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# TAMEST NATURAL HAZARDS SUMMIT

Responding to and Mitigating the Impacts

LUBBOCK, TEXAS 05.16.2022 #NATURALHAZARDSSUMMIT



## Long-term Consideration: Risk and Mitigation



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**TAMEST NATURAL HAZARDS SUMMIT** Responding to and Mitigating the Impacts



#### **Integrated Modeling to Promote Resilience to Natural Hazards**

Prepared for the TAMEST Natural Hazards Summit May 16, 2022 Lubbock, Texas

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### Natural Hazards Research

- Issue-driven research
- Captures the phenomena, scope of disruption and recognizes the interdependencies within the <u>built, social</u>, <u>health and economic ecosystem</u>
- Goal: absorb the impact and recover all societal functions
  - (move from Risk Management to *Resilience Management*)



# **Functionality:** The quality level and ability of a system to perform its intended functions.

Functionality can be <u>measured relative to a baseline level of services</u>, which is usually defined by pre-event conditions such as occupancy, commercial and organizational activities, and availability of utilities.



"...resilience is the ability to prepare for and adapt to changing conditions and to withstand and recover rapidly from disruptions..."

-Presidential Policy Directive 21























**NIST Center for Risk-Based Community Resilience Planning** 

# Is Resilience a new concept?



"...what has so often excited wonder, the great rapidity with which countries recover from a state of devastation; the disappearance, in a short time, all traces of the mischiefs done by earthquakes, floods, hurricanes, and the ravages of war. ...





#### .... <u>all the inhabitants are ruined, and yet in a</u> <u>few years after, everything is much as it was</u> <u>before</u>."

Principles of Political Economy, 1896

John Stuart Mill

### <u>Resilience</u>





### A new kind of research is needed ...

"A new kind of research is needed that:

- can address the dynamic state of communities and their changes in risk and resilience over time, and
- can link information or data from disparate programs with each other and to community resilience priorities, to ultimately
- link research, data, and information with decision making."
- The NIST CoE had been underway for four years when this report was issued

The National Academies of SCIENCES • ENGINEERING • MEDICINE



National Academies of Sciences, Engineering, and Medicine 2019. Building and Measuring Community Resilience: Actions for Communities and the Gulf Research Program. Washington, DC: The National Academies Press. https:doi.org/10.17226/25383.

#### **Developing Core Metrics for Community Resilience**

- Goal: develop core metrics
  Built around the NIST stability areas
  - - Population, Economy, Physical Services, Social Services, and Governance

#### YOU CAN'T MANAGE WHAT YOU DON'T MEASURE



### Community Resilience Metric Ideals

 Accurate, Reliable, Comprehensive, Scalable, Affordable, Actionable metrics of the community's capacity to plan for, respond to and recover from hazard events. Metrics ideally are open and transparent and align with the community's goals and vision (Cutter, 2014). "Further community resilience metrics should be simple and well-documented." (NIST SP 1190 v.2)



### Core Metrics (all measures over time)

#### • Population Stability:

- Population count
  - age,
  - income
  - race/ethnicity
  - disability status
- Household Composition
  - Housing unit-single/multi-family
  - Renter/owner occupied
  - Mobile or manufactured home
  - Vacant
  - Housing costs
- Post event changes from baseline (losses, population displacement)





### Core Metrics (all measures over time)

#### • Economic Stability:

- Household Income
- Community Level GDP/Economic Output
  - Tax revenues
- Employment/Unemployment
- Gini Coefficient or other measure of inequality
- Post event changes from baseline (losses)



Shaded areas indicate US recessions - 2015 research.stlouisfed.org



#### **NIST Center for Risk-Based Community Resilience Planning**

### Core Metrics (all measures over time)

- Social Services Stability:
  - Hospital capacity per capita
    - Staffed bed availability
    - Waiting/treatment time
  - Education-school capacity per capita
    - K-12 Staffed desk-seat availability
    - K-12 student/teacher ratio
  - Post-event changes/losses





### Core Metrics (all measures over time)

- Physical Services Stability:
- Built environment (structures)-
  - Count of functional buildings by archetype
- Infrastructure (water, transportation, electrical power)-
  - Water network functionality
  - Transportation system functionality
  - Electrical Power System functionality
- Post event changes from baseline







# **IN-CORE** Interdependent <u>Networked-</u> <u>Co</u>mmunity

#### <u>Resilience Modeling</u> Environment

- Physical infrastructure
- Economic health
- Social services
- Information science



https://incore.ncsa.illinois.edu https://github.com/IN-CORE/

IN - CORE

Resilience



hazards on

communities





Alternative actions to enhance community resilience & inform planning

http://resilience.colostate.edu

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# Extreme Weather and Population Health

Ghosh, Kruse, Curtis, Helgeson, Mukherji

#### Disasters (extreme weather events):

- SHELDUS (Spatial Hazard and Loss Database for the United States)
- County-level
- Major disasters including hurricanes, cyclones, floods, thunderstorms, etc.

#### Hospitalizations

- Comprehensive set of inpatient and ED databases
- All NC counties, all-payer
- Multi-year: 2011-2018
- Diagnoses and procedure codes
- Inpatient: 8 M observations
- Emergency Department: 33 M observations



Preparing for, responding to, and mitigating compound coastal water hazards for resilient rural communities , Supported by National Oceanic and Atmospheric Administration, NA190AR4310312

### **Econometric Analysis**

- Asthma
- Cardiovascular events
- Diabetes
- Mental health
- Water-borne/gastrointestinal illnesses
- Outcomes: Rate of hospitalizations per 10,000 population  $y_{c,t} = \alpha + \beta \ Disaster_c + \gamma Post_t + \theta \ Post_t * Disaster_c + \Gamma X_{ct} + \tau_t + \eta_c + e_{c,t}$

- Controlling for county unemployment rate, per capita damages
- County Fixed Effects, time Fixed Effects



# Preliminary Results (NC Inpatient)

	(1)	(2)	(3)	(4)	(5)
	Cardiovascular			Mental	Gastrointestinal
	Asthma	Event	Diabetes	Health	Illnesses
Post x					
Disaster	-0.024	4.267***	0.565***	0.512	1.337***
	(0.237)	(0.996)	(0.204)	(0.385)	(0.434)
Observations	60,339	60,339	60,339	60,339	60,339

Resilience

IN - CORE

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## Preliminary Results (NC Emergency Dept)

(1)	(2)	(3)	(4)	(5)
	Cardiovascular			Gastrointestinal
 Asthma	Event	Diabetes	Mental Health	Illnesses

0.395 0.009 *Post x Disaster* 1.427\*\*\* -6.591\*\*\* 0.329\*\* (1.561)(0.296)(0.609)(0.495)(0.135)

Observations	119,153	119,153	119,153	119,153	119,153	
Resilience IN-ron	- C					

IN - CORE

## Thank you



