THE URBAN ATLAS PROJECT: HISTORICAL AND CARTOGRAPHIC REVIEW

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The presentation of high quality graphics, particularly maps, has in the last 60 years been a major feature of census publications. Periodically the Census Bureau has published a series of maps showing the spatial patterns of various demographic, social, agricultural, or economic data. These maps, sometimes presented in an atlas format, have occasionally been issued separately; however, most of the time the maps have been included directly as part of the United States summary reports. The graphics, whether they entailed the creation of choropleth maps, dot maps, or cartograms, had always, until 1972, been the products of manual cartography. Consequently, the number of maps which have been included in the various census reports has always been, of necessity, limited compared to the number of maps which could have been included or were desired.

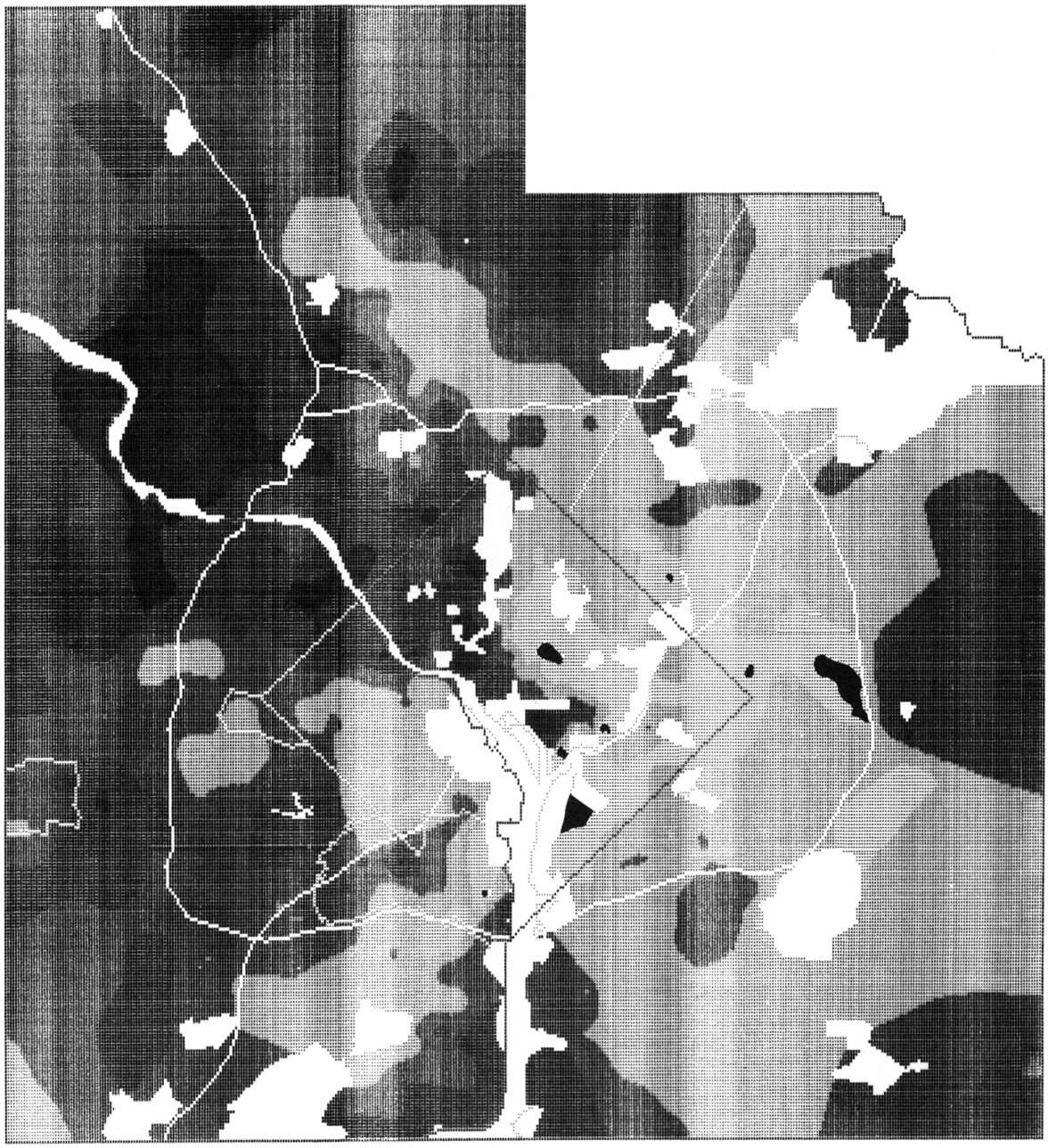
Early in the planning of the publications for the 1970 Censuses of Population and Housing, considerable thought was given to the creation of an urban atlas or the preparation of maps showing the spatial patterns of selected demographic characteristics within the major metropolitan areas of the nation. However, it was felt that as of 1970 the state of the art, insofar as computer cartography was concerned, had not advanced enough to support the large-scale effort that would be necessary to prepare a comprehensive series of maps of urban America. Likewise, the cost, both in fiscal and human terms, required to prepare choropleth maps of the major metropolitan areas by the standard manual cartographic techniques was too expensive and time-consuming to permit the maps to be produced in this manner. As a result of the suspected inability of automated cartography to economically mass produce the number of the map sheets that would be required and the high costs of traditional cartographic methods, the idea of producing an urban atlas or individual maps of urban America was dropped.

Even at that point of time it was acknowledged, nevertheless, that computer mapping offered a tremendous potential for presenting census data in its spatial setting at a reasonable cost. This capability had been demonstrated in several of the reports which were produced as a part of the 1967 Census Use Study in New Haven, Connecticut. However, the experimental, custom-made maps included in these reports did not reflect the problems that would be encountered in the production of a series of urban atlases for the nation's largest metropolitan areas.

Throughout the early 1970's computer graphics technology progressed far more rapidly than many of its most ardent proponents had hoped was possible. During 1972, the Census Bureau acquired considerable experience in producing computer maps of various metropolitan areas. Figure 1 is an example of an early SYMAP covering the Washington, D.C. urban area. This experience, plus other research and development work, demonstrated that it was now possible to produce a national series of urban atlases.

AVERAGE HOUSING VALUE OF OWNER OCCUPIED UNITS

Washington, D.C. - Md. - Va. SMSA (part)



VALUE

- under $15,000
- $15,000 - 19,999
- $20,000 - 29,999
- $30,000 - 39,999
- $40,000 - 49,999
- over $50,000

U.S. DEPARTMENT OF COMMERCE

BUREAU OF THE CENSUS

SYMAP MAPPING PROGRAM

The feasibility of such a project, both from the technological and economic perspectives, had been tested by the publication of the Graphics Summary, 1969 Census of Agriculture in 1972. This Atlas contained a total of 219 computer-generated dot and choropleth maps representing all facets of American agriculture. This publication demonstrated that the automated cartography technology had advanced from line printer images to graphics arts quality maps produced by micrographics. This technological breakthrough, which is described in more detail elsewhere, allows the rapid production of either black or white or color maps. Even though the technology had been demonstrated, it had never been used to produce maps as large as the atlas sheets (15 x 19 inches) or in such volume -- over 1,000 maps.

The entire Atlas project was tempered by the basic purpose of the reports. The Atlases were intended and designed to provide a descriptive graphical presentation of several of the basic statistical indicators that were included in the Census Tract Reports. They provide a basic overview of the spatial patterns of 12 major indicators of urban life. The data items that are included are:

1. Population density: population per square mile.
2. Percent of the population under 18 years of age.
3. Percent of the population over the age of 65.
4. Black population as a percentage of the total population.
5. Percentage of persons over 25 years of age who are high school graduates.
6. Median family income.
7. Interrelationship of family income and educational attainment.
8. Percentage of the labor force employed in blue collar occupations.
9. Median housing value.
10. Median contract rent.
11. Percentage of housing units which are owner occupied.
12. Percentage of occupied units constructed after 1960.

The only attempt to provide any analysis of the data is Map 7 which presents family income and educational attainment on a single map. This was intended to graphically illustrate the sociologist's classic contention that educational attainment and income have a high positive correlation.

Because of budgetary considerations, the publication program was limited to the presentation of 12 data characteristics for the largest 65 Standard Metropolitan Statistical Areas of the nation. The larger metropolitan areas are shown either with insets or in sections in order to provide the reader with the ability to clearly identify individual census tracts. Four reduced examples of sample urban atlas pages are shown in Figures 5 through 8 on pages 256-259.

OPERATIONAL CONSTRAINTS

The overall format of the Atlases was a subject of extensive discussions. For instance, many hours of discussions were devoted to evaluating the various viewpoints on the size of the Atlases. In the end it was decided to use a large Atlas format rather than the standard census publication ($8\frac{1}{2}$ x 11 inch) size for two reasons: (1) the ability to show an entire SMSA on one sheet, and (2) the desire not to artificially subdivide the larger SMSA's into many sections in order to show the detail necessary to clearly show an individual census tract.

Similarly, because of the very positive reactions to the color maps in the Census of Agriculture's Graphics Supplement, it was decided that the Atlases would be printed in color if funds were available. At the time the printing was commissioned, the funds were available. An additional reason for the use of color was the inclusion of a cross-map which had been developed as the result of a suggestion of Vincent P. Barabba, Director of the Bureau of the Census. This mapping technique, which has been described elsewhere, requires the use of at least three colors in order to be effective.

Another major constraint was that the maps had to be choropleth maps and show census tract boundary lines. This was required because of the nature of the census data. Many of the data items included in the Urban Atlases are based on sample statistics. That is, the final figures for most census data items are determined by the responses from only a fraction of the inhabitants of the census tract. Because of the problems of confidentiality and also the limitations imposed by sample size and sampling theory, inferences could not accurately be made within a census tract. Therefore, the characteristics had to be displayed as if they were distributed uniformly within the census tract boundaries. Proximal or contour mapping techniques could not be used because they would distort the data and imply patterns within the tracts which could not be supported by the data.

CARTOGRAPHIC CONSIDERATIONS

Even though several unique techniques were used to produce the Atlases, most of the fundamental, traditional cartographic judgements still had to be answered. However, some of the traditional aesthetic judgements were, in effect, preempted by the use of automated techniques. The discussions that were undertaken are illustrative of the types of constraints that automated techniques impose upon traditional cartographic standards.

SCALE

Since the primary purpose of the Atlases was to provide a means of comprehending the spatial patterns of the data, the map scale was varied between different standard metropolitan statistical areas (SMSA's). The scale of the maps for any area was strictly a function of the size of the smaller tracts and the overall size of the entire SMSA. A rough rule of thumb was that the smallest tracts should be no smaller than a tenth of a square inch. Whenever this required that the SMSA be shown on two (or more) pages, one (or more) insets were shown on additional pages so that each tract could be easily identified.

Since the maps were strictly statistical maps with no planemetric data, it was felt that the legibility of the statistical areas was more important than holding to a set of fixed map scales. Individual census tract outline maps were included in the rear of each Atlas to assist the reader in relating the statistics to local landmarks and specific locations. A bar scale is included on each map so that relative distances can easily be determined.

SUBJECTS

Early in the planning of the program, a set of potential subjects were extracted from the published 1970 Census Tract Reports. These tentative items were submitted to the Bureau's Population and Housing Divisions for review. They were asked to provide a list of specific data items that could be used to display the desired subjects. In addition they were asked to place the subjects and specific data items into a rank order of their preference.

In addition, the members of the Bureau's Small Area Data Advisory Committee were briefed on the program and asked to submit suggested items which might be mapped.

A total of 25 specific items was suggested for inclusion. Several, particularly in the income and poverty areas, appeared to reference the same basic data area with a different emphasis. When the overlapping subjects were eliminated, only 21 unique subjects remained. These were ordered on a consolidated list pending the determination of how many maps could be prepared.

Budgetary constraints limited the number of maps to twelve for each area. As a result, the original list of proposed map subjects was again reviewed. Three of the proposed subjects in the demographic area which had been originally ranked in the top twelve subjects were dropped because of data comparability problems (Spanish ancestry), or because of maps already available in other Bureau publications (poverty), or because of the age of the data (unemployment). The Bureau's executive staff then approved the inclusion of the twelve data items that were previously noted.

The population density map was included to provide the reader with a means of evaluating in his own mind the relative importance of the physical size of the tract in respect to the number of persons residing in the tract. These maps also provide a useful means of relating the effects of urban expansion on the surrounding land area.

CLASS INTERVALS

In a similar manner to the choice of the subjects, the determination of the class intervals was made by subject matter specialists within the Bureau's Population and Housing Divisions. They were asked to examine the data for the particular items for the metropolitan areas of 500,000 population and larger. Six classes, not including "Data not Available," were to be selected so that they were representative of the candidate metropolitan areas as a whole. The only exception occurred with the population density map. The population density of all tracts ranged from 0 to 257,000 persons per square mile. However, only 3.7 percent of the tracts had densities over 50,000 persons per square mile. Therefore, six classes were designed to cover tracts under 50,000 persons per square mile and an additional four classes were created to display the tracts with extremely high population densities. These four "extra" classes were needed in only 14 metropolitan areas. The same class intervals were used on corresponding maps in every Atlas so that cross-area analysis could be made.

In some cases special data tabulations were prepared for the use of the subject matter specialists to assist in the choice of appropriate and reasonable breaks. Even so, some of the maps in a particular Atlas reveal almost no internal divisions because the data for that SMSA were so highly skewed in comparison to the national norms. A table showing the comparison of the data for the Nation, States, the component counties, and the larger places within the SMSA was included in each Atlas.

COLOR CHOICES

In order to avoid having all of the maps look the same, a wide variety of color sets were used. Most of the color sets had been used previously in the Bureau's GE-50 map series. In all but one of the maps, the lower data values are shown with lighter colors.

The map displaying the percentage of owner occupied housing units uses a dark blue color to represent the class interval where most housing units are owner occupied. A dark red color is used where very few residences are owner occupied (i.e., highest proportion of rental units).

INSETS

As mentioned earlier, the use of insets was kept to a minimum because of the large image area provided by the use of the atlas format. However, when it was necessary to provide additional detail to clearly represent individual census tracts, the fewest number of insets were used. Whenever possible the boundaries of the insets were chosen to respect recognized political boundaries, or physical features, or major cultural boundaries. An example of the latter situation was the use of circumvential highways or beltways in Washington, D.C. and Atlanta, Georgia to enclose the inset area.

LINE-WEIGHT

The line-weight of the census tract boundaries was directly a function of the spot size of the computer output to microfilm (COM) unit that was used to prepare the window negatives. As a result, the actual width of the printed lines does vary in respect to the degree of enlargement that was required for each set of film. Most of the differences are so slight that they are not noticeable. In a few cases the base map and inset are shown on the same page, and the difference in line-weight is noticeable.

The Urban Atlas Project clearly represents a major new advance in automated cartography. The size of the undertaking and the number of statistical units mapped precluded the use of traditional techniques. However the utilization of automated techniques did necessitate the revision of some of the standards that have traditionally been used to judge fine cartographic efforts. However, we believe that the results speak for themselves and do illustrate that automated cartography is capable of producing graphics art quality at a lower unit cost.

REFERENCES

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