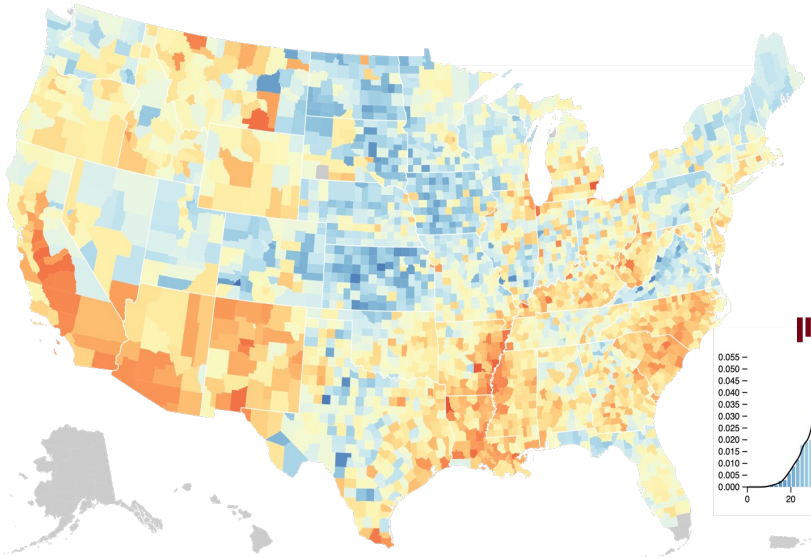
# Compounding and Intersecting Landscapes of Physical and Societal Impacts

Adam Schlosser, MIT CS3

Triage & “Hotspot” Mapping



STRESS

System Triage Risks Environmental Socioeconomic Stressors

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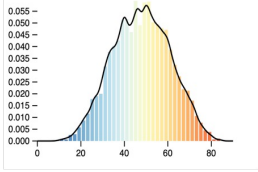
Center for Sustainability Science and Strategy




HAQAST Workshop, St. Louis, MO, November 6, 2025

# The MIT Center for Sustainability Science and Strategy (CS3)
# Who we are… Where we came from


**Our research advances fundamental understanding of the interconnected physical and socio-economic systems that impact human well-being.**

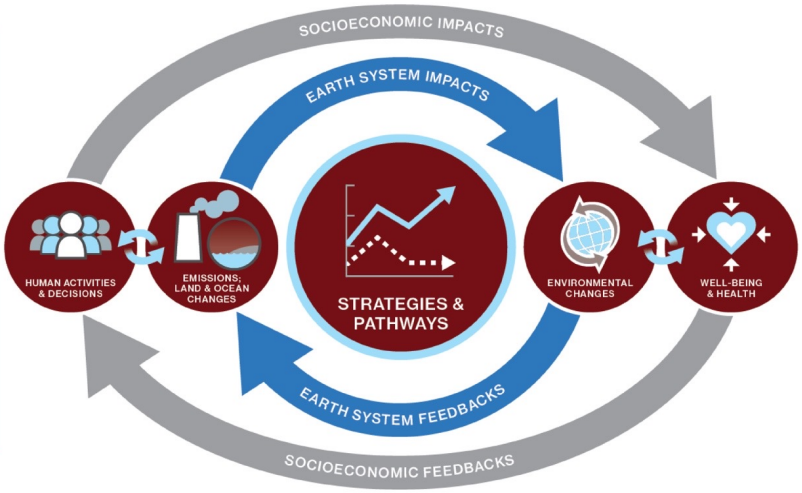
*"Ensuring human well-being for present and future generations is the primary challenge of sustainable development."*

—Noelle Selin, CS3 Director

## CS3 Research

- Global Change Outlook
- Linking sustainability & human health outcomes
- Multi-sector dynamics and risk analysis
- The value of $CO_2$ removal in delivering the Paris Agreement's 1.5–2°C objectives
- Preparing for a new world of weather and climate extremes

More details at cs3.mit.edu.




## CS3 Leadership

**Noelle Selin**
Director

**Anne Slinn**
Executive Director

**Sergey Paltsev**
Deputy Director

**C. Adam Schlosser**
Deputy Director

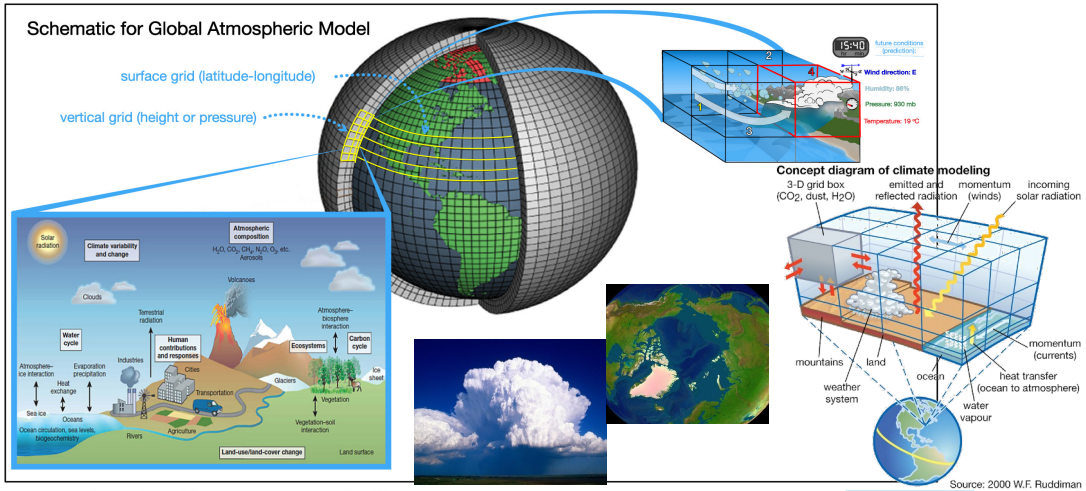
**Contact: Darby Kirven, Development Officer** andarbs7@mit.edu 207-245-8278

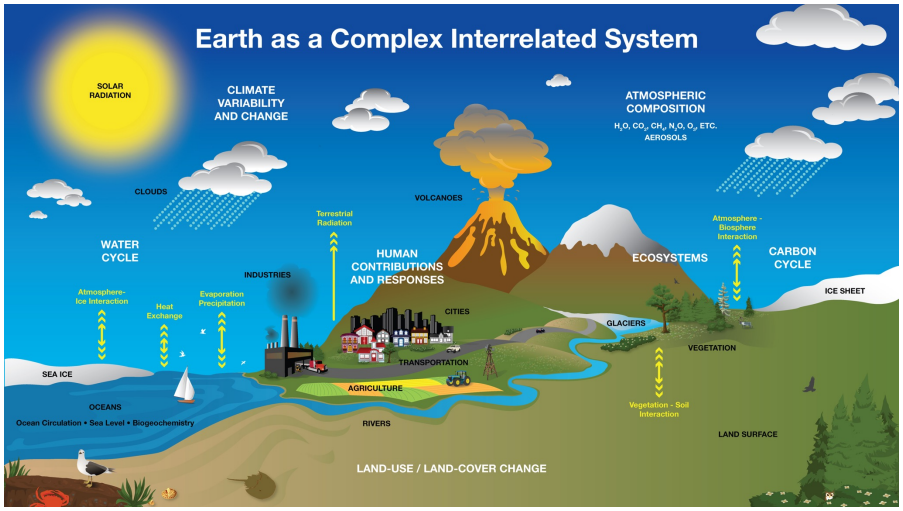
*With thanks to Prof. Ron Prinn, EAPS, for his foundational leadership of CGCS and the Joint Program, and to former co-directors of the Joint Program Prof. Henry (Jake) Jacoby and Dr. John Reilly*

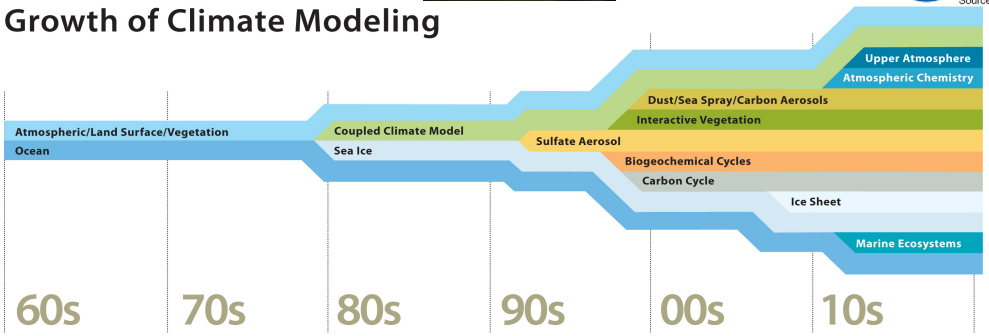
MIT CENTER FOR GLOBAL CHANGE SCIENCE

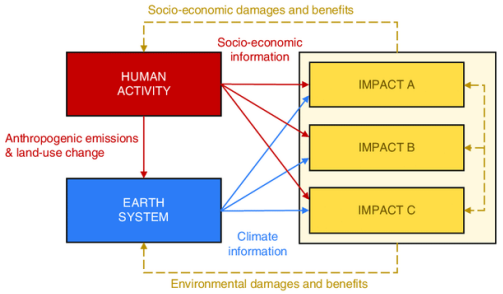
MIT JOINT PROGRAM ON THE SCIENCE AND POLICY of GLOBAL CHANGE

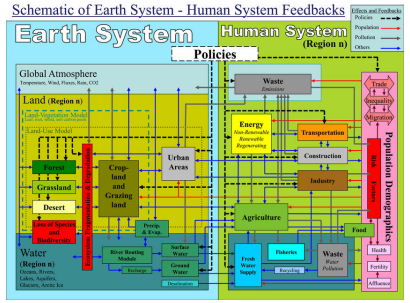
# Earth and Human Systems Models: Prediction Challenge




**As processes, system representations as well as space/time increments more explicit and detailed** → **Demands for capacity, speed, storage and efficiency of compute and data systems increase (non-linearly)**

**Need for Triage-Based Screening Tools to Prioritize Assessments and Support Action**

# Risk Triage Approach and Combinatory Metrics

**Triage:** Assign priority-actions based on where resources can be best used, most needed, or likely achieve success.

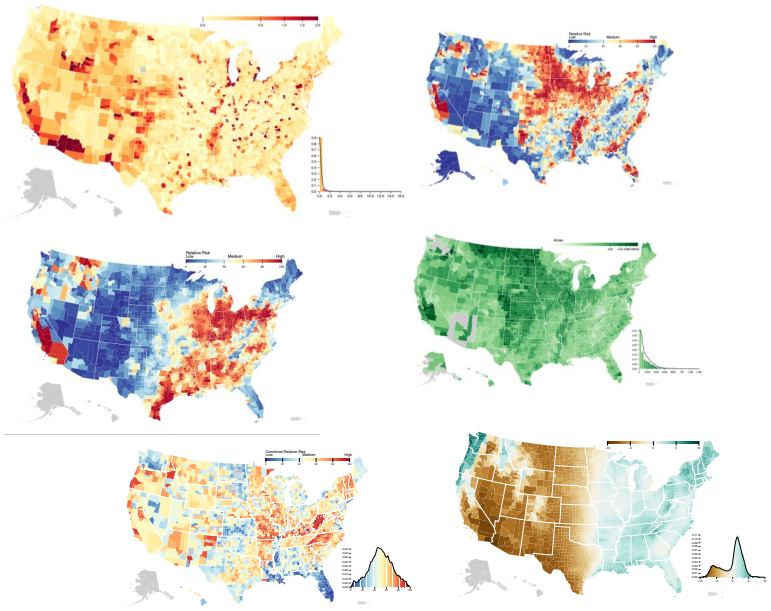
Use-inspired to assess and combine multiple indices

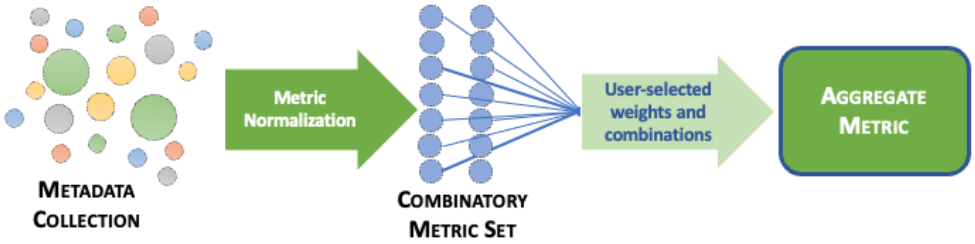
Flexible, open-science, open-source platform

Stage 1: Assess current stressors and vulnerabilities

- Over 100 variables collected, constructed, and quality-controlled at county level
- Quantify conditions of water-land-energy resources, economics, climate, demographics, air quality, health
- Infrastructure overlays: Highways, railways, waterways, transmission lines, critical habitats, endangered species
- Combinatory metrics: Currently 25 metrics (physical, economic, and socio-demographic risks)
- Software Engineering: Flexible "backend" design provides use-inspired augments to platform database.

***What are the resulting landscapes of combined social and environmental threats?***

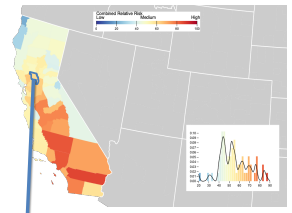




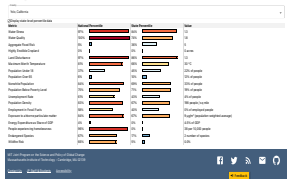
# System for the Triage of Risk from Environmental and Socioeconomic Stressors (STRESS) Data-Visualization Platform

## Examples of STRESS Platform Data-Visualization Capabilities

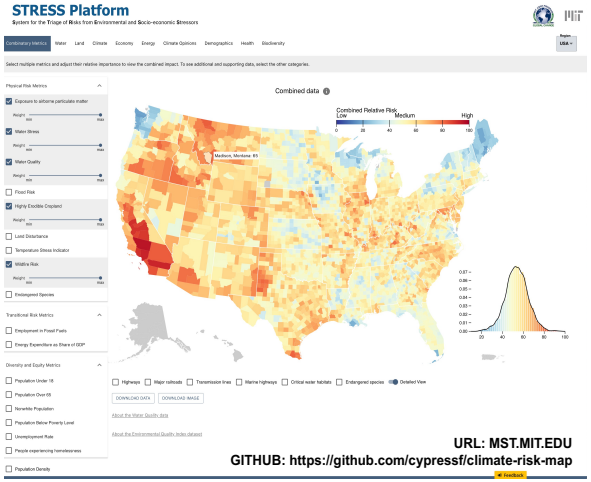
### State-Based Close-Up



### County-by-County "Report Card"



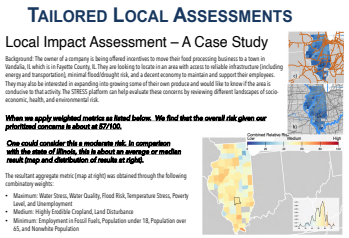
### STRESS Platform



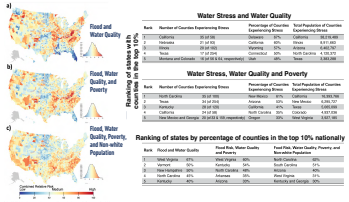
URL: MST.MIT.EDU

GITHUB: https://github.com/cypressf/climate-risk-map

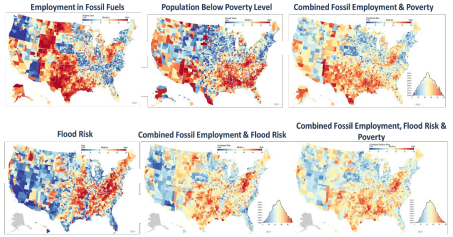
### Tailored Local Assessments




### Intersection of Stressors and Equity

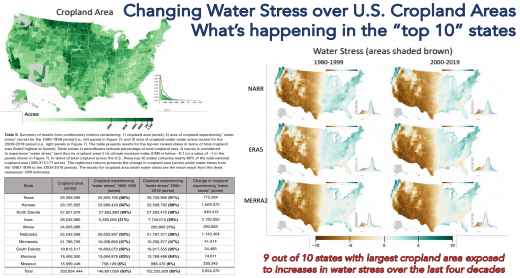


### Physical and Transition Risk Combinations




High poverty rate and fossil employment have potential for significant job loss with a transition away from fossil fuel use and vulnerable to environmental risks. Areas facing high physical risks (i.e., flooding) need detailed assessments for protective measures.

### Data Download and Multi-Metric Analyses




The STRESS platform currently provides several visual and user-inspired features:

- Growing collection of over 100 variables
- Subset of combinatory metrics that allow user-inspired, interactive combinations.
- Risk "report card" for any selected U.S. county
- Downloadable data & maps for tailored analyses
- Open-science, open-source philosophy and software design.
- **More to come!** Future scenarios & sub-county maps

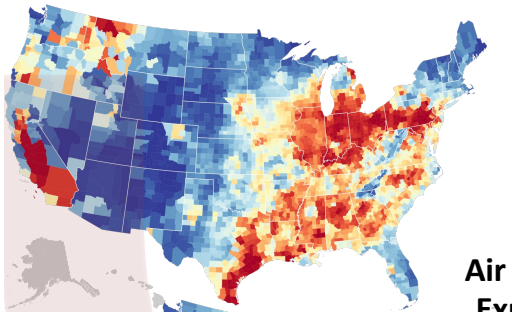

Schlosser, C. Adam, C. Frankenfeld, S. Eastham, X. Gao, A. Gurgel, A. McCluskey, J. Morris, S. Orzach, K. Rouge, S. Paltsev and J. Reilly (2023): Assessing Compounding Risks Across Multiple Systems and Sectors: A Socio-Environmental Systems Risk-Triage Approach. *Frontiers in Climate*, Accepted (Vol. 5, doi: 10.3389/fclim.2023.1100600)


System Triage Risks Environmental Socioeconomic Stressors

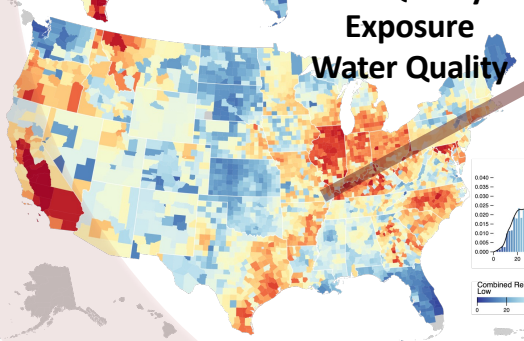
**MST.MIT.EDU**

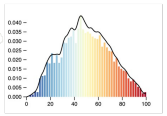
**GITHUB: https://github.com/cypressf/climate-risk-map**

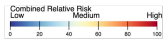
Air Quality Exposure



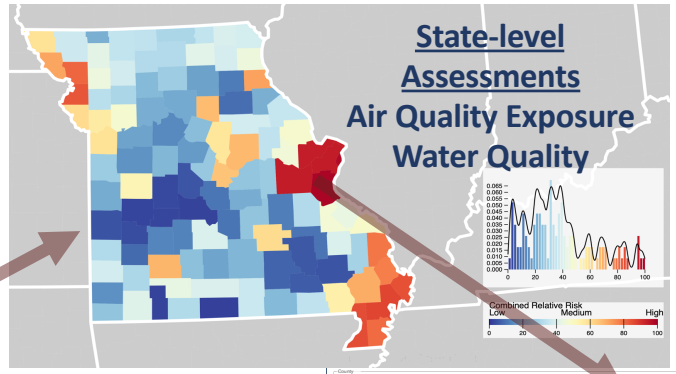
Air Quality
Exposure
Water Quality







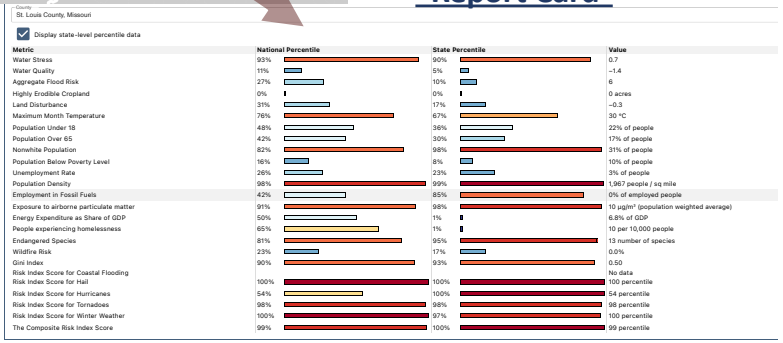

<u>State-level Assessments</u>
Air Quality Exposure
Water Quality








<u>County-Level "Report Card"</u>

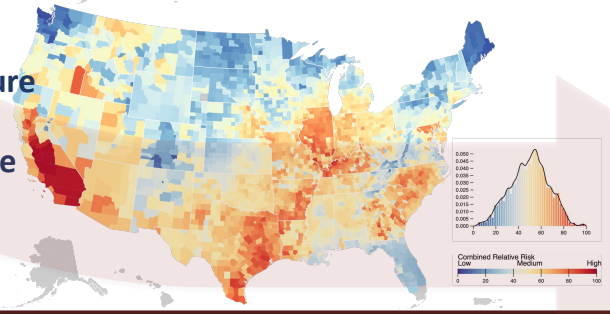


St. Louis County, Missouri

Display state-level percentile data

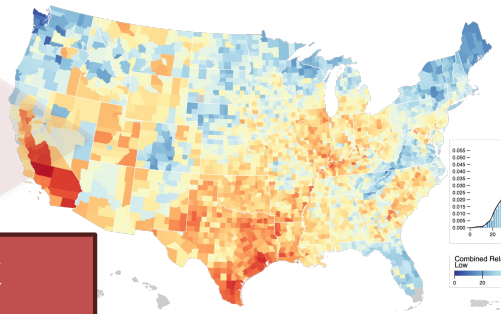
| Metric | National Percentile | State Percentile | Value |
|---|---|---|---|
| Water Stress | 93% | 90% | 0.7 |
| Water Quality | 11% | 5% | −1.4 |
| Aggregate Flood Risk | 27% | 10% | 6 |
| Highly Erodible Cropland | 0% | 0% | 0 acres |
| Land Disturbance | 31% | 17% | −0.3 |
| Maximum Month Temperature | 76% | 67% | 30 °C |
| Population Under 18 | 48% | 36% | 22% of people |
| Population Over 65 | 42% | 30% | 17% of people |
| Nonwhite Population | 82% | 98% | 31% of people |
| Population Below Poverty Level | 16% | 8% | 10% of people |
| Unemployment Rate | 26% | 23% | 3% of people |
| Population Density | 98% | 99% | 1,967 people / sq mile |
| Employment in Fossil Fuels | 42% | 85% | 0% of employed people |
| Exposure to airborne particulate matter | 91% | 98% | 10 µg/m³ (population weighted average) |
| Energy Expenditure as Share of GDP | 50% | 1% | 6.8% of GDP |
| People experiencing homelessness | 65% | 1% | 10 per 10,000 people |
| Endangered Species | 81% | 95% | 13 number of species |
| Wildfire Risk | 23% | 17% | 0.0% |
| Gini Index | 90% | 93% | 0.50 |
| Risk Index Score for Coastal Flooding | | | No data |
| Risk Index Score for Hail | 100% | 100% | 100 percentile |
| Risk Index Score for Hurricanes | 54% | 100% | 54 percentile |
| Risk Index Score for Tornadoes | 98% | 98% | 98 percentile |
| Risk Index Score for Winter Weather | 100% | 97% | 100 percentile |
| The Composite Risk Index Score | 99% | 100% | 99 percentile |

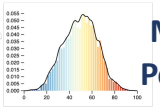
Air Quality Exposure
Water Quality
Max Temperature

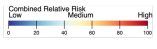











Air Quality
Exposure
Water Quality
Max Temperature
Population < 18 yrs
Fossil Fuel
Employment

STRESS
System
Triage
Risks
Environmental
Socioeconomic
Stressors

# Hotspots of physical, socio-economic and demographic Intersections

# Closing Remarks

- Currently able to receive county-level (over US) and national-level data (global).
- Developing sub-county visualizations.
- Under HAQAST project (PI: Fiore) enable gridded data visualization
- Convey current and future conditions.
- Welcome any/all datasets!
- Explore multiple/compounding exposures and landscapes.
- Give it a try!  Provide feedback!

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