Collapse

A Systems Perspective

Dr. David Gould

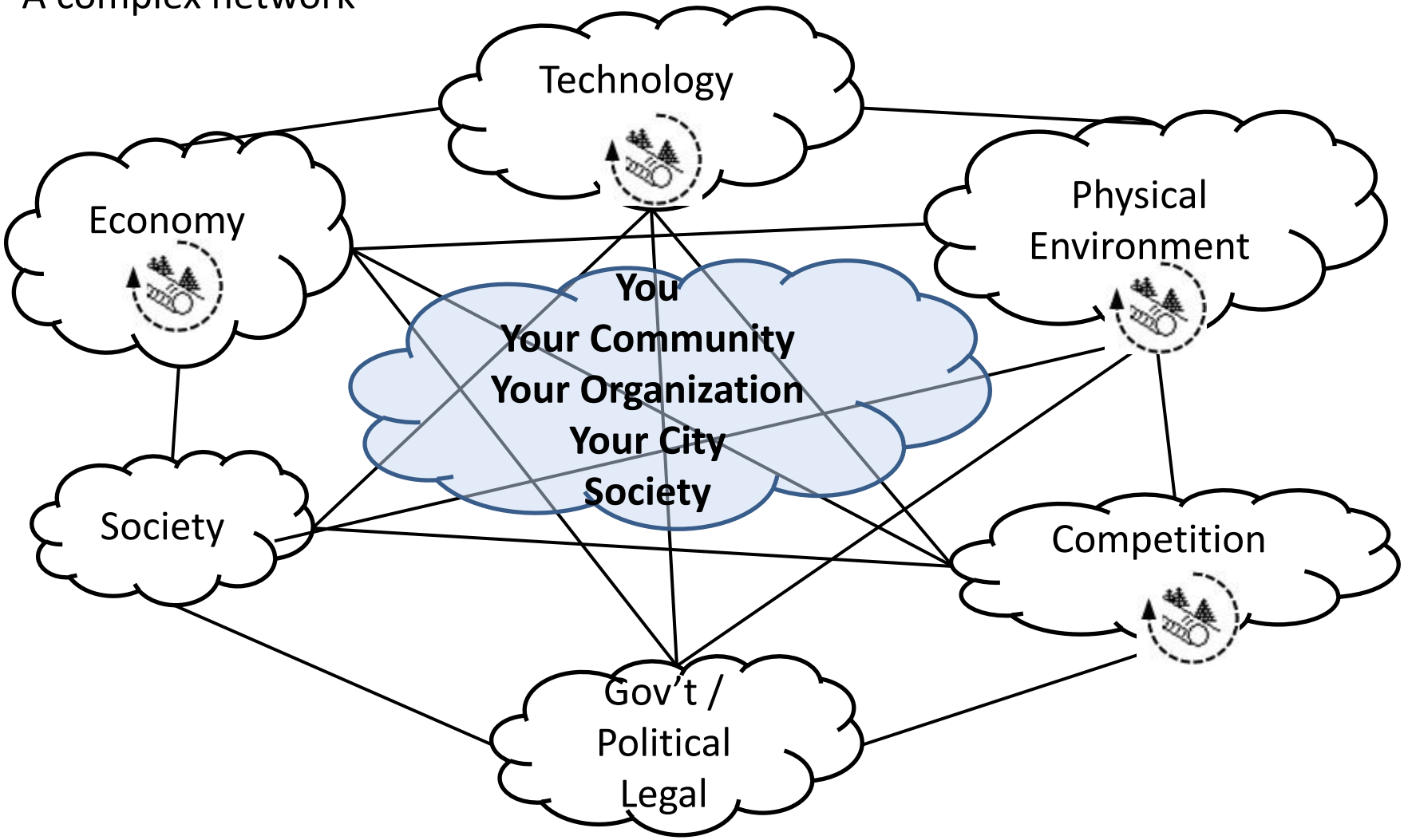
Complex Systems

A complex system is a group of “agents” existing far from equilibrium, interacting through positive and negative feedbacks, forming interdependent, dynamic, evolutionary networks, that are sensitive dependent, fractionally organized, and exhibit avalanche behavior (abrupt changes) that follow power-law distributions.

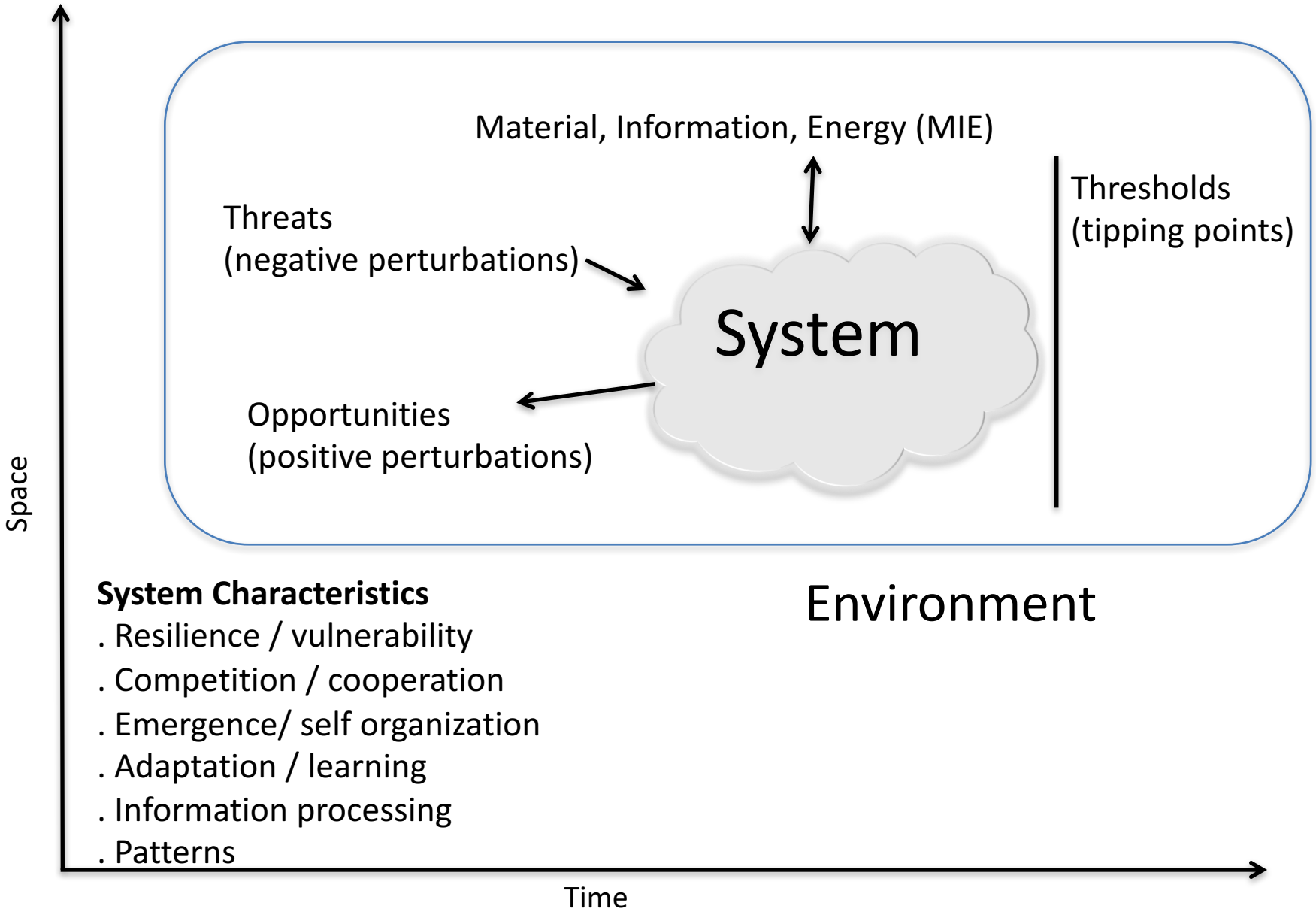
Fichter, L.S., Pyle, E.J., & Whitmeyer, S.J. (2010). Strategies and Rubrics for Teaching Chaos and Complex Systems as Elaborating, Self-Organizing, and Fractionating Evolutionary Systems. *Journal of Geoscience Education*. *58*(2)

The Environment (for Social Systems)

A complex network



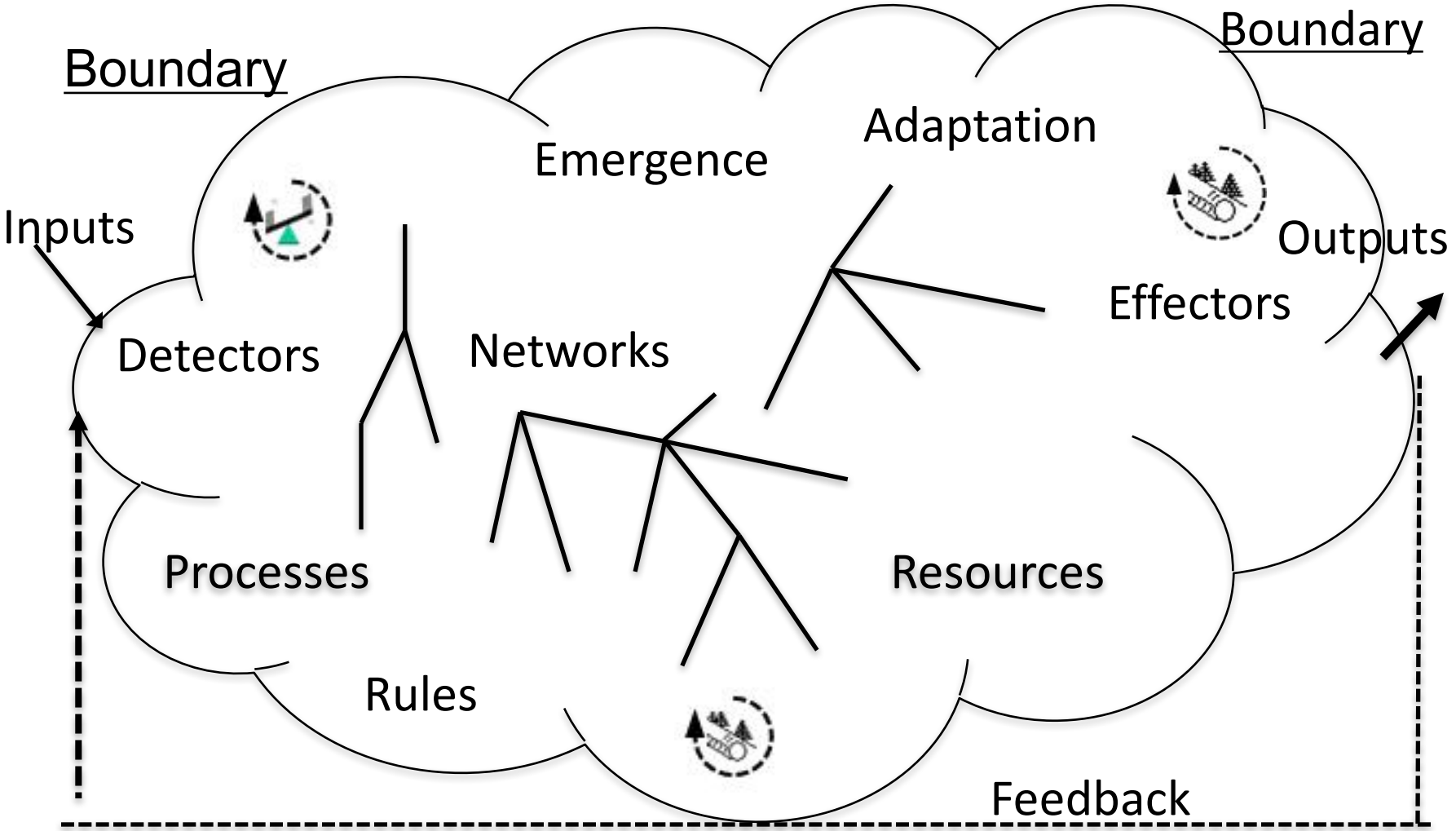
A Complex Systems Model



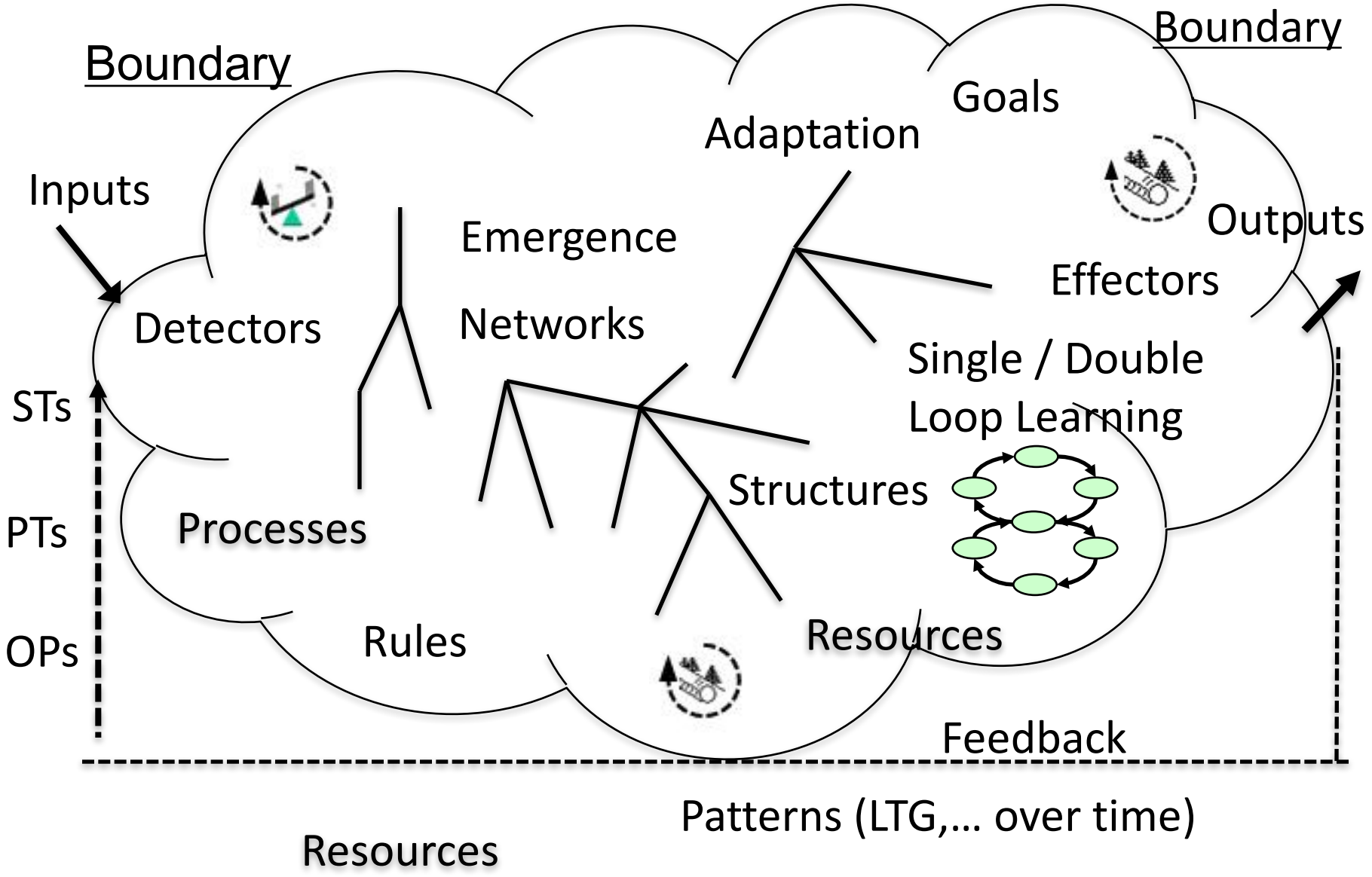
System Characteristics

. Resilience / vulnerability
. Competition / cooperation
. Emergence/ self organization
. Adaptation / learning
. Information processing
. Patterns

Complex Systems Model



Complex Social Systems Model



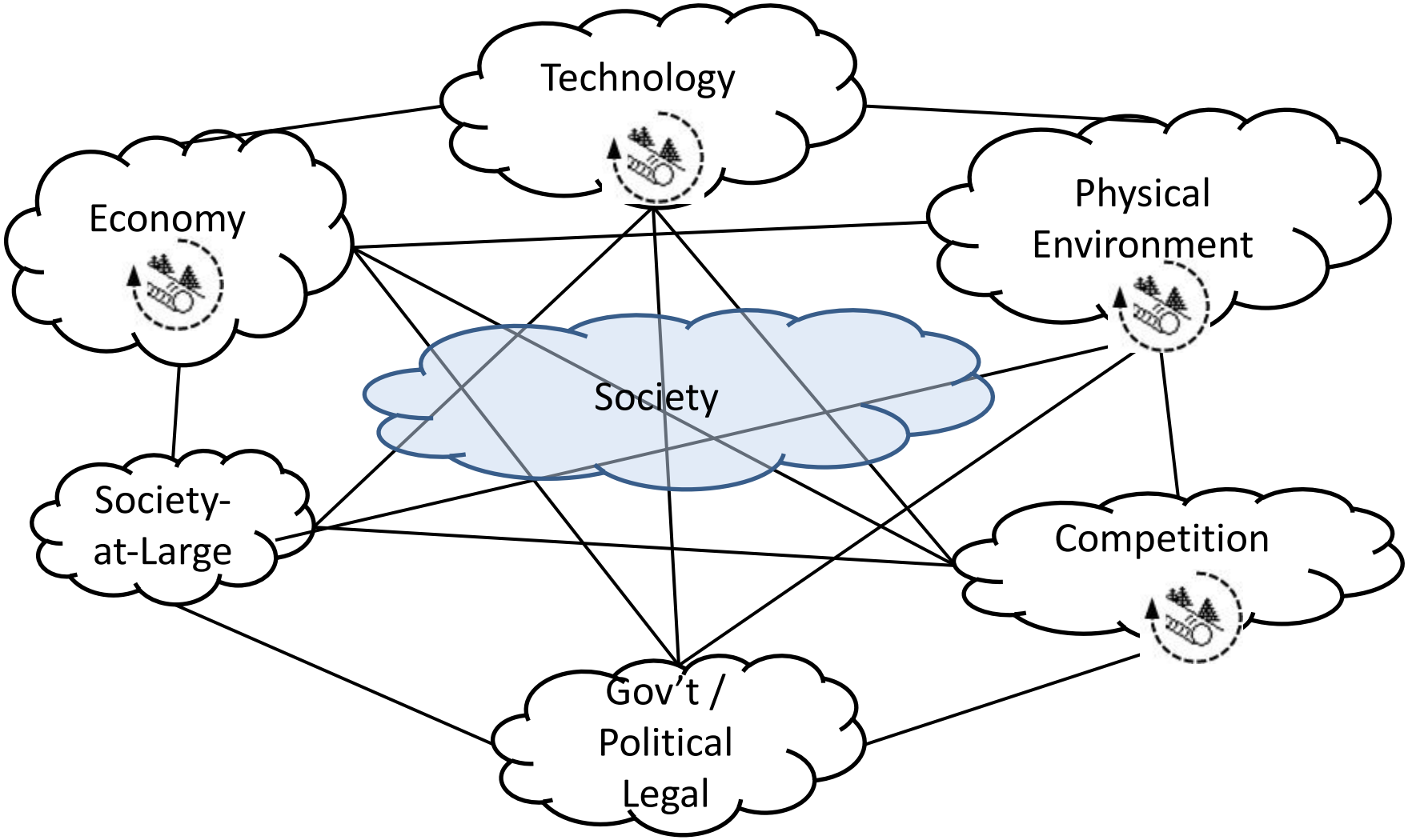
Collapse

- Systems, including societies, may fail or collapse for one or a combination of a variety of factors
- External perturbations may affect the flow of material, information, and energy (MIE) to or from a system.
- External perturbations may be threats or opportunities
- Threats may overwhelm or change a system by disrupting the flow of MIE
- Opportunities may offer a possibility to improve a system.

Collapse

- Strengths and weaknesses are internal to a system
- Weaknesses within a system may cause it to fail or collapse, such as a failure or inability to respond to a threat
- A systems strengths may stop a threat, mitigate a threat, or help a system adapt to a threat.

System Collapse or Failure



Collapse (cont)

- From the systems model (previous page).
  - Human social systems are dependent on their environment
  - Human social systems are dependent on resource supplies (within a range) of MIE
  - Changes (perturbations) to MIE supplies flowing into a system or out of a system may result in threats or opportunities

Collapse (cont)

- Exogenous perturbations to a social system may cause it to fail or collapse
  - Physical Environment (climate change, pests disease, viruses, pollution, wildfires, earthquakes …)
  - Economics (The law of diminishing returns, disruption of MIE from suppliers, recessions, depressions, …)
  - Competition (war, conflict, disruption of MIE,)
  - Technology (unable to keep up with advanced technology)
  - Society-at-large (disruption of MIE flows)
  - Political (war, conflict, terrorism, ….)

Collapse (cont)

- Endogenous perturbations within a social system may cause it to fail or collapse
  - Technology (insufficient to meet social, economic, or environmental requirements)
  - Physical Environment (infrastructure failures such as the electronic grid, roads, bridges, water, ..; unable to keep up with demands, …
  - Society-at-large (apathy, unable or unwilling to learn, rejection of science and evidence, extreme inequality, lack of talent and expertise, inability or willingness to lead, inability or unable to respond to threats or risks …)
  - Political (civil war, conflict, domestic terrorism, ….)

Top 5 Global Risks

2020 Global Risks Report (weforum.org)

1. Extreme Weather
2. Climate Action Failure
3. Natural Disasters
4. Biodiversity Loss
5. Human-made Environmental Disasters

In Terms of likelihood

Top 5 Global Risks

2020 Global Risks Report (weforum.org)

1. Climate Action Failure
2. Weapons of Mass Destruction
3. Biodiversity Loss
4. Extreme Weather
5. Water Crisis

In Terms of Impact

Today's Top Risk

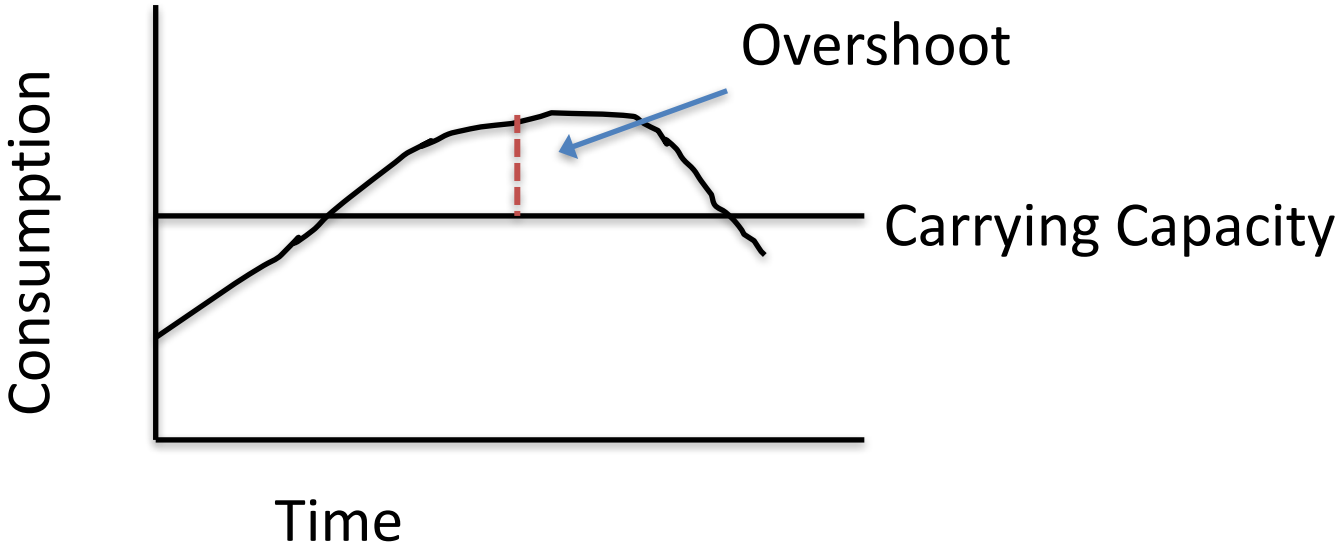
Coronavirus

- Coronavirus was recognized in January 2020, perhaps earlier in the US and after the World Economic Forum published their Global Risks Report.
- And coronavirus has now pushed the world into an economic recession / depression as of April 2020.
- Yet, climate risks as described by the World Economic Forum and not going away.
- This leads to a "perfect storm" of three existential threats: a pandemic, an economic depression, and climate change.
- As of May 2020, the US federal response is essentially missing, while some states have engaged.
- As of May 2020, the outcome of addressing these risks is uncertain.

Essentially systems fail or collapse when a system-threatening problem cannot be solved.

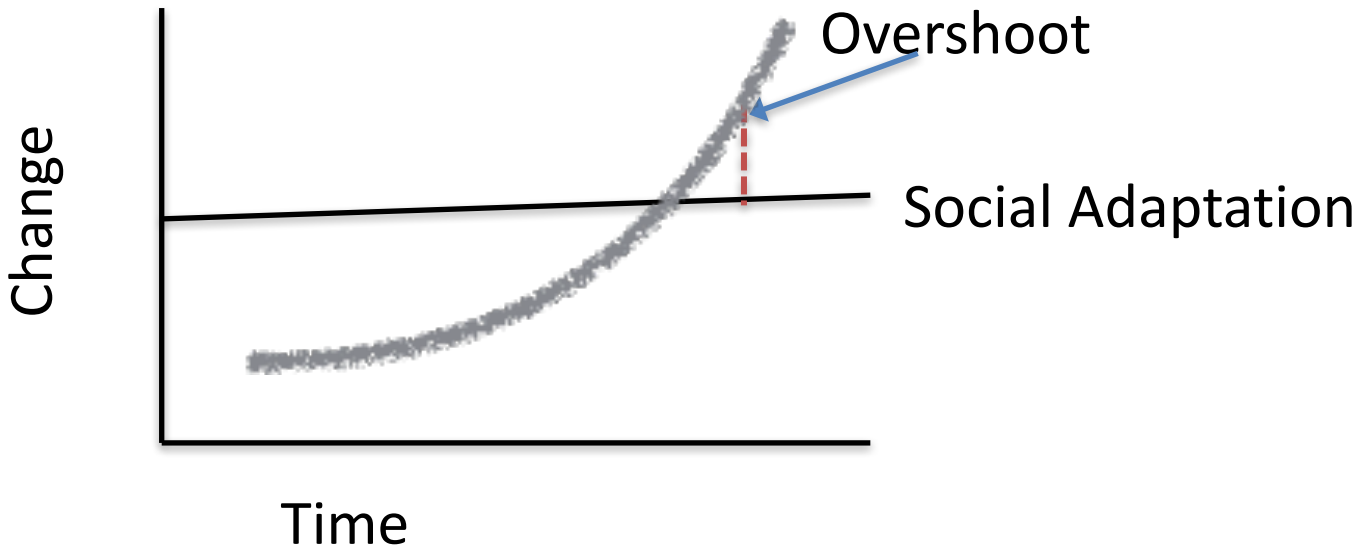
- Adapted from Arnold Toynbee

Collapse (overshoot)



Overshoot occurs when a population exceeds the carrying capacity of its environment. Note: The carrying capacity varies depending on factors in the environment such as the availability of food and water, climate change, ….

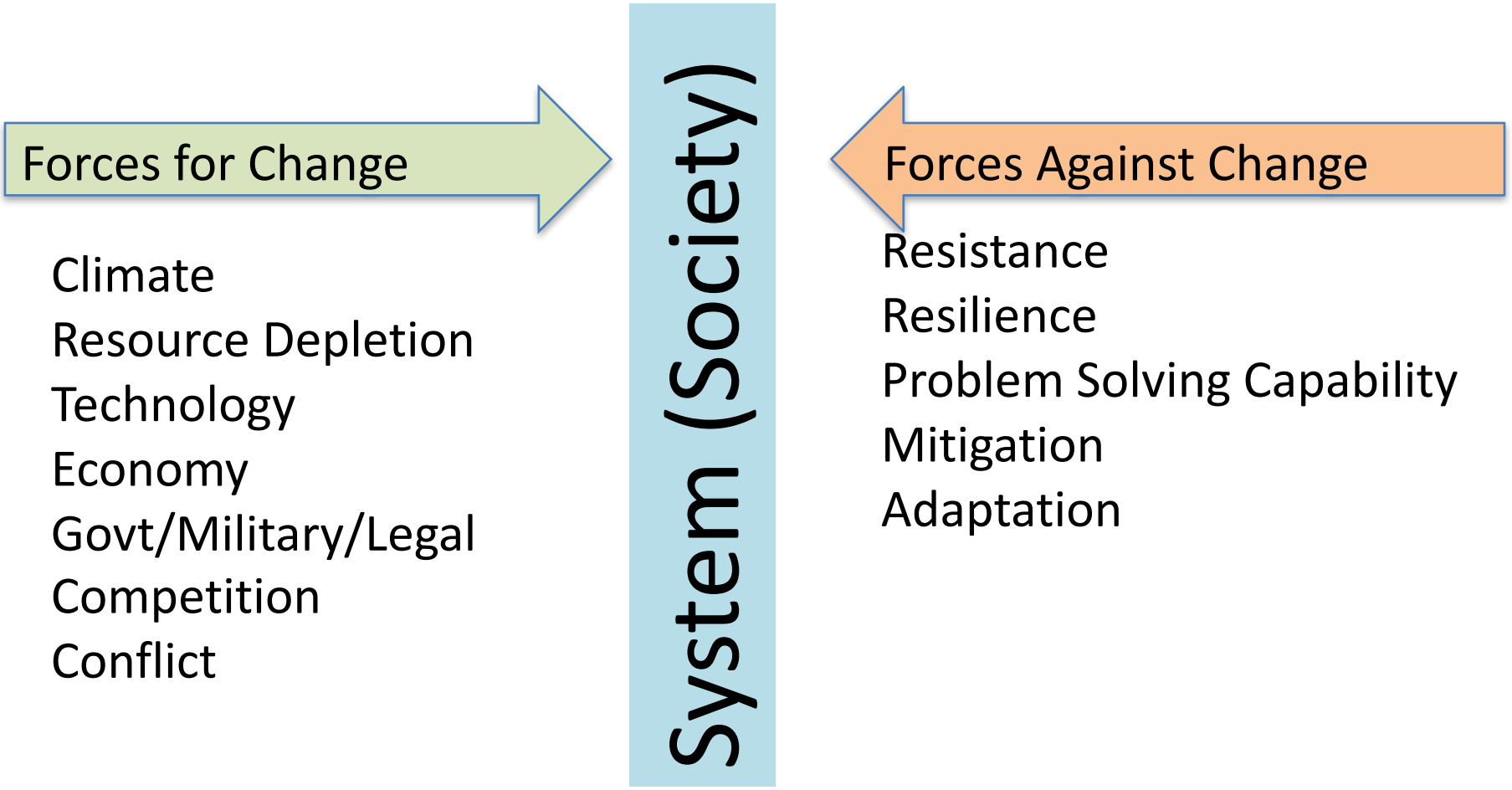
Social Overshoot



Social overshoot occurs when environmental change exceeds the ability of a social system to adapt. Note: environment change includes economic, technological, physical environmental, government / military / legal, and / or competitive changes. What might happen when social adaptation cannot keep up?

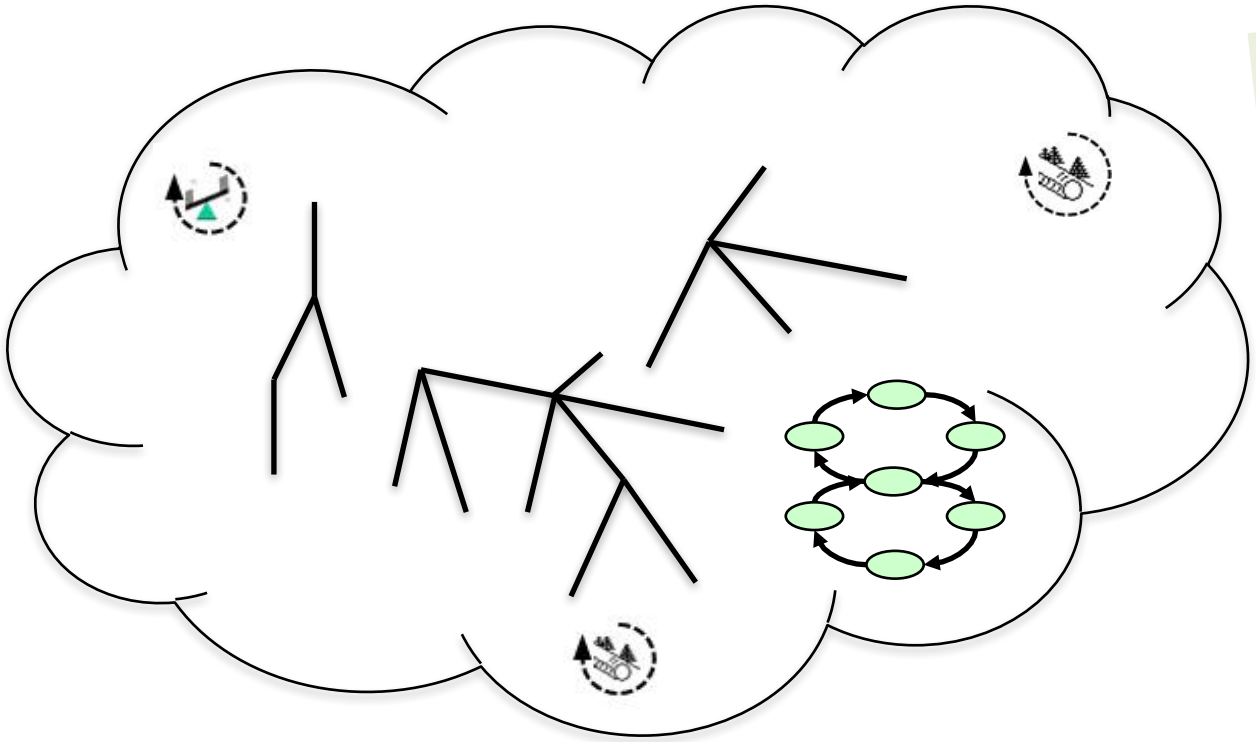
Force Field Analysis

Example



Complex Social Systems

Behavior Patterns Over Time



Equilibrium

Periodic

Random / Chaotic

Complex

Perturbing a system results in one of four possible system outcomes: equilibrium, periodic, chaotic, or complex.

Note: equilibrium means stable, possibly because of systems failure / collapse

Theories

- Jared Diamond
  - As described in his book, Collapse. Nonsustainable exploitation of resources, climate change, diminishing support from friendly societies, hostile neighbors, and inappropriate attitudes for change.[1]
- Joseph Tainter
  - Societies exhaust their own designs and are unable to adapt
- Arnold Toynbee
  - “They find problems they cannot solve.”
- Thomas Homer-Dixon
  - EROI or energy returned on energy invested. Societies need energy to maintain it and if the costs of obtaining additional sources becomes too expensive, society will decline …

Collapse

Some thoughts at this point..

References

- Adizes, A. (1999). *Managing corporate lifecycles*. Paramus, NJ: Prentice-Hall.
- Diamond, J. (2013). *Collapse: How societies choose to fail or succeed (Revised edition*). New York, NY: Penguin.
- Tainter, J. A. (1990). *The collapse of complex societies*. New York, NY: Cambridge University.