

On Modeling the Travel Behavior- GHG Emissions Linkage

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and Livable Communities**

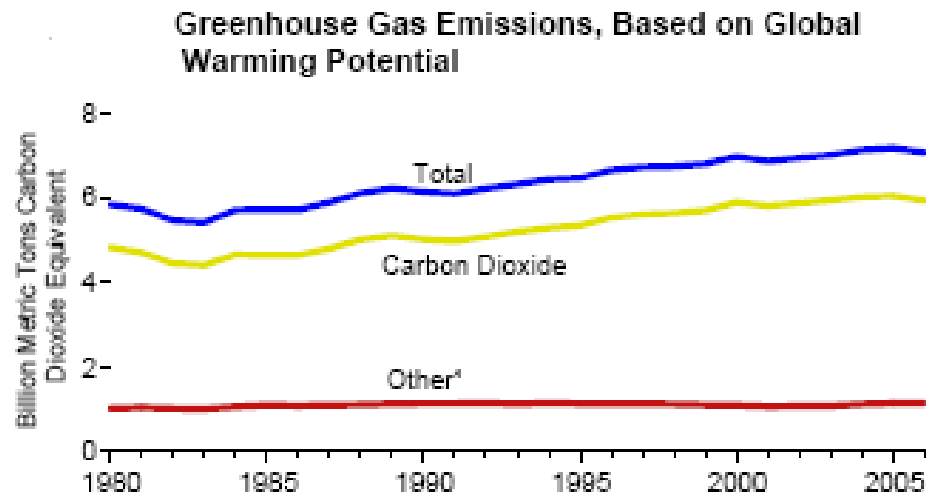
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Several Collaborators and Former/Current Graduate Students

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- Ram Pendyala, ASU
- Jessica Guo, UW
- Siva Srinivasan, UF
- Rachel Copperman, CS
- Abdul Pinjari, USF
- Aruna Sivakumar, Imperial College
- Naveen Eluru, Ipek Sener, several other UT students

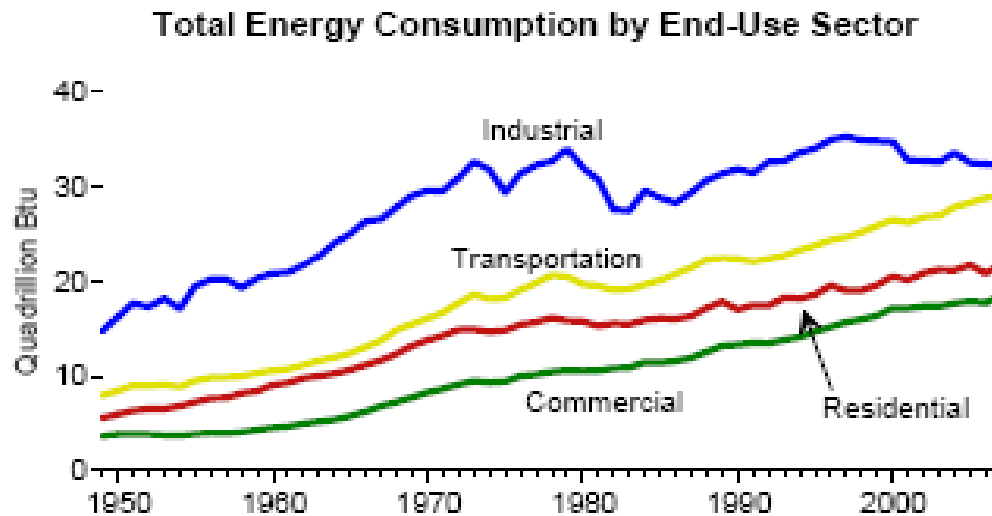
Greenhouse Gas Emissions

- Energy-related activities account for about three-quarters of human-generated greenhouse gas (GHG) emissions.
 - Mostly in the form of Carbon dioxide (CO₂) emissions from burning fossil fuels.
- If measures are not taken to reduce carbon emissions (NAS, 2008):
 - 5.9 million metric tons in 2006 **→** 7.4 million metric tons in 2030



Contribution of Transportation Sector to GHG Emissions

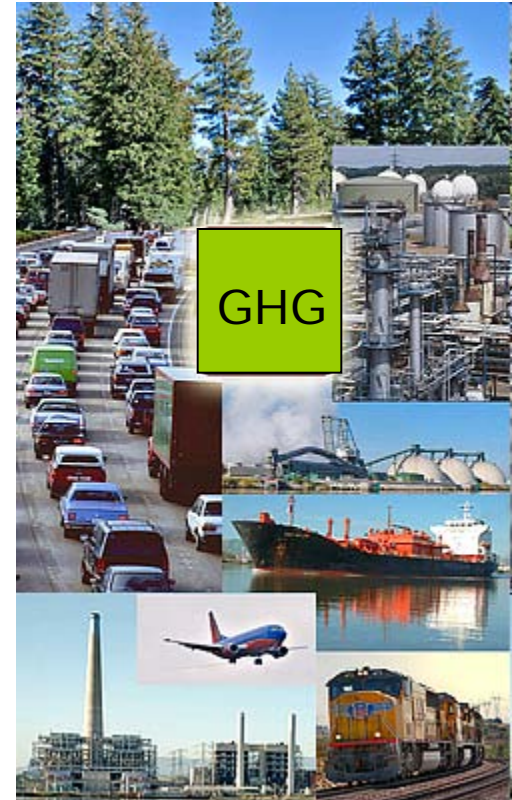
- The transportation sector is one of the most rapidly rising sources of GHG emissions.
- Overall, the transportation sector accounts for about one-third of all human generated GHG emissions.



EIA, 2008

Transportation-sector Related Sources of GHG Emissions

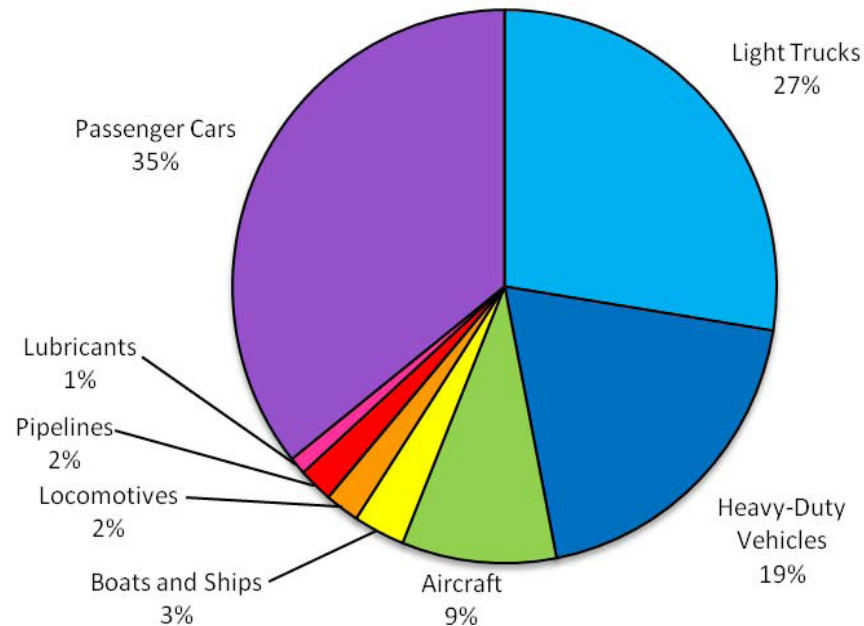
- Vehicular travel sources
- Life cycle transportation sources
- Non-road transportation mobile sources
- Mobile air conditioning and refrigerated transport sources



Vehicular Travel Sources

“On-road and non-road vehicles”

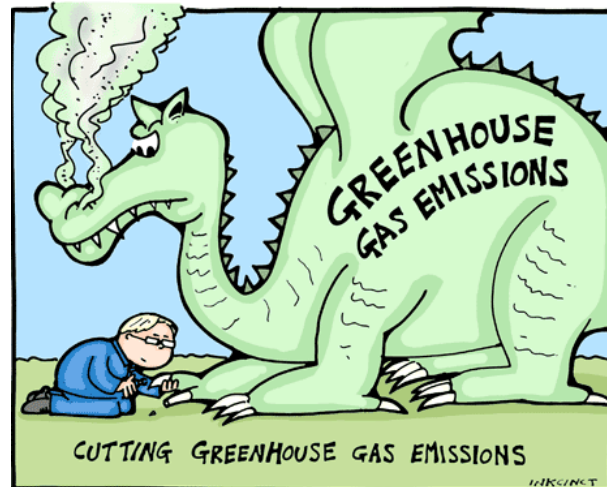
- Accounts for a substantial portion of GHG emissions.
- Household automobile dependency is an important contributor



Source: EPA, 2006

Reduction and Mitigation Measures for GHG Emissions

- Transportation-related GHG reduction measures:
 - Improve fuel economy
 - Decrease carbon content of fuel
 - Reduce growth in travel demand (or vehicle travel)
 - Reduce emissions from infrastructure



Improve Fuel Economy

- Enhance vehicle technology (both operation system and fuel)
- Increase transportation system efficiency
- Improve traffic operations
- Change vehicle purchase/retirement decisions

Decrease Carbon Content of Fuel

- Research, development and commercialization on alternative fuel infrastructure and distribution
 - Examine trade-offs in cost, size, power, mileage, etc. between alternative fuel vehicle types
 - Evaluate impact of infrastructure (fueling station availability)
 - Forecast temporal rate of adoption
 - Assess potential of government initiatives and policies
- Tax incentives
- Life cycle analyses to ensure sustainability of resources
- Adopt regional low carbon fuel standards

Reduce Growth in Travel Demand-1

- Change land-use patterns:



- Provision for alternative modes:



Reduce Growth in Travel Demand-2

- Changes in availability and price of parking:



- Employer initiatives to reduce commuting:



- Pricing Strategies:



Reduce Growth in Travel Demand-3

- Enhanced freight strategies:
 - Modal alternatives (barge, rail, etc.)
 - Freight bottlenecks, especially on intermodal connectors
 - Reduced truck idling
 - Reduce empty backhauls



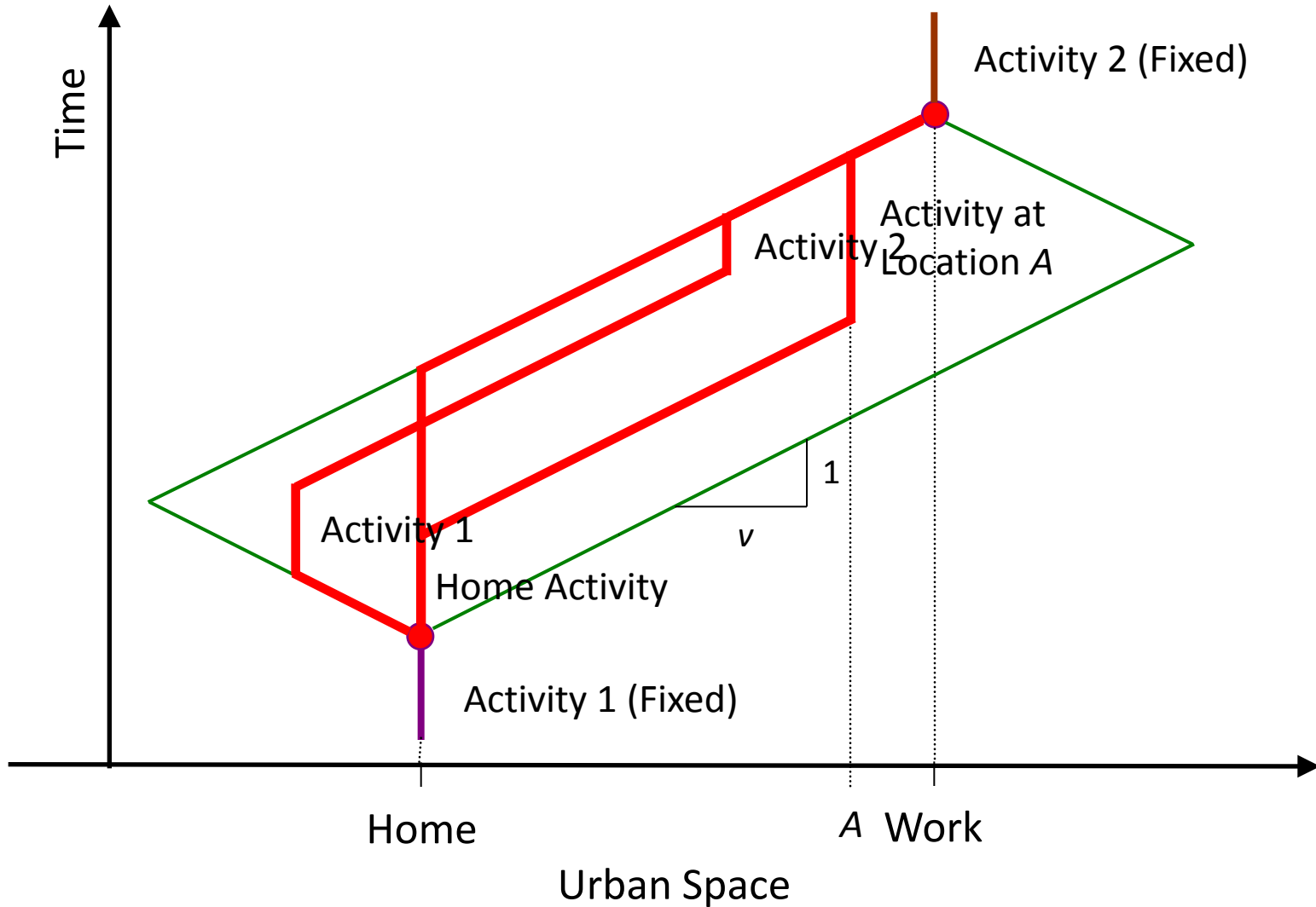
Five Pillars of ABM Design

- Sensitive to policy issues and planning applications of interest
- Based on sound behavioral theory/paradigm
- Computationally feasible and tractable
 - Model estimation
 - Model implementation
- Optimal use of available data (present and future)
- ABM should be both an Activity-Based Model and an Agent-Based Model

Time-Space Interactions

- Activities and travel distributed in time-space continuum
 - Recognize time-space constraints affecting mode choice (transitions), destination choice, and activity-type choice
- Role of time-space accessibility
 - Critical to modeling activity generation processes
 - Ability to explicitly represent induced or suppressed demand
 - Incorporation of Hägerstrand's prism concept

Time-Space Interactions



Agent Interactions

My meeting is in the morning. I have to go to Jane's office today.

today
take

Don't worry Jane; we'll drop you off on the way to the store and pick you up later. Run along now, you'll miss the bus.

sounds like a good idea. I'll go to the store and take the subway tonight rail today to work. See you later.

Hey, Mom and Dad, don't forget; you have to drop me at Johnny's house in the evening today



Activity Attributes

- Activity purpose definition
 - Challenge traditional notion of mandatory and discretionary activities/trips
 - Movie, ball game, and child's tennis lesson or soccer game often have spatial and/or temporal fixity
 - Characterize activities and trips by level of spatial and temporal fixity/constraints (besides purpose)
 - Can be incorporated using concepts of time-space geography
 - Automated method to add attributes describing degrees of freedom according to set of spatial/temporal fixity criteria to activity records in data set

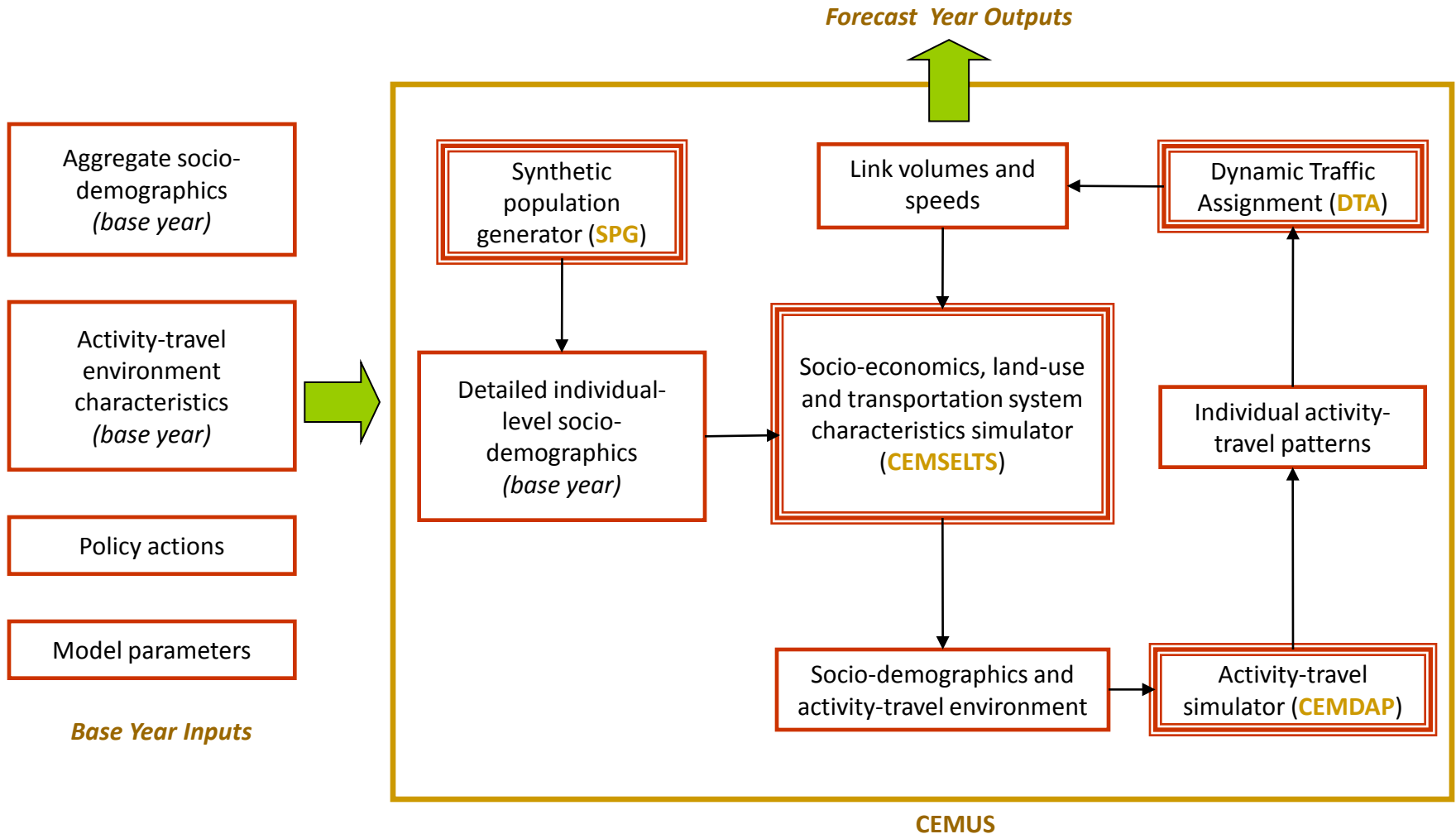
Notion of Time Use

- Notion of time is central to activity-based modeling
 - Explicit modeling of activity durations (daily activity time allocation and individual episode duration)
 - Treat time as “continuous” and not as “discrete choice” blocks
- Evidence of increased availability of leisure time and increasing travel time expenditures
 - Loosening of time, space, and money constraints
 - Productivity efficiencies brought about by technology and specialized services
- Reconcile activity durations with network travel durations (feedback processes)

In Summary

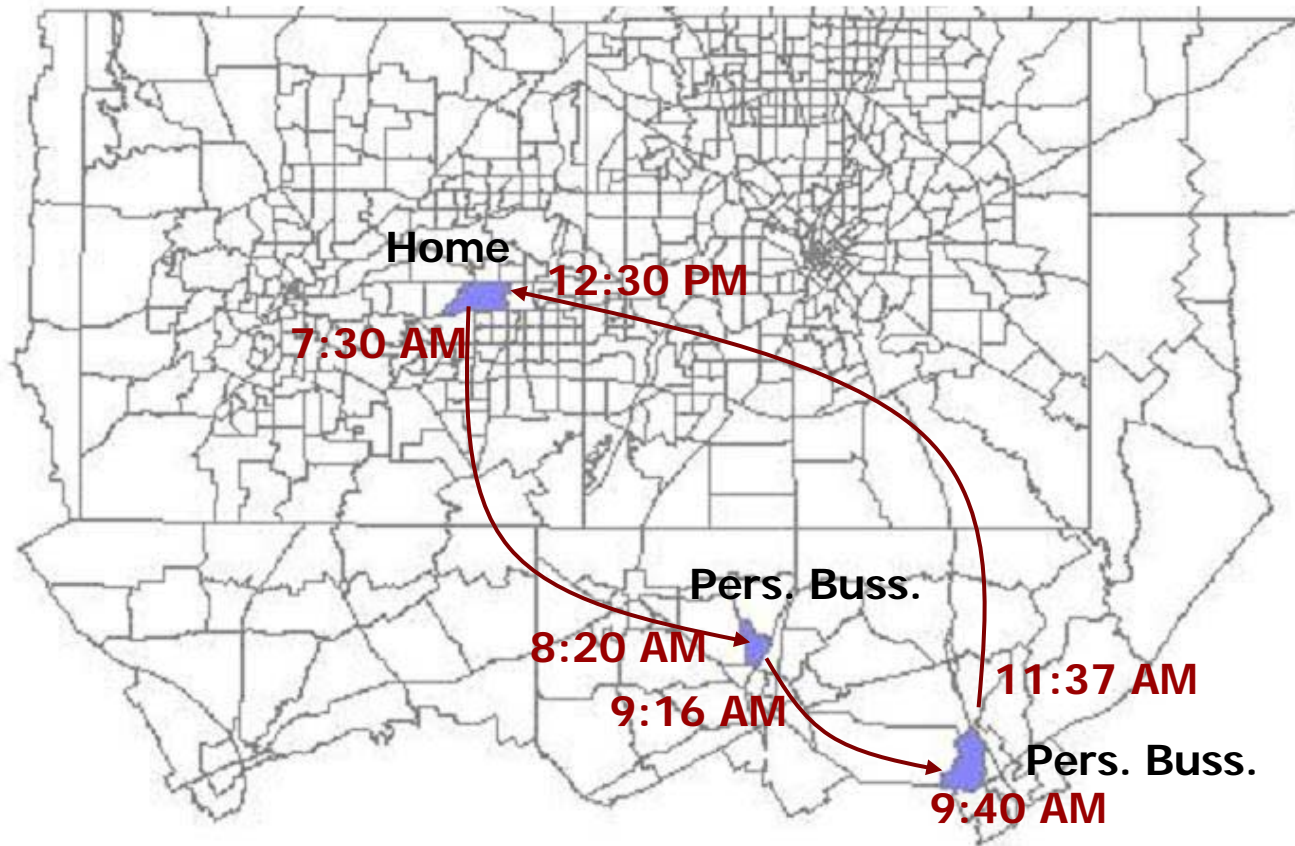
- ABM should...
 - Capture the central role of time and space in a continuum
 - Explicitly recognize constraints and interactions
 - Represent simultaneity in behavioral choice processes
 - Account for heterogeneity in behavioral decision hierarchies
 - Incorporate feedback processes to facilitate integration with land use and network models

Conceptual Overview of CEMUS



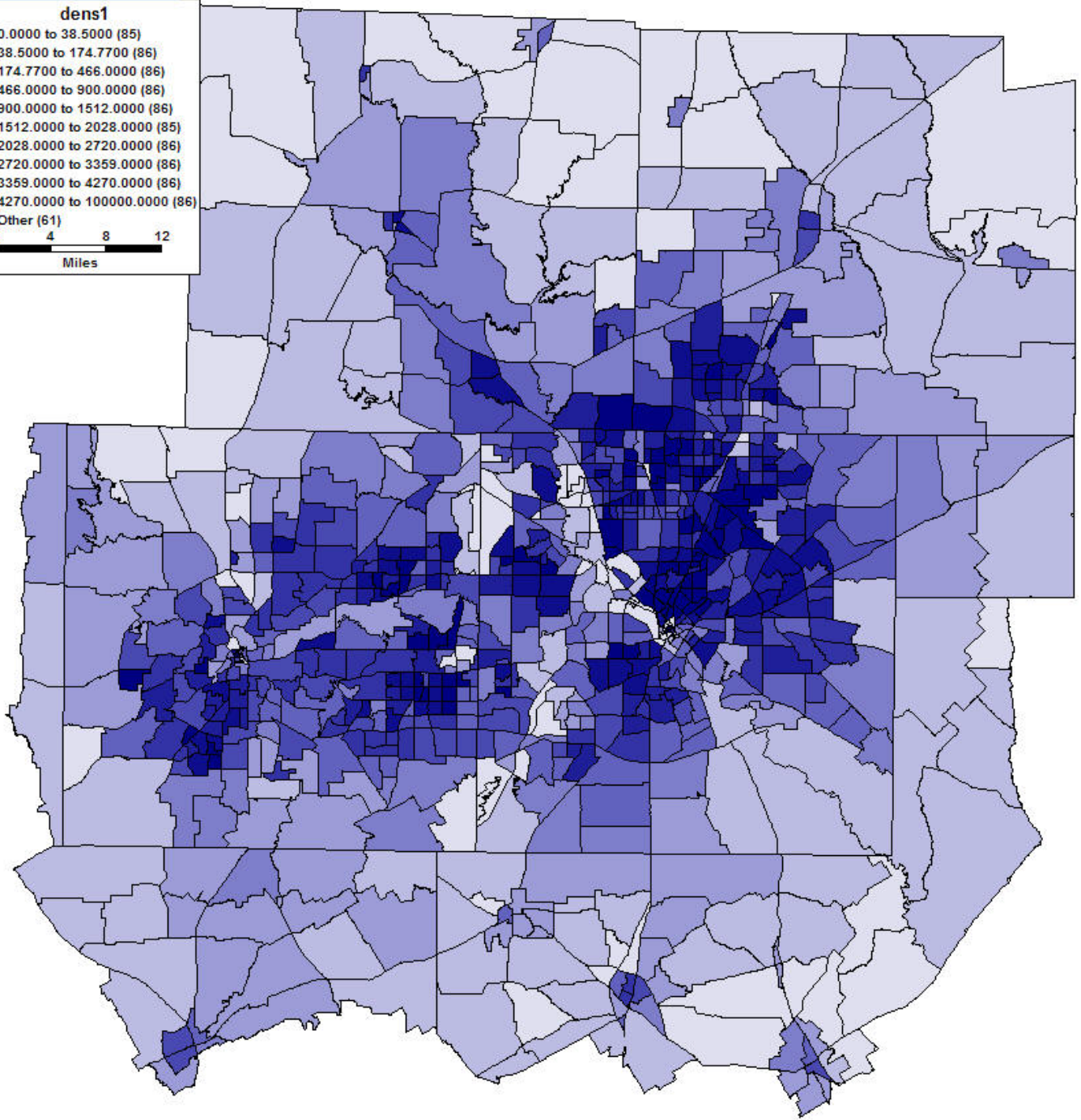
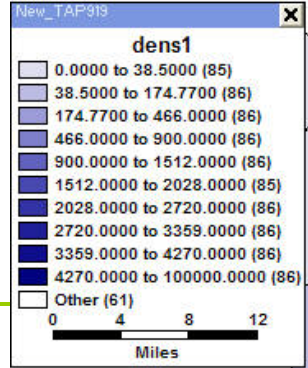
Simulation Outputs

A Graphical Illustration

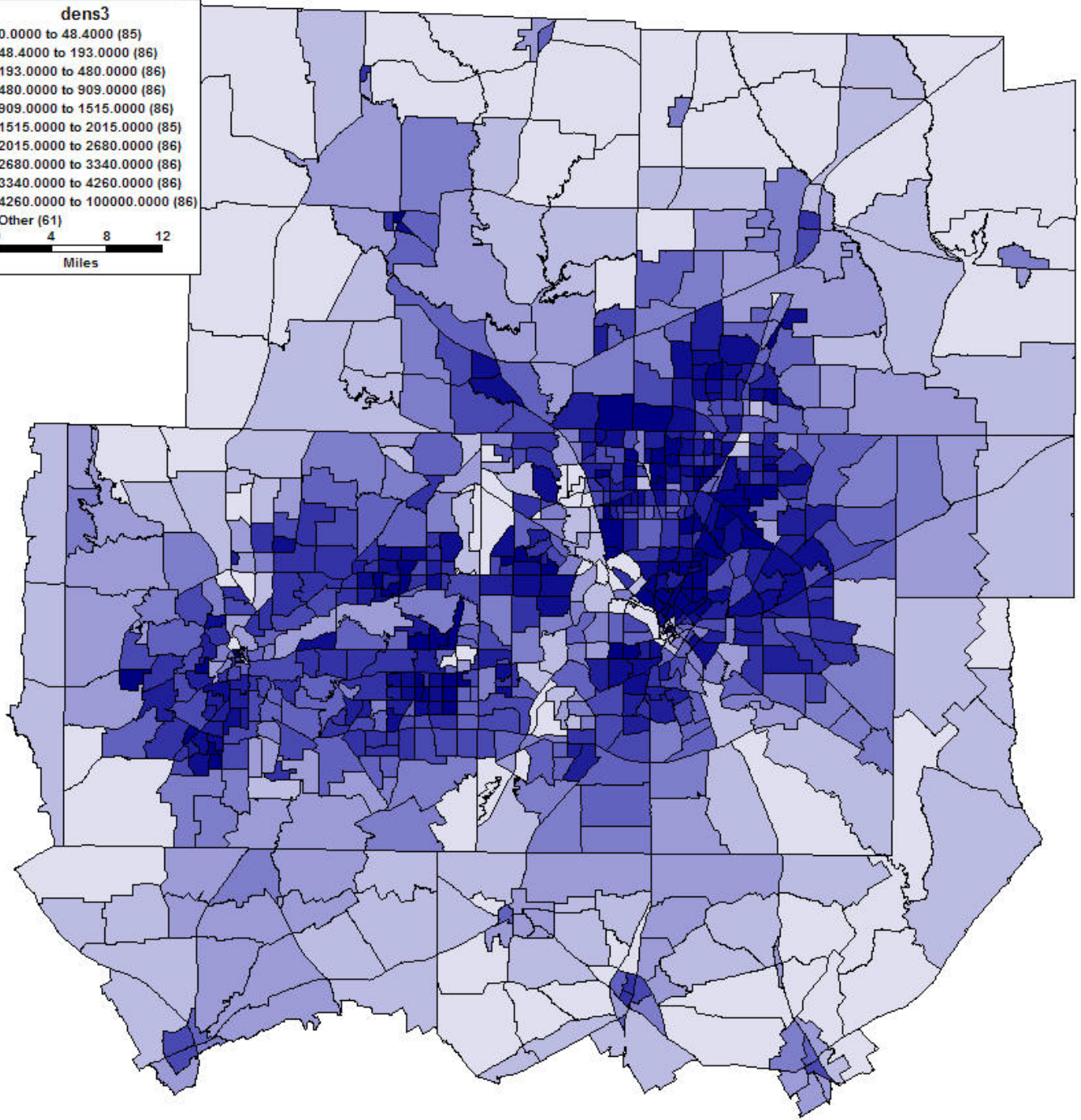
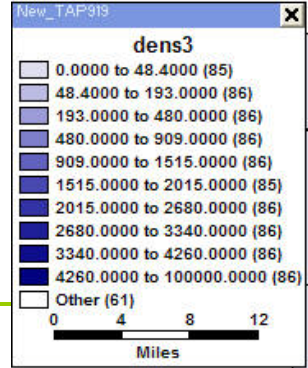


**Non-worker
Multiple Stop
Tour**

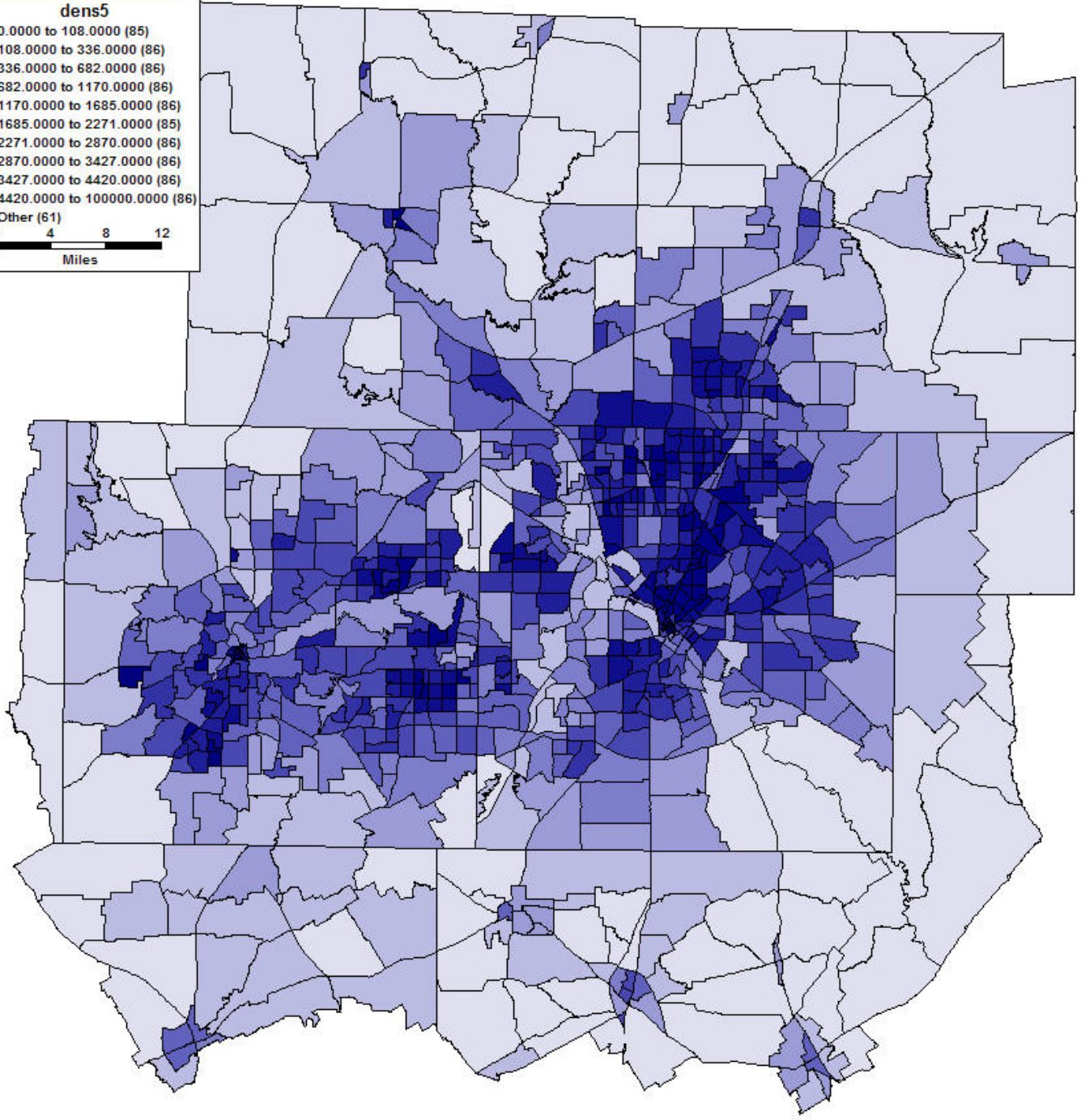
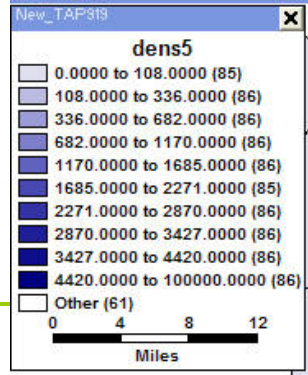
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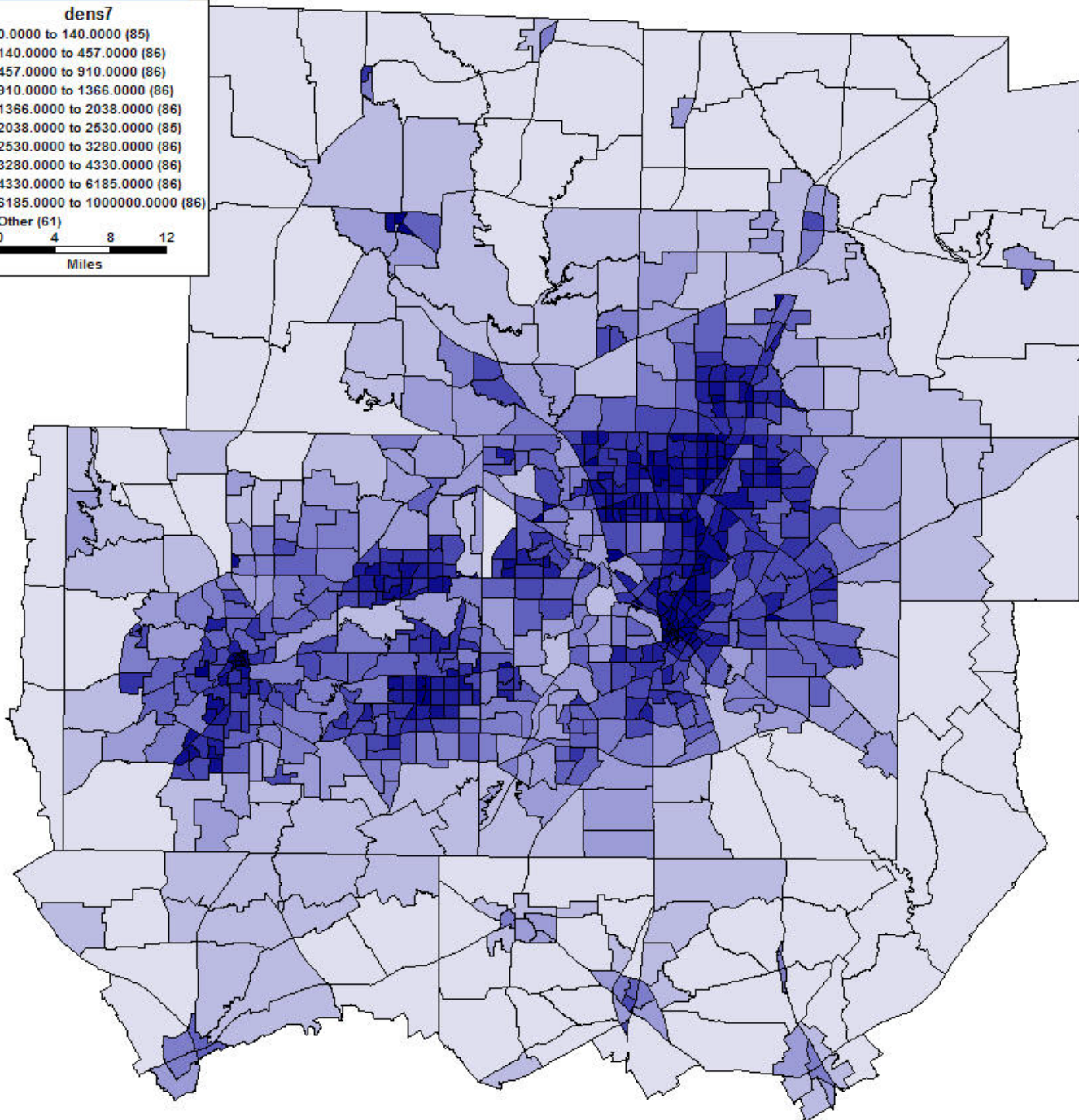
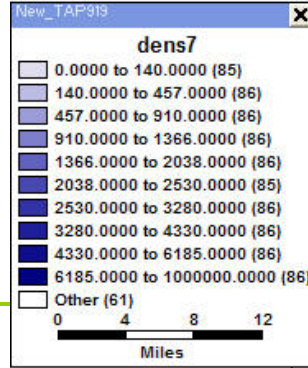
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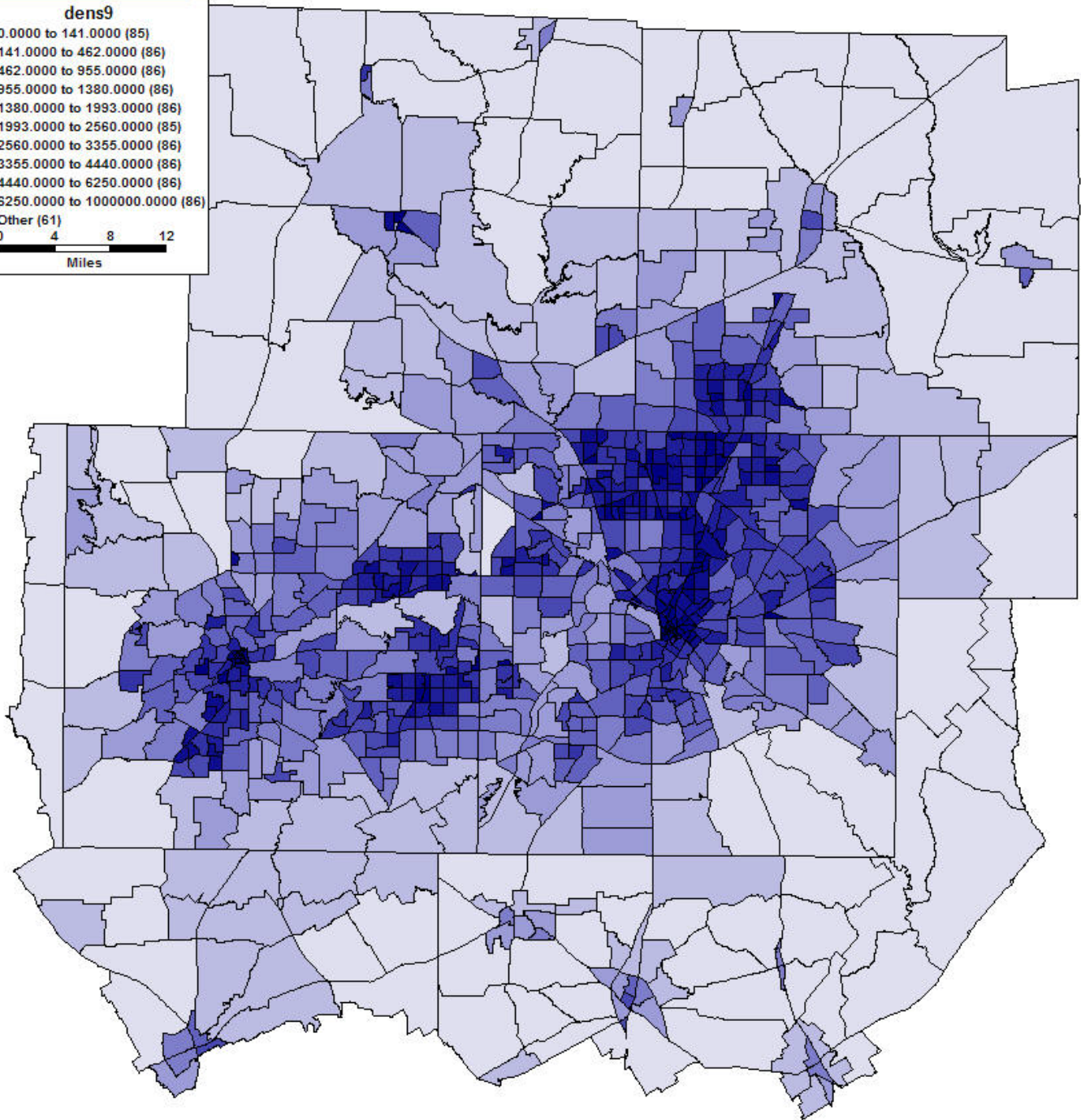
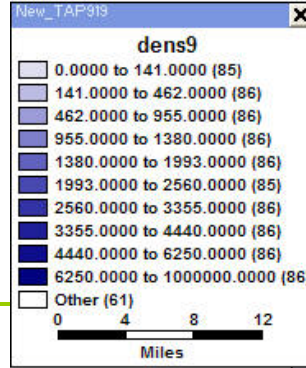
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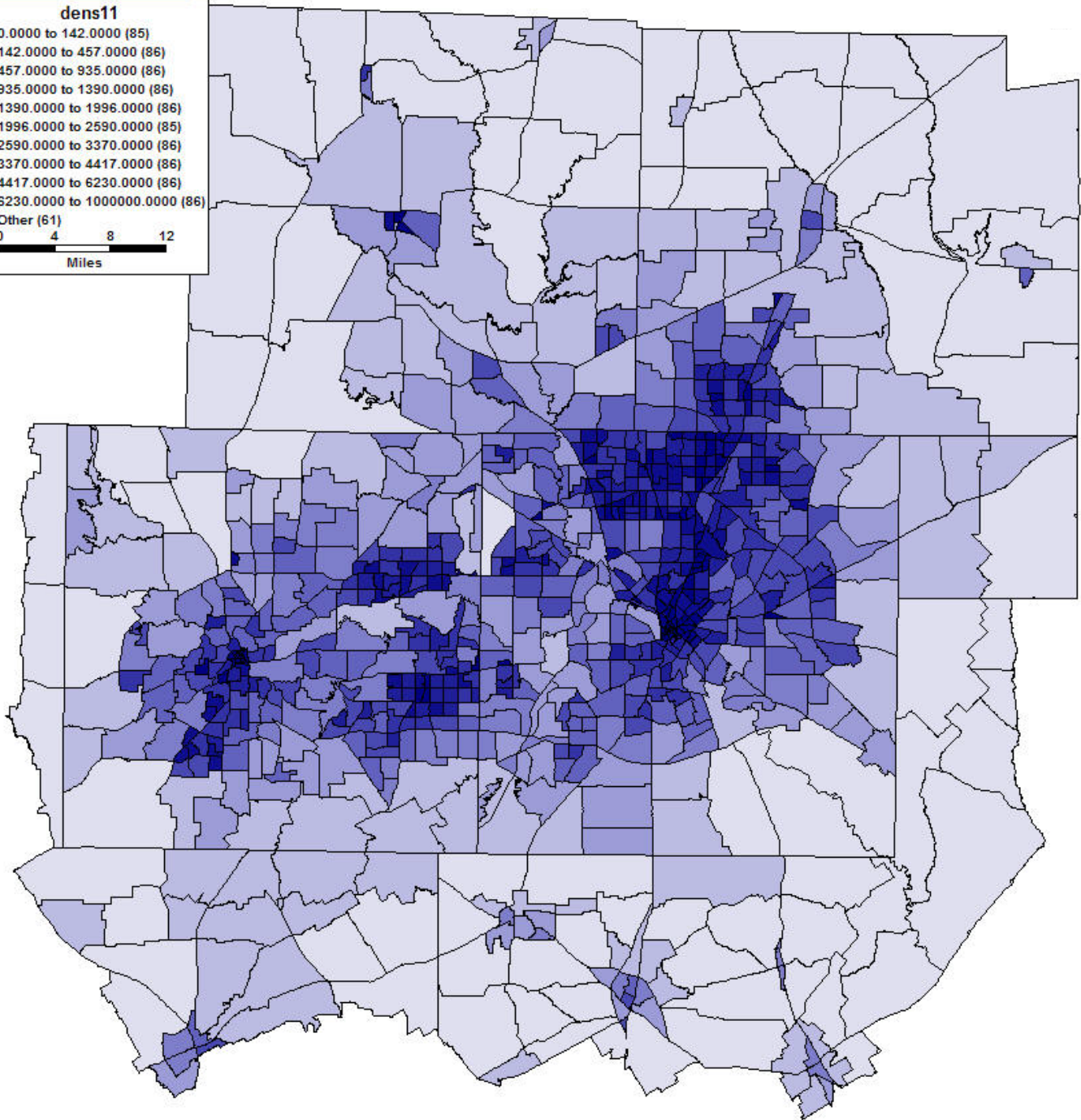
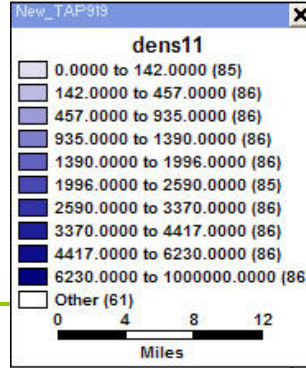
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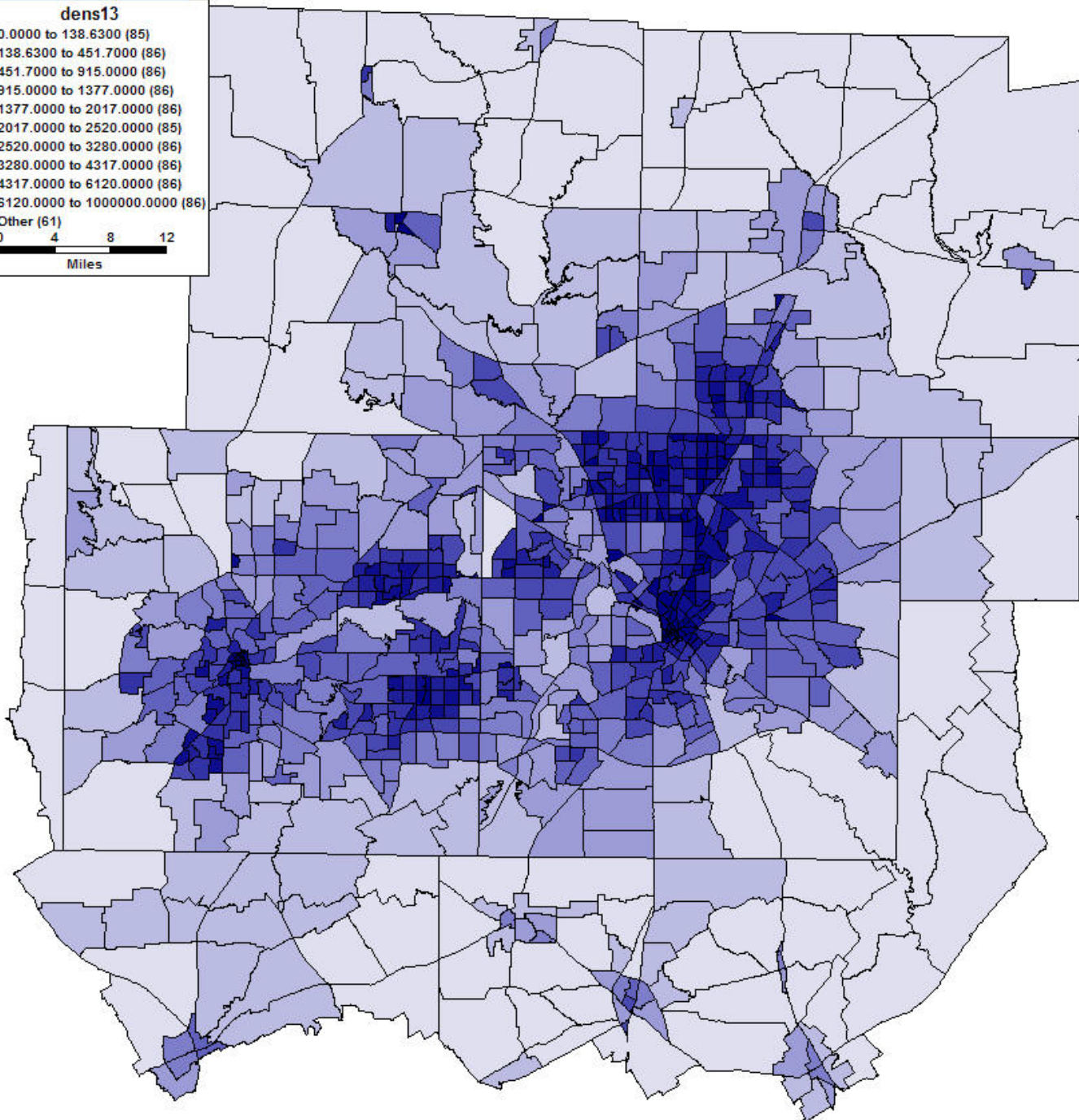
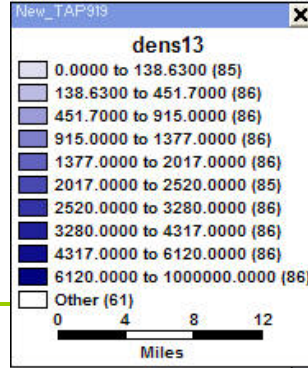
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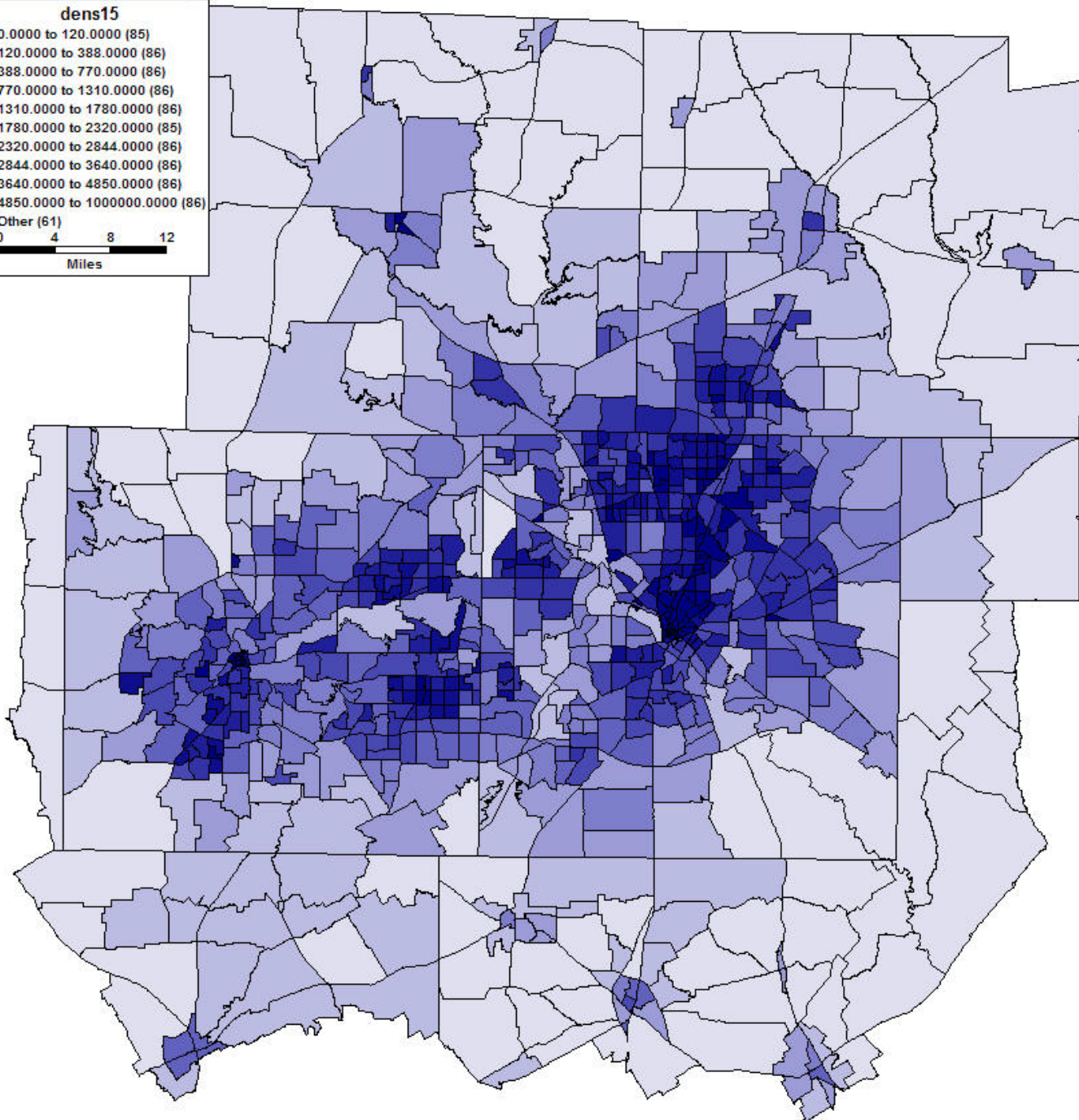
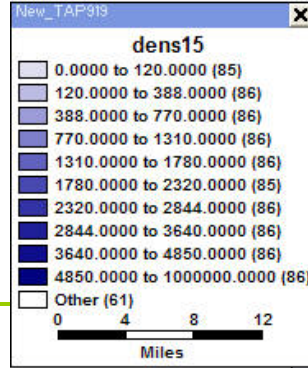
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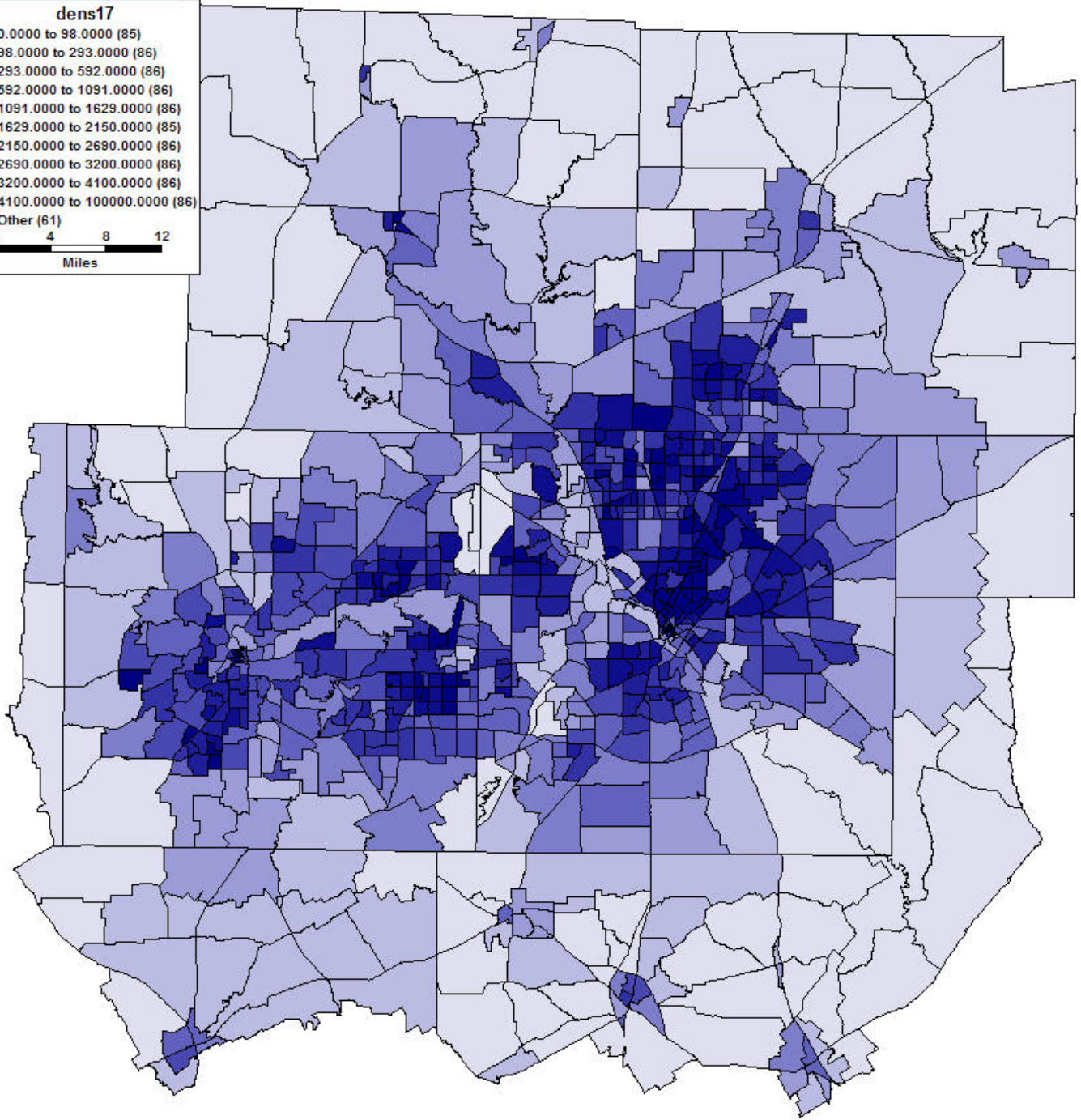
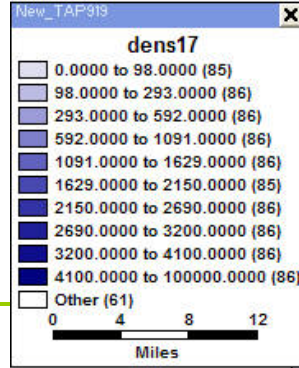
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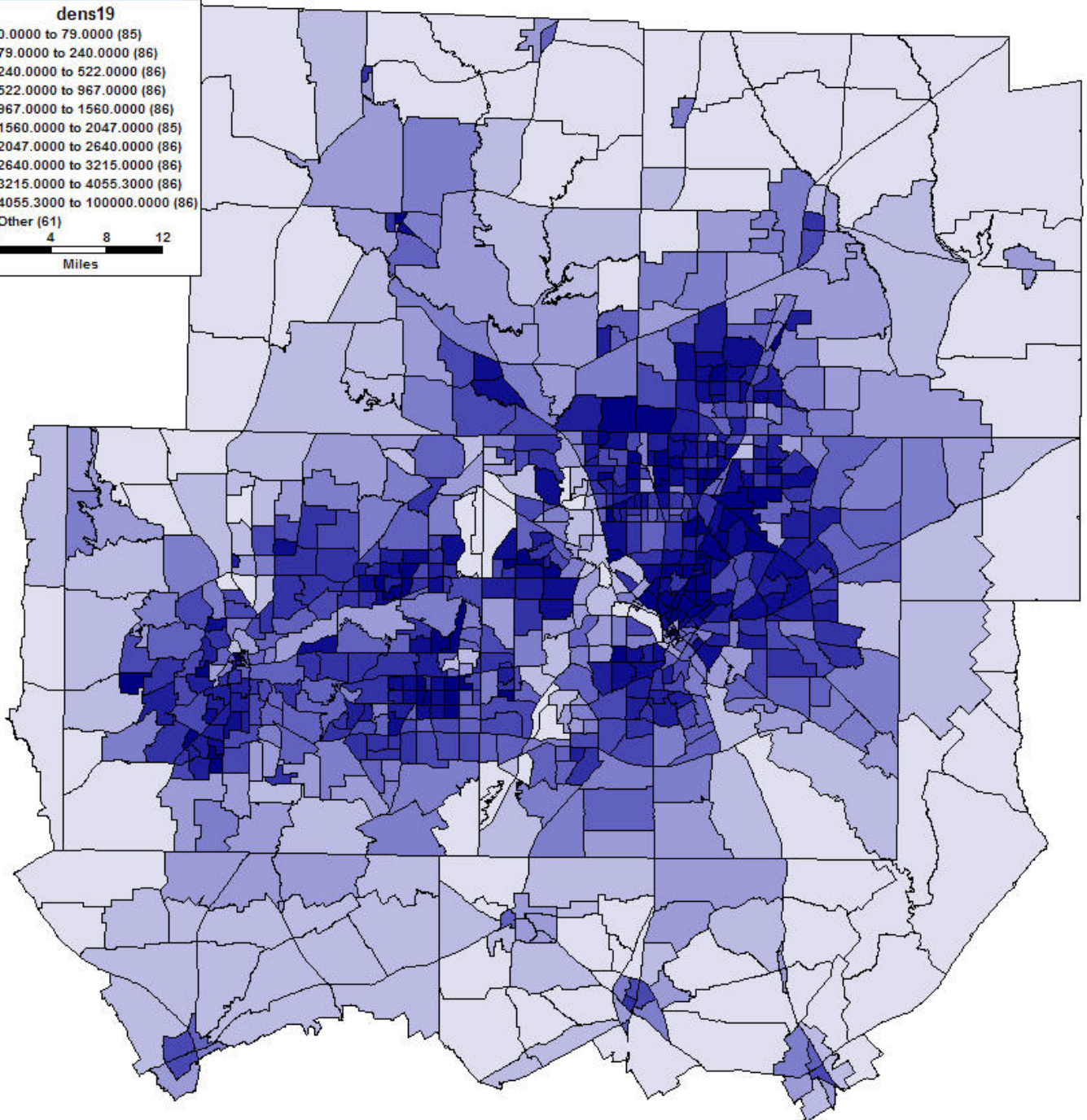
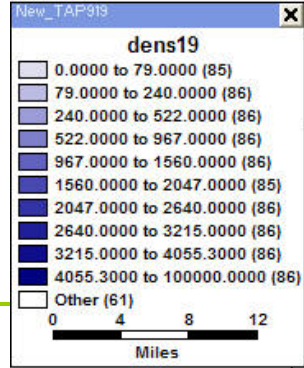
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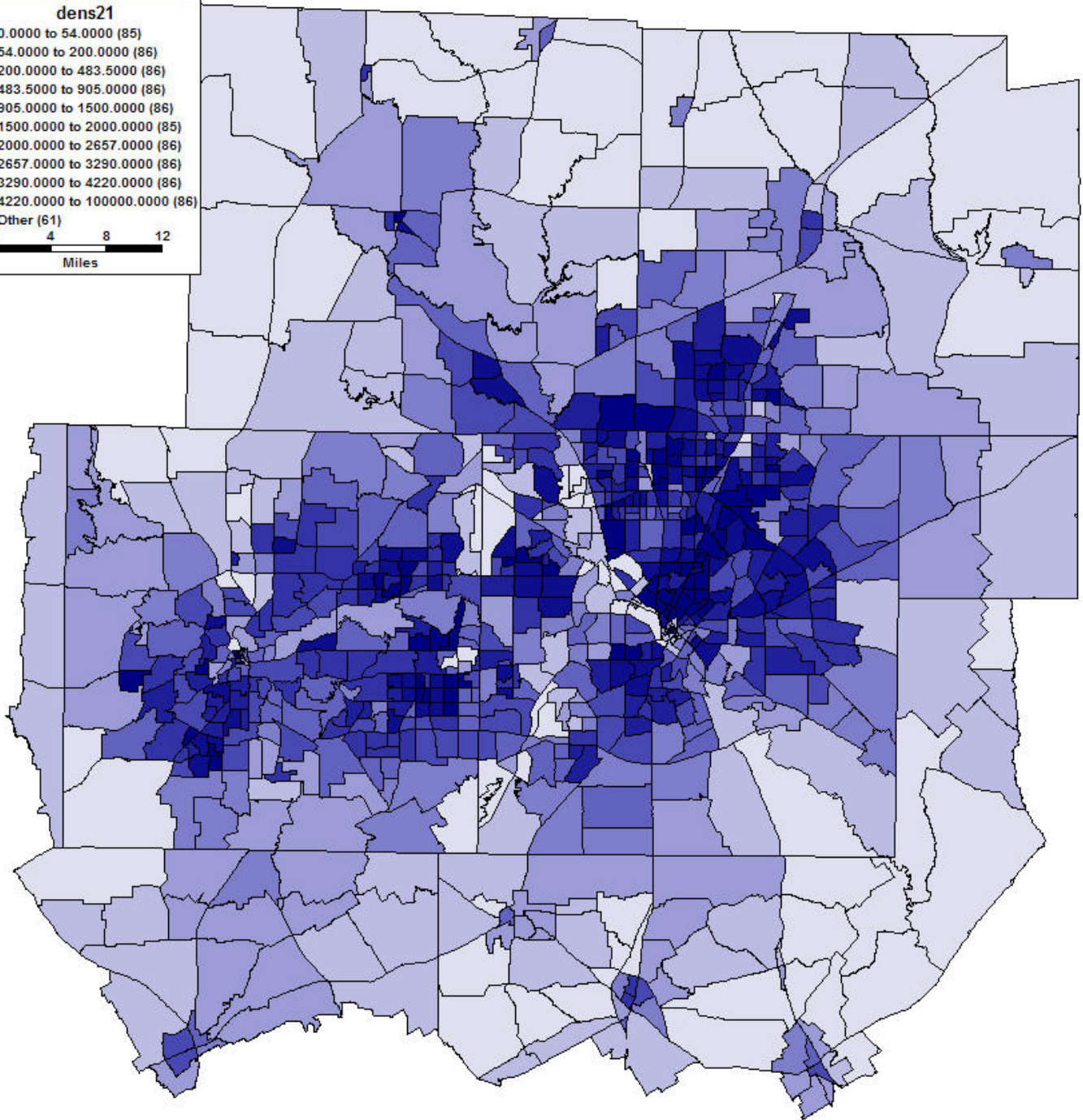
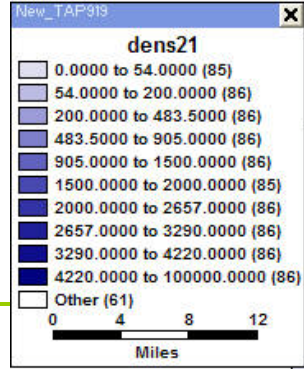
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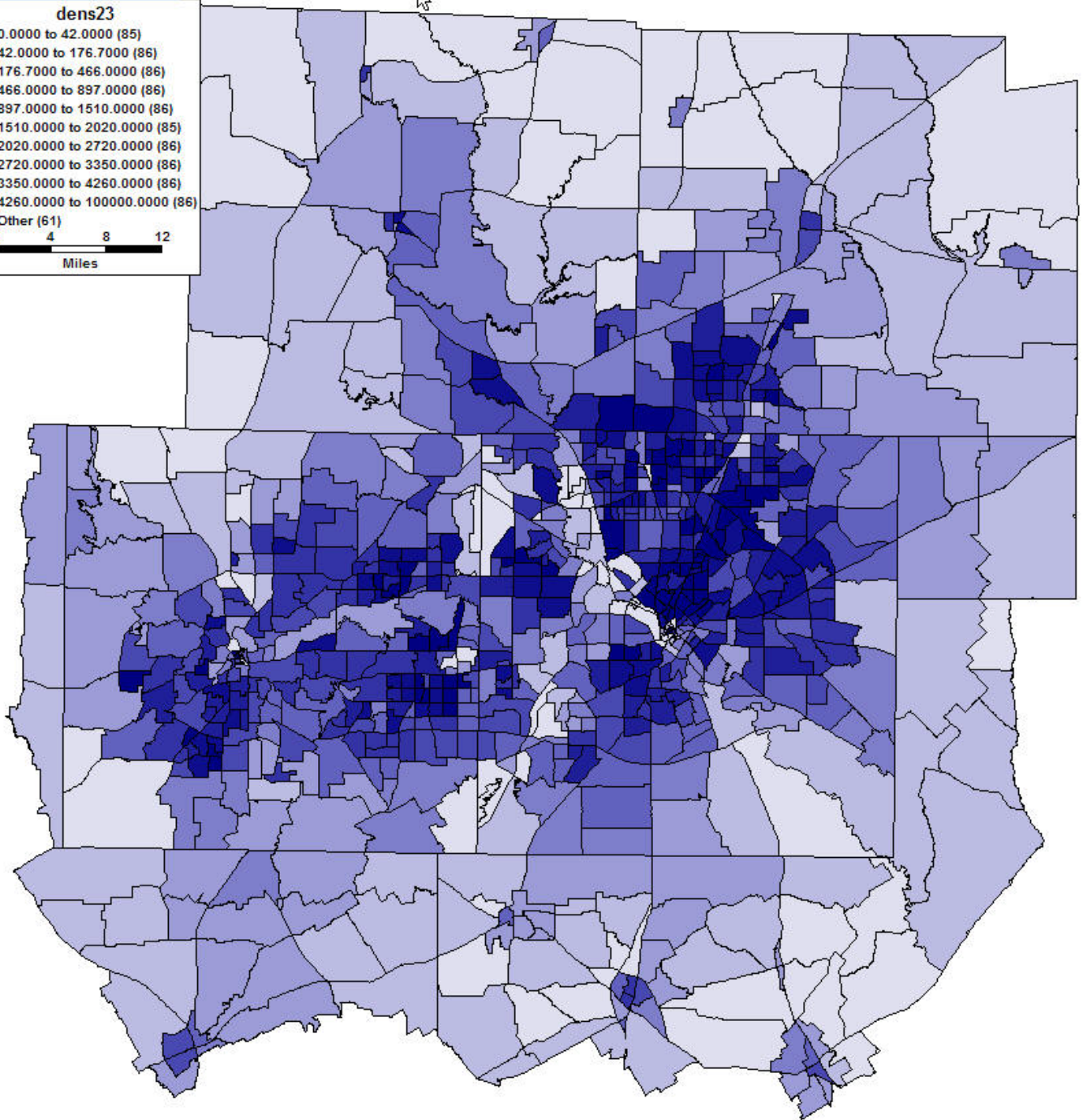
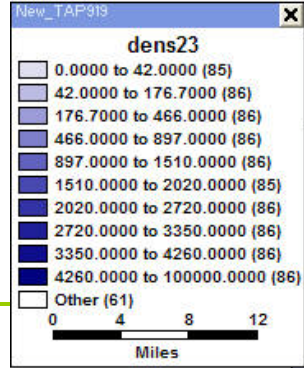
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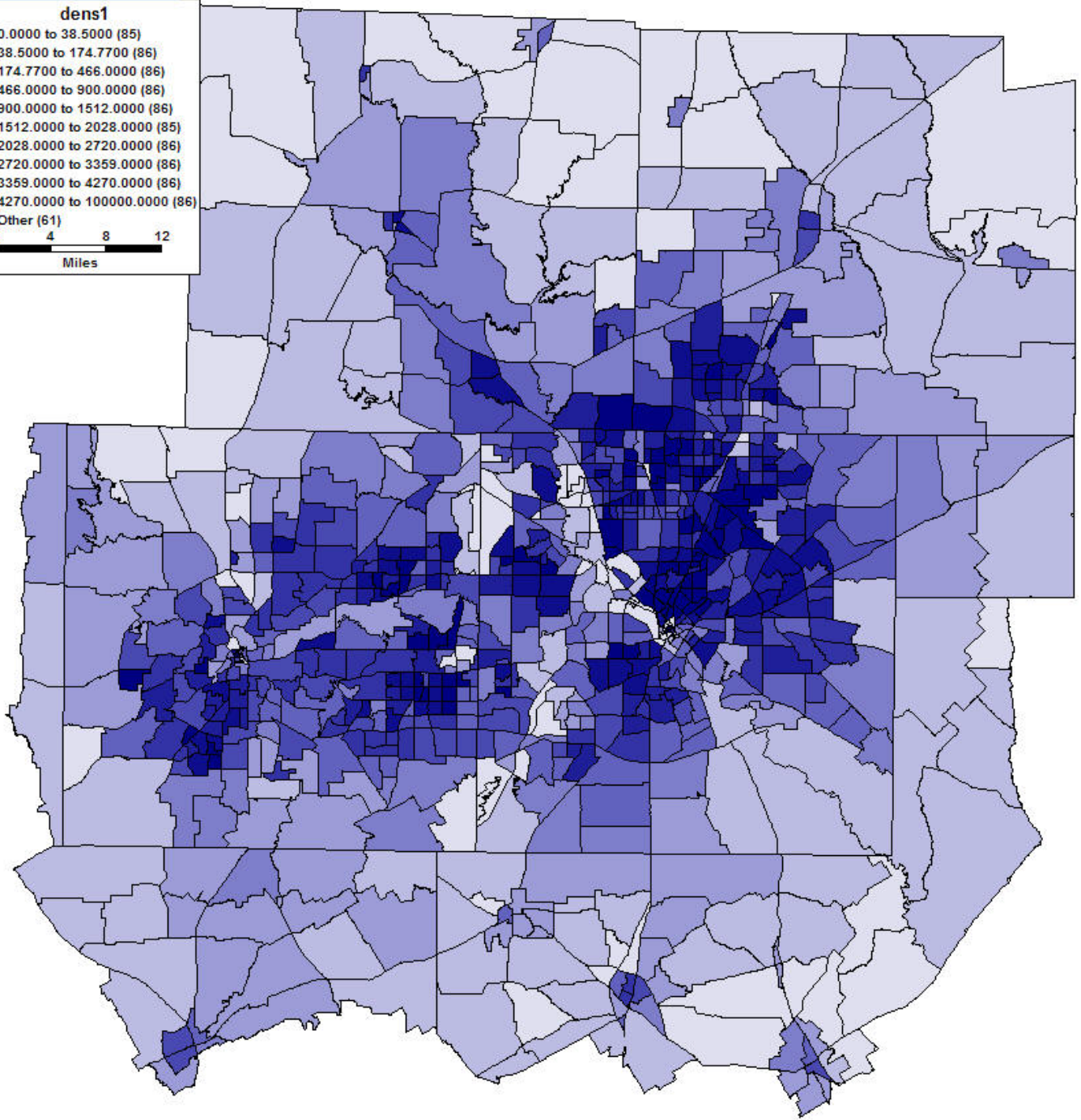
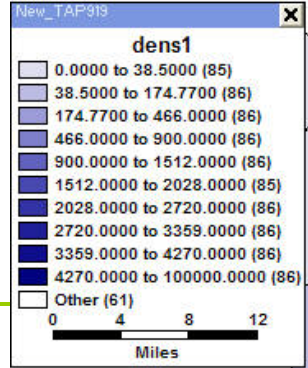
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What do we need to do?

- Understanding the effects of GHG emissions to develop successful reduction/mitigation measures requires extensive data and advanced data analysis techniques.
- For instance, models integrating household vehicle ownership, vehicle type and vehicle usage decisions.
 - Help understand decision makers' behaviors regarding the shift from small cars to larger vehicles
 - Help develop reliable policy initiatives to reduce GHG emissions by encouraging fuel economic vehicle usage