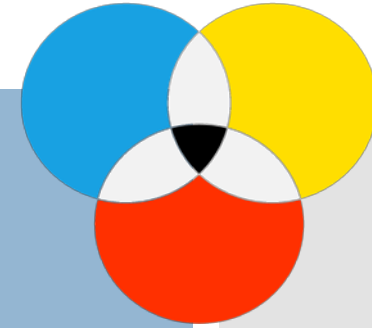


# Principles of Participatory Ensemble Modeling to Study Complex Socioecological Systems

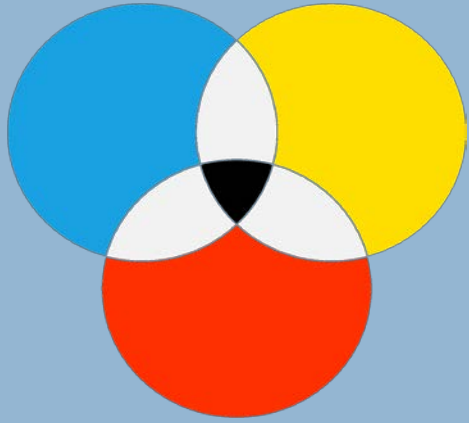
Arika Ligmann-Zielinska, Laura Schmitt Olabisi,  
Sandy Marquart-Pyatt, Eric Jing Du, Louie Rivers III,  
Saweda Liverpool-Tasie



Innovations in  
Collaborative  
Modeling

June 4-5 2015

East Lansing, MI, USA



## Synopsis

- The success of participatory modeling requires a comprehensive representation of **all relevant perspectives**, which are **clearly and concisely formalized**, and which are implemented in a manner that **encourages reasoning** about future scenarios under a wide range of assumptions and hypotheses.
- We propose three design principles that should guide the development of policy-relevant models: **legitimacy**, **parsimony**, and **practicality**.
- Taken together, these principles provide a foundation for a new framework for studying complex socioecological systems that we call ***participatory ensemble modeling***.



# Motivation

# Case Study: Food Security

We are building, with iterative stakeholder involvement, a variety of simple yet parsimonious models to understand and address the multiscale dynamics of food security in dryland West Africa.



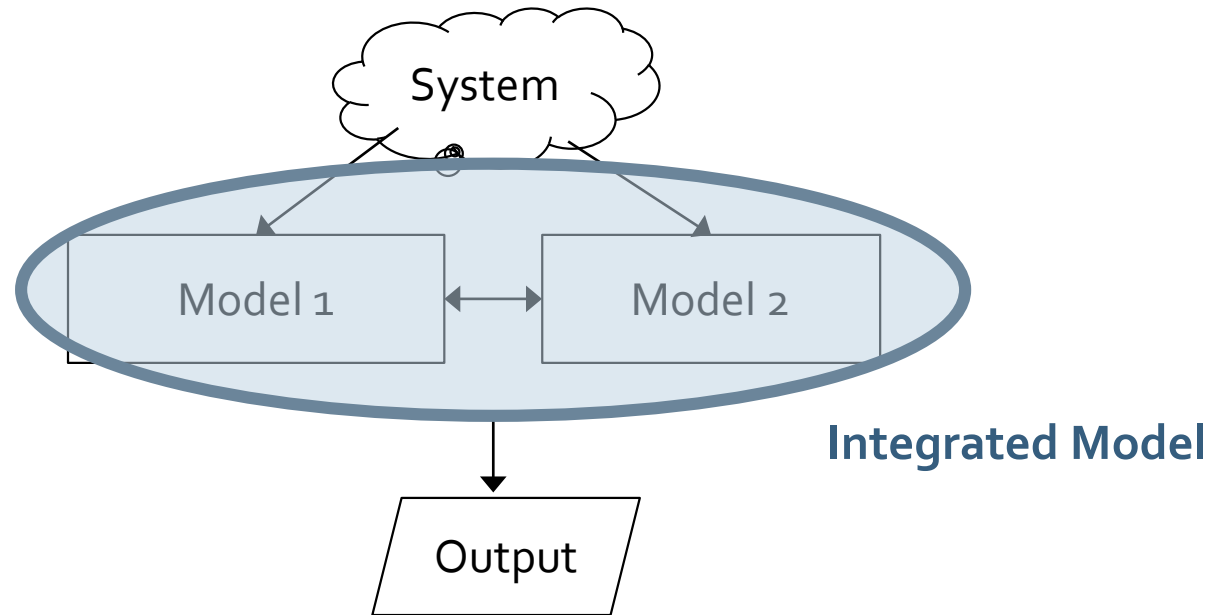
Image source: <http://www.odishanewsinsight.com/odisha/odisha-launch-food-security-mission-soon/>

# PROBLEM

*How to simultaneously capture the complexity of food security, reflect broad-based knowledge and information, and provide cognitive tractability to inform policy (for implementation)?*

# Integrated Modeling

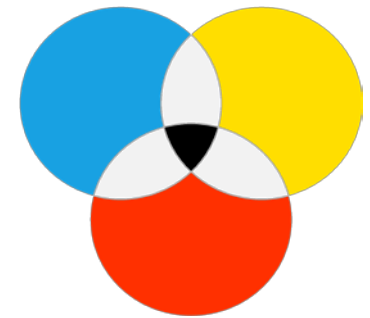
**Integrated modeling:** multiple disciplines contribute to building one comprehensive model that jointly emulates human and biophysical systems.

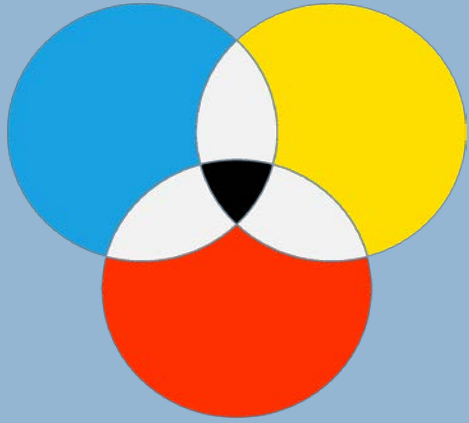


Adapted from: Swinerd, C., & McNaught, K. R. (2012). Design classes for hybrid simulations involving agent-based and system dynamics models. *Simulation Modelling Practice and Theory*, 25, 118-133.

# Integrated Modeling

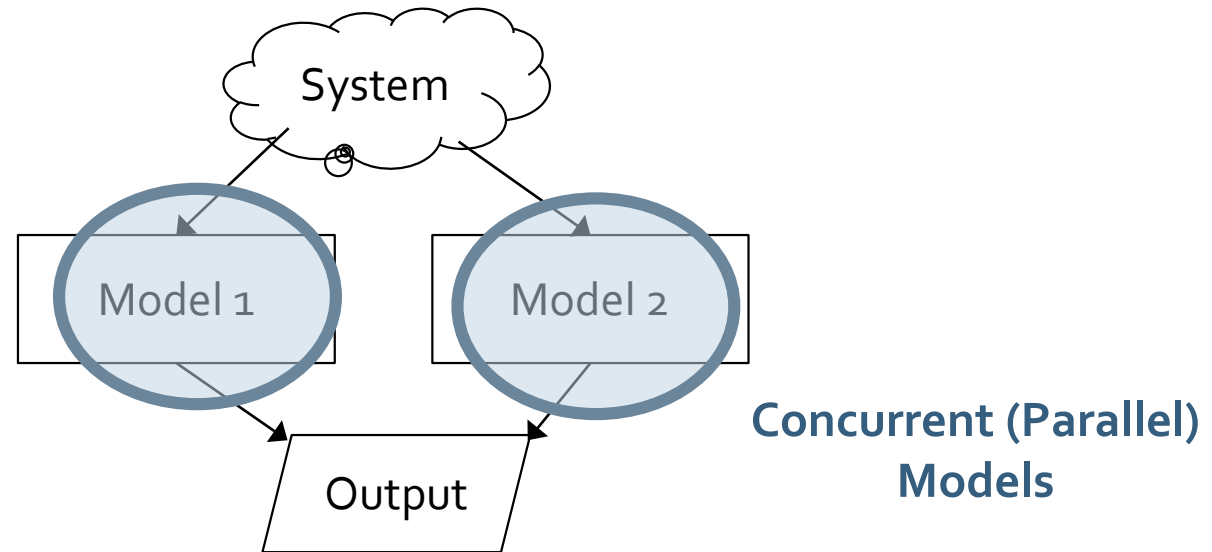
- Integrated modeling has its limitations, including high computational cost, algorithmic complexity, and confounded uncertainty.
- We argue that a useful socioecological model should be:
  - Acceptable by interested individuals
  - Easy to understand by diverse stakeholders
  - Uncertain to allow for collaborative experimentation





## Our Framework

- Instead of one colossal model we propose to use ensembles of small(er), independent, and simple models that are **legitimate**, **parsimonious**, and **practical**.



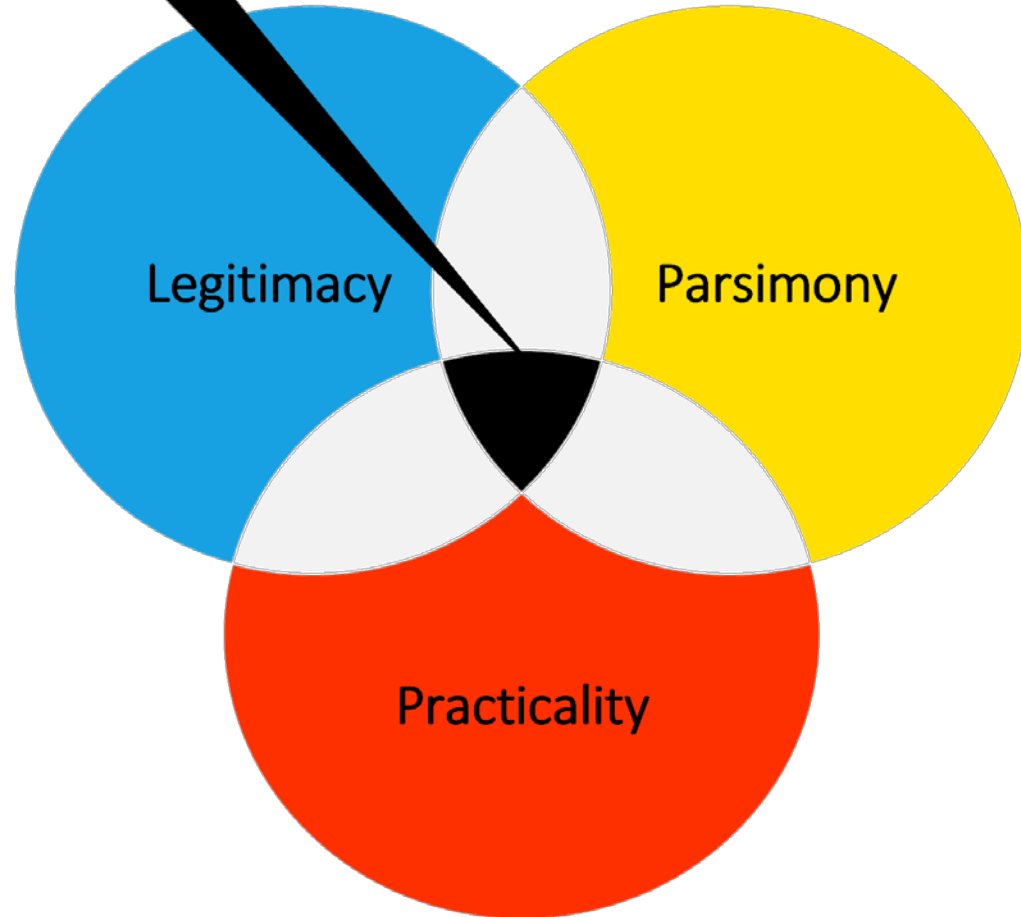
Adapted from: Swinerd, C., & McNaught, K. R. (2012). Design classes for hybrid simulations involving agent-based and system dynamics models. *Simulation Modelling Practice and Theory*, 25, 118-133.



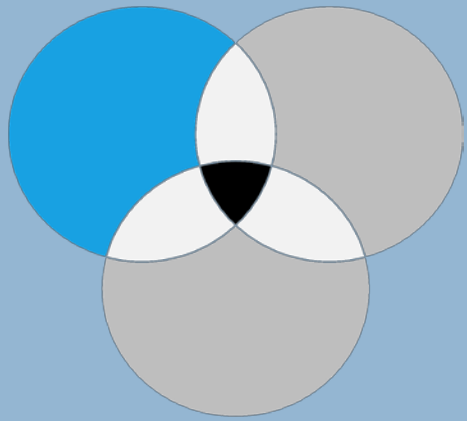
# The PEM Framework

PEM: Participatory Ensemble Modeling

## Participatory Ensemble Modeling

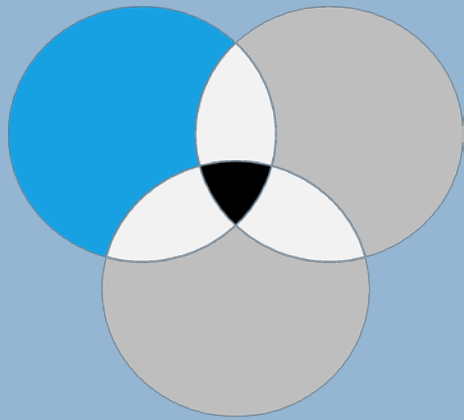


Collaboratively developing a large number of differing, multi-valued, simple, and robust representations of a given system, in order to generate scenarios that would hold under variable future conditions.



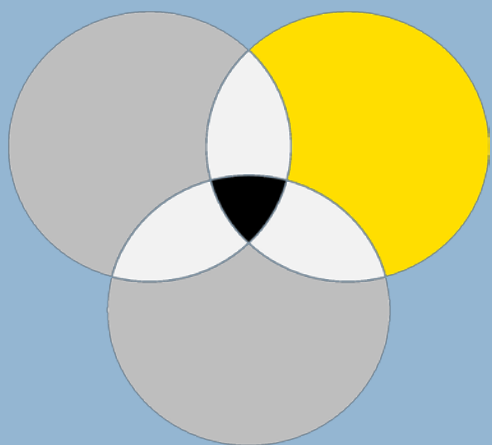
Legitimacy





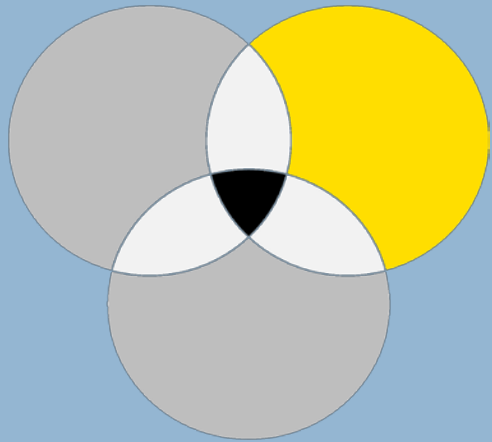
## Legitimacy

- **Model legitimacy** aims at faithful representation of perspectives of all involved stakeholders.
- Interaction with stakeholders is necessary to incorporate expert knowledge, thereby increasing the transparency and applicability of the model in real-world decision-making.



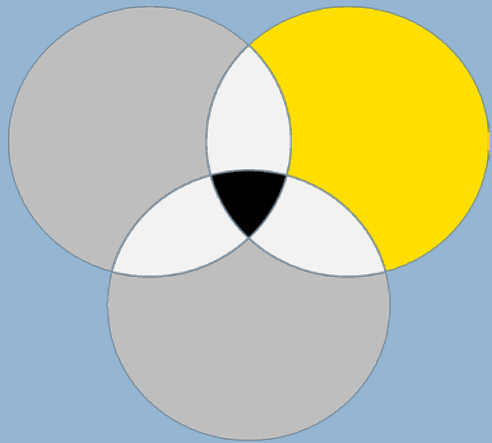
# Parsimony





## Parsimony

- Achieving legitimacy through collaborative problem solving may lead to a myriad of overlapping representations of the system under study. Aggregation and generalization is necessary.
- **Parsimony**: well-founded model simplification
- The challenge is to end up with representations that have high fidelity to the system being modeled but do not contain unnecessary details.

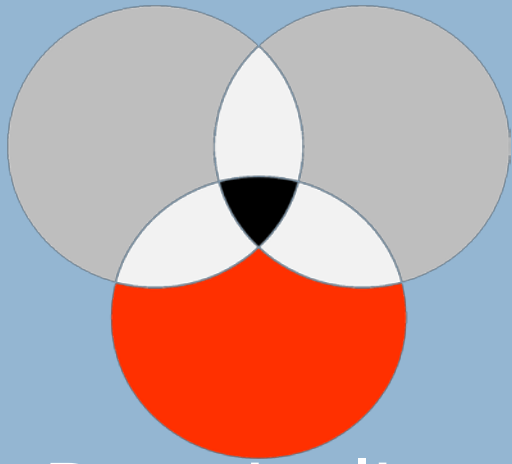


Parsimony



But **WHY**  
simplify?

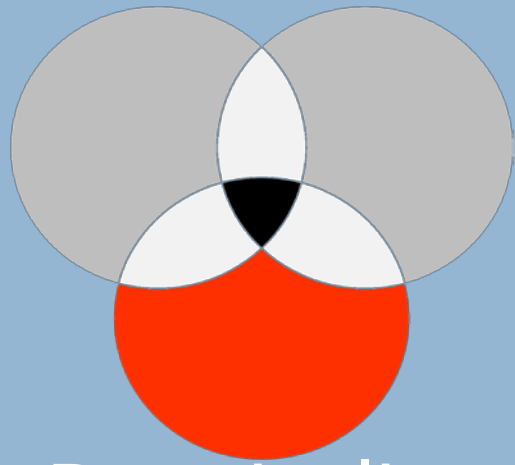
Reaching parsimony should not be done in a way that **compromises the exploratory** power of models



Practicality







Practicality

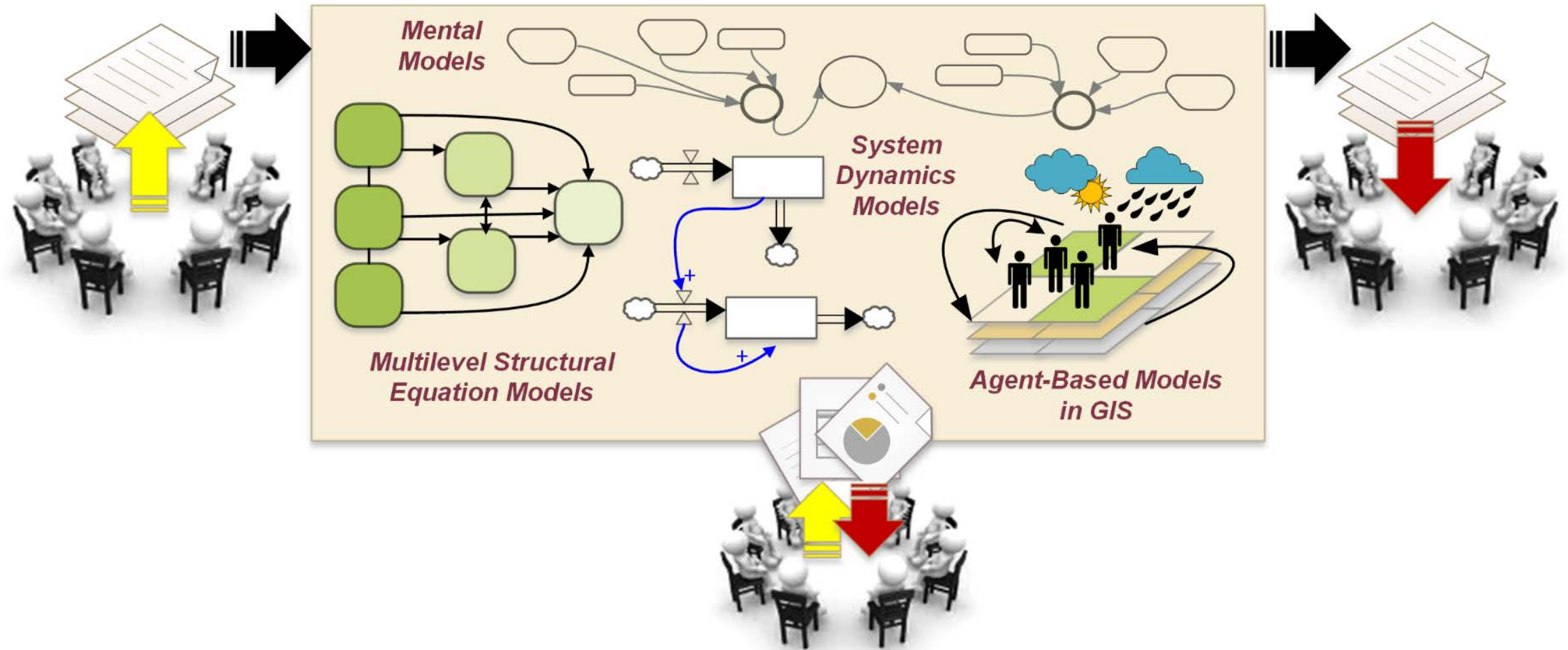
*How can we design models that are understandable yet warrant surprise?*

- Model **practicality** concentrates on leaving some form of uncertainty in the models.
- Uncertainty can be constructive - it enables choices, provides opportunity for discovery, and provokes creativity.

# Implementation Plan

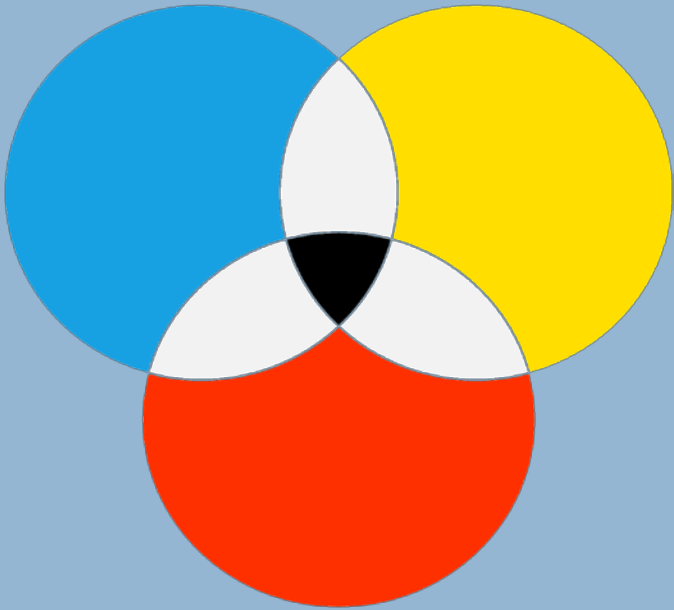
PEM Methodology

# Scenario Study Tool



# Summary

# Take-Home Message



- **Participatory Ensemble Modeling** embodies three intertwined principles:
- **Legitimacy:** ensembles of models should incorporate the perspectives of all involved stakeholders.
- **Parsimony:** legitimate models often result in a large number of overlapping system representations, which can be further simplified and grouped to minimize model complexity.
- **Practicality:** a certain level of uncertainty in models is necessary to provide means of experimentation that can augment consensus building.

# Thank You

Q&A

Contact [ligmannz@msu.edu](mailto:ligmannz@msu.edu)

Financial support for this work was provided by the Environmental Science and Policy Program at Michigan State University, as well as the National Science Foundation, Interdisciplinary Behavioral and Social Science Grant No. SMA 1416730



# Smaczne [Enjoy your lunch]

