An Empirical Investigation of the Impacts of Sun-Related Glare on Traffic Flow

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Presentation Outline

- Motivation
- Site and Data Description
- Assumptions
- Analyses
- Results
- Conclusions
Motivation

- Congestion
- What are the impacts of environmental factors on traffic flow?
  - Snow, wind and rain well-investigated
  - Most research studies crash-related factors
  - Sun-related glare not studied
Sun Glare Effect

- Physiological action
- Two aspects: disability and discomfort
- Heterogeneity of the reaction
Methodology

- Select site(s) with known glare issues
- Collect archived traffic data
- Reconstruct sun position by time of day and month
- Gather weather information
- Estimate likely glare-effect windows
- Compare data for evidence of effect
  - Statistical and traffic flow
Site Description

- Located on northbound Interstate 5, Portland, Oregon
- Approaching downtown Portland
- Unique geometry
Data Description

- Traffic Data: Loop detectors record flow, speed, and occupancy at 20-second intervals.

- Weather Data: Station located at the Portland International Airport and data are recorded hourly.
## Available Data

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Days</td>
<td>275</td>
<td>264</td>
</tr>
<tr>
<td>Available Clear Days</td>
<td>99</td>
<td>92</td>
</tr>
<tr>
<td>Available Overcast days</td>
<td>115</td>
<td>116</td>
</tr>
</tbody>
</table>
Assumptions

- Solar Angle: maximum sun angle with potential influence on traffic
- Weather Conditions: determination of sky coverage categories used
- Traffic: Sorting method using speed and flow
Data Cleaning Process

- Creation of time window using sun charts
- Sorting by different weather characteristics
- Sorting by traffic state
Sun Chart Use

Solar Elevation

East <-- Solar Azimuth --> West
Available Data

<table>
<thead>
<tr>
<th>Condition</th>
<th>Congested</th>
<th>Uncongested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear Sky</td>
<td>1,304</td>
<td>1,106</td>
</tr>
<tr>
<td>Overcast Sky</td>
<td>6,654</td>
<td>4,857</td>
</tr>
<tr>
<td>Sun Angle &lt; than 15°</td>
<td>198</td>
<td>1,797</td>
</tr>
<tr>
<td>Total</td>
<td>198</td>
<td>1,797</td>
</tr>
<tr>
<td>Sun Angle &gt; than 15°</td>
<td>898</td>
<td>7,093</td>
</tr>
<tr>
<td>Overcast Sky</td>
<td>3,011</td>
<td>26,101</td>
</tr>
<tr>
<td>Total</td>
<td>898</td>
<td>26,101</td>
</tr>
</tbody>
</table>
Evidence of a Sun Related Glare Effect
## Statistical Results

<table>
<thead>
<tr>
<th>Congested</th>
<th>Sun Angle &lt; 15° Clear Sky</th>
<th>Sun Angle &lt; 15° Overcast Sky</th>
<th>Sun Angle &gt; 15° Clear Sky</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD, n)</td>
<td>Mean (SD, n)</td>
<td>Mean (SD, n)</td>
</tr>
<tr>
<td>Speed</td>
<td>31.09 (5.21, 200)</td>
<td>29.33 (5.67, 1797)</td>
<td>33.32 (5.92, 898)</td>
</tr>
<tr>
<td>Volume</td>
<td>1,719 (202, 200)</td>
<td>1,682 (195, 1797)</td>
<td>1,645 (249, 898)</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>5.22 (200)</td>
<td>5.67 (1797)</td>
<td>5.93 (898)</td>
</tr>
</tbody>
</table>
## Statistical Results

<table>
<thead>
<tr>
<th>Free Flow</th>
<th>Sun Angle &lt; 15° Clear Sky</th>
<th>Sun Angle &lt; 15° Overcast Sky</th>
<th>Sun Angle &gt; 15° Clear Sky</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD, n)</td>
<td>Mean (SD, n)</td>
<td>Mean (SD, n)</td>
</tr>
<tr>
<td>Speed</td>
<td>57.90 (4.40, 1004)</td>
<td>57.31 (4.33, 4857)</td>
<td>55.92 (2.90, 7093)</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>4.41 (1004)</td>
<td>4.34 (4857)</td>
<td>2.91 (7093)</td>
</tr>
</tbody>
</table>


Speed-Flow Relationship

- Issue of drawing solid conclusions
- Same global shape of the curve
- Different characteristics
Conclusions

- Evidence of a sun related glare effect
- Impact on traffic flow
- Impact on driver behavior
Potential Future Research

- Expand the on-site investigation with more field instrumentation
- Repeat the investigation somewhere else
Acknowledgments

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- J. B. Lesort, INRETS
Questions?