Communicating heat-health vulnerability in preparation for heat events:

Development and Assessment of the Internet-Based Heat Evaluation and Assessment Tool (I-HEAT)

Kathryn Conlon, MPH
Susan Maxwell, PhD
Robert Rommel
Natalie Sampson, MPH
Geoffrey Jacquez, PhD
Marie O’Neill, PhD
Heat and Health

- Heat leading cause of death due to weather
- Vulnerable populations
  - “Capacity to be harmed” (National Research Council)
  - Individual characteristics
  - Community characteristics
- Adverse health outcomes are preventable
Heat Health Preparedness

- To improve communication of population-level factors that contribute to heat-health vulnerability for emergency planning and response purposes
Urgent need for effective mapping, modeling tools for health organization use

Innovative, advanced software tools to improve capability to mitigate, respond to heat events
Internet-based Heat Evaluation and Assessment Tool (I-HEAT)

- **Objective:** Evaluate the feasibility of integrating multi-scale remotely sensed imagery, demographic and health data in internet-based software to enable health professionals to rapidly identify populations at risk from extreme heat events.
  - Funded by U.S. National Aeronautics and Space Administration
  - Data inputs compiled with support from U.S. Centers for Disease Control and Prevention, U.S. Environmental Protection Agency
Conceptual Framework

Other Geospatial Data
- Demographic
- Socioeconomic
- Health

Earth Science Model
- Web-Enabled Landsat Data (WELD)

Earth Observations
- Landsat
- MODIS

Decision Support System
- Internet-based Heat Evaluation and Assessment Tool (I-HEAT)

Decision Support System Users
- Health professionals
- Emergency responders
- Urban planners
- Local policymakers

Value and Benefits
- Reduce morbidity, mortality
- Focus on at-risk populations
- Improve urban living conditions

Decisions
- Education/Risk Communication
- City, Community heat mitigation planning
- Adaptation planning
- Emergency response planning
Heat Vulnerability Index

A Place

Populations not equally vulnerable to effects of heat

Successful interventions need to know WHERE to find vulnerable populations

Data

- Heat Vulnerability Index
  - Place-based
  - Populations not equally vulnerable to effects of heat
  - Successful interventions need to know WHERE to find vulnerable populations

<table>
<thead>
<tr>
<th>Category</th>
<th>Data Source (year)</th>
<th>Variable Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic variables</td>
<td>US Census (2000)</td>
<td>Percent population below the poverty line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent population with &lt; HS diploma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent population, non-white</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent population living alone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent population ≥ 65 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent population ≥ 65 years, living alone</td>
</tr>
<tr>
<td>Land cover</td>
<td>National Land Cover Database (2001)</td>
<td>Percent census tract area not covered in vegetation</td>
</tr>
<tr>
<td>Air conditioning</td>
<td>American Housing Survey (2002)</td>
<td>Percent households without any central AC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent households without any AC</td>
</tr>
</tbody>
</table>

*adapted from Reid et al., 2009

<table>
<thead>
<tr>
<th>Computed Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1</td>
<td>Social/Environmental Vulnerability</td>
</tr>
<tr>
<td>Factor 2</td>
<td>Social Isolation</td>
</tr>
<tr>
<td>Factor 3</td>
<td>Lack of AC</td>
</tr>
<tr>
<td>Factor 4</td>
<td>High Proportion of Elderly with Diabetes</td>
</tr>
</tbody>
</table>

I-HEAT Components
Data

- **Temperature data**
  - Landsat 5
  - Local surface temperature (120 meters), temporal repeat cycle 8-16 days

- **Vegetation**
  - Normalized Difference Vegetative Index (from satellite imagery)

- **Demographic data**
  - 2000 Census

“At-risk” (R) calculation:

R = f(D,E)

(D = demographic, E = environmental)

R = (x)(T) + (1-x)*HVI

- T = temperature, rescaled 0-1
- HVI = Heat Vulnerability Index
- x = relative weight of temperature and HVI
Software

- Ideally suited for representation, visualization and analysis of spatial patterns
- Web-based tool → ideal for collaborations
- Secured environment

- Supports:
  - Street map view
  - Satellite imagery

- Tabs:
  - “At-Risk” Areas
  - Temperature
  - Demographics
  - Vulnerability
  - About
I-HEAT in Action
Case Study – Detroit, Michigan

- **Our goal:** test the prototype tool as a case study, evaluating tool utility among users from local health departments, local community organizations, and city policymakers.

- **Detroit, Michigan**
  - Lacks heat wave warning system
  - Known disparities in heat exposure, heat-related health effects
  - Prior University of Michigan research in Detroit
    - Quantified heat risk perception
    - Identified prevention, intervention programs
    - Collaborated with residents, local government officials, community leaders
I-HEAT Workshop


- Organized with Michigan academic and government partners

- Participants:
  - State agencies
  - Local health departments
  - Emergency preparedness agencies
  - Academic institutions
  - Community-based, non-profit organizations

- 12-Question survey

- Semi-structured focus group
User Feedback

Participant Satisfaction with I-HEAT Data, Appearance, and Performance (n=22)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data types (e.g., temperature, vulnerability, demographics) decision-makers can select to view</td>
<td>3.86 (0.64)</td>
</tr>
<tr>
<td>User-friendliness of web interface (5 = easy to use, 1 = too complicated)</td>
<td>3.64 (1.09)</td>
</tr>
<tr>
<td>General appearance of web interface</td>
<td>4.09 (0.68)</td>
</tr>
<tr>
<td>Graphics of application (e.g., map output)</td>
<td>3.86 (0.79)</td>
</tr>
<tr>
<td>Performance (speed) of application</td>
<td>2.65 (1.11)</td>
</tr>
</tbody>
</table>

Possible responses: Extremely unsatisfied “1”, Unsatisfied “2”, Neither satisfied or unsatisfied “3”, Satisfied “4”, Extremely satisfied ”5”
## User Feedback

### Participant Mean Likelihood of Using I-HEAT (n=20)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data types (e.g., temperature, vulnerability, demographics) decision-makers can select to view</td>
<td>3.71 (0.90)</td>
</tr>
<tr>
<td>If suggested improvements were addressed, how likely are you to use I-HEAT software if it were available for your region?</td>
<td>4.18 (0.61)</td>
</tr>
</tbody>
</table>

Possible responses: Extremely unlikely “1”, Unlikely “2”, Not sure “3”, Likely “4”, Extremely satisfied "5"
User Feedback – Future Updates

- Improvements needed on:
  - Performance
  - Terminology
    - “At-risk”
    - “Vulnerability”
  - Data updates
    - Heat vulnerability index
    - Temperature
    - Local inputs
  - Explicit mitigation/adaptation potentials

Moving Forward
Acknowledgements

- NASA Contract: NNH11CD21C
- CDC R18EH000348
- EPA 832752010

- Robert Rommel
- Geoffrey Jacquez
- Susan Maxwell
- Marie O’Neill
- Natalie Sampson