*Aerial Photographic Interpretation and the Social Structure of the City**†

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ABSTRACT: *This paper discusses the rationale, procedures and findings of research studies exploring applications of aerial photographic interpretation in urban sociology. The concept of the "urban socio-physical nexus" generates the underlying hypothesis indicating the feasibility of interpreting social data from aerial photographs. This position recognizes that urban social systems exist in a physical environment, and that they are characterized by material-cultural features which limit, condition and facilitate social interaction. The research problem involves empirical definitions of these multiple socio-physical relationships which may be used for predicting social structural information from the photo interpretation data. The accuracy of the photo interpretation information on several critical categories was evaluated in an experimental test, correlating photographic and ground observations of several urban residential areas. The photo interpretation data were sufficiently accurate for classifying the sub-areas according to physical structural attributes statistically associated with many sociological variables in American cities. A method of multi-variate analysis, the Guttman scalogram technique, was then applied to data for Birmingham, Alabama. This phase of the research which produced a mathematical model of the city considered as a complex socio-physical system, provided supporting evidence of the utility of the aerial photographic method in urban social analysis.*

THE PROBLEM AND RATIONALE

CONSIDERING the rapid development of applications of aerial photographic interpretation in many varied fields, there is reason to assume that further exploitation of this relatively new medium of study will contribute to knowledge in the social sciences. In particular, there are indications that aerial photography offers a unique methodological approach to the analysis of urban social systems. Research efforts in this direction would be well justified in view of the realities of contemporary world urbanization and the paucity of systematic data required for a scientific understanding of urban social phenomena.

The purpose of this paper is to describe the rationale, procedures and findings of studies exploring the problem of applying photographic interpretation in urban sociology.[1] Within this context, several interrelated concepts are considered. These concepts, referring to the spatial organiza-

[1] For the most part, this paper was developed from the author's doctoral dissertation in the Department of Sociology, University of North Carolina, 1955, entitled, "Aerial Photography in the Analysis of Urban Structures, Ecological and Social." Attention has also been given to this same problem by P. H. Chombart de Lauwe and his colleagues at the Centre d'Études Sociologique in Paris. Summaries of this work are published in the two excellent volumes (1952) on *Paris et L'Agglomération Parisienne.*

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tion, social ecology and demographic characteristics of the city, represent central interests of the sociologist. In combination, they constitute a framework for studying the social structure of the city. The present problem concerns the extent to which urban social structural analysis may be faciliated by photographic interpretation.

To a considerable degree, the answer to the problem hinges upon identification and definition of a variety of socio-physical relationships within the urban agglomeration. Photo interpretation data in themselves are not "social data." However, they are pertinent to social research needs in so far as such "physical data" have meaningful sociological correlates. This socio-physical connection provides the underlying rationale for accepting the feasibility of applying photographic interpretation to problems of urban sociology. Such relationships, furthermore, are assumed to exist in varying forms in urban organization cross-culturally.

The city comprises both a physical system having physical structure and a social system having social structure. The two components are not logically separable. Human groups occupy physical space and facilities in their interactions and adjustment to the environment. Linkages between physical and social elements are the specific point of reference in Park's well-known statement:

"It is because social relations are so frequently and so inevitably correlated with spatial relations; because physical distances, so frequently are, or seem to be, the indices of social distances, that statistics have any significance whatsoever for sociology. And this is true, finally because it is only as social and psychical facts can be reduced to, or correlated with, spatial facts that they can be measured at all."[2]

In summary, the fundamental hypothesis recognizes that urban social systems exist in physical settings and are housed in and characterized by material-cultural features. Such physical units are sociologically significant in that they limit, facilitate or condition social interaction. Accordingly, certain aerial photographic information about the city should be meaningful for social science research because of the multiple interdependencies among physical and social elements. Evidence for this may be seen in a brief discussion of physical-spatial features identifiable in the photographic image as keys to an understanding of the social structure of the city.

Related Research Evidence

The literature of American sociology contains many references to research regarding empirical relationships between physical-material aspects of the city and several less tangible sociological and demographic elements. Concentric circular zones[3] and distance gradients from the center of dominance are frequently representative of significant differences in social class, occupational status, ethnic groupings and other population characteristics. Zonal and gradient measures are also found to be associated with variations in social integration and deviant behavior.

The size and shape of the city, the transportation routes, and the pattern of work-residence locations largely determine the temporal life and daily movement of the population. Physical features, such as high ground or "the lake front," become visible symbols of status locations. Likewise, differences in types and densities of man-made structures, particularly the habitat, mark the difference between a slum district and a "gold coast," or a rooming-house section and a "zone of working men's homes."

Many researchers have investigated the sociology of housing and the social attributes of residential communities. Prominent here is the work of Faris and Dunham[4] who demonstrated several linkages between social facts and neighborhoods classified according to certain housing characteristics. Among others, Louis Wirth[5] emphasized housing as a social value, and of all housing types in American cities, the single-family structure seems to have particular sociological significance. It has been said to be indicative of family solidarity. Its occupants are generally ascribed higher social status. Some writers have used

[2] Park, Robert E., "The Urban Community as a Spatial Pattern and a Moral Order," in E. W. Burgess (ed.), *The Urban Community* (Chicago: Press, 1926), pp. 3–18.

[3] For a comprehensive treatment of the concentric circular zonal hypothesis, see Quinn, James A., *Human Ecology*, New York: Prentice-Hall, Inc., 1950, Ch. VI.

[4] Faris, R. E. L., and Dunham, H. Warren, *Mental Disorders in Urban Areas*, Chicago: The University of Chicago Press, 1939.

[5] Wirth, Louis, "Housing as a Field of Sociological Research," *American Sociological Review*, XII (April 1947), pp. 137–143.

prevalence of single-family homes as an index of urbanization, fertility, and labor force characteristics. In addition, this structure is a symbol of home-ownership which in turn relates to many social phenomena. The many investigations reporting relationships between residence locus and status position are aptly summarized by Reimer:

"The city dweller's 'address' tells not only where he lives, but where he belongs on the social scale . . . From street to street and from block to block, there is a consciousness of social status as conveyed by residence in that very location."[6]

Thus, only a cursory look at sociological literature reveals several physical-spatial data categories intimately related to the social structure of the city and capable of study by photographic interpretation.

Photo Data of Primary Interest

In the present research, there were four "photo data" items of primary interest in analyzing residential sub-areas of several American cities.

(1) *The location of the area relative to three concentric circular zones with mid-point in the central business district.* In a photographic study of Birmingham, Alabama, the zonal classification was obtained by plotting roughly circular ecological divisions on a photo-map of the city. These outlines were determined by noting major breaks in land use, and referring to terrain features and transportation arteries. The inner-zone borders were identified by changes in building types, such as a merging commercial and warehouse area joining a transitional, lower-class residential district. For the most part, the inner-zone was included within a radius of one and a half miles from the mid-town point. The middle-zone was drawn to contain most of the city's heavy industrial installations. It extended to the mountain ridges on the north and south and included the longer established, denser sections to the east and west. The outer-zone comprised more recent residential developments on the eastern and western edges of the elliptical-shaped city. This zone also included certain typical, inter-mixed "fringe" developments.

(2) *The description of the area in terms of internal and adjacent land usage.* This photo-data item was also divided into three categories, a breakdown intended for sub-area classification according to a generalized consensus of "residential desirability." Thus, depending on certain objective evidence reflecting varying degrees of residential status ascription, each sub-area could be classified as having generally "favorable," "neutral" or "unfavorable" attributes. These neighborhood descriptions were determined by noting street patterns, house and lot sizes, mixture of land use, presence or absence of trees and sidewalks, and the age and quality of construction where such was evident. Account was also taken of the surrounding land usage, the presence or absence of industrial, commercial or railroad facilities assumed to influence residential desirability.

(3) *The prevalence of single-family homes.* This photo-data item, concerned with the proportion of all dwellings of the single-unit, detached-type, was subjected to experimental accuracy tests comparing the photographic observations with data obtained by ground surveys. These tests required detailed interpretation and enumeration of all individual residences. However, in the later analytical phases, the residential sub-areas were simply labeled according to descriptive categories of prevalence of single-family homes, such as "high," "medium," "low," etc.

(4) *The density of housing in average numbers of dwellings per block.* This item, also concerned with quantitative information on residential structures, was assumed to be related to additional social characteristics. For example, two residential sub-areas might each have approximately 60 percent single-units, detached, but the average density of one might be twice that of the other. Such a situation may spell significant differences in population density, ethnic composition and socio-economic status in general. Here again, while the photo-data accuracy test (described below) required interpretation of total numbers of dwellings, in the later correlational analyses each sub-area was given a qualitative classification on this item, such as "high," "medium" or "low" density.

All four of these primary interest photo-data items were assumed to be related to residential desirability and, in turn, to social structural characteristics. The first two do not require specialized photo inter-

[6] Reimer, Svend, *The Modern City*, New York: Prentice-Hall Inc., 1952, p. 111.

pretation skills. Descriptions of residential sub-areas by zonal location or land use are routine products of urban analysis. The accuracy of such photographically obtained information is not seriously questioned. However, quantitative descriptions of various housing types, estimates of percentages, densities, etc. require more detailed study and somewhat specialized techniques. Therefore, since these two housing items seemed quite crucial to the over-all project, a systematic accuracy test was considered necessary. The discussion which follows describes the procedures and results of this experimental task critically related to the objectives of the entire undertaking.

Photo-Data Accuracy Test

The test centered on a sample of seventeen varied residential sub-areas in Birmingham, Alabama. Following the methodology developed in a pilot study, its purpose was to evaluate the accuracy of photo interpretation data describing various types of residential structures. Specifically, the evaluative analysis correlated photo and ground observations concerning the last two items described above: Item 3, Prevalence of single-family homes; and Item 4, Average density of dwelling-units per block.

In the photo-data collection phase, several categories of housing types were recorded by code symbols on block outline cards: single dwelling-unit, detached; double-unit; multi-unit, 3–5; multi-unit, 6–8; multi-unit, 9–11, etc.; and "other" types of mixed occupancy such as retail sales with dwellings attached. These residential types were identified by stereostudy with reference to previously developed recogniton "keys" including such features as form and structure of roofs, yards and courts, driveways, entranceways, size, shape, and height of structures and their spatial relationships to other buildings. In the field-data collection phase, surveys were made in the 17 sub-areas, and the housing information was recorded on a duplicate set of block outline cards. The data were then organized to permit correlational analyses between the photographic observations (experimental data) and the ground observations (control data).

The results indicate that the photographic method is sufficiently accurate for obtaining housing data according to the previously described categories of prevalence of single-family homes and density of dwellings per block. Of particular interest was the finding that the photo interpretation errors were not distributed randomly. There were, for example, consistent over-estimates of numbers of single-family structures, and consistent underestimates of numbers of double-unit residences. This situation provided a compensating effect, producing a "net" accuracy figure. In addition, the amount of absolute error (each individual photo interpretation discrepancy) was found to increase in areas having higher prevalence of multi-unit structures. These two findings concerning amount and direction of absolute errors indicate a basis for constructing systematic correction factors for further study in the continuing methodological development.

For immediate purposes, the specific findings are summarized as follows:

1. Ninety-nine percent of the existing total of 3623 residential structures studied were correctly identified.

2. The total number of individual dwelling-units in all types of structures was underestimated by seven percent.

3. The over-all average density of dwelling-units per block was underestimated by 1.7; the range of error was from 0 to -7.1 units per block.

4. The percentage of single dwelling-units, detached was overestimated by 5.3 per cent; the range of error was from 0 to 15 per cent, all discrepancies being underenumerations.

Although the absolute errors were present as indicated, the final evaluation of the photographic interpretation observations (net error) disclosed a comparatively accurate picture of the relative structural characteristics of the sub-areas under study. The consistency of the error direction resulted in each sub-area being interpreted as having slightly greater proportions of single-family homes and slightly less dwelling-unit density than the ground-control data revealed. Consequently, when the 17 sub-areas were ranked according to the photo-data on these two primary interest items, the correlations with their ranks according to the ground data were found to be .98 and .99 respectively. The figures supporting these accuracy measures are shown in Tables 1 and 2.

Inspection of these tables makes it quite clear that the photographic interpretation

study of these residential sub-areas succeeded in portraying their true relative structural characteristics. The near-perfect rank orderings produced by the photographic analysis permit a realistic classification of the sub-areas by categories found to have predictive value regarding the social structure of American cities. In summary, this preliminary test indicates that the photographic data are sufficiently valid for describing residential sub-areas according to physical structural attributes empirically related to social structural attributes. The discussion which follows summarizes related research findings showing statistical associations between the photo-data categories described herein and several variables of sociological interest. By this means, inferences may be drawn regarding the operational utility of the photographic interpretation method in urban sociology.

Socio-Physical Structural Correlates in U. S. Cities

In an ecological analysis of census tract data and block statistics for six regional U. S. cities,[7] attention was focused on these same physical structural variables. This study was oriented toward the ultimate development of predictive generalizations linking physical and social structure in American cities. While the initial phases of the project investigated the "photo-data" categories individually, the later phases, including studies of two additional cities centered on multi-variate analyses attempting to describe the city as a complex socio-physical system. Thus, the ultimate purpose was to obtain more precise estimates of the predictive value of the photo interpretation data categories.

In the six regional cities, significant differences between zones were found for five social-data categories: prevalence of home-ownership, median income, per cent foreign-born whites, per cent of population in households, average number of persons per household. Marked between-zone differences were found in three broad occupational status groupings: professional and managerial, craftsmen and foremen, and laborers. In Birmingham, Alabama, significant differences between zones were found in educational status, average

TABLE 1

Rank Order of 17 Sub-areas by Photographic and Ground Data on Percentage of Single-Dwelling-Units, Detached to Total Dwelling-Units*

Sub-area Number	Per Cent Single D/U's, Detached		Rank Order	
	Photo	Ground	Photo	Ground
10	96.7	93.6	1	1
8	92.0	90.0	2	2
9	80.2	77.1	3	3
14	75.0	72.0	4	5
11	72.9	72.4	5	4
12	72.2	66.0	6	7
3	69.9	66.2	7	6
17	68.8	60.2	8	8
2	62.7	60.1	9	9
16	55.9	45.8	10	10
4	44.5	36.8	11	11
7	36.1	21.0	12	14
5	30.8	24.1	13	13
13	29.1	25.8	14	12
6	23.4	13.5	15	16
1	21.0	20.1	16	15
15	17.1	12.1	17	17

* Spearman Rank Correlation Coefficient =.983.

TABLE 2

Rank Order of 17 Sub-areas by Photographic and Ground Data on Average Number of Dwelling-Units per Block*

Sub-area Number	Density of Dwelling-Units per Block			
	Average Number		Rank Order	
	Photo	Ground	Photo	Ground
9	11.5	11.7	1	1
11	11.7	11.9	2	2
10	13.1	13.4	3	3
12	13.8	14.2	4	4
3	14.4	15.2	5	5
8	15.2	15.3	6	6
14	16.0	16.4	7	7
7	20.1	24.4	8	8
17	24.8	26.2	9	9
4	27.5	30.3	10	11
5	28.4	29.9	11	10
16	31.4	35.1	12	12.5
6	33.9	41.0	13	15
2	34.6	35.1	14	12.5
1	35.4	35.4	15	14
13	42.3	43.4	16	16
15	43.4	49.4	17	17

* Spearman Rank Correlation Coefficient =.988.

[7] Austin, Texas, Bridgeport, Conn., Chattanooga, Tenn., Duluth, Minn., Spokane, Washington, and Wichita, Kansas.

monthly rentals and adult crime rates. A study of Rochester, New York revealed statistically significant between-zone differences in median annual income, formal education, rental values, crowding within dwellings, and home-ownership. These findings, supporting classical ecological theory, indicate that the tri-zonal[8] classification is sensitive to differences in social structural distributions. Consequently, they provide supporting evidence of the utility of photographic information in urban social analysis.

Another phase of the Birmingham study concerned land use characteristics. Eighteen census tracts were classified as either "primarily residential" or "primarily industrial," a description readily accomplished by photo interpretation. Analyses of social data for these areas demonstrated that this simple grouping by major land use provided a key to the locations of two distinctly different types of social environment within the city. The primarily industrial subareas have much higher rates of social disorganization, and over twice as much within dwelling-unit crowding as primarily residential areas. In terms of occupational status, there were proportionately over five times as many laborers and operatives residing in the industrial subareas, and nearly three times as many professional and technical workers in the primarily residential sub-areas. While these findings are not contrary to expectation, they do show that even relatively gross "photo-data" categories such as these are correlated with several social data categories.

Similar evidence of the socio-physical nexus was found in the analysis of the third physical-data item. Consistent correlations were found between prevalence of single-family homes and ten social-data categories. These variables, relating directly to the socio-economic status rankings of urban subareas, included occupational status breakdowns such as managerial versus labor groups, income, educational achievement, foreign-born whites, non-whites, crowding within dwellings, and rental values. In Birmingham, Alabama, residential sub-areas were grouped in classes of "high" and "low" prevalence of single-family homes. These two contrasting types of "natural areas" were then analyzed in terms of residence locations of four occupational status groups. In the high-prevalence class the percentages of managerial and professional residents were well over twice as great as in the low prevalence sub-areas. On the opposite end of the occupational status scale, the proportion of laborers living in the low-prevalence sub-areas was three times as great as in areas of high-prevalence of single-family homes. Thus, such photographic information indicates that social distance on the occupational scale is reflected in an ecological pattern segregating high and low status groups at each end of the residential-desirability continuum.

Also in Birmingham, an analysis of social disorganization in areas of high and low prevalence of single-family homes was undertaken. Striking and statistically significant differences were found. Both adult crime and juvenile delinquency rates were four times as great in the low prevalence sub-areas as in neighborhoods having high proportions of single-family homes. Such relationships, describing spatial distributions of deviant behavior, define an important point of linkage between physical structure and social dynamics of the urban environment.

Analysis of the fourth photographic-information item, dwelling-unit density, revealed similar socio-physical relationships in several American cities. Consistent negative correlations were found between density averages and owner-occupancy, income, and proportions of high occupational status groups. In Birmingham, the description of residential subareas in terms of "high" and "low" dwelling-unit density essentially defined the ecological pattern of racial segregation. While these correlations demonstrate associations between dwelling-unit density and urban social structure, this particular data category was found to have greatest predictive value with respect to population size and density rankings of residential neighborhoods.

As might be expected, for all cities studied, the correlations between average number of dwellings per block (by census tracts) and average number of persons per block were consistently on the order of .95 and above. This fact provides a basis for deriving certain population estimates for residential neighborhoods studied pho-

[8] A similar tri-zonal analysis was used by Homer Hoyt in his work, *The Structure and Growth of Residential Neighborhoods in American Cities* (Washington: U. S. Government Printing Office, 1939).

tographically. For example, with reference to Table 2 above, the ranks of the 17 Birmingham sub-areas according to photo-data on dwelling-unit density correlate .95 with their ranks on population density.

In another evaluation of this item, 43 Rochester, New York census tracts were grouped into five dwelling-unit density classes ranging from "very low" to "very high," the accuracy tests having indicated the validity of similar information collected by photographic interpretation. The resident population-density in average number of persons per block was computed as shown below.

Dwelling-Unit Density	*Average Number of Persons per Block*
Very Low	89
Low	123
Medium	153
High	175
Very High	246

An analysis of variance test showed that these sharp differences in resident population-density are highly significant statistically. These results thus indicate that the photo interpreter's classification of neighborhoods according to these dwelling-unit density categories provides a meaningful description of population-density patterns within the urban complex.

Multi-Variate Analysis of Urban Structures

The several ecological analyses briefly described above demonstrated that the various physical structural categories derived from the four photo data items are useful for defining the social topography of the city. However, generally speaking, any one item, as a single variable, has somewhat limited predictive value. This fact, coupled with a theoretical position recognizing existence of plural structure-function interdependencies within the urban social system, suggests the application of multi-variate analytical techniques to obtain more complete definitions of socio-physical relationships. Such procedures, including index construction and scale analysis, might be expected to yield more precise formulations regarding the predictive value of the photographic data.

Exploratory investigations of this nature attempted applications of the Guttman scalogram model[9] to the six regional cities. This technique offers a convenient procedure for combining several qualitative variables which, if scalable, form a single continuum defining the exact position or rank of each object (or sub-area) in relation to every other object in the sample. It was hypothesized that the photo-data categories, considered as physical structural attributes of residential neighborhoods, represent a scalable content area. Since, for American cities, the photo items, in general, reflect status location and ability to pay for preferred residential sites, the hypothetical continuum could be called a scale of "residential desirability." This scale, comprising the several physical structural categories might then be expected to correlate significantly with a variety of social-data categories. Because of the mathematical properties of the Guttman scale variable, this technique simplifies the problem of gaining maximum predictive power from the series of photo-data categories, and thus provides for more precise definitions of linkages with the urban social-structure. Specifically, the outstanding advantage of the scalogram method is that the scale variable, used as a predictor, has a value equal to the multiple correlation of all the combined photo data attributes with particular external variable of interest.

Analyses of the six cities revealed preliminary supporting evidence of the scalability of the physical structural categories. In all cases it was possible to construct fully acceptable or closely approximated scales of residential desirability. The scalogram model for Chattanooga, Tennessee reflected the pattern of racial segregation in that city. In the case of Spokane, Washington, the scale types helped to define the ecological pattern of the social areas of the city by portraying rental value distributions. In Austin, Bridgeport and Spokane, the residential-desirability scale scores correlated on the order of .85 with median annual income. Generally speaking, the exploratory tests indicated the residential-desirability scale variable to be a considerably efficient predictor of the socio-economic status ranks of urban sub-areas.

These initial studies applying scale analysis to areal units of the city led to more intensive investigations of data for Birmingham. Although this particular phase

[9] For a complete treatment of the Guttman scale analysis method see Samuel A. Stouffer, et al., *Measurement and Prediction*, Princeton, N. J.: Princeton University Press, 1950.

of the research has been reported elsewhere,[10] the findings may be briefly reviewed in the present summary paper. Twenty-eight census tracts, comprising about 50 per cent of the city area, were chosen to represent the 58 such units in Birmingham. Four physical data items, as described above, were employed in the development of a scale of residential-desirability. The 11 "response" categories contained in the three trichotomous items and one dichotomous item were assumed to define varying degrees of neighborhood status ascription. Analysis of the resulting total of 112 responses (four per tract) followed the procedural steps outlined by Guttman's "Cornell technique."[11] The findings demonstrated that the physical structural categories constitute a single continuum. The resulting scale, having a coefficient of reproducibility of .93, revealed an internally consistent ranking of the 28 tracts in eight scale types ordered from high to low on this dimension of residential desirability.

The second phase of this Birmingham study hypothesized that the several social-data categories, describing the same census tracts, and referring generally to the social-stratification system of the city, would also be scalable. Such a scale could be called a continuum of socio-economic status. Five trichotomous social data items were constructed: 1. Median annual income; 2. Prevalence of within-dwelling crowding; 3. Prevalence of home-ownership; 4. Prevalence of social disorganization; 5. Educational achievement. The categories of these items were arranged by a system of ranks. To illustrate, the highest seven ranks of the tracts on income were classified as "positive" (favorable) in terms of socio-economic status, the middle fourteen ranks, "neutral," and the lowest seven, "negative," etc. In this case, also, scale analysis of the 140 responses demonstrated that the five trichotomous items represent a single scalable universe of content for these census tracts. The resulting scalogram, having a coefficient of reproducibility of .92, was defined as a continuum of socio-economic status.

Each of the two scales provides an empirical definition of commonalities among urban spatial patterns, one referring to physical structure and the other to social structure. In each case, the scale types account for the joint relationships among the all data categories analyzed. According to the underlying hypothesis, postulating plural interrelationships among urban social and physical elements, the correlation between the two scale variables should be substantially high. This was confirmed by a product-moment coefficient of .88, a high positive relationship, significant beyond the .001 level of confidence. Thus, for the city of Birmingham, the aerial photographic type data, comprising a scale of residential desirability, account for 78-per cent of the variation in socio-economic status distributions. The predictive value of the physical data categories is more precisely described by the resulting regression equation representing a mathematical model of the city considered as a complex socio-physical system: $Y_c = 2.8027 + 1.20883(X)$.

Summary and Implications

In summary, it may be inferred that photographic interpretation information may be profitably utilized in supplementing and substituting for other social-data sources, particularly in studies concerning ecological bases of the urban social-stratification system. This is true because patterns and variations in residential distributions parallel variations in socio-economic status distributions. Further, it is indicated that the Guttman scalogram model is an excellent analytical technique for defining structural interrelationships within urban social-systems.

At the present writing additional studies in the scale analysis of urban structures are being undertaken. An investigation of data for Rochester, New York has produced similar results, further supporting the socio-physical hypothesis and the utility of aerial photographic interpretation information in urban social analysis. Beyond this, further investigations of the techniques and relationships suggested herein, particularly in other culture areas, may contribute to an increased understanding of world urbanization within a more comprehensive theoretical framework.

[10] Green, Norman E., "Scale Analysis of Urban Structures: A Study of Birmingham, Alabama," *American Sociological Review*, XXI (February 1956), pp. 8–13.

[11] Guttman, Louis, "The Cornell Technique for Scale and Intensity Analysis," *Educational and Psychological Measurement*, VII (Summer 1947), pp. 247–280.