Estimating the Vehicle-Miles-Traveled Implications of Alternative Metropolitan Growth Strategies

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Talk Outline

● Metro-Boston Growth Management Setting

● Addressing a New Priority
  ● ‘Climate Roadmap’: Responding to Gas Price Impacts and Green House Gas Emissions
  ● Class project: Estimate VMT Impacts of Alternative Growth Scenarios

● Implications for Urban Growth Models
Metro Boston
164 municipalities (with local land use control)

United States ➔ Massachusetts ➔ Boston
Metro-Boston Regional Planning

Key Agencies

- **State:** New Governor in 2007
  - Exec. Office of Energy & Environmental Affairs (EOEEA)
  - State GIS agency: MassGIS

- Metropolitan Area Planning Council (MAPC)
  - Regional planning part of Boston Metro Planning Organization (MPO)
  - 101 member Municipalities
  - MetroFuture - ongoing regional planning for 2030

- Central Transportation Planning Staff (CTPS)
  - Transportation planning part of Boston MPO
  - Transportation and policy analysis support for Metro Boston
MetroFuture is the regional plan for development and preservation in Metropolitan Boston. The plan is built on the principles of smart growth. Instead of being dispersed across the region, growth will be focused where infrastructure and services already exist. MetroFuture will balance the growth of jobs and homes, cut down on traffic and climate-changing emissions, conserve water and other resources, and protect parks, green space, farms, and habitat. Focused growth will allow for more cost effective investments in transportation alternatives such as transit. Metrofuture promotes equitable development, where the benefits of growth are realized for people living in cities, suburbs, and rural areas alike. This generalized map shows some of the growth areas proposed by MetroFuture.
Planning Data and Analytic Models

Metropolitan Area Planning Council (MAPC)
- Population and employment forecasts
- MetroFuture ‘Alternative Scenario’ modeling for 2030
  - “Let It Be” versus “Winds of Change” scenarios
  - Task forces & public forums for education, tuning, choice
  - ArcGIS + Community Viz for modeling and visualization
  - Town and TAZ-level projections (2727 traffic analysis zones)

Central Transportation Planning Services (CTPS)
- Support for highway and transit agencies
- Origin/Destination (O/D) travel times (by TAZ)
- Journey-to-Work counts by mode (TAZ to TAZ)
- EMME/2 multi-mode travel network allocation model
Planning Data and Analytic Models
Part 2

MassGIS - basemaps and derived datasets

- Standard GIS ‘framework’ layers
  - Land use, roads, terrain, water, political, census, …
  - Online (downloadable with web services & metadata)

- Activity locations:
  - Schools, hospitals, churches, businesses, …
  - From municipal data, InfoUSA business locations, …

- Development constraints:
  - zoning, environmental limits, …
  - Derived layers from earlier ‘buildout analysis’
Analyzing a New Priority

State Request of EOEEA: Develop ‘Climate Roadmap’
- What can be done to mitigate impact of:
  - CO2 emissions and Gas price increases

One Analysis: Forecast travel patterns
- Estimate spatial pattern of travel (VMT) for various metro growth scenarios
- Integrate basemaps, travel data, and MAPC scenarios
  - Estimate VMT patterns for current households
    - Residences from Census and land use data
    - Destinations from job and business location data
    - VMT from proximity calculations
- Get housing growth locations from MetroFuture scenarios
  - Let-It-Be (LIB) scenario - business as usual
  - Wind-of-Change (WOC) scenario - corridor and activity center emphasis
  - And prior 'buildout analysis' of development constraints
- Assume new growth has VMT behavior of neighbors
New Grid Layer from MassGIS

Integrate detailed data to get new derived layer
- About residences-jobs and proximity to activities
- Create 250x250 meter grid cell layer
  - 125K cells for metro Boston
- Allocate census population to residential grid cells
- Locate job/business destinations
- Compute 'accessibility' of every grid cell
  - Inverse of estimated daily car travel for
    - Journey-to-work (by car)
    - Local shopping and non-work trips (by car)
Census Population Counts on MassGIS Basemap in SE Mass
Census Population Counts on MassGIS Basemap in SE Mass
...with Land Use
Business Locations
Business Locations

…with Euclidean Distance from Grocery Stores to Grid Cells
Class project with MAPC and MassGIS

Estimate VMT Impacts of Alternative MetroFuture Growth Scenarios (Let-It-Be & Winds-Of-Change)

- Utilize new MassGIS 250x250m grid cell derived data
- Compare VMT implications of new household locations under LIB and WOC scenarios

Half-semester project in Advanced GIS class

- PhD and MCP students who worked on project: Wanli Fang, Paul Green, Lissa Harris, Shan Jiang, Masayoshi Oka, Abner Oliveira, Yi Zhu
- Co-instructor for project: Dr. Fabio Carrera
- Maps below are from student work
Demand for New Housing Units (by TAZ)

- Let It Be
  +307476

- Winds of Change
  +348505

MIT 11.521 Project Work (Spring 2008)
VMT Estimation

- Each cell in the grid has a value representative of the total meters traveled one-way for an “average” (non-work) trip for a single household.

- Non-Work VMT = Average Non work trip distance (tripmerge) * No of households (hshlds_250m) * 4.18 trips/household
Accessibility Measurement at Grid Level

- Accessibility measurement
- The darker in color, the higher in accessibility (with lower non-work VMT value)
Development Demand on Buildable Non-Wetland: Let-It-Be Demand Pattern

Single Family Demand Pattern
- Most Single Families with .25 Acre lot locate in inner areas
- Most Single Families with .5 Acre lot locate in intermediate areas
- Most Single Families with 1 Acre lot locate in outer areas
Grids Cells within 1 of 3 TAZ in Suburb of Hopkington
Grids Cells within 1 of 3 TAZ in Suburb of Hopkington

…showing Buildable Non-Wetland Area
Grids Cells within 1 of 3 TAZ in Suburb of Hopkington
…showing Buildable Non-Wetland Area …Raterized
Grids Cells within 1 of 3 TAZ in Suburb of Hopkington

…showing Buildable Non-Wetland Area …Raterized

…compared with 1/VMT Accessibility Measure
Allocation Goals and Requirements

- Allocate all units demanded by MAPC model (or as many as possible)
- Several housing types compete for the same land
- Secondary Goal: Minimize Vehicle Miles Traveled (VMT) per household
Development Demand on Buildable Non-Wet Land: LIB v.s. WOC

Housing Demand at TAZ Level on Buildable Non-Wet Land: Let It Be and Winds of Change Scenarios

LIB_BNW_Total: 179645 Units
WOC_BNW_Total: 107513 Units
Allocation Strategies Within Municipalities

Low VMT Strategy

Neighborhood Emphasis Strategy
# Scenario Differences in Estimated VMT

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Allocation</th>
<th>Average Non-Work VMT/day per new HH</th>
<th>Percent Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winds of Change</td>
<td>Low VMT within TAZ</td>
<td>1.85 km</td>
<td>baseline</td>
</tr>
<tr>
<td>Let It Be</td>
<td>Low VMT within TAZ</td>
<td>2.51 km</td>
<td>+36 %</td>
</tr>
<tr>
<td></td>
<td>Random within TAZ</td>
<td>2.80 km</td>
<td>+51 %</td>
</tr>
</tbody>
</table>
Conclusions

- VMT impact of growth scenarios
  - Crude assumptions but sizeable impact - 50%
    - 'Sprawl' of LIB has much bigger non-work VMT
  - Non-work VMT estimate is small - 2 km/day per HH
    - But journey-to-work and other travel follow same pattern

- Further work using new VMT data
  - Detailed 2001-2008 VMT data from safety inspection data for 6 million Mass vehicles
  - Address-match and associated with 250x250 meter grid cells
Conclusions - Part 2

Feasibility of analysis

- Quick and Practical (January-May 2008 study)
  - IF, basic data/models are developed/maintained
  - MassGIS: 3-months to prepare 250x250m grid cell layers
  - MAPC: had MetroFuture model (2727 TAZ projections)
  - Class: 1.5 month class GIS project

- Still complex and quasi-static
  - 16 development types, complex GIS operations, MatLab for within-TAZ allocation, …
  - Ripple effects of development are not modeled
  - But, easily redone, shared, explained, and visualized

- Good institutional fit
  - MassGIS: basemaps and derived 250x250 m grids
  - MAPC: regional plan with population / job projections
  - CTPS: O/D counts / time / distance (+EMME/2 ?)
Additional Links

- MIT Department of Urban Studies & Planning
  - Department of Urban Studies & Planning (DUSP): http://dusp.mit.edu
- MassGIS: http://www.mass.gov/mgis
- MAPC: http://mapc.org

Related GIS infrastructure sites:
- Open Geospatial Consortium (OGC): http://www.opengeospatial.org

Thank you – Joe Ferreira, jf@mit.edu

谢谢！