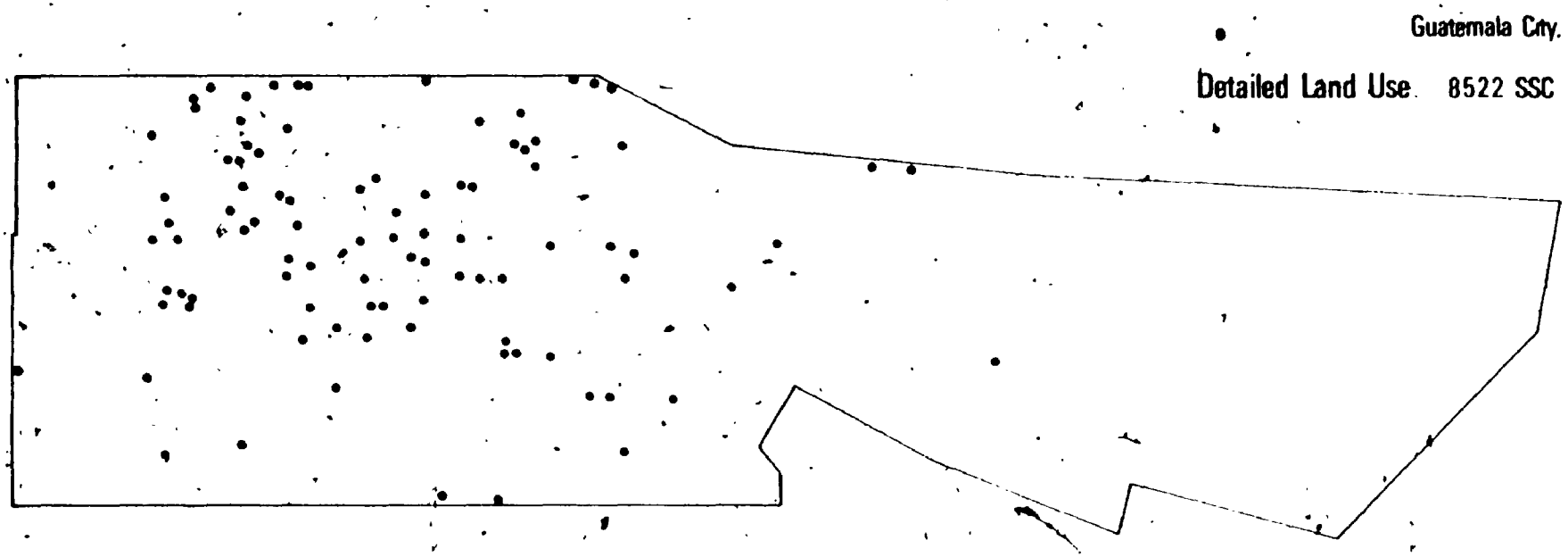
Detailed Land Use 61234 CSC

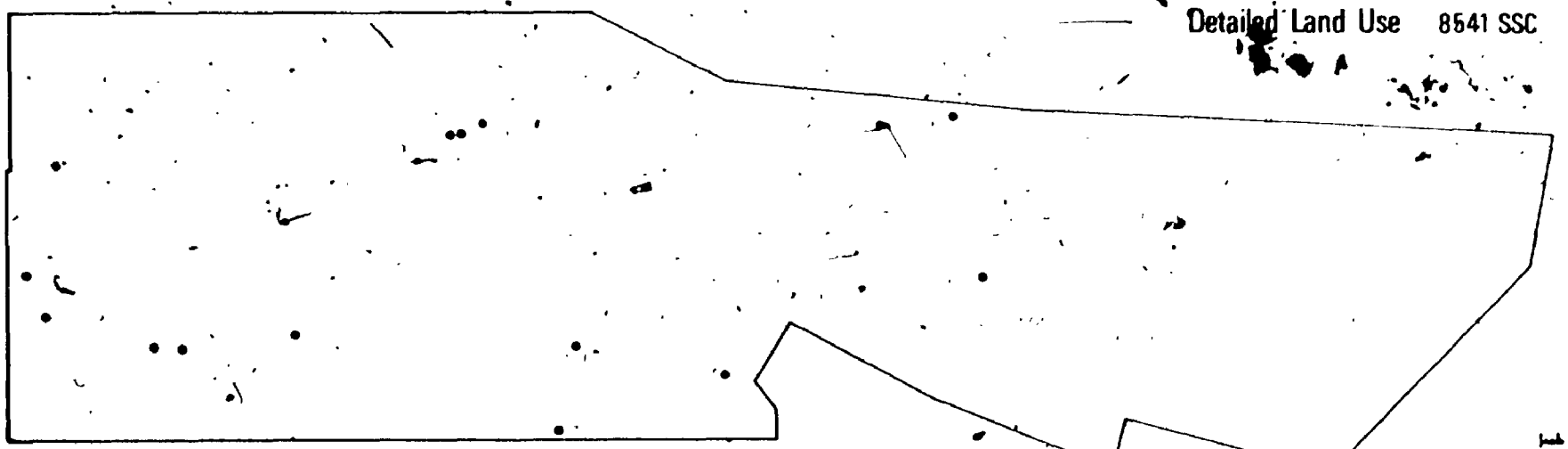


Map XXII


Guatemala City.
Detailed Land Use 8522 SCC
Detailed Land Use 8541 SCC

Map XXIII

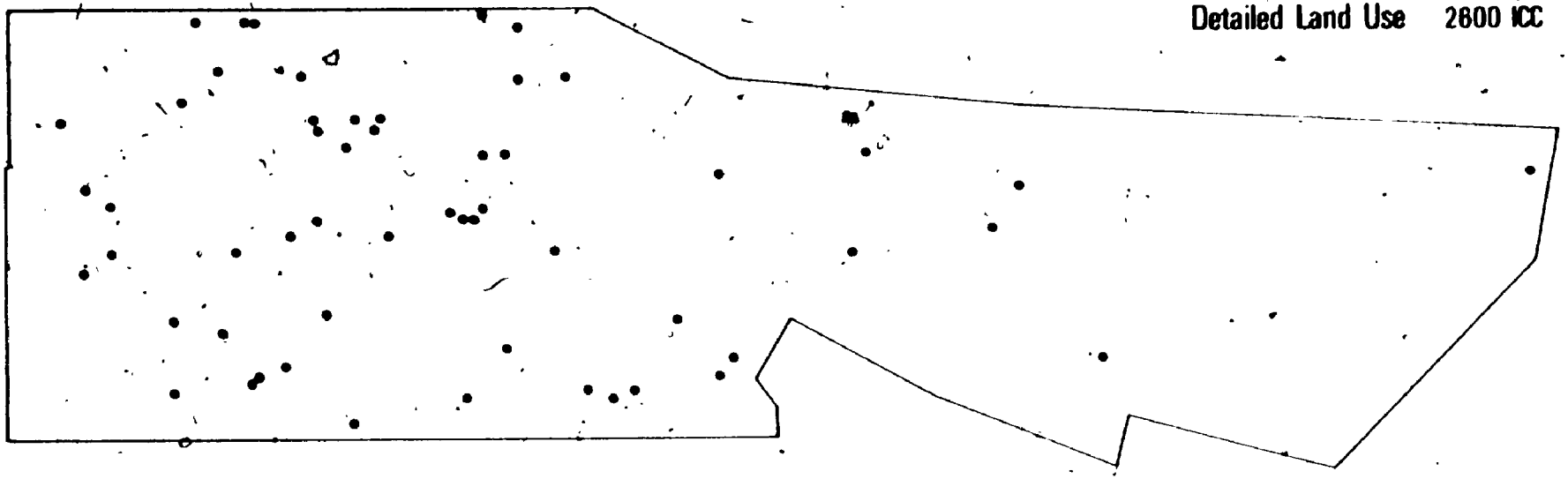

Guatemala City.
Detailed Land Use 8522 SSC


Detailed Land Use 8541 SSC

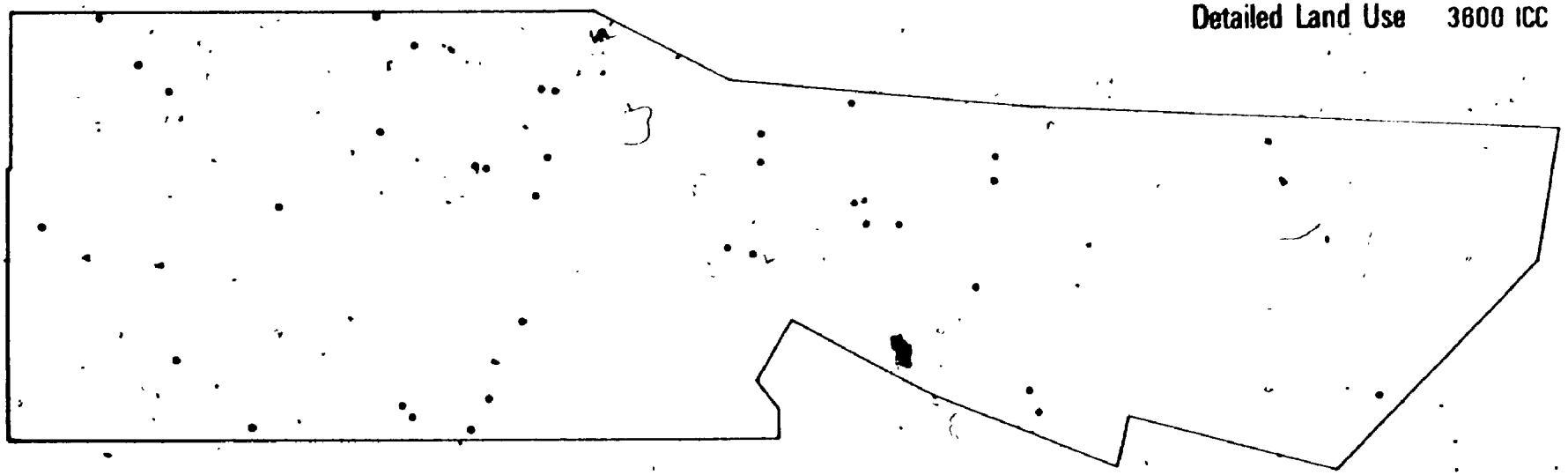
Map XXIV

Guatemala City.

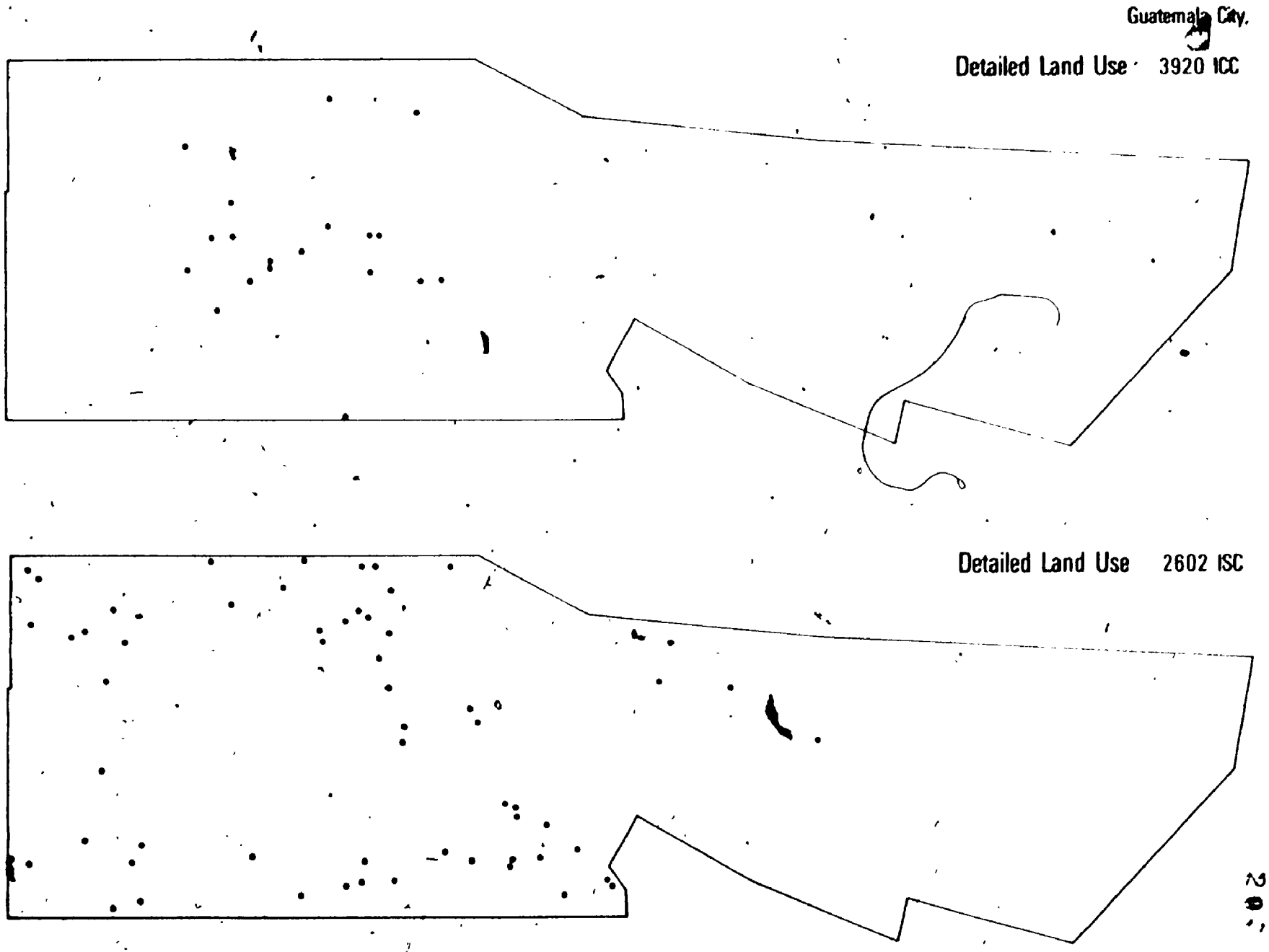
Detailed Land Use 2600 ICC



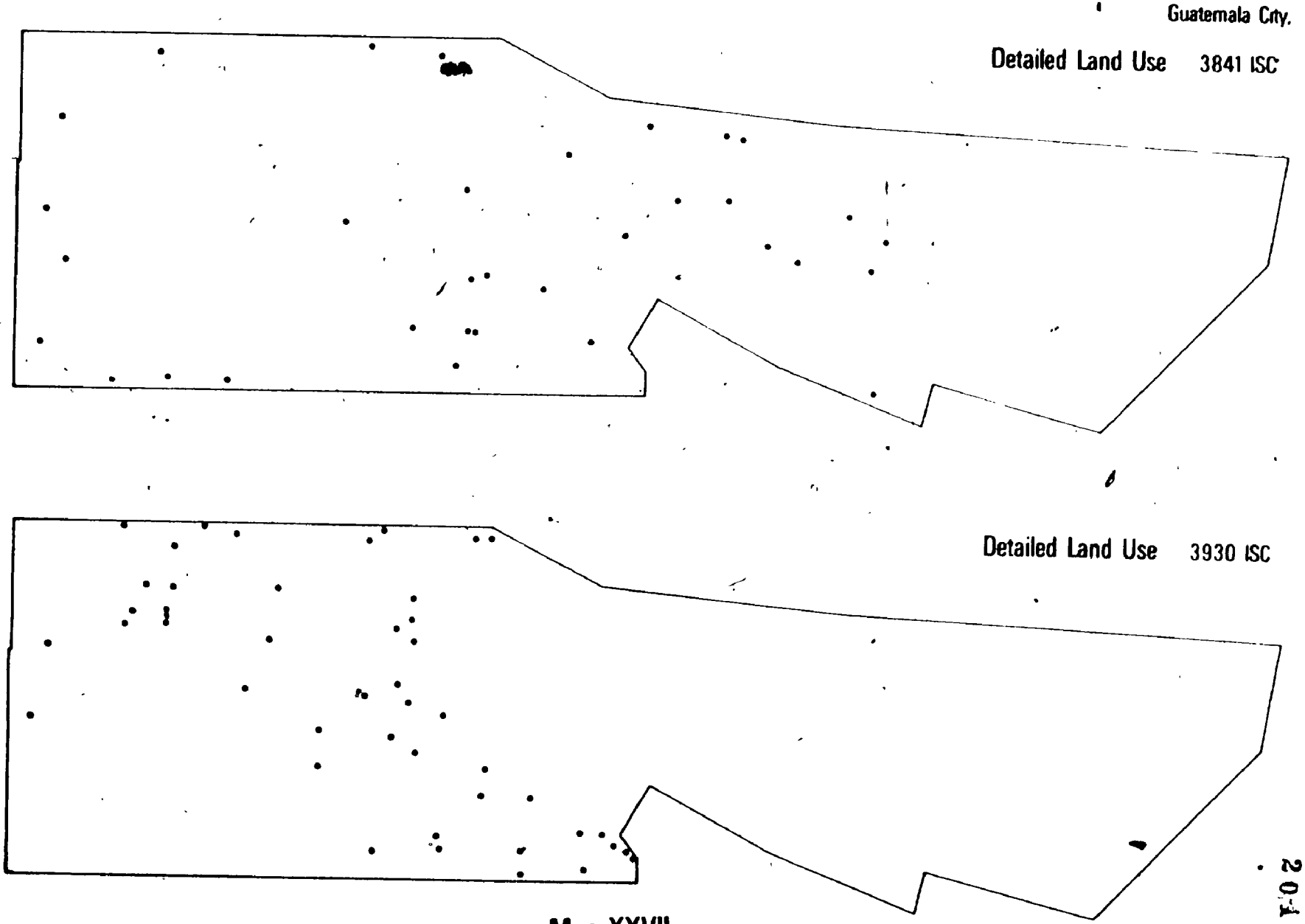
Detailed Land Use 3600 ICC



Map XXV


Guatemala City,
Detailed Land Use 3920 ICC
Detailed Land Use 2602 ISC

Map XXVI

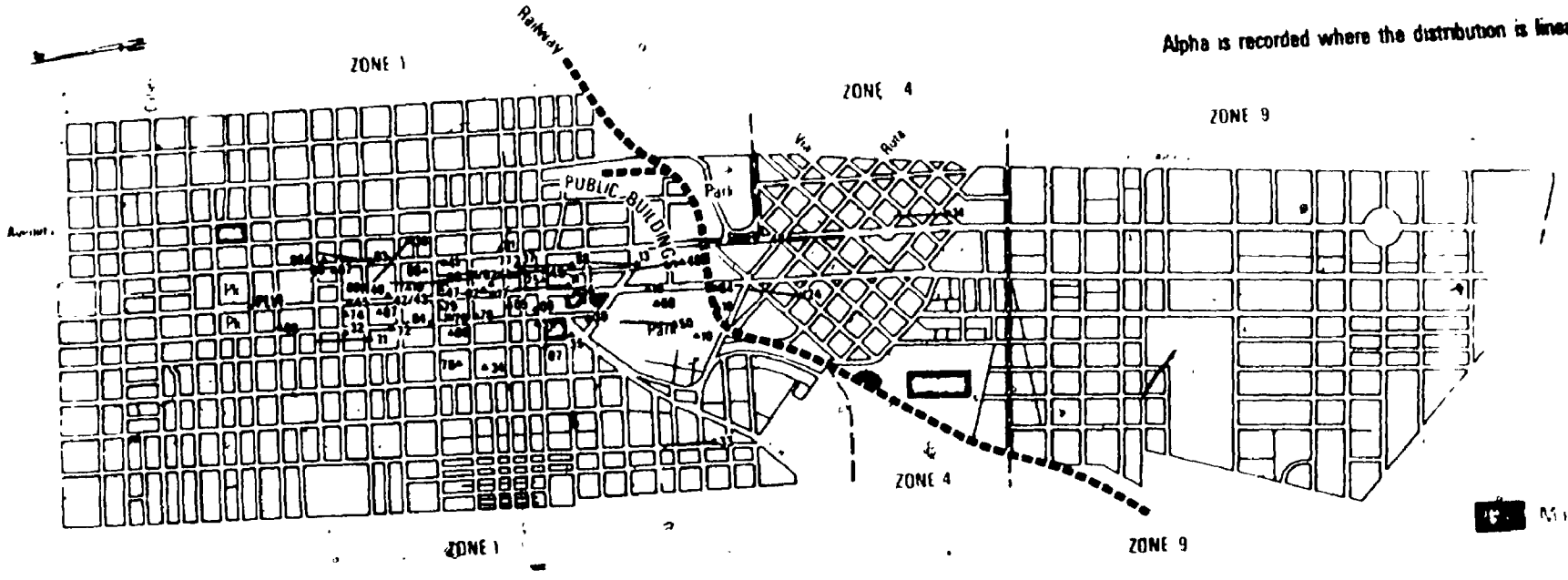

Guatemala City.
Detailed Land Use 3841 ISC
Detailed Land Use 3930 ISC

Map XXVII

Guatemala City, Guatemala

Accumulated Land Uses
Mean Centres & Alpha Statistic

Alpha is recorded where the distribution is linear.



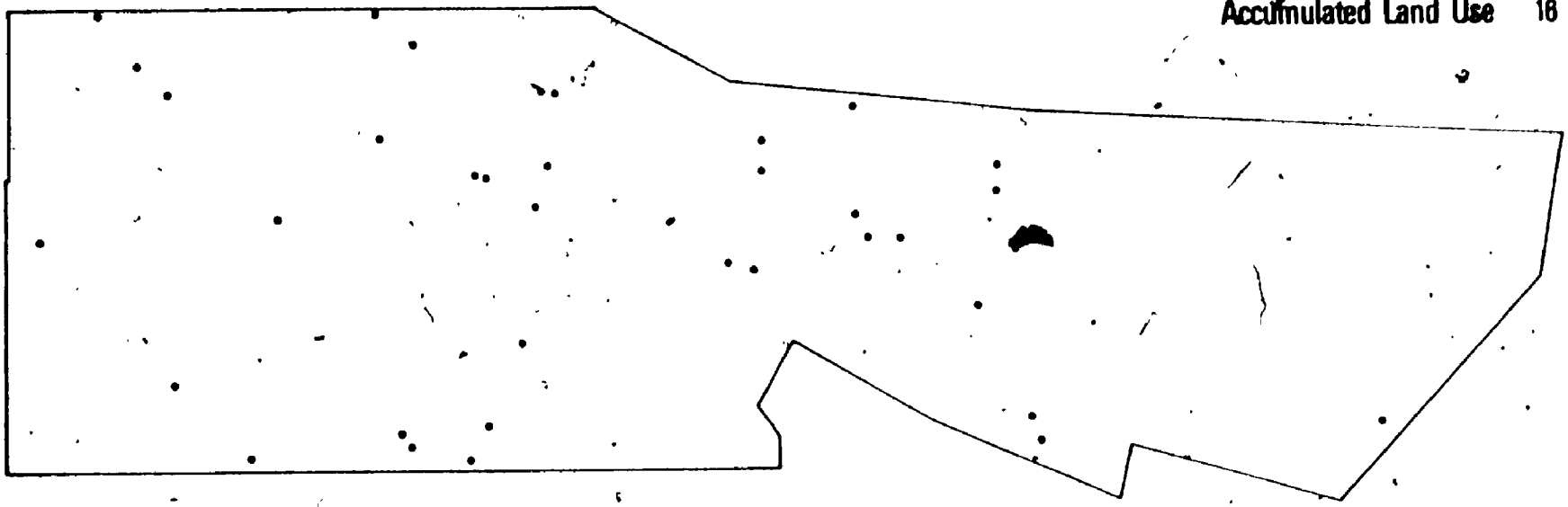
PLVI = Peak land value intersection

Orientation of the land use distribution

Map XXVIII

Guatemala City.

Accumulated Land Use 16

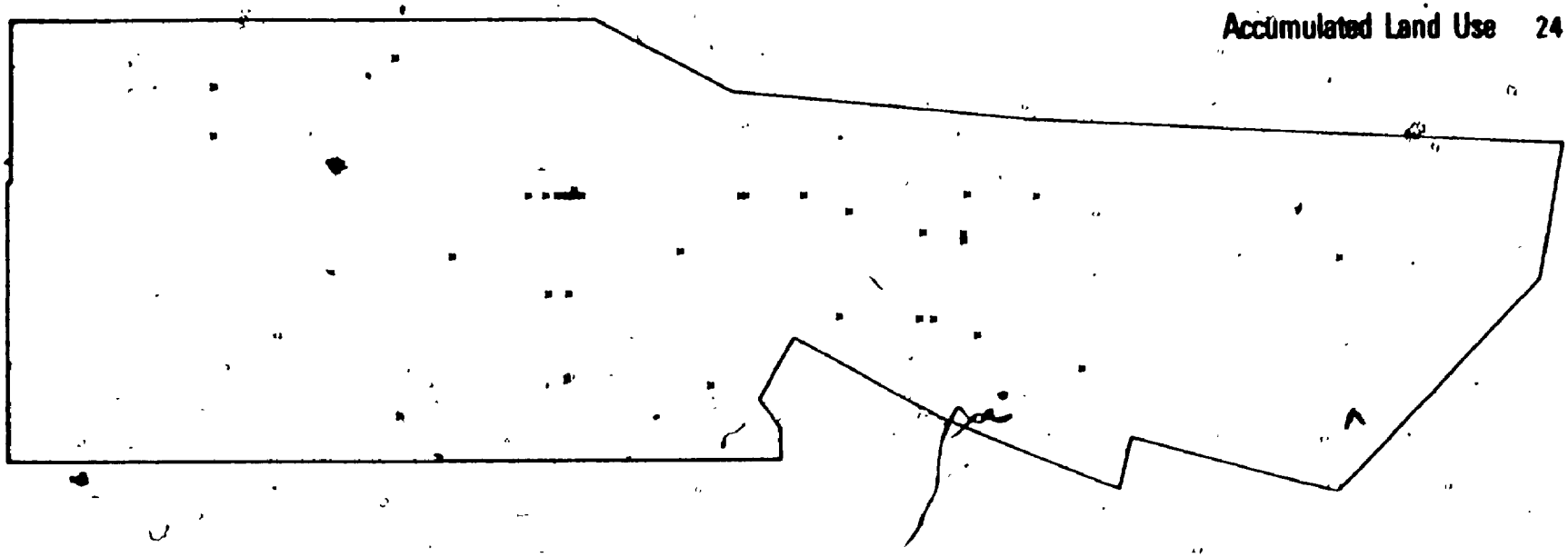


Accumulated Land Use 17

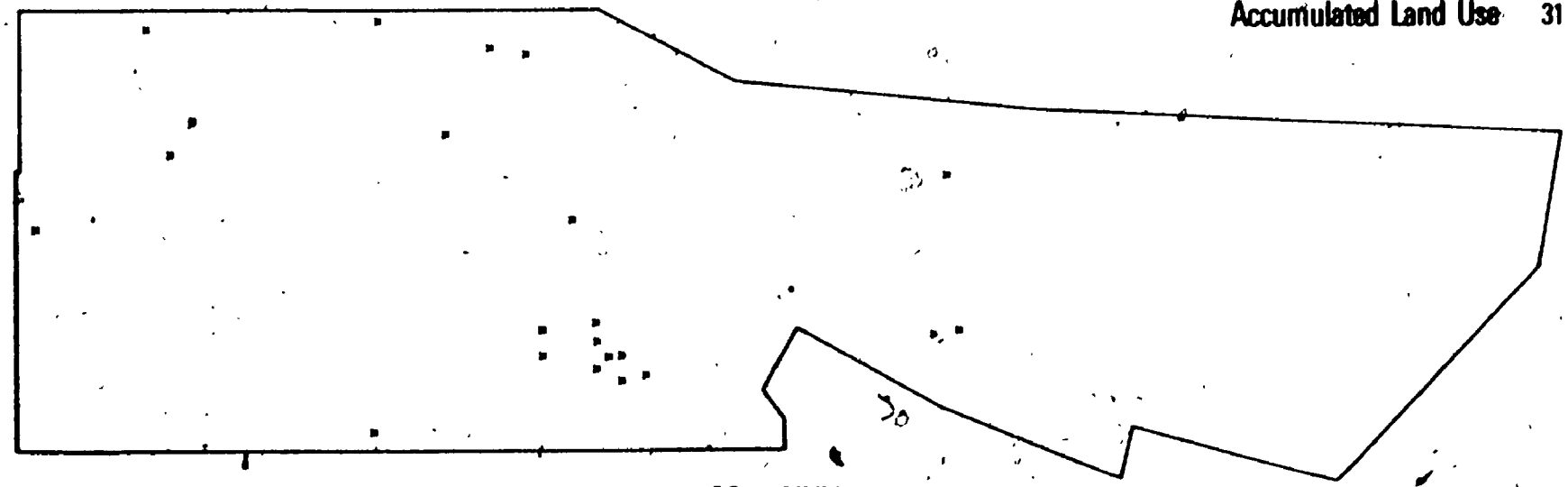
Map XXIX

Guatemala City.

Accumulated Land Use 24



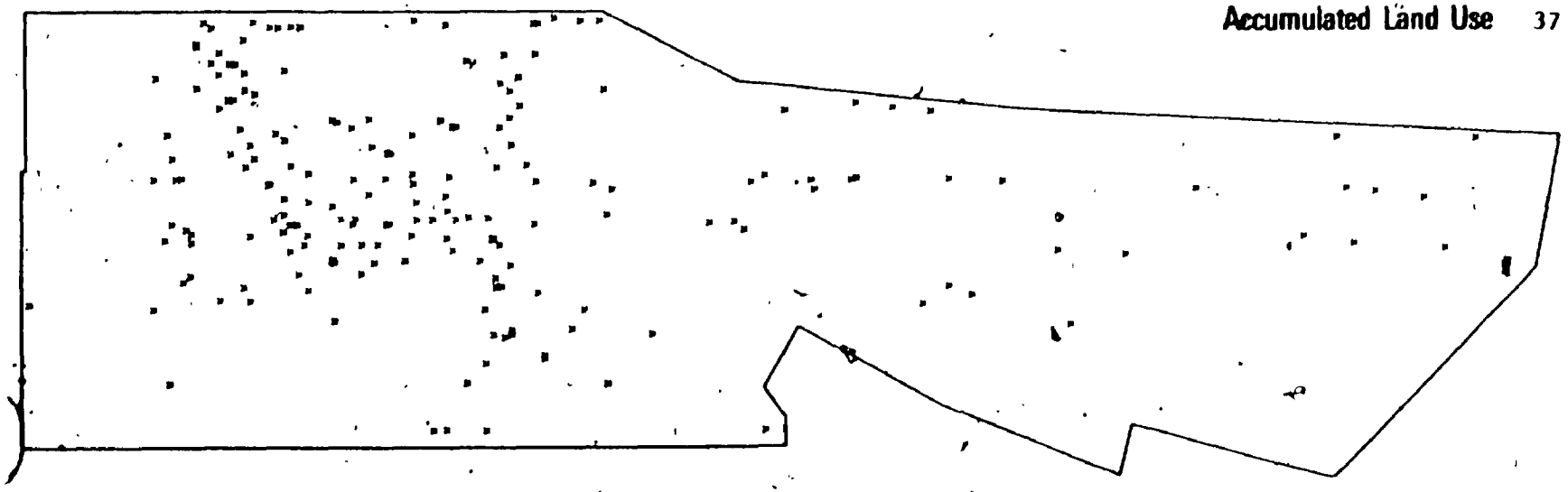
Accumulated Land Use 31



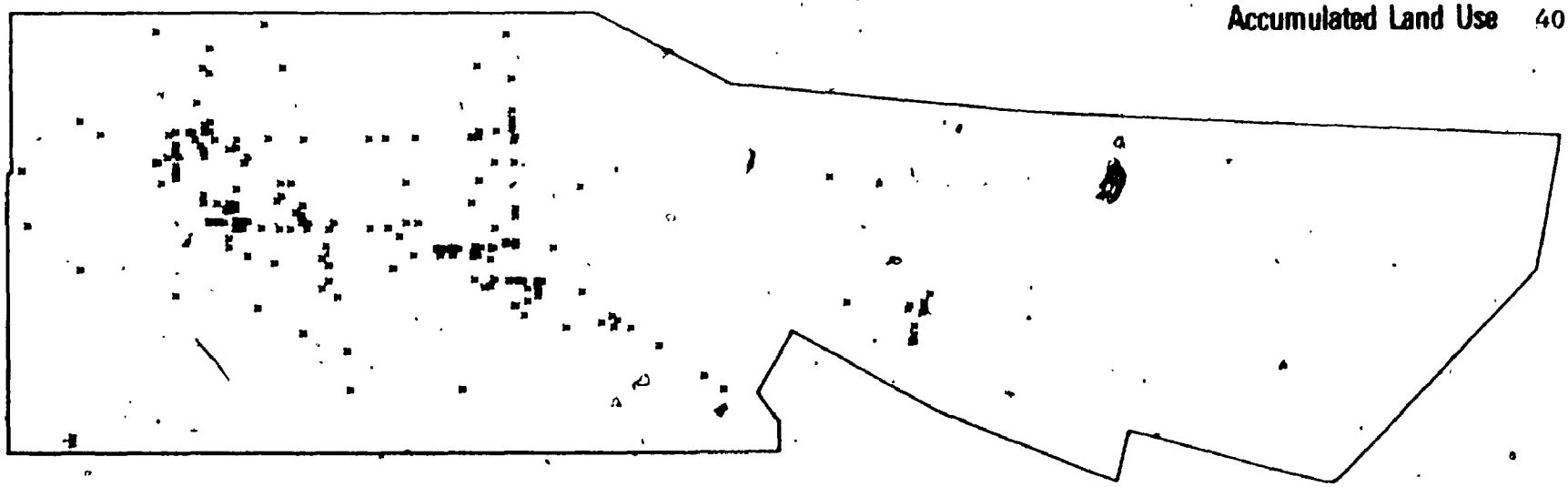
Map XXX

Guatemala City.

Accumulated Land Use 37



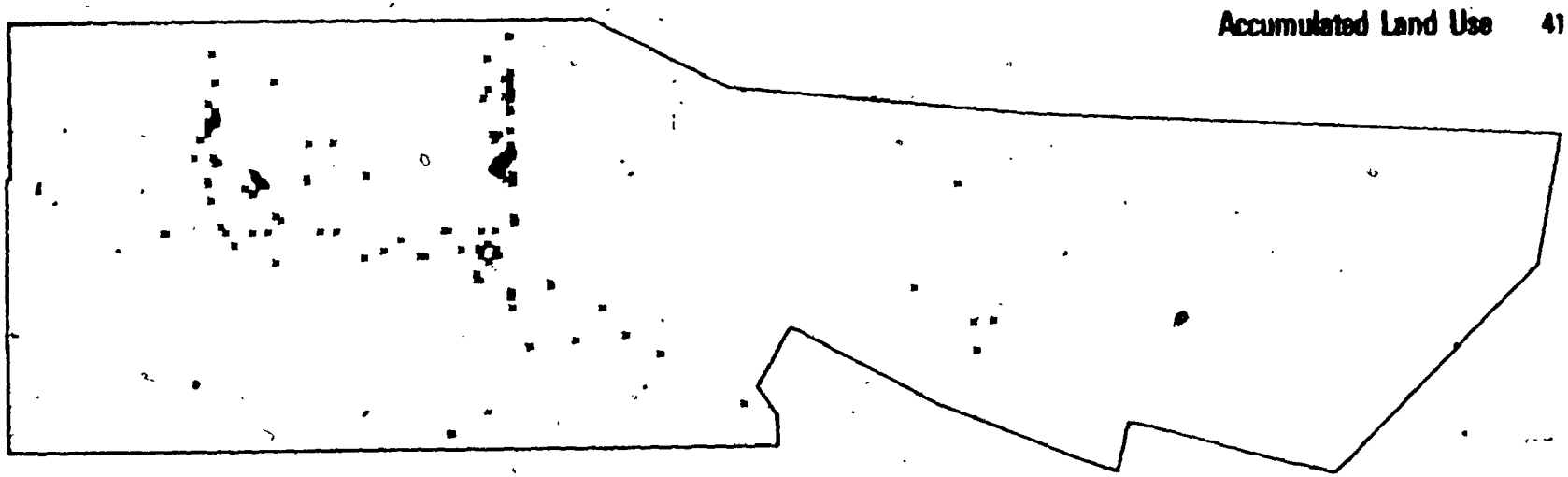
Accumulated Land Use 40



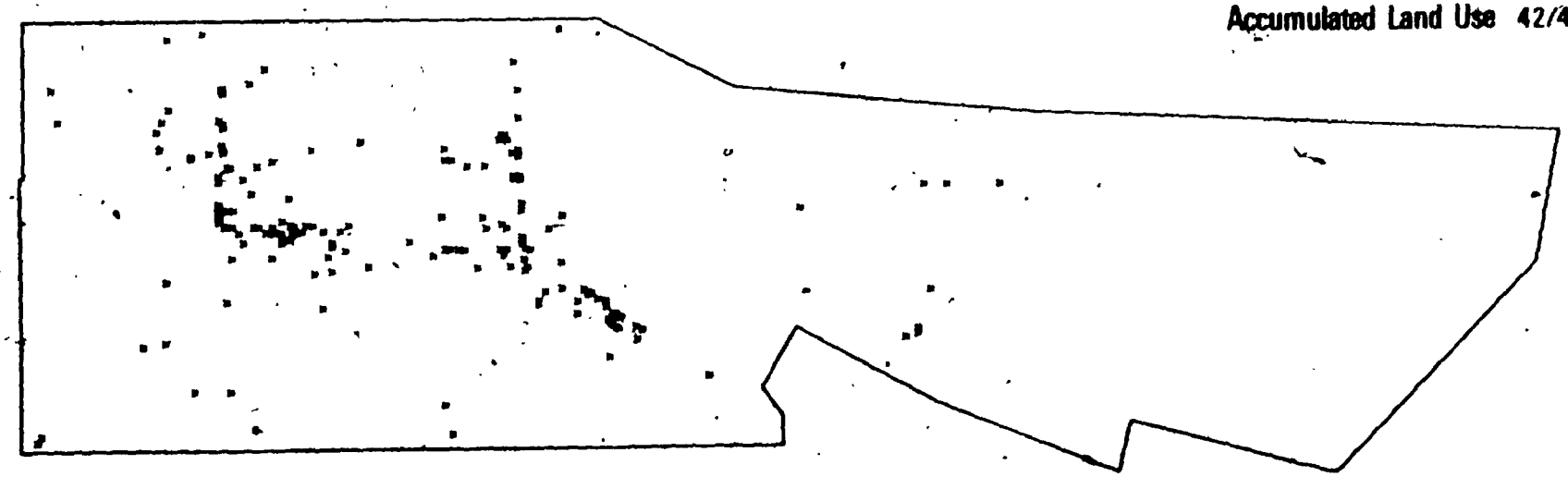
Map XXXI

Guatemala City.

Accumulated Land Use 41

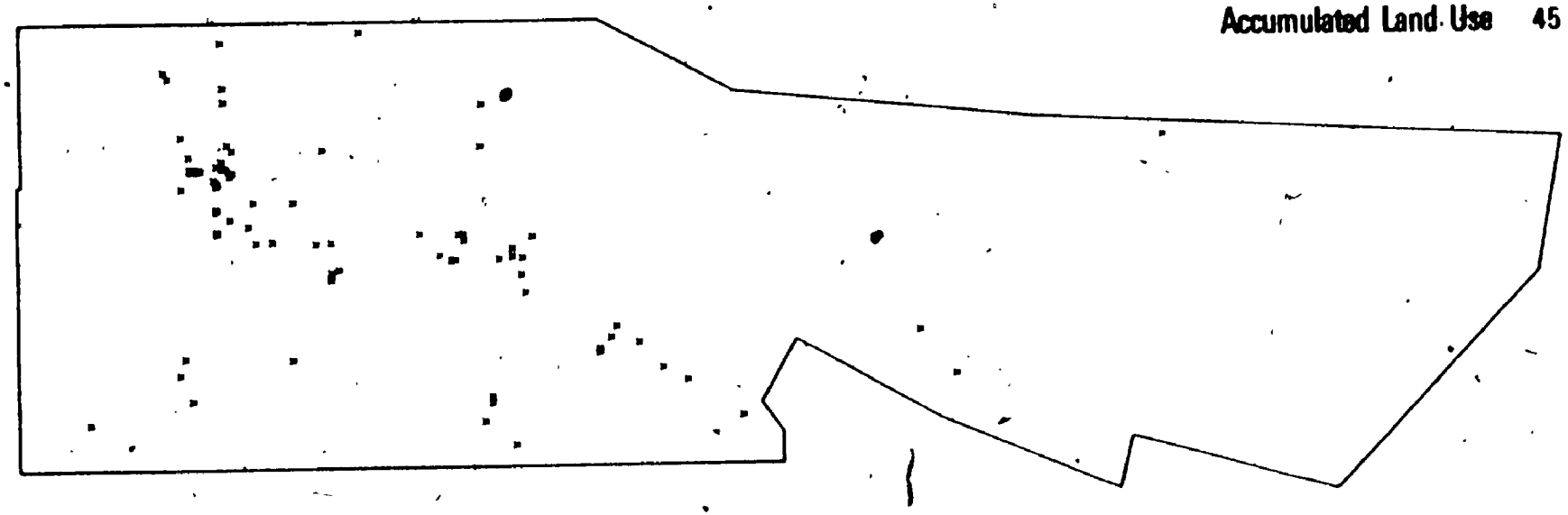


Accumulated Land Use 42/43

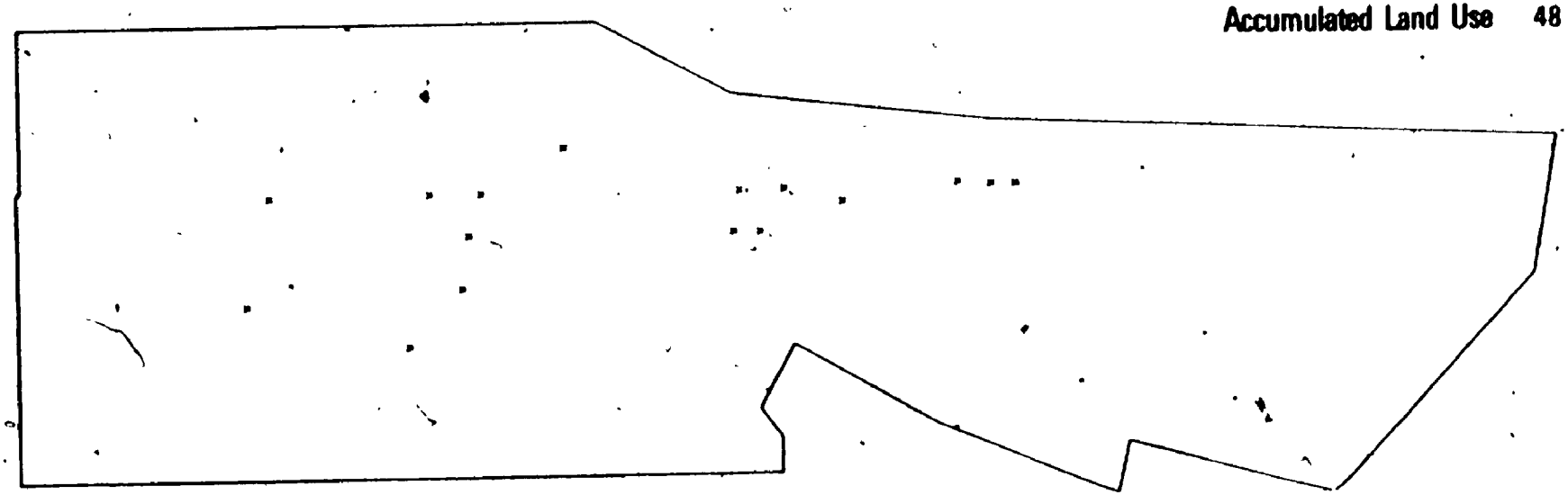


Guatemala City.

Accumulated Land Use 45



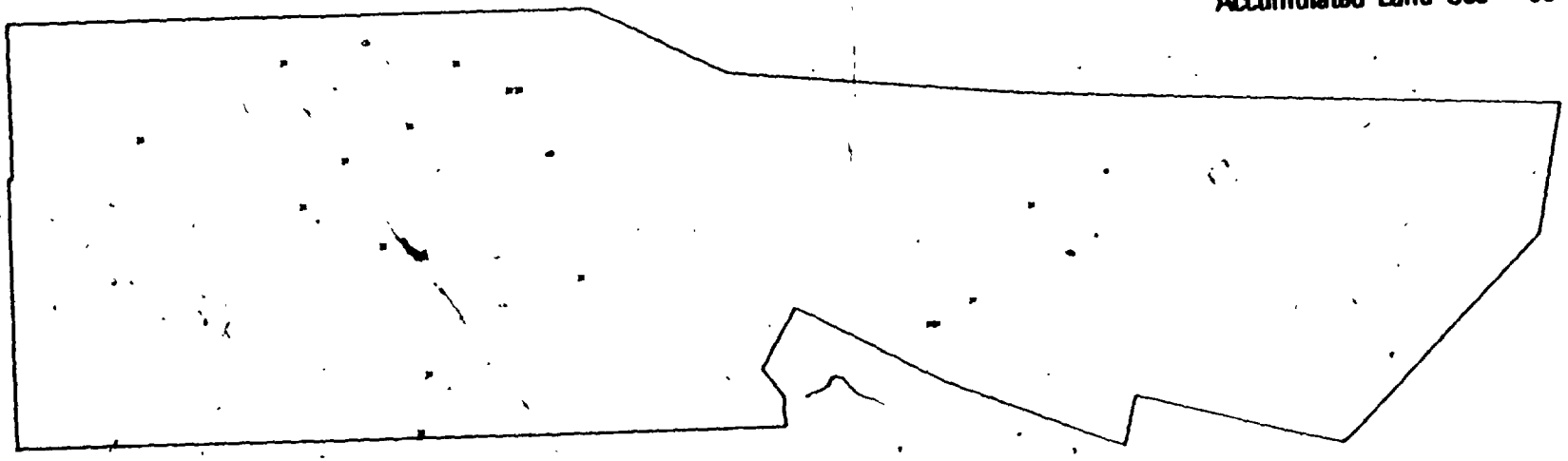
Accumulated Land Use 48



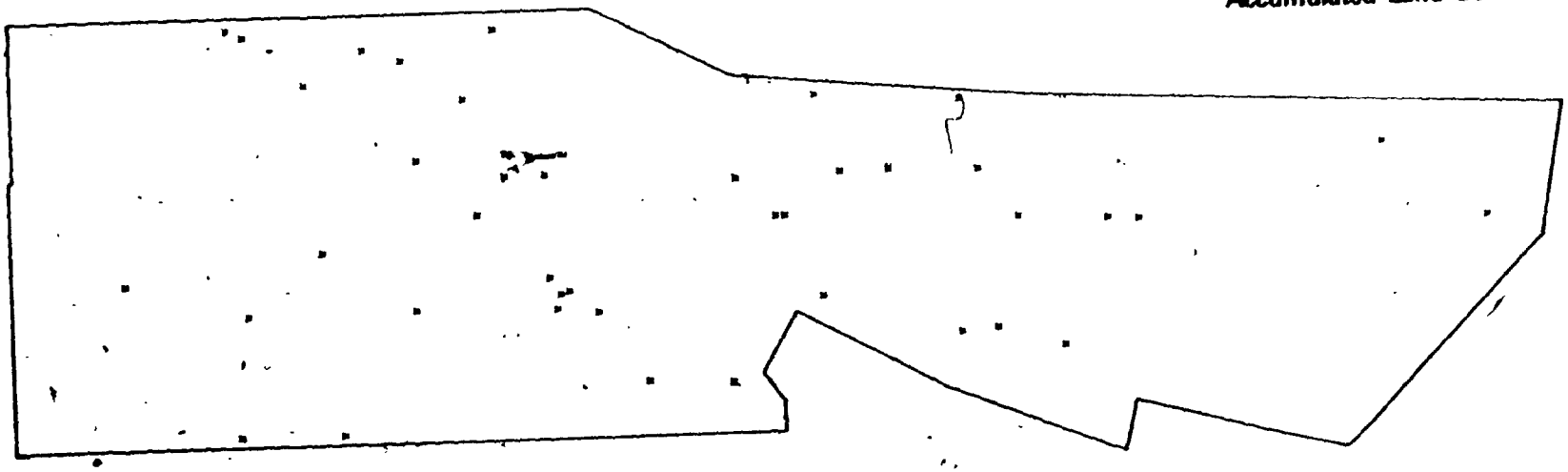
Map XXXIII

Guatemala City.

Accumulated Land Use 55



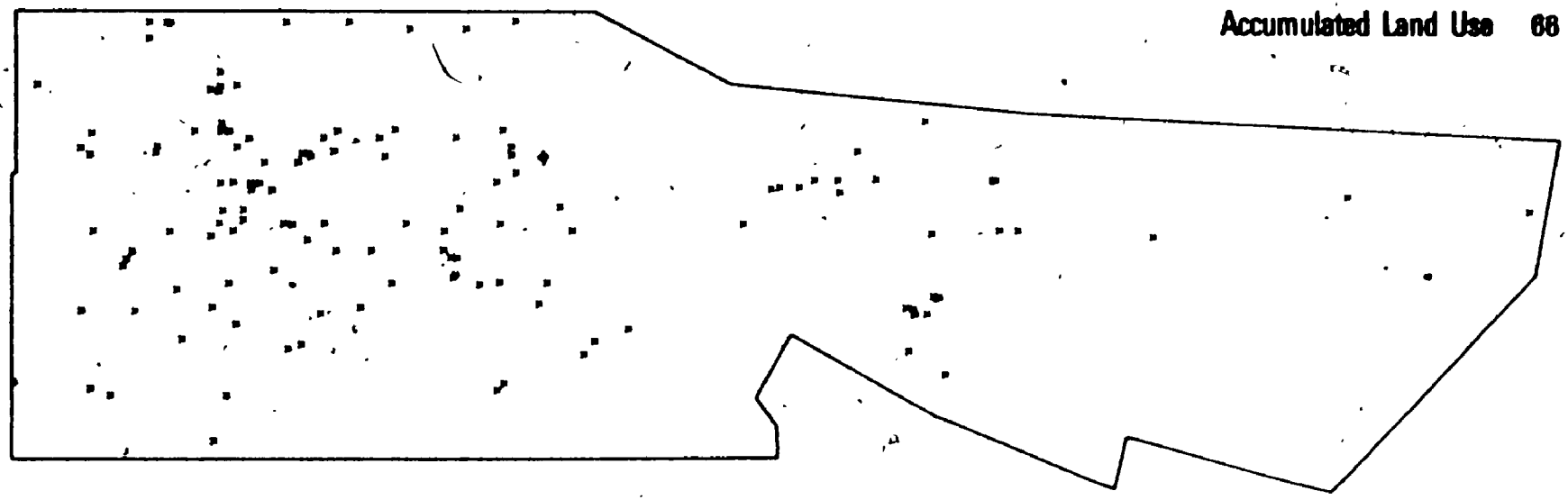
Accumulated Land Use 64



Map XXXIV

Guatemala City.

Accumulated Land Use 68

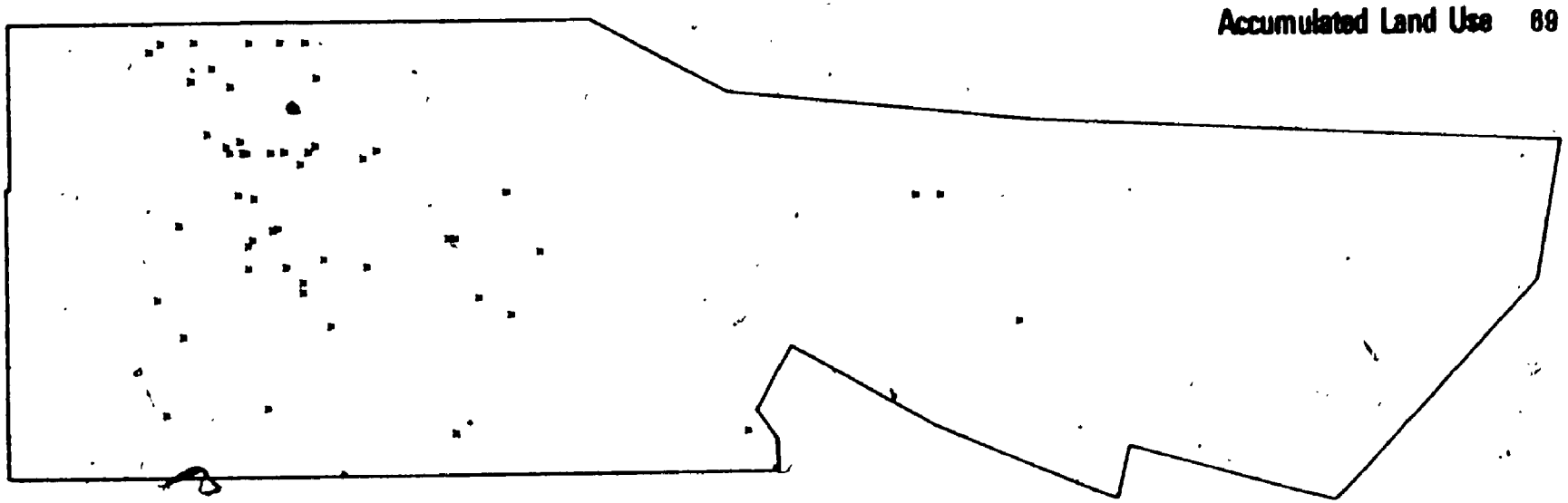


Accumulated Land Use 68

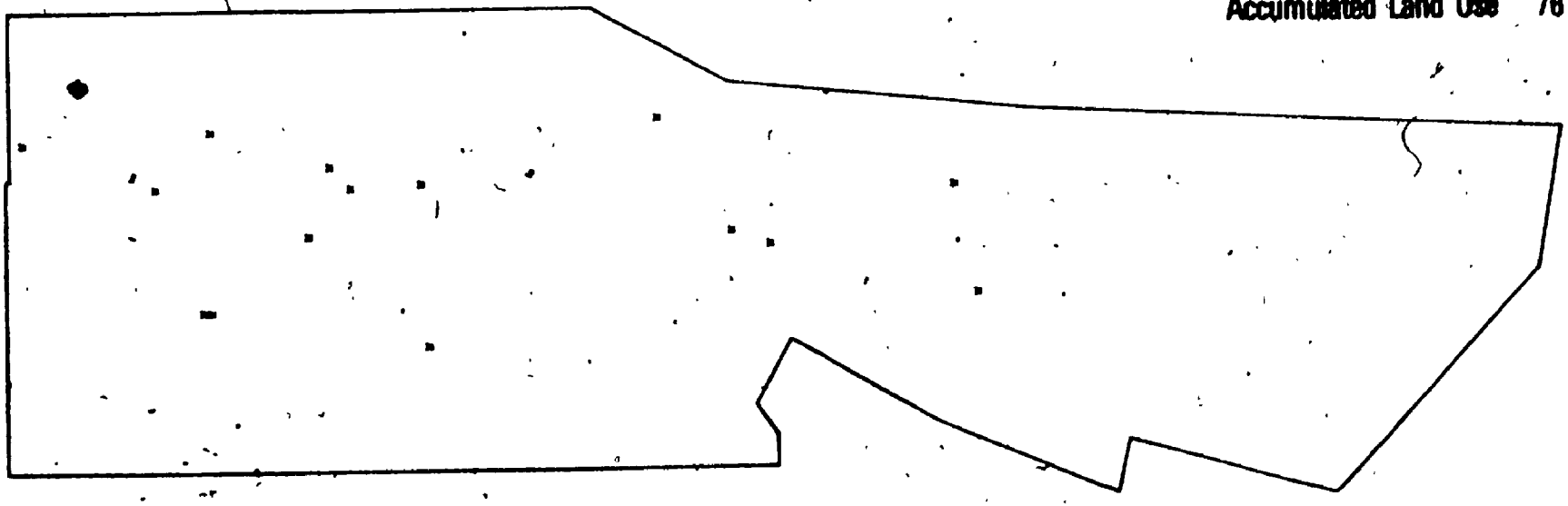
Map XXXV

Guatemala City.

Accumulated Land Use 69



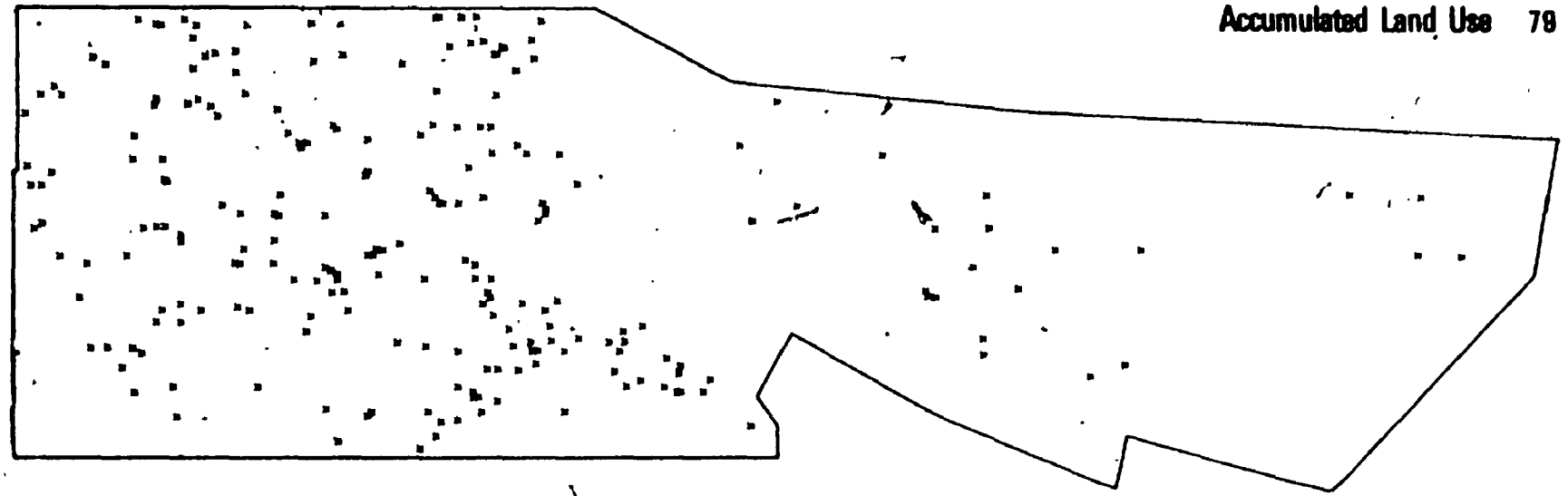
Accumulated Land Use 76



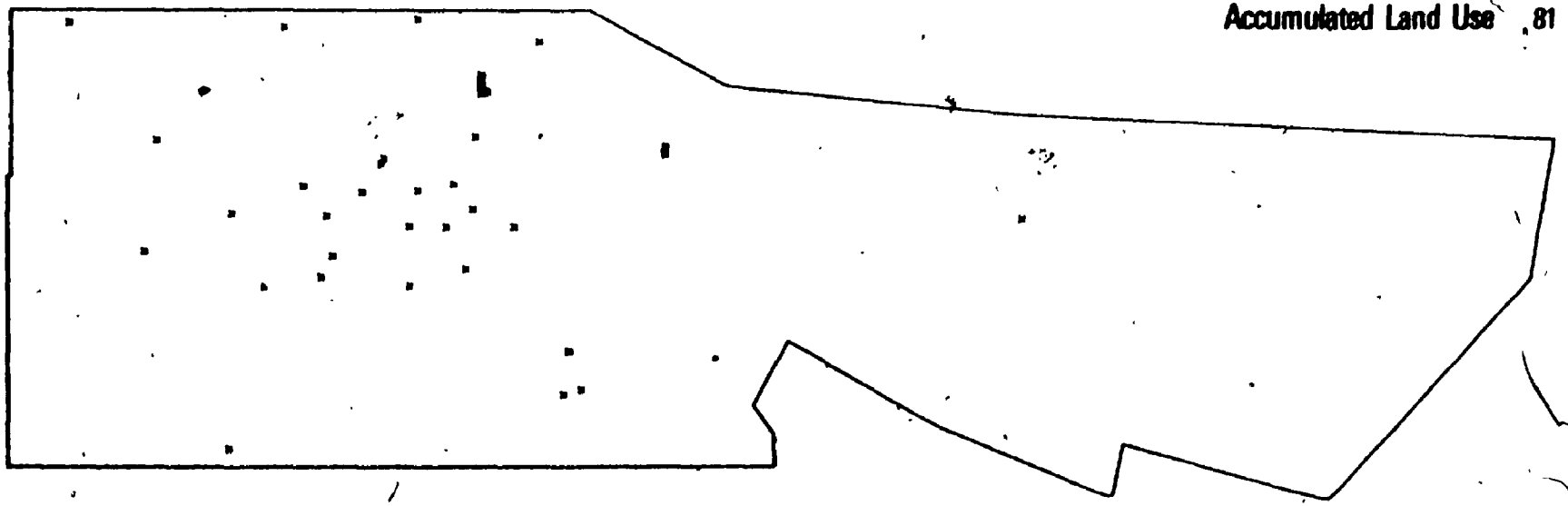
Map XXXVI

Guatemala City,

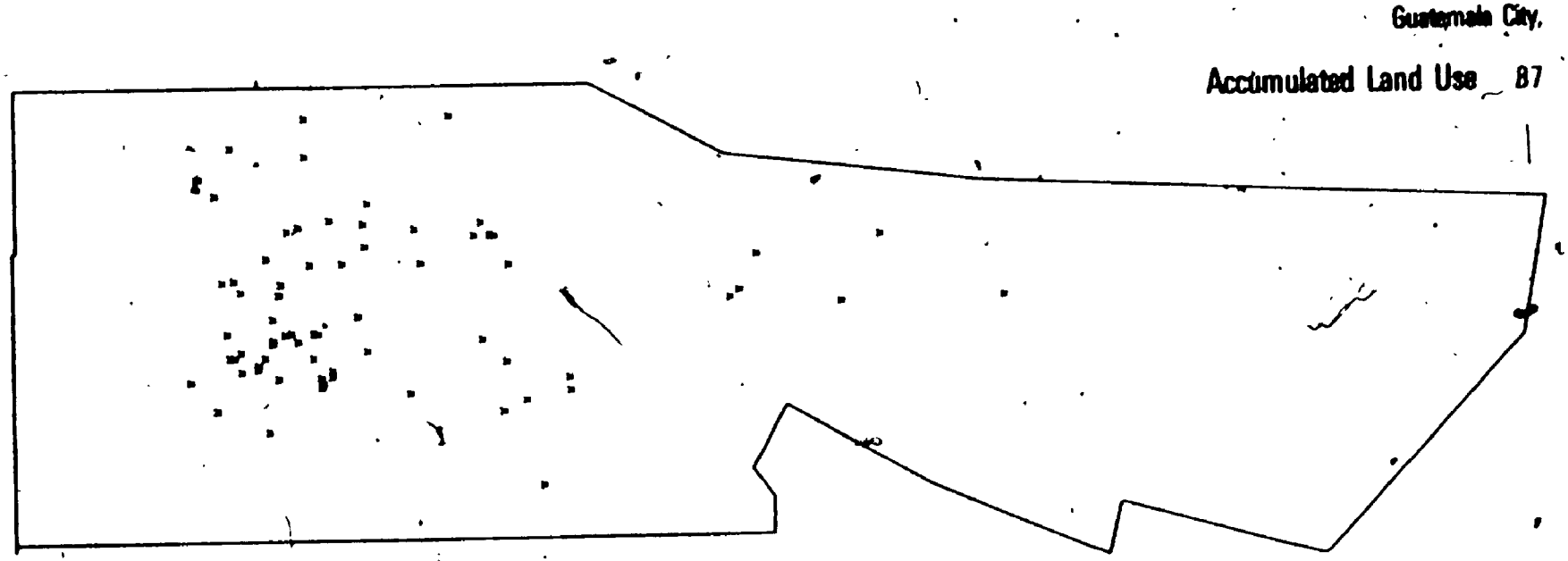
Accumulated Land Use 78



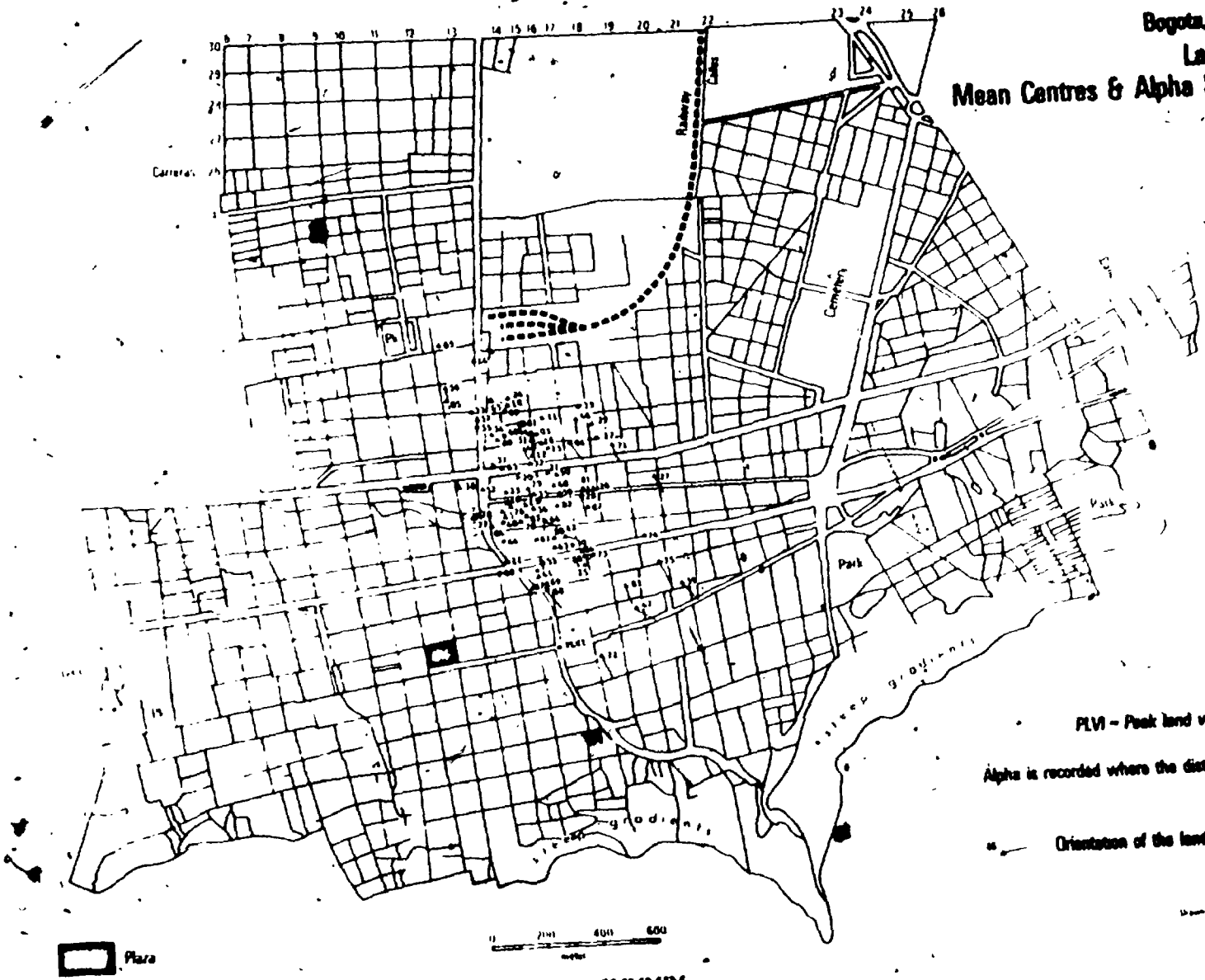
Accumulated Land Use 81



Map XXXVII



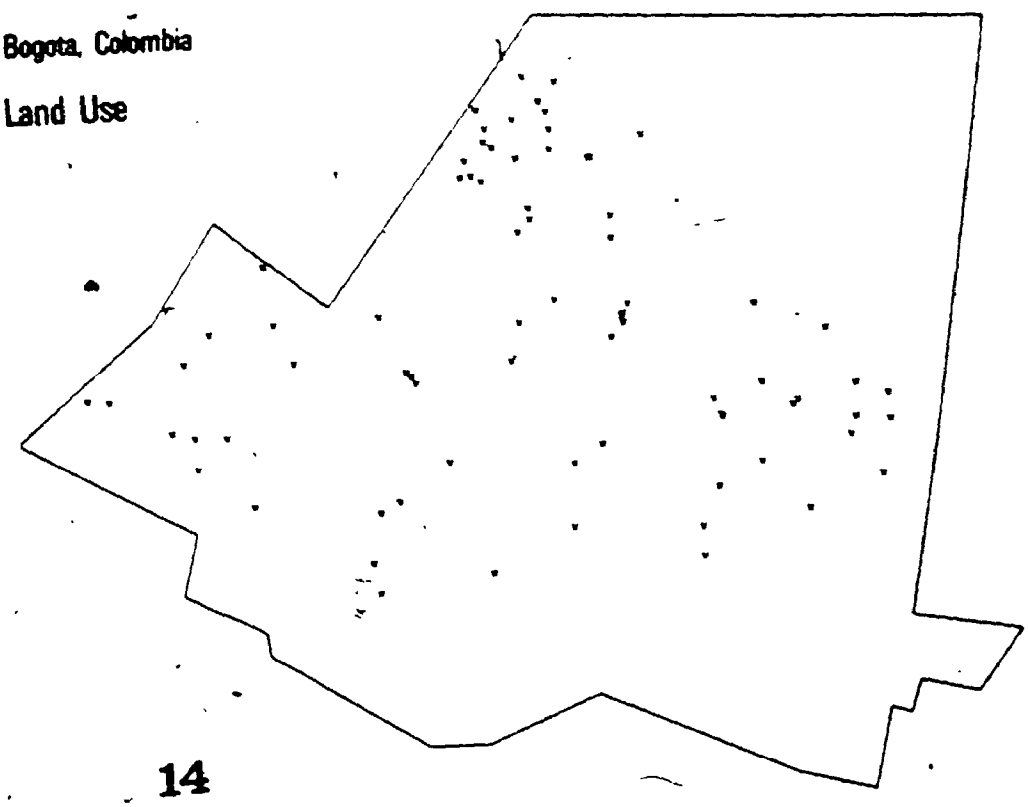
Map XXXVIII


Bogota, Colombia
Land Uses
Mean Centres & Alpha Statistics
Railway
Cemetery
Park
PLVI – Peak land value intersection.
Alpha is recorded where the distribution is linear.
Orientation of the land use distribution.
Plaza

Map XXXIX

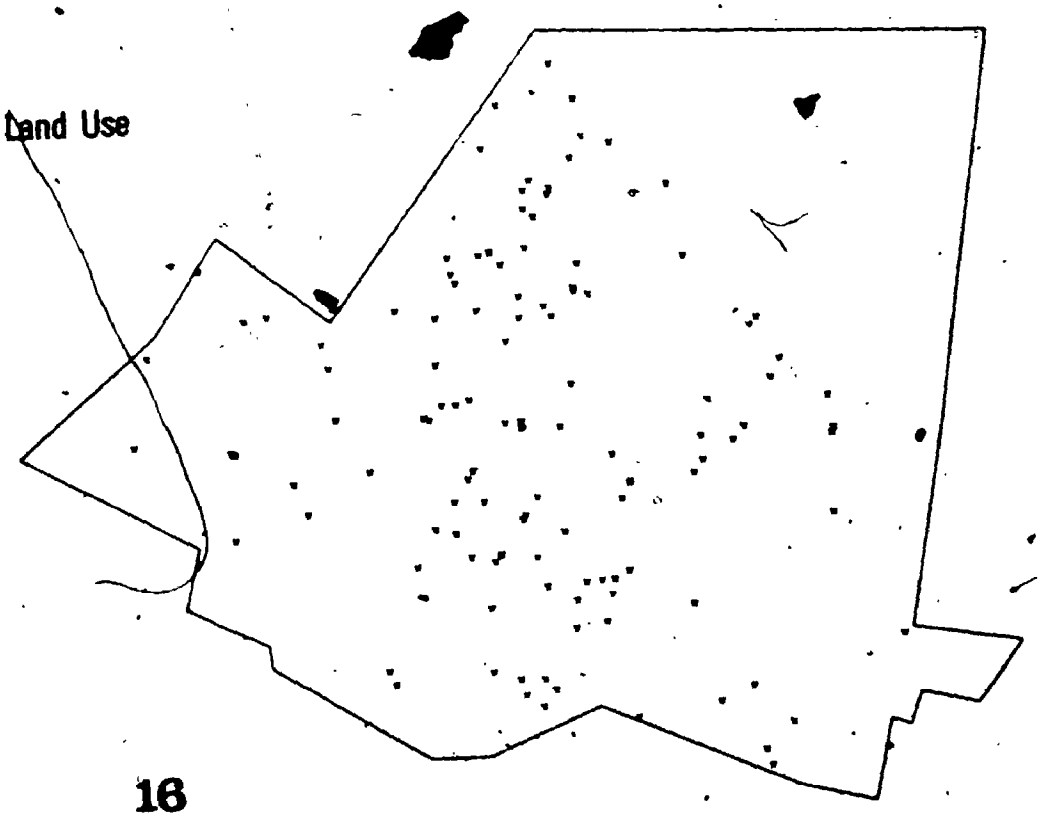
Bogota, Colombia

Land Use



14

Land Use

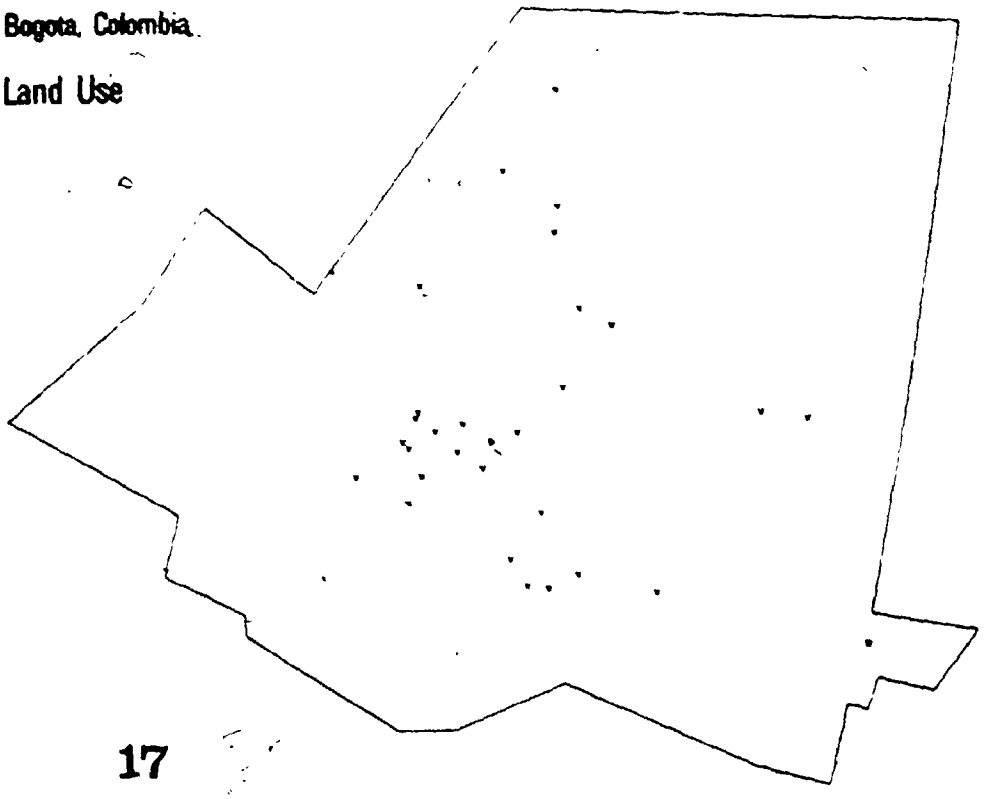


16

Map XL

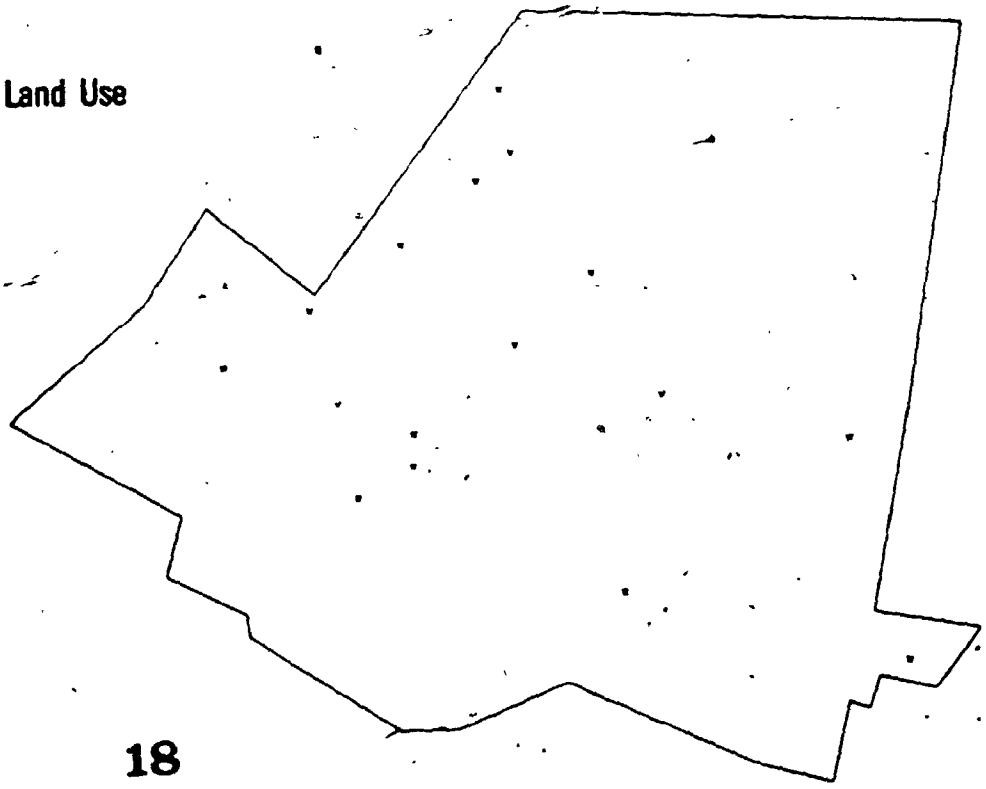
Bogota, Colombia

Land Use



17

Land Use

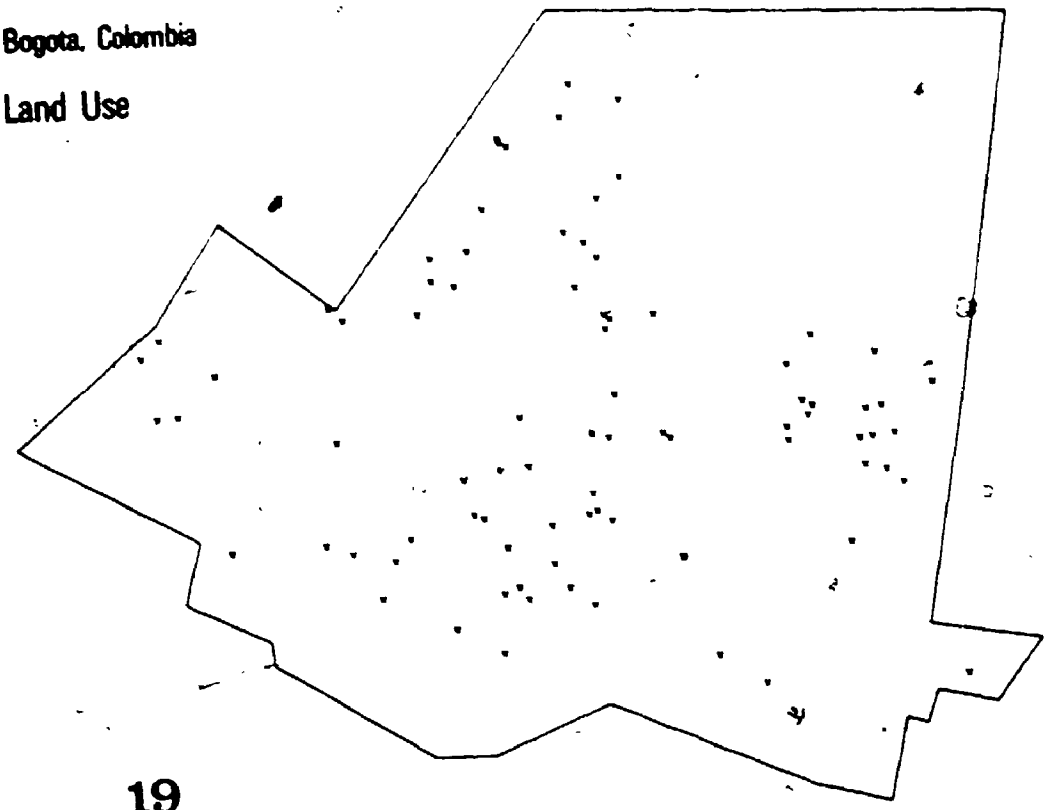


18

Map XLI

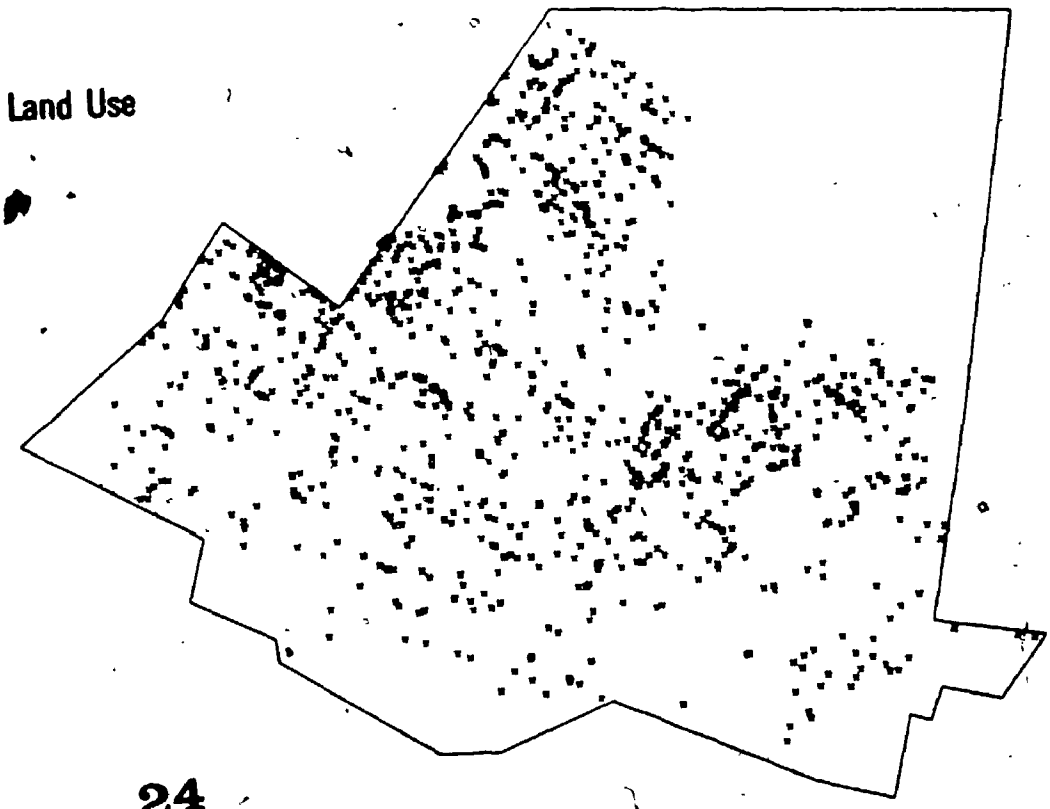
Bogota, Colombia

Land Use



19

Land Use

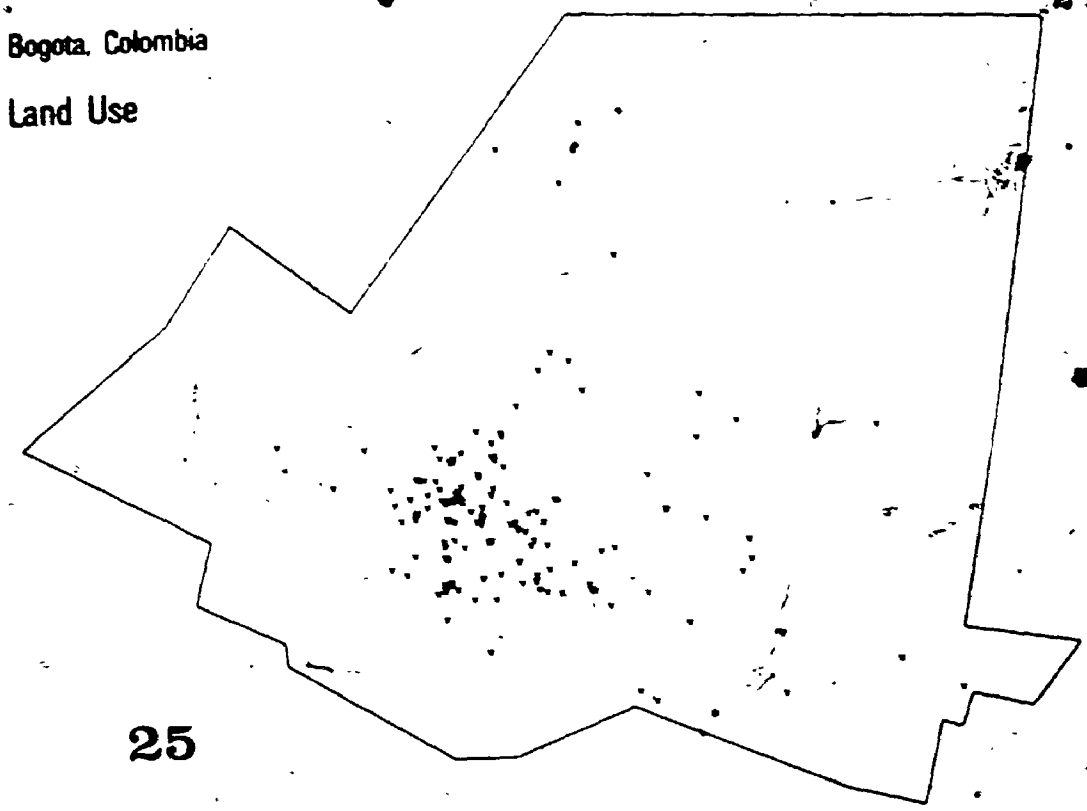


24

Map XLII

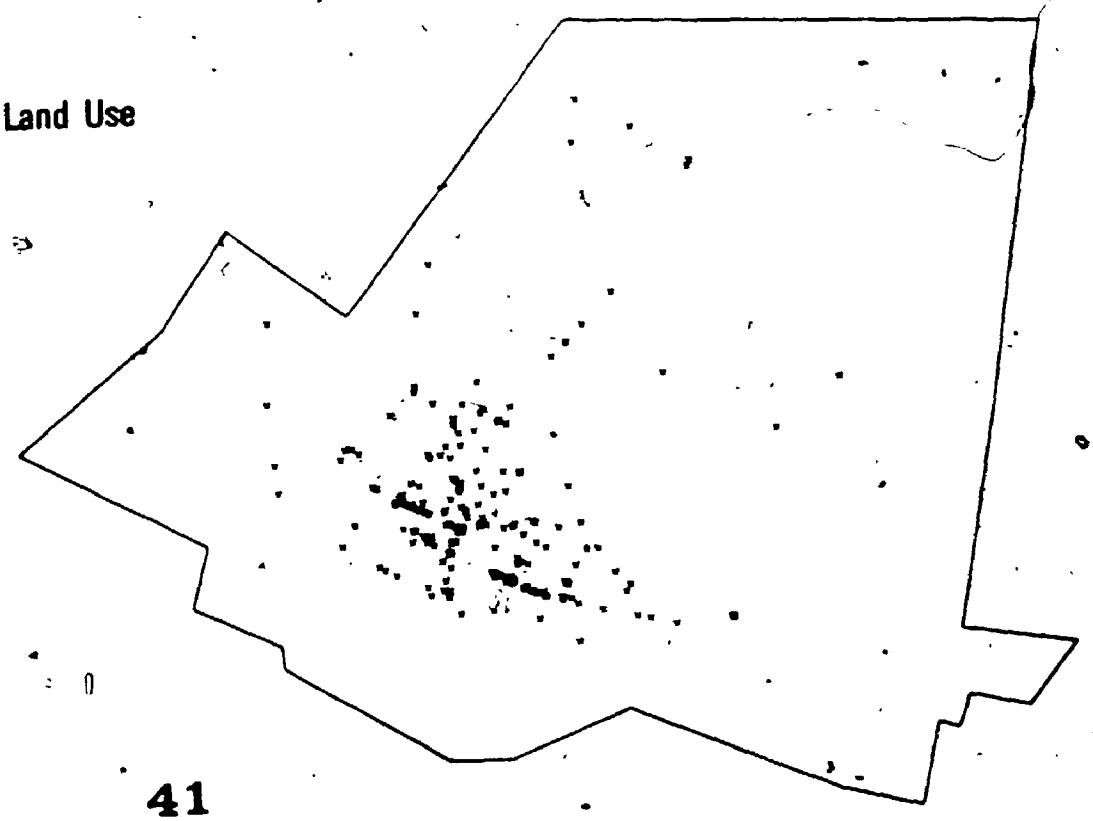
Bogota, Colombia

Land Use



25

Land Use

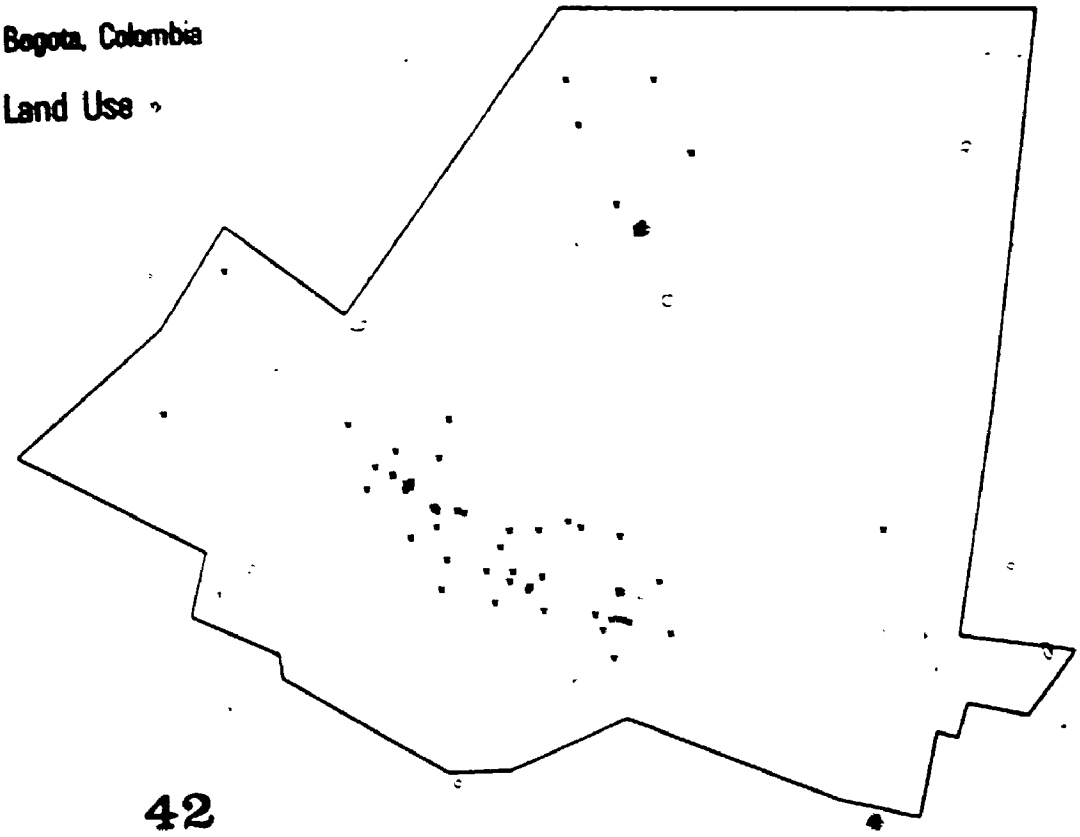


41

Map XLIII

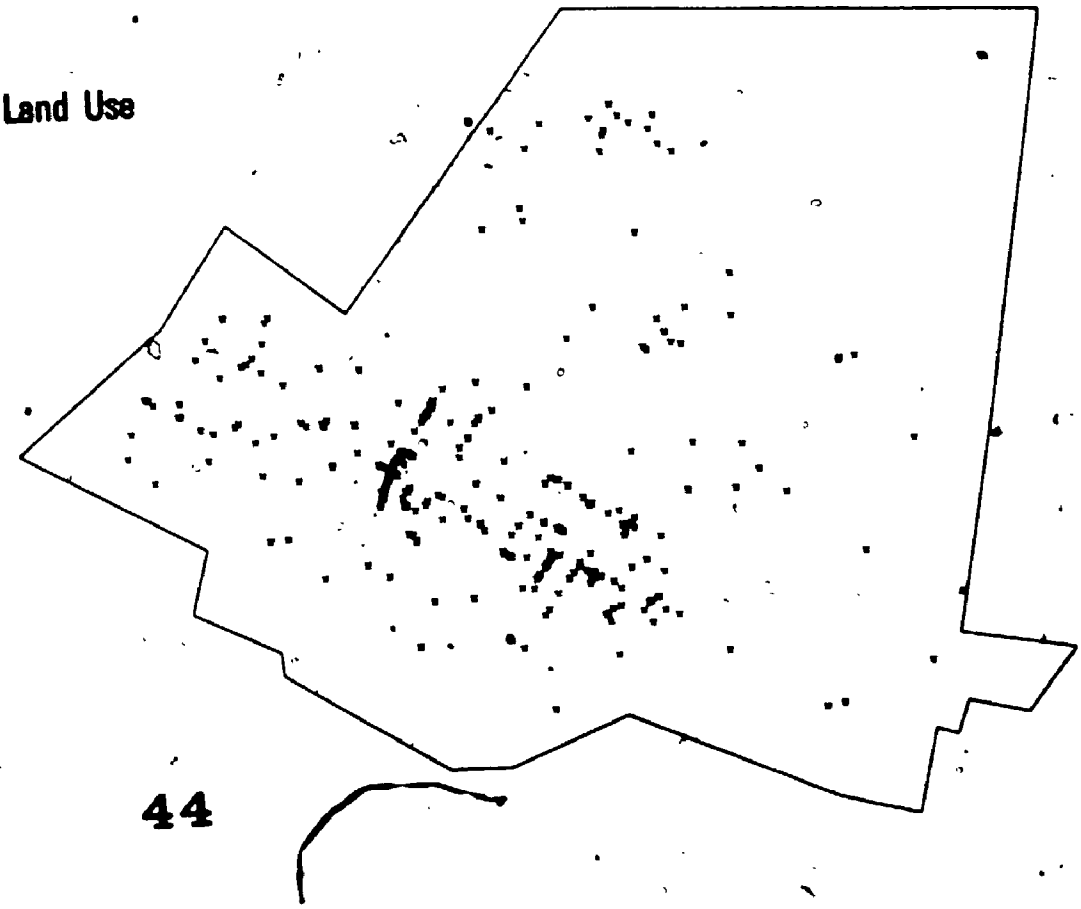
Bogota, Colombia

Land Use



42

Land Use

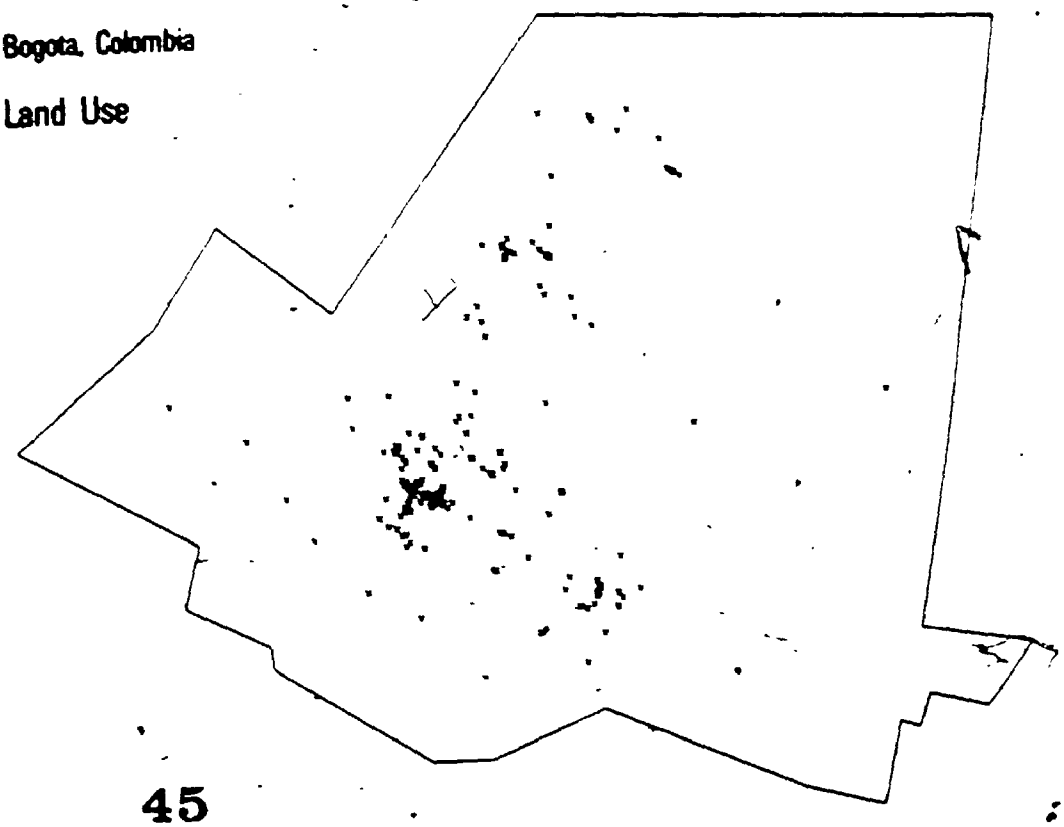


44

Map XLIV

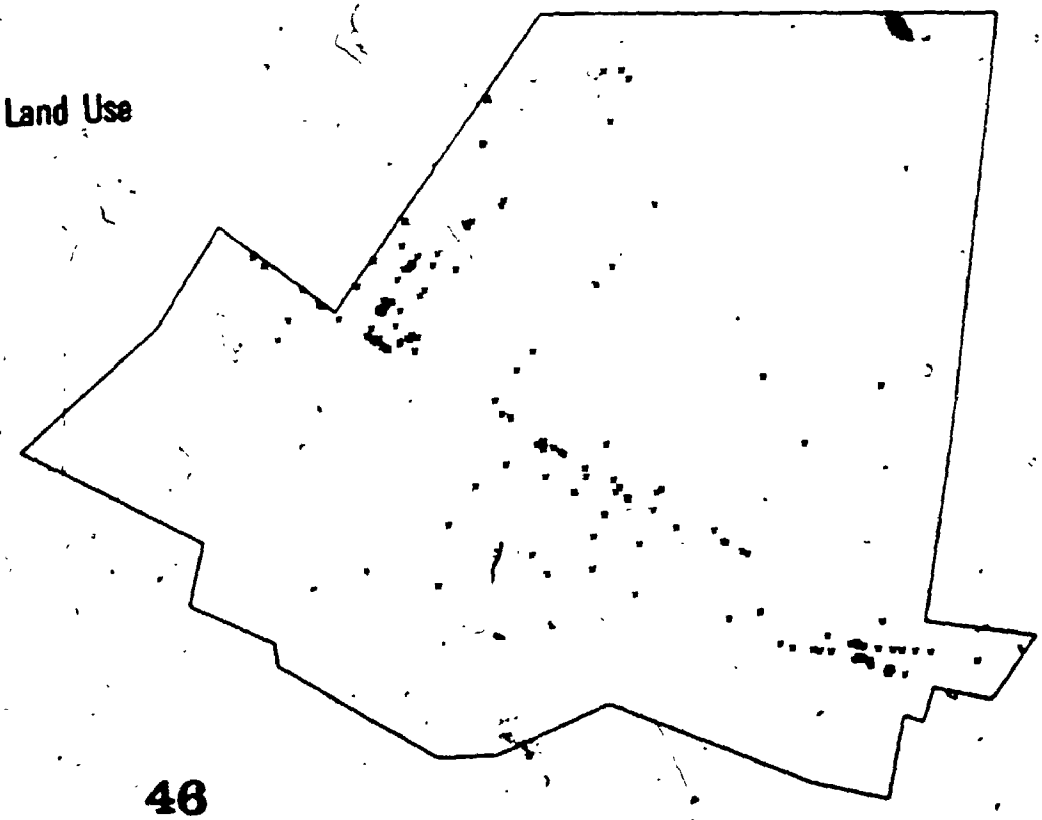
Bogota, Colombia

Land Use



45

Land Use



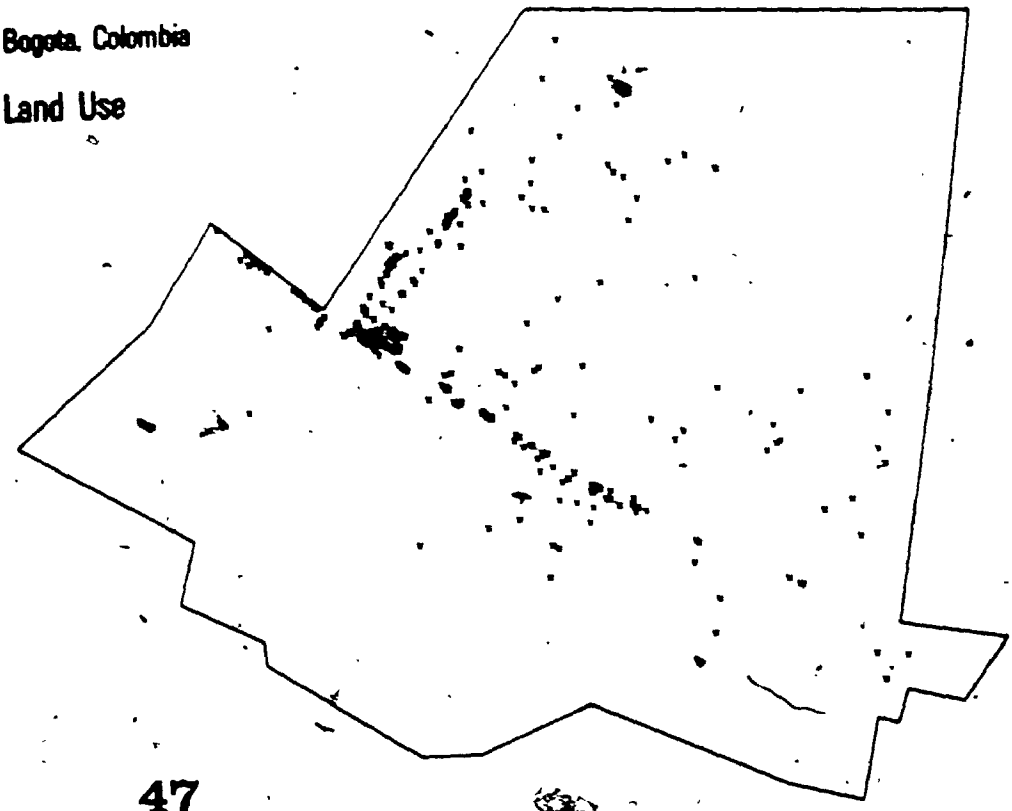
46

Map XLV

220

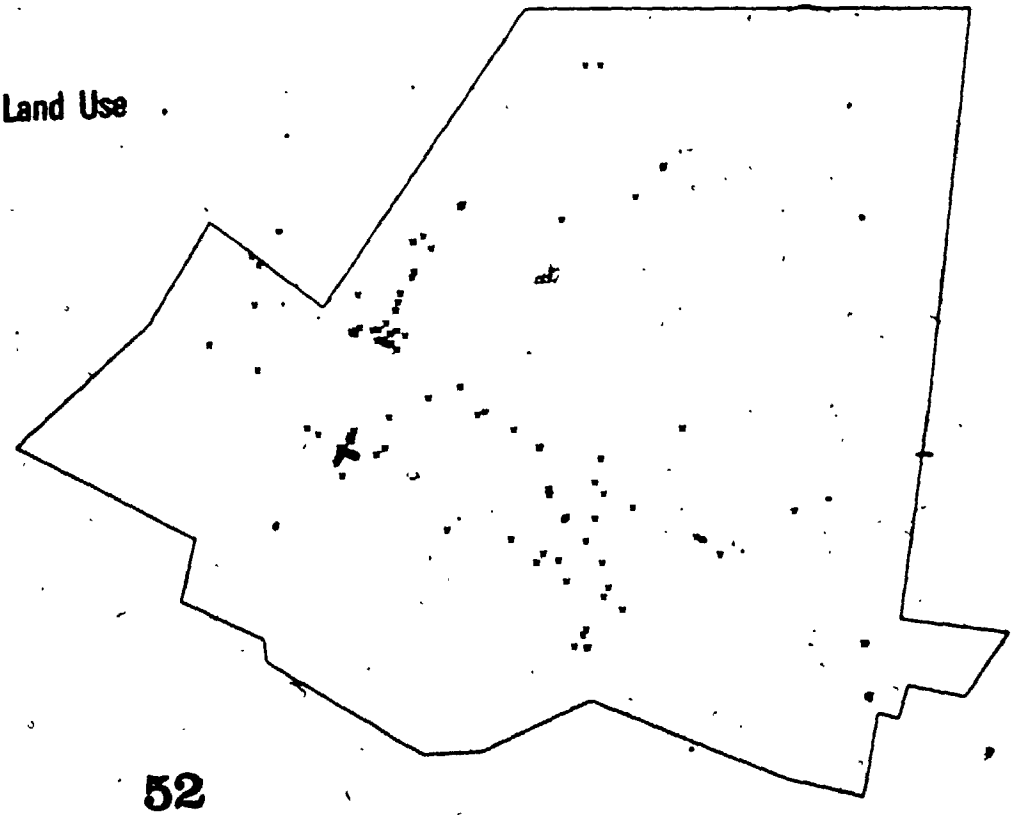
Bogota, Colombia

Land Use



47

Land Use

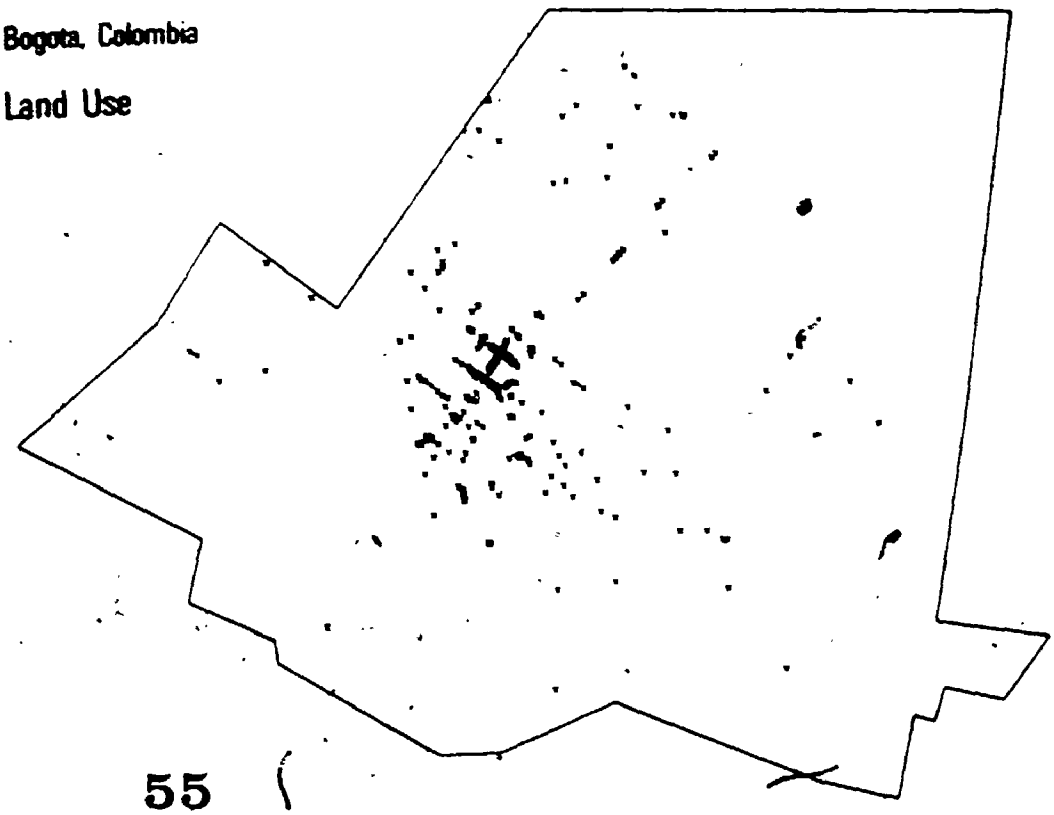


52

Map XLVI

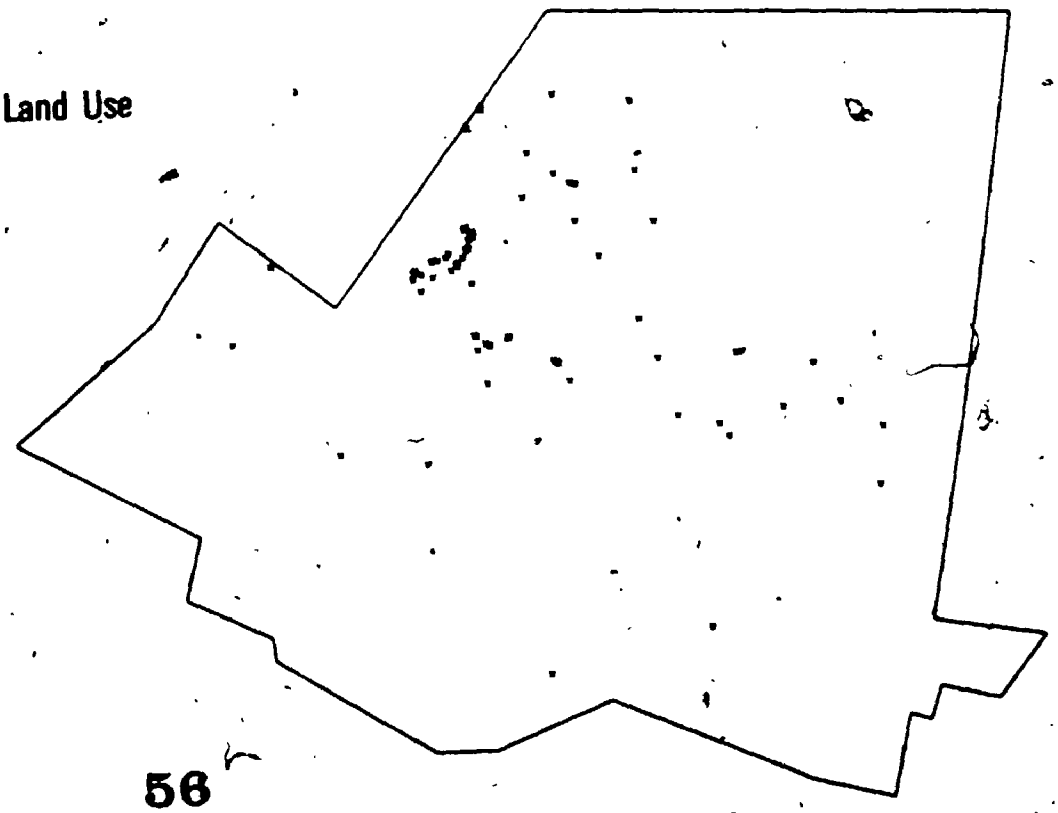
Bogota, Colombia

Land Use



55

Land Use

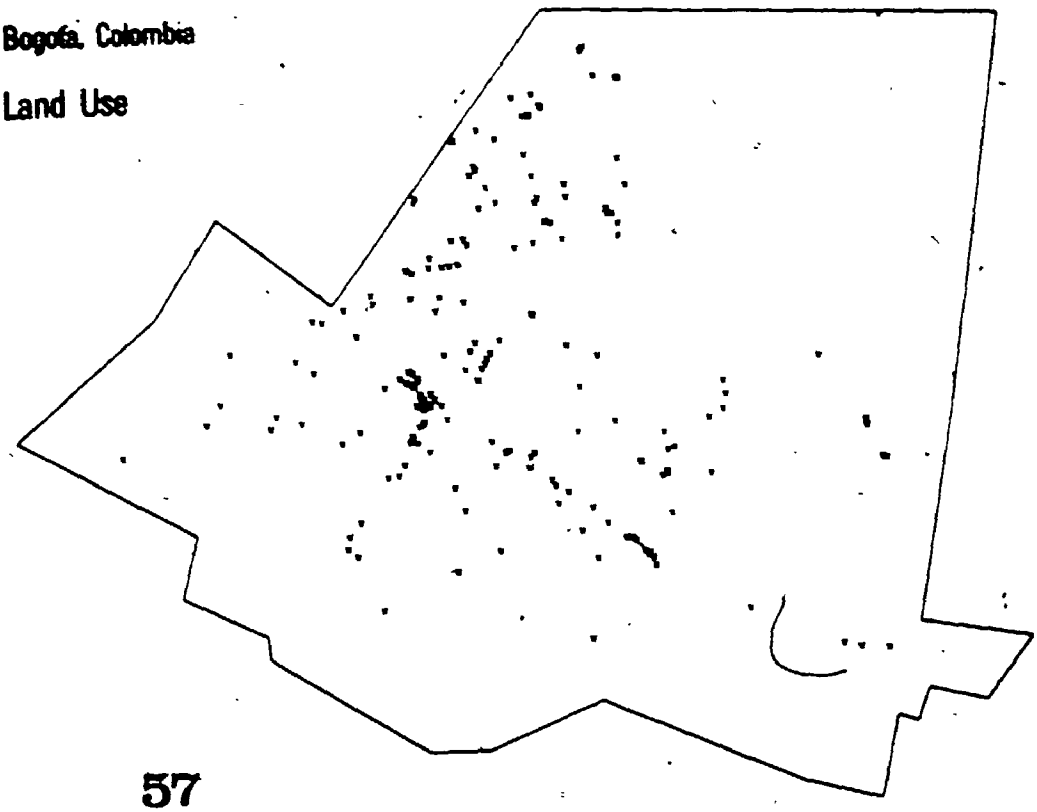


56

Map XLVII

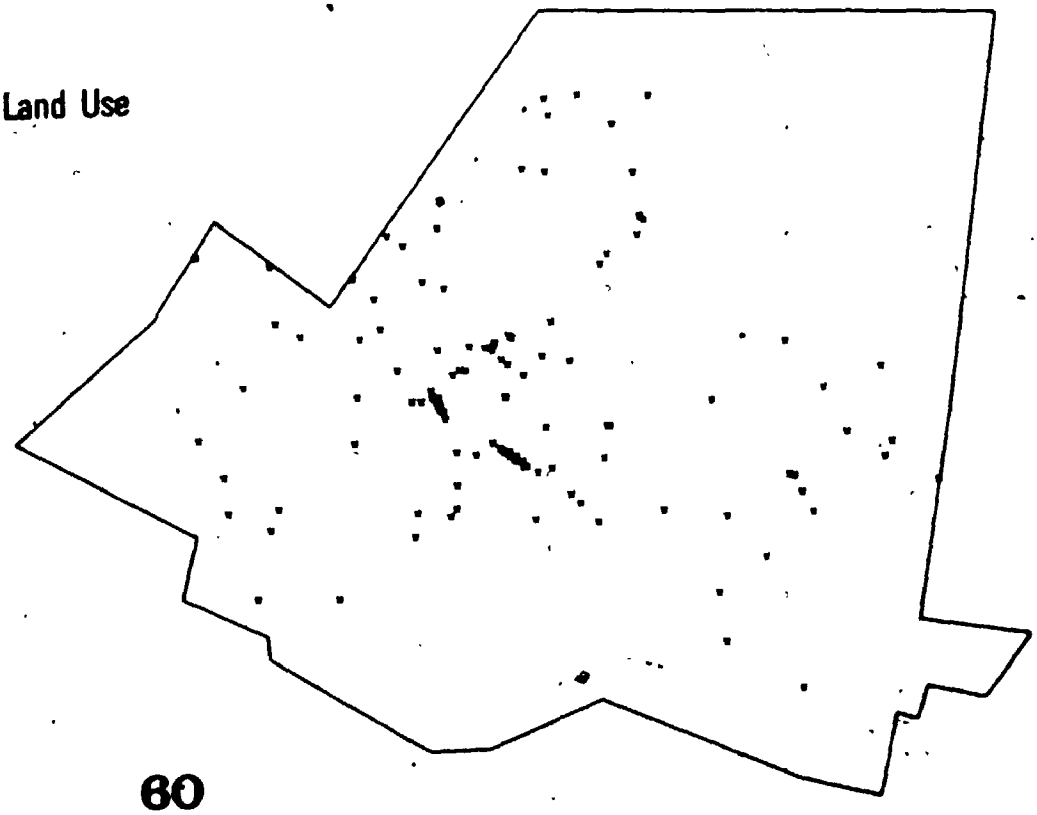
Bogotá, Colombia

Land Use



57

Land Use

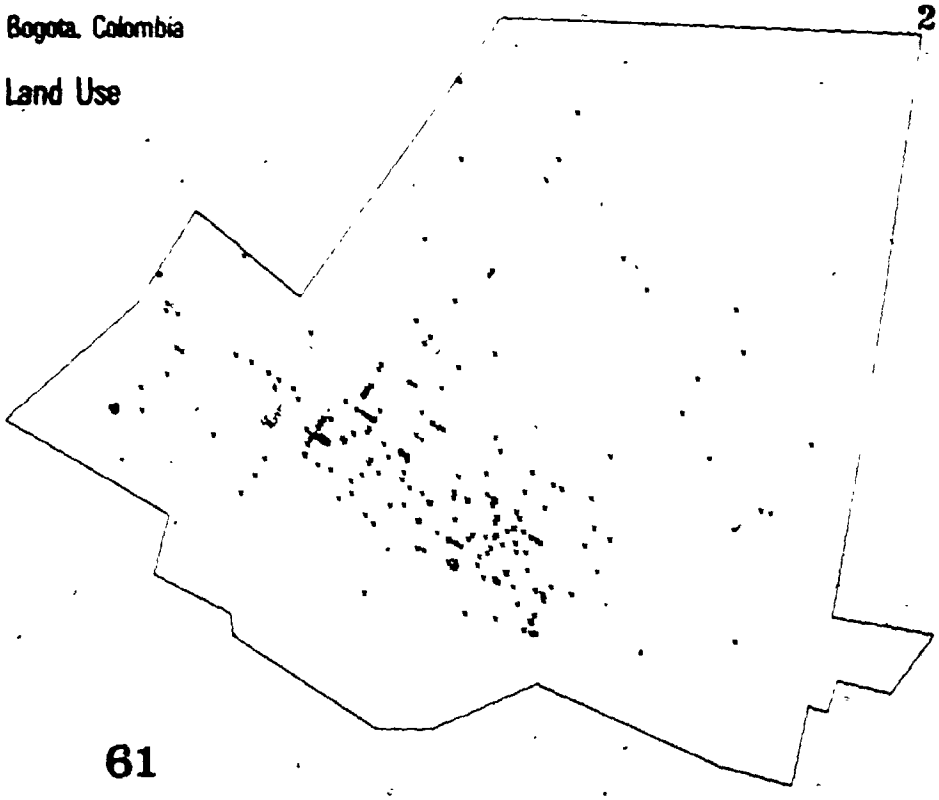


60

Map XLVIII

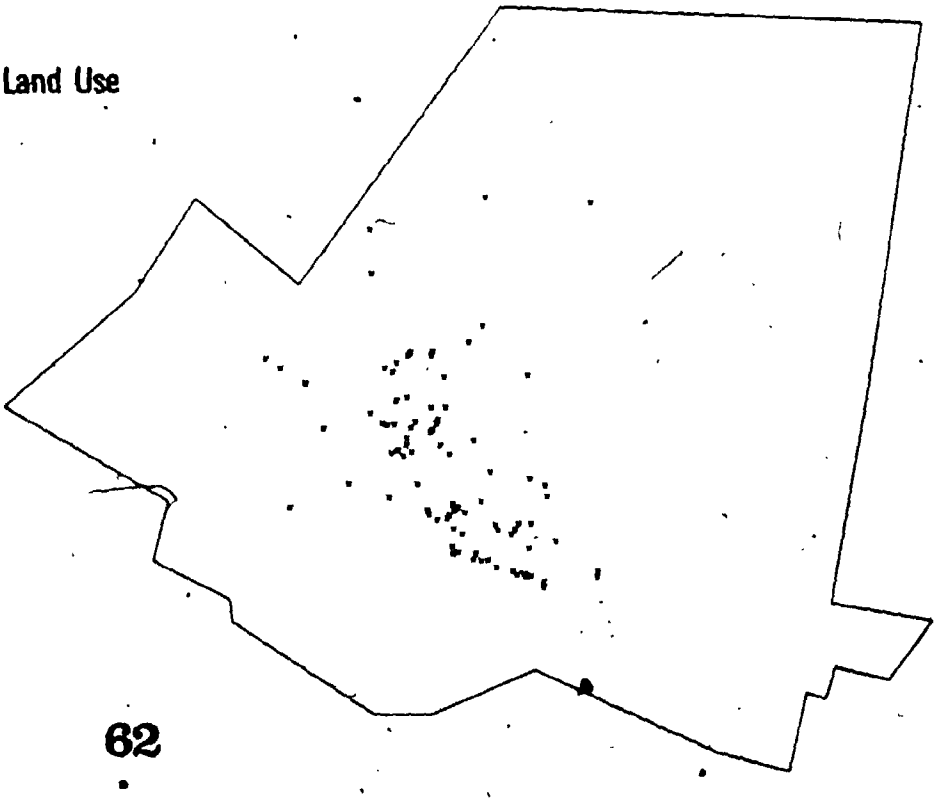
Bogota, Colombia

Land Use



61

Land Use

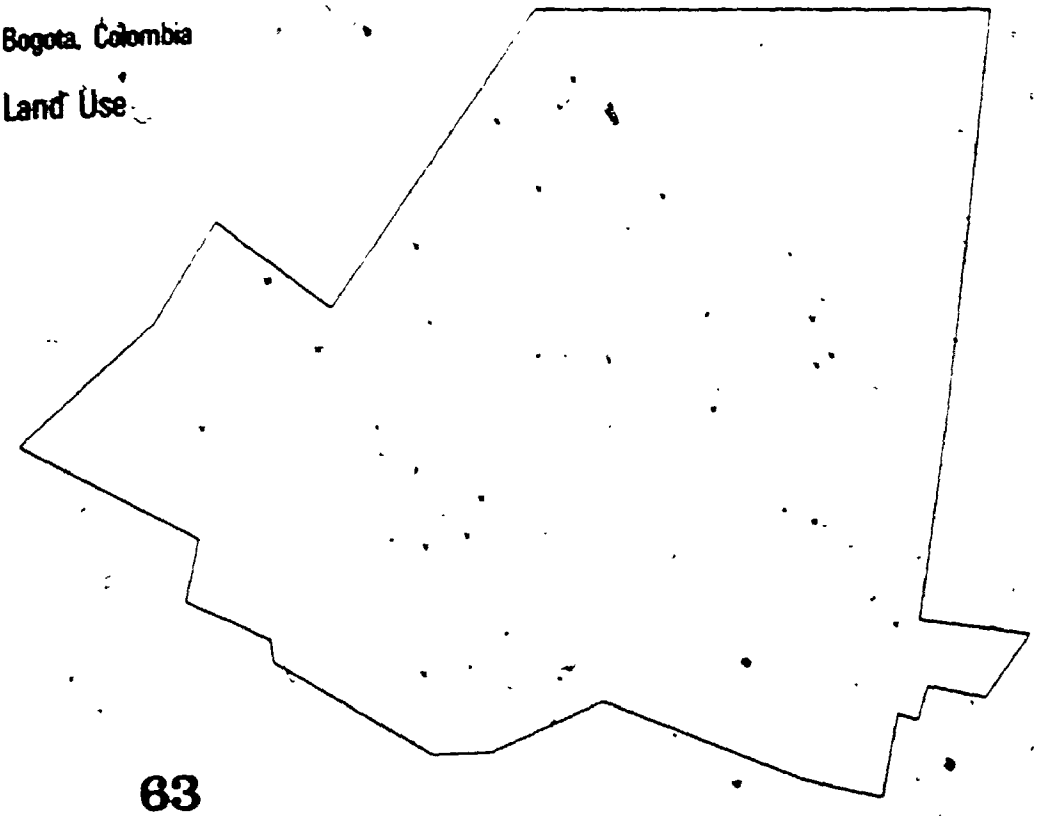


62

Map XLIX

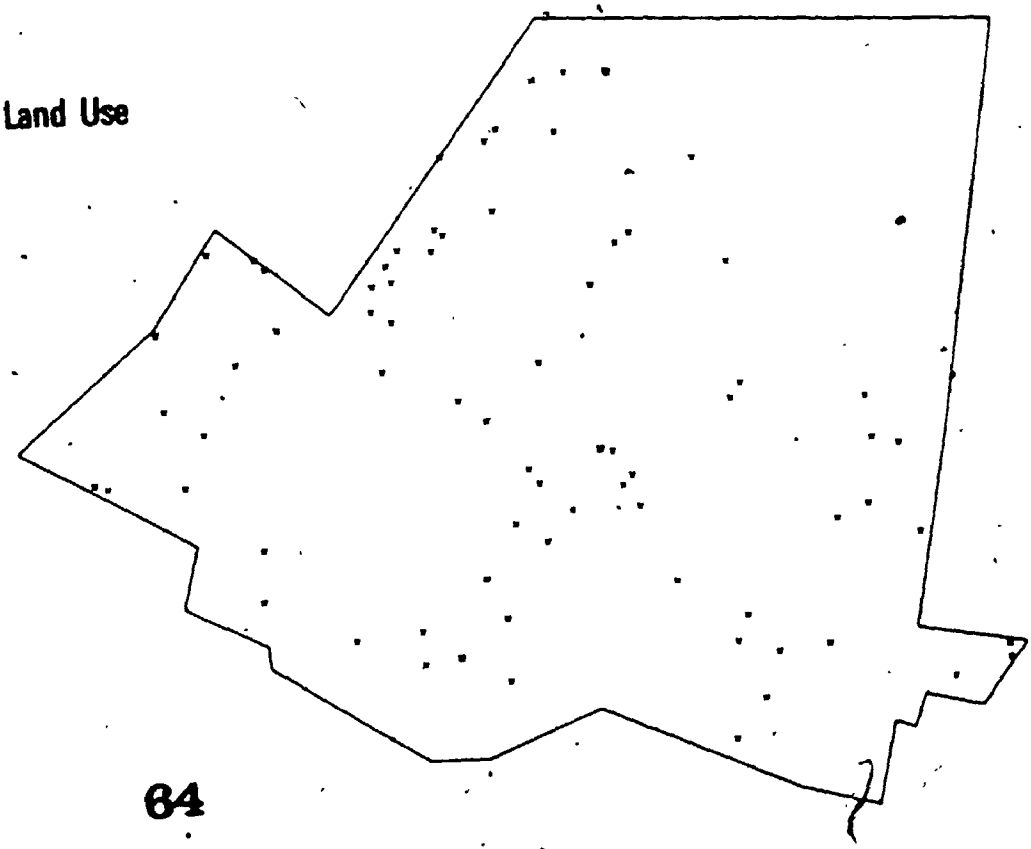
Bogota, Colombia

Land Use



63

Land Use

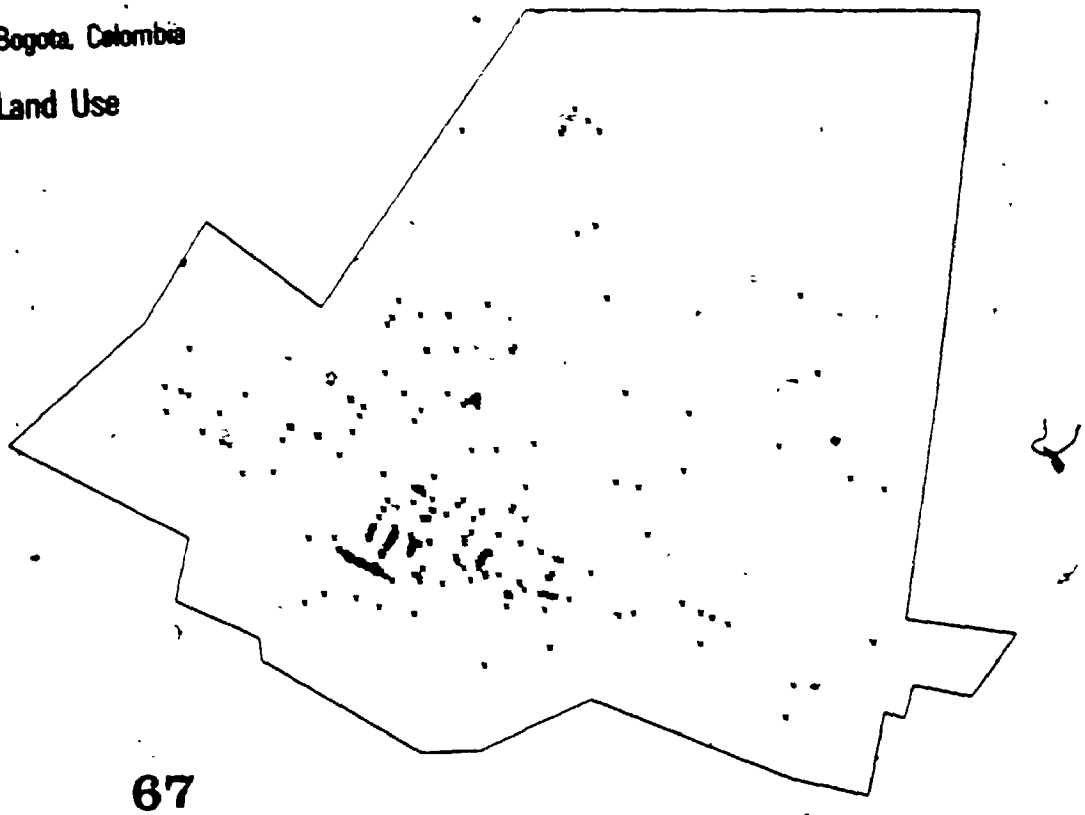


64

Map L

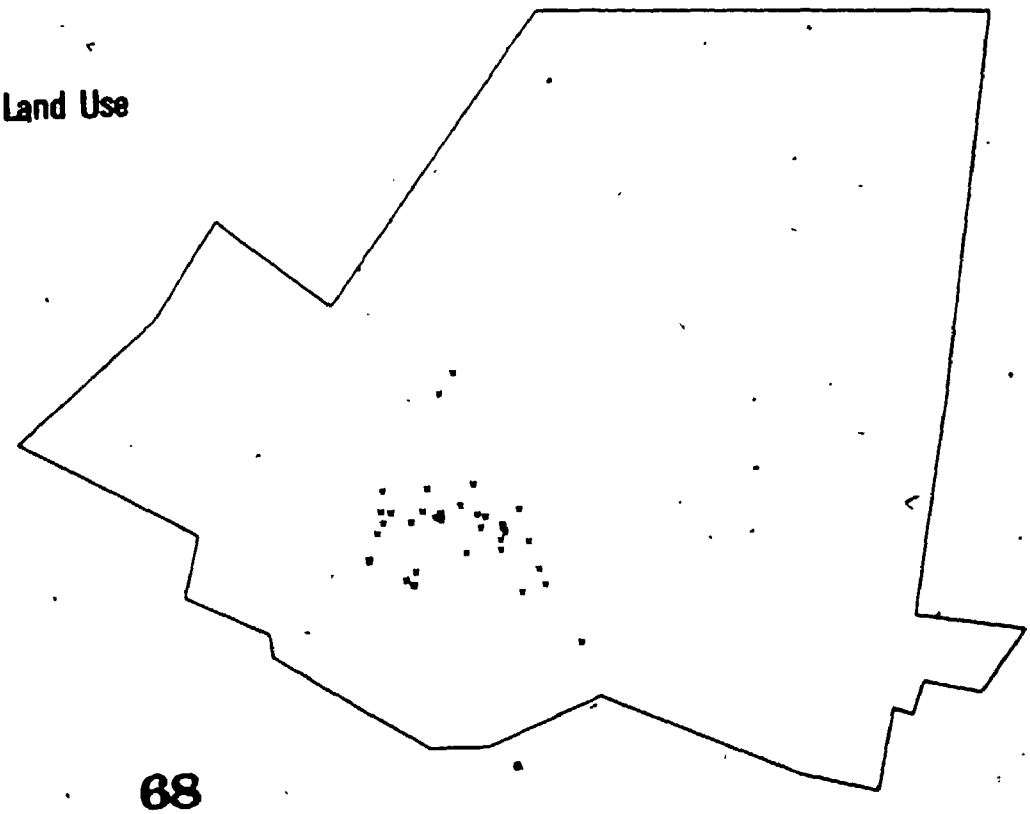
Bogota, Colombia

Land Use



67

Land Use

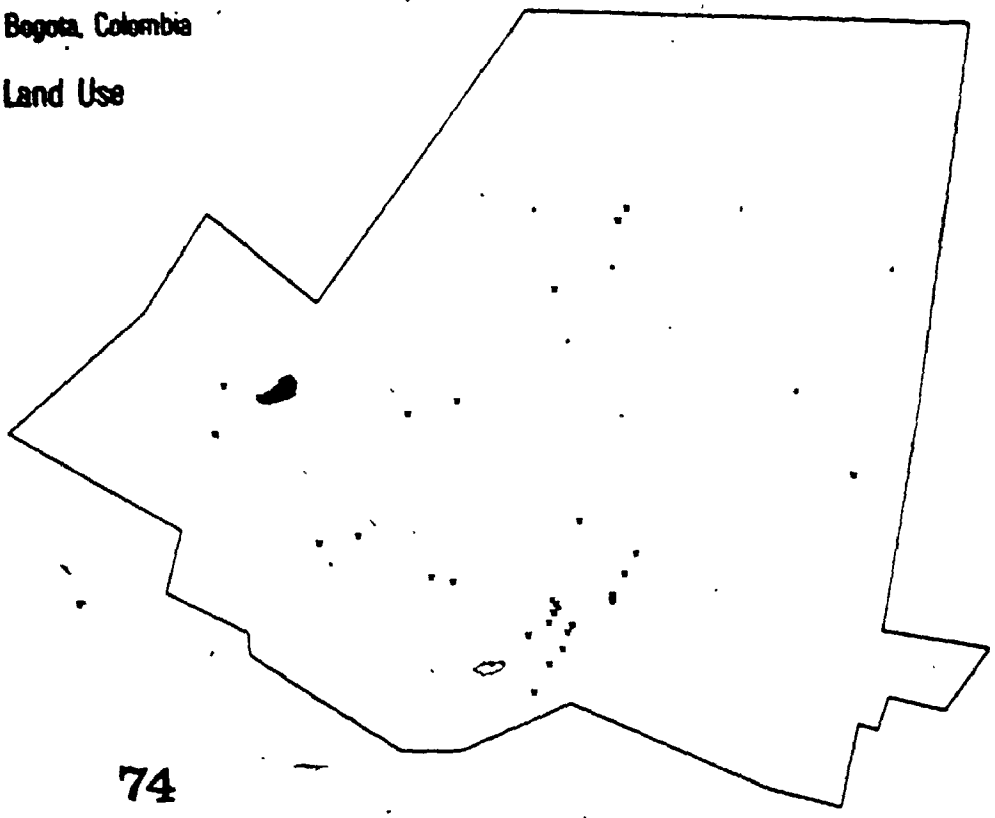


68

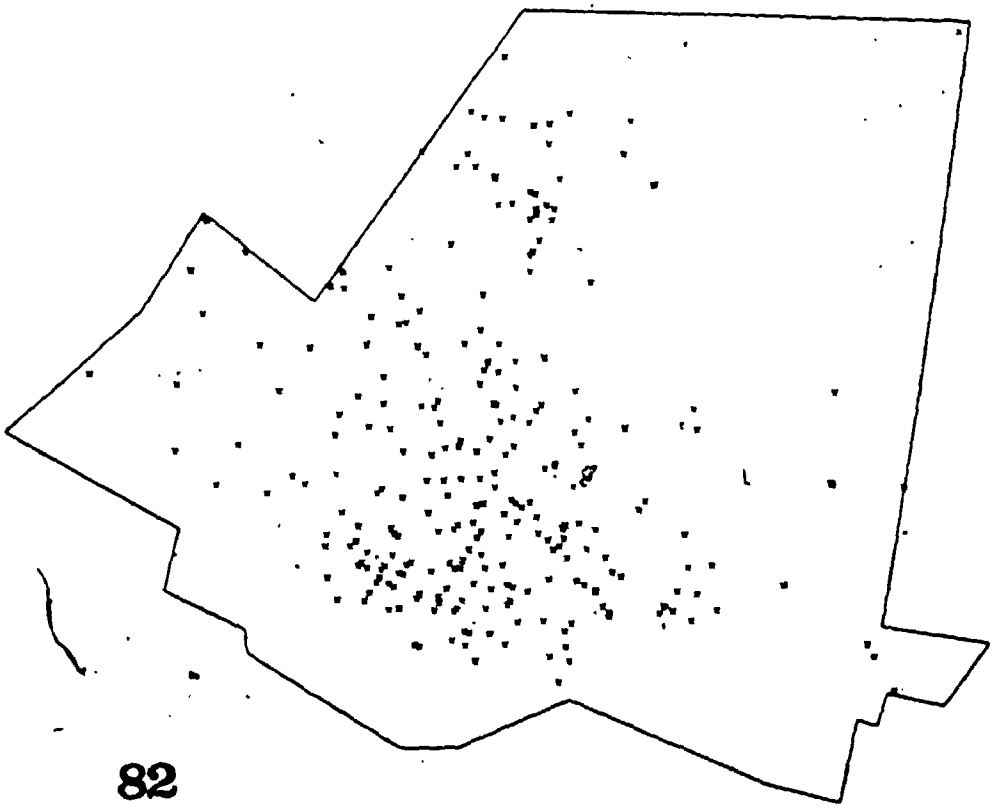
Map LI

Bogota, Colombia

Land Use



74

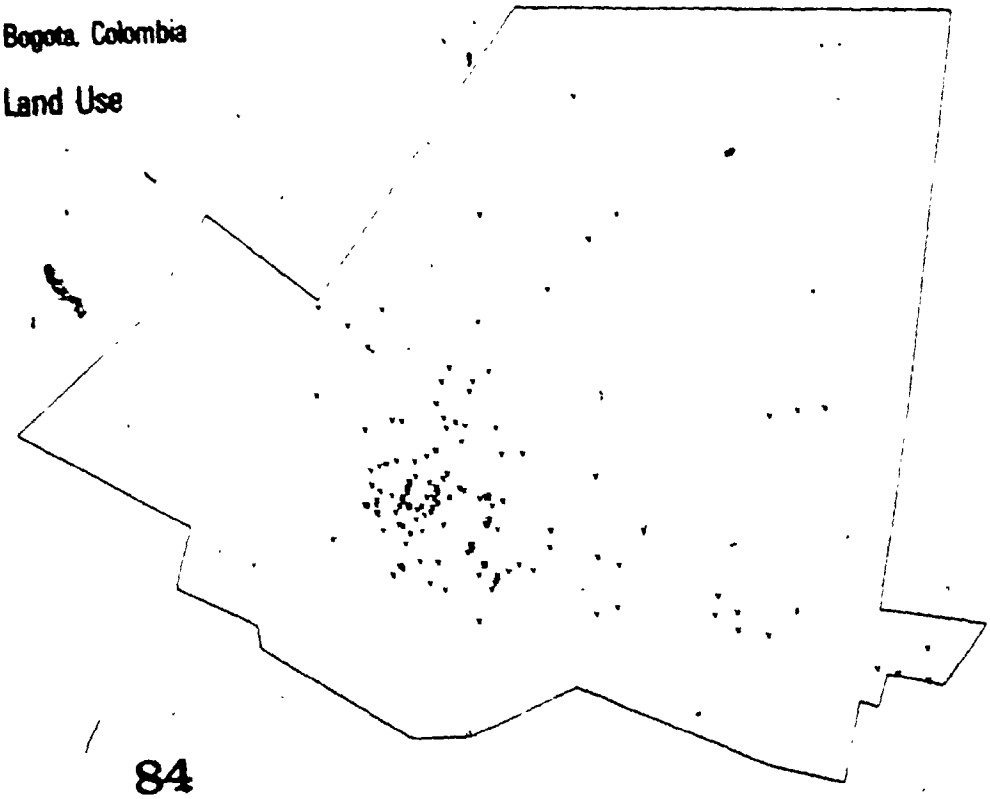


82

Map LII

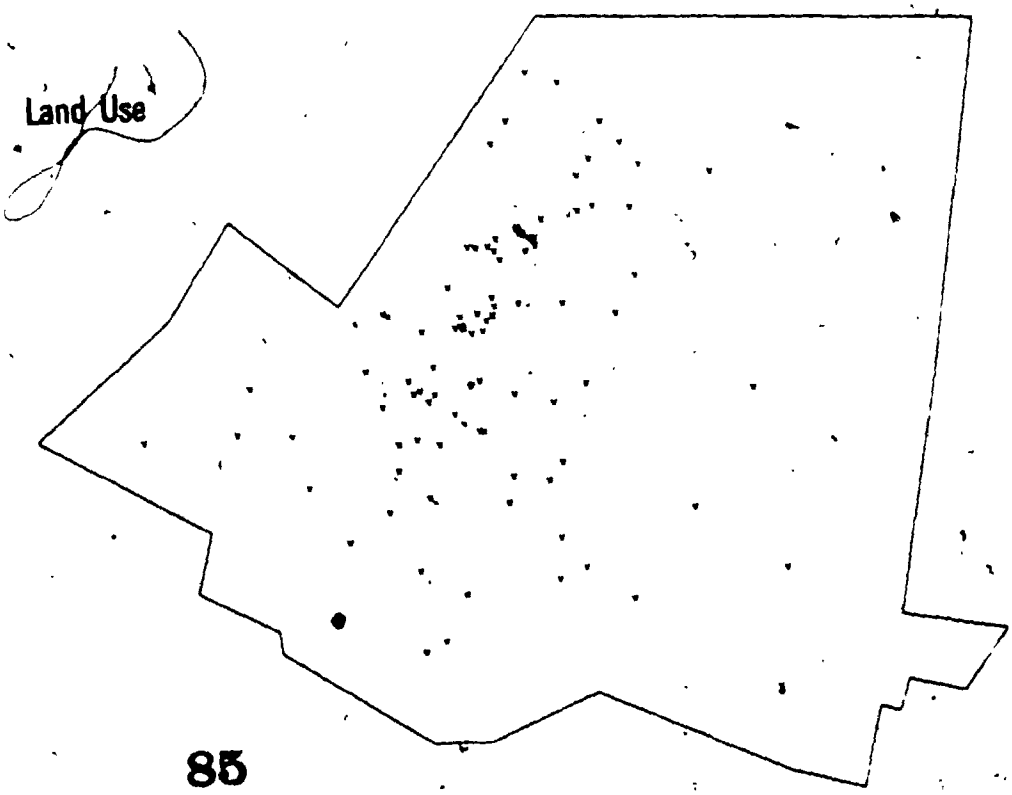
Bogota, Colombia

Land Use



84

Land Use

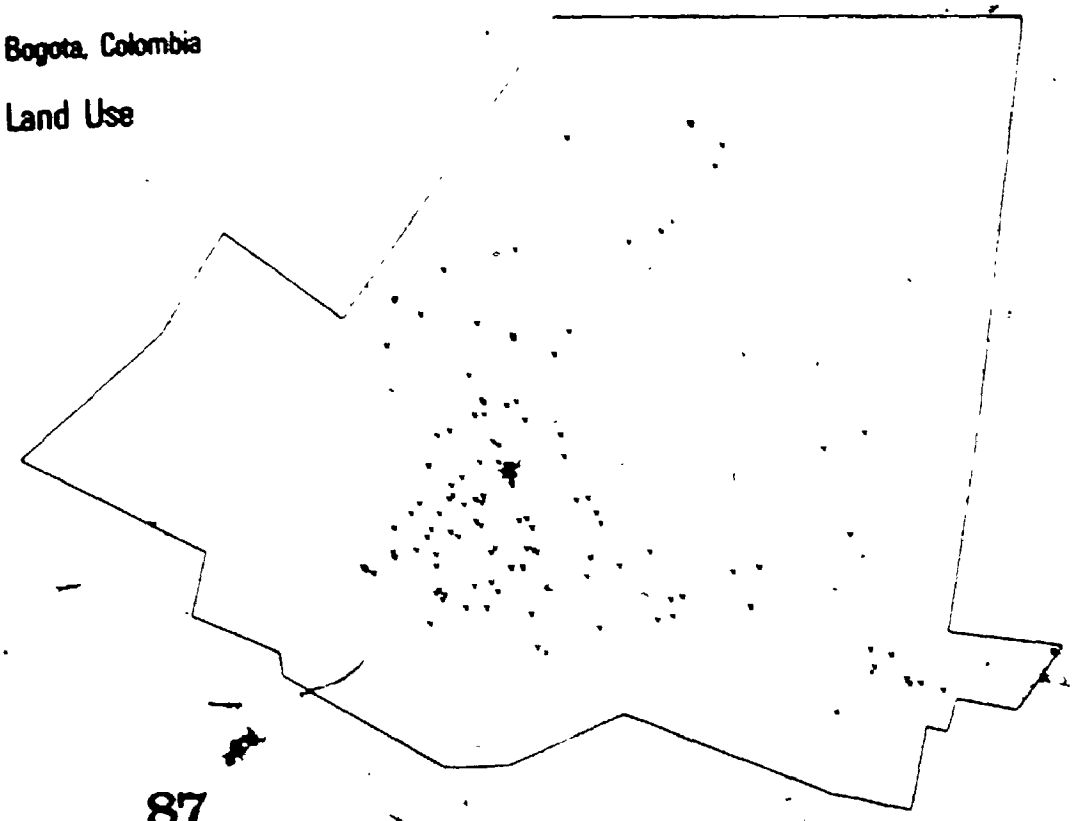


85

Map LIII

Bogota, Colombia

Land Use



87

Land Use

88

Map LIV