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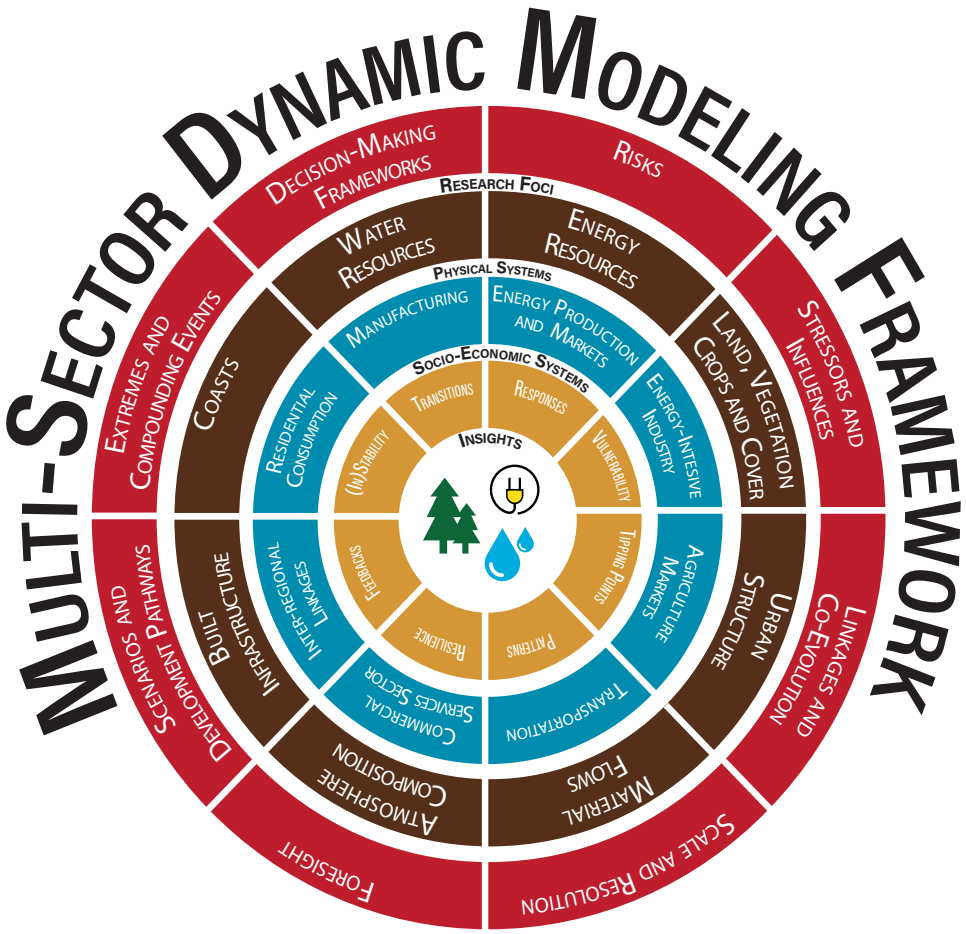


John Reilly

Snowmass Summer Workshop, 2019 (7/16-7/18)

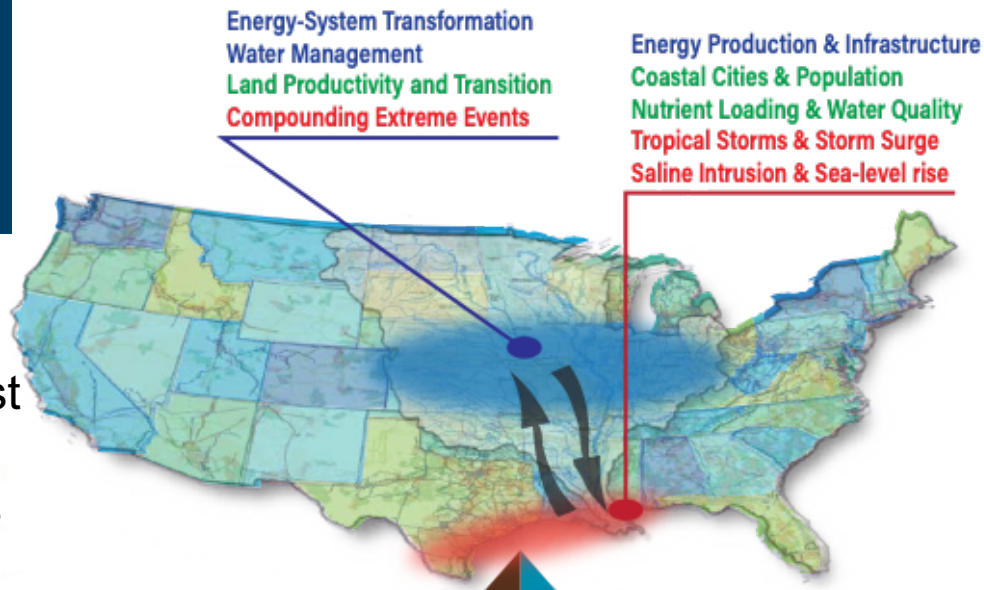
http://globalchange.mit.edu/

Changing Focus: Global to Regional

To develop generalizable insights, we will focus on:

- 2 regions: lower mid-west and Gulf coast
- 3 systems: water/land, energy infrastructure, and coastal communities
- multiple economic sectors (transport, agriculture, industry, and energy industries)
- subject to compounding extreme events and more gradual transitions driven by long run forces and patterns of development

The regional boundaries are fuzzy—some systems require a broad geographic focus while others may require focus on specific communities/facilties.



Major Science Questions

1. What combination of **forces**, varying by geography, contribute to ***patterns of economic and infrastructure development within and among regions***, including interdependencies among natural and built environments and human processes and systems?

2. What characteristics of interacting systems lead to ***stabilities***, ***instabilities, and tipping points*** in economic and infrastructure development across systems, sectors, and scales?

3. How will different characteristics of human response and ***foresight*** (to 1 and 2, above) affect the evolution of the resilience of these systems and what characteristics and risk profiles may emerge from ***both gradual and abrupt transitions***?

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Specific Questions

Could changes in the severity, frequency, and intervals of extreme and/or compounding events significantly exceed the resilience of the coupled system and/or alter the trajectories of regional and sub-regional multi-sector dynamics and economic activity?

What insights can be gained from a focus on these events, such as coastal and inland flooding from tropical storms, extreme heat, ice storms and droughts, accompanied by significant changes involving water, energy, land use, populations, and the built environment?

The chosen use-case regions provide interesting natural (river), built (levee system, transportation network), and economic (fuels, electricity, transportation, ports) connections between the regions.

Tasks for "example" coastal, water/land, energy systems

a) *Collect data on existing built infrastructure and resources at risk in the sub-regions, apply multi-stressor triage to evaluate highly vulnerable physical, natural, and built systems.*
b) *Select, from a large ensemble of economic simulations, scenarios for development in the regions with a range of end-states in absence of new environmental extremes*.
c) *Develop estimates of changing compound multistressor extremes, and gradual changing conditions*.
d) *Evaluate possible responses to increased intensity, return interval (frequency), and compound stressors under myopic, perfect foresight, and hedging behavior.*
e) *Simulate the impact of these different behavioral rules in scenarios (chosen in b above) to evaluate robustness of decisions under different evolutions of the economic system.*
f) *Simulate the combined system under gradual evolution of combined stressors and changing extreme frequency and intensity, allowing comparison of the new end-state to the original end-state. Substantial changes in the end-state would then indicate that tipping points had occurred and combined multistressor effects had changed the co-evolution of the system.*

Tools we will apply and link

a) *Land-water system model that simulates how precipitation, temperature, geomorphology, and land cover affect water run-off and river flow, including metrics of water resource quantity and quality.*
b) *Large ensembles of the evolution of the global atmosphere and climate system under varying economic conditions and ranges of earth system response, with various downscaling techniques to improve simulation of changes in likelihood of extreme events at local and regional levels*.
c) *Various stochastic dynamic program approaches that can represent a variety of decision making behaviors.*
d) *Large ensembles of scenarios of regional economic development representing different patterns and level of population and productivity growth, technological development, and household consumption patterns*
e) *Coupled models of agriculture, energy, transportation, industry, services; household consumption and sources of household incomes that include factor inputs including natural resources; interindustry demands and supplies, final demands, and trade among regions. The modeling system includes supplemental physical accounts to link the economic projections to physical and natural systems such as oil, gas, coal resources, land, people.*

Hypothesized generalizable insights

- Uncertainty quantification and risk assessment can lead to more stable and resilient development pathways.
- The scale of decision-making contributes to the stability of systems, with independent optimal local decisions potentially adding instability to larger systems while optimal system-level decisions could create greater stability (levees upstream create greater flood risk downstream).
- The level of foresight factored into decision-making affects the resulting stability and resilience of systems. (Decision-making under uncertainty frameworks perform better than myopic or perfect foresight behaviors).
- Considering regional, sectoral and system connections results in more resilient response strategies (energy, water/land, coastal port facilities).
- Considering risks jointly with their compounding influences and stressors, rather than in isolation, results in more resilient response strategies (e.g. storm surge, and inland flooding)

Thank You