A data-driven approach to designing a community-focused indoor heat emergency alert system for vulnerable residents (CommHEAT)

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Award Type: IRG Track 2 [2226880]

Project Challenge

- **Extreme heat** is the deadliest type of weather in the US, severely affecting vulnerable populations.
- Called 'silent killer' due to gradual, unseen impact.
- High risk for elderly and low-income without adequate cooling.
- The 4th US National Climate Assessment predicts that **extreme heat events will increase markedly** with significant threat to human health.
- **Lack of air-conditioning** and urban heat islands exacerbate risks in low-income areas.

Project Vision

- Develop a **community-focused, microclimate-informed indoor heat emergency alert system (CommHEAT)**.
- Enhance and personalize community heat-related emergency management.
- Combine data collection from Capitol East neighborhood residents and community partners in Des Moines.
- Utilize human behavior change theory and scientific machine learning (SciML) to predict heat flux and human response.
- Novel approach: **empirical data and participatory modeling** with vulnerable community residents and stakeholders to co-design IT for public health.

Major Outcomes/Progress

- Task 3.1. Mobile weather stations and 10 in-home temperature and RH sensors installed & data assessed for summer of 2023.
- Task 3.2. Existing spatially-explicit tree inventory data corresponding with near-building climatic assessments (Task 3.1) and detailed building characteristic data collected using newly purchased LiCor sensors. Data compared with literature.
- For Objective 4: As preliminary work to Predict Indoor Thermal Condition with SciML/Energy a Python-based Grasshopper (visual programming tool) for the 3D Rhino modeling environment was created for each home, where thermal data was collected.

- Task 1.3 Target Sample Identified for Data Collection.
- Task 1.1 & 1.3. Focus Group Recruitment and Data Collection completed.
- Tasks 1.1 & 1.3. Neighborhood Survey and Sample Recruitment completed.
- Task 1.4. Real-time heat-event behavioral reports via experience sampling methods gathered.
- Task 2.1. Preliminary agent community developed.

The experiential sampling of the Quick Capture surveys resulted in an analysis of resident awareness, individual adaptation behaviors, and external support during heat events.

Future Goals

For Objective 1: Conduct more data collection on human adaptive behavior during heat events next summer with refined protocol and expanded recruitment engaging additional community groups and trusted partner organizations.

For Objective 2: Preliminary ABM representing target community, create virtual app usage model, refine and validate preliminary ABM via participatory modeling.

For Objective 3: A second set of summer in home and microclimate data collected in the target neighborhood, deploying all three weather stations, and the Licor Sensors.

For Objective 4: Predict Indoor Thermal Condition with ML/Energy+ and characterize the near-building environment as a feature signal to a model that maps hourly land and air temperature data, wind data, local GIS information, and vegetation inventory to predict thermal fluxes on the building envelope. Construct indoor climate condition model by integrating human adaptation behaviors with building thermal fluxes.

For Objective 5: Develop CommHEAT alert application via a Community Design Slam.
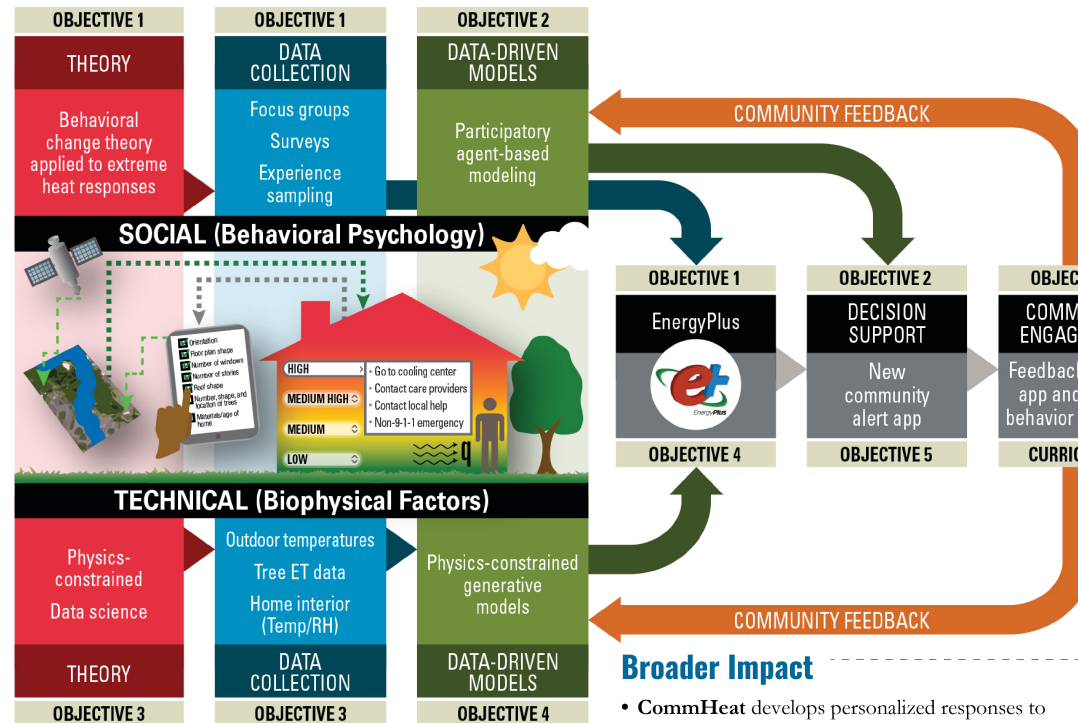
Broader Impact

- **CommHeat** develops personalized responses to extreme heat, focusing on vulnerable populations.
- Uses **Behavior Change Theory** and **SciML models** to understand and predict responses to heat.
- Aims to improve alert systems by integrating social and microclimate data.
- **Tailors alerts for specific situations** or high-risk locations to enhance decision-making.

- Supports distribution of cooling resources, reducing vulnerability to heat.
- Project aligns with the City of Des Moines Climate Action Plan.
- Engage two middle school teachers in year 2 through RET to introduce their students to advanced scientific equipment for microclimate data collection in Des Moines, broadening their perspective on science practice.