A Public Health Computer Simulation Tool to Improve Disaster Preparedness in Rural Communities

Kristina W. Kintziger, Tom Berg, Tracey Stansberry, Scott Lawson, Gerald Jones, Jr., and Liem Tran

Spencer Dam; Spencer, NE; March 2019. Source: State of Nebraska.

Trace Creek; Waverly, TN; August 22, 2021. Source: Andrew Nelles, The Tennessean.

Call 3 and Continuation Call: Public Health Disaster Research Award Webinar
Public Health Disaster Research Award Program
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NATURAL HAZARDS CENTER

Project Overview

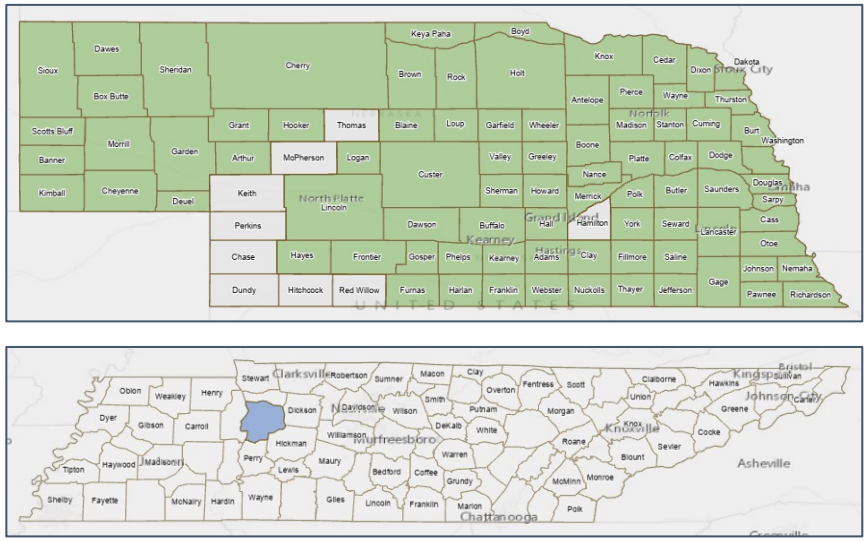
Purpose

- Develop a computer simulation that provides an in-depth understanding of how rural disaster preparedness systems interact and improves response capabilities of their healthcare systems to natural hazard events

Research Site

Case Studies:

- 84 Counties in Nebraska (2019)
- Humphreys County, Tennessee (2021)



Timeline

- Nov-Dec: Model conceptual development & building
- Jan: Stakeholder Workshop 1
- Jan-Apr: Model building & calibration
- May-Jun: Stakeholder Workshop 2

Research Questions

1. How do the rural healthcare system components interact with other related systems during an acute natural hazard response?

2. Can these interactions be modeled in a multi-method computer simulation?

3. Can the resulting computer simulation be applied to improve rural healthcare system efficiency and, therefore, overall public health outcomes after a natural hazard?

Methods

Task 1: Model Conceptual Design

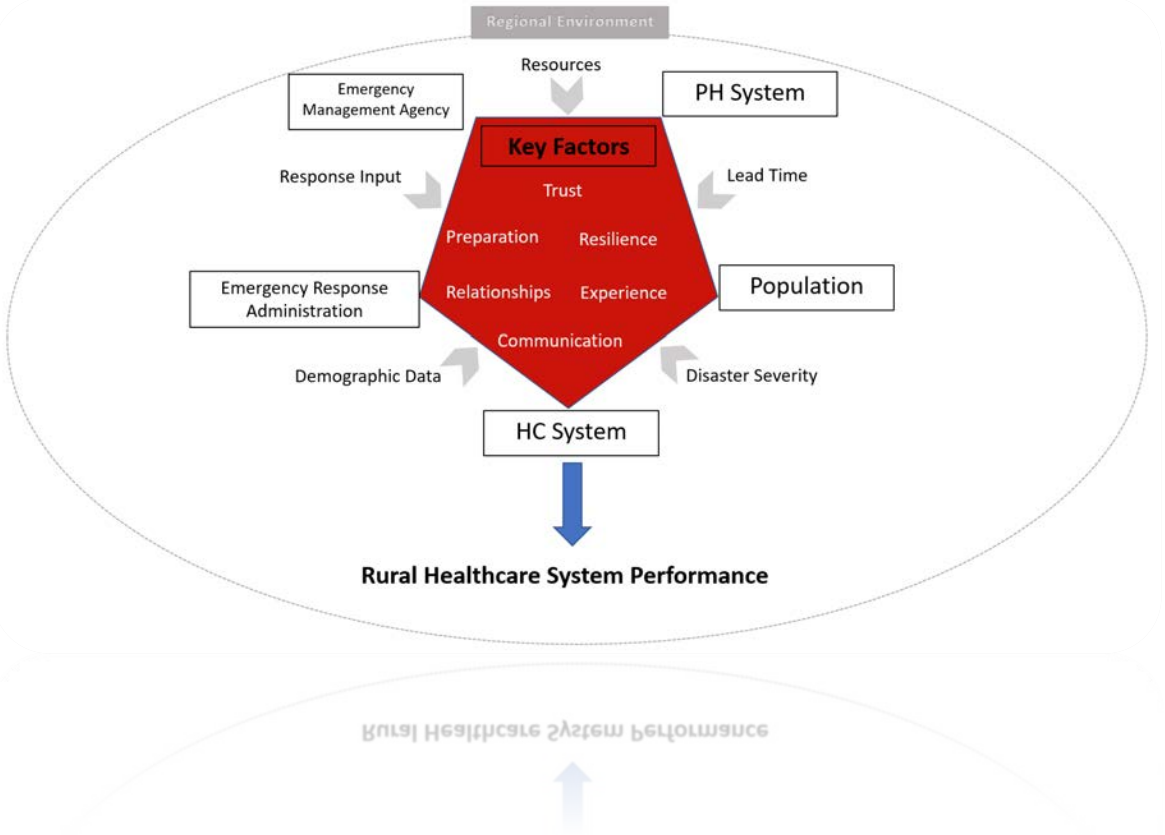
- Select case events
- Stakeholder Workshop 1

Task 2: Model Development

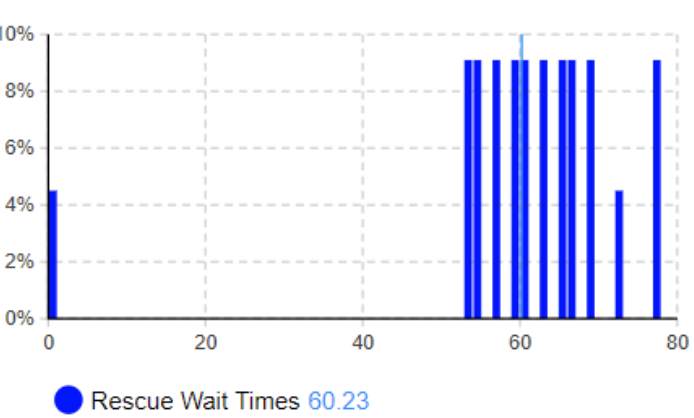
- System dynamics model
- Agent-based model
- GIS layers/SDOH data

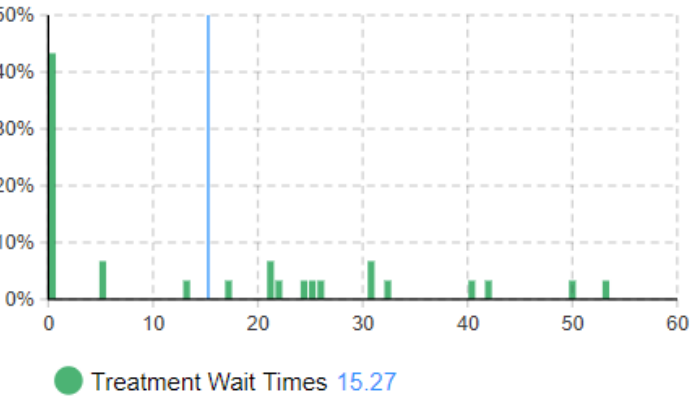
Task 3: Model Calibration

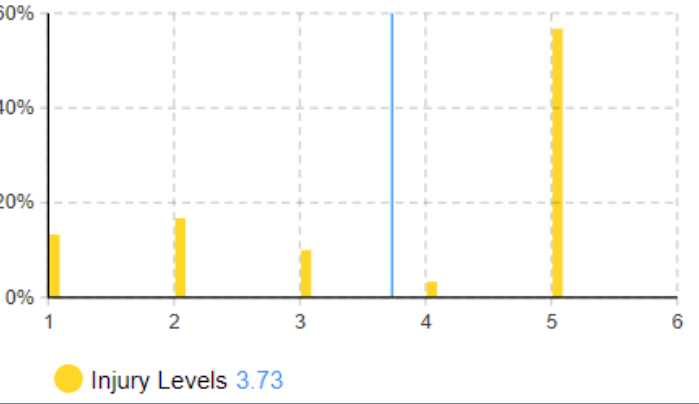
- Stakeholder Workshop 2
- Public-facing tool



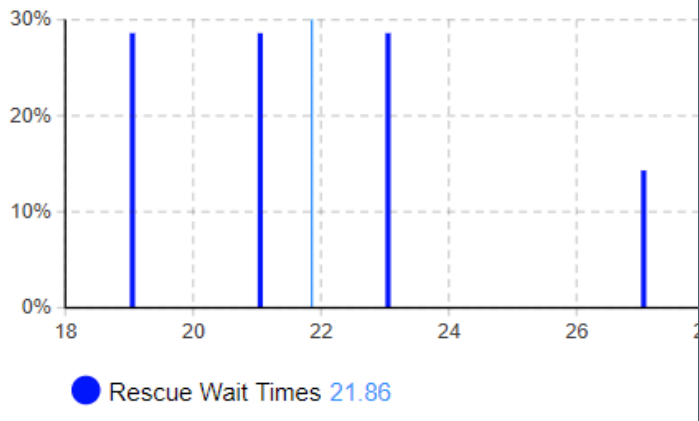
Preliminary Findings

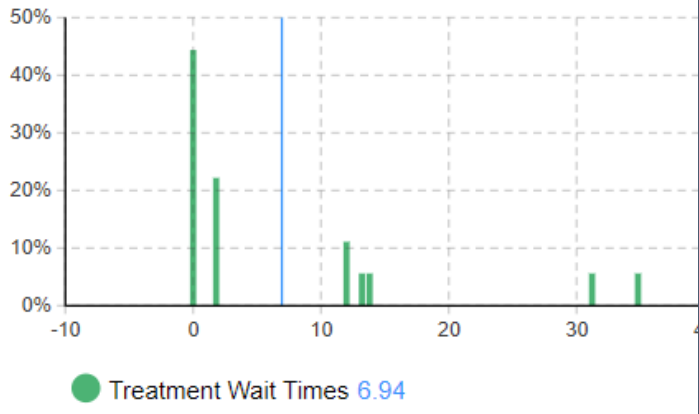


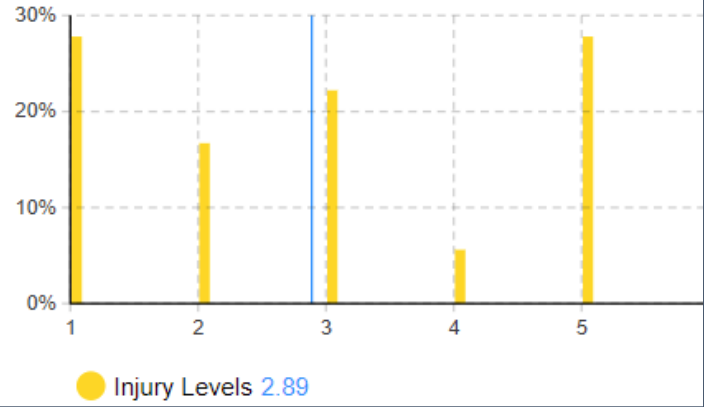




- Accurately reflects the outcomes of events as they unfolded
- Waverly: worst vs. best case system configurations
  - Preventable deaths: ↓ 89%
  - Average emergency response times: ↓ 77%
  - Average patient wait times: ↓ 38%
  - Average condition of patients: ↑ 8%

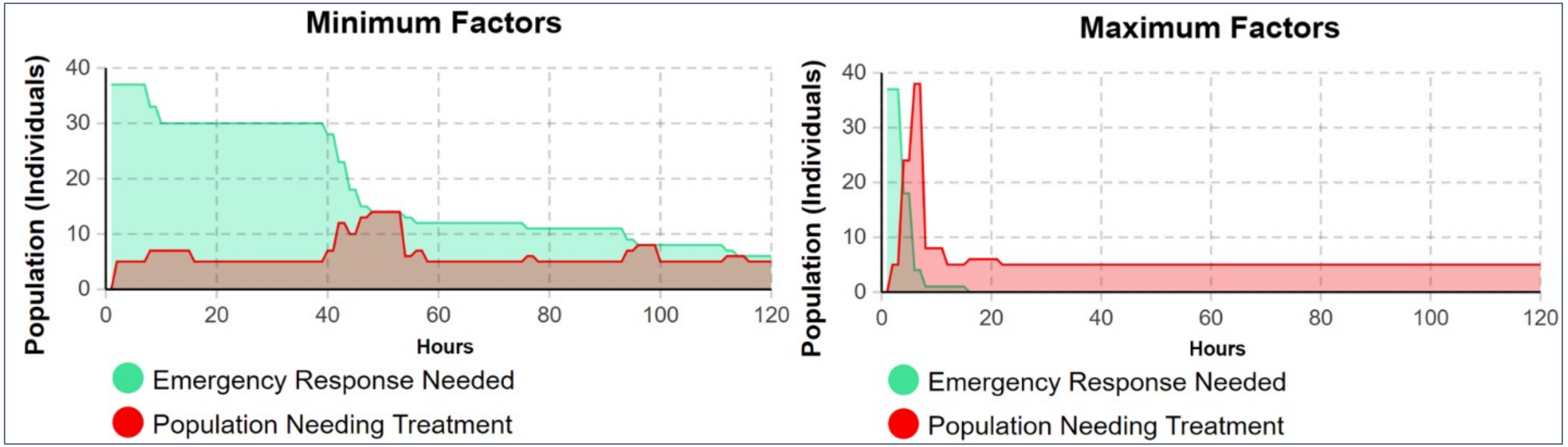




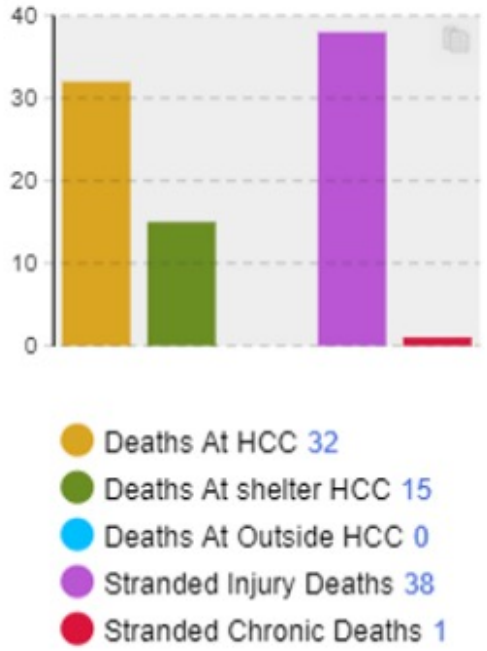


Preliminary Findings

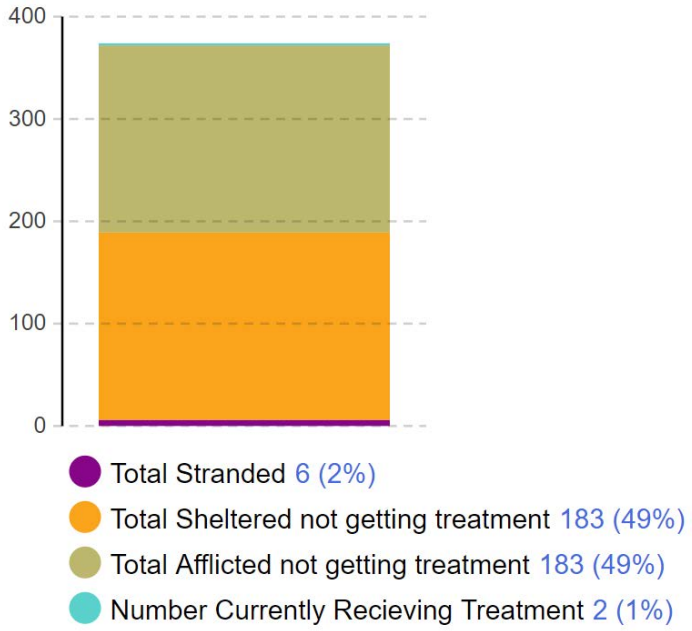
- Waverly: worst vs. best case system configurations
  - Baseline: 4 people per day
  - Best case: response and return to baseline is immediate/quick



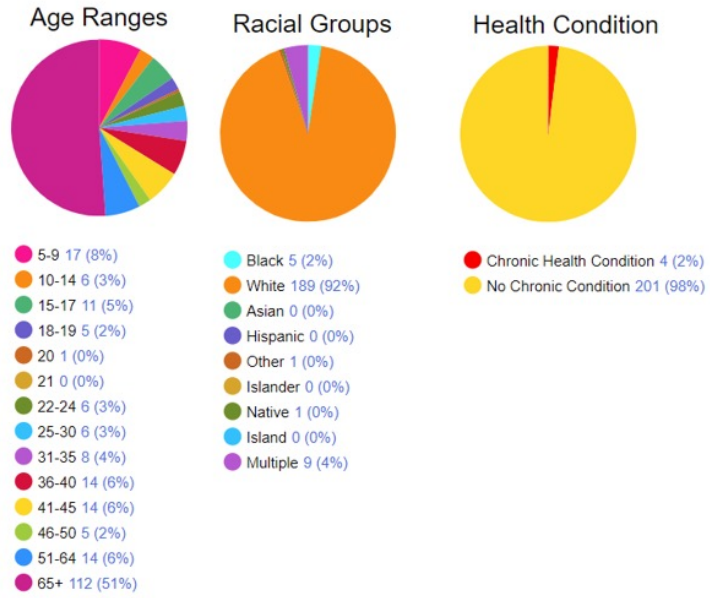
Preliminary Findings



Casualties Over Time Across Different Healthcare Sites



Number of Affected and Afflicted Individuals During Event by Location



Age, Race, Chronic Condition Status of Those Affected by Flood Event

Public Health Implications

1. In-depth understanding and simulation of how rural preparedness systems interact to prepare for and respond to a natural hazard

2. Creation of a public health simulation tool

Public Health Implication

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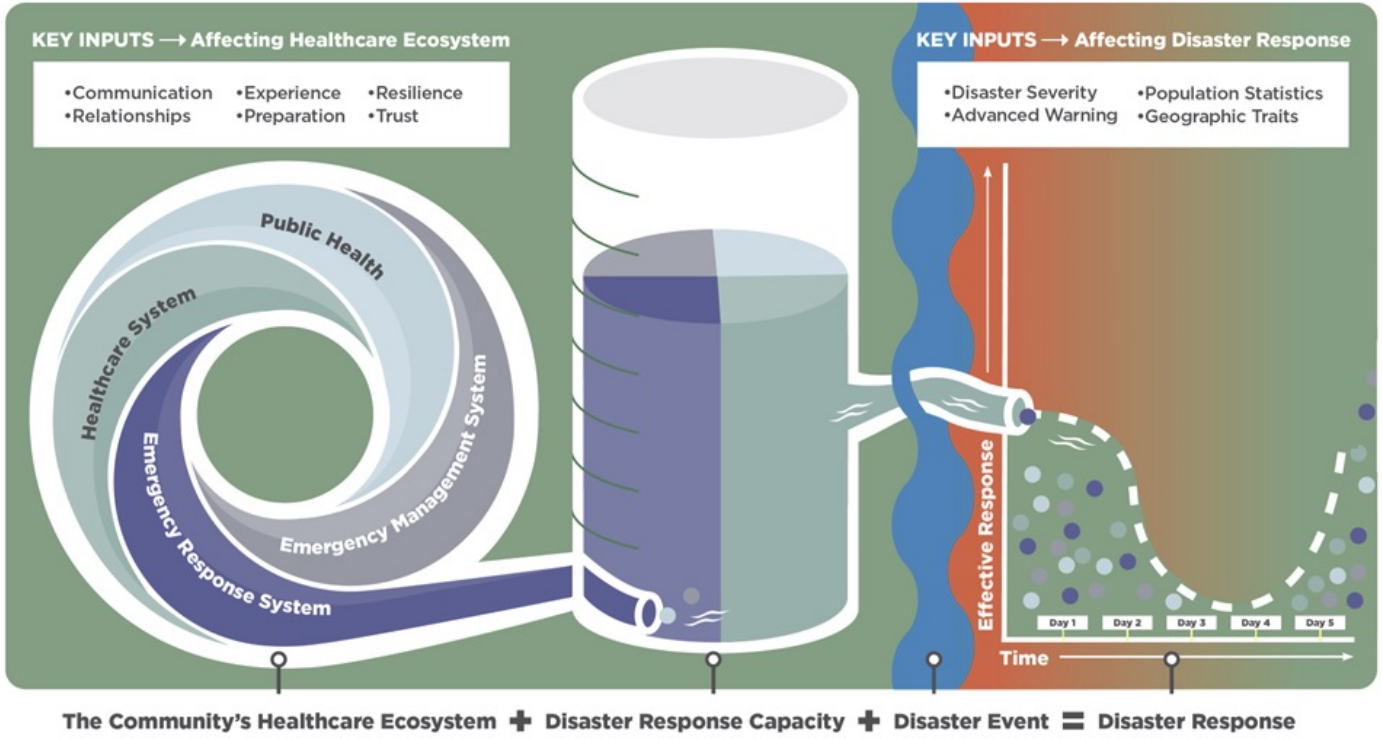

Integration of:

- Separate systems ("system of systems")
- Key inputs that impact response capacity
- Natural hazard and community characteristics

Public Health Implication

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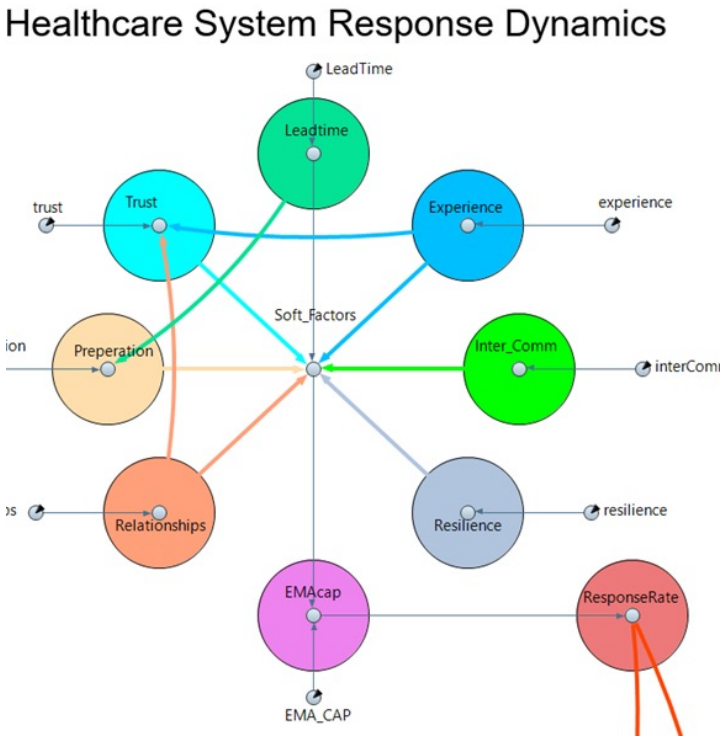
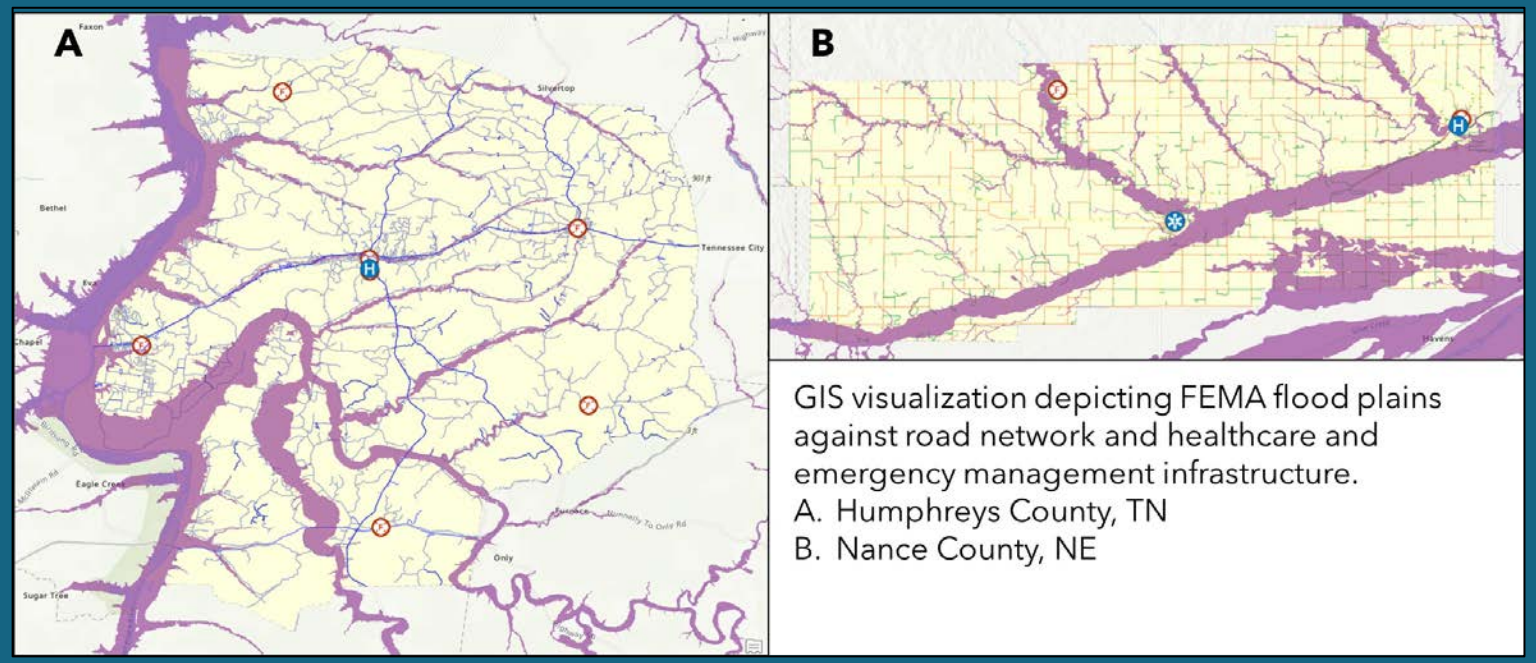


Name	Type	Value	Operational definition
Trust	Factor	1-5	Interorganizational trust
Resilience	Factor	1-5	Community resilience
Communication	Factor	1-5	Effectiveness of communication among organizations
Preparation	Factor	1-5	Degree of disaster planning and activities prior to an event
Relationships	Factor	1-5	Formal and informal relationships among organizations
Experience	Factor	1-5	Prior experience with similar events
Demographic Data	Variable	1-5	Population data, i.e., socioeconomics and location
Response Input	Variable	1-5	Ability to respond to an event
Resources	Variable	1-5	Availability of resources
Disaster Severity	Variable	1-5	Relative impact of event on the community
Lead Time	Variable	1-5	Amount of advanced notice for event

- Includes user adjustable inputs
- Can be used to
  - Test existing policies and procedures
  - Determine how to use existing resources
  - Identify where additional resources are needed

Acknowledgements

We thank the emergency managers, first responders, public officials, and public health practitioners who provided feedback and insight into these events to help in model development and testing.



GIS visualization depicting FEMA flood plains against road network and healthcare and emergency management infrastructure.
A. Humphreys County, TN
B. Nance County, NE

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