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House Density vs. Socioeconomic Conditions

Photos offer an effective method for measuring house density but the temporal and regional elements of the socioeconomic relationship need to be understood better.

ABSTRACT: Density of single family housing is measured in units of houses per acre, and correlated with socioeconomic variables. The results show that house density can be used with aerial photographs advantageously in an analysis of urban housing. Refinements to include change through time and multiple-family dwellings are additional factors.

INTRODUCTION

IN A CITY with constantly changing population patterns, planners must be able to obtain current data on socioeconomic conditions. The usual source of social and economic information is the questionnaire and interview. This direct contact method is time consuming, and the use of aerial photographs as an alternative has been proposed for many years (Wittenstein, 1954; Green, 1957). More recent work on the use of photographs in urban research has led to the identification of visible characteristics of a residential area which may be related to the socioeconomic attributes of a neighborhood (Mumbower and Donoghue, 1967; Mullens, 1969; Marble and Horton, 1969).

The physical, visible variables, which seem to be related to low-income housing, usually include a combination of measurable as well as subjective attributes. Such a list will usually consist of measurable features such as lot size, number of buildings per block, and street width, along with subjective conditions such as maintenance, presence of sidewalks, degree of littering, landscaping, and presence of off-street parking.

The objective of a study should be considered before selecting any of these residen-

tial variables for use in an air photo analysis of urban socioeconomic conditions. It may be preferable to have only those measurable variables such as distance, area, and density. These measures are relatively free of interpreter bias, and could lend themselves to automated interpretation, but they will tend to remain constant through time because they are fixed at the time of construction. On the other hand, subjective variables, though open to bias, may best reflect the changing aspect of a declining neighborhood.

In a preliminary project to map regions of housing quality from air photos in Lexington, Kentucky, it was observed that relative density of single-family houses was the criterion most frequently used to identify poverty housing (Metivier and McCoy, 1971). The resulting map, derived by eye from relative house density, conformed very closely with a map of substandard housing prepared by the Lexington-Fayette County Planning Commission based entirely on field data.

Because house density proved a useful guide to the earlier mapping procedure, this present study was made to determine the extent to which socioeconomic information can be derived from air photos by measurement of house density as a single variable.

METHOD OF ANALYSIS

PHOTOGRAPHS

All measurements of house density were made on 1:6,000 black-and-white air photos taken of Lexington, Kentucky in 1969. Photographs at a scale of 1:20,000 were also available, and could have been used satisfactorily with magnification.

PHOTO DATA

In each sample block two items were measured: the number of houses on the block, and the area of the block in acres. From this information house density was computed by dividing the number of houses by the acreage. In the earlier studies referenced above, house density was examined in terms of houses per lot or block, and the resulting significance of house density was low. By defining density in terms of unit areas, i.e., acres, the effect of variations in block size was removed.

SAMPLING PROCEDURE

Nine census tracts around the Lexington central business district are composed of a variety of land uses including commercial, industrial, warehousing, multiple-family residential, and single-family residential structures. For this study data were obtained in the nine tracts only for 109 sample blocks which consist wholly of single-family units. For the present, multiple-family units are ignored, especially where they comprise entire blocks of apartment buildings. Analysis of multiple-family dwellings is now under study as a separate component of this investigation. The residential sample, therefore, consists of all the blocks that are predominantly single-family dwellings within the central core of nine census tracts in Lexington (Figure 1). Houses were counted on the photographs and the acreage of sample blocks was measured from city maps. Totals for the number of houses and the acreage were accumulated by tract, and used to com-

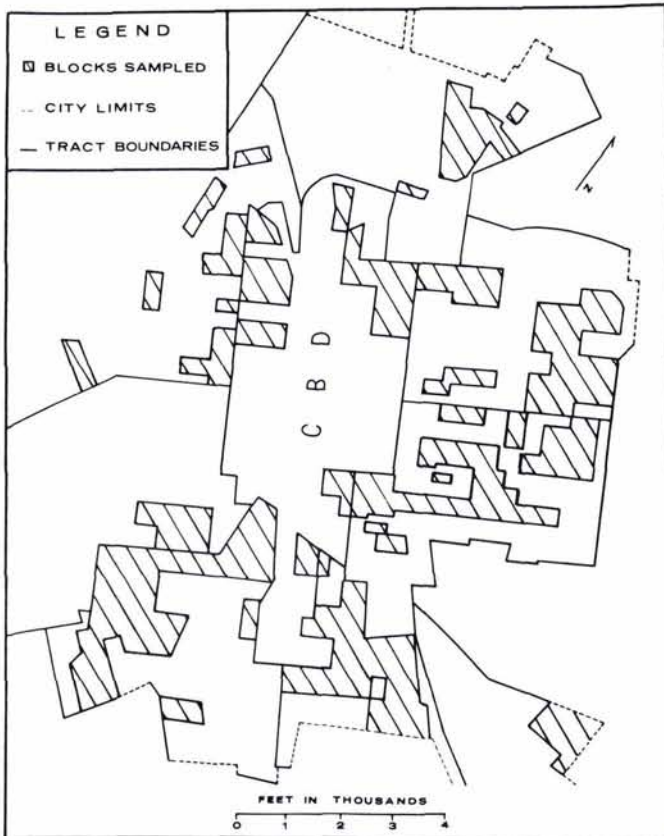


FIG. 1. Distribution of blocks included in sample. Only blocks composed wholly of single-family dwellings are considered.

TABLE 1. MATRIX OF CORRELATION COEFFICIENTS

House Density	Percent Owner Occupied	House Value	Percent Renter Occupied	Average Rent	Median Family Income
1. 1.000					
2. -0.774	1.000				
3. -0.787	0.561	1.000			
4. 0.809	-0.980	-0.610	1.000		
5. -0.801	0.631	0.909	-0.707	1.000	
6. -0.875	0.808	0.766	-0.808	0.844	1.000

pute average house density for each of the nine census tracts.

Census data from 1960 were used to obtain socioeconomic information in each block for which a house density had been measured. At the block level, data were obtained for average house value, average rent, percent of houses occupied by owner, and percent of houses occupied by renters. Each of these variables was totalled by tracts and divided by the number of sampled blocks to obtain an average value for each tract. Because a value for median family income was not available at the block level, the census median family income for the tract was used. With this one exception, all data were obtained at the block level and aggregated to census tracts.

ANALYSIS AND RESULTS

The sampled data approximated normal distributions except for house density which

showed a strong positive skewness. A logarithmic transformation of density data produced the desired correction, and indicates a log-normal distribution for house density.

A simple correlation and regression analysis was made using values of house density with house value, average rent, median family income, percentage of owner occupied houses, and percentage of renter occupied houses. The correlation matrix obtained in this analysis is shown in Table 1. Tests of significance of correlation coefficients show density-income, density-house value, and density-average rent to be significant at a .01 level. Figures 2, 3, and 4 show scatter diagrams and regression lines for house density with median family income, average rent, and average house value respectively.

The mapped distribution of high house-density and low house-value (Figure 5) conforms closely with the Lexington-Fayette

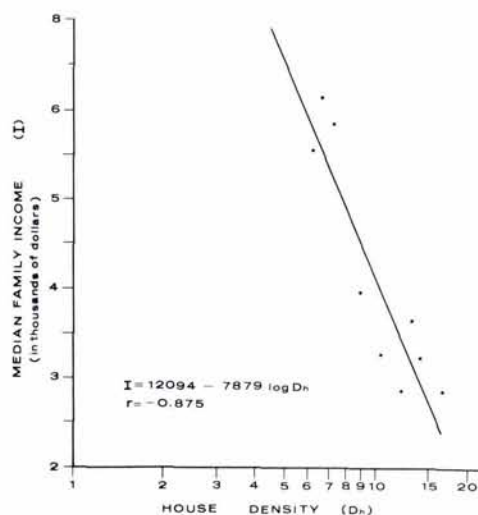


FIG. 2. For the nine tracts, 77 percent of the variation in median family income can be explained by house density.

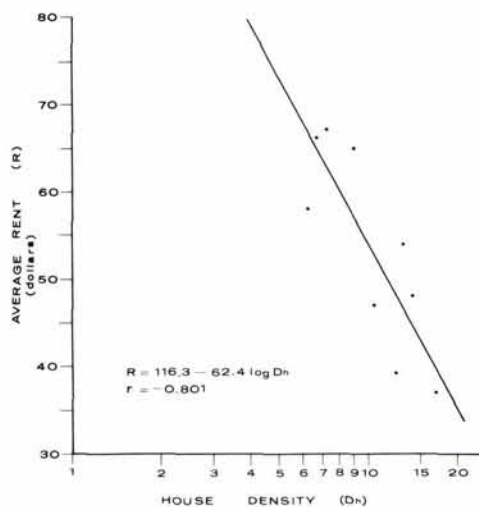


FIG. 3. Average rent paid by residents is inversely related to house density.

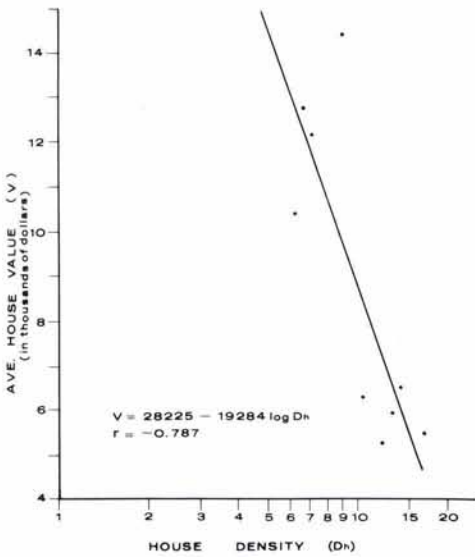


FIG. 4. Average house value may be estimated from measurements of house density.

County Planning Commission map of substandard housing. This would suggest that much of the planner's initial mapping could have been done accurately from aerial photographs.

CONCLUSIONS AND FUTURE WORK

From this study, one concludes that density of single-family dwellings is a useful and promising indicator of socioeconomic conditions. House density may be considered the strongest single visible measure of economic conditions inasmuch as it accounts for 77 percent of the variation in income data, and for 64 percent of the variation in rent data.

For the use of house density to be effective, several refinements are needed. First of all, data should be analyzed at the block level rather than aggregating to the tract level. Much variation can exist within a tract, and planning problems must be met on each individual block. Therefore, it will be much

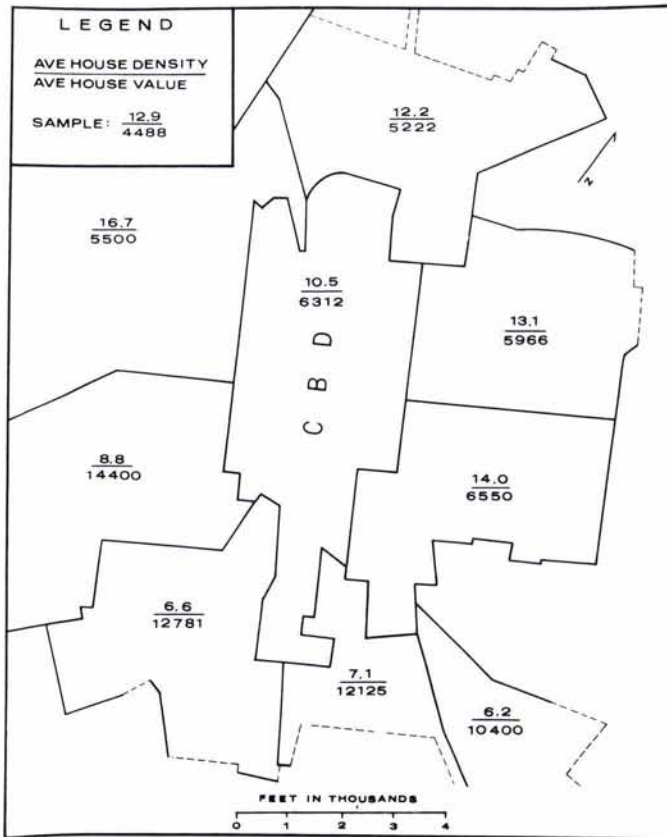


FIG. 5. Data plotted in Figure 4 is mapped by census tract.

more useful to obtain results for blocks rather than for census tracts. A second necessary refinement to this work is an analysis of multiple-family units for means of obtaining additional socioeconomic information from air photos in an objective way. Measurable variables being considered for multiple-family units are distance from center of city, and percent of area used for off-street parking.

Important considerations in the analysis of urban housing are the factors of regional location, and time period. Both of these factors are being studied in a future extension of this work. It is known that poverty housing in cities of the eastern United States does not necessarily have the same visual appearance as those in the far west. Therefore, an attempt is being made to identify regional differences in the relationship between house density and socioeconomic conditions. Also the visual characteristics of poverty housing may change through time within any given city. This change would take place through a filtering process whereby low income population expands from an initial core area into surrounding houses formerly occupied by a middle-income population. In this situation the socioeconomic level of the inhabitants is changed, but the structures and their densities are fixed.

In order to identify such a temporal change on air photos it may be important to give greater consideration to neighborhood characteristics such as maintenance, littering, and vegetation. Furthermore, interpretation of these features will be more efficient on color aerial photographs. The temporal and regional elements of the relationship between housing and socioeconomic conditions must be understood before

air photos can be fully utilized to update housing quality maps.

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