Outline

• “Shout out” on WMO/USAID/World Bank book
• Are there any fundamental economic (theoretical / methodological / application) questions in HIWeather?
• Why a “Weather Information Value Chain”
• What is the “Weather Information Value Chain”
• Example of value study
• Recommendations
What is the value of weather information?

Economics?

Are there any fundamental economic (theories/methods/applications) questions in HIWeather?

- integration of economics with user-relevant decision making
- insights from behavioral economics
- optimization of research based on quantified economic benefits (broadly defined)
- issues of measurement of vulnerability, impacts, and benefits in context of fundamental income inequality, socio-economic barriers to response, institutional failures (corruption?)
Far too many research and operational programs justify themselves as “providing benefits to society” without actually measuring or even characterizing that value or how the new products and services will be created, communicated, understood, or used.

What is the weather information value chain?

- A model of the value creation process that can be used to understand and explicate societal benefits of hydromet information products and services.
- If this process is not adequately assessed then benefits to society have not been adequately and may not be validly and reliably assessed.
Why the Weather Information Value Chain?

• Use economic concepts to explicate mapping of the value of information from creation to valuation
  – Stakeholders (Agents)
    • Objectives
    • Resources
    • Constraints
• Tie information to value so value estimates are valid and reliable
• Detail potential contributions of other social sciences – to evaluating the chain and to enhancing value
• Explicate how user-relevant information can drive product and service development
Weather Information Value Chain
Weather Information Value Chain

Observations
Satellites
Radar
Ground stations
...
Your car ...
Weather Information Value Chain

Modeling
- Numerical Weather Prediction
- Nowcasting
- Climate models
Weather Information Value Chain

Forecasting
- Weather forecast
- Seasonal forecasts
- Climate forecasts
- Watches and warnings
Weather Information Value Chain

- Dissemination
  - Internet
  - Television
  - Radio
  - Telephone
  - Newspapers
  - Sirens
  - Word of mouth
Weather Information Value Chain

Communication
Format
Content
Detail
Uncertainty
Weather Information Value Chain

Perception / Interpretation
Threat Impacts Probability Reliability / trust ...

NCAR
Weather Information Value Chain

Decisions
Run / hide
Buy / sell
Sunglasses / coat...

Layers:
Weather Information Use / Decision Making
Economic Values

Steps:
Monitoring Observation
Modeling Forecasting
Dissemination Communication
Perception Interpretation
Information Use / Decision Making
Weather Information Value Chain

Value of Information

Decisions
Run / hide
Buy / sell
Sunglasses / coat
...

Subject to objectives, resources, constraints
Weather Information Value Chain

Economic impact of weather

Outcomes
- Live / die
- Happy / sad
- Cold / wet
- Profit / loss
- ...

Ex post
Each stakeholder, agent, and decision maker has his or her own set of:

- objectives
- resources and
- constraints

that frame their transformation or use of information.
Economic values are the result of a complex process

- Ultimately value of information is a function of the ability of decision makers to receive, understand, and act on information on uncertain future events.
- Have to be able to tell the story end-to-end to derive valid benefit estimates.
Valuation is at the end of the chain so valuation methods ultimately depend on the decisions and potential outcomes being evaluated

- Morbidity / mortality (VSL)
  - Reduced costs
  - Reduced damages
  - Increased profits
  - Improved welfare (WTP)
Stakeholder preferences and information needs

- Monitoring Observation
- Modeling Forecasting
- Dissemination Communication
- Perception Interpretation
- Information Use / Decision Making
- Economic Values

User needs assessment
Example of a Wx Info Value Chain – DOE Solar

Value Chain:
What is the value of solar power forecasting?

NCAR
Value of **research** to improve solar power forecasts

- Based on measures of improved power forecasts – reduced error in power by up to 50% (Mean Absolute Error - MAE)
- Utilities - historical data on forecast and actual power to evaluate historical errors
- Utility provided year of (historical) hourly solar power generation
- Generated “synthetic” forecasts with reductions in MAE
- Utility used “synthetic” forecasts to run production cost model (PCM) under different error reduction scenarios and percent of solar in overall generation profile – including perfect information
Value of improved solar power forecasts

PCM – used in day ahead decision making to decide what “assets” to use to meet demand based on demand (and solar power) forecasts – PCM runs cost minimization

- PCM Costs with current forecast error
- PCM Costs with reduced forecast errors

Value of improved forecasts

- For different levels of error reduction
- For different levels of solar generation
Value of improved solar power forecasts

Analysis Scenario:
• Public Service Company of Colorado
• 2024 Solar Integration Study
• 1,800 MW solar generation capacity (~15% of total)
• 20% Mean Absolute Error (MAE) reduced to 10%

PCM Costs with current forecast error
- PCM Costs with reduced forecast errors

Value of improved forecasts
Value of improved solar power forecasts – PSCo Results

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Forecast (1800MW of solar state-wide) $(000)</th>
<th>50% Improvement to Forecast (1800MW of solar state-wide) $(000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation Cost</td>
<td>1,173,816.71</td>
<td>1,173,056.56</td>
</tr>
<tr>
<td>Start &amp; Shutdown Cost</td>
<td>22,009.18</td>
<td>21,985.44</td>
</tr>
<tr>
<td>Wind Curtailment Cost</td>
<td>13,603.99</td>
<td>13,568.06</td>
</tr>
<tr>
<td>Total Production Cost</td>
<td>1,209,429.88</td>
<td>1,208,610.06</td>
</tr>
<tr>
<td>Value of forecast improvement</td>
<td></td>
<td>819.82</td>
</tr>
</tbody>
</table>

- $819,820 annual savings just for PSCo
- total reduction in forecast errors over the year to 290,755 MWh
- averages into a savings of $2.82 per MW reduction in error
National Aggregation -
Projected US Total Solar PV Generation

- Assume similar baseline MAE – 20%
- Assume similar 50% reduction in MAE – to 10%
- Assess benefits (no cost estimates) from 2015-2040
## National Aggregation

### Present Value of National Benefits (26 years – 3% Discount Rate)

<table>
<thead>
<tr>
<th>Year</th>
<th>Current Value Benefit</th>
<th>Discount Factor</th>
<th>Present Value Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>10,969,888</td>
<td>1.000</td>
<td>10,969,888</td>
</tr>
<tr>
<td>2016</td>
<td>12,814,133</td>
<td>0.971</td>
<td>12,440,906</td>
</tr>
<tr>
<td>2017</td>
<td>14,658,379</td>
<td>0.943</td>
<td>13,816,928</td>
</tr>
<tr>
<td>2038</td>
<td>39,776,104</td>
<td>0.507</td>
<td>20,154,224</td>
</tr>
<tr>
<td>2039</td>
<td>41,555,127</td>
<td>0.492</td>
<td>20,442,369</td>
</tr>
<tr>
<td>2040</td>
<td>43,334,149</td>
<td>0.478</td>
<td>20,696,631</td>
</tr>
<tr>
<td></td>
<td>Present Value Total Benefits</td>
<td></td>
<td>454,854,415</td>
</tr>
</tbody>
</table>

- **Present Value Benefit**
- **2015-2040 with 3% Discount rate**
- **$455 Million – value of research improving solar power forecast**
Value of improved solar power forecasts

Value Chain:
What is the value of solar power forecasting?
Final thoughts and recommendations

• Ethical, metaphysical, epistemological questions that haven’t been mentioned ... (e.g., what is the “right” response to a flash flood warning? Can we model human behavior?)
• Are there any fundamental economic (theories/methods/applications) questions in HIWeather?
• in a “perfect” world ... development and prioritization of research approaches starts with identification of needs, preferences, and economic values of end-users
• economic valuation must be based on adequate and meaningful characterization of the information value chain
• HIWeather needs to fully integrate economics
Thank You!

Jeff Lazo
lazo@ucar.edu
PO Box 3000, Boulder, CO 80307
Office: 303-497-2857