



# The Science of Community Resilience Measurement

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*Jarrold Loerzel (past member), Emily Walpole (past member)*



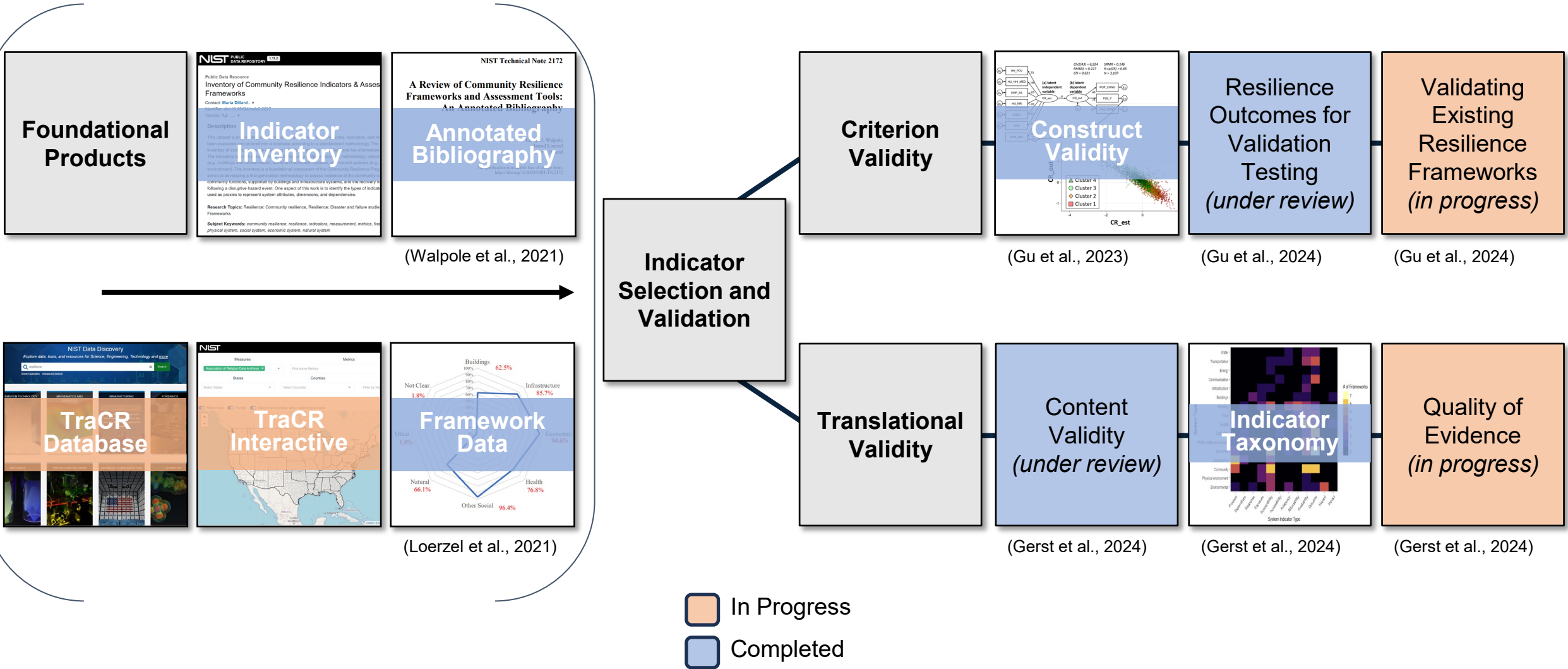
# NIST Project on Community Resilience Measurement



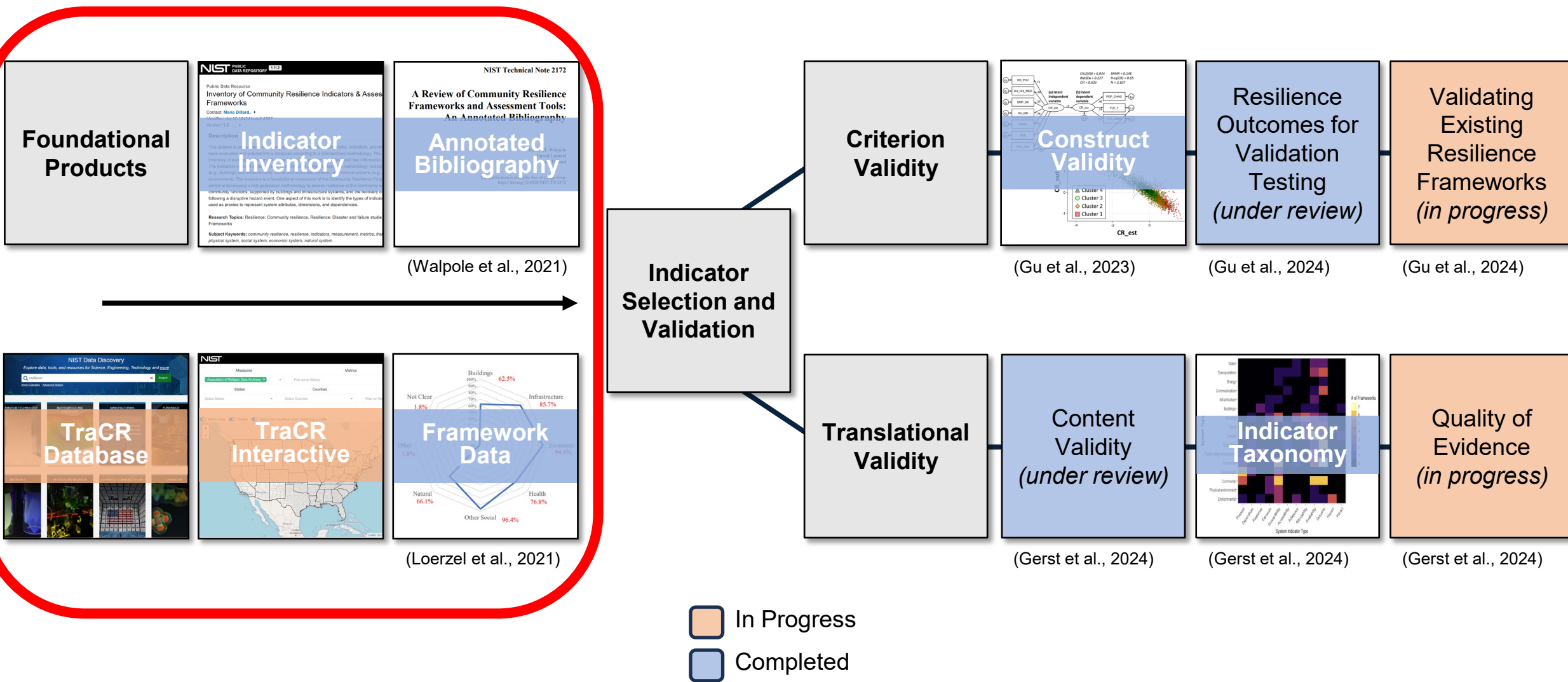
**Objective** - To develop and disseminate a database of county level community resilience indicators, an inventory and analysis of published frameworks and indicators, and scientifically grounded guidance necessary to quantitatively assess community resilience over time for the nation, based on a suite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



# Assessment Methodology



# Assessment Methodology - Foundation



# 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

**NIST PUBLIC DATA REPOSITORY 1.12.1**

Public Data Resource  
**Inventory of Community Resilience Indicators & Assessment Frameworks**  
Contact: [Maria Dillard](#)  
Identifier: doi:10.18434/inds2-2297  
Version: 1.2

**Description**  
This dataset is an inventory of existing quantitative resilience frameworks, indicators, and measures that have been evaluated and entered into a database according to a standardized methodology. The inventory is a broad inventory of existing resilience indicators (whether proposed or applied) and key information for each indicator. The indicators span all systems likely to be included in the assessment methodology, including physical systems (e.g., buildings and infrastructure), social and economic systems, and natural systems (e.g., natural environment). The inventory is a foundational component of the Community Resilience Program's research aimed at developing a first-generation methodology to assess resilience at the community-scale based on community functions, supported by buildings and infrastructure systems, and the recovery of those functions following a disruptive hazard event. One aspect of this work is to identify the types of indicators that are used as proxies to represent system attributes, dimensions, and dependencies.

**Research Topics:** Resilience: Community resilience, Resilience: Disaster and failure studies, Standards and Frameworks

**Subject Keywords:** community resilience, resilience, indicators, measurement, metrics, framework, physical system, social system, economic system, natural system

- 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

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## Inventory of Community Resilience Indicators & Assessment Frameworks

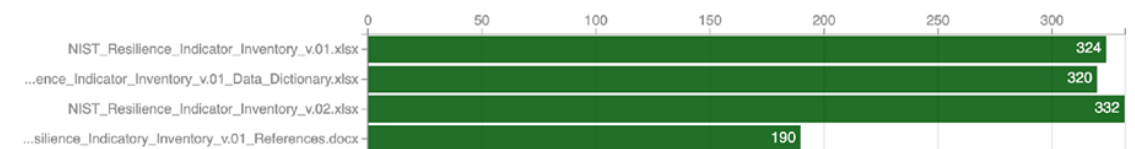
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### Dataset Summary

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# Research Infrastructure for Community Resilience Measurement Science

NIST GCR 15-1010

## Critical Assessment of Existing Methodologies for Measuring or Representing Community Resilience of Social and Physical Systems

Prepared for  
U.S. Department of Commerce  
Engineering Laboratory

Willie May, Under Secretary

NIST GCR 16-001

## A Conceptual Framework for Assessing Resilience at the Community Scale

Prepared for  
U.S. Department of Commerce

Willie May, Under Secretary

NIST GCR 17-013

## Further Development of a Conceptual Framework for Assessing Resilience at the Community Scale

Prepared for  
U.S. Department of Commerce  
Engineering Laboratory  
National Institute of Standards and Technology  
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This publication is available free of charge from:  
<https://doi.org/10.6028/NIST.GCR.17-013>

July 2017



U.S. Department of Commerce  
Wilbur L. Ross, Jr., Secretary

National Institute of Standards and Technology  
Kent Rochford, Acting NIST Director and Under Secretary of Commerce for Standards and Technology

Volume 126, Article No. 126011 (2021) <https://doi.org/10.6028/jres.126.011>  
Journal of Research of the National Institute of Standards and Technology

## An Analysis of an Inventory of Community Resilience Frameworks

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Key words: assessment methodology; community resilience; indicators; resilience framework

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### 1. Summary

In previous publications [1–8], the National Institute of Standards and Technology (NIST) adopted the definition of resilience as “the ability of a system to resist, absorb, and recover rapidly from the effects of a disturbance, while maintaining its essential functions and structure.” This paper provides a detailed analysis of the way in which resilience is defined and measured on community-level frameworks developed and examined.

To connect concepts of resilience to the concept of resilience, this paper provides a decision support tool for the Resilience Program. The paper presents the theoretical approach among the framework of resilience frameworks. This paper provides an inventory of 56 resilience frameworks. The paper provides an inventory of 56 resilience frameworks. The paper provides an inventory of 56 resilience frameworks.

1. Introduction  
Loerzel, J., Dillard, M.  
Community Resilience Frameworks

NIST Technical Note 2172

## A Review of Community Resilience Frameworks and Assessment Tools: An Annotated Bibliography

Emily H. Walpole  
Jarrod Loerzel  
Maria Dillard  
Materials and Structural Systems Division  
Engineering Laboratory

This publication is available free of charge from:  
<https://doi.org/10.6028/NIST.TN.2172>

August 2021



U.S. Department of Commerce  
Gina M. Raimondo, Secretary

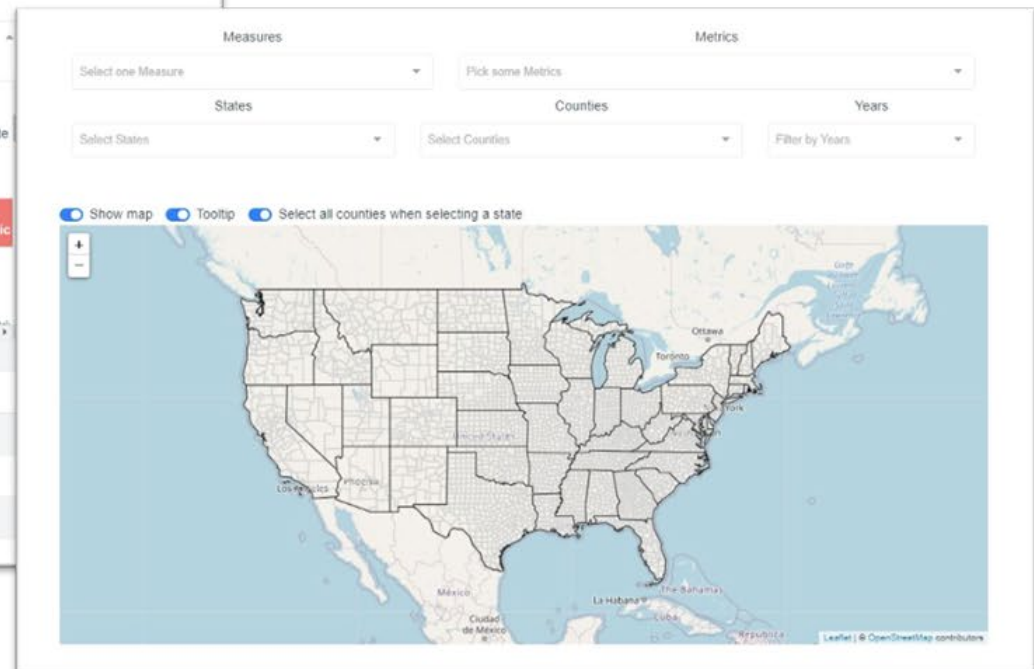
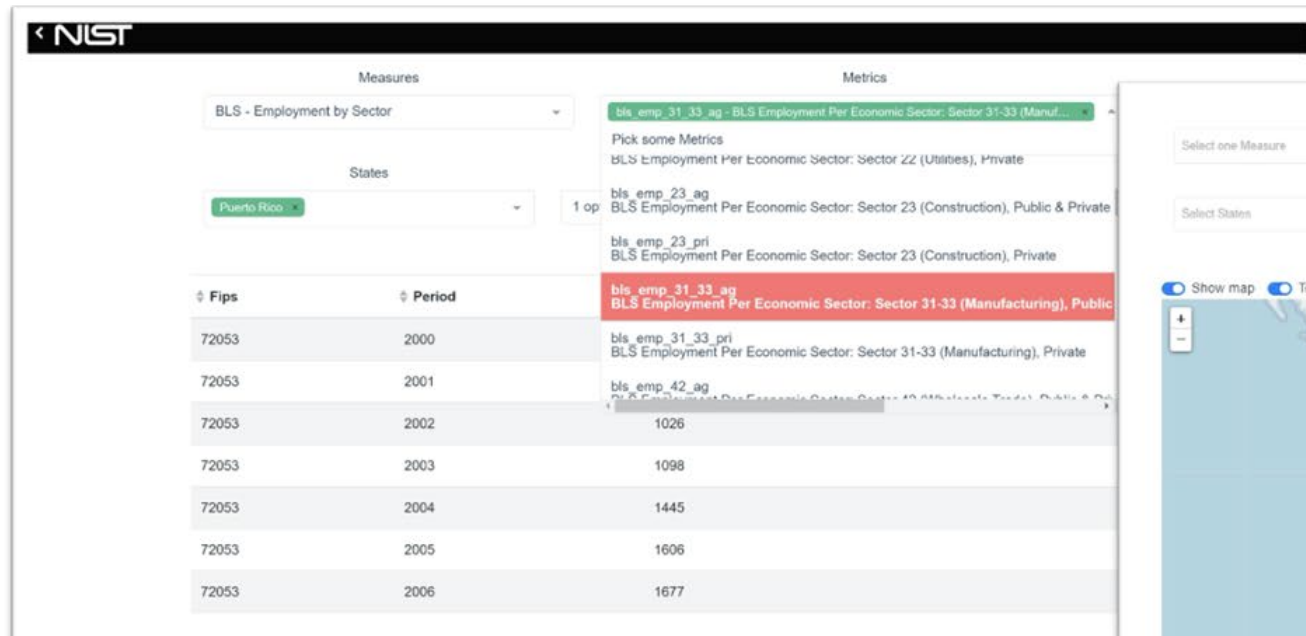
National Institute of Standards and Technology  
James K. Olthoff, Performing the Non-Exclusive Functions and Duties of the Under Secretary of Commerce for Standards and Technology & Director, National Institute of Standards and Technology

- 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

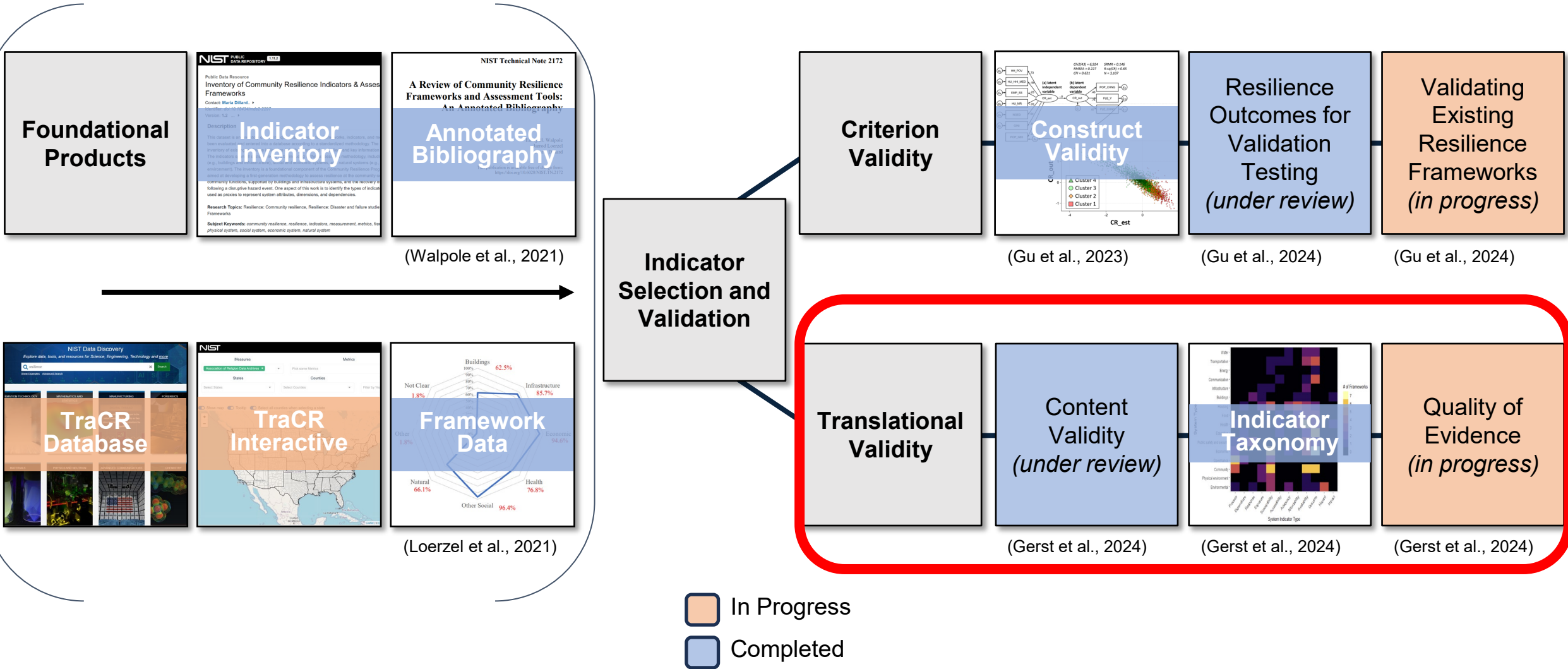
# Research Infrastructure for Community Resilience Measurement Science

## 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)



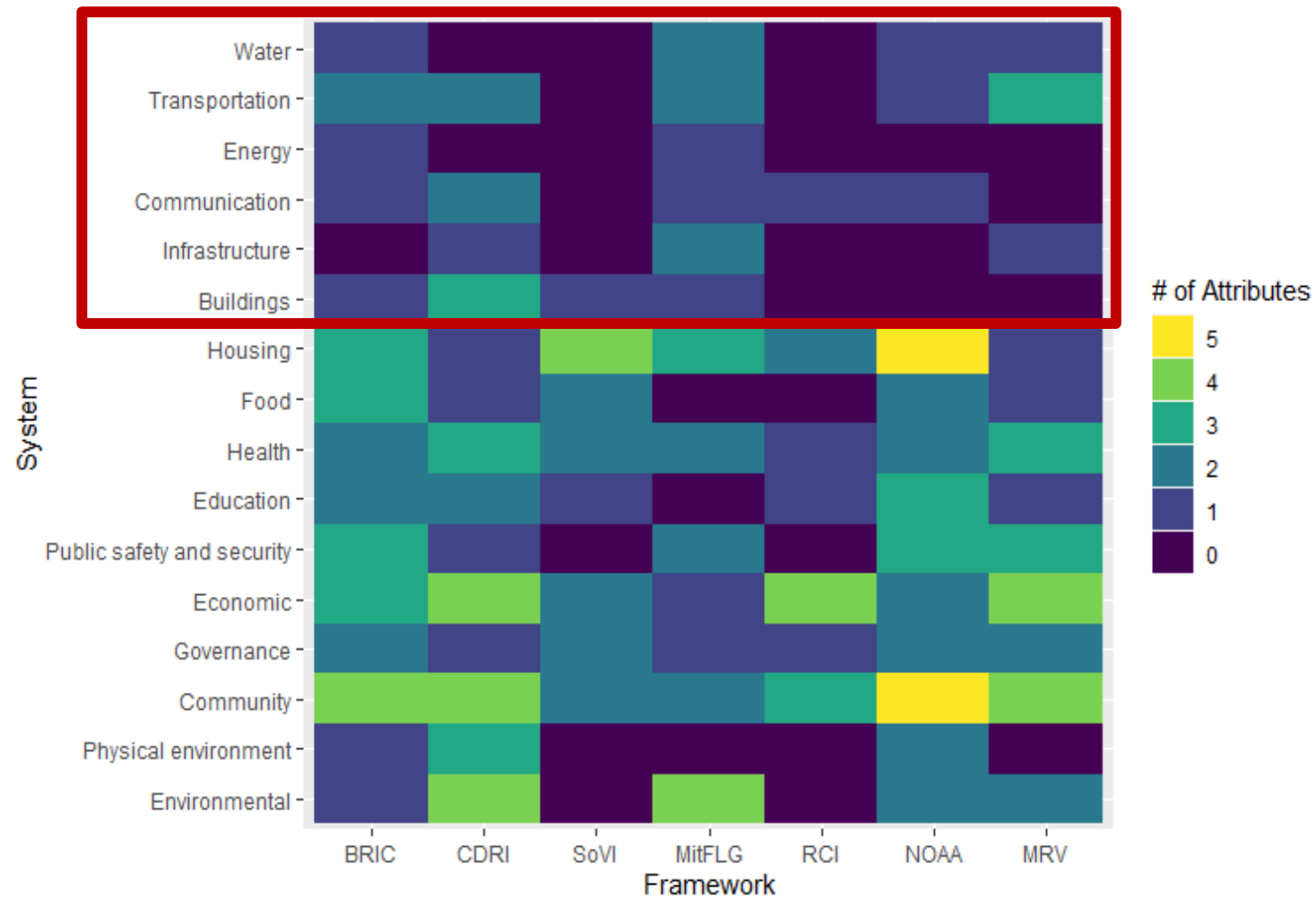
# Assessment Methodology - Validation



# Translational Validity Workstream

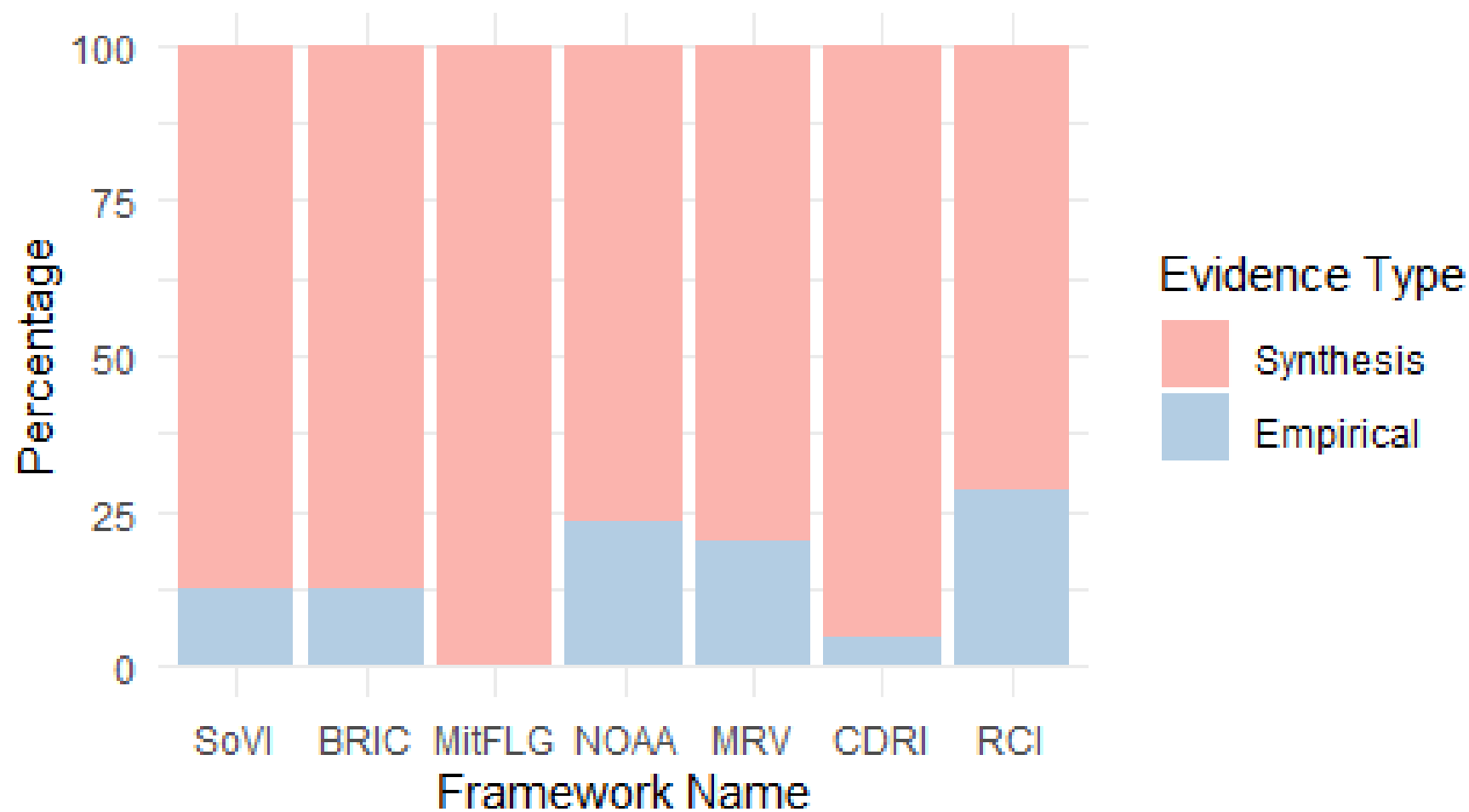
- Establishes link between observations and theory
  - Taken at 'face value', are indicators interpretable?
  - Is content appropriate, such that no extraneous indicators are included and no important items are excluded?
- Most studies engage in face validity, which is weaker than content validity
- 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*

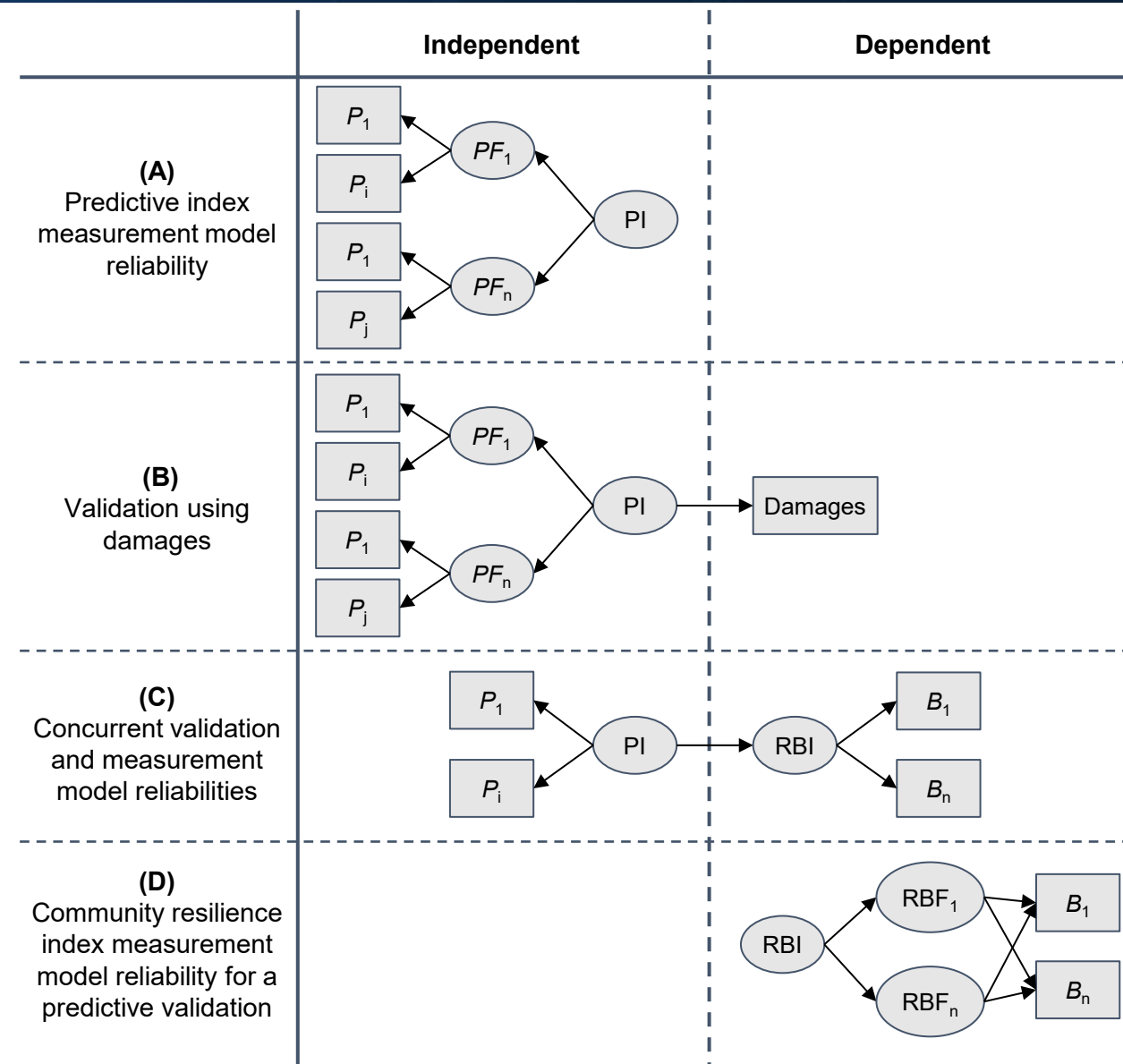
# Evidence types





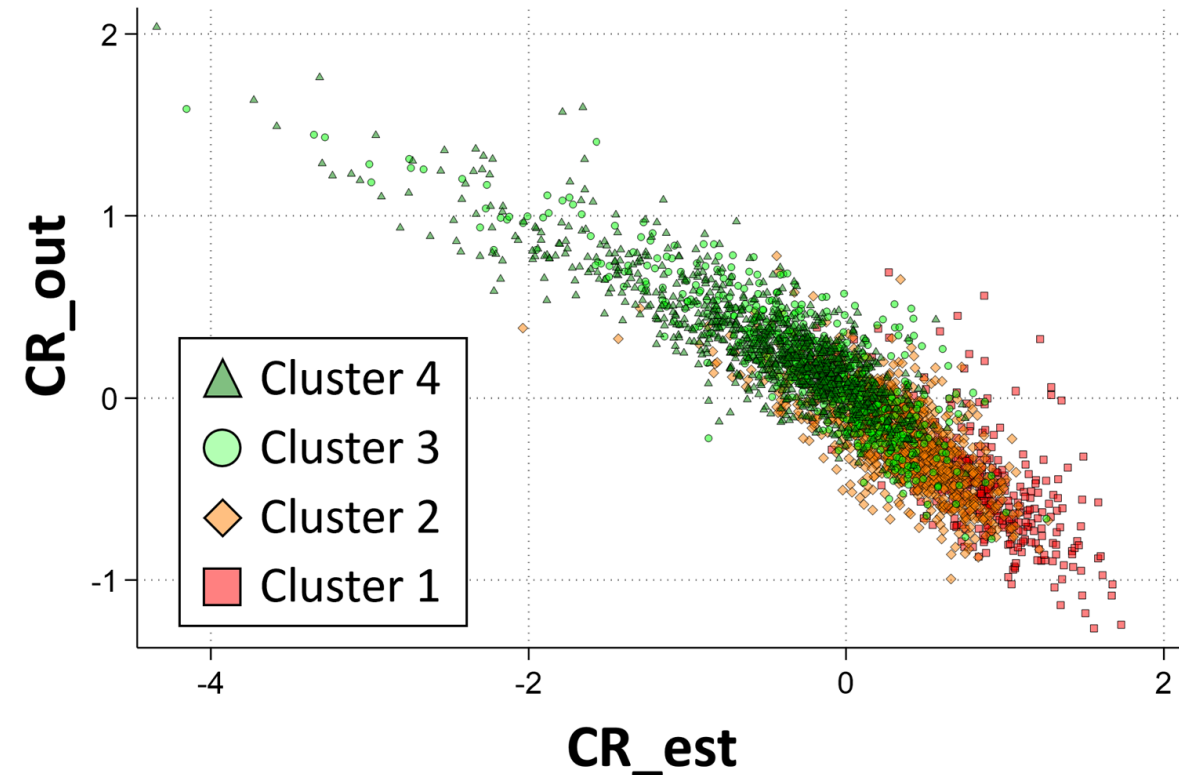
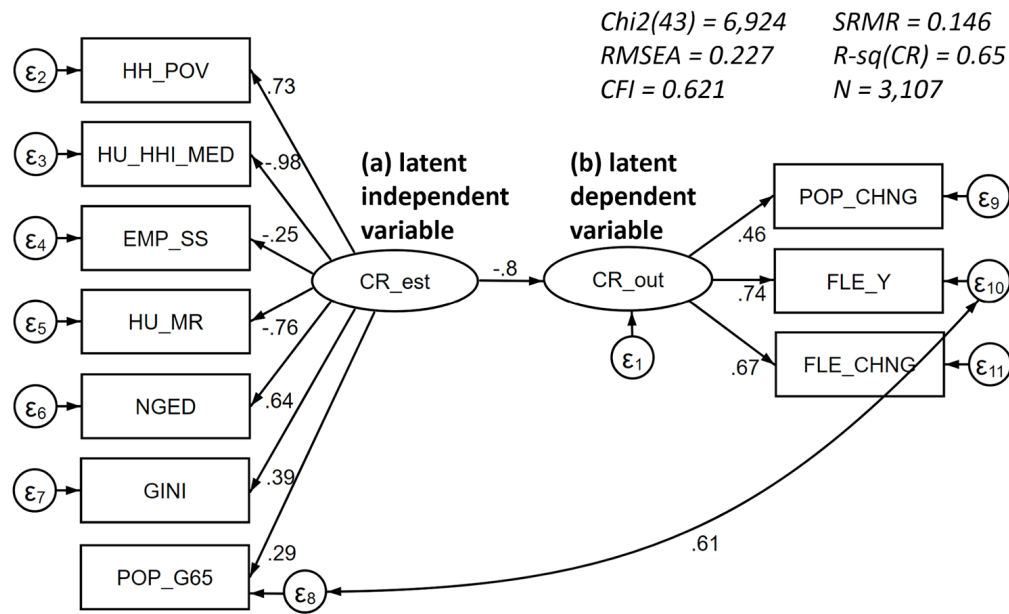
# Indicator Validation Efforts

- 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

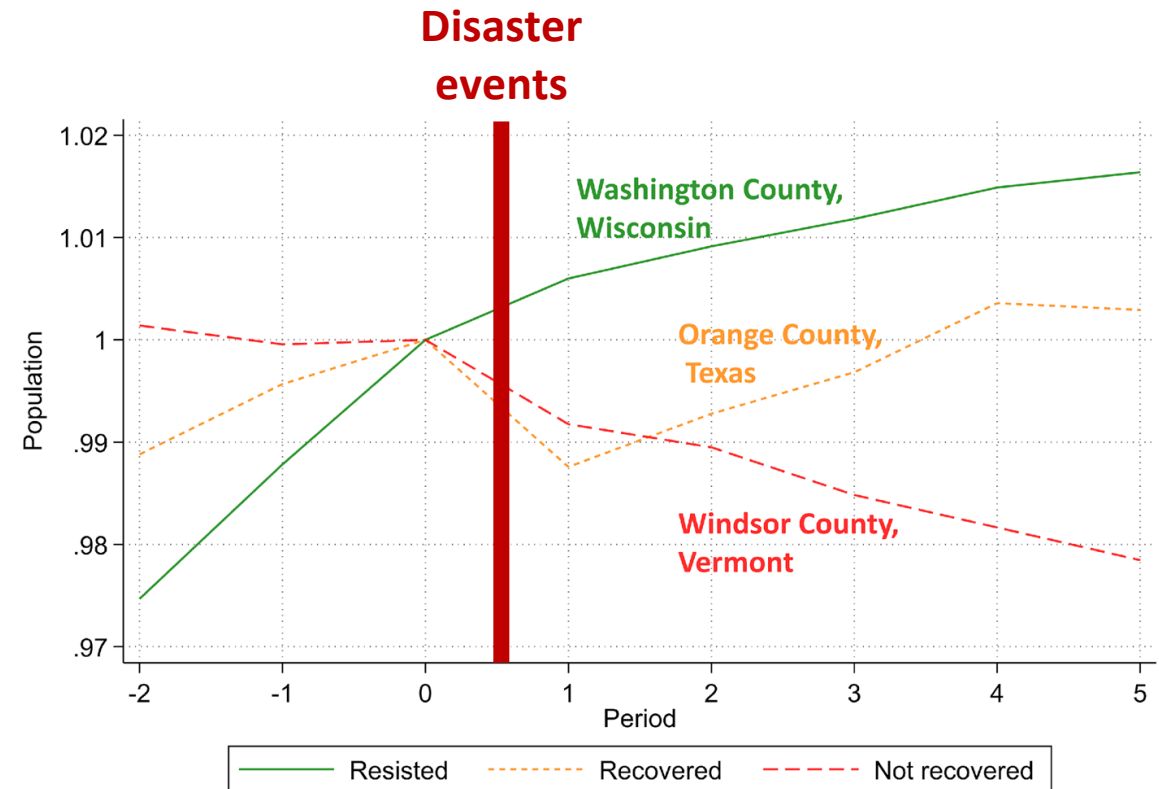


# Outcome Indicators

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

Three categories

- Resisted
- Recovered
- Not recovered

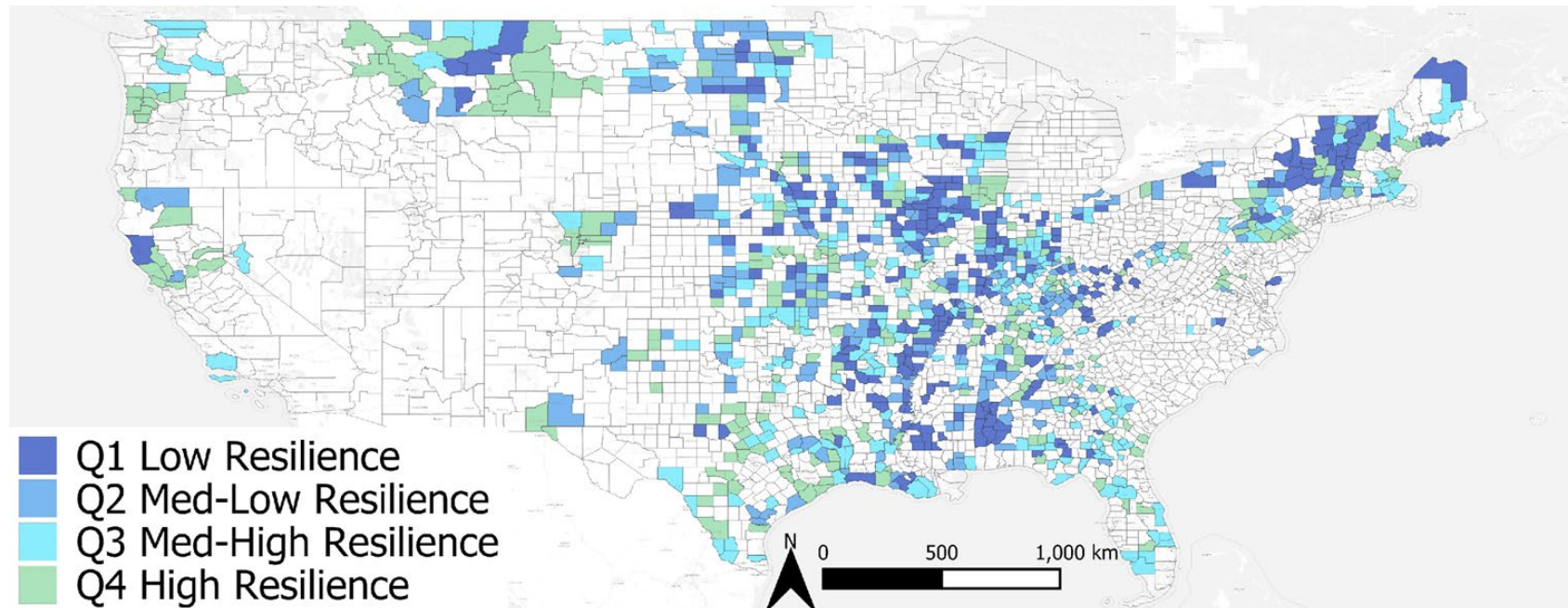


# Outcome Indicators

**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?

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### SP 2300: Resilience Indicator Development and Best Practices

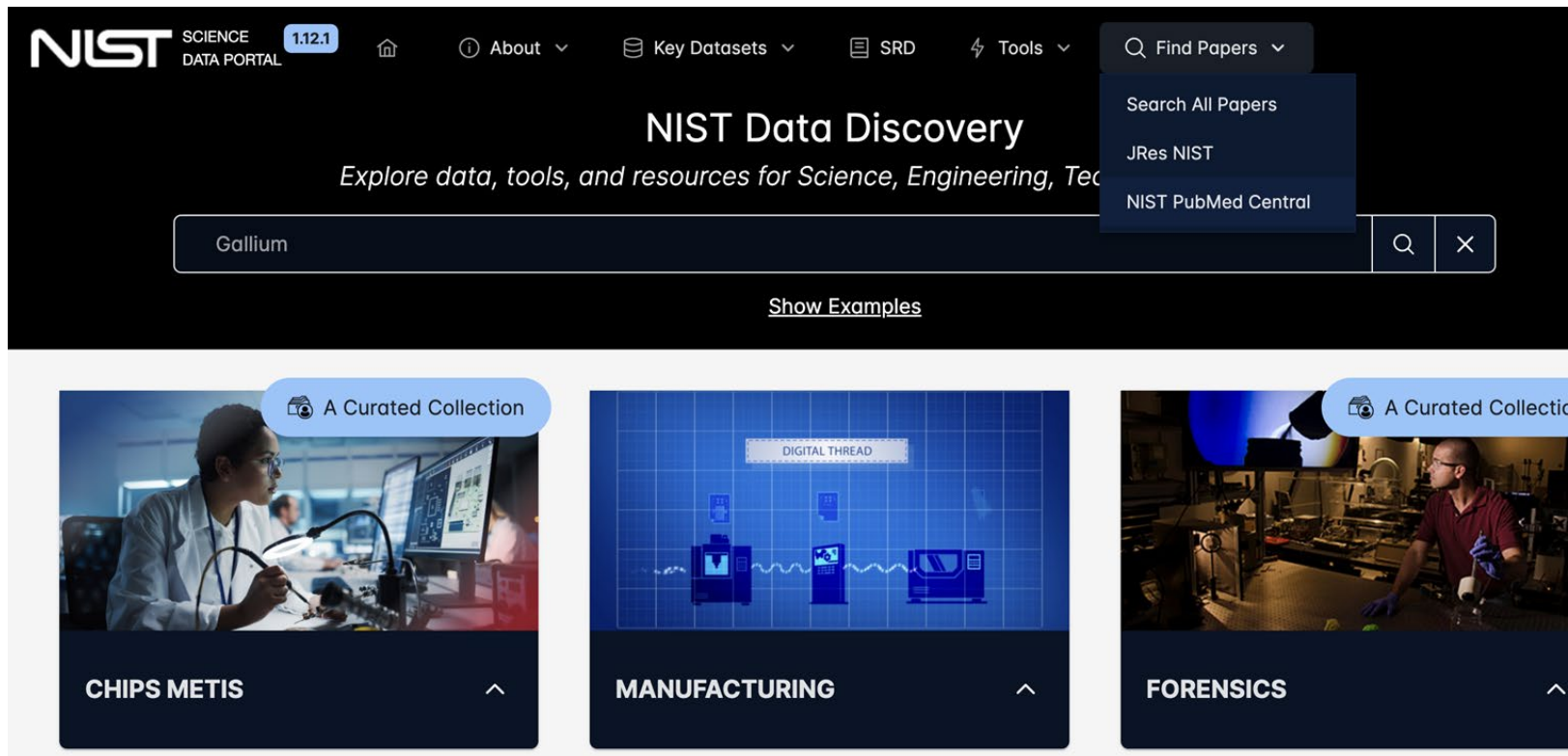
Developed in May 2023

*(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