

The Science of Community Resilience Measurement

Project Team: Maria Dillard, Michael Gerst, Donghwan Gu
Jarrod Loerzel (past member), Emily Walpole (past member)



NIST Project on Community Resilience Measurement

NIST

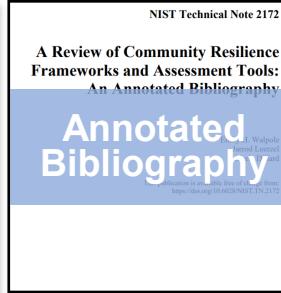
Objective - To develop and disseminate a database of county level community resilience indicators, an inventory and analysis of published frameworks and indicators, and scientifically grounded guidance necessary to quantitatively assess community resilience over time for the nation, based on a suite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



Assessment Methodology

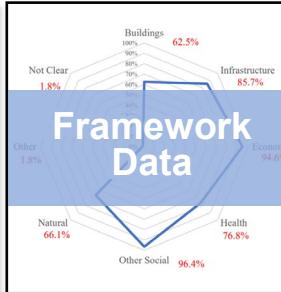
NIST

Foundational Products



(Walpole et al., 2021)

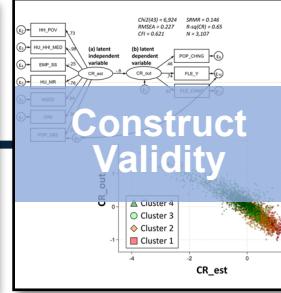
TraCR Database



(Loerzel et al., 2021)

Indicator Selection and Validation

Criterion Validity



(Gu et al., 2023)

Content Validity (under review)

Resilience Outcomes for Validation Testing (under review)

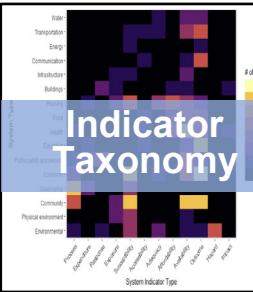
(Gu et al., 2024)

Validating Existing Resilience Frameworks (in progress)

(Gu et al., 2024)

Translational Validity

Indicator Taxonomy (under review)



(Gerst et al., 2024)

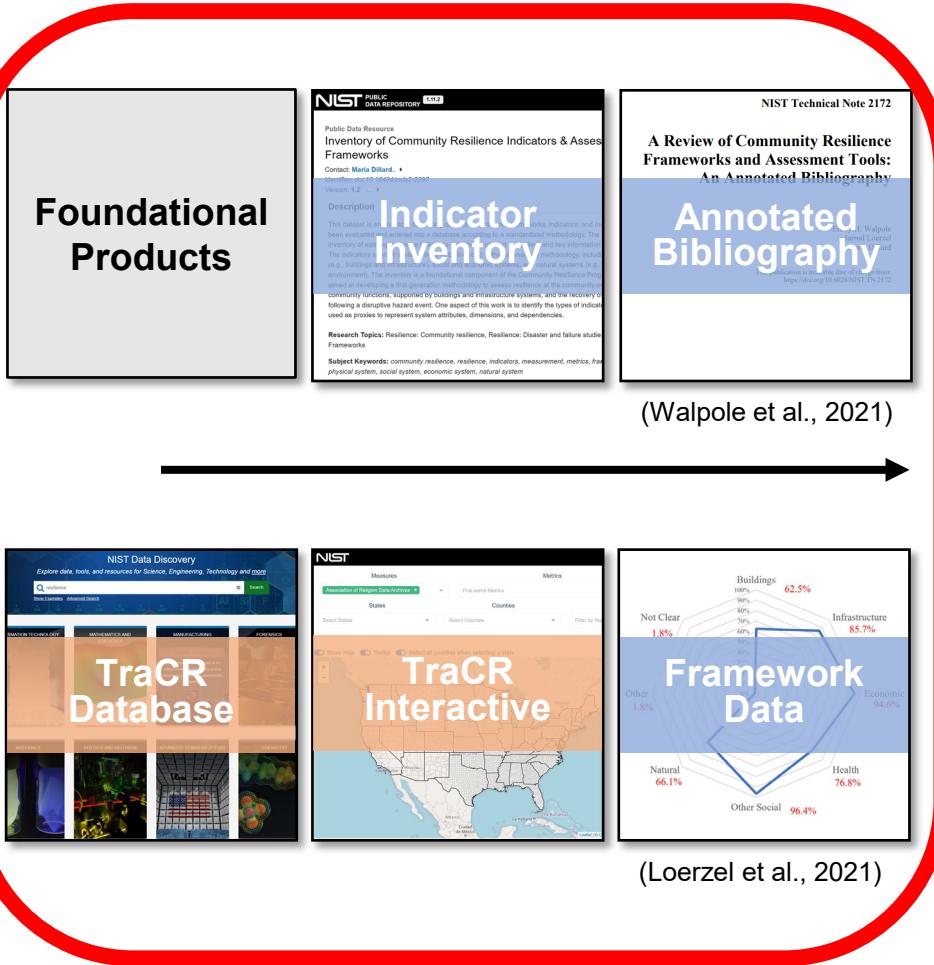
Quality of Evidence (in progress)

(Gerst et al., 2024)

In Progress

Completed

Assessment Methodology - Foundation

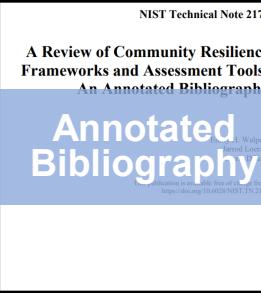


Foundational Products



(Walpole et al., 2021)

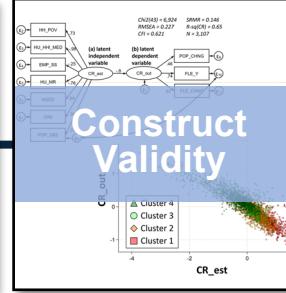
A Review of Community Resilience Frameworks and Assessment Tools: An Annotated Bibliography



(Walpole et al., 2021)

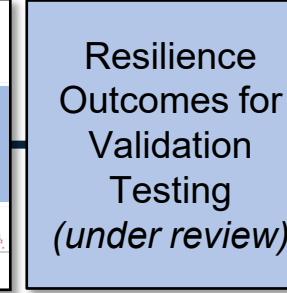
Indicator Selection and Validation

Criterion Validity



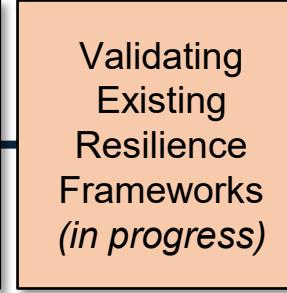
(Gu et al., 2023)

Resilience Outcomes for Validation Testing *(under review)*



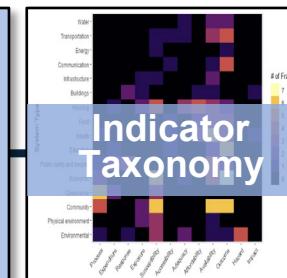
(Gu et al., 2024)

Validating Existing Resilience Frameworks (in progress)



(Gu et al., 2024)

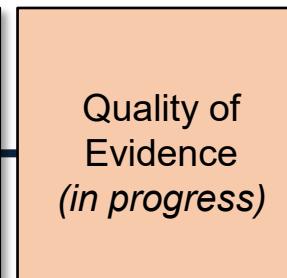
Translational Validity



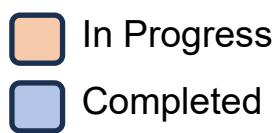
Content Validity (under review)

(Gerst et al., 2024)

Quality of Evidence (in progress)



(Gerst et al., 2024)



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

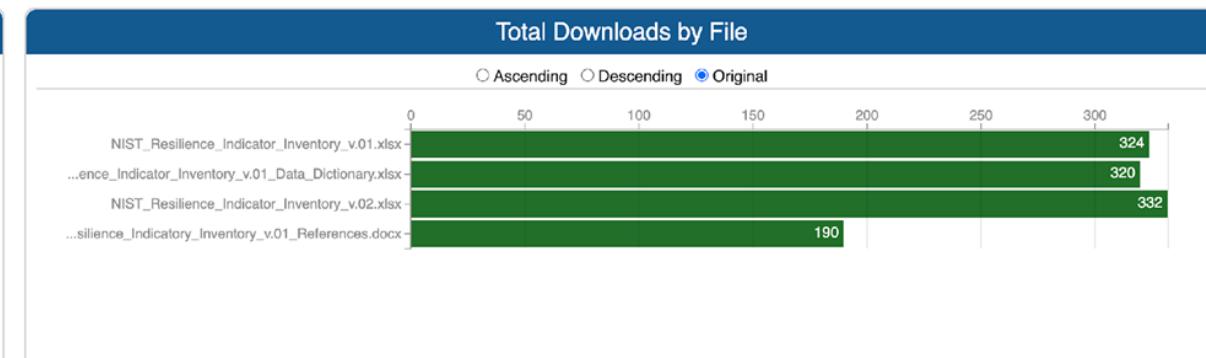
The screenshot shows the NIST Public Data Repository interface. The dataset title is "Inventory of Community Resilience Indicators & Assessment Frameworks" (version 1.12.1). It includes sections for Description, Research Topics, and Subject Keywords. The Description section provides a detailed overview of the inventory's purpose and scope. The Research Topics section lists "Resilience: Community resilience, Resilience: Disaster and failure studies, Standard Frameworks". The Subject Keywords section lists "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

Inventory of Community Resilience Indicators & Assessment Frameworks

Metrics Since Jan 11, 2021

Dataset Summary	
Total file downloads	1288
Total dataset downloads	646
Total bytes downloaded	1.98 GB
Total unique users	551
Last downloaded	Oct 31, 2024





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

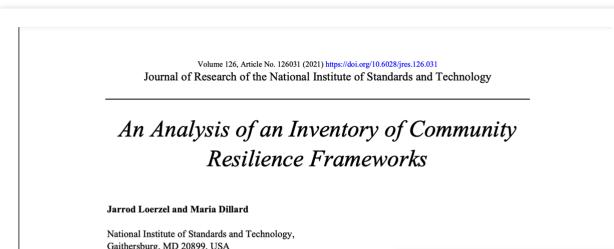
NIST GCR 16-001

A Conceptual Framework for Assessing Resilience at the Community Scale

Prepared for
U.S. Department of Commerce

Willie May, Under Secretary

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
Gaithersburg, MD 20899

By
Alexis Kwasinski
University of Pittsburgh
Joseph Trainor
University of Delaware
Royce Francis
George Washington University
Cynthia Chen
University of Washington
Francis M. Lavelle
Applied Research Associates, Inc.

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.GCR.17-013>



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

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

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. Oithoff, 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)

The image shows the TraCR v0.2 web-based tool interface. The left panel displays a table of data for 'BLS - Employment by Sector' in Puerto Rico, with columns for 'Fips' and 'Period'. The right panel shows a map of the United States with county-level data overlays.

Left Panel (Measures):

Fips	Period	Value
72053	2000	1026
72053	2001	1098
72053	2002	1445
72053	2003	1606
72053	2004	1677

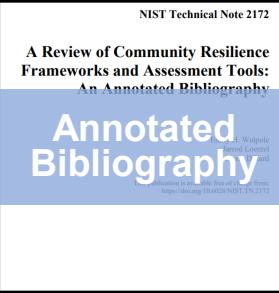
Right Panel (Metrics):

Map of the United States showing county-level data overlays. The map includes labels for major cities like Los Angeles, Mexico City, and La Habana, and countries like Canada, Mexico, and Cuba. The interface includes dropdown menus for 'Select one Measure', 'Select States', 'Select Counties', and 'Filter by Years'.

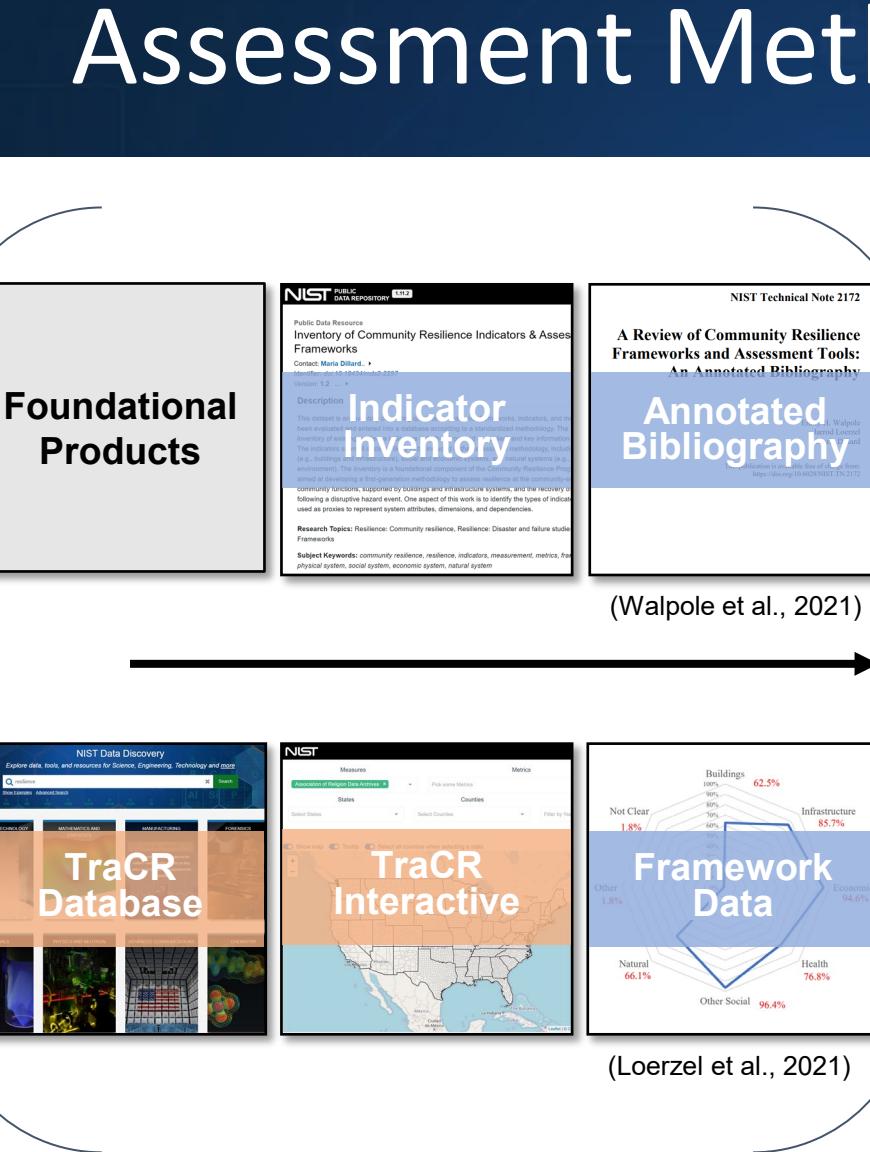
Assessment Methodology - Validation

NIST

Foundational Products

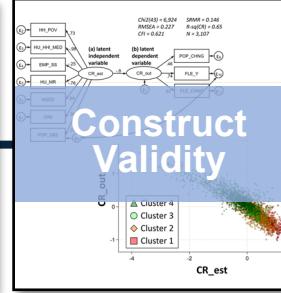


(Walpole et al., 2021)



Indicator Selection and Validation

Criterion Validity



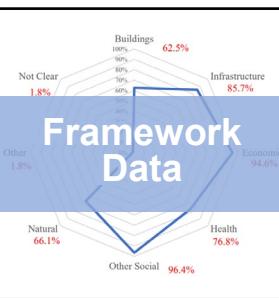
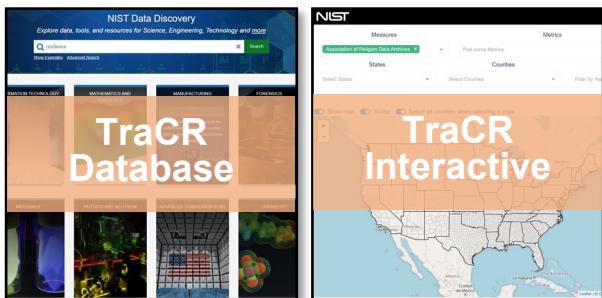
(Gu et al., 2023)

Resilience Outcomes for Validation Testing (under review)

(Gu et al., 2024)

Validating Existing Resilience Frameworks (in progress)

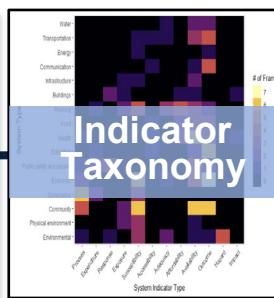
(Gu et al., 2024)



(Loerzel et al., 2021)

Translational Validity

Content Validity (under review)



(Gerst et al., 2024)

Quality of Evidence (in progress)

(Gerst et al., 2024)

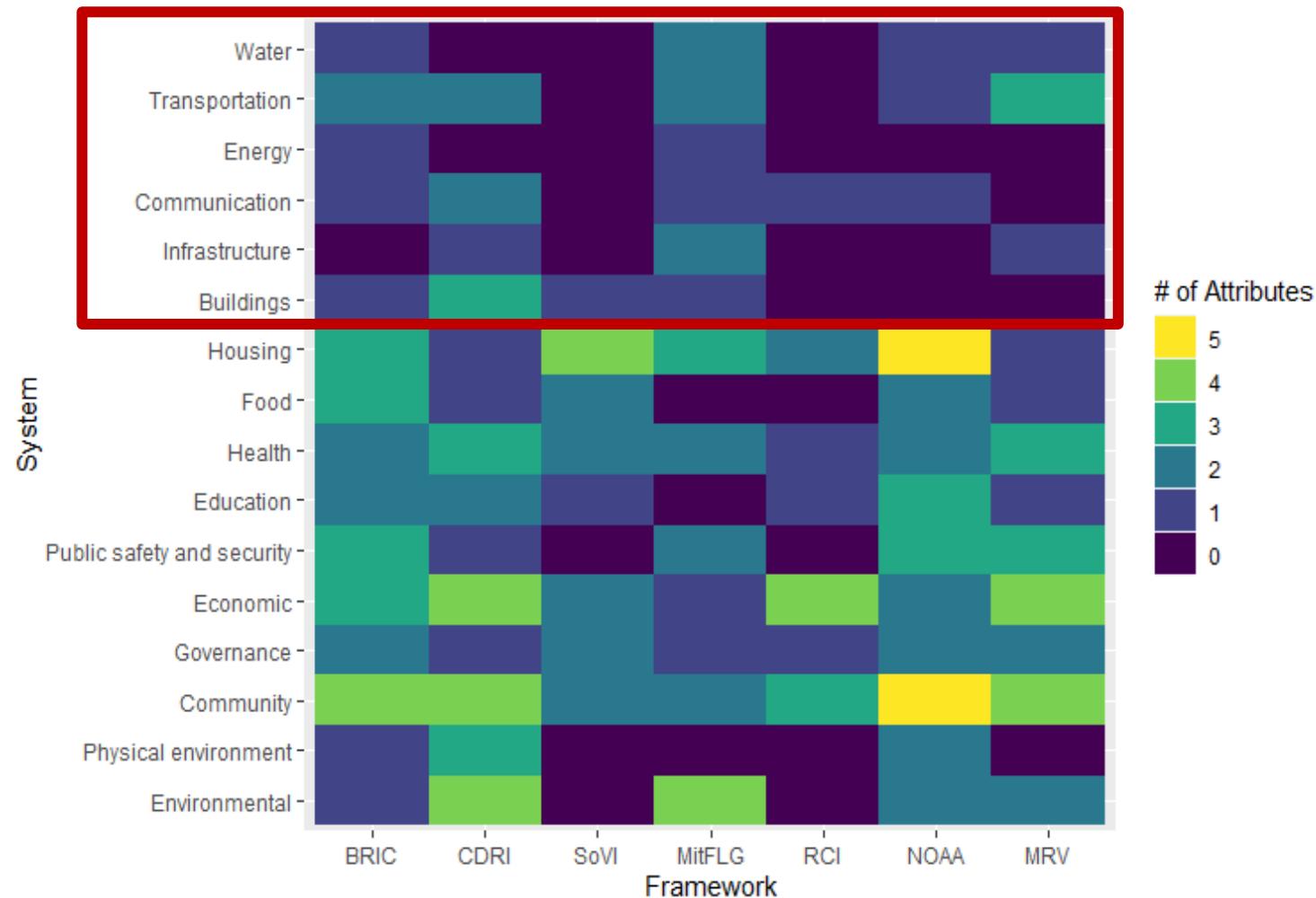
In Progress

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

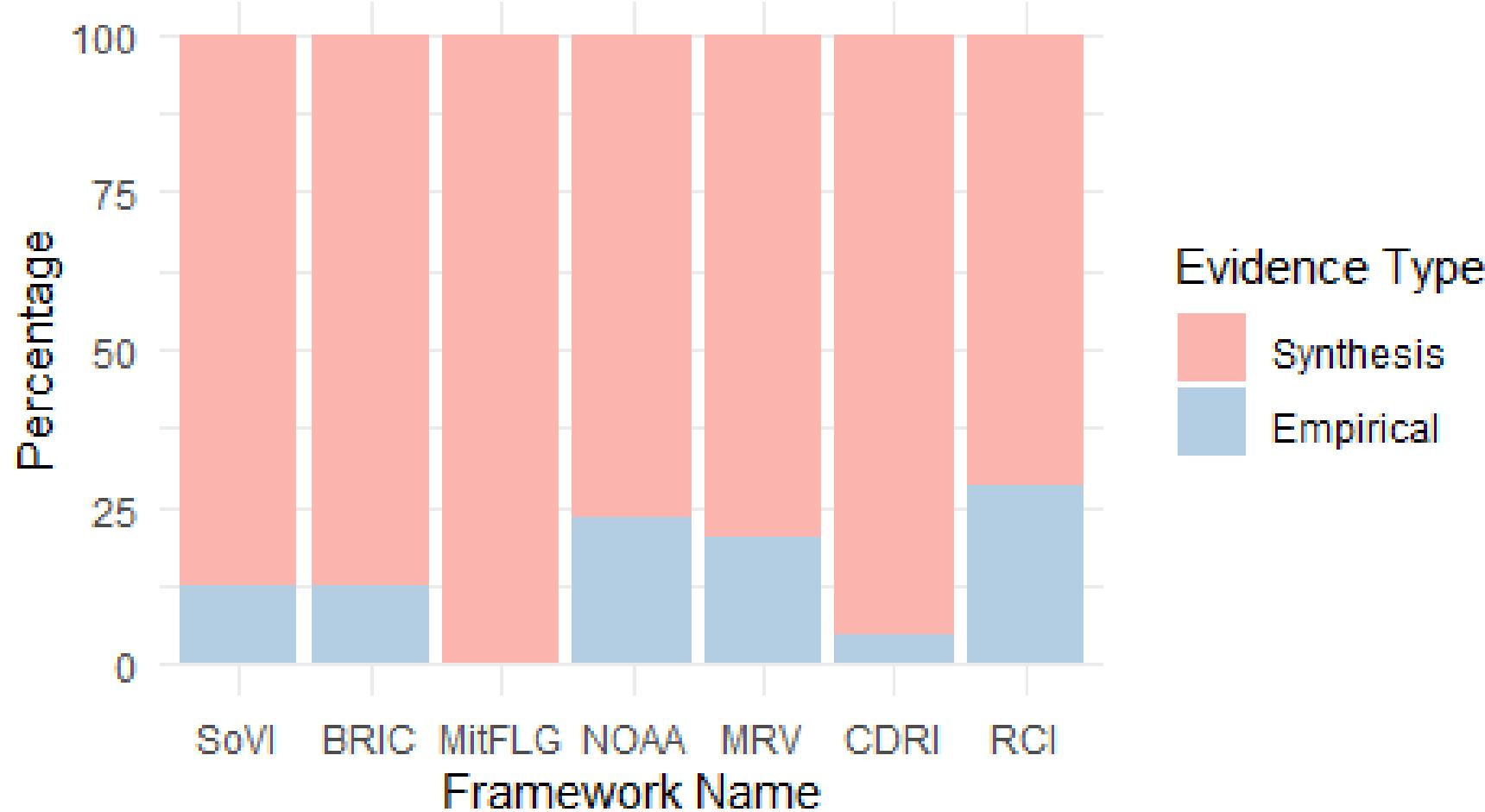
Indicators by Systems and Attributes



Frequency of attributes by framework and system

Evidence types

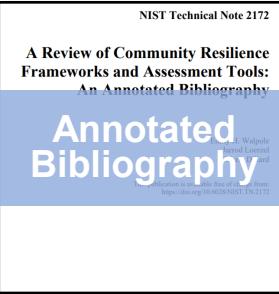
NIST



Assessment Methodology - Validation

NIST

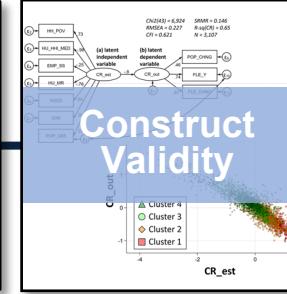
Foundational Products



(Walpole et al., 2021)

Indicator Selection and Validation

Criterion Validity



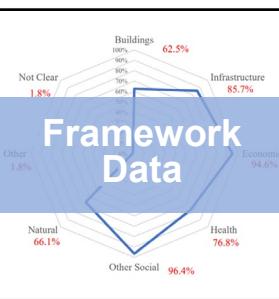
(Gu et al., 2023)

Resilience Outcomes for Validation Testing (under review)

(Gu et al., 2024)

Validating Existing Resilience Frameworks (in progress)

(Gu et al., 2024)

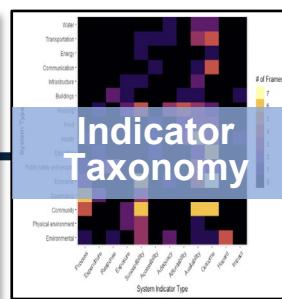


(Loerzel et al., 2021)

- In Progress
- Completed

Translational Validity

Content Validity (under review)



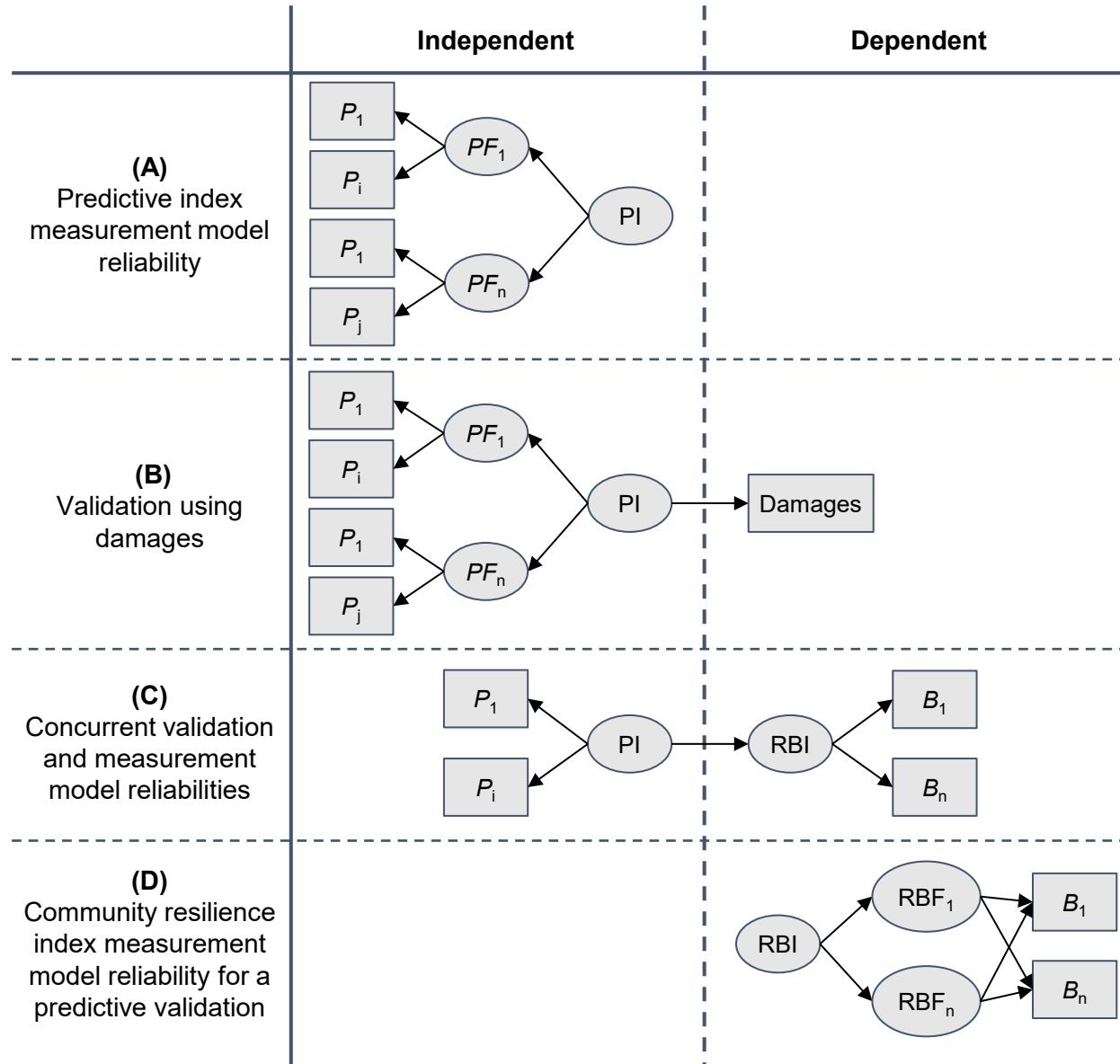
(Gerst et al., 2024)

Quality of Evidence (in progress)

(Gerst et al., 2024)

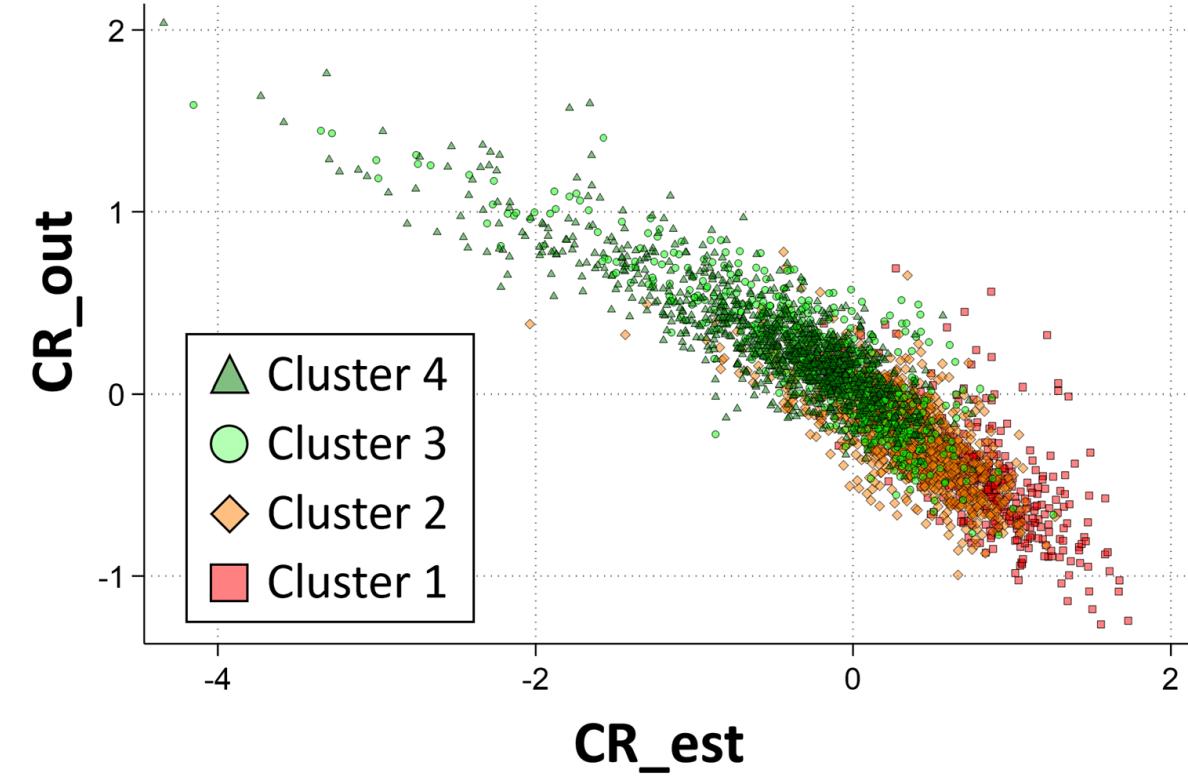
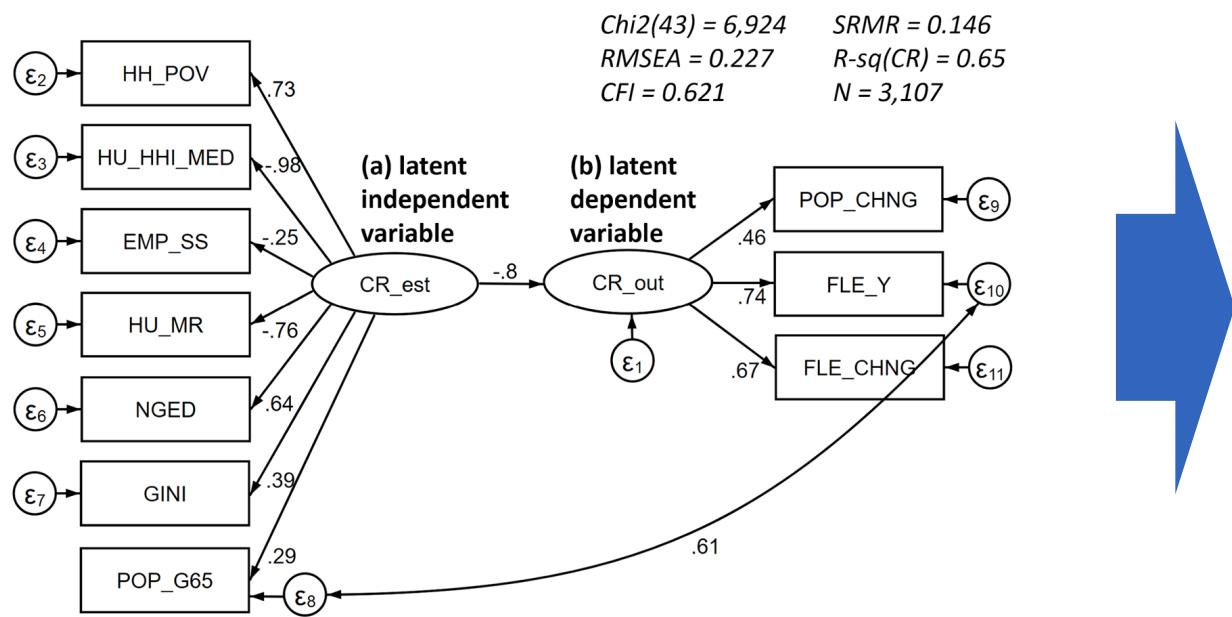
Indicator Validation Efforts

- 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

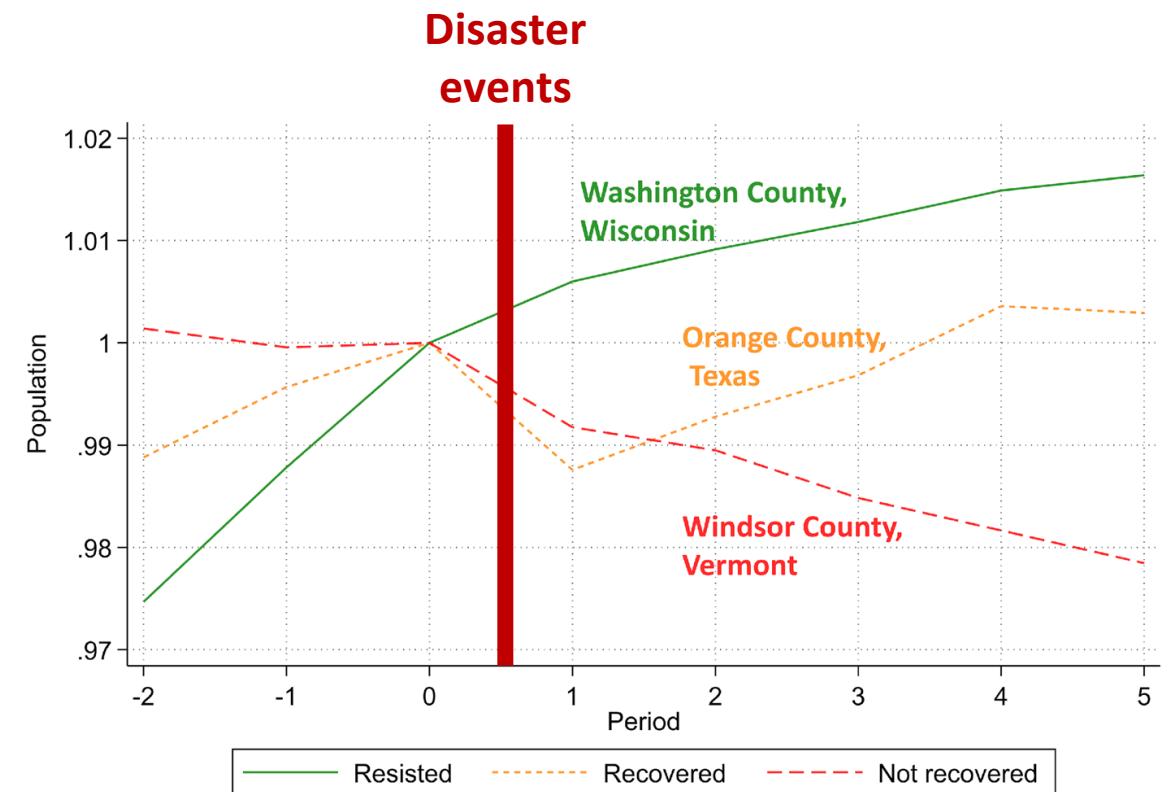


Outcome Indicators

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

Three categories

- Resisted
- Recovered
- Not recovered

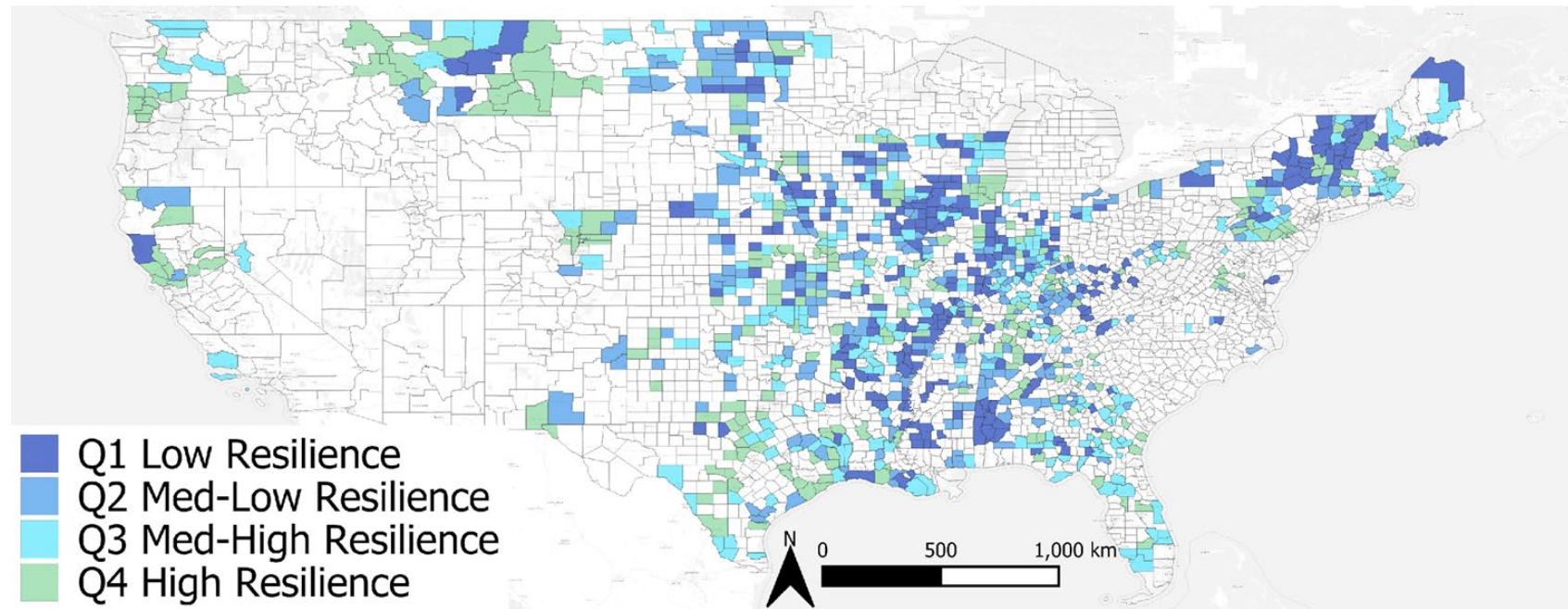


Outcome Indicators

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?

NIST

NIST

NIST RESEARCH LIBRARY

Search NIST



Menu

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?

NIST

The screenshot shows the NIST Data Discovery homepage. At the top, there is a search bar with the placeholder "Find Papers" and a dropdown menu showing "Search All Papers", "JRes NIST", and "NIST PubMed Central". Below the search bar, there is a section titled "Gallium" with a "Show Examples" button. The main content area features three "A Curated Collection" sections: "CHIPS METIS" (showing a person in a lab), "MANUFACTURING" (showing a digital interface for a "DIGITAL THREAD"), and "FORENSICS" (showing a person in a lab). Each collection has an upward arrow icon at the bottom right.

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

What's Next?

A screenshot of the Engineering With Nature (EWN) website. The header features the EWN logo (a stylized green and blue globe icon followed by the text "Engineering With Nature®") on the left, a search bar with the placeholder "Search..." on the right, and a green navigation bar with dropdown menus for "ABOUT", "NEWS", "PODCAST", "IMPLEMENTATION", "RESEARCH", "RESOURCES", "ENGAGEMENTS", and "NBS". Below the header, a dark blue banner displays the text "Signed: A New Memorandum Of Understanding With The National Institute Of Standards And Technology To Collaboratively Quantify Nature's Benefits For Human Well-Being" in white. At the bottom left of the banner, there is a "News" tag with a small green icon. The date "April 17, 2024" is also visible on the banner.

- 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