Application of Census Data to Transportation Planning at New York State Department of Transportation

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The use of census and transportation data products by the Planning Data Analysis Group (PDAG) at the New York State Department of Transportation is examined. PDAG's experience as both data provider and data user, the types of outreach efforts employed, typical data requests, and products developed and how they helped end users are described. The importance of census data to planning activities is highlighted through specific application examples that address travel access to a primary urban core, the use of census data for regional comprehensive planning, and the use of census data and geographic information systems for transit planning.

This paper focuses on the work of the Planning Data Analysis Group (PDAG) at the New York State Department of Transportation (NYSDOT) and its experience and use of census and transportation data products. The approach of PDAG as both a provider and a user of census data products is described, along with three applications focused on different aspects of planning at NYSDOT. Each application illustrates how crucial the census or transportation data are, why these data are essential, what problems are encountered with their use, and suggestions for their improvement. In all cases, if the data were not available, the analyses described would not, in all likelihood, have been possible, because no other primary or secondary data source was available.

In the first section PDAG's approach and experience in working with the various census and transportation data products are examined and issues such as software and packaging problems and the ease of using these products are explored. Next two applications derived directly from user requests are described in which census and transportation data were assembled to assist the end user in a specific undertaking. Last, the experience of a planning department starting on the process of melding a geographic information system (GIS) and census data is outlined. The focus is on the GIS as a tool to understand complex spatial relationships important in assessing transit market areas.

NYSDOT Census Data Experience

NYSDOT consists of a main office and 11 regional offices executing the department's programs. In addition to the department's regional offices, there are 12 metropolitan planning organizations (MPOs) in the state with transportation planning responsibilities. PDAG serves as a data clearinghouse and an analysis resource for NYSDOT's Planning and Program Management Division, providing assistance to the department, its regions, and the MPOs. PDAG is responsible for the management and development of the congestion, pavement, and traffic management systems; pavement and bridge condition forecasting; and estimation of vehicle miles of

travel (VMT), as well as serving as the planning GIS coordinator. PDAG, with the New York State Department of Economic Development (NYSDED), participates in the Census Bureau's Data Affiliate Program. In its role as an affiliate, PDAG has access to many census data products and resources from the Census Bureau and from other New York State affiliates.

PDAG functions as both a census data provider and a census data user. As a provider, it frequently makes census data available to users who are involved in a variety of activities, such as statewide planning, metropolitan planning, trend analysis, travel model simulation, small area and project assessments, surveys, market analyses, and various other transportation planning applications. As a census data user it is often involved directly with users in undertaking the census and transportation analysis components of their project.

To address regional and MPO requests, PDAG has available both magnetic tape and CD-ROM census and transportation data products, such as Summary Tape Files (STFs), the Public Use Microdata Sample (PUMS), the Economic Census, the Census Transportation Planning Package (CTPP), the Nationwide Personal Transportation Survey (NPTS), and other data products available from the Census Bureau, NYSDED, FHWA, and the Bureau of Transportation Statistics (BTS). The Statewide and Urban elements of the CTPP were available to PDAG on magnetic tapes before the CD-ROM versions. As the CTPP became available, first at the statewide level and then at the MPO level, PDAG provided general information on product availability, along with copies of the data dictionaries for CTPP Parts A, B, C, and 1, 2, 3, and distributed CTPP CD-ROMs and TransVU software to both regional offices and MPOs. PDAG also developed a series of reports called *FACTS* (analytical and data) to provide key census and transportation data and offered its assistance in preparing any particular summarizations or reports from census products.

Census Transportation Planning Package

The 1990 CTPP represents a watershed in transportation census data products because for the first time a comprehensive nationwide data set of tabulations on residence, work place, and work flow was available from the state to the census place level and within urban areas to the block group or traffic analysis zone (TAZ) level. In 1980, individual states or MPOs had to purchase such data themselves. The CTPP is the only source of data at this level of geographic detail in the state. No other survey since the major urban area surveys of the mid-1960s is as useful a data source for work flow travel primarily because of its comprehensive and uniform availability for all locations in the state. Perhaps most important is the provision of this information in CD-ROM format.

End-User Outreach

In attempting to perform its function and provide meaningful assistance to its clients and to improve data dissemination and assistance, PDAG sought to assume a proactive and multifaceted role. For a data provider, it is easy to recognize areas in which work is needed to assist users who have little familiarity with census and transportation data products, computer resource limitations, frequent questions about data, and need help in breaking down their problems to focus the data requested on the actual data required. This breakdown moves the user to the critical second and third questions that are really the focus of their data request.

The most common data requests were found to focus on area profiles, trend analyses, or a combination of both, and on future forecasts. Area profile requests attempt to gather all of the relevant census data for a geographic area associated with a project service area. Trend analysis requests are for census data to explore many of the following questions: How have conditions changed? Why have they changed? What are current growth rates? Are there any emerging trends? Often these questions are associated with comparable requests for flow data between geographic areas, volume, speed, classification, VMT, pavement condition, and congestion. Many users are interested in the cross-sectional and cross-temporal review of sociodemographic conditions and their impact on operational measures. Forecasts of sociodemographic data during a project study period of typically 20 to 30 years pose the greatest difficulty. Often the only solution is to use the historical census trend data that can be assembled.

To increase knowledge and awareness about census data and available products, PDAG uses several different approaches, including training courses about basic census information; National Highway Institute (NHI) training for the CTPP, reports on topical transportation information called *FACTS*, graphical data sheets, and PDAG analyses focused in areas of greatest end-user concern. Experience suggests considerable enlargement of the practitioner-based examples as instructional aids is needed. FHWA, along with the Census Bureau and BTS, must develop better overview materials about the census transportation products that focus on what the products are and how to use and apply them in everyday work.

NHI CTPP Training

To increase awareness and use of the CTPP by the Main Office and regional and MPO staff, two NHI courses were sponsored. A review of the course materials suggested them to be comprehensive in coverage of the CTPP and overwhelming in length, but lacking in the number and variety of practitioner-based examples.

Experience with the NHI course suggested several areas in which change would benefit the student:

1. The journey-to-work (JTW) Statewide and Urban elements of the CTPP on CD-ROM need to be available at the time the course is conducted.
2. The number of practitioner-based applications spanning state, metropolitan, and small area analysis needs to be significantly increased.
3. Historical census data must be provided to address the obvious questions about change between the decennial censuses, such as how the means of transportation work, the work flow at the county, town, and place level, and the use of carpooling or transit have changed.
4. The obvious potential for misinterpretation of data brought about by CD-ROM ease of access needs to be addressed.

Sample Data Requests

From experience with end users, PDAG staff have observed that census information requests take several forms, for example,

- Sociodemographic data requests by different geographic levels;
- JTW TAZ matrices requested by an MPO;
- Workplace travel for employment, JTW, modal choice, and air quality assessments for conformity in capital projects;
- Market access requests for origins and destinations and JTW means of transportation for a specific tract, block group, or block;
- Feasibility studies for ferry service;
- Comparison of 1970, 1980, and 1990 census data, especially travel data;
- Travel data by occupation and average vehicle occupancy (AVO) for the Employee Commute Option (ECO) program;
- Determination of internal and external trips;
- Block-group-to-block-group travel time data;
- Bicycle and pedestrian planning;
- Intracounty travel;
- Income; and
- Projections of population, employment, households, income, automobile registrations, and travel.

Utilization

To increase end-user knowledge about the various census and transportation data products, reports entitled *FACTS* were prepared to address common data and key issues such as the following:

1. Basic census concepts and definitions: This report clarifies designations such as CMSA, PMSA, MSA, urban, urbanized, CDP, and so on, and summarizes population for each area by area and county for 1980 and 1990 (*1*).
2. Comparing different census products: This report provides a discussion of the CTPP and the PUMS, methods of data extraction, comparison of tables, tables not available in the CTPP (Statewide Element) that can be created in PUMS, and standard error and statistical differences (*2*).
3. JTW data: This report presents county-based JTW data from the Regional Economic Information System (REIS) and compares them over time (a companion document, *FACTS* Number 10, examines JTW data by residence county) (*3*).
4. Transportation-related sociodemographic data: population, households, vehicles available, population density, and so on, by region, county, and town from Summary Tape File (STF) data (*4*).
5. Population estimates and projections: population projections by county from 1980 to 2020; current population estimates from 1990 to 1994 by county and town; and analysis of household characteristics for 1980 and 1990 (*4*).

Distributing these reports to the regional offices and MPOs has increased their awareness of census and transportation data that are available and has led to requests for more detailed information.

Data Products and Software

From undertaking the *FACTS* reports and working with transportation analysts and their data applications, much was learned about census data and software products. The accessibility of census data via CD-ROM and the Internet enables PDAG staff to easily examine many more complex questions concerning how New York State compares with other states. However, in doing so several areas were identified in which end-user experiences suggest improvements in software that would benefit users. Some of these are noted below:

- All Census Bureau products are issued with user-friendly access software to find and extract a table at some level of geographic detail. A special type of soft-

ware called "extract software" exists that enables the user to find the same data for more than one area. This program should be included with all products.

- The PUMS CD software allows questions to be asked of either the household or the person file, but not if the question straddles both files. Census Bureau data products that are based on multiple file structures should facilitate this type of cross-sectional analysis.
- All software products should support spreadsheet or DBase output formats.
- STF data are summarized by table for geographic level. PUMS contains sample survey data. A comparable CTPP product is needed to support a user-specified cross-sectional analysis.
- End-user utilization of CD-ROM products would be enhanced with additional documentation describing what each field means and how these data items compare with similar data items in other products and providing interactive data dictionaries and, where appropriate, several simple, moderate, and complex data extraction examples.

CTPP and TransVU Software

When the CTPP Statewide Element CD-ROM became available, NYSDOT's regional offices were issued the CD-ROM, a CD drive, TransVU software, and the extracted LandVU portion of the regional geography. Each MPO was also given a copy of the CTPP CD-ROM and the TransVU software. From the use of this product, the following approaches for future products of this nature are recommended:

- FHWA and BTS should form an end-user beta test committee to evaluate all software for functionality and simplicity of use. The committee should be afforded the resources necessary to have timely modifications made in the event that problems or useful features need to be resolved or incorporated. The committee should also focus on the interrelationship of the various census data products and their software.
- In using TransVU it has been found that the inclusion of filtering criteria to more narrowly or precisely select localities within census-level geography (and items within the tables) would greatly improve the accessibility of the desired data. The ability to replace the column heading codes with acronyms for the data would improve data extraction. The inclusion of thematic mapping capability with the CTPP software would bring a very helpful descriptive tool to the CD-ROM data.

Specific CTPP User Problems, Issues, or Questions

Documentation of the census questionnaire and comparability between decennial censuses on the CD-ROM would be helpful. It would also be advantageous to include documentation to assist users who may be unfamiliar with the products. Frequently asked questions that should be addressed include the following:

- Does the CTPP cover all work trips or only those to the primary job?
- Which work place is used if a person has more than one job?
- Is the number employed the same as the number of workers?
- How are school trips coded?
- If the CTPP asks where an individual works, does his or her residence-workplace travel time include trip chaining?
- If you leave your house for work and it takes 45 min to get to the daycare center and then 5 min to get from there to work, did you make a JTW trip?
- Why do walk JTW trips from California to Manhattan exist?

Use of census data products such as the CTPP raises the following concerns:

- The user should be able to identify the mode of transportation correctly (it is possible that commuter, subway, and heavy rail may be confused in the New York City or Chicago area).
- Segmentation of transit trips should be ensured to improve the reliability of data regarding the means of transportation.
- It is important to know that survey definitions vary between the NPTS and CTPP, for example, that for home-based-work (HBW). Age summary categories vary among CTPP, NPTS, and STFs, and these should be standardized.
- The REIS CD-ROM provides county work flow data from 1960 to 1990. In 1980 and 1990 the unallocated origin and destination flow was allocated on the basis of the employment site data from the census. However, this was not done for 1970 or 1960. It is important that a uniform approach exist within the data.
- As with other states that border Canada or Mexico, New York State has several international crossings. Knowing the origin and destination of cross-border travel with Canada is important in analyzing travel.
- In giving MPOs TAZ-level coding, the Census Bureau eliminated the ability to identify the block or block-group data that make up the TAZ. The Census Bureau should provide both TAZ and census geography and not aggregate the file to TAZ level. The CTPP data must remain compatible with the data from STF3 and should be available for other uses outside the simulation model. In addition, errors in origin-destination trip allocation to TAZ and changes or adjustment to TAZ boundaries can then be corrected.

Application 1: Transportation Access to New York City (Manhattan) Core

Application 1 deals with the selection and prioritizing of capital projects in the New York City metropolitan area. Census and transportation data were utilized to compare and illustrate the flow and type of travel from the suburban counties to the city core, Manhattan, and between the suburban counties.

Overview

The New York City metropolitan area is the largest in the country and is represented by two NYSDOT regions and part of a third, as well as by one large and two smaller MPOs at its periphery. For clarity, New York City consists of five boroughs, each also a county: Manhattan (New York County), the Bronx (Bronx County), Brooklyn (Kings County), Queens (Queens County), and Staten Island (Richmond County). Each has a central business area. Four of the five counties have populations of between 1.2 million and 2.2 million, and if they were separate cities, they would rank as the third-, fourth-, seventh-, and ninth-largest cities in the nation. The Metropolitan Transportation Authority (MTA), the Port Authority of New York and New Jersey, New York City (NYC), the New York Metropolitan Transportation Council (NYMTC), and NYSDOT are the major stakeholders in this transportation analysis area. Allocation of financial resources in an equitable fashion, balancing the infrastructure needs of highways with those of transit, and providing for the improved mobility of the resident population while reducing congestion are all difficult tasks. Often many competing needs exist, and choices have been made more difficult because of declining funds.

Recently, the department's planning groups (Corridor Management, Program Management, and Data Analysis) undertook a major study to categorize metropolitan travel in the proper context (i.e., access to the urban core, Manhattan; noncore travel to other counties in the metropolitan area; and multimodal highway versus rail travel). The intent was to examine the current mobility and congestion situation and assess the proposed solutions. The effort relied greatly on the CTPP and the NPTS to help describe the travel backdrop for the MPO area.

The primary focus of the study was on work trips by means (mode) of transportation from the noncore counties to Manhattan (New York County) and between the noncore counties. Data showing the county of residence, employment, and the work flow to and from each county to Manhattan were assembled and were subdivided by means of transportation to work. These data were graphically presented to visualize the proportional county contributions.

The CTPP was used for the county JTW data and the NPTS for the resident-based total travel picture. In 1990 the NYMTC, the MPO, purchased an NPTS add-on, bringing the number of samples in the 12-county study area to approximately 1,700. Approximately 1,000 were in the five counties of NYC, 500 in the eastern counties of Nassau and Suffolk, and the remainder were in the northern suburban counties. The NYC sample taken together is large enough to be considered highly reliable. However, the data from individual counties are much less reliable.

Comparisons have been developed contrasting the study area, the nation, NYC, the suburban counties, and Manhattan. Transit shares were examined for those transit modes operating on fixed guideway and those operating on the highway. Because the CTPP data were only readily available on CD-ROM for 1990, preparing a comparison of how the region had changed over time was difficult. The REIS CD-ROM contained the county work flow data for 1960-1990 and showed how residence to workplace county core travel (to Manhattan) and noncore travel had grown during the period. Unfortunately, these data were not broken out by means of transportation to work.

Data Summaries

The illustrations in the following represent typical examples of the data summaries and graphics used in the analysis:

1. The question arose of how NYC compared with the rest of New York State and the nation on the means used to travel to work. Figure 1 shows the CTPP means (mode) of transportation to work for NYC (the five boroughs), New York State with and without NYC, and the nation as a whole. Except for NYC, the state is similar to the rest of the nation in the means used to travel to work. However, transit usage in NYC represents 50 percent of the means of transportation to work, and this usage is equal to one-third of the entire transit usage in the nation. Notwithstanding the high percentage of public transit usage in NYC, walk trips to work exceed public transit trips in upstate New York.
2. Figures 2 and 3 show the distribution of JTW trips from the residence counties to the core of NYC, Manhattan (New York County), and from those counties to all other counties in the study area. The data demonstrate that Manhattan is clearly the paramount focus of work travel, especially by transit. However, nearly two-

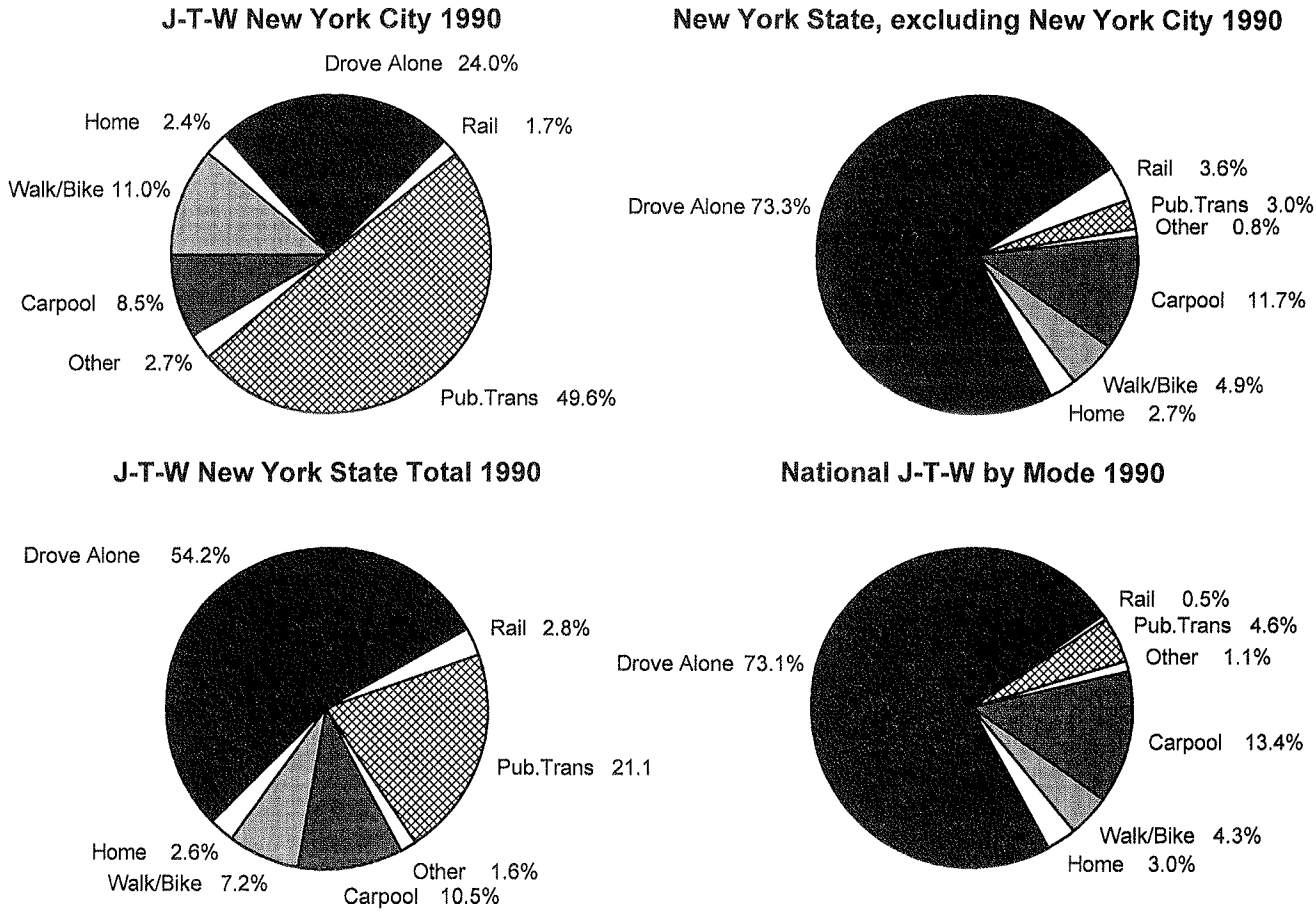

FIGURE 1 Journey to work by mode of choice, 1990 (source: 1990 STF3).

thirds of all work trips that occur in the study area do not involve Manhattan. These trips are typically made by highway, and this point is even more important when one realizes that work travel for NYC is only 25 percent of all travel.

3. A more detailed examination of where resident workers are employed shows that for the five boroughs of NYC, one-third or more of the residents work in the resident county, with 12 to 25 percent working in a county other than Manhattan. Outside NYC, 17 to 31 percent of the area's county residents work outside the county, with the exception of 63 percent in Putnam County. In NYC, 92 percent of the city residents work in one of the five boroughs, with 49 percent of the city's residents working in Manhattan.

Observations

The CTPP and the county work flow data (REIS) are the only resources available with comprehensive national detail by state collected with a high degree of accuracy over time. If these sources were not available, no data would exist except from the various disparate travel surveys collected over time within the region. The CTPP's high sampling rate is most important, especially when comparing data with other reference material, studies, and plans.

The presentation of significant tabular data is often difficult to comprehend readily. Graphical presentation of data in colored thematic maps, graphs, or pie or bar charts is more readily understood. Clearly, new ways for graphical analysis of data need to be explored.

The CTPP represents work trips to the primary work place, and not work trips to all work places. As such, the number of workers in the 1990 CTPP deviated somewhat from the number of persons holding jobs. Also, the lack of detail on the multiple modal segments that make up trips in this complex urban area seriously limits understanding of how the JTW modes are interrelated for travel from different sections of the area. For example, a 1-hr public transit trip from Staten Island (Richmond County) to downtown Brooklyn (Kings County) might typically contain a walk of less than 5 min to the bus, a 15-min bus ride (or an automobile commute to the ferry), a walk of less than 5 min to the ferry, a 20-min

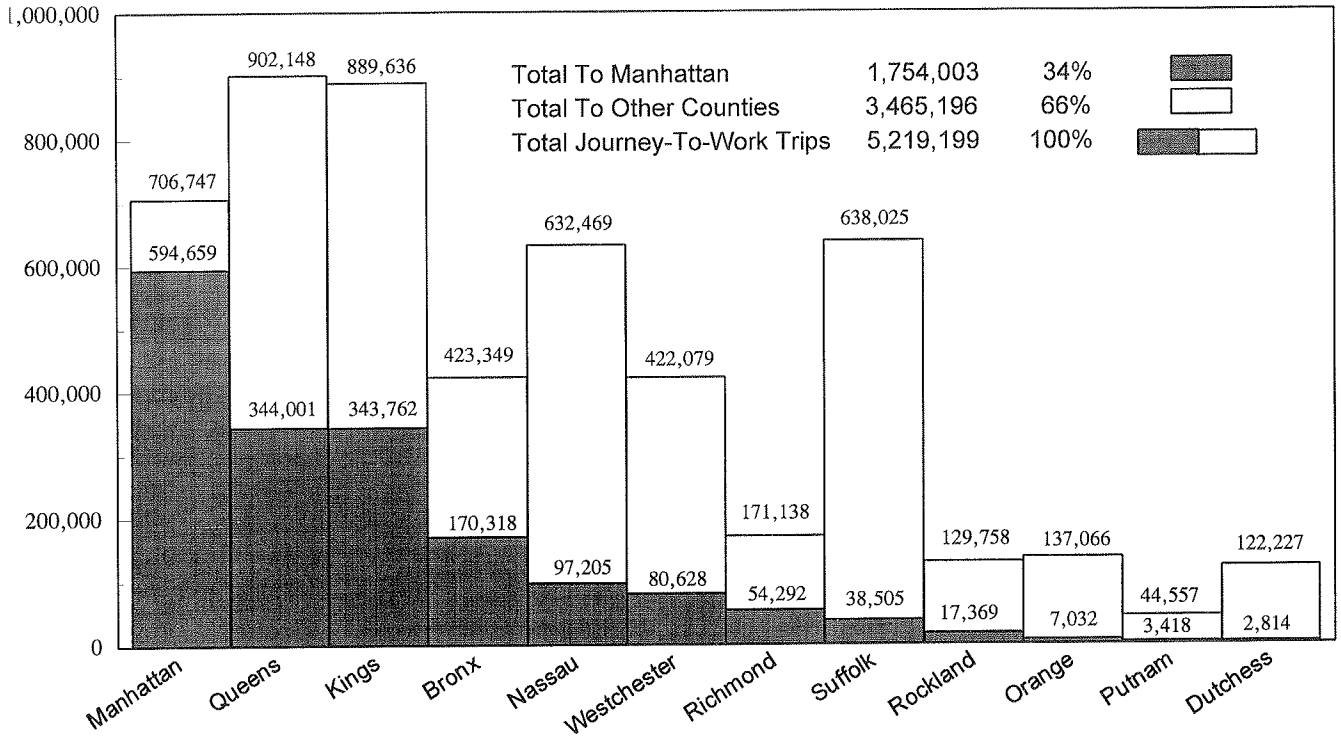

FIGURE 2 NYMTC area JTW trips from residence counties to Manhattan and residence counties to all other locations (source: 1990 CTPP).

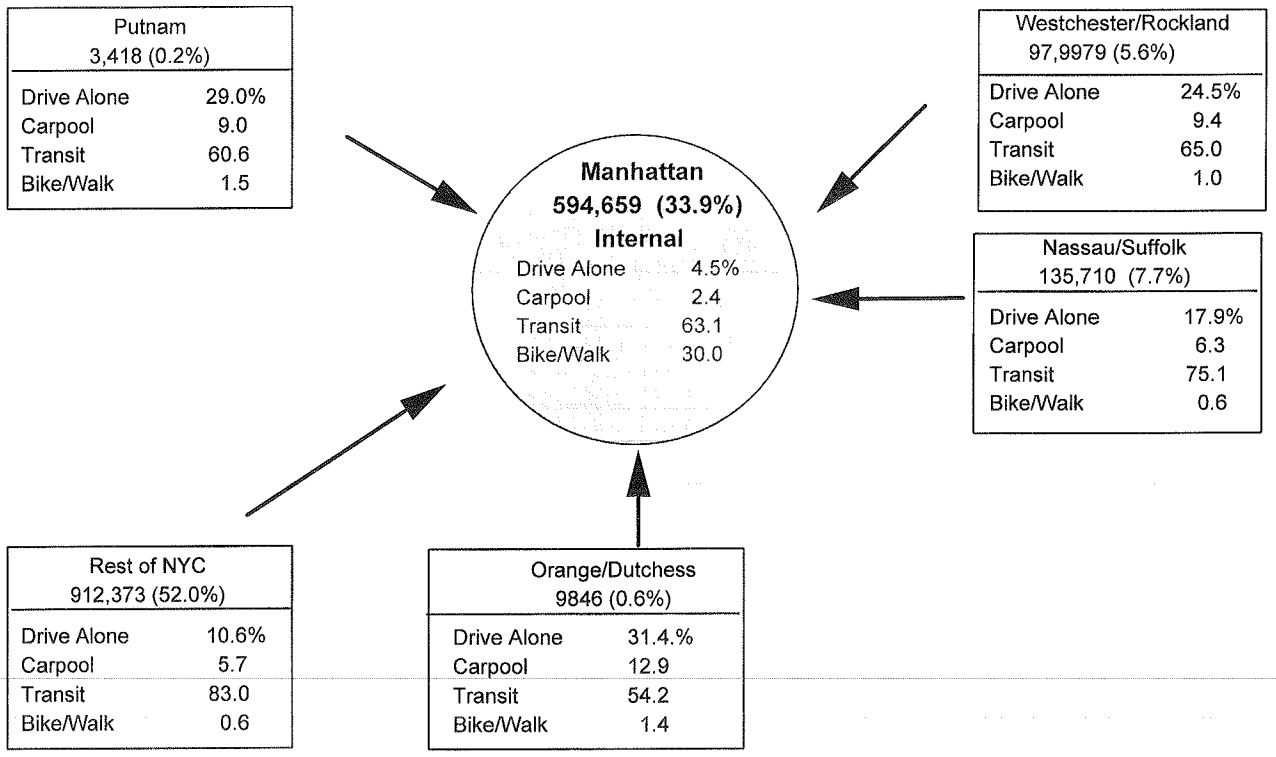

FIGURE 3 Means of transportation to work: workplace county = Manhattan (total work trips = 1,754,003) (source: 1990 CTPP).

ferry ride, a walk of less than 5 min to the subway, a 15-min subway ride, and a walk of less than 5 min to the destination. Transportation planners are clearly interested in the mode, the modal interface, and exchange points and their impact on access for both the highway and transit systems.

The CTPP JTW data demonstrate that the transit and highway systems primarily support access to the core of the NYC urban area. The CTPP also suggests that the potential for deficiencies in access within individual counties or across counties may exist for both transit and highways. The resident-based travel data from the CTPP and NPTS imply a sense of community and urban form within the counties, suggesting that trip and employment needs are more often met locally. This finding, in turn, implies that a priori assumptions for simply shifting travel among modes are not always feasible. Most transportation investments are focused on peak-period congestion or JTW travel activity, yet the work trip is only 25 percent of total travel during the day. Even in a very dense, highly transit-oriented environment, there is still a need for necessary highway improvements and a balanced transportation system. One should not forget that 75 percent of all trips are not work trips and occur throughout the day and that the combination of trips often determines the mode chosen.

Application 2: Regional Data Profiles for Regional Comprehensive Planning

NYSDOT in cooperation with the MPOs and other local governments is responsible for seeing that regional transportation needs are identified and met through the department's Statewide Transportation Improvement Program (STIP). To help the planning and prioritization of needs, a Regional Comprehensive Plan (RCP) is under development for each NYSDOT region. The RCP focuses on the 20-year vision for the region, suggesting how that future might be achieved and providing guiding principles that must be emphasized in developing the region's transportation systems. The RCP includes demographic, economic, and transportation information to help reveal regional trends that must be supported or overcome. County profiles have been developed to describe the current environment affecting travel within and through the regions.

Development of regional data profiles began in early 1995, with the NYSDOT region in Rochester. A draft document was prepared for this region, and on the basis of the feedback, the model data profile was reproduced and sent to the other regions to obtain their comments. Currently regional data profiles are being prepared for the department's other regions. The regional profiles contain the following information:

- Demographic and economic data from STF3: population characteristics, workers by category of work, income, revenue, workers, employment, unemployment, household income, persons, and automobile availability.
- County business patterns from STF3, REIS, and CTPP: household vehicle availability, JTW by county of residence and work place, JTW by county and means of transportation, JTW travel time by county, and residence of those employed in each county.
- From the Economic Census: county data by industry, agriculture, retail and wholesale trade, manufacturing, and service sector.
- From NYSDOT data files: highway infrastructure, jurisdictional ownership of the highway system, centerline and lane miles, pavement condition, motor-vehicle-related data, driver's licenses, vehicle registrations, urban and rural daily vehicle miles of travel, Highway Performance Monitoring System data, and transit system usage and fares.

The regional profile is essentially a tabular and graphical presentation at the county level of readily available information. It contains both a statewide and regional overview and presents basic county-level socioeconomic data. The data profile relies upon the CTPP for travel time, detailed residence and work place JTW by county within the NYSDOT region, and workers within and outside the residence county. Tables that illustrate population changes, travel over time from the REIS, and highway system system extent are included, along with appendixes that illustrate detailed data within each county and the region as a whole. The profile also includes regional summaries from INFO New York, a data product produced by the New York State Department of Economic Development. INFO New York contains most of the available STF data over time, including data from the Economic Census at the county level.

It is interesting to note how regional staff dealt with information during the development of the regional profile. When PDAG originally polled the regional offices to determine what information was required, it was difficult to identify specific items. After copies of a draft regional data profile were sent to all of the regional offices, it became a shopping catalogue for data. This has generated many special requests from the regional offices for components of the profile in greater geographical detail. By placing a regional profile in the regional office, PDAG has enabled the regional staff to examine in tabular and graphical detail background information from which they can better formulate a problem-solving approach or a policy position. If the profile falls short, it does so

only because it is unable to adequately describe total travel from a sociodemographic standpoint. Many questions are asked regarding total travel that cannot be answered by the CTPP.

A composite view may be obtained from three different regional offices as to the most useful census data included in their regional data profile for use with their RCPs (*5-10*). Given their location in the state and the local issues they must address, each region may choose to package and present this information in slightly different formats.

Application 3: Census Data, GIS, and Transit Market Area Analysis

The department recently obtained software from the Environmental System Research Institute—ArcInfo and ArcView—to use as the GIS platforms in New York State. GIS implementation and application have begun for the department and the MPOs. Many traditional uses of linear GISs have been developed to improve program and resource management. This improvement includes association of transportation facility data with cartographic base maps for the purpose of constructing maps on flow, condition, and categorical routes, such as the National Highway System and truck routes. More recently PDAG has worked to relate census data with highway and cartographic map coverage. Three primary activities are involved in this process: development and processing of census data coverage, association of census data with this coverage, and provision of data to a transit market research project. Using the GIS, NYSDOT's Public Transportation Division is identifying market opportunities as an input to bus route and service planning activities. The Public Transportation Division developed the transit bus route coverage and PDAG provided the demographic, economic, and travel data from the STFs and the CTPP, along with the Topologically Integrated Geographic Encoding and Referencing (TIGER) File base map.

Tiger File Base Map for Census/GIS Coverage File

In undertaking this activity, a number of technical issues were identified.

- Differences existed among the highway system coverage designed to cartographic standards, the simplicity of the TIGER File coverage used by the Census Bureau, and the MPO simulation TAZ boundaries.
- When the Census Bureau has information that does not fit into a place within the town geography, it identifies a place called "remainder of the town." Existing coverage that represents the mapping of cities, towns, and villages does not account for the remainder concept.
- It became apparent that the geographic levels of block group and block were essential for any analysis requiring census and TAZ data. TIGER File block and block group coverage was subsequently purchased from another state agency.

Linking Census Data with Coverage Polygons

PDAG staff had trouble matching the Federal Information Processing Standards (FIPS) place codes used by the Census Bureau with their coverage. Somewhere in the process during the development of the TIGER File coverage purchased, the FIPS place codes had been subjected to "text to numeric to text conversions" and leading and lagging zeros were missing in the left-justified fields. It was necessary to add the New York State code to the base map polygons, since the NYC urban area spans more than one state; however, for New York State map making, it is not important. In addition, it was discovered that TransVU was using the Census Bureau place codes. This meant that data extracted from the CTPP were incompatible with the FIPS place codes being used for linkage to STF3 data. An equivalency table was developed for the two codes.

Census Data Bases for GIS Applications

The most important question in relating census data and GIS coverage was what type of census information should be included because of its importance to transportation planners. Working with the Public Transportation Division, PDAG selected the most obvious transportation items from STF3. In developing data transformations for their application, it was discovered that the GIS product was not as robust as spreadsheets were for this purpose. There was also no indication in the GIS of the best way to store the data (data normalization) other than in flat file format. Storage of data requires consideration as to how data will be displayed. In the GIS, data can be displayed at a geographic level using a selection of colors to describe the ranges of interest for the number of workers. However, to show shares by mode of travel, totals and proportions need to be constructed. Using proportional data, a much more meaningful graphical display can be created. The GIS is limited to providing two dimensions, geography and the spatial context in color, for the variable being examined. Multidimensional tabular data are difficult to present beyond area and color. In addition, displaying automobiles available per household and population density simultaneously is difficult.

Using GIS in Transit Service Planning

To define the market for new or reoriented transit services, the analyst must first address questions concerning the geographic patterns of travel, demographic attributes, and economic activity. In particular, where do people travel and by what means? Where are there concentrations of population that present opportunities for transit service? How many households do not own an automobile or have persons over age 60? Are clusters of work trip origins destined for work destinations concentrated in a particular zone or zones?

As is the case for most spatial analyses of travel, the STF and the CTPP are the only data sources available short of undertaking primary survey research. To analyze the geographic distribution of existing and potential transit markets, population age characteristics, household income, and automobile ownership characteristics were selected from STF3 to define the relationship between the fixed bus routes and where service demand may exist. To analyze existing transit market shares, CTPP Urban Element JTW by TAZ was examined.

Most TAZs used in the simulation network of the Albany area MPO, the Capital District Transportation Committee (CDTC), often do not mirror census block groups very well. By relating TAZ to census blocks, CTPP transit usage can be linked to the population and household data from STF3. Background sociodemographics may then explain why two similar origin zones with trips to a common destination zone have differing levels of JTW transit usage. Relative modal JTW travel times from the CTPP may offer possible explanations for differing modal usage.

Population Density

Population density is a commonly used gauge of transit market viability. The standard transit industry rule of thumb is that frequent service can be supported by population densities of 3,000 persons per square mile. By overlaying the Capital District Transportation Authority (CDTA) bus routes onto block groups, transit supply and demand issues can be examined.

Zero Automobile Households

Households without an automobile available are an another indicator of the potential for transit usage. It should be noted that variations exist in size and compactness of urban and rural census block groups. A concentration of 10 households without automobiles available in an urban block group is enough to allow bus service. The same number of households without automobiles available may be miles apart in a suburban or rural block group.

Color can be used to denote the number of households present within a block group; a proportion like density can address measures of uniformity. There is a need to visually display both quantity and uniformity to get the complete demographic picture. By using shades, patterns, or color with the numeric value and creating indexes by multiplying the household number by population density and shading the product, several measures can be displayed.

Bus Transit Market Share by TAZ

Figure 4 shows the CTPP JTW transit bus share for CDTA by TAZ. The highest market share can be observed in areas with the greatest population density and transit service. This level of detail in the data enables a visual comparison of relative transit service in demographically similar TAZs.

Transit Share Versus Automobile Ownership

Figure 5 contrasts the CDTA transit market share of a group of TAZs by color with the number of households without automobiles for the nearest census block group. The TAZs used by the CTPP are not 100 percent consistent with the block groups contained in STF3. Both are based on combinations of blocks, but block group boundaries are frequently crossed by TAZs. The result is difficulty in correlating CTPP and STF3 data for these areas. With the GIS, a visual comparison is obtained by overlaying the two sets of data. However, since the Census Bureau did not include both TAZs and block groups, inconsistent data definitions preclude the analyst from drawing direct correlations.

Recommendations

- Recommendations based on the experience of others as to data, structure, and tricks of the trade would be very helpful to those just getting into work with census data and the GIS.
- A one-to-one consistent geographical linkage across all census and transportation survey data and software products should be maintained (e.g., census data should not be aggregated to TAZ if it means the loss of block group and block level linkages).
- A CD-ROM containing self-extracting TIGER File coverage for the geographic areas contained on each CTPP CD-ROM would be very useful.

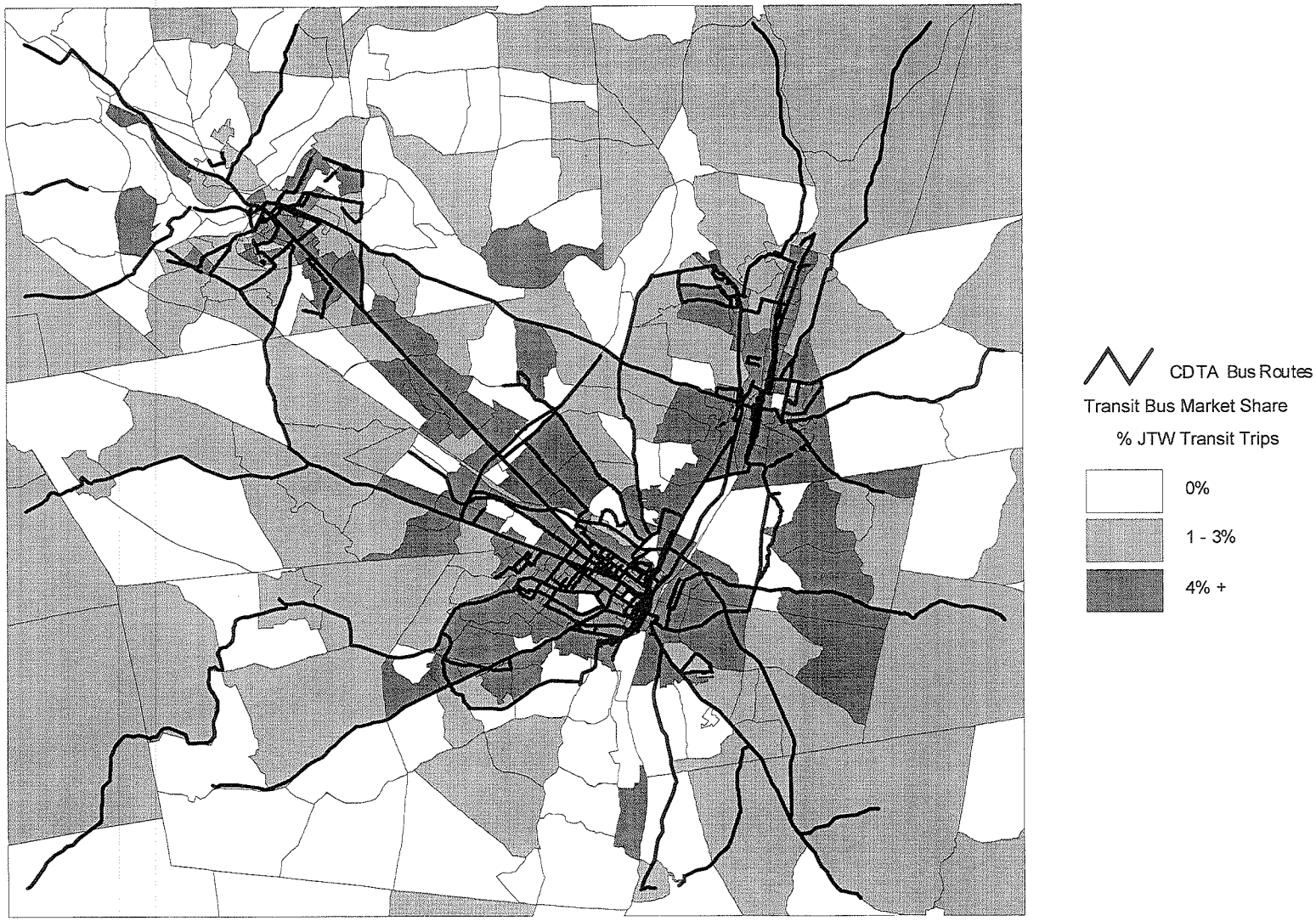

FIGURE 4 1990 CDTA market area transit market share (source: 1990 CTPP, STF3).

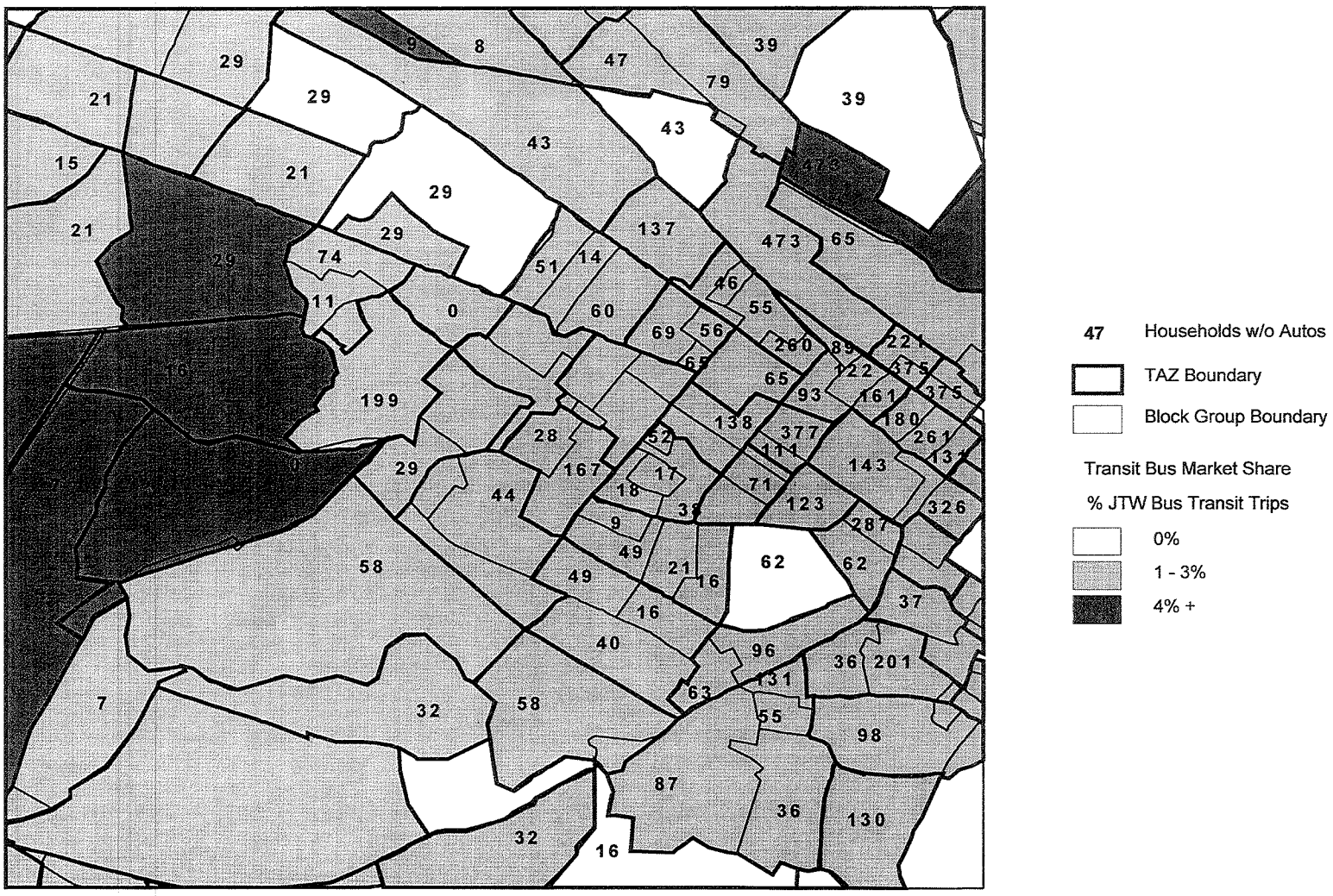

FIGURE 5 1990 CDTA market area households without automobiles by TAZ block group (source: 1990 CTPP, STF3).

- The graphic on page 1 of the *Census Mapbook for Transportation Planning* (*11*) illustrates a multidimensional presentation of JTW data. This is a very powerful presentation and is not easily performed by most GIS software. A project to explore the presentation of information in more graphically innovative ways and work with vendors and universities to identify new software display techniques should be undertaken by FHWA, BTS, and the Census Bureau.
- Presentation graphic packages and spreadsheets often provide data analysis and display capabilities more powerful than those in a GIS. FHWA, BTS, and the Census Bureau should work with GISs, simulation modeling, and other software vendors to develop standard formats and coverage translation procedures.
- BTS and FHWA should lead in developing examples of census and travel data buffered within a project corridor.

In 2000, computers will have advanced significantly in power and capability. The GIS should be viewed as the analyst's window on data, a tool that is essential to show information. The selection and presentation of census and transportation information drive data collection, delivery format, and analysis software. Focusing on how the data are used is essential to better address what information is required and what presentation tools are necessary.

- New graphical analysis and data management software should be examined to look at areawide data as a surface foil. For example, traffic can be viewed as a 24-hr surface along a route. Population at the block group and block level can be observed in a similar way along with any other variables.
- Examination of spatial data in three-dimensional space by changing the perspective of the surface foil enables a new perspective on census and travel data that has never been examined. Information that remains hidden in tables is now visible in this manner.
- Examining basic demographic variables such as population, households, and automobile availability by using a topographical format, time of day, and the ability to create holographic images is the goal for future data analysis techniques.

Despite the difficulties encountered in applying this technology, it is very powerful. The coupling of GIS and census data provides an advanced set of analytical tools previously unavailable for use with census data. The GIS clearly enables the user to portray various spatial interrelationships, location of service corridors, and factors influencing the transportation dynamic. Census 2000 will benefit greatly from the advances in this technology.

SUMMARY

Census and transportation data are invaluable for transportation planning. None of the three applications discussed could have been accomplished if these data were not available. Having these data allows analysts to develop a better understanding of the underlying elements shaping travel. Better information clearly leads to improved decision making. The three applications and the provider-user approach applied by PDAG serve to bridge the gap between data and information. Key issues and concerns encountered are summarized below:

- FHWA and the Census Bureau should explore improvements in documentation, terminology, definitions, products, and software for all end-user CD-ROM data products.
- FHWA and the Census Bureau should create an inventory of practitioner-based examples, application-oriented documentation, frequently asked questions, and experiences of others.
- Census Bureau software needs to be more robust to address how data will actually be used. Currently, it just provides access to singular data items within consistent geographical areas. Data requests are driven by area profiles, trend analyses, and future forecasts to support cross-sectional or cross-temporal views of sociodemographic data.
- Historical census and transportation data products should be made available on CD-ROM.
- Software products should have consistent output file formats, printing capability, and access methods.
- An end-user committee should be established to review and examine software and census data products before and after distribution.
- Census geographical referencing should remain available even when data are aggregated to TAZ. The Census Bureau should ensure that a consistent referencing system and linkage are maintained across all census data files and all geography.
- TIGER File coverage should be provided with CTPP data.
- New initiatives concerning the graphical analysis and presentation of data should be explored.
- The development of sociodemographic data estimates beyond population forecasts should be considered.

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