Using GPS & GIS Technologies to Improve Transport Planning

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GeoStats, Atlanta

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Presentation Outline

- Transport Planning Background
- Overview of Borlange Safety Study
- Characteristics of GPS Dataset
- Trip End Identification
- Trip Activity / Purpose Imputation
- Study Conclusions and Next Steps
- Transport Planning Opportunities
Transport Planning

- Travel Demand Models use sample households to represent regional and statewide mobility patterns.

- These sample household typically report travel information for one to two days:
  - 1-2 days of travel may not represent real travel behavior.
  - Increasing data needs has increased respondent burden.
  - Reporting accuracy is suspect.
  - Response rates are declining.

- Key challenge: to find methodology to passively collect accurate, detailed travel data for longer durations.
Swedish Intelligent Speed Adaptation Study

- GPS-based units were installed in hundreds of cars in 3 cities
- Drivers were provided feedback (sound or display) whenever posted speed limit was exceed based on GIS network database
- Vehicles were observed for up to two years
- In Borlange, speed and location data of each vehicle was sent to central server for later analysis
- These data were processed prior to storage
  - Trip ends identified based on engine on / off events
  - GPS points snapped to link (including off network travel)
  - Out of area travel truncated at area boundary
Data Sets Available for Transport Analysis

- Processed vehicle files
  - trip summaries
  - GPS point files
- GIS files
  - road network
  - land use
- RES Data (2000-2001 Swedish National Travel Survey)
Vehicle File Statistics

- 186 private vehicles with GPS data (>30 days) and s/e information
- June 22, 2000 through March 4, 2002
- 49,667 vehicle days of travel
- 240,435 trips inside study area
- 9,873 trips starting or ending outside study area
- 148 vehicles – maximum number observed on any one day
Number of Vehicles Traced by Week

![Bar chart showing the number of vehicles traced by week. The x-axis represents the weeks, and the y-axis represents the number of vehicles traced. The chart shows a trend with variations throughout the weeks.]
Comparison of Trip Lengths < 25km
(Borlänge GPS and 2001 RES)
Correcting the Traces – Bad or Missing Points

Examples of False Deviation From Path
Identifying All Trip Ends

- Some trip ends were missing within the initial trips
  - Short stops that do not involve an engine on/off event

- Some trip ends could be false
  - Possibly an engine stall
  - Driver could turn off engine during congestion delay

- Some trips may include abandoned trips
Summary of Vehicle GPS File Import Results

- 24 vehicle datasets imported
- 13,375 trips identified initially
- 2421 travel days
- 3,393,570 GPS points
- 1 second and 10 second logging frequencies used
- 36,492 points filtered (1.1%)
Identification of Missing Trip Ends

Example of High-Circuity with Overlap
Trip End Identification Results

- 13,375 trips initially tagged for the 24 vehicles
- 4 trip ends were reclassified as engine stalls
- 3006 additional trip ends were found (22.5% increase)
  - 235 trips based on vehicle stops greater than 5 minutes
  - 420 trips based on vehicle stops between 2 and 5 minutes
  - 1751 trips based on high circuity routes with 5-120 second delay
  - 600 trips based on habitual destination
- 324 trips contained abandoned trip ends
- 5517 delays were tagged as ‘probable congestion’
Info Sources for Activity Purpose Imputation

- **GPS Traces**
  - Destination location, activity duration, day of week, time of day, frequency of visit across study period

- **Associated Surveys**
  - Age, gender, education, profession, working hours, hobbies and social commitments, home locations of friends & relatives

- **Other Sources**
  - Cross-sectional or panel travel diary survey
  - Land use database or map, parcel-level information
Clustering of observed last positions (crosses) to cluster centres / activity locations (boxes)
Identification of Trip Purposes by Land Use
# Borlänge GPS Data Compared with RES data: Selected Mobility Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Retirees</th>
<th>Fulltime workers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RES</td>
<td>Borlänge GPS</td>
</tr>
<tr>
<td>Mean number of daily trips (Std.)</td>
<td>3.8</td>
<td>-3.8</td>
</tr>
<tr>
<td>Mean daily trip distance [km] (Std.)</td>
<td>24.6</td>
<td>-33.7</td>
</tr>
<tr>
<td>Mean daily trip duration [min] (Std.)</td>
<td>44.1</td>
<td>-55.2</td>
</tr>
</tbody>
</table>

* Local car trips made by respective groups; Sample sizes: RES weighted by sex & age, N(Fulltime workers) = 1516, N(Retirees) = 440; Borlänge: N(Fulltime workers) = 28, N(Retirees) = 11
**Borlänge GPS Trip Purpose Assignment Compared with RES Data: % Trip Purpose Shares**

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Retirees RES</th>
<th>Borlänge GPS</th>
<th>Fulltime workers RES</th>
<th>Borlänge GPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pick up / Drop off</td>
<td>6.8</td>
<td>7</td>
<td>8.9</td>
<td>8.6</td>
</tr>
<tr>
<td>Private business</td>
<td>4.6</td>
<td>10</td>
<td>3.7</td>
<td>8.2</td>
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<tr>
<td>Work related</td>
<td>0.1</td>
<td>9.8</td>
<td>8.3</td>
<td>5.7</td>
</tr>
<tr>
<td>School</td>
<td>-</td>
<td>0.1</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>Work</td>
<td>0.3</td>
<td>-</td>
<td>16</td>
<td>10.2</td>
</tr>
<tr>
<td>Daily shopping</td>
<td>12.4</td>
<td>4.4</td>
<td>6.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Long-term shopping</td>
<td>8.6</td>
<td>7.3</td>
<td>5.7</td>
<td>7.9</td>
</tr>
<tr>
<td>Leisure</td>
<td>20.7</td>
<td>23.6</td>
<td>10.6</td>
<td>20.4</td>
</tr>
<tr>
<td>Other</td>
<td>5.2</td>
<td>-</td>
<td>4.1</td>
<td>-</td>
</tr>
<tr>
<td>Home</td>
<td>41.3</td>
<td>37.8</td>
<td>36.6</td>
<td>37.4</td>
</tr>
</tbody>
</table>

* Local car trips made by respective groups; all days; RES weighted by sex and age, N(retirees) = 1516, N(fulltime workers) = 440; Borlänge: N(Fulltime workers) = 28, N(Retirees) = 11
Variety Seeking in Location Choice

Mean weekly number of “new” locations, i.e. locations which had not been previously visited during the observation
Study Conclusions and Next Steps

- Initial results show promise in use of GPS and GIS data collected in safety study for use in transport planning.

- Great potential for intense spatial and temporal investigation of daily life travel (variability and regularity of trip making).

- Trip end identification may be improved by performing sensitivity analyses on key variable settings.

- Trip activity / purpose identification may also be improved by further evaluation of activity buffer range.

- These tasks will be performed using the same vehicle datasets.
GPS/GIS Opportunities for Transport Planning

- GPS-enhanced Household Travel Surveys
- GPS-based Prompted Recall Surveys
- GPS data collected for other purposes can be archived and used for transport planning
  - AVL data
  - Safety studies
  - Behavioral change studies (to reduce travel)
- In all cases, GIS is the key to unlocking the information contained in the GPS data