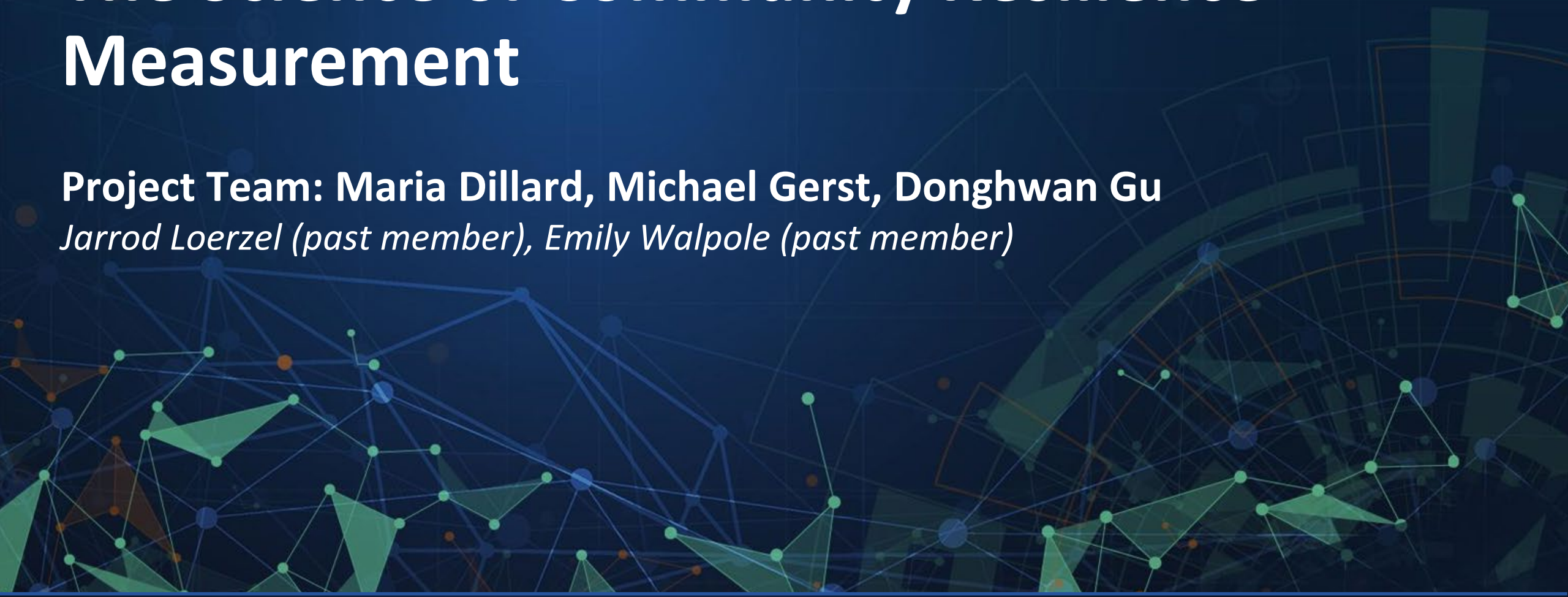
The Science of Community Resilience Measurement

Project Team: Maria Dillard, Michael Gerst, Donghwan Gu

Jarrod Loerzel (past member), Emily Walpole (past member)



NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

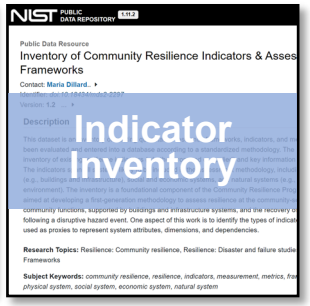
November 2024

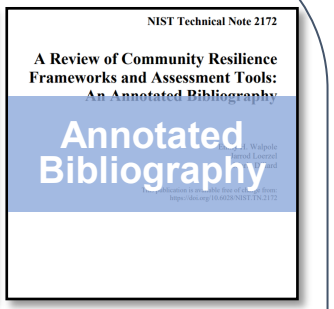
NIST Project on Community Resilience Measurement

Objective - To develop and disseminate a database of county level community resilience indicators, an inventory and analysis of published frameworks and indicators, and scientifically grounded guidance necessary to quantitatively assess community resilience over time for the nation, based on a suite of community resilience indicators that account for meaningful aspects of physical, social, and economic systems.

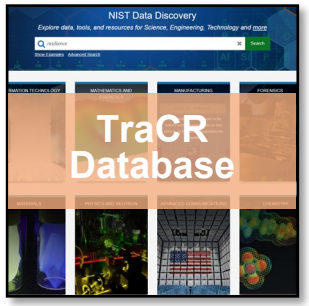
Assessment Methodology

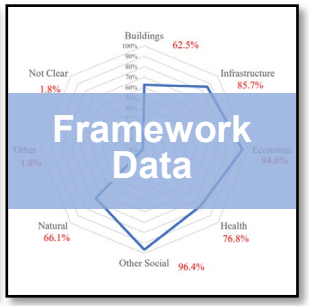
Foundational Products





(Walpole et al., 2021)

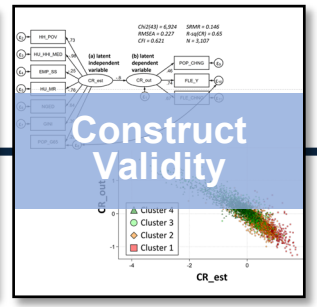




(Loerzel et al., 2021)

Indicator Selection and Validation

Criterion Validity



(Gu et al., 2023)

Resilience Outcomes for Validation Testing *(under review)*

(Gu et al., 2024)

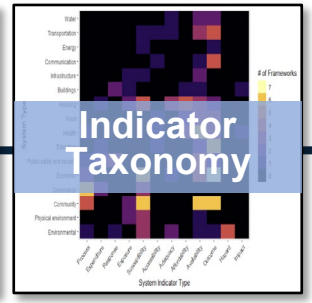
Validating Existing Resilience Frameworks *(in progress)*

(Gu et al., 2024)

Translational Validity

Content Validity *(under review)*

(Gerst et al., 2024)



(Gerst et al., 2024)

Quality of Evidence *(in progress)*

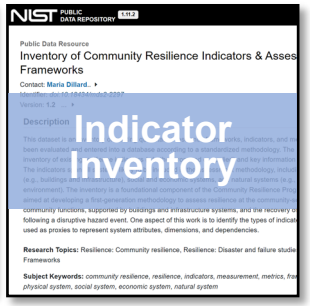
(Gerst et al., 2024)

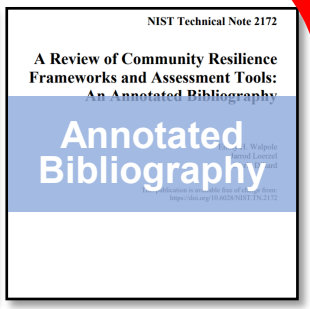
In Progress

Completed

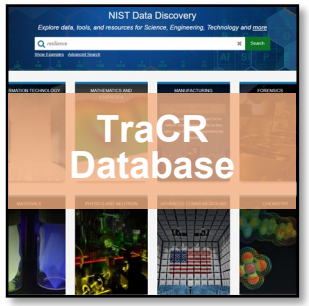
Assessment Methodology - Foundation

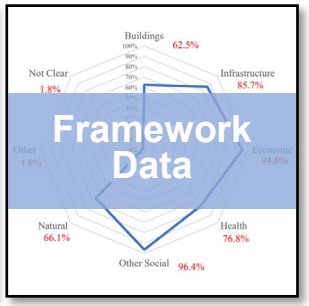
Foundational Products





(Walpole et al., 2021)

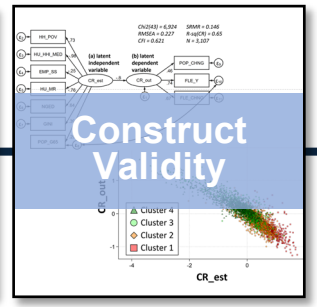




(Loerzel et al., 2021)

Indicator Selection and Validation

Criterion Validity



(Gu et al., 2023)

Resilience Outcomes for Validation Testing *(under review)*

(Gu et al., 2024)

Validating Existing Resilience Frameworks *(in progress)*

(Gu et al., 2024)

Translational Validity

Content Validity *(under review)*

(Gerst et al., 2024)

(Gerst et al., 2024)

Quality of Evidence *(in progress)*

(Gerst et al., 2024)

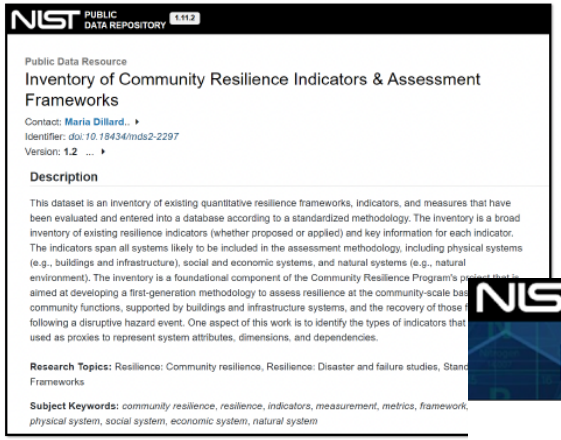
In Progress

Completed

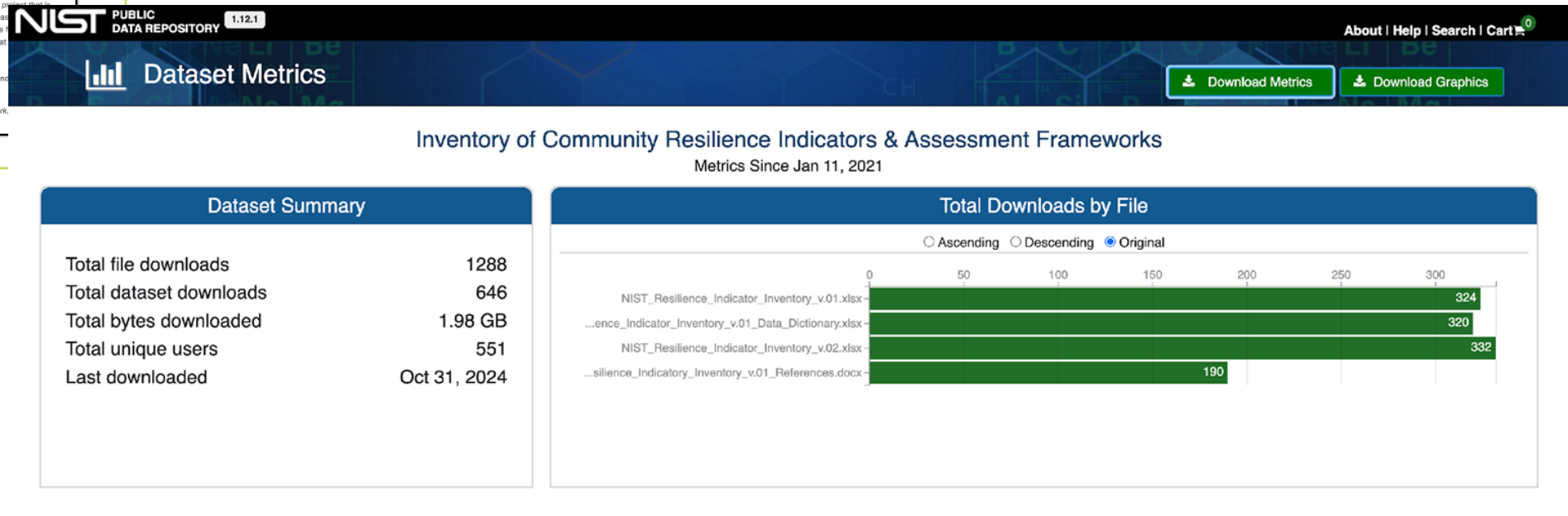
Research Infrastructure for Community Resilience Measurement Science

Community Resilience Indicator Inventory to support the identification and consensus of indicators for testing and evaluation

- Based on 56 existing quantitative resilience frameworks
- 3,298 indicators and 7,165 measures



- The Community Resilience Indicator Inventory contains indicators and measures from existing frameworks and methodologies
- The inventory serves multiple purposes including analysis and as a resource for others interested in developing their own measurement of resilience



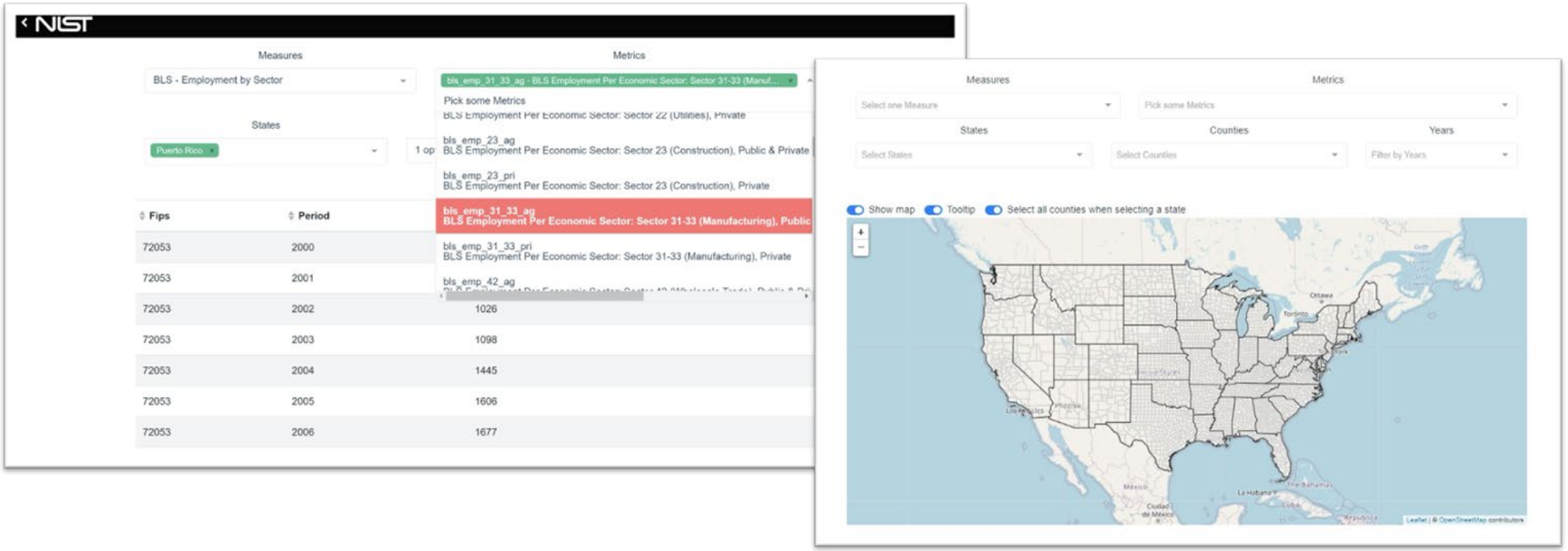
Research Infrastructure for Community Resilience Measurement Science

- Several bodies of work are part of the critical foundation of the validation methodology phase
- These include early work to create a conceptual framework, review of existing frameworks, and analysis of the indicator inventory

Research Infrastructure for Community Resilience Measurement Science

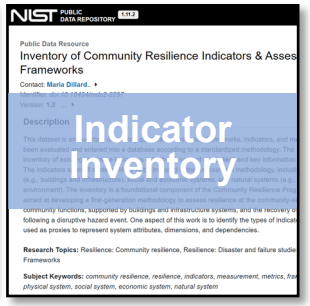
TraCR Database Development

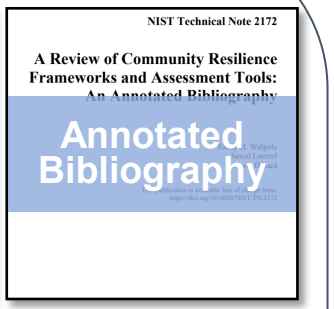
- Database of existing and new data/indicators for social, economic, and physical systems
- Foundational source for developing analytical methods for indicators
- Web-based tool TraCR v0.2
- Data collected for TraCR v0.2 (2000-2020): >300 variables | >25 unique sources | 3230 counties (50 US states, selected territories)



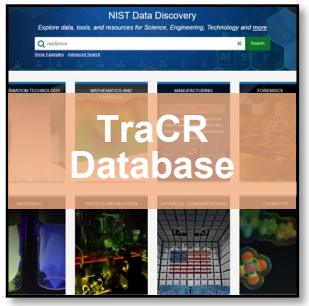
Assessment Methodology - Validation

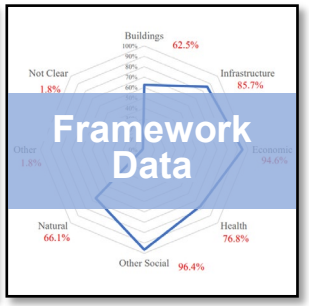
Foundational Products





(Walpole et al., 2021)

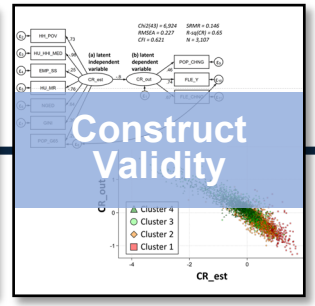




(Loerzel et al., 2021)

Indicator Selection and Validation

Criterion Validity



(Gu et al., 2023)

Resilience Outcomes for Validation Testing *(under review)*

(Gu et al., 2024)

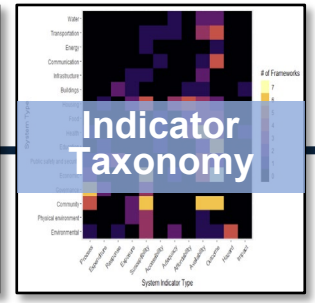
Validating Existing Resilience Frameworks *(in progress)*

(Gu et al., 2024)

Translational Validity

Content Validity *(under review)*

(Gerst et al., 2024)



(Gerst et al., 2024)

Quality of Evidence *(in progress)*

(Gerst et al., 2024)

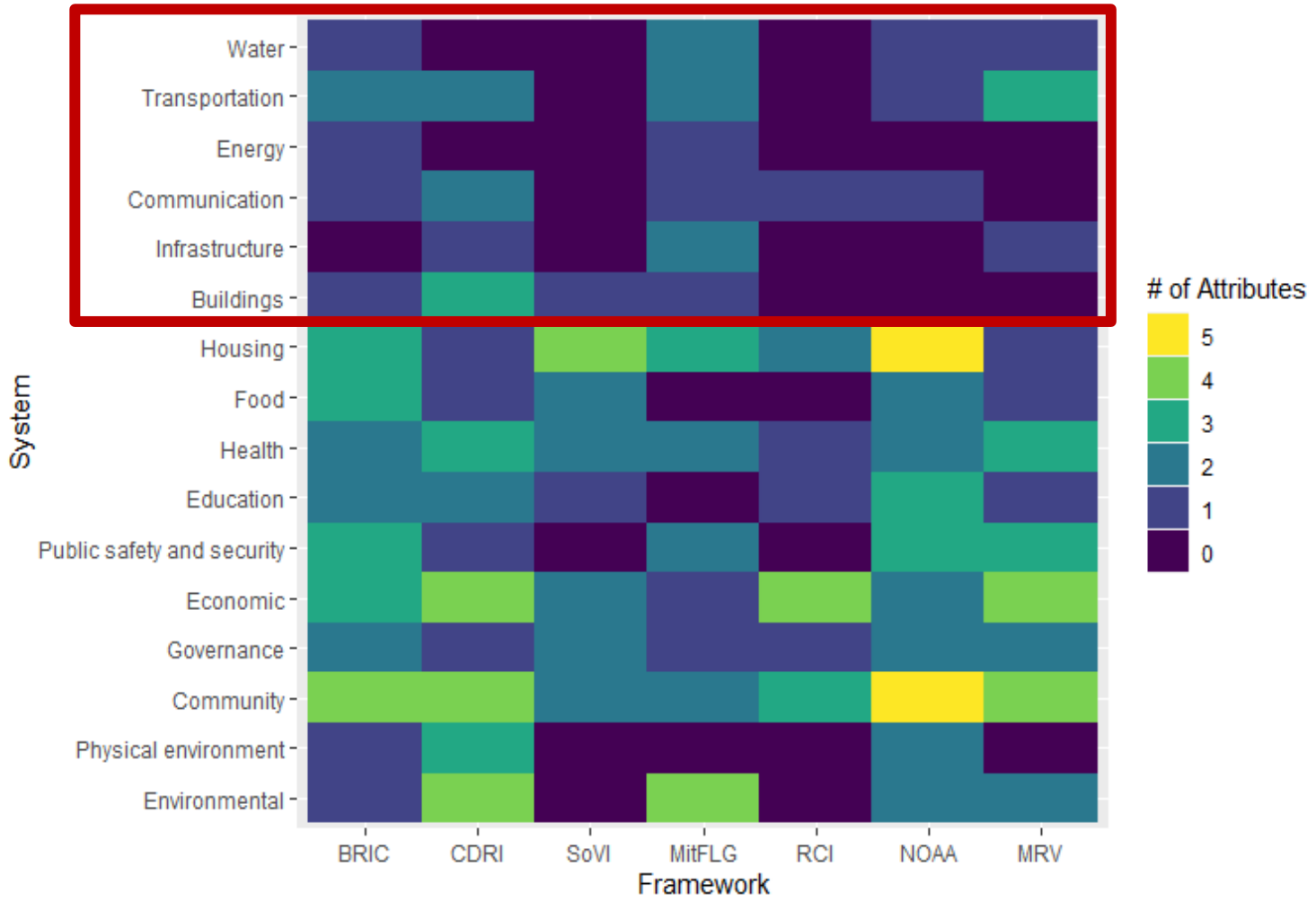
In Progress

Completed

Translational Validity Workstream

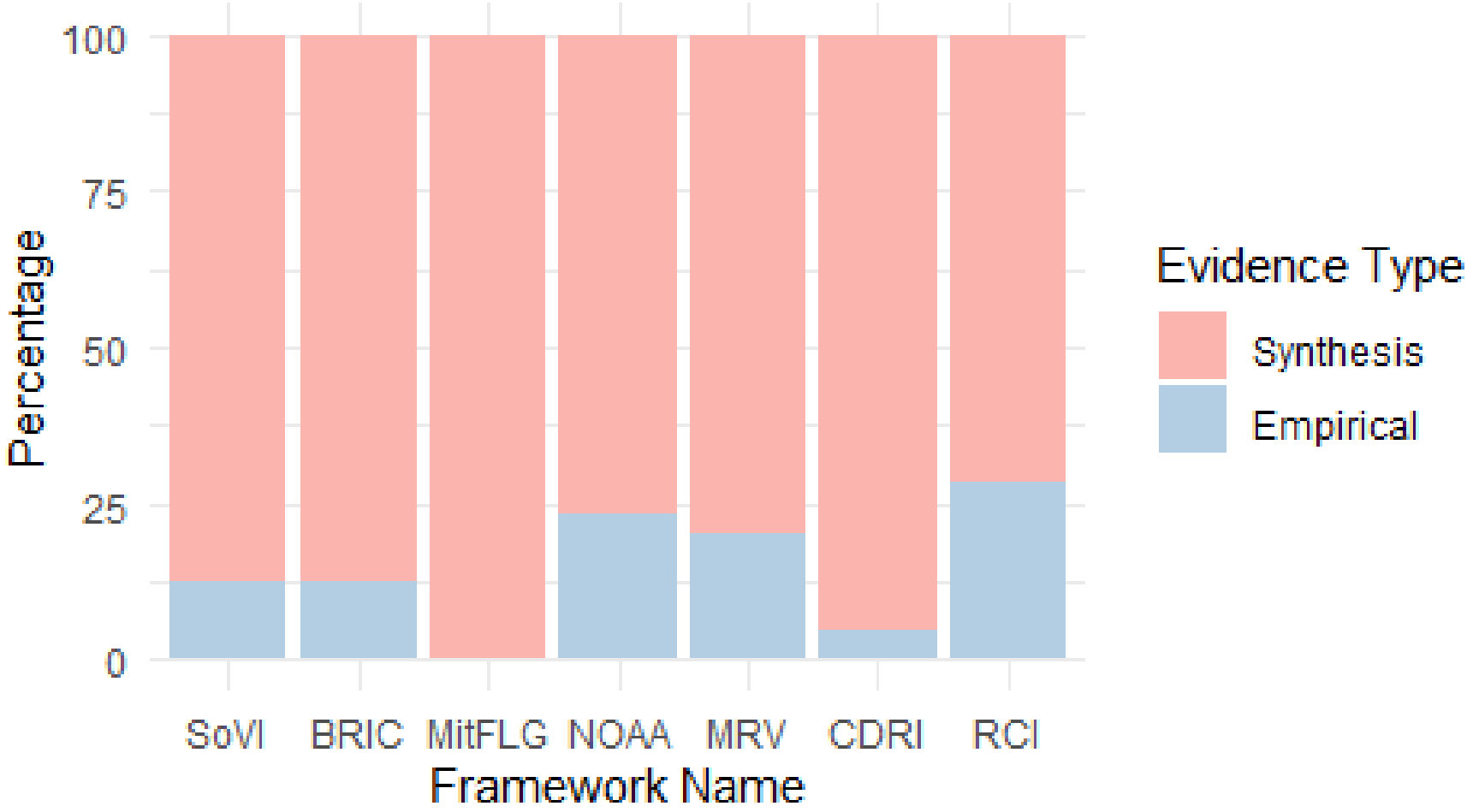
- Establishes link between observations and theory
  - Taken at ‘face value’, are indicators interpretable?
  - Is content appropriate, such that no extraneous indicators are included and no important items are excluded?
- Most studies engage in face validity, which is weaker than content validity
- Content validity is usually established by literature review or comparison of common indicators, which is a weaker method for assessing content
- Given that more robust methods, such as expert panels, are more resource intensive, we are developing methods to strengthen review techniques

Indicators by Systems and Attributes



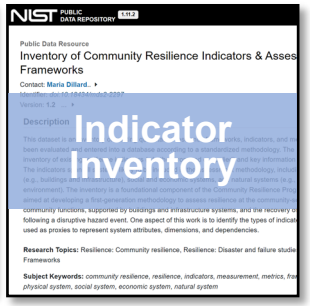
Frequency of attributes by framework and system

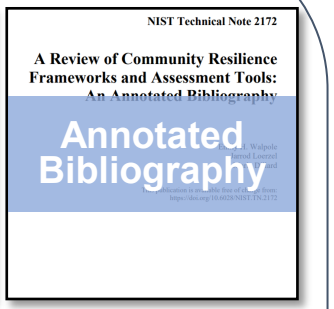
Evidence types



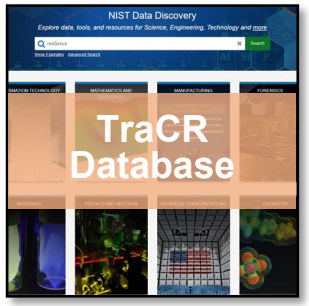
Assessment Methodology - Validation

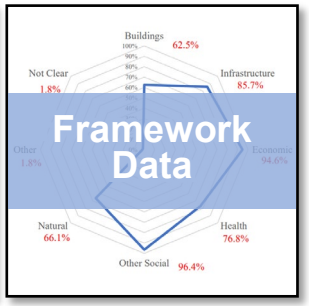
Foundational Products





(Walpole et al., 2021)

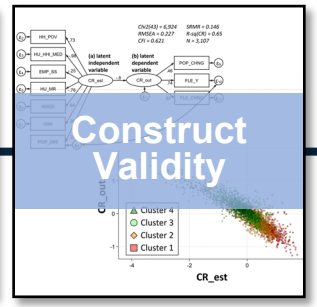




(Loerzel et al., 2021)

Indicator Selection and Validation

Criterion Validity



(Gu et al., 2023)

Resilience Outcomes for Validation Testing *(under review)*

(Gu et al., 2024)

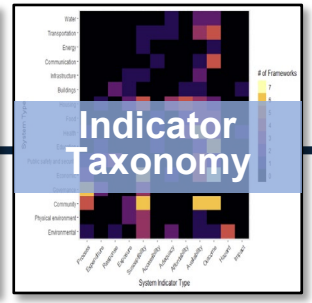
Validating Existing Resilience Frameworks *(in progress)*

(Gu et al., 2024)

Translational Validity

Content Validity *(under review)*

(Gerst et al., 2024)



(Gerst et al., 2024)

Quality of Evidence *(in progress)*

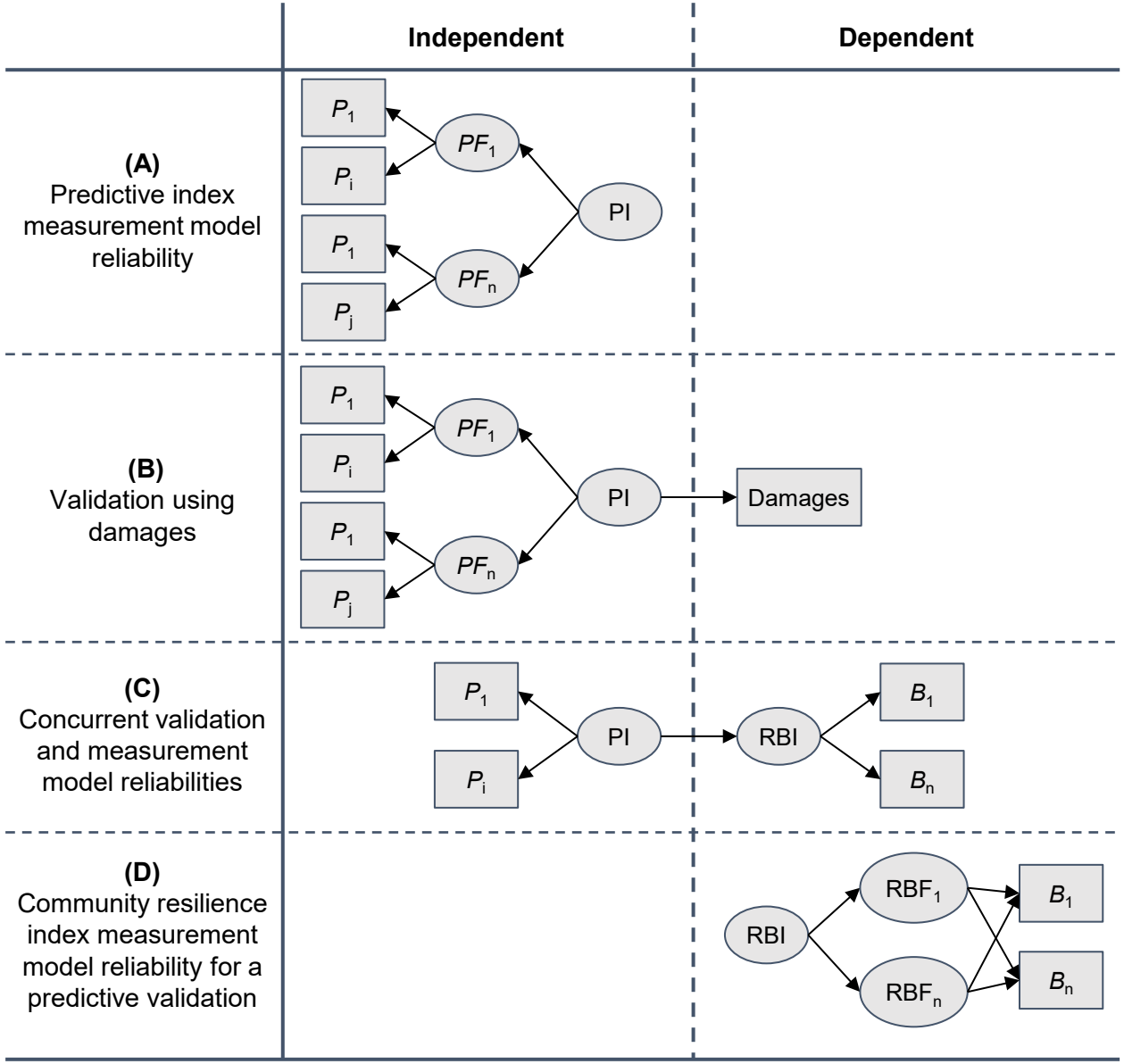
(Gerst et al., 2024)

In Progress

Completed

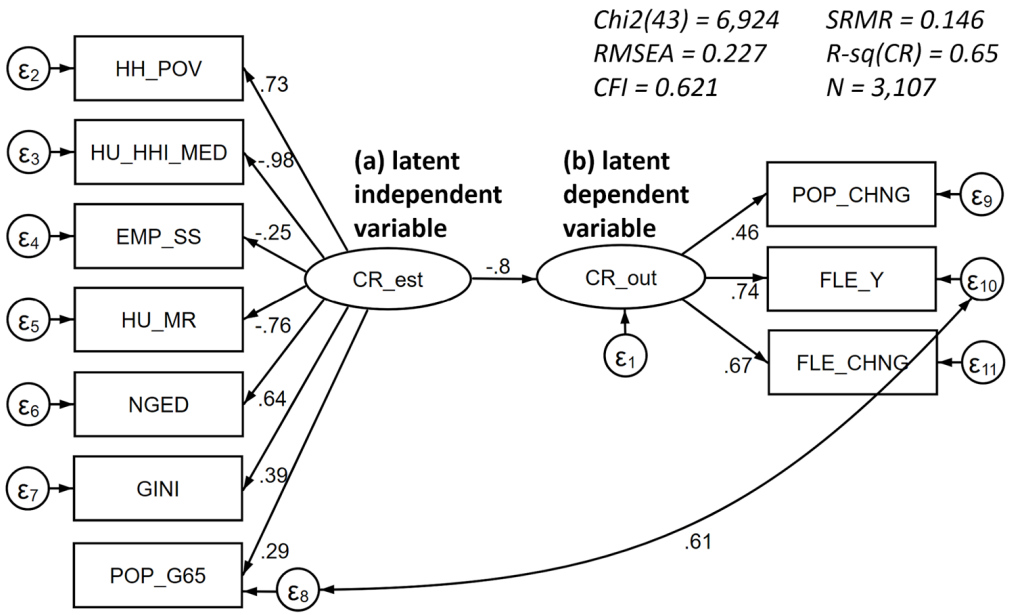
Indicator Validation Efforts

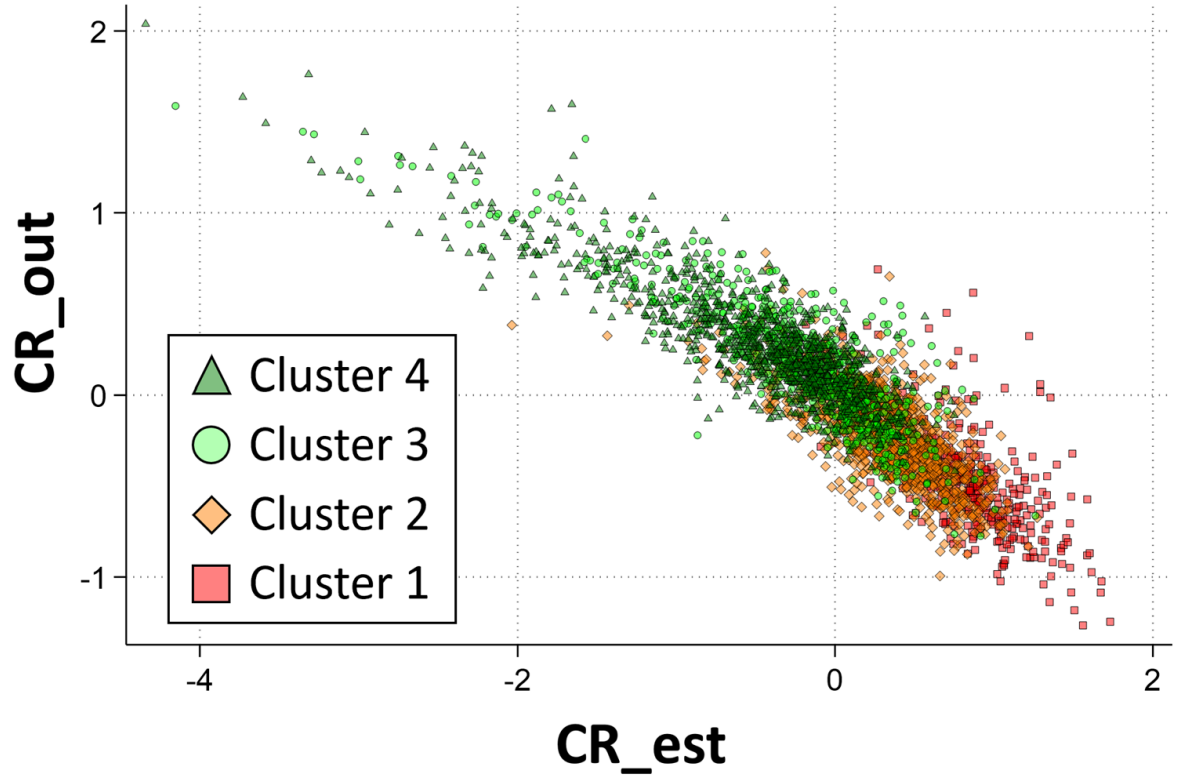
- Comparison of our indicator validation efforts (Row D) to previous resilience studies, which are grouped into Rows A, B, and C, shown in structural equation format.
- The vertical dotted line delineates whether studies consider independent and/or dependent latent (oval) and measurable (rectangle) variables.
- Key: P = predictive indicator, PF = predictive factor, PI = predictive index, RBI = resilience baseline index, B = baseline indicator, RBF = resilience baseline factor.



Indicator Validation Using Latent Variable

- Scatter plot of the predicted factor scores for the latent variables in the SEM result



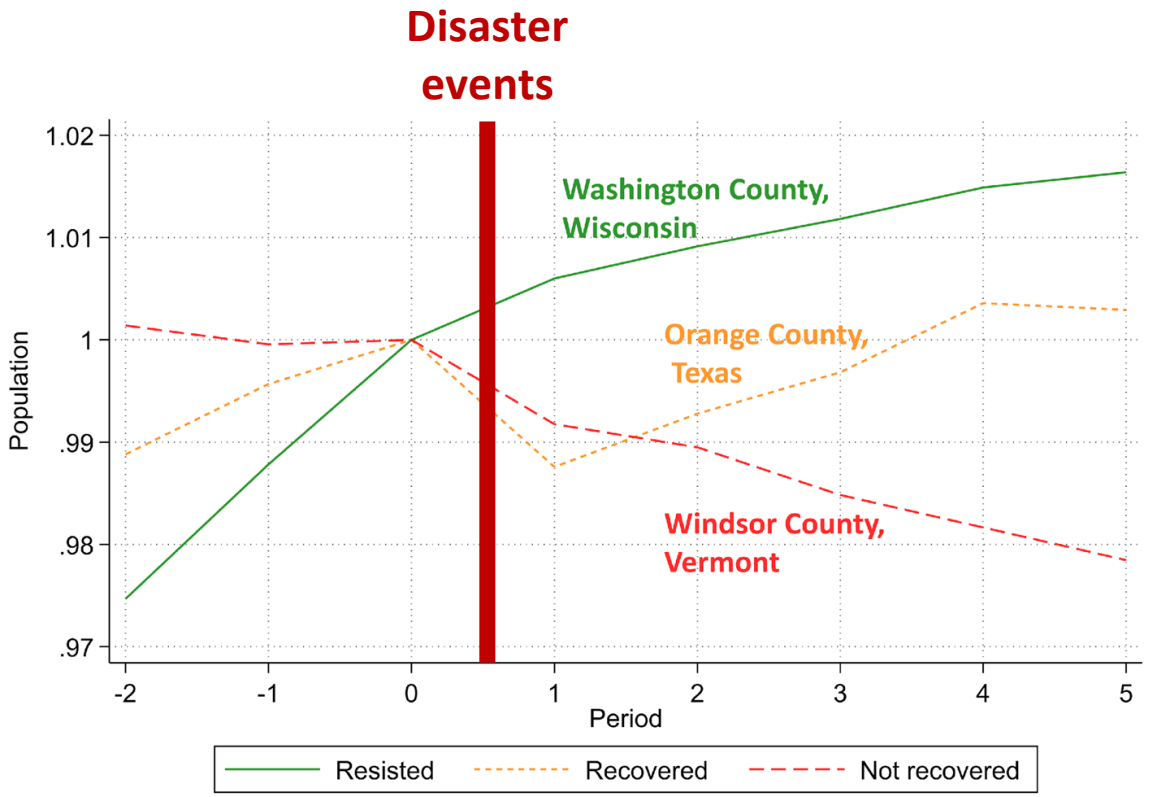


Outcome Indicators

A standardized and replicable way to validate commonly used and other indicators

Three categories

- Resisted
- Recovered
- Not recovered

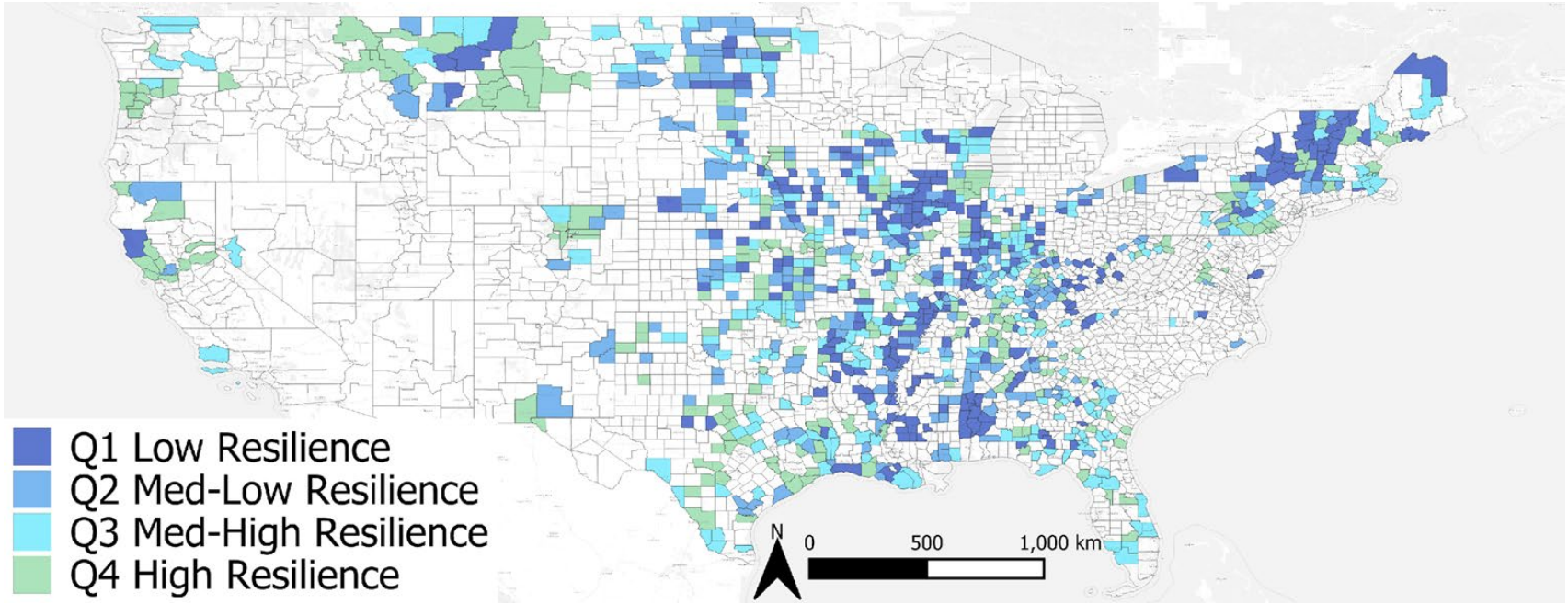


Outcome Indicators

A measure to quantify the levels of community resilience for input to further analyses

Based on four outcome indicators

- Population
- Employment
- Eviction
- Life expectancy



What's Next?

About the NIST Research Library and Museum
NIST Publications
Journal of Research of NIST
NIST Library Search
NIST Museum and Archives

NIST Special Publication Subseries Descriptions

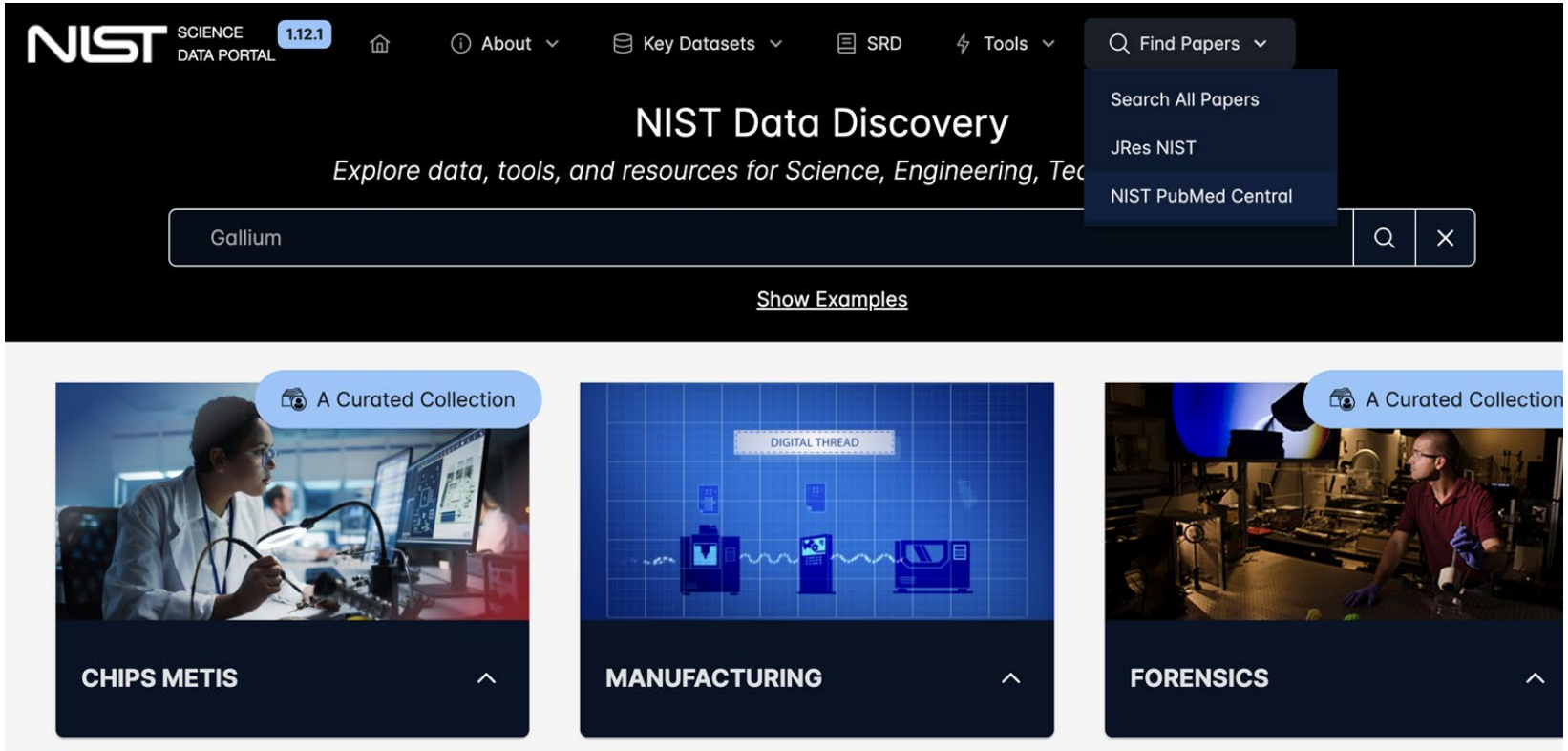
SP 2300: Resilience Indicator Development and Best Practices

Developed in May 2023
(Publications forthcoming as of June 6, 2024)

This technical subseries will be used to document the resilience indicator development methodologies used by the NIST Community Resilience Program and highlight the best practices for the development, selection, testing, and validation of resilience indicators for inclusion in a framework to assess community resilience. The methods used to assess, test, and validate resilience indicators detailed in this special publication subseries are based on the extensive research and experience of NIST researchers.

- Science based guidance on development and validation testing of indicators

What's Next?



- Science based guidance on development and validation testing of indicators
- Publication of TraCR Database

What's Next?

- Science based guidance on development and validation testing of indicators
- Publication of TraCR Database
- Technical assistance for those developing or evaluating indicators for resilience or other latent constructs like well-being

Community Resilience Measurement Project Team

Assessment Products and more!

Maria Dillard

Michael Gerst

Donghwan Gu

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Project Team