UNIVERSITY OF MICHIGAN

OpenClimate.org

Climate Change: An Inter-disciplinary Approach to Problem Solving (AOSS 480 // NRE 480)

Richard B. Rood
Cell: 301-526-8572
2525 Space Research Building (North Campus)
rbrood@umich.edu
http://aoss.engin.umich.edu/people/rbrood

Winter 2015
January 15, 2015

Class Information and News

- Ctools site: AOSS_SNRE_480_001_W15
  - Record of course
- Rood's Class MediaWiki Site
  - http://climateknowledge.org/classes/index.php/Climate_Change:_The_Move_to_Action
- A tumbler site to help me remember
  - http://openclimate.tumblr.com/

Required Reading and Response

- Assignment on CTools Site
  - Dilling and Lemos: Usable Science

Resources and Recommended Reading

- Cash et al: 2002: Knowledge Systems
- Usable Science? Tang and Dessai (2012)
- Hines, Hungerford, Tomera, Responsible Environmental Behavior, 1987
- Rood: Solving the Problems of Climate Change and Sustainability, Michigan Journal of Sustainability, 2, 2014.

Outline: Class 3, Winter 2015

- Organization: structure and language
  - Identification of complexity
- Knowledge system / examination of successful problem solving
  - Formal construct or theory to approach problems
- Breaking the problem down →
  - to, ultimately, build back up
- The need to evaluate data, information and knowledge

A question for short discussion

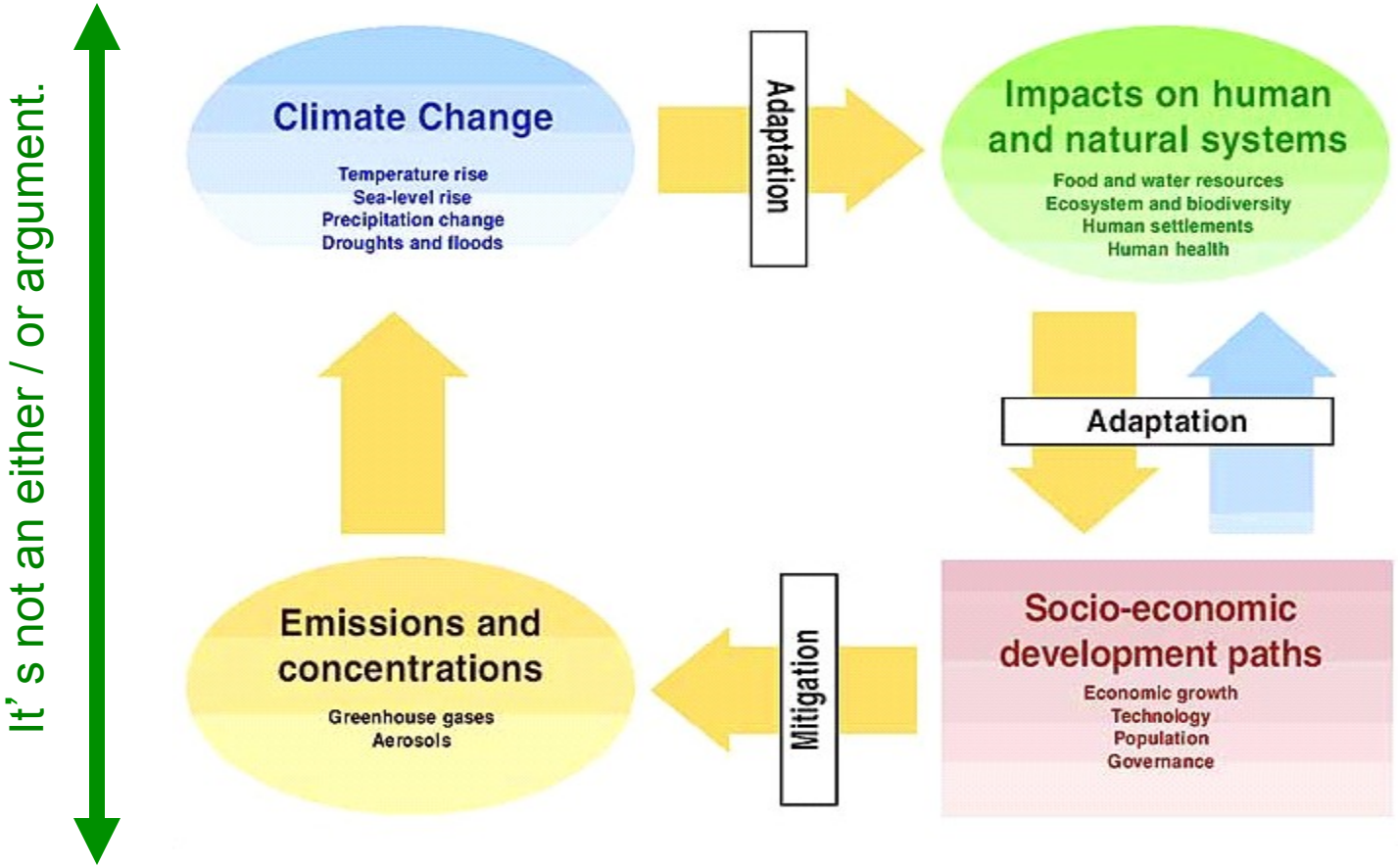
- Why haven't we done more about climate change than we have?

Assumption

- That we are satisfied the that scientific investigation of climate change is robust, and we want to incorporate knowledge about climate change into our jobs or our daily lives.
  - How do we do that?

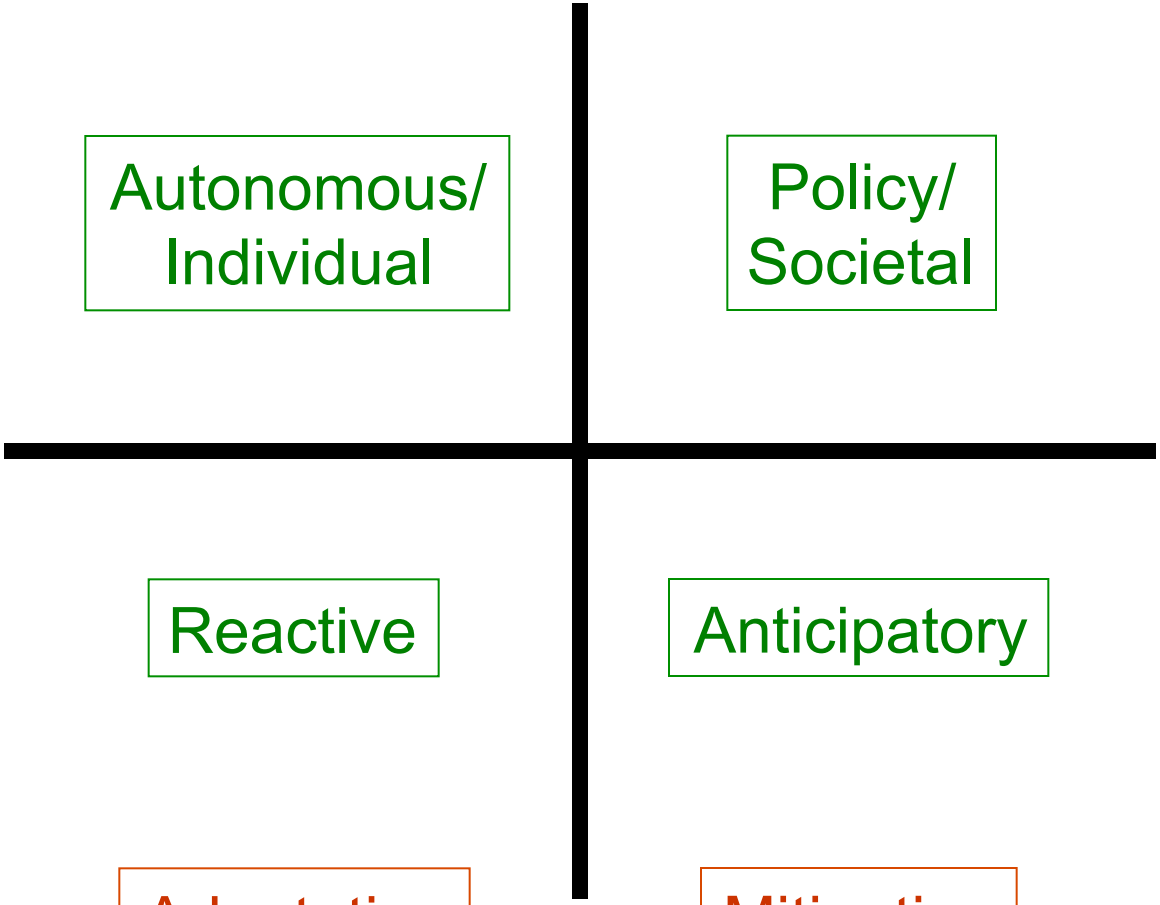
Science, Mitigation, Adaptation Framework

Adaptation is responding to changes that might occur from added CO_2



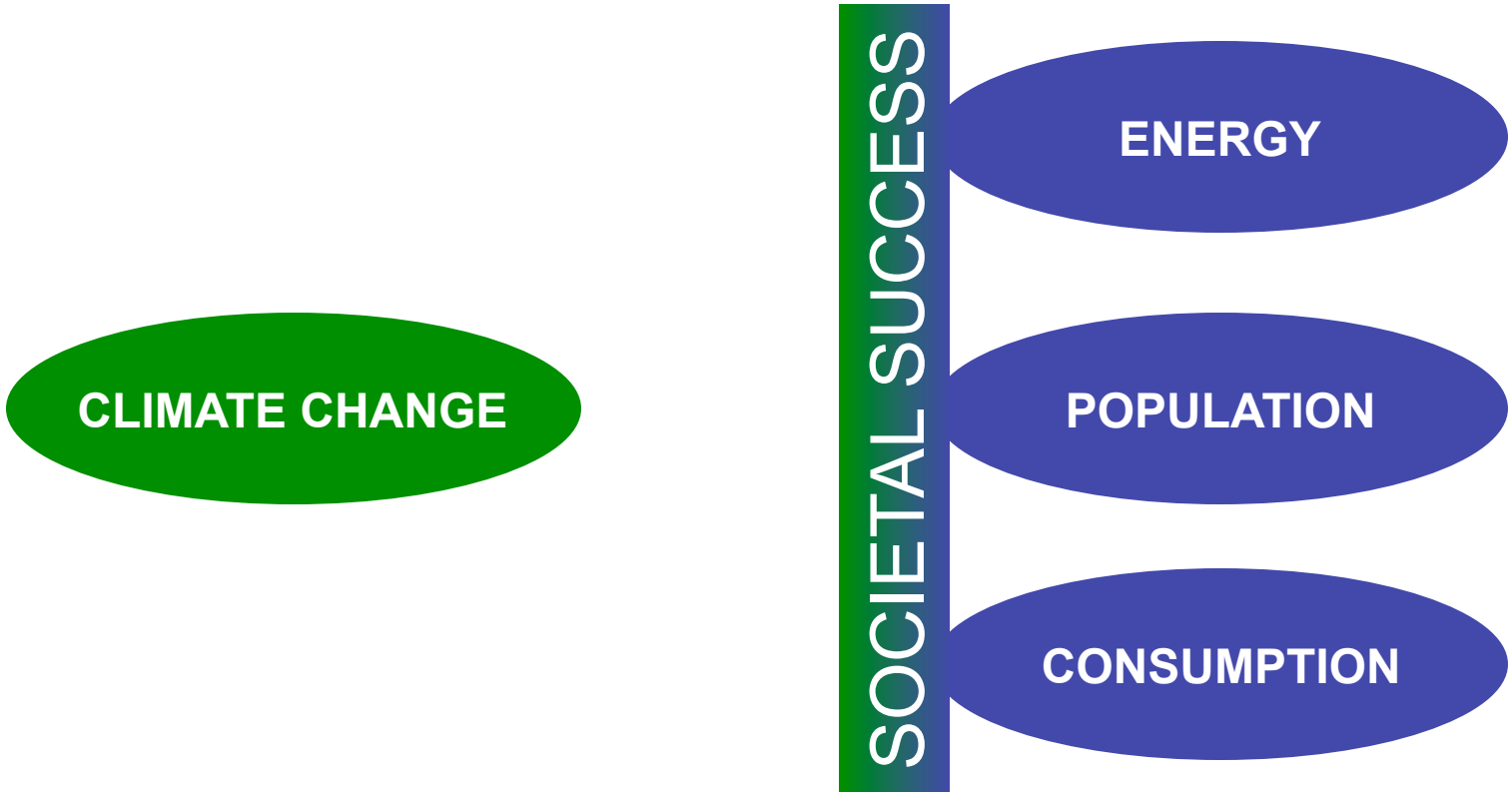
Mitigation is controlling the amount of CO_2 we put in the atmosphere.

Responses to the Climate Change Problem



Climate Change Relationships

- Consumption // Population // Energy



Knowledge System: Translation

- Need to bring together disparate information and different points of view to develop strategies for applied problem solving
- Key to development of successful strategies: iterative process or co-development with information providers and information users

Cash et al: 2002
Lemos & Morehouse, 2005
Dilling & Lemos, 2011

Knowledge System, Science Focused

- Two Points
  - This figure overstates the role of “science” in the knowledge systems.
  - I choose not to draw a line between the two bubbles, as the relation between “science” and the application is not direct.

Knowledge System, Science Focused

Dilling & Lemos, 2011

- Information brokers
- Collaborative group processes
- Embedded capacity
- Boundary Organizations
- Knowledge Networks

Cash et al: 2002

- Boundary Management
- Dual Accountability
- Boundary Objects

Knowledge System, Science Focused

Dilling & Lemos, 2011

- Information brokers
- Collaborative group processes
- Embedded capacity
- Boundary Organizations
- Knowledge Networks

Cash et al: 2002

- Boundary Management
- Dual Accountability
- Boundary Objects

Cash et al: 2002

- **Legitimacy**
- **Credibility**
- **Salience**

Credibility, Legitimacy, Salience

- Credibility is an attribute of scientific adequacy.
- Legitimacy is an attribute of objectivity, fairness, and a lack of political bias.
- Salience requires that information be relevant to the problem to be addressed.

Heuristic Knowledge System

Applications

These elements sit in a complex and changing relationship within any specific application, as well as across multiple applications.

In Complex Problem Solving Bring Attention to Interfaces

- Climate – Energy – Population – Economic Success
- Climate – Health – Economic Success -
- Climate – Agriculture – Population – etc.
- etc …

- What are the major sensitivities?
- What is entrée into the field and access to experts?
- Translation and communication,
  - salient communication
  - Not dumbing down

Useful and Usability

- Scientists often talk about the usefulness of their data (observations or projections)
- Practitioners talk about the usability of data, information and knowledge
  - Practitioners?
    - Urban planners
    - Public health
    - Ecosystem managers
    - Water managers
    - …

Salience is most Challenging

- Usable Science? Tang and Dessai (2012)
  - U.K. Climate Projections 2009 (UKCP09)
  - Bayesian probabilistic projections – highly quantitative uncertainty descriptions
  - Increases credibility and legitimacy
  - Reduces salience and usability
    - Understanding and Interpretation
    - Information required
  - Strategy to increase salience
    - Tailoring to adaptation context or problem

How do we organize problem solving?

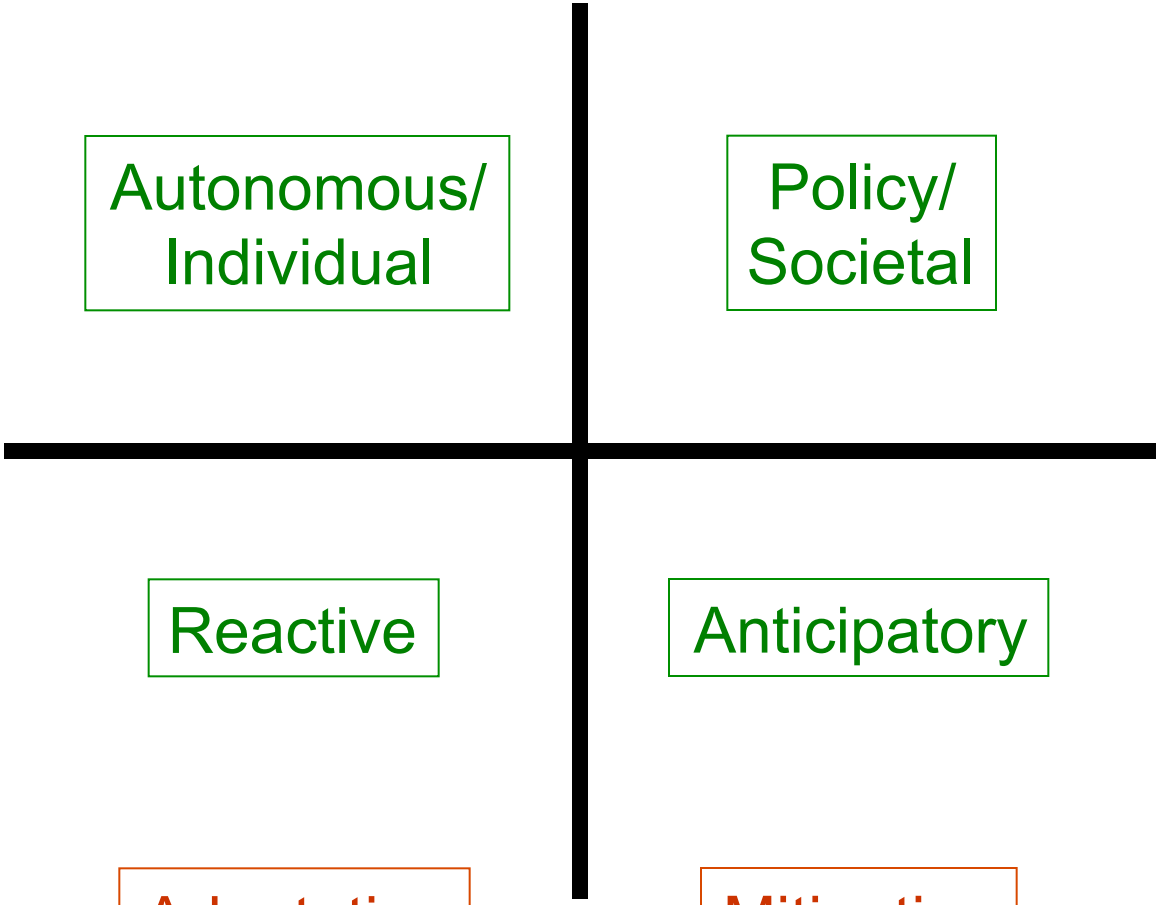
Knowledge at the Loading Dock

- Information, data knowledge at the loading dock ("made available") is necessary, but it is not sufficient to assure usability and use.

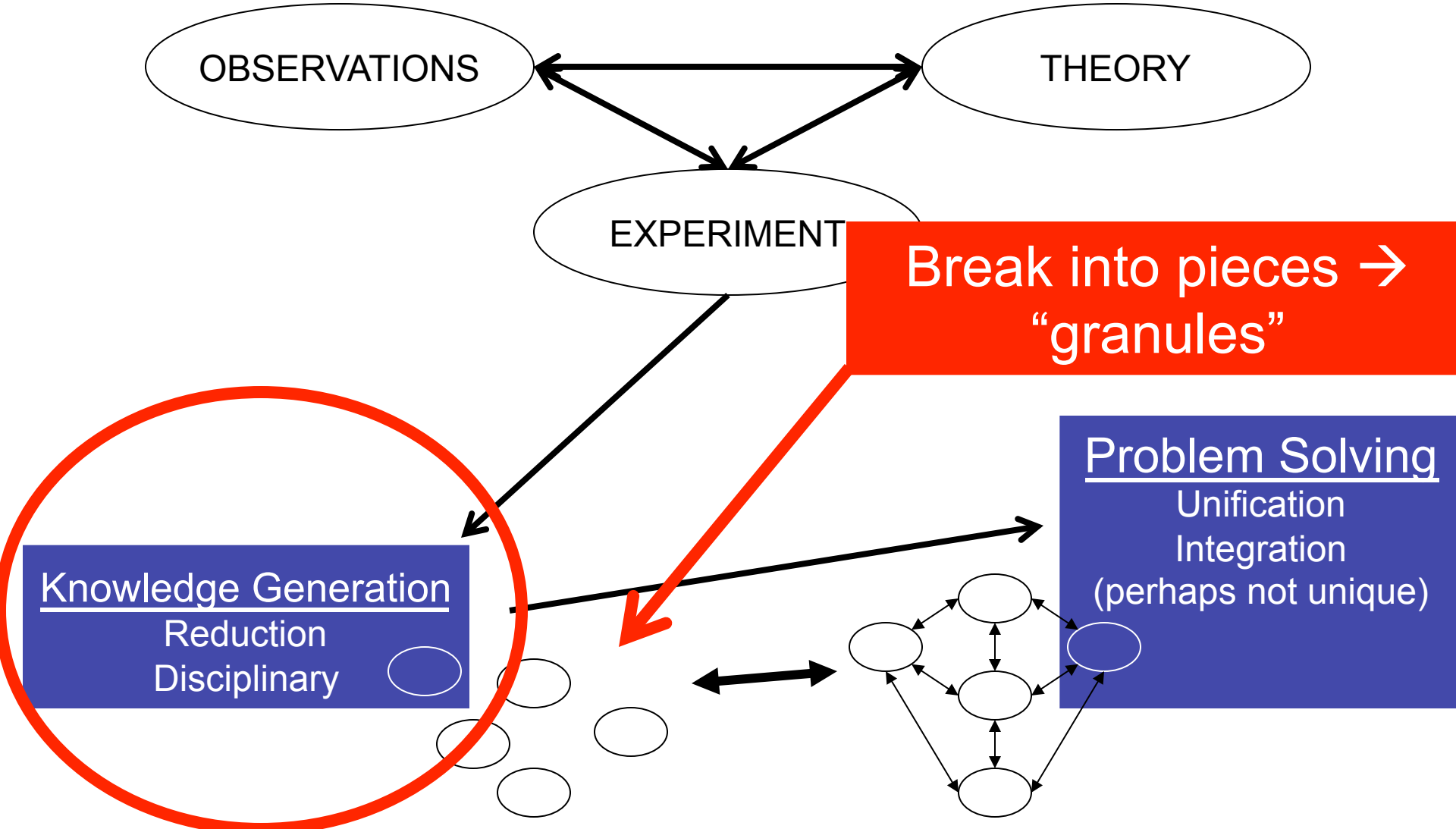
Motivator: Environmental Behavior

- Hines, Hungerford, Tomera, Responsible Environmental Behavior, 1987.
  - We need to correct "[t]he erroneous assumption…that skills evolve naturally from knowledge"
  - What to do and the skills to do it
- Rood: Solving the Problems of Climate Change and Sustainability, Michigan Journal of Sustainability, 2, 2014.

Responses to the Climate Change Problem



Scientific Investigation



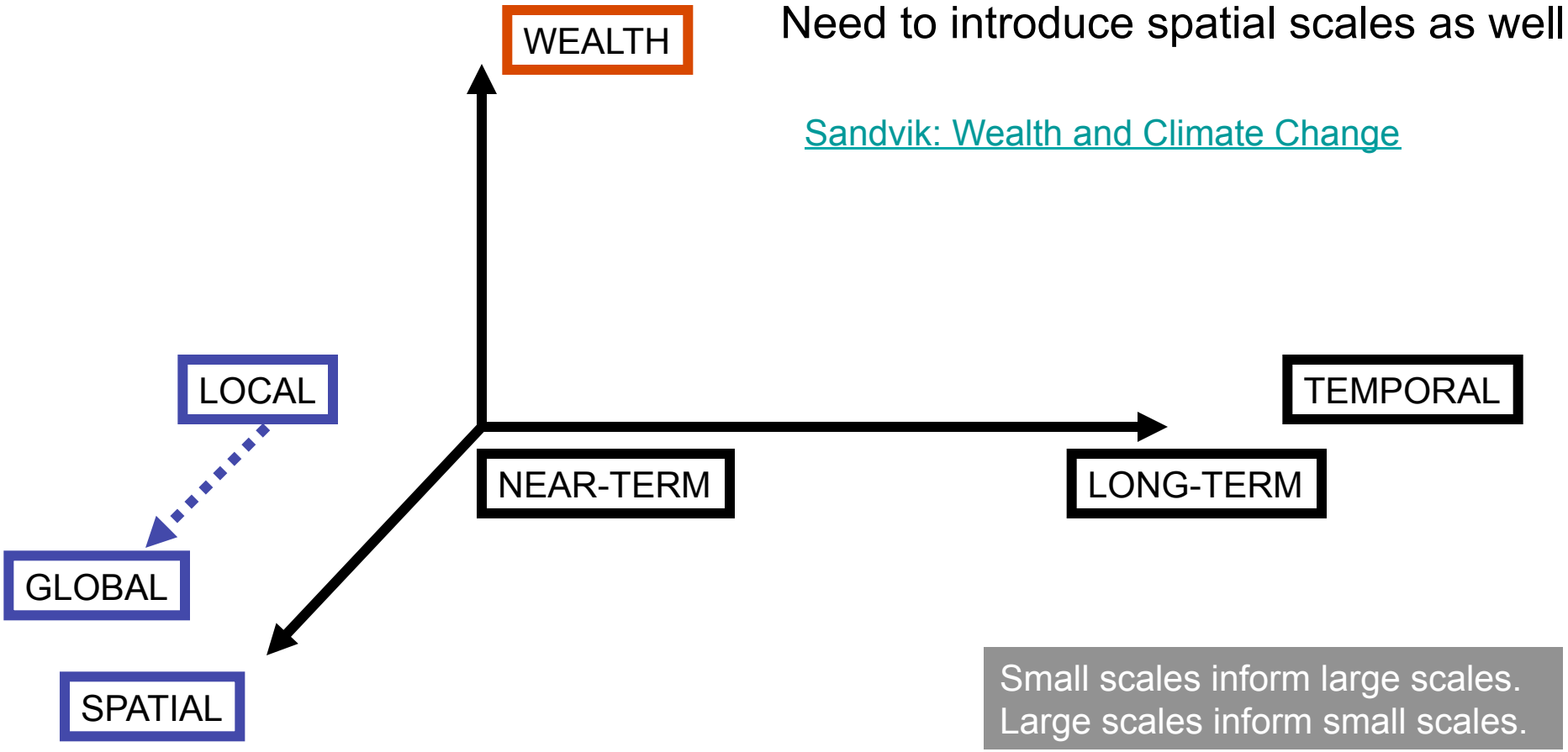
Granularity

- No matter how we cut through this problem we come to the conclusion that there is a lot of granularity within the problem. This granularity represents complexity, which must be used to develop a portfolio of solutions rather than to classify the problem as intractable.

The previous viewgraphs have introduced "granularity"

- This is a classic short-term versus long-term problem.
  - Ethics
  - Economics
  - Reaction versus anticipation
- Similarly, regional versus global
- Rich and poor
- Competing approaches
  - Mitigation versus adaptation
  - Transportation versus Electrical Generation
  - This versus that

Reducing Climate Complexity



Need to introduce spatial scales as well

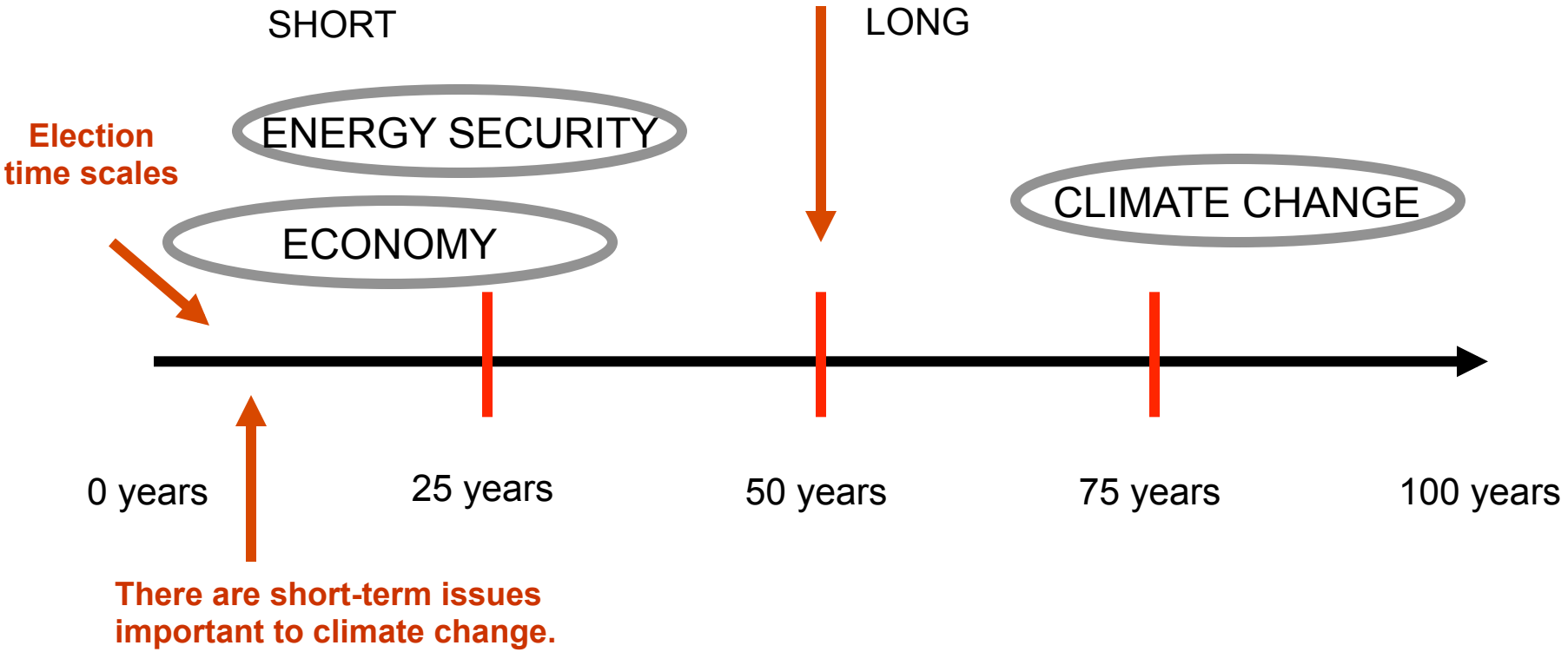
Sandvik: Wealth and Climate Change

Small scales inform large scales.
Large scales inform small scales.

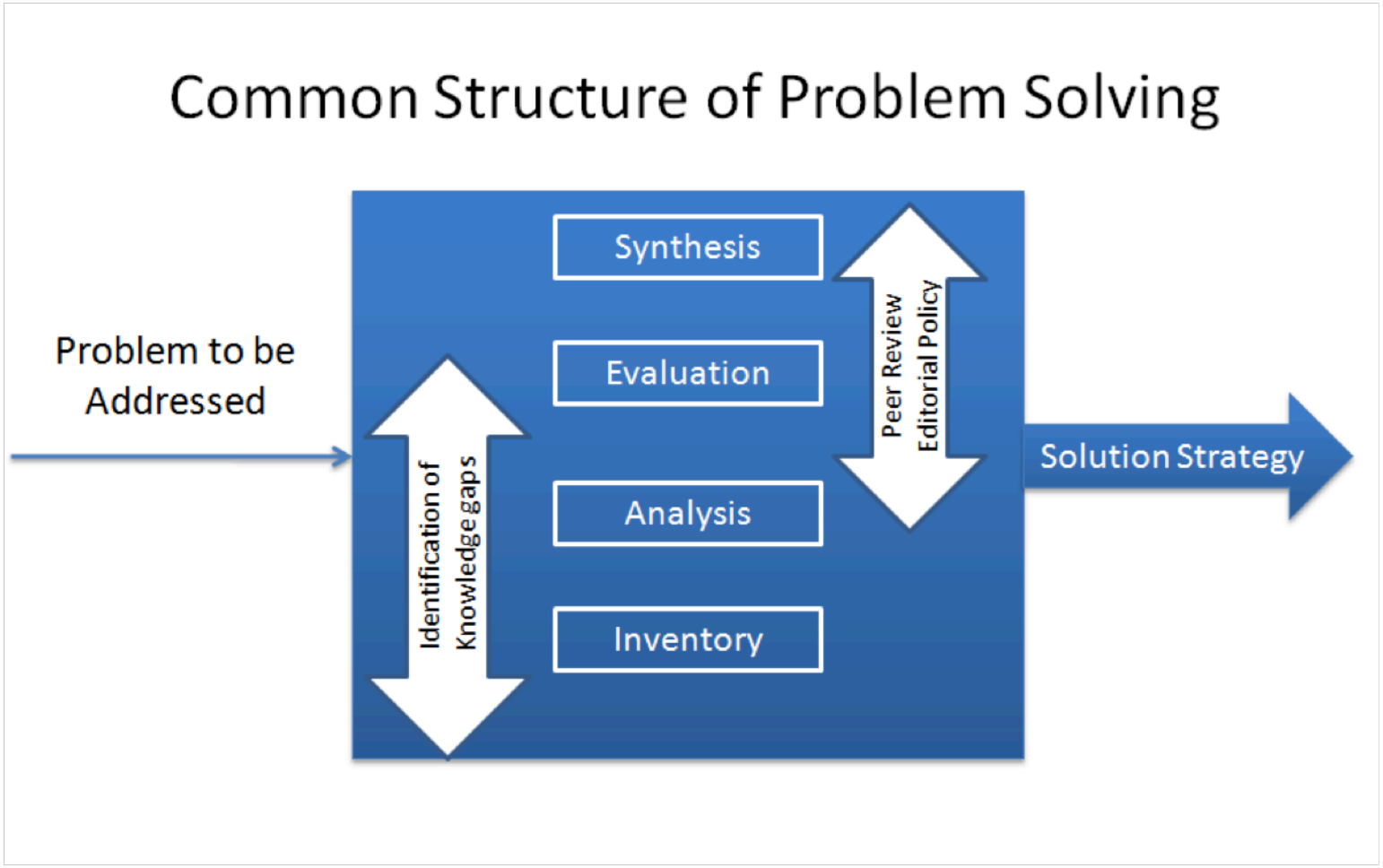
How do we define time?

What is short-term and long-term?

Pose that time scales for addressing climate change as a society are best defined by human dimensions. Length of infrastructure investment, accumulation of wealth over a lifetime, ...



Structure of Problem Solving (http://glisaclimate.org/home)



Skill Set

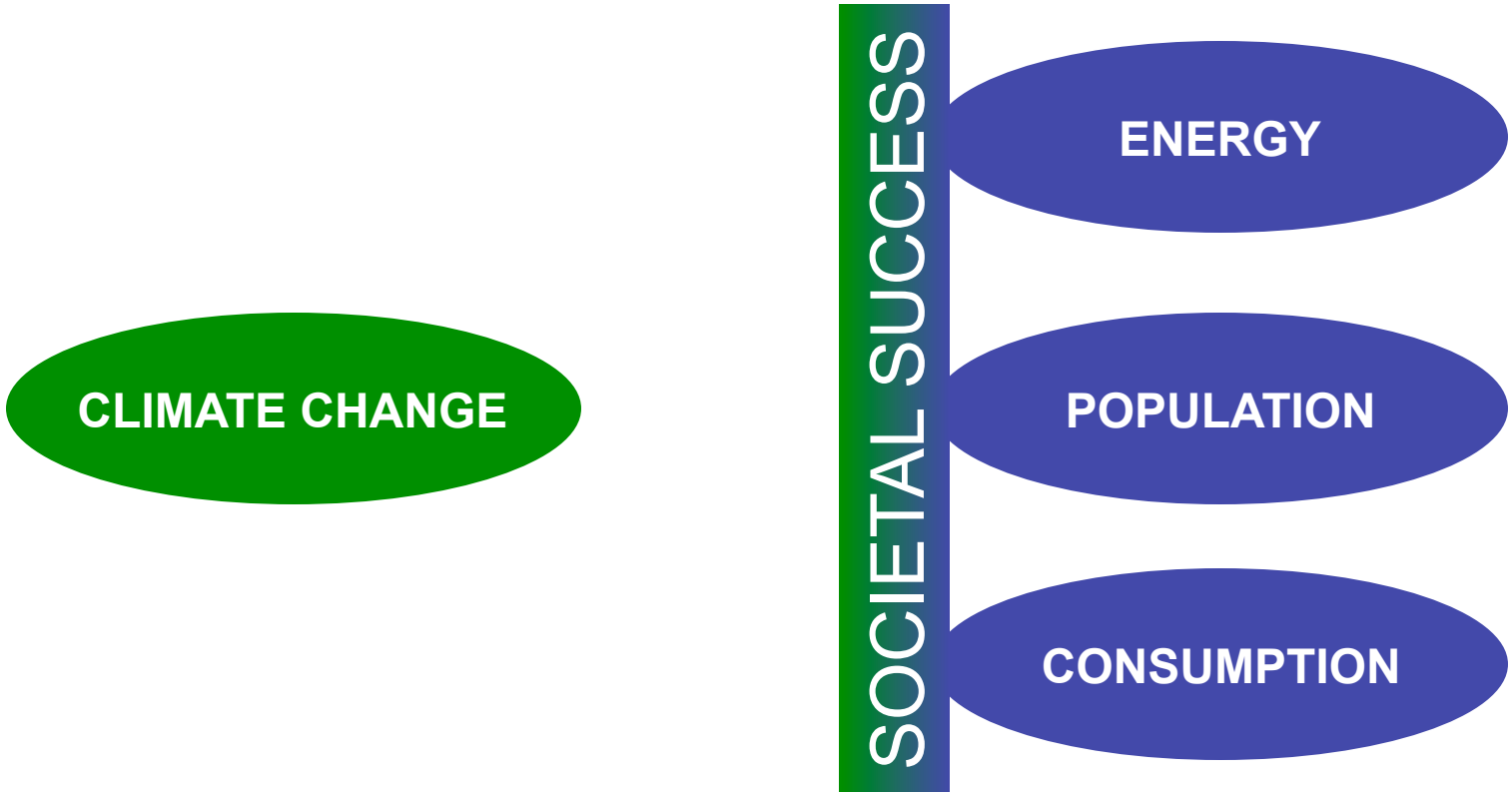
- Analysis
  - Determination of knowledge that is important to the application
  - Distinguish between facts and inferences
  - Identify advocacy
- Evaluation / Judgment
  - What is the quality of the knowledge?
- Synthesis
  - How do pieces fit together?

Some approaches to analysis

- There are attributes of analysis and evaluation that are shared
  - Evaluation is intrinsic in the analysis process
  - Evaluation becomes more rigorous as the problem advances through its iterative steps

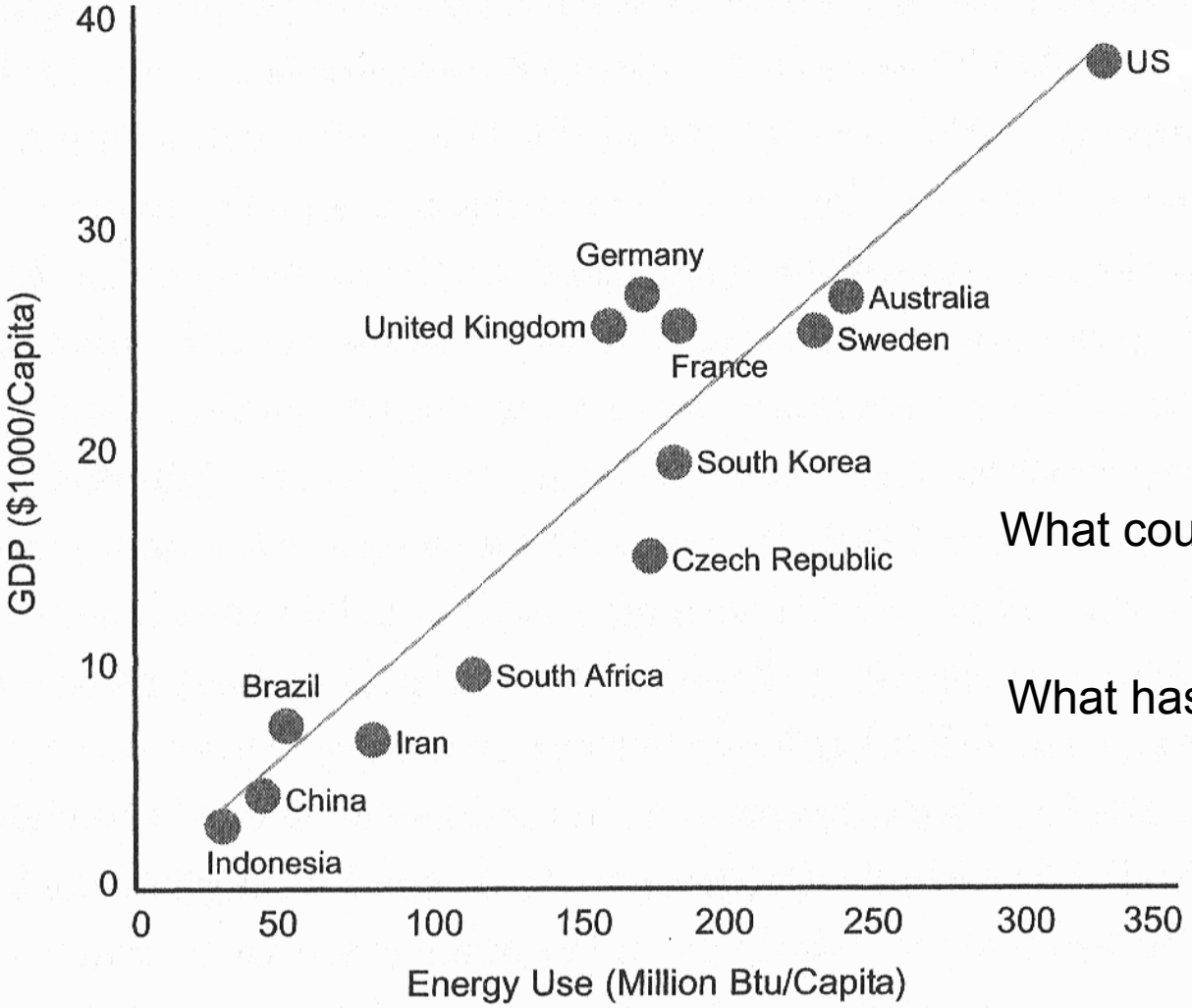
Climate Change Relationships

- Consumption // Population // Energy



Energy and Economic Success

FIGURE 8.2 Energy and Prosperity

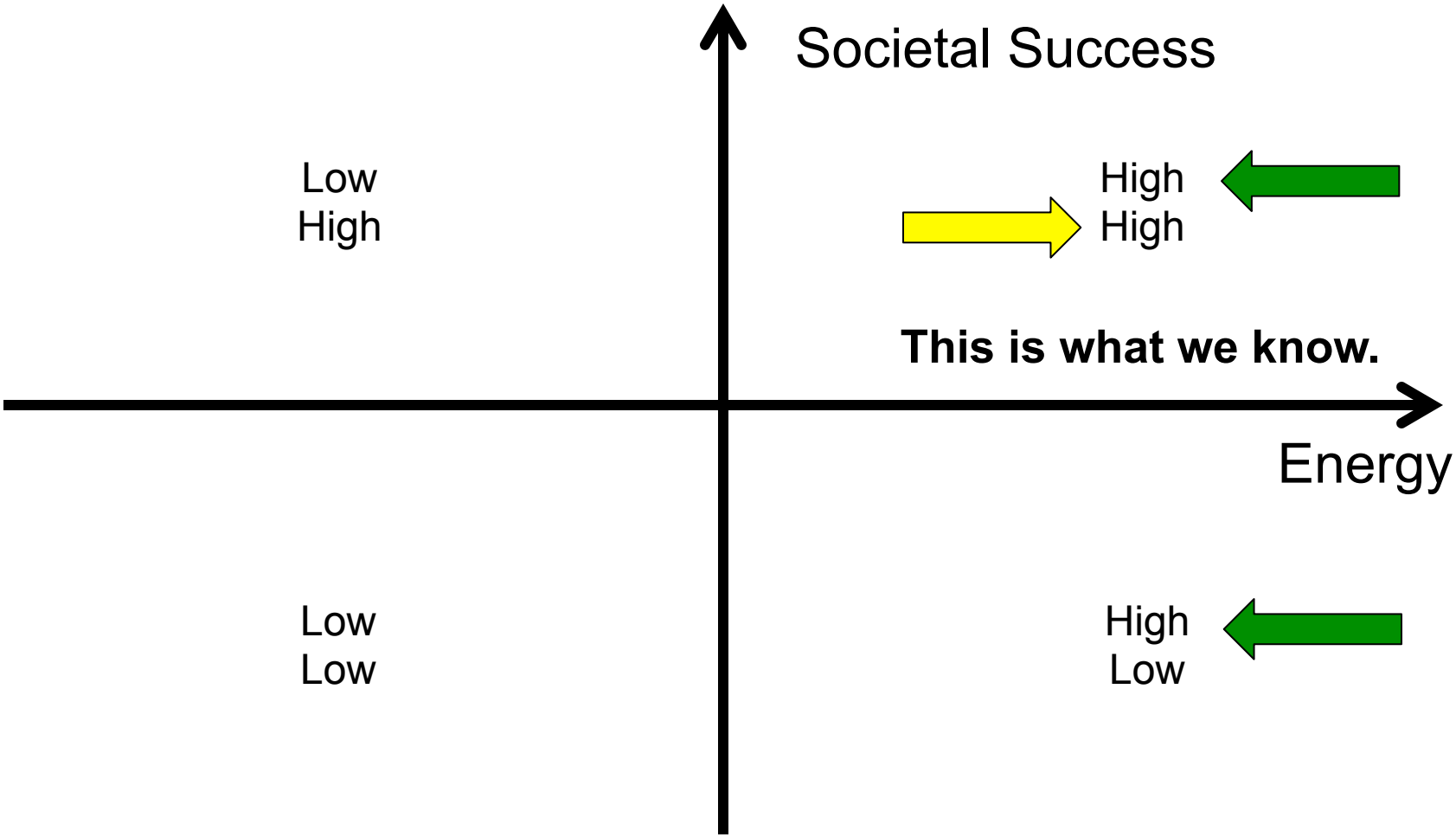


What countries are missing from this figure?

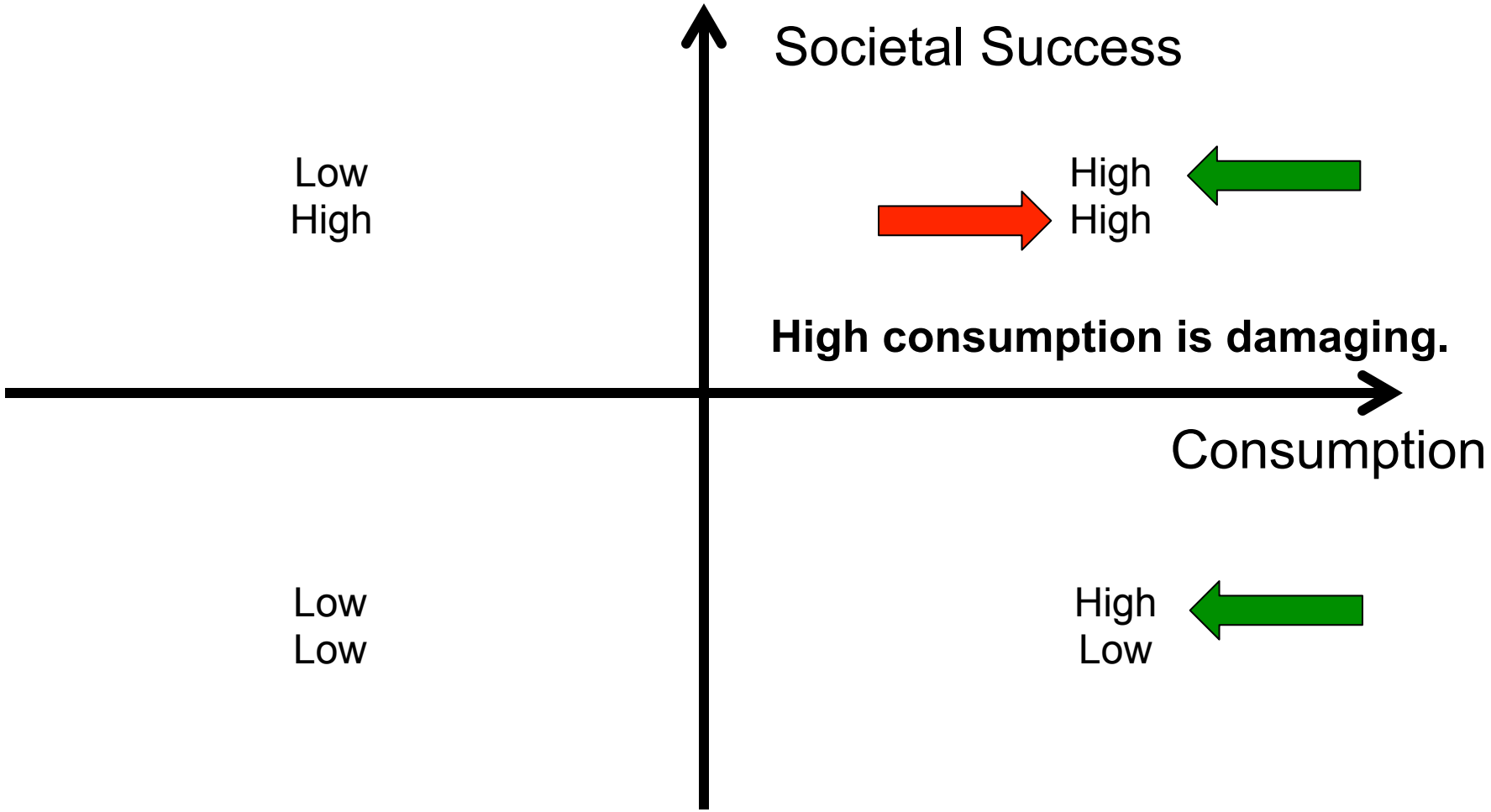
What has changed since 2005?

The Bottomless Well: Huber and Mills (2005)

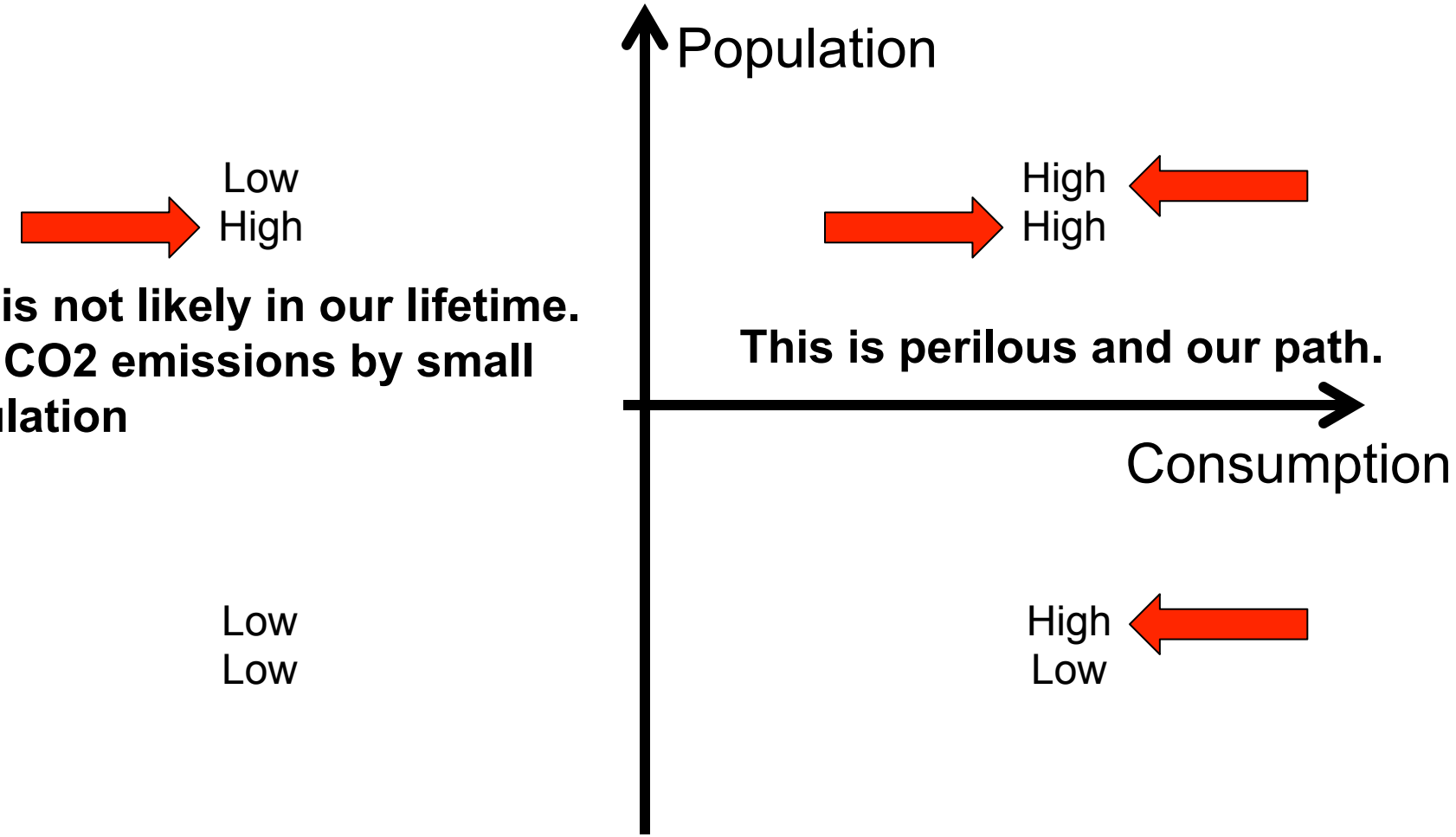
Societal Success and Energy



Societal Success and Consumption

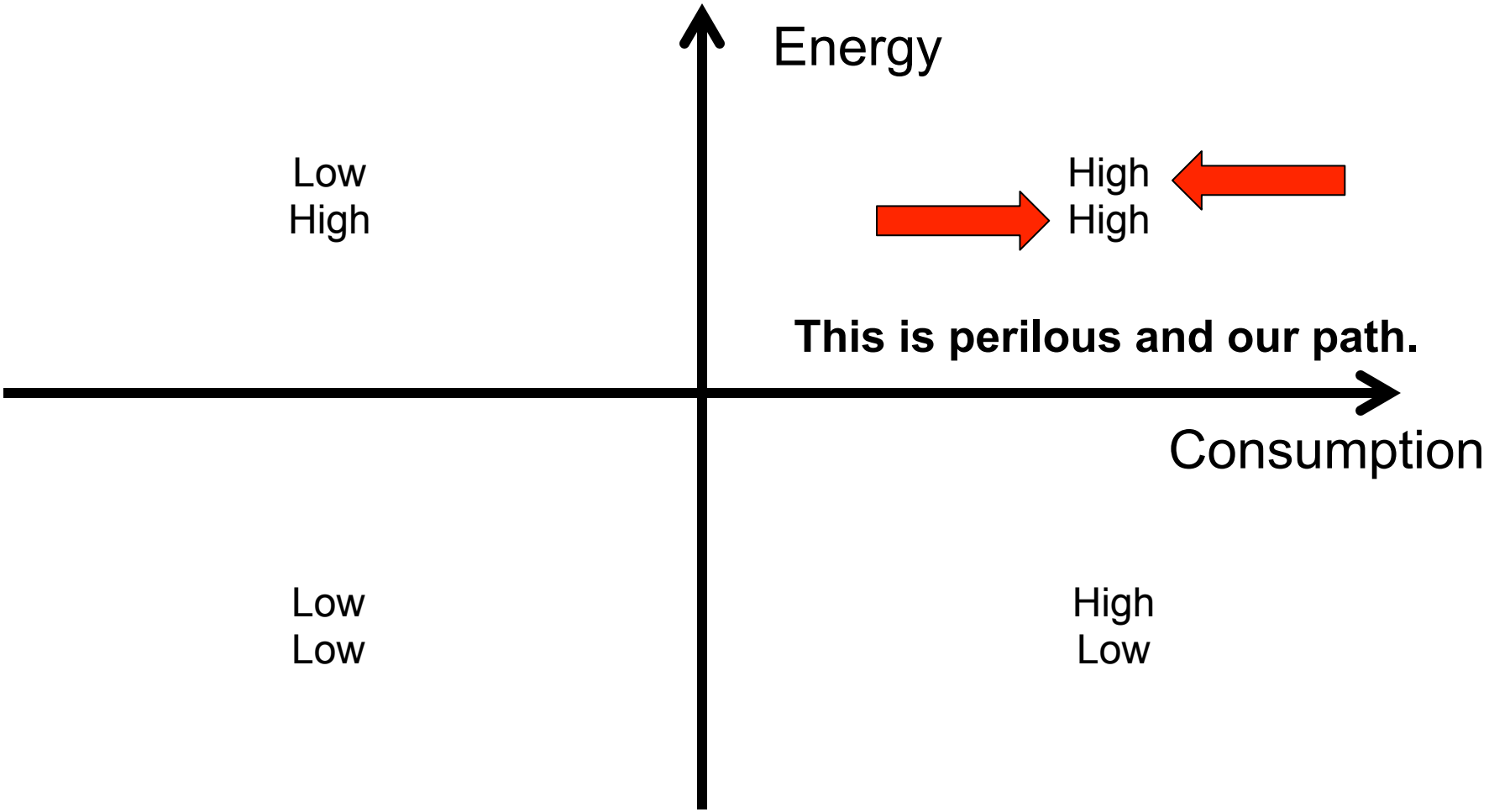


Population and Consumption



- **This is not likely in our lifetime.**
- **Past CO2 emissions by small population**

Energy and Consumption



This thought **model** leads to

- Economic success needs to be decoupled from
  - Consumption, Energy Use
- Consumption needs to be decoupled from energy use.
- Energy use needs to be decoupled from CO_2 emissions to mitigate warming.
- High population, high consumption, high energy use is not sustainable.
- Have not considered other resources and other pollutants.

Climate Change Relationships

- Climate change is linked to consumption.
  - The economy depends on us consuming
  - Consuming generates the waste that causes climate change.
  - The consumption that has set us on this road of global warming has been by a relatively small percentage of the population.
    - Wealth is an important variable.
    - Hence, social equity is an issue.

Solution Space: For Warming Problem

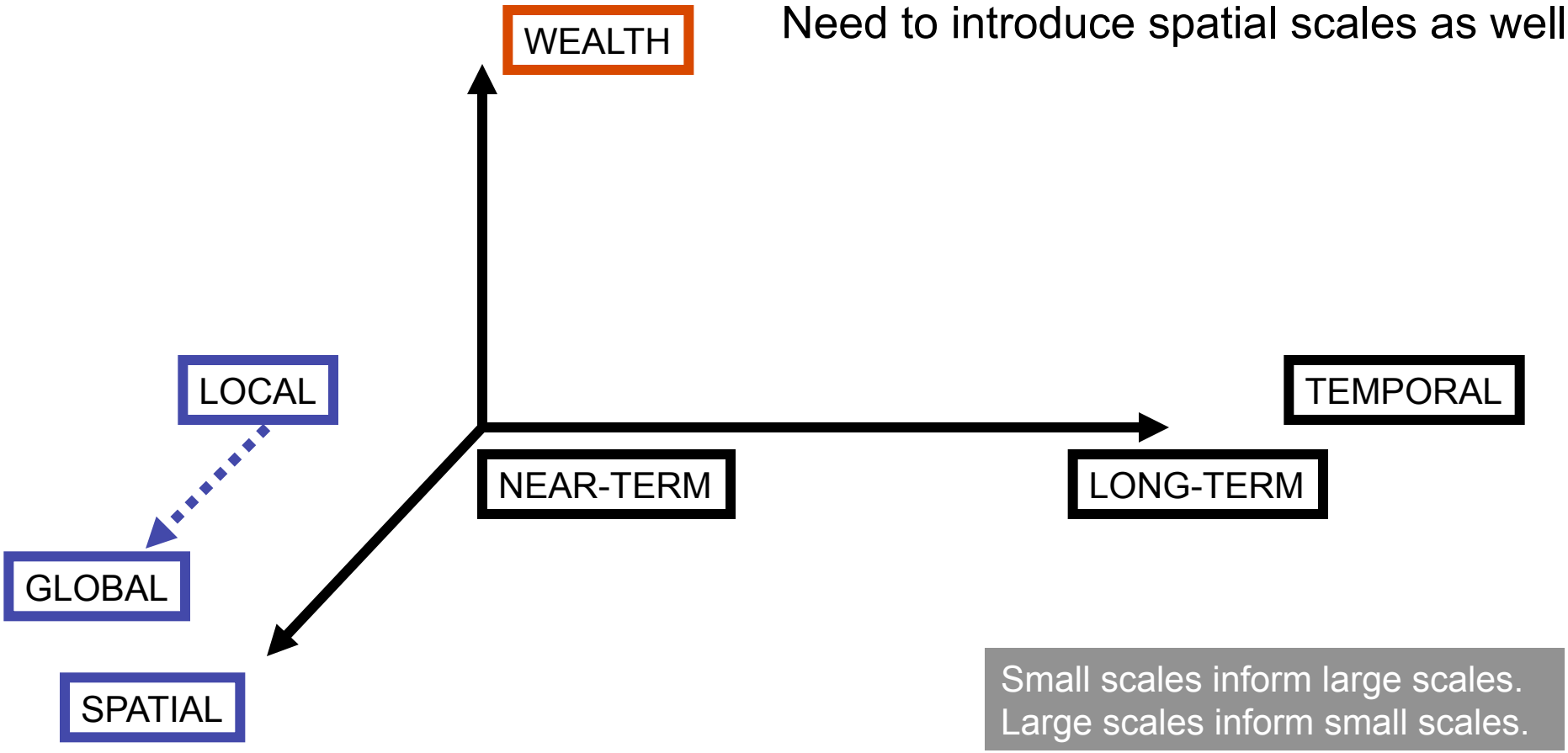
- Our current behavior suggests the most desired solution is high energy, high consumption, which leads to the need for energy use to not pollute.

- Don’t forget about water. (And a myriad of other resources and sources of pollution.)

Some challenges

- If it was not clear when you woke up this morning, climate change touches every element of society.
  - It sits in relationship with some other fundamental societal challenges.
- Solutions will be required to infiltrate all elements of society.
  - What sort of things scale to all society?

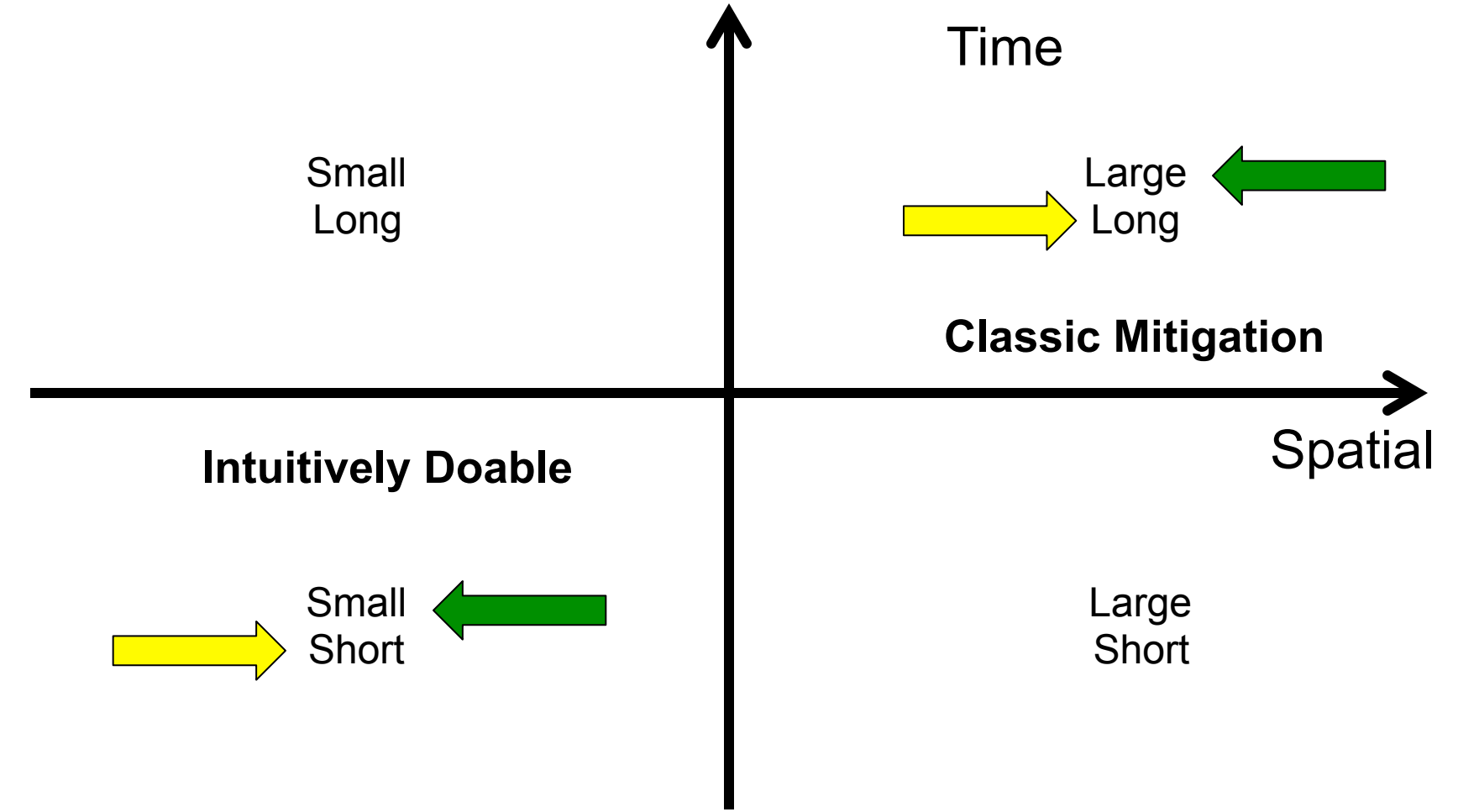
Reducing Climate Complexity



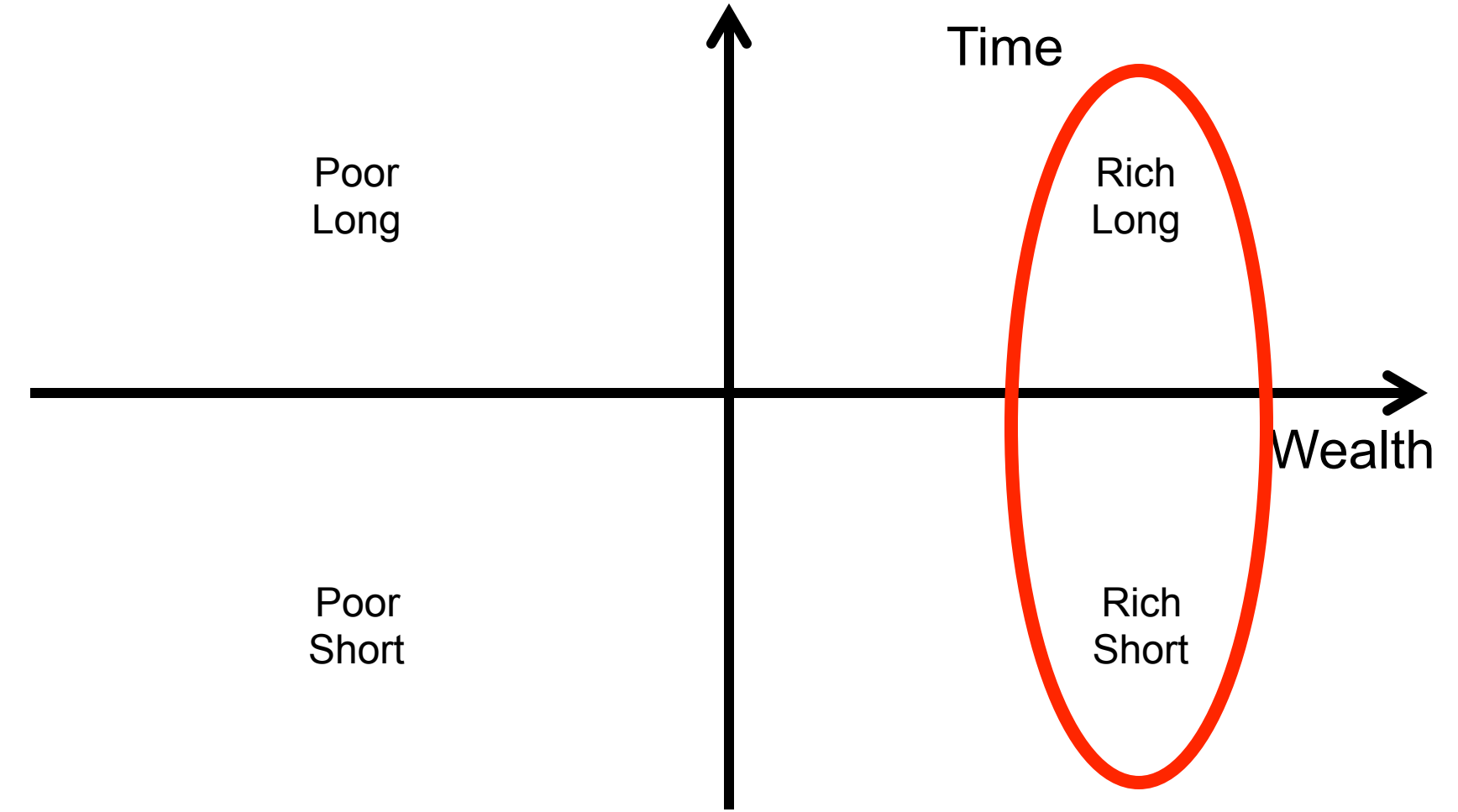
Need to introduce spatial scales as well

Small scales inform large scales.
Large scales inform small scales.

Space and Time

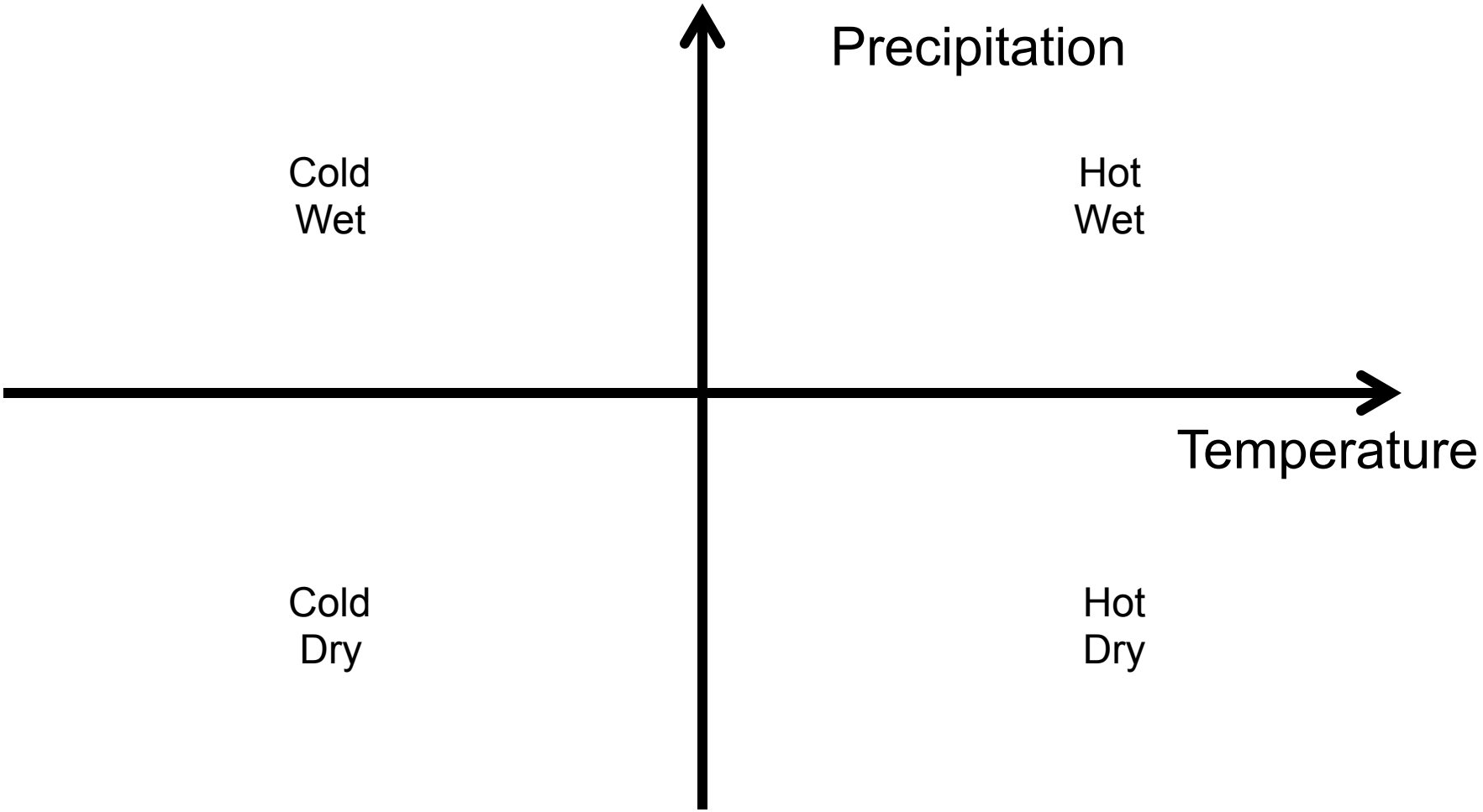


Wealth and Time



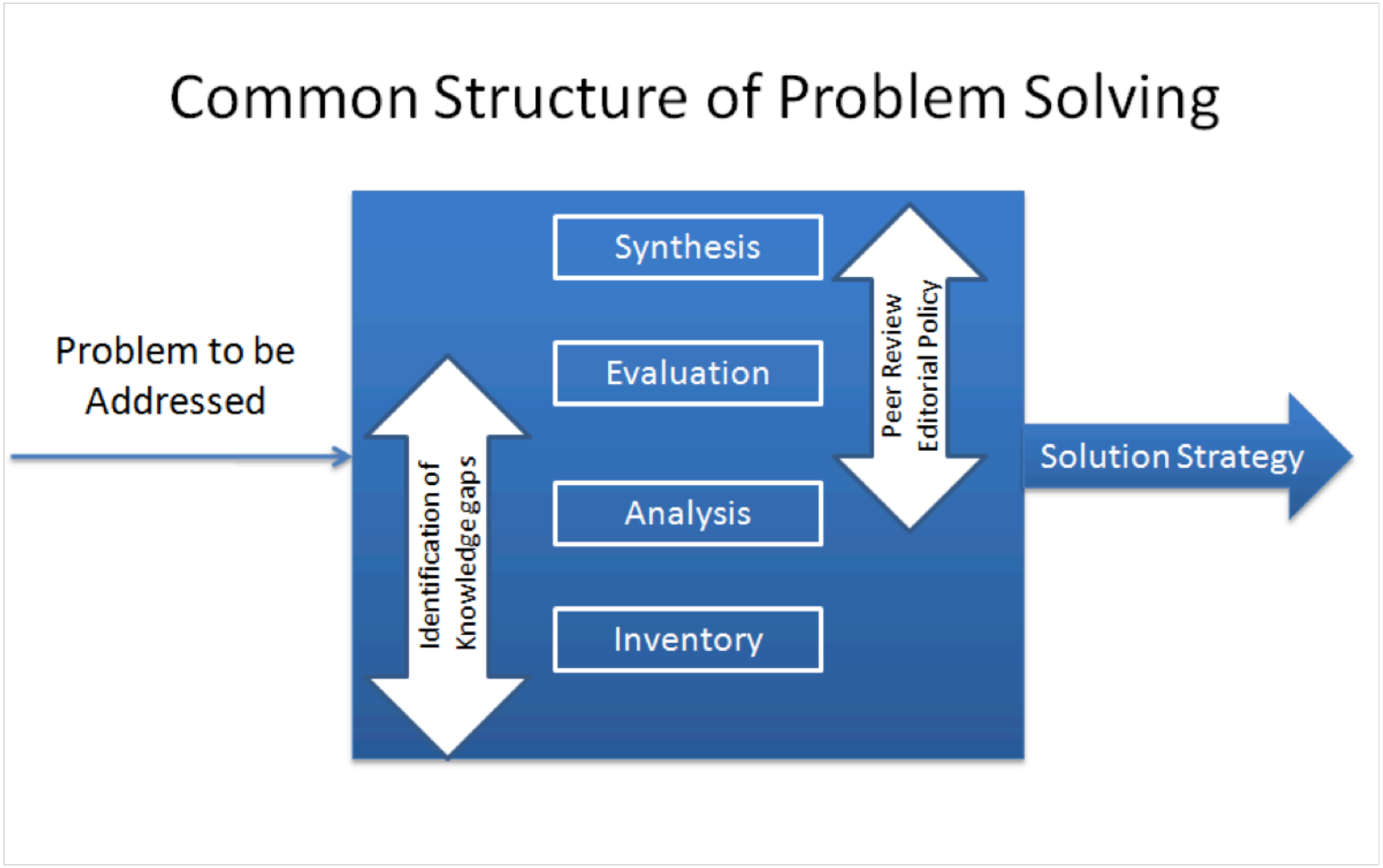
A couple of climate variables

Temperature and Precipitation



Return to Structure of Problem Solving

Structure of Problem Solving (http://glisaclimate.org/home)



What about Evaluation?

Elements of Evaluation

- Source of information
- Process for development of knowledge
  - Scientific method?
  - Simple observation
  - Externality
- Peer reviewed?
- Reproduced?

Summary: Class 3, Winter 2015

- Organization: structure and language
  - Necessary to find an anchor
- Knowledge system / examination of successful problem solving
  - Brings attention to end-to-end system
  - Reveals importance of interfaces
  - Interpretation, translation
  - Iterative, negotiation
  - Human aspects
- Breaking the problem down →
  - Temporal, spatial, wealth, cultural values and norms
- The need to evaluate data, information and knowledge

Summary: Class 3, Winter 2015

- Evaluation: An important part of the climate knowledge system is the need to evaluate the suitability of data, information and knowledge for a particular application. The unmet need for evaluation stands as a barrier to delivering the most appropriate and readily usable data for particular purposes.
  - Salience

Summary: Class 3, Winter 2015

- Human "Experts": Human experts are an integral part of the knowledge system. Learn early to identify the needed expertise, stakeholders, find them, and involve them in problem solving. To accelerate problem solving focus on organization of human expertise and improving the efficiency of the human expert.
  - This is often contrary to the schoolbook approach of individuality, testing unique contributions. A paradigm shift.