Societal Impacts and Economic Benefits of Weather Information (Collaborative Program)

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Task Force on Social and Economic Applications of Public Weather Services
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Outline

- Assessing communication, perception, use, and value of weather forecasts
- US Sector Sensitivity Assessment
- Household Valuation Study
- WAS*IS
- SIP Information Resources
- Research Topics
Value of Weather Forecasts

value chain

data ➔ information

value of information
Characteristics of Weather Information

- temporal
- spatial
- information content
- public goods?
  - rival – my use keeps you from using it?
  - exclusion – possible to prevent you using it without paying for it?
- challenge - to provide optimal information “optimally”
  - structure of information provision
Mental Models of Weather Information
Value of Weather

- value of weather impacts
- value of weather forecasts
- value of improved weather forecasts
US Sector Sensitivity Assessment
What is Weather Sensitivity?

P$

P^1

P*

GSP

Change in GSP

Q*

Q'

Q

S(K^0, L^0, E^0; W^0)

S(K^0, L^0, E^0; W^1)

D(W^1)

D(W^0)
**Conceptual Approach**

**Sensitivity Analysis:** Using econometric models, we hold economic inputs constant, and use 70 years of weather data to see how economic output varies as a result of variation in weather.
## National Sensitivity

(Billions $2000)

<table>
<thead>
<tr>
<th>Sector</th>
<th>GDP</th>
<th>Range</th>
<th>%Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>127.6</td>
<td>15.4</td>
<td>12.09%</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>601.5</td>
<td>13.3</td>
<td>2.20%</td>
</tr>
<tr>
<td>Retail trade</td>
<td>761.5</td>
<td>17.3</td>
<td>2.27%</td>
</tr>
<tr>
<td>Finance, Insurance, Real Estate</td>
<td>1,639.3</td>
<td>132.5</td>
<td>8.08%</td>
</tr>
<tr>
<td>Communications</td>
<td>237.3</td>
<td>11.1</td>
<td>4.68%</td>
</tr>
<tr>
<td>Utilities</td>
<td>212.9</td>
<td>14.9</td>
<td>6.98%</td>
</tr>
<tr>
<td>Transportation</td>
<td>276.1</td>
<td>9.8</td>
<td>3.53%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1,524.8</td>
<td>125.1</td>
<td>8.20%</td>
</tr>
<tr>
<td>Construction</td>
<td>374.5</td>
<td>17.7</td>
<td>4.71%</td>
</tr>
<tr>
<td>Mining</td>
<td>102.0</td>
<td>14.7</td>
<td>14.38%</td>
</tr>
<tr>
<td>Services</td>
<td>1,834.9</td>
<td>60.5</td>
<td>3.30%</td>
</tr>
<tr>
<td><strong>Total National</strong></td>
<td>7,692.4</td>
<td>258.7</td>
<td>3.36%</td>
</tr>
</tbody>
</table>
Household Valuation Study
# Perceptions - Importance of Weather Forecast Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean</th>
<th>SD</th>
<th>Kruskal-Wallis Test, $\chi^2$ (prob $H_0$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chance of rain, snow, or hail</td>
<td>4.30</td>
<td>0.82</td>
<td>12.44 (0.13)</td>
</tr>
<tr>
<td>Amount of rain, snow, or hail</td>
<td>4.02</td>
<td>0.96</td>
<td>21.73 (0.01)</td>
</tr>
<tr>
<td>High temperature</td>
<td>3.85</td>
<td>1.01</td>
<td>9.77 (0.28)</td>
</tr>
<tr>
<td>Low temperature</td>
<td>3.74</td>
<td>1.06</td>
<td>10.69 (0.22)</td>
</tr>
<tr>
<td>How windy it will be</td>
<td>3.28</td>
<td>1.08</td>
<td>7.60 (0.47)</td>
</tr>
<tr>
<td>How cloudy it will be</td>
<td>2.74</td>
<td>1.08</td>
<td>14.38 (0.07)</td>
</tr>
<tr>
<td>Air pressure</td>
<td>2.21</td>
<td>1.13</td>
<td>10.81 (0.21)</td>
</tr>
</tbody>
</table>
### Household Valuation Study

- non-market valuation
- survey based valuation
- “ordinary” weather

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#### 17 If you had to choose, would you prefer Program A or Program B? Check one box at the bottom.

<table>
<thead>
<tr>
<th></th>
<th>Program A</th>
<th>Program B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FREQUENCY OF UPDATES</strong>&lt;br&gt;(Currently 4 times a day)</td>
<td>9 times a day</td>
<td>12 times a day</td>
</tr>
<tr>
<td><strong>ACCURACY OF ONE-DAY FORECASTS</strong>&lt;br&gt;(Currently correct about 80% of the time)</td>
<td>correct 90% of the time</td>
<td>correct 85% of the time</td>
</tr>
<tr>
<td><strong>ACCURACY OF MULTIDAY FORECASTS</strong>&lt;br&gt;(Currently accurate up to 5 days into the future)</td>
<td>accurate up to 14 days in the future</td>
<td>accurate up to 14 days in the future</td>
</tr>
<tr>
<td><strong>GEOGRAPHIC DETAIL</strong>&lt;br&gt;(Currently to 30 by 30 miles)</td>
<td>to 7 by 7 miles</td>
<td>to 30 by 30 miles</td>
</tr>
<tr>
<td><strong>ADDED YEARLY COST TO YOUR HOUSEHOLD</strong></td>
<td>$15 more</td>
<td>$8 more</td>
</tr>
</tbody>
</table>

Check (✔) the box for the program you prefer.

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#### 18 Would you rather the NWS continue with current weather forecast technologies at current budget levels or would you rather have the program you chose above (A or B)?

Circle the number indicating your preference.

1. I would rather have no change in weather forecasting and no increase in costs to my household than have the program that I chose above.

2. Make the improvements in the program I that chose above and pay the amount indicated.
# Household Valuation Study

## Preliminary Results
Sample = 381
Willingness to pay for maximum improvement $15.27 / household /yr

## Tobit Model on WTP

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-2.601</td>
</tr>
<tr>
<td>Age (Years)</td>
<td>0.152 ***</td>
</tr>
<tr>
<td>Income</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>Education (Years)</td>
<td>-0.493 ***</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.390</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>0.059</td>
</tr>
<tr>
<td>% Work Outside</td>
<td>-0.006</td>
</tr>
<tr>
<td>% Leisure Outside</td>
<td>0.036 **</td>
</tr>
<tr>
<td>Discretionary Use</td>
<td>2.087 ***</td>
</tr>
<tr>
<td>Non-discretionary Use</td>
<td>-1.873 ***</td>
</tr>
<tr>
<td>Weather Variability</td>
<td>1.640 ***</td>
</tr>
<tr>
<td>Frequency</td>
<td>-0.022</td>
</tr>
<tr>
<td>One Day</td>
<td>0.437 ***</td>
</tr>
<tr>
<td>Multiday</td>
<td>-0.013</td>
</tr>
<tr>
<td>Geographic</td>
<td>-0.137 ***</td>
</tr>
</tbody>
</table>
WAS*IS

- Workshops to integrate weather and social science
  - WAS*IS I – Nov/Mar 2005/6 - 23 participants
  - WAS*IS Norman - 40 participants.
  - Summer 2006 WAS*IS - 35 participants.

- Empower practitioners, researchers, and stakeholders to forge new relationships and use new tools for more effective socioeconomic applications and evaluations of weather products.
WAS*IS Topics
Challenges for integrating weather and social science
Communicating and collaborating with users and decision-makers
Communicating with the media
Decision analysis
Economics
GIS (Geographic Information Systems)
Lessons from Hurricane Katrina
Public education and outreach
Qualitative research methods
Survey research methods
Warnings and false alarms
SIP Information Resources

- SIP Home page [www.sip.ucar.edu](http://www.sip.ucar.edu)
- Digital Library
- Societal Aspects Web page
- Extreme Weather Sourcebook
- Society and Weather Newsletter
- Society and Weather Newsgroup
THORPEX SERA
Societal and Economic Research and Applications

Research

- Communicating uncertainty
  - Decision analysis
  - Risk analysis
- User relevant verification
  - Development of verification methods for ensembles
  - Survey instruments
- Marginal benefits of high impact forecasts
- Societal impacts (cost-benefit) of THORPEX forecast improvements
- International equity & GIFS
- Cost of THORPEX programmes
- Develop protocol for user engagement
- User requirements / engagement (trust)
- Beta-test products
- Use of current products

Applications

Capacity Building

- Database weather impacts / forecasts
- Developing country training
Some Issues

- quantitative precipitation forecasts
- communicating uncertainty
- non-linear warning systems
- improving forecasts not same as improving value of forecasts
  - communication
  - perception (understanding)
  - use (behavioral response)