Operationalizing "Resilience"

a critical piece of the Sustainability Puzzle

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Future Earth

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RESILIENCE cuts across all Global Policy Frameworks for Sustainability and Human Security

But today is still not operational for policy and finance

TODAY's TALK

- What is resilience
- Why it is important
- Research & applications
- Opportunities to *operationalize resilience*

WHAT IS RESILIENCE?

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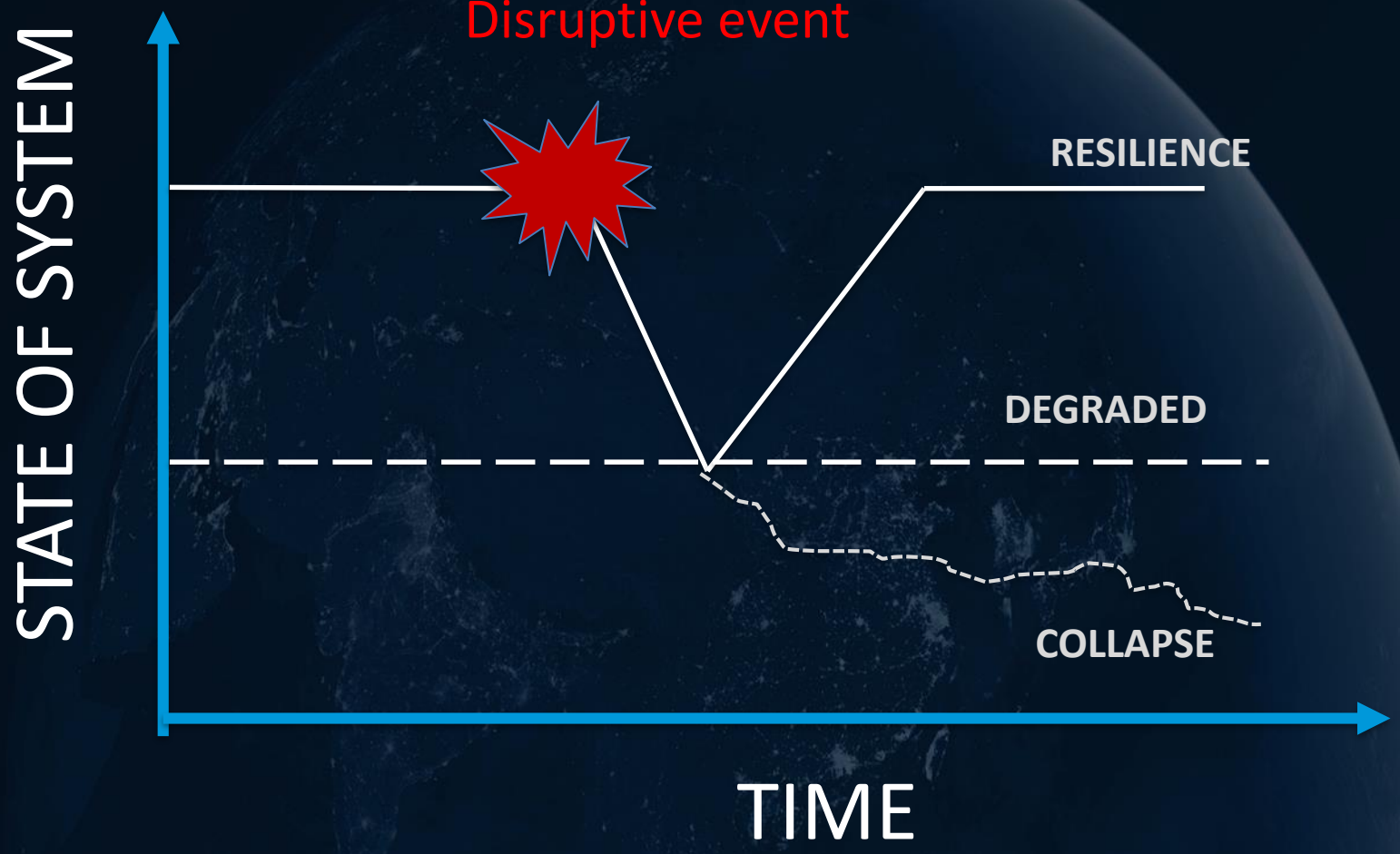
“Engineering Resilience”



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What is resilience?

The ability of a system to absorb or withstand perturbations and other stressors such that the system remains within the same regime, essentially maintaining its structure and functions.

-- Holling 1973

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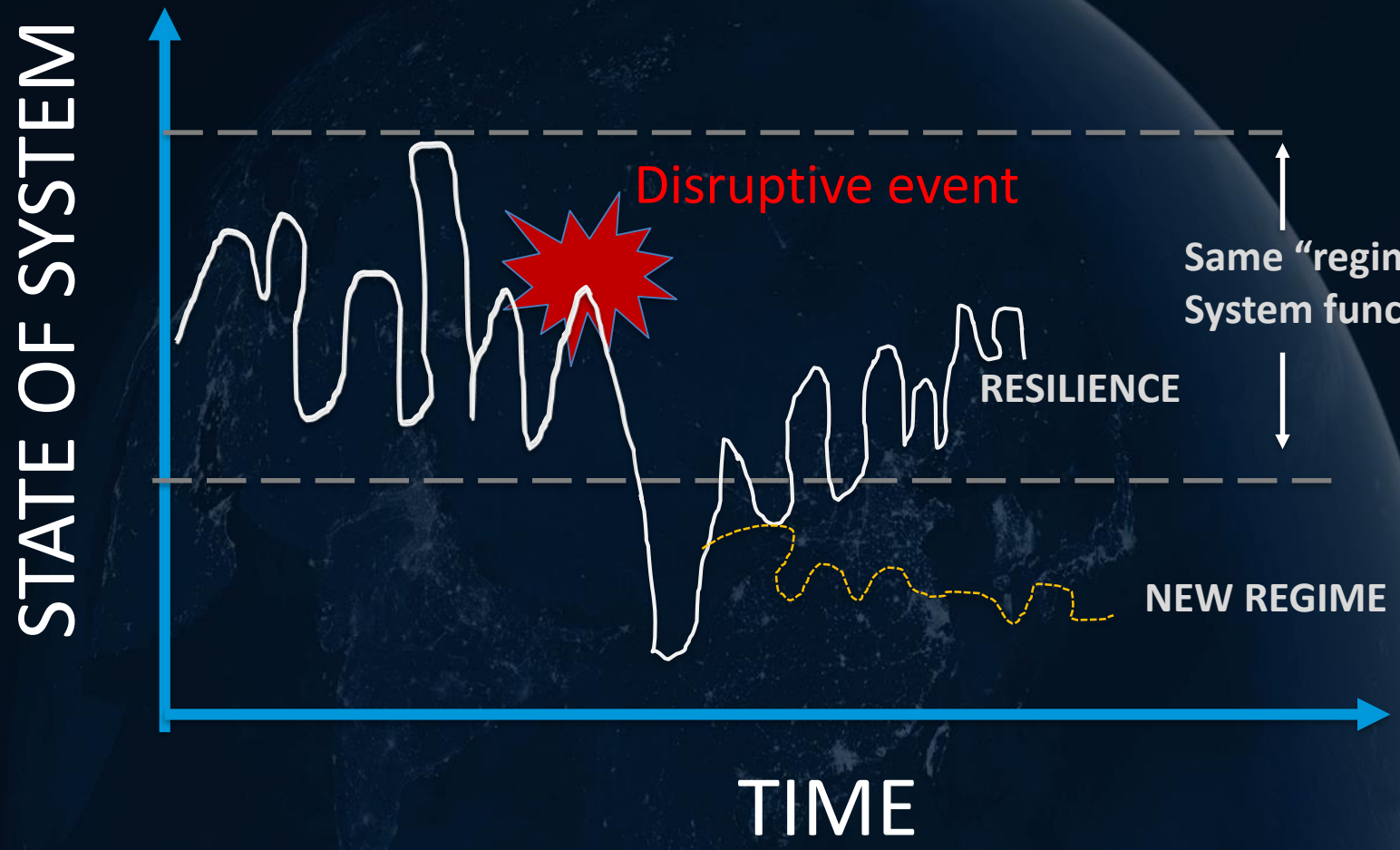
"Social-Ecological Resilience"



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REGIMES SHIFTS

REGIMES SHIFTS

Folke et al. 2004

Lots of Research on REGIMES SHIFTS

REGIME SHIFTS IN
SOCIAL-ECOLOGICAL SYSTEMS



Regime Shifts DataBase
Large persistent changes in ecosystem services

HOME WHAT IS A REGIME SHIFT? DATASETS & RESOURCES ADD DATA CONTRIBUTORS ABOUT REGISTER LOGIN

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Quick Search
Regime Shift

PNAS
Proceedings of the National Academy of Sciences of the United States of America

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Format: Abstract

Proc Natl Acad Sci U S A. 2016 Dec 20;113(51):14560-14567. doi: 10.1073/pnas.1604978113. Epub 2016 Nov 4.

Early warning signals of regime shifts in coupled human-environment systems.

Bauch CT[1], Sigdel R[2], Pharaon J[3], Anand M[4].

Author information

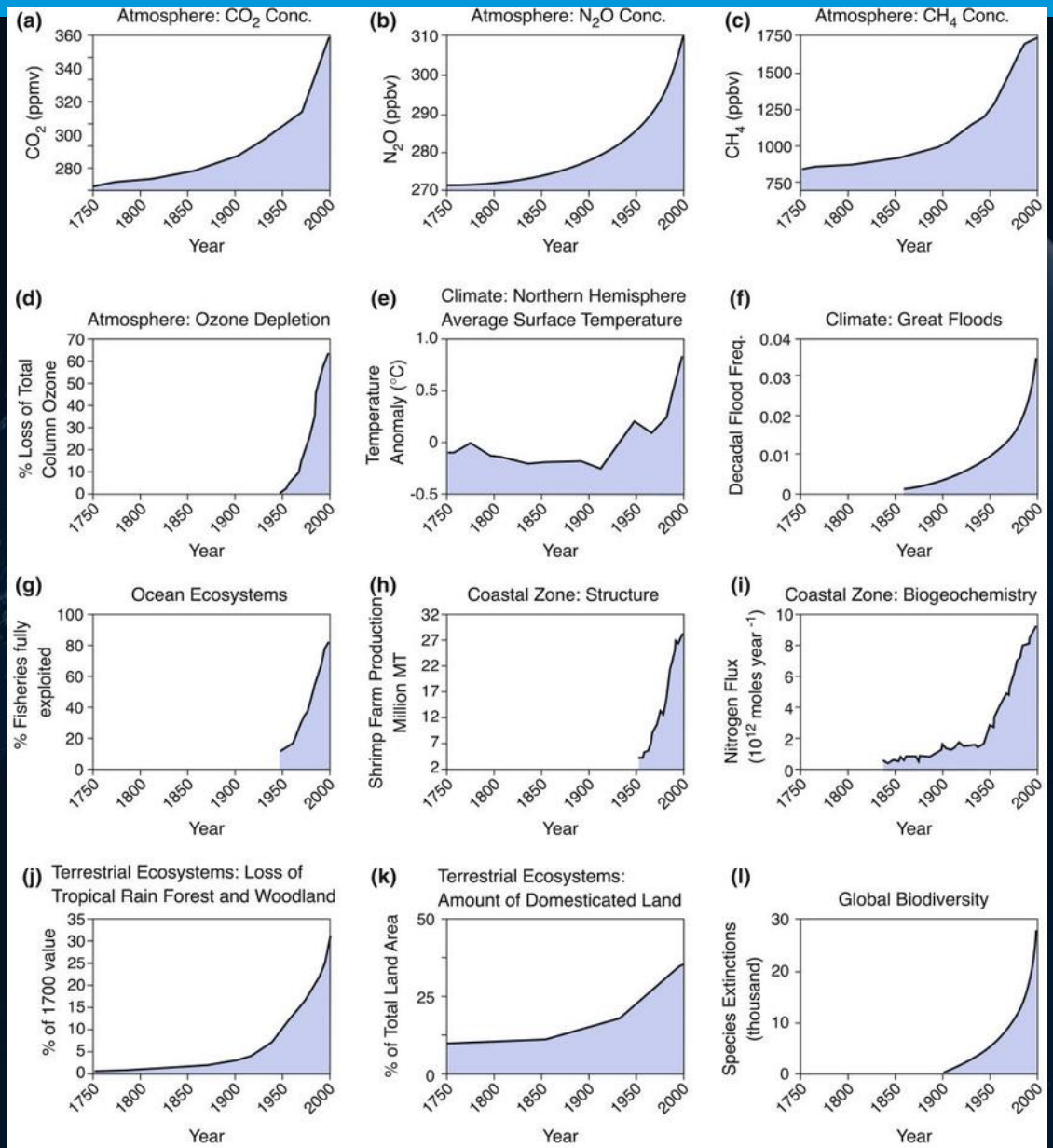
Abstract

In complex systems, a critical transition is a shift in a system's dynamical regime from its current state to a strongly contr
external conditions move beyond a tipping point. These transitions are often preceded by characteristic early warning sig
increased system variability. However, early warning signals in complex, coupled human-environment systems (HESs) re
Here, we compare critical transitions and their early warning signals in a coupled HES model to an equivalent environme

WHY IS RESILIENCE IMPORTANT?

How to

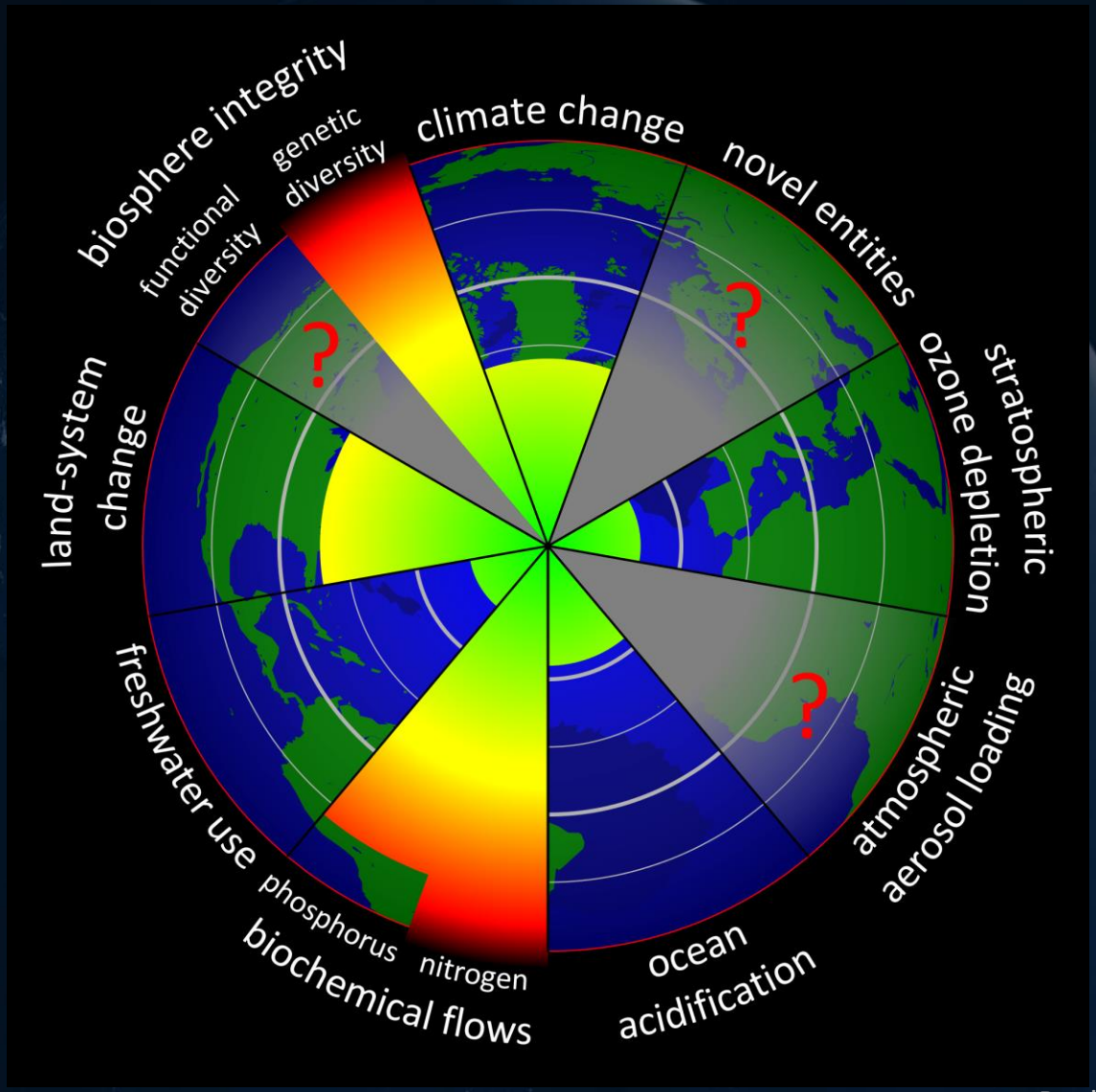
Facing the Great Acceleration



How to

Steffen et al. 2007

To avoid planetary regime shifts



How to

Roskcstrom et al. 2009

NOW FACE MASSIVE GLOBAL CHALLENGES

BY 2050 …

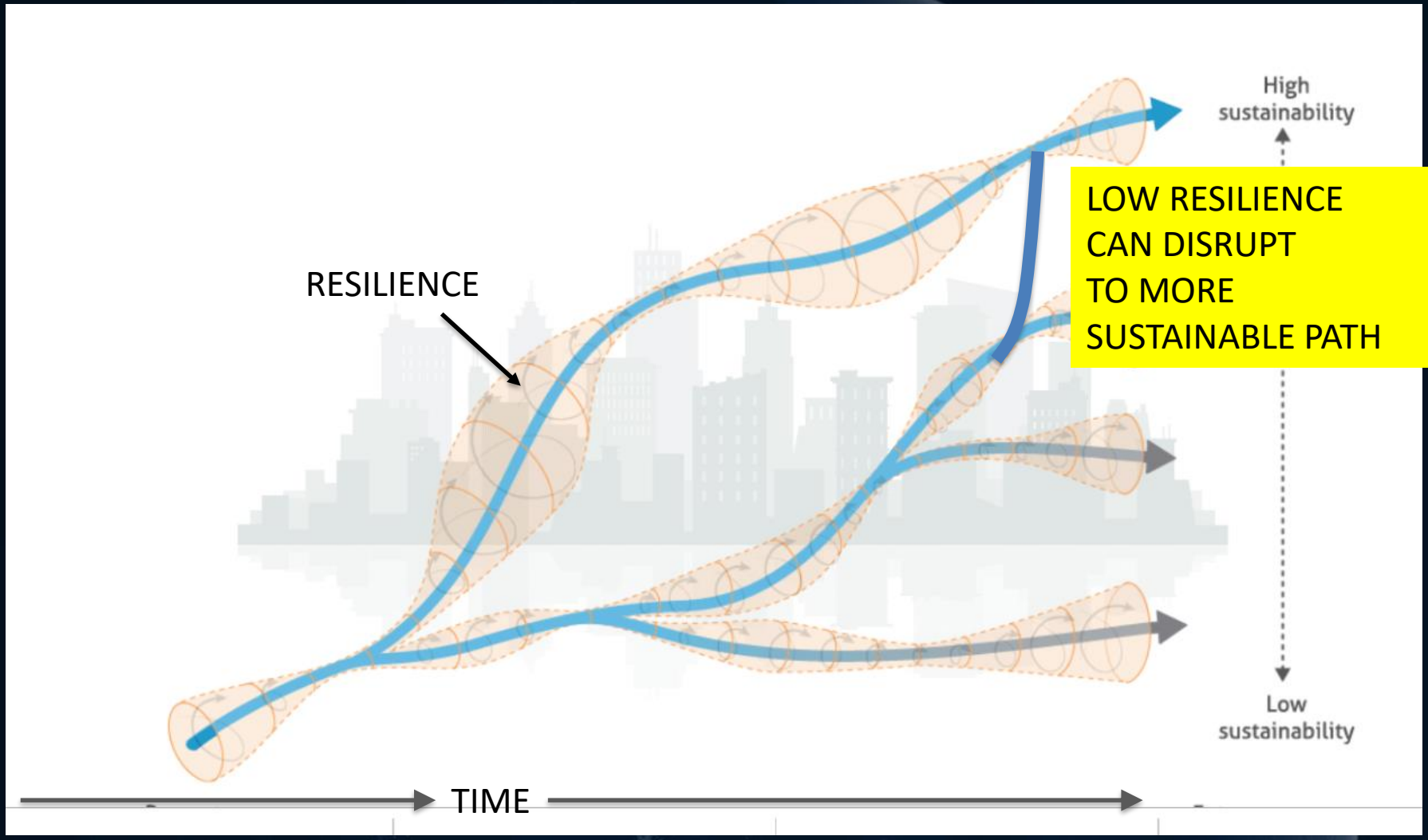
Population will grow as much as 30%, with triple GDP.

Need to grow more food than we have in past 10,000.

Need to bring modern energy services to 1-2 billion more people

ALL WITH LESS RELIABLE WATER,
DECREASINGLY AVAILABLE LAND,
PRESERVING BIODIVERSITY,
W/ NET-ZERO CAROBN EMISSION BY 2050

Resilience and Sustainability



Elmquist et al. *Nature Sustainability* 2019

RESILIENCE cuts across all Global Policy Frameworks for Sustainability and Human Security

Sendai Framework for Disaster Risk Reduction

2015 - 2030

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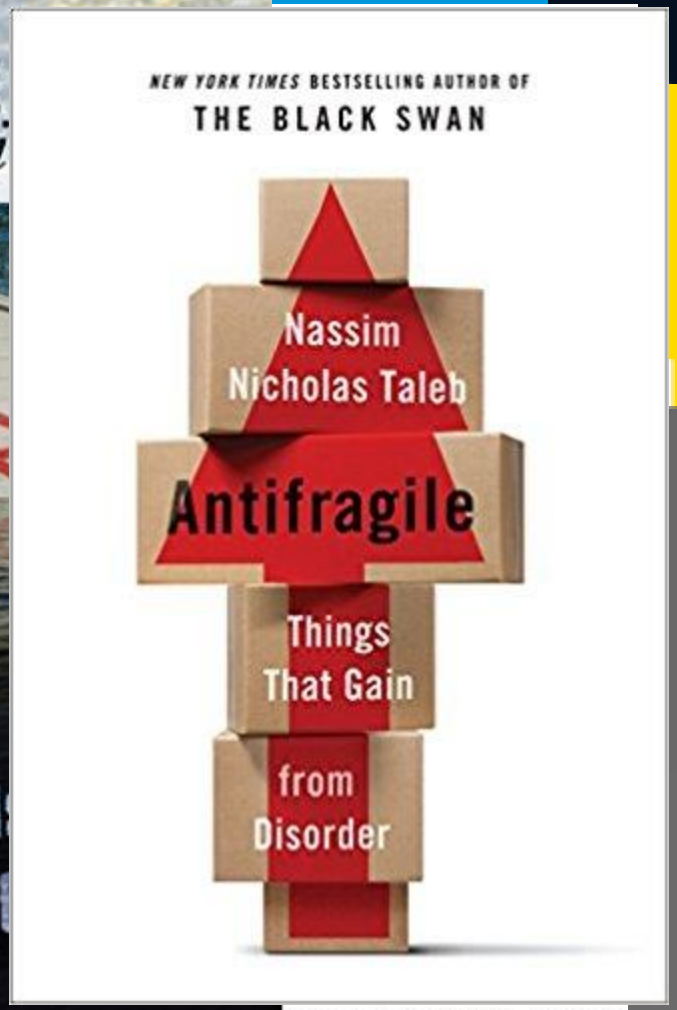
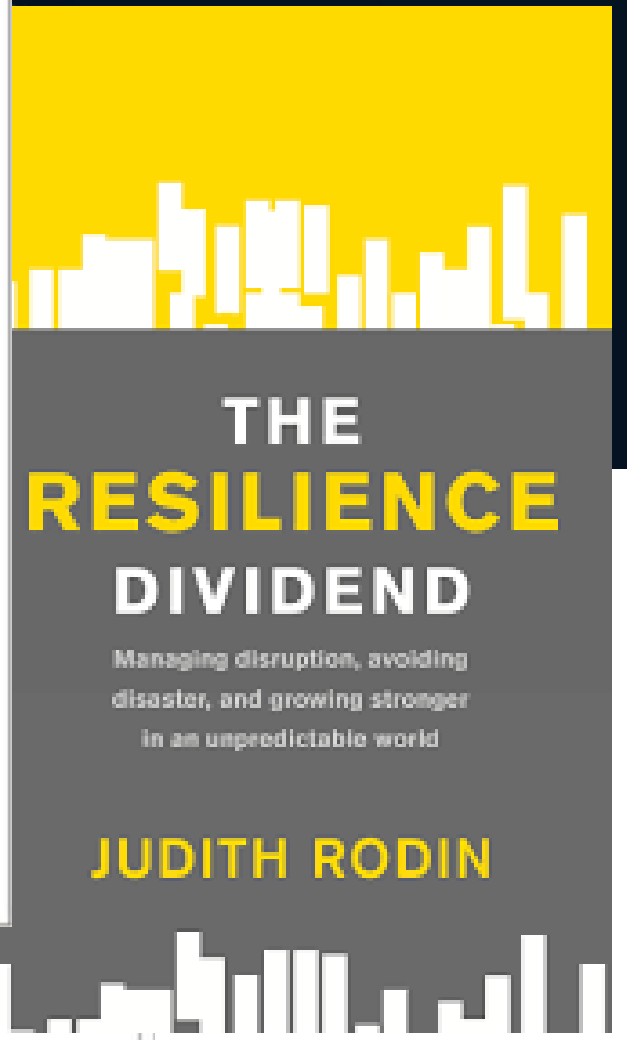
RESEARCH TO DATE





What Makes Human-Environmental Systems Resilience

Regenerative Capacity

Adaptive

How to

Sensing Emerging Risks

Maintain Diversity

Experimentation

Learning

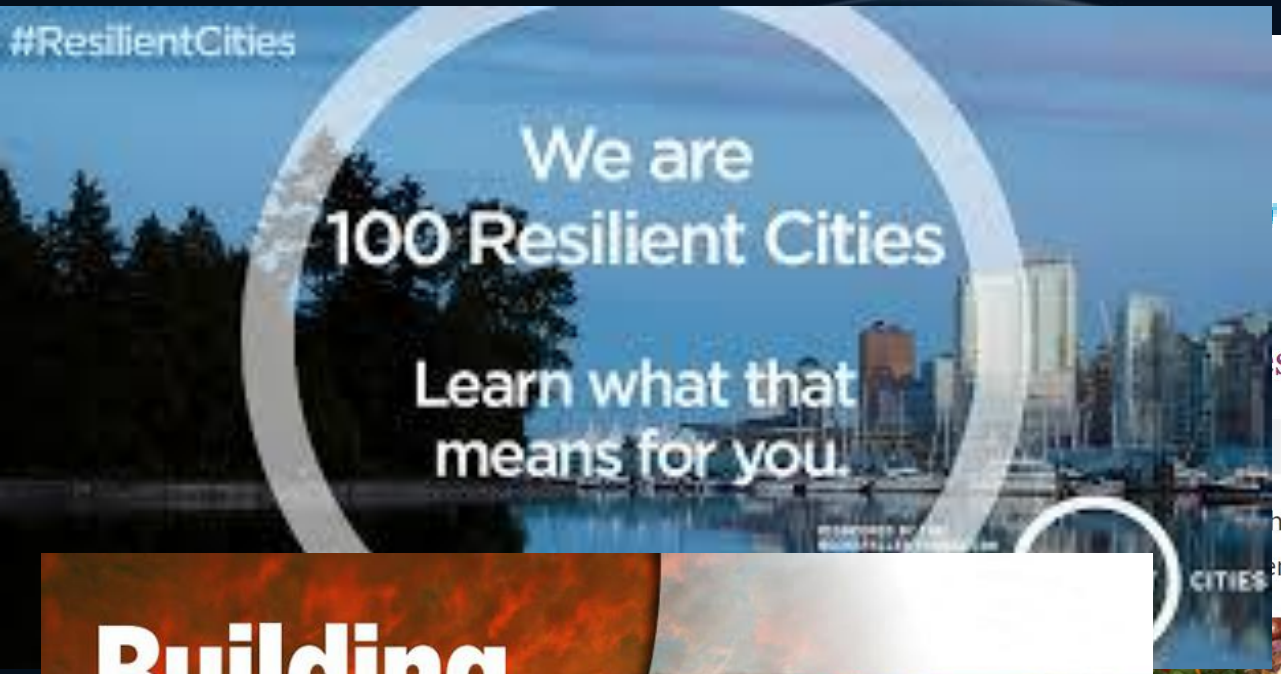
Manage Slow changing Variable

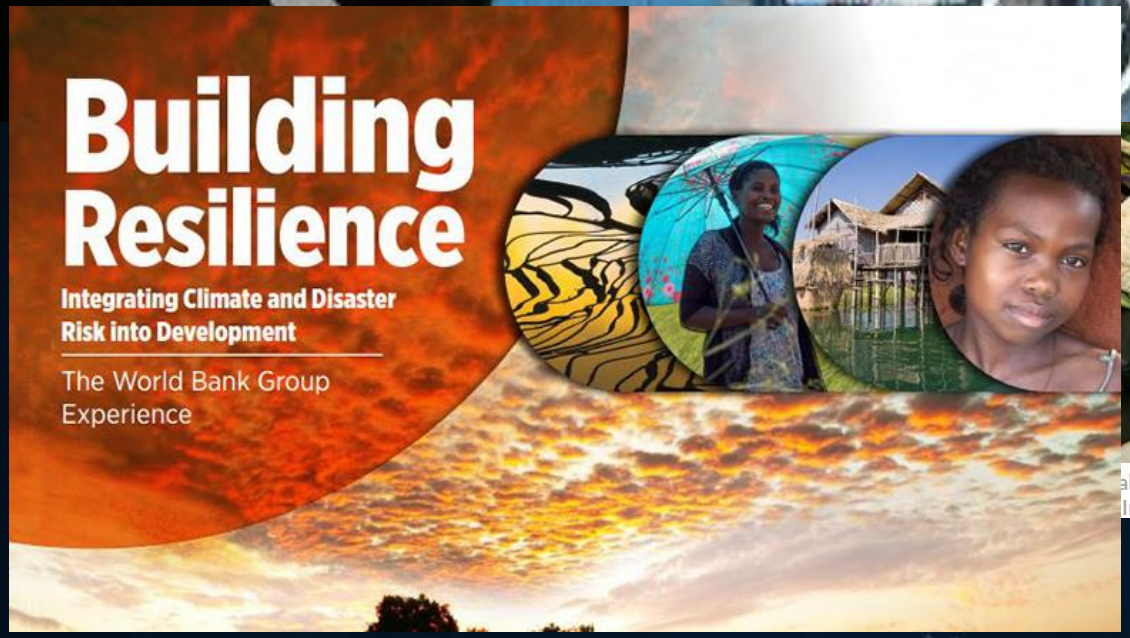
Polycentric Governance

Manage Connectivity

Feedbacks

HOW RESILIENCE RESEARCH IS USED…





International Institute
for Environment
and Development

silient food systems

he capacity of local organisations and institutions
nt food systems and sustaining local food systems.

l biodiversity on show at a family market stall in Puno, Peru. Photo:
International/A. Camacho

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BUT NOT YET OPERATIONAL AT SCALE…

Answers essential
to implement policies & unleash investments

"You can't manage what you can't measure"
-- Peter Drucker

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Resilience:
Does not have metrics to scale action.

Article 7 of the Paris Agreement

Global Goal *"of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change."*

- What defines a resilient, vulnerable, and adaptive capacity of a place?
- How do we, can we measure progress toward achieving this goal?

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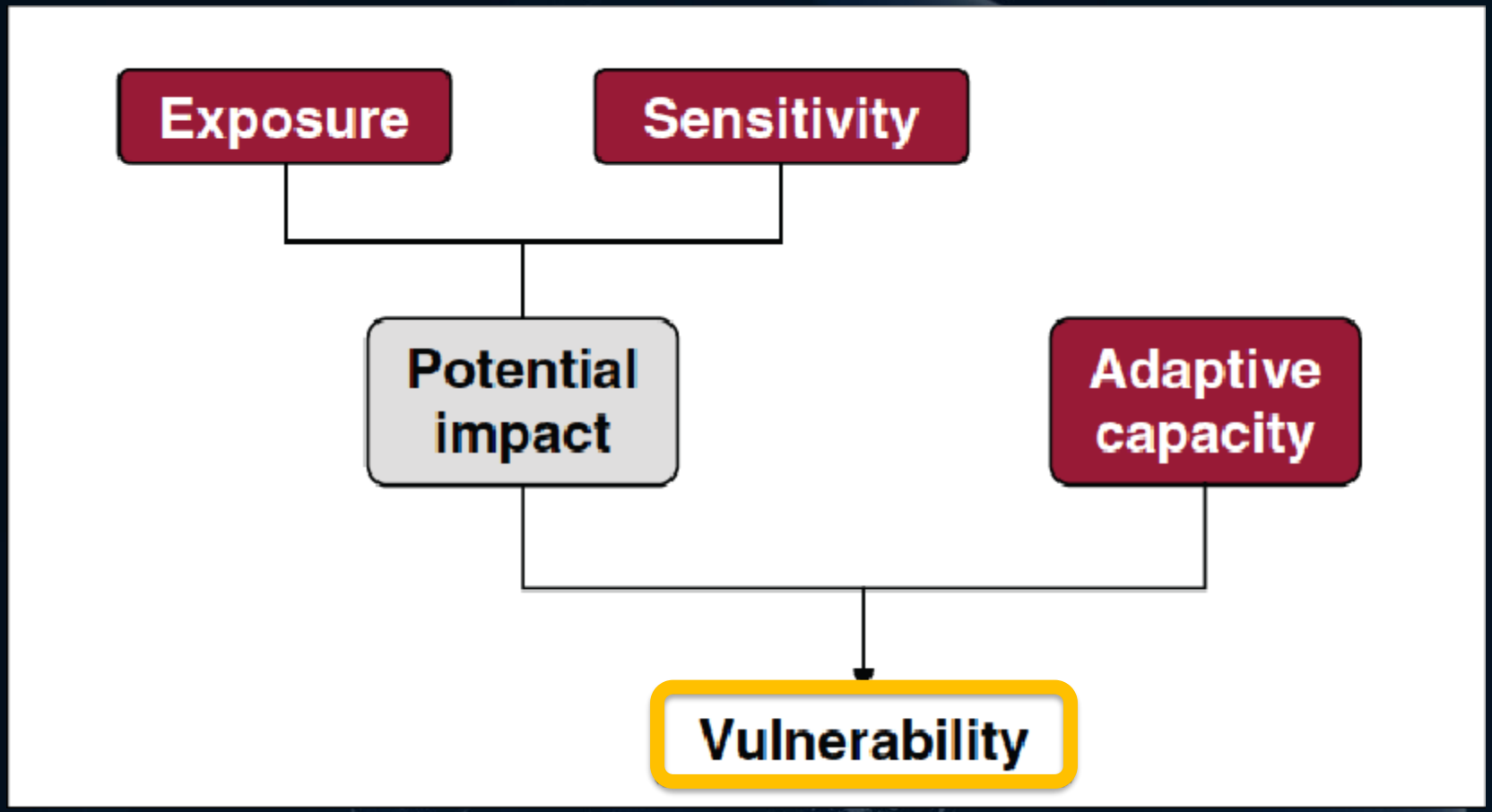
Related Concept: Vulnerability



COMMONLY USED CONCEPTS IN THE IPCC

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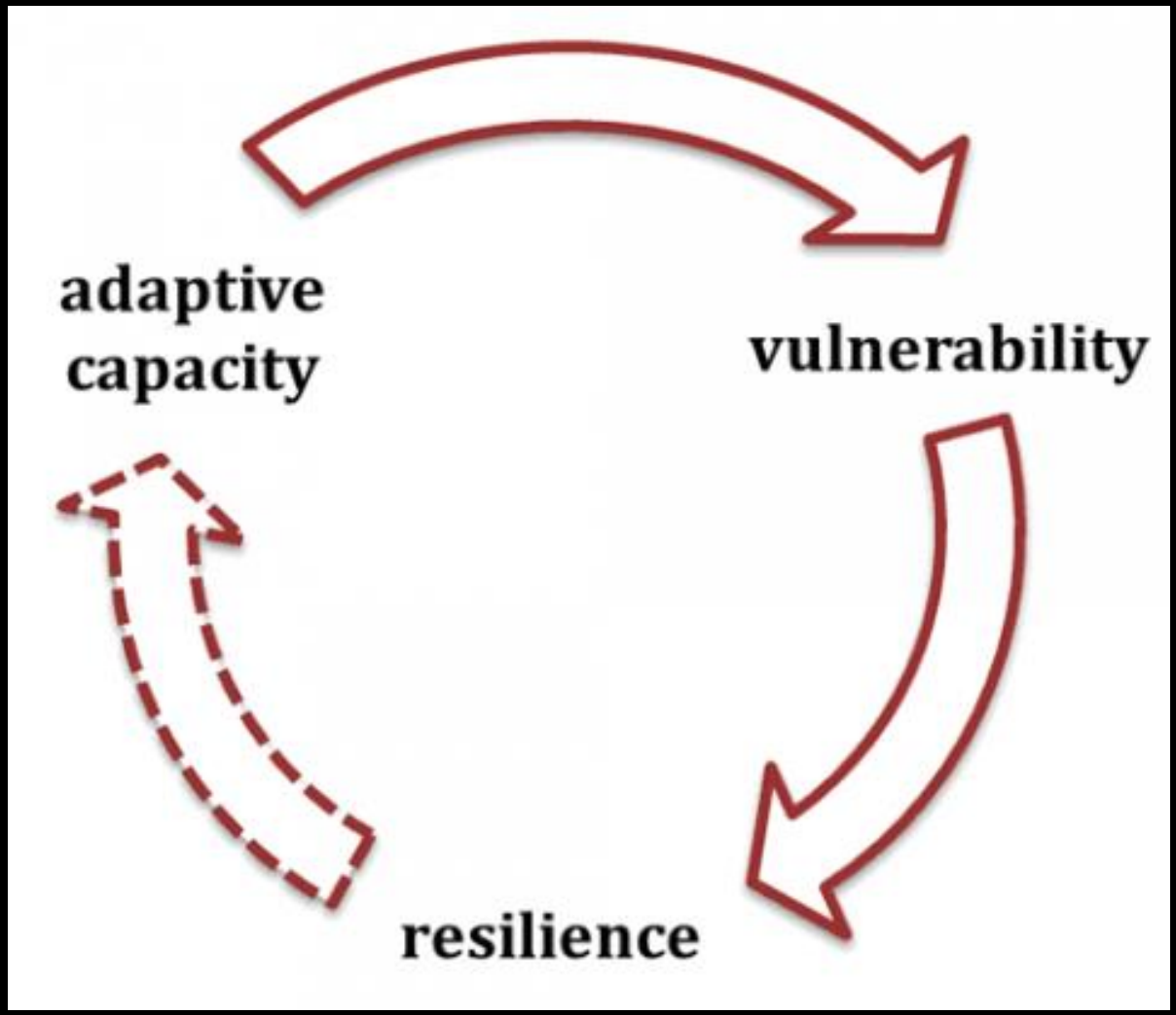
INTER-RELATED CONCEPTS



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METRICS CRITICAL
EVEN IF THEY ARE NOT PERFECT

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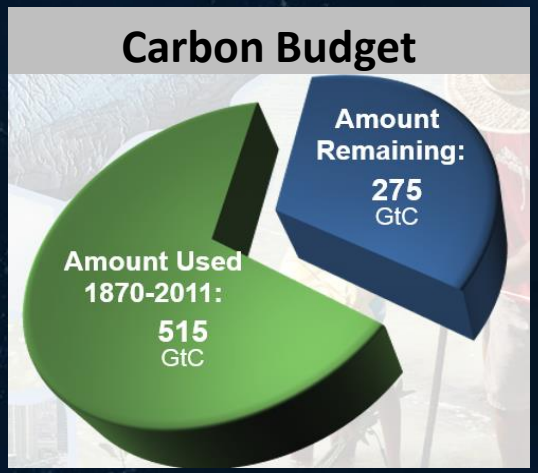
Mitigation:
Quantitative metrics helped to scale action.

*"Avoid **dangerous anthropogenic interference** with the climate system".* *-UNFCCC 1992*

What is dangerous?
And how do we track progress to this goal?



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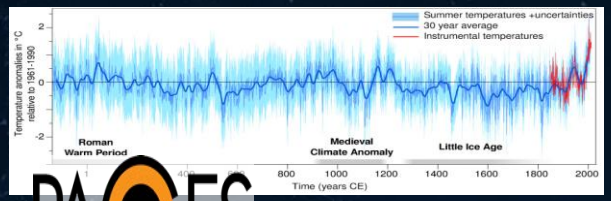
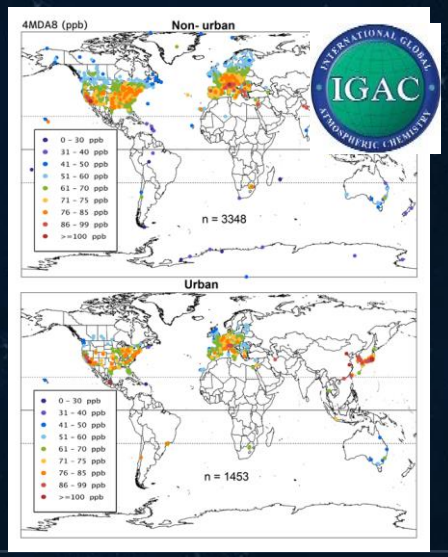
30 years of collaboration in global change research lay the groundwork for policy frameworks

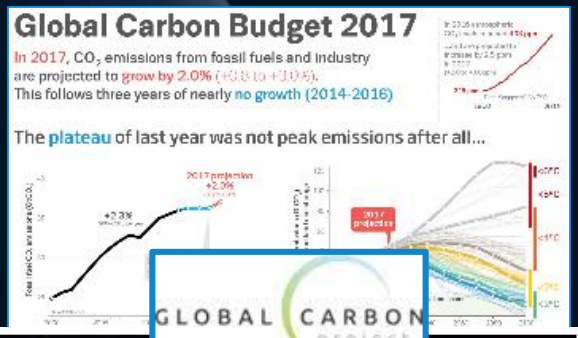


PAGES
PAST GLOBAL CHANGES

AIMES



Earth System Governance
People, Places, and the Planet



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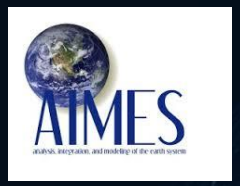
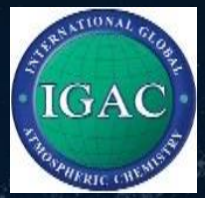
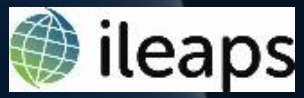
30 years of collaboration in global change research lay the groundwork for policy frameworks & metric







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BUT STILL DON'T HAVE
RESILIENCE METRICS THAT ARE
- EFFECTIVE IN MULTIPLE PLACES
--GENERALIZABLE
-- GLOBALLY TRACKABLE

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METRICS: To scale investment and actions

Global Goal *"of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change."*

We need METRICS to track progress that are:

- Place based
- Generalizable
- Globally trackable

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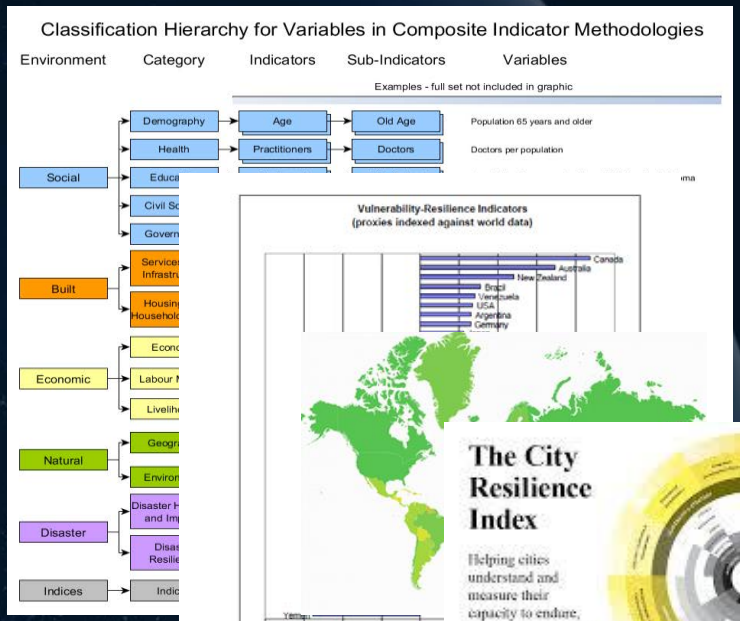
Existing Metric are all theory based not data based, and thus not effectively generalizable

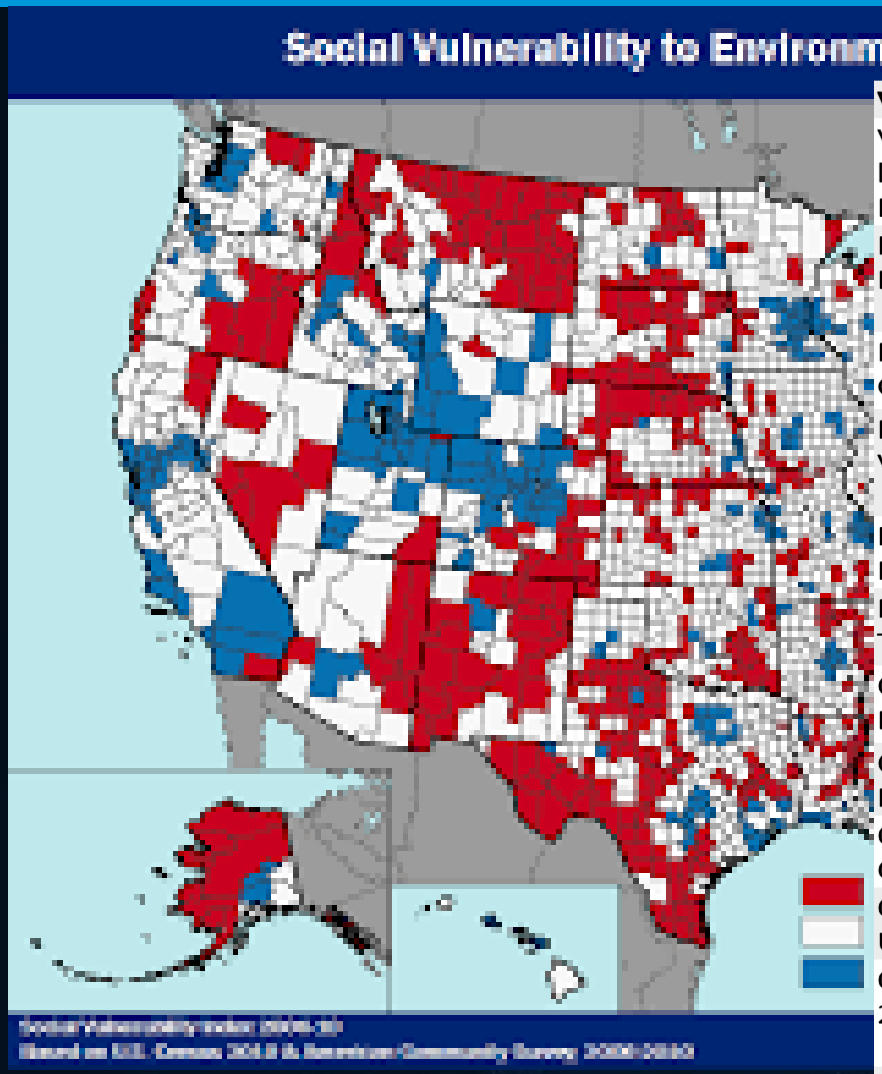
Proxy Indicators
determinants of Resilience

Place-based



One-size fits all

Related Issue Social Vulnerability



CENSUS DATA

Variables Used in SoVI®	
Variable Name	Description
MDGRENT	Median gross rent for for renter-occupied housing units
MEDAGE	Median age
MHSEVAL	Median dollar value of owner-occupied housing units
PERCAP	Per capita income
PPUNIT	Average number of people per household
QAGEDEP	% Population under 5 years or age 65 and over
QASIAN	% Asian population
QBLACK	% African American (Black) population
QCVLUN	% Civilian labor force unemployed
QED12LES	% Population over 25 with less than 12 years of education
QESL	% Population speaking English as a second language with limited English proficiency
QEXT	% Employment in extractive
QHISP	% Hispanic population
QMOHO	% Population living in mobile homes
QNATAM	% Native American population
QNOAUTO	% Housing units with no car available
QNRRES	% Population living in nursing facilities
QPOVTY	% Persons living in poverty
QRENTER	% Renter-occupied housing units
QRICH200K	% Families earning more than $200,000 per year
QSERV	% Employment in service occupations
QSSBEN	% Households receiving Social Security benefits
QUNOCCHU	% Unoccupied housing units
QNOHLTH	% population without health insurance (**COUNTY SoVI® ONLY**)
HOSPTPC	Community hospitals per capita (**COUNTY SoVI® ONLY**)

•Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards.

People & Pixels to scale from bottom up

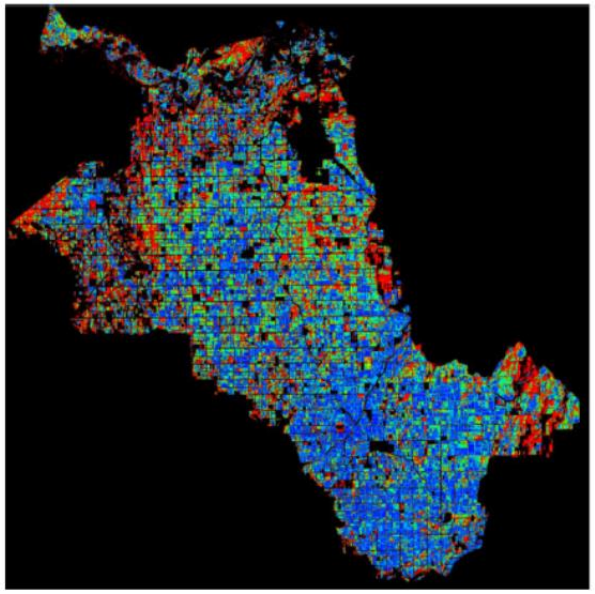


Fig. 3. Vulnerability, Yaqui Valley irrigation district. The most vulnerable are shown in red and the least vulnerable in dark blue.

V = Expected Value
(sensitivity/state relative to a threshold),

$$V = \int \left(\frac{|\partial W / \partial X|}{W / W_0} \right) P_X \, dX,$$

Yaqui Valley

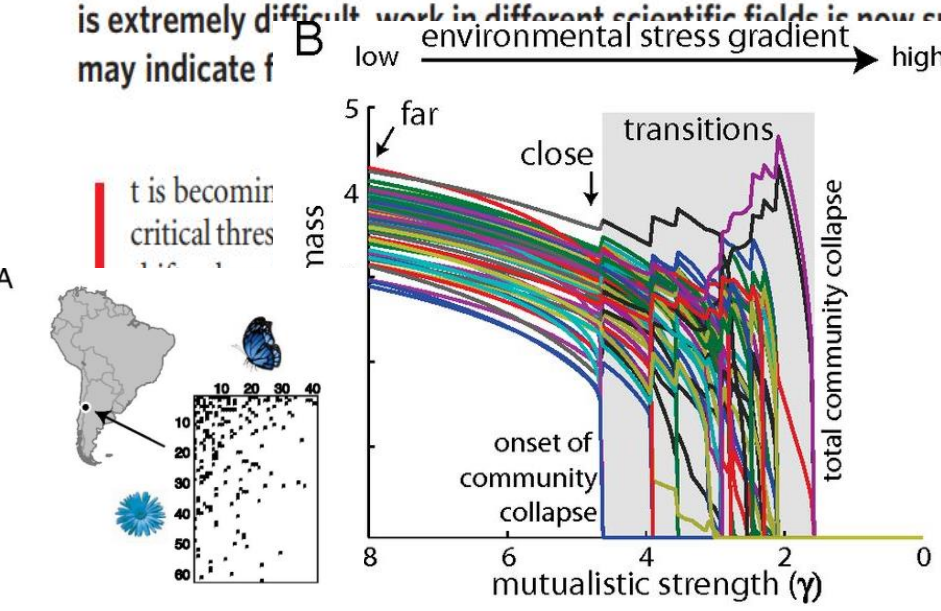
Generalizable
Place-based

Early-warning signals for critical transitions

Marten Scheffer[1], Jordi Bascompte[2], William A. Brock[3], Victor Brovkin[5], Stephen R. Carpenter[4], Vasilis Dakos[1], Hermann Held[6], Egbert H. van Nes[1], Max Rietkerk[7] & George Sugihara[8]

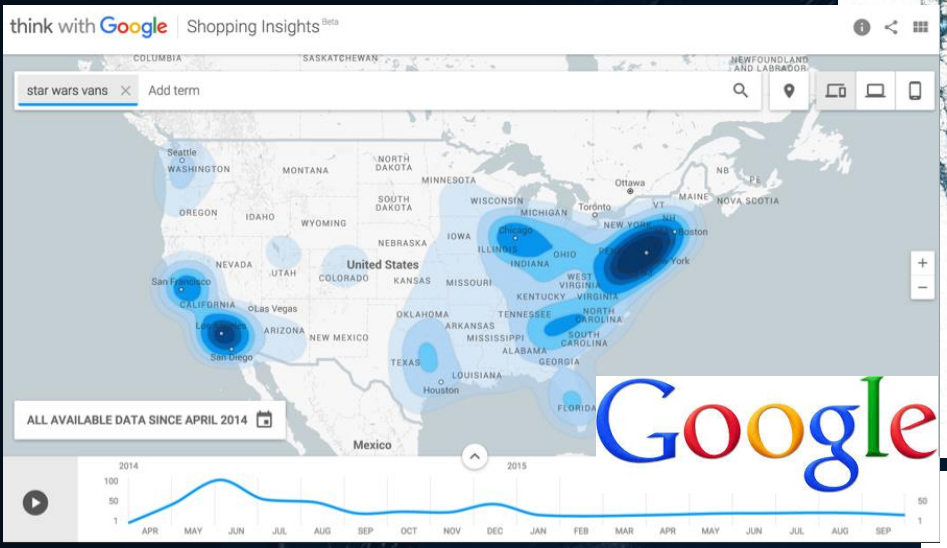
Complex dynamical systems, ranging from ecosystems to financial markets and the climate, can have tipping points at which a sudden shift to a contrasting dynamical regime may occur. Although predicting such critical points before they are reached is extremely difficult, work in different scientific fields is now suggesting the existence of generic early-warning signals that may indicate f

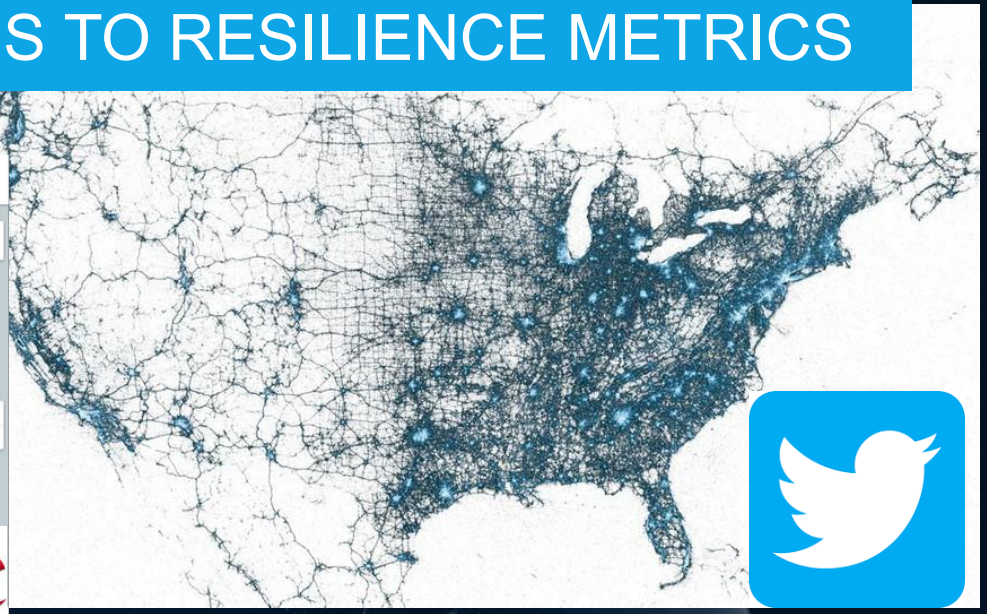
t is becomir
critical thres



NEW DATA & ANALYSTICS →

Open up NEW APPROACHES TO RESILIENCE METRICS





Popular times

Tuesdays

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9a 12p 3p

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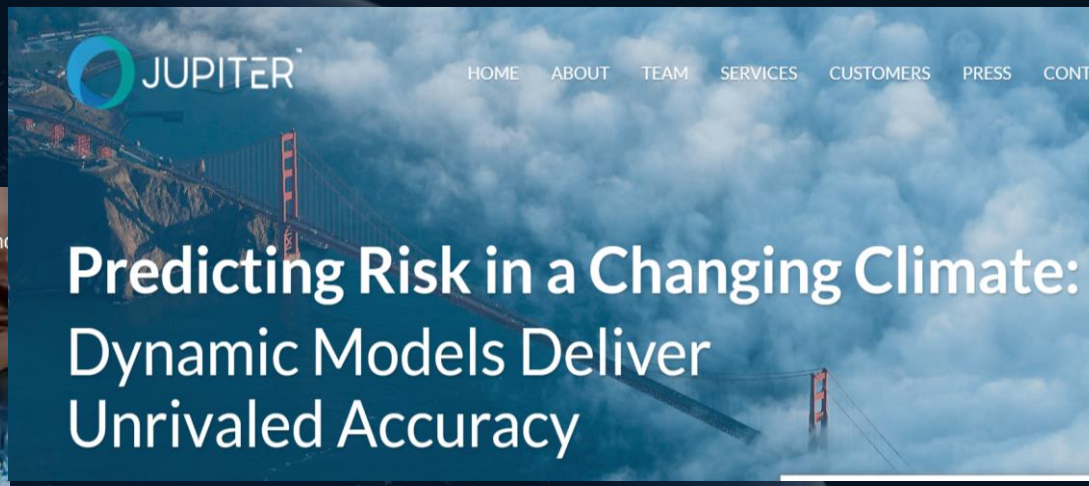
AI for Earth

Microsoft

NEW DATA & ANALYSTICS →

Data and pattern-based approached to complement theory



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We need a focused transdisciplinary research-based approach for resilience metrics

Place based
Generalizable
Globally trackable
Which requires a data analytics approach

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How to operationalize resilience to scale?

A DATA-BASED, TRANSDISCIPLINARY APPROACH

The data and the theory are now there to scale
we just need to work together
to make it happen

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Sustainability in the Digital Age

BIG DATA, PATTERNS, SCALE

THEORY, SMALL DATA, PLACE-BACED

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Thank you!