Introduction to Systems Thinking for Wildlife Disease Management

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6th cycle Training of National Wildlife Focal Points
World Organisation for Animal Health
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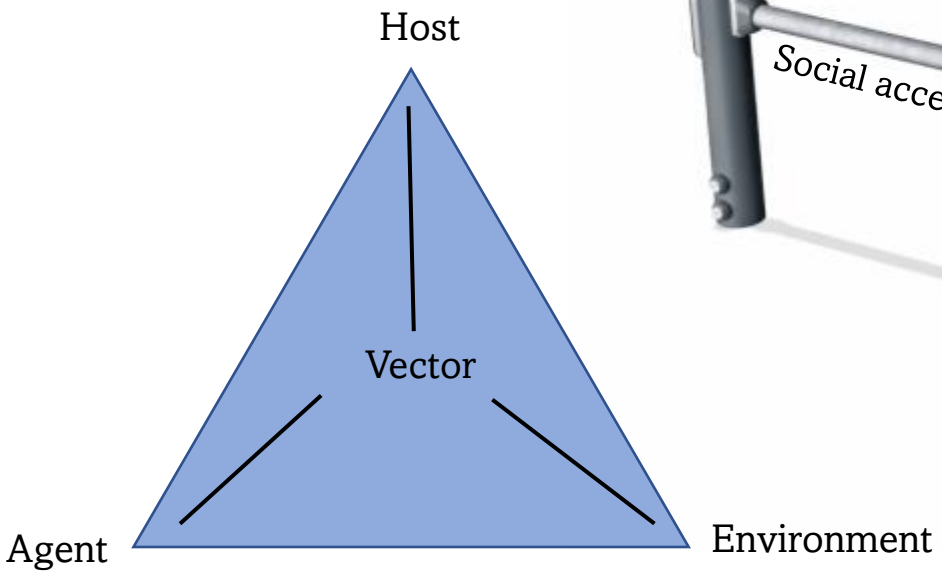
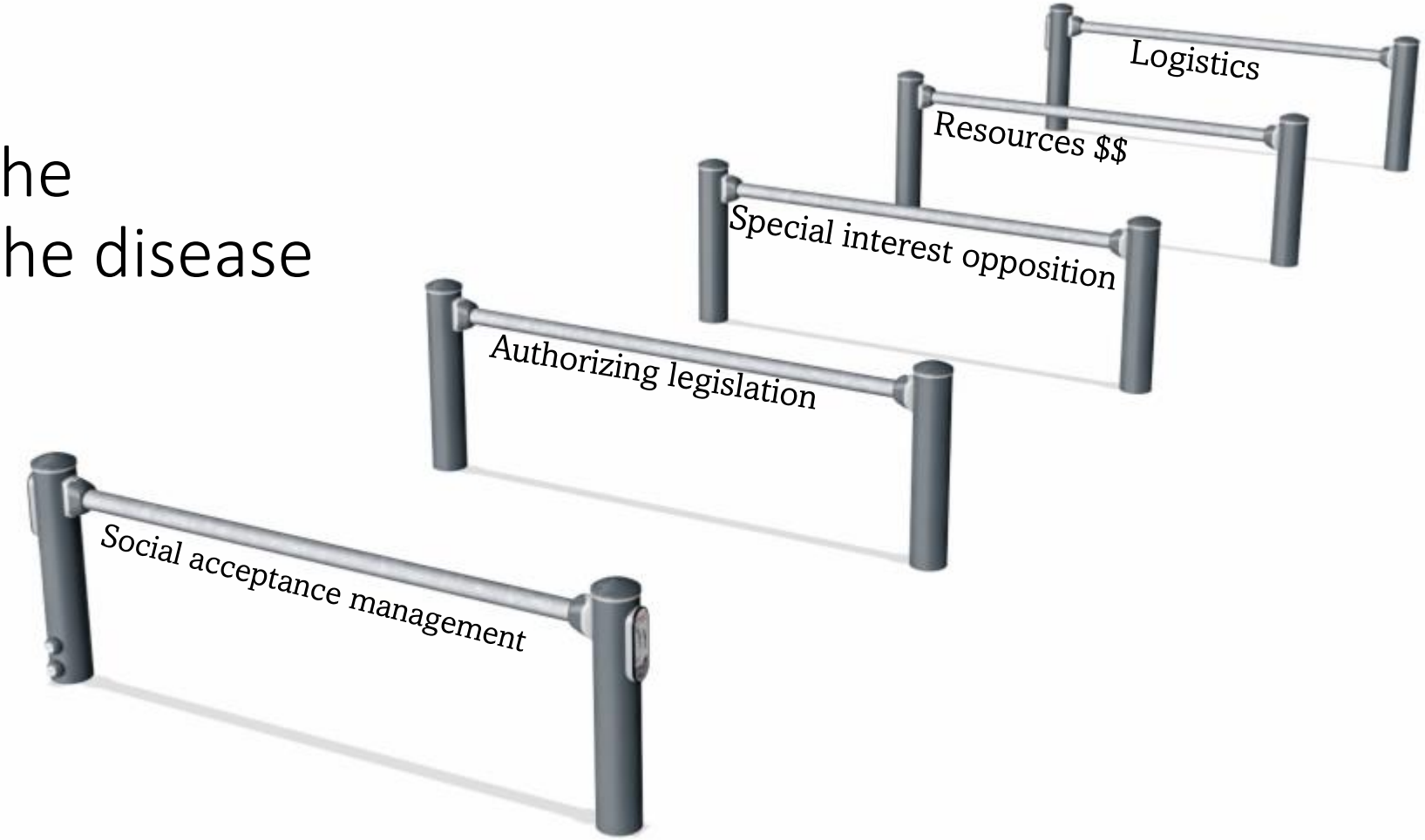
Impediments to managing disease

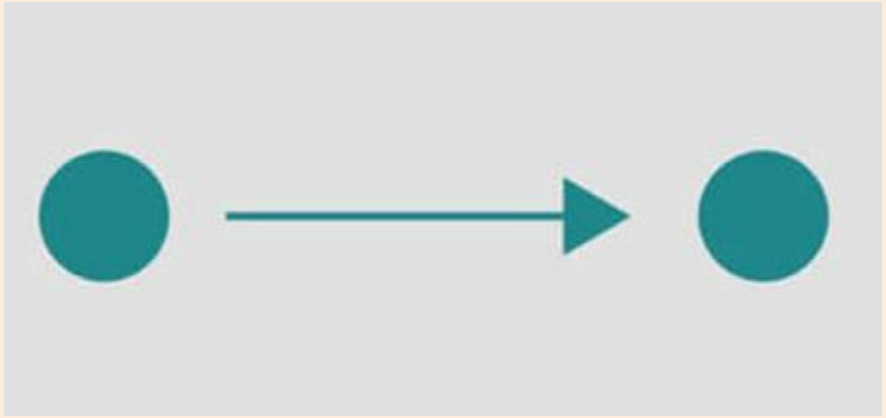
- Development/use of techniques can be resource intensive (e.g., vaccines, fencing, culling)
- Can be difficult to disperse to wild animals (e.g., vaccines)
- Some pathogens can persist in the environment
- Some control mechanisms (e.g., insecticides) can have serious environmental side effects or result in selective pressure for resistant organisms
- Actions can sometimes be counterproductive and spread the disease to new areas (e.g., dispersal and density reduction)
- Actions can be highly controversial (e.g., depopulation of wildlife)

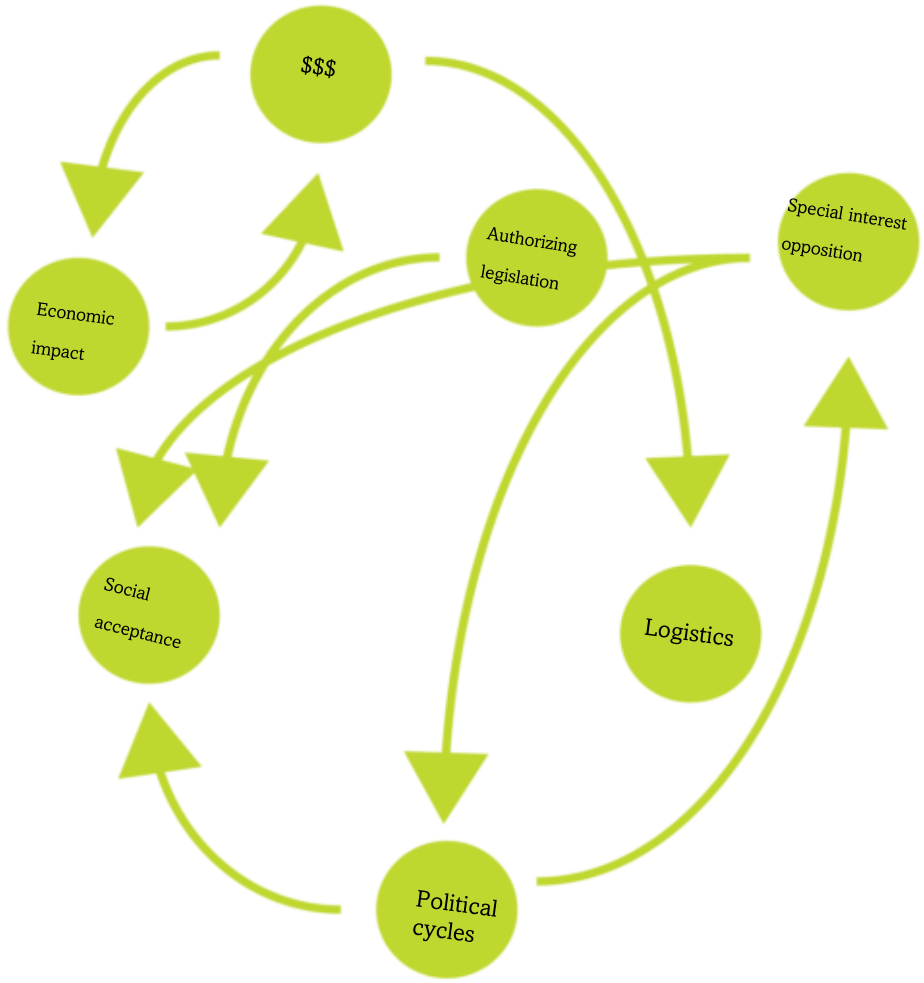
The Triad is only the epidemiology of the disease





The hurdles to management are not linear problems



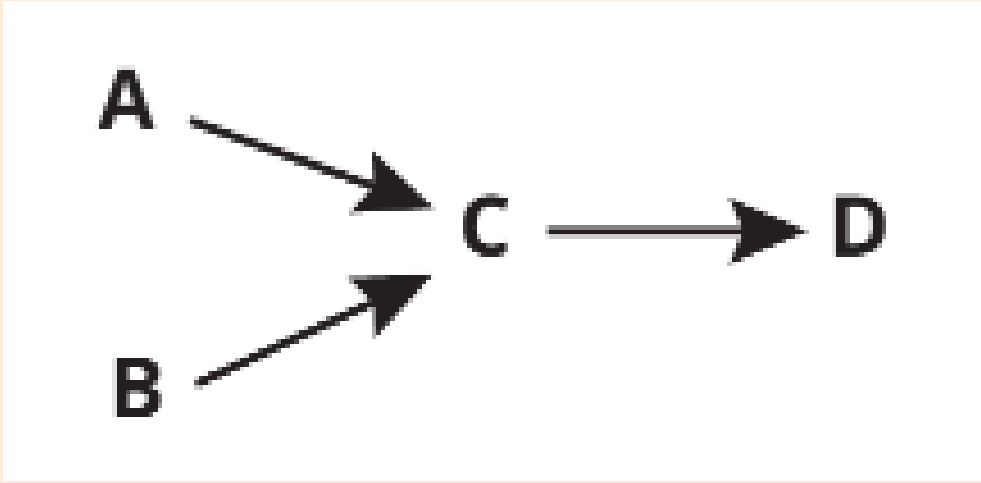


What is systems thinking?

System: A set of interacting elements that function together to produce a certain outcome

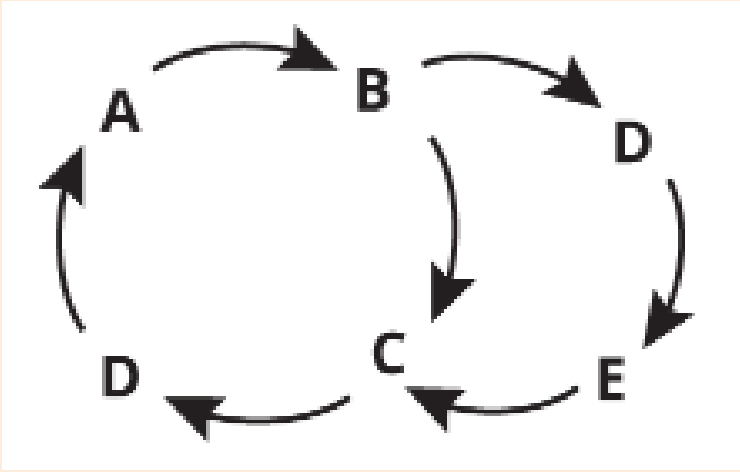
Systems can be simple

- Simple systems have clear cause and effect
  - Reductionist techniques work well for problem-solving
    - Reductionist: Reducing to components



Systems can be complex

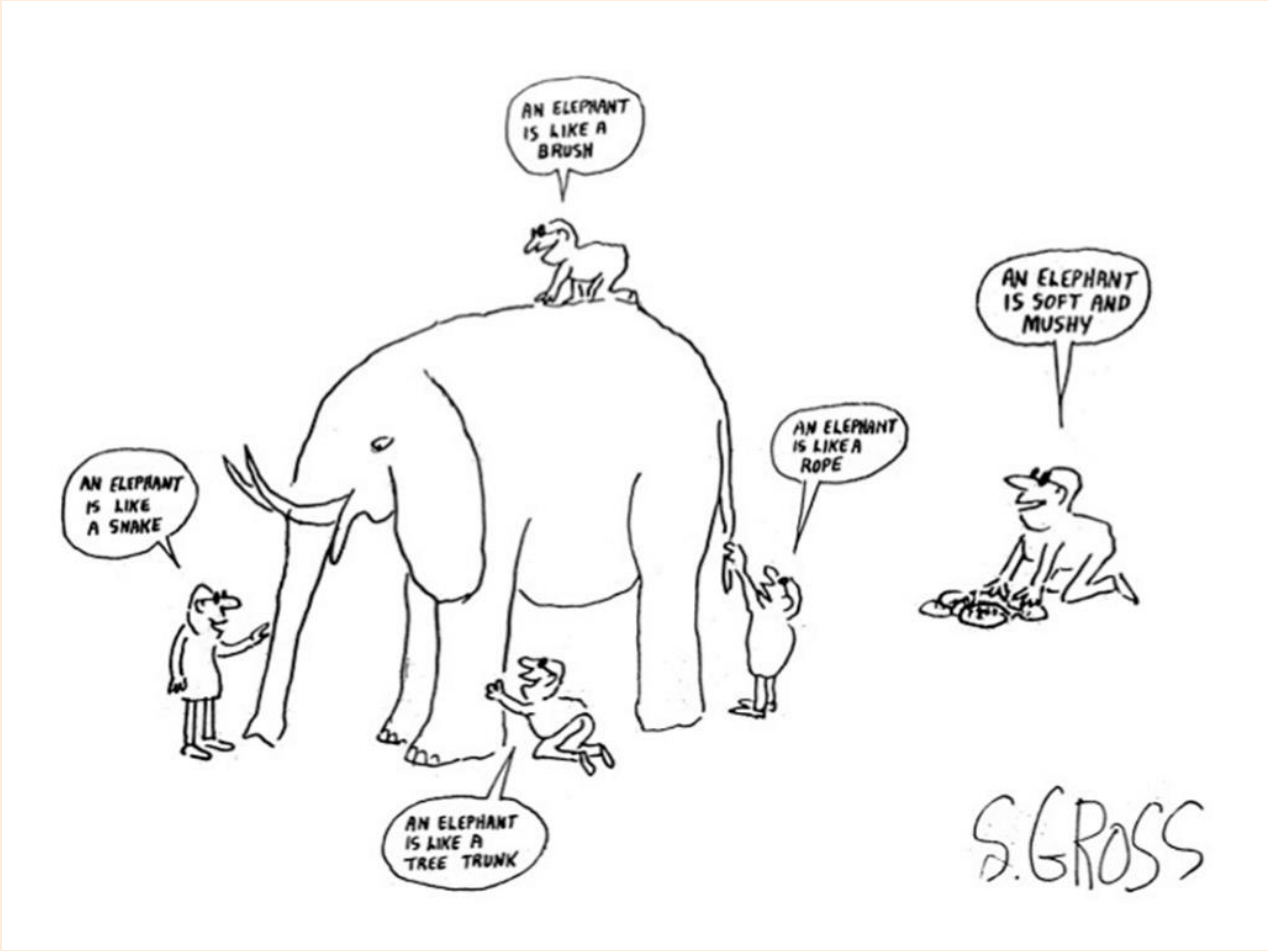
- Complex systems lack clear cause-effect relationship
  - Holistic approaches to problem-solving are needed
    - Holistic: Relating to the whole rather than the parts
  - Can create persistent problems due to system stability and resistance to change
  - Often involve social, economic, or political factors



System Behavior

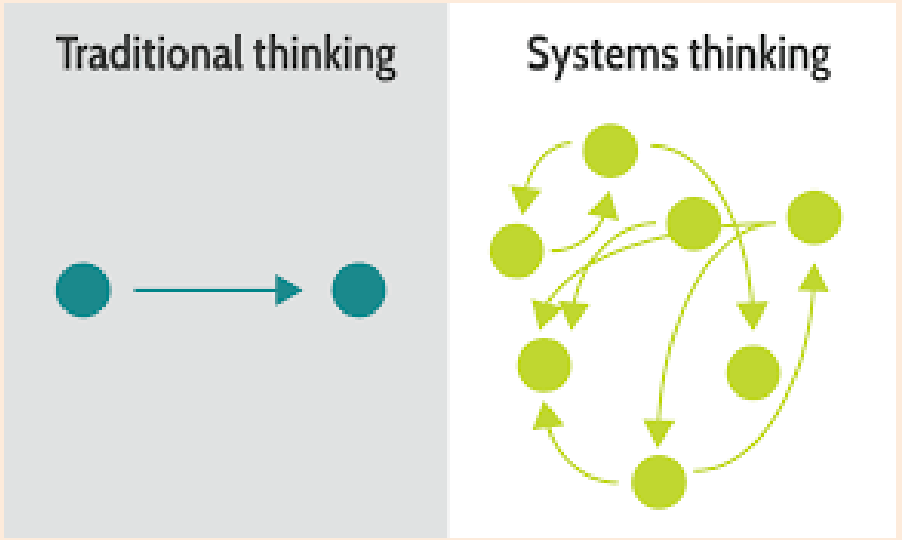
The behavior of the system cannot be known by only knowing the elements of the system.

– Donella Meadows

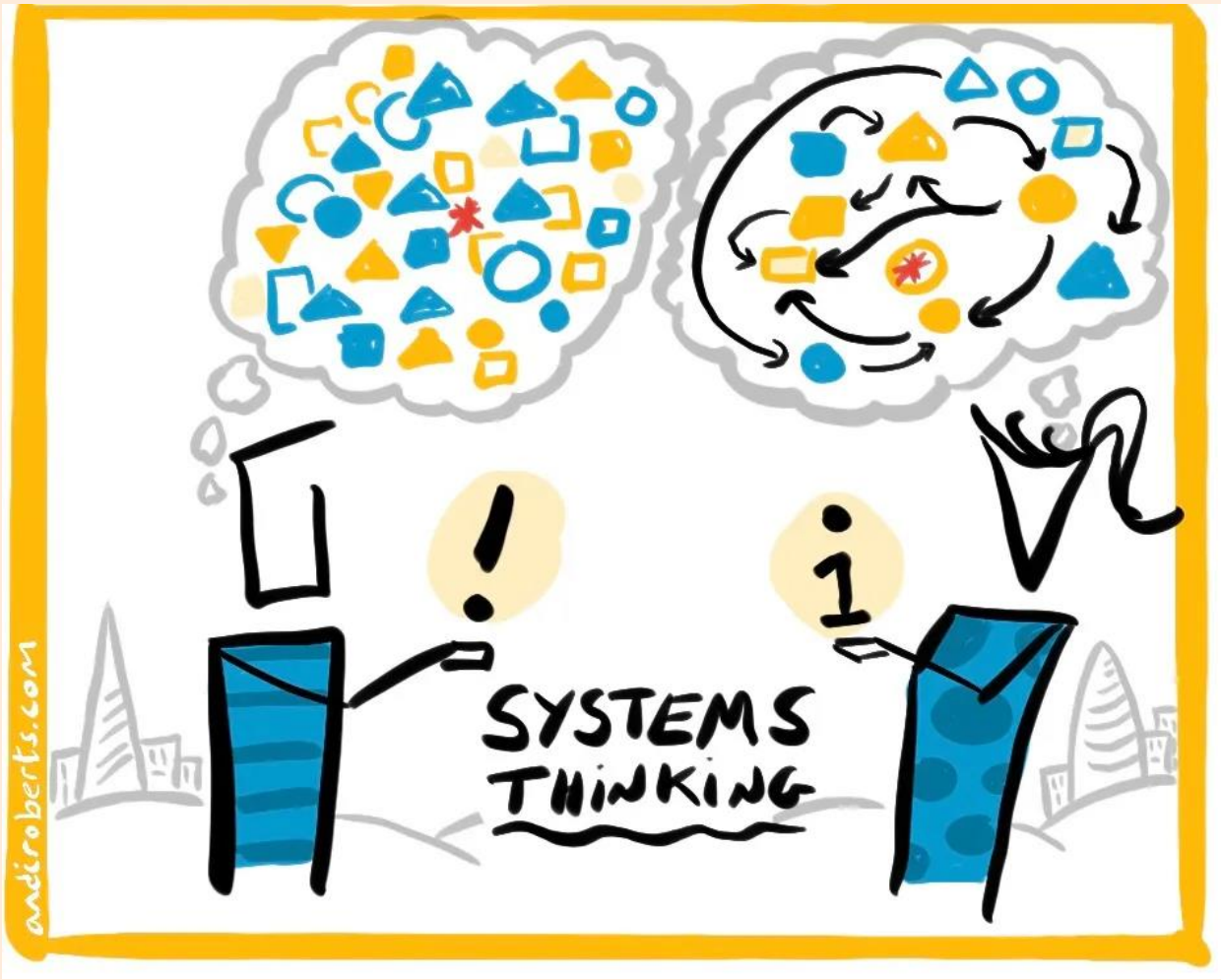


Benefits of Systems Thinking

- Improves understanding of complex problems
- Highlights static and dynamic elements (relationships and behavior)
- Allows discovery of new intervention points
- Help recognize hidden and unintended consequences
- Help push behavioral change
- Help look for small changes that can have meaningful impacts
- Improves understanding of complex problems

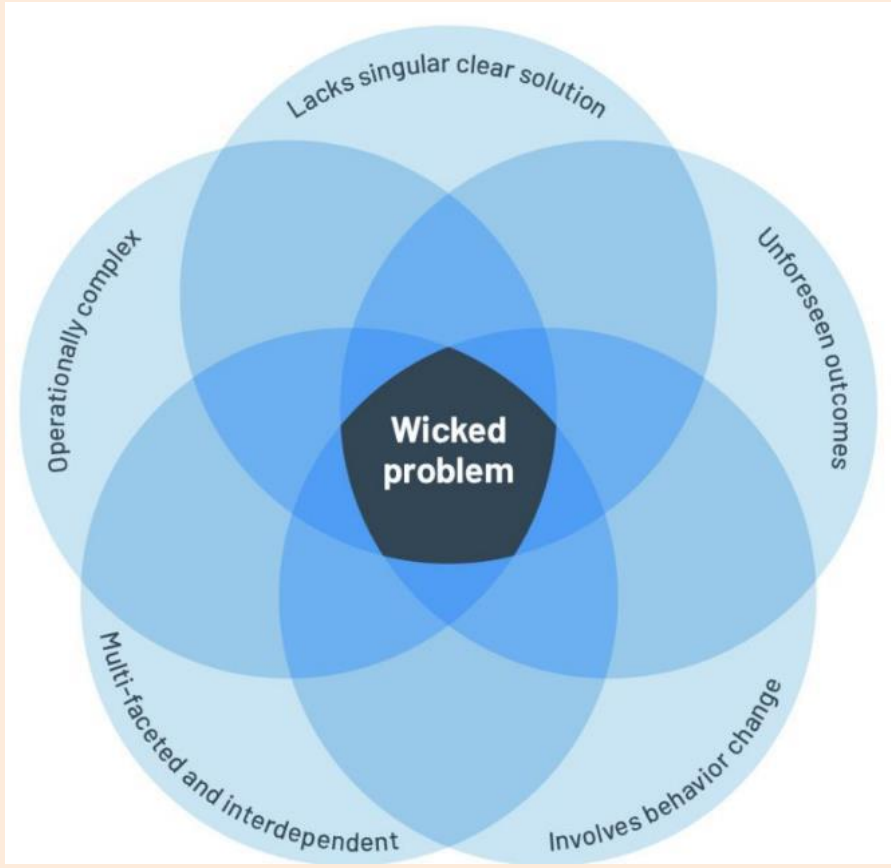


When Should We Use Systems Thinking?



"Wicked" Problems

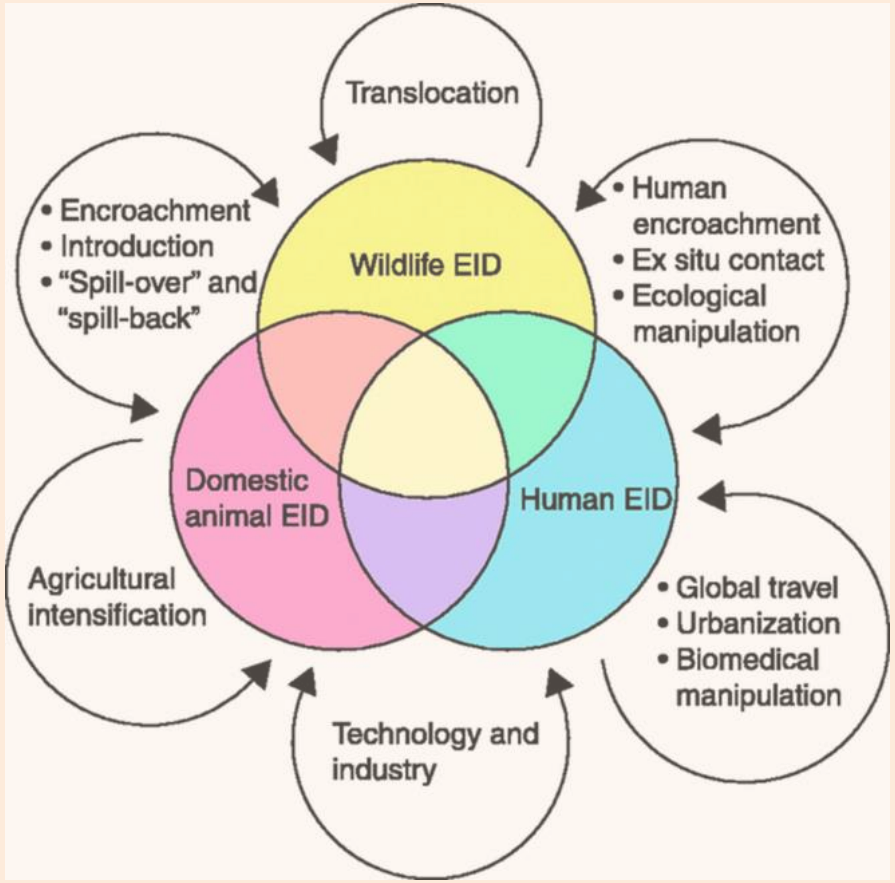
- The problem is longstanding and attempts to solve it have failed
- There are multiple perspectives on the cause of the problem and what should be done
- Diverse stakeholders find it difficult to align their efforts; people are working on many different elements at the same time
- Actions may have unintended consequences



https://www.intapp.com/blog_posts/tackling-wicked-problem-firm-leadership-continued-success-conundrum-part-1/

Is management of wildlife disease a wicked problem?

- Drivers of wildlife disease are complex and often involve interconnected ecological and social factors
- Stakeholders are diverse
- Management actions can have unintended consequences

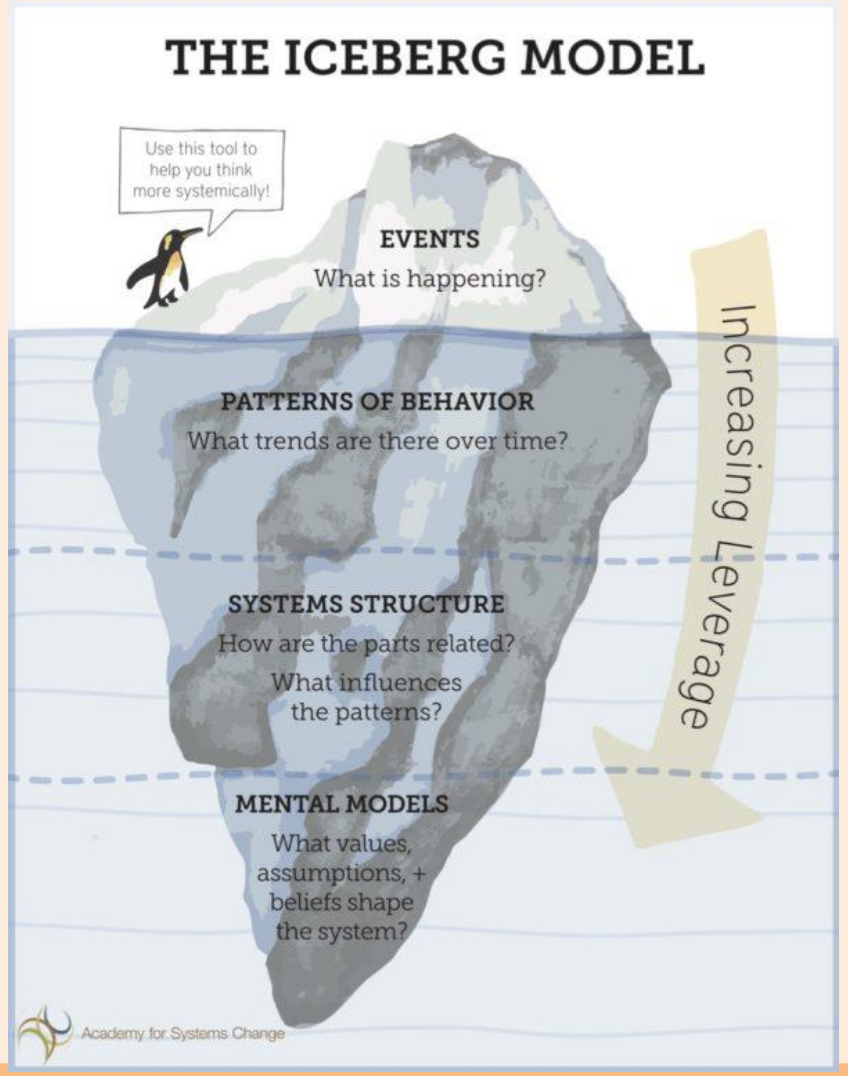


What are some systems thinking tools?

- Iceberg model
- Causal loop diagram
- Flight simulator

Tool #1: Iceberg Model

Purpose: To uncover the root causes of an event by identifying the underlying patterns of behavior, supporting structures, and mental models.



Example: CDV in Tigers

HYPOTHETICAL SCENARIO FOR A FICTIONAL NATIONAL PARK (PLACE X)

- **Events**
  - Tiger mortality event from canine distemper virus (CDV) in Place X
- **Patterns**
  - Cases of CDV in tigers have increased over the past 5 years in Place X
- **Structures**
  - Audience: What are some structures that could lead to this pattern?
- **Mental models**
  - Audience: What are some mental models that could lead to these structures or patterns?

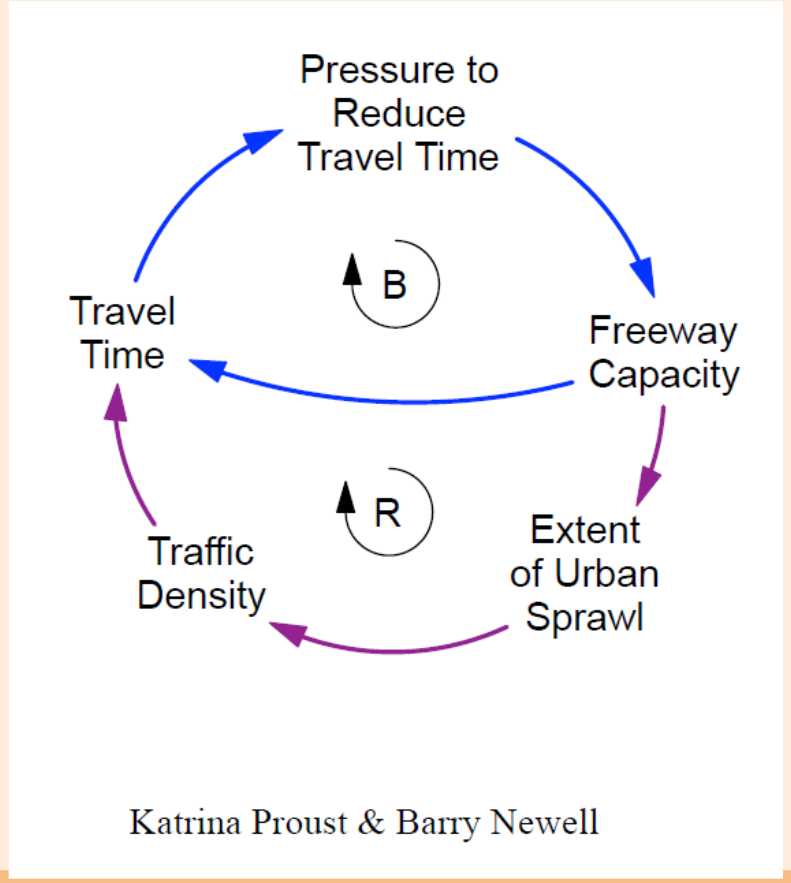
Example: CDV in Tigers

HYPOTHETICAL SCENARIO FOR A FICTIONAL NATIONAL PARK IN ASIA (PLACE X)

- **Events**
  - Tiger mortality event from canine distemper virus (CDV) in Place X
- **Patterns**
  - Cases of CDV in tigers have increased over the past 5 years in Place X
- **Structures**
  - Hunting with dogs is common on public lands near Place X
  - A major road runs past an unmonitored access point to Place X
- **Mental models**
  - People should be able to use public lands for their own benefit
  - Enforcing park access rules is not an important use of Place X funds

Tool #2: Causal Loop Diagram

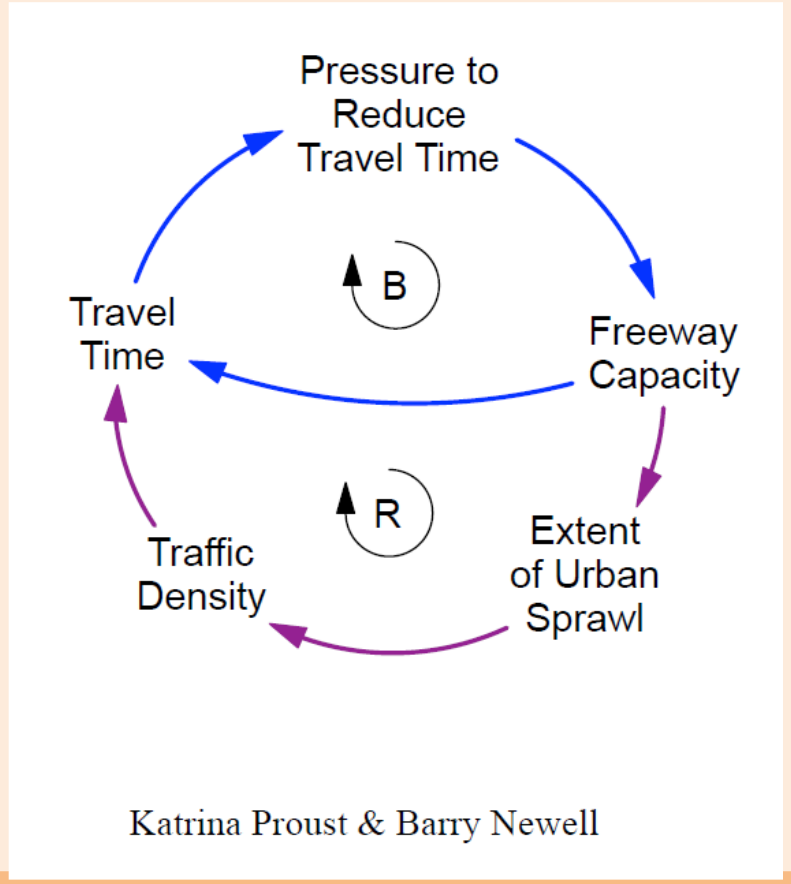
- Conceptually model dynamic systems
  - Allows quantitative modeling
- Useful for uncovering feedback loops
- May be able to identify novel intervention points in the system



Balancing and Reinforcing Feedback Loops

- Balancing loops (B)
  - Negative feedback loops
  - Self corrective
  - Self-regulating
  - Seek stability; maintain condition or state
  - Primary source of resistance to change

- Reinforcing loops (R)
  - Positive feedback loops
  - Vicious cycles that worsen the problem
  - Virtuous cycles that generate growth



Test: Balancing or Reinforcing Loops?

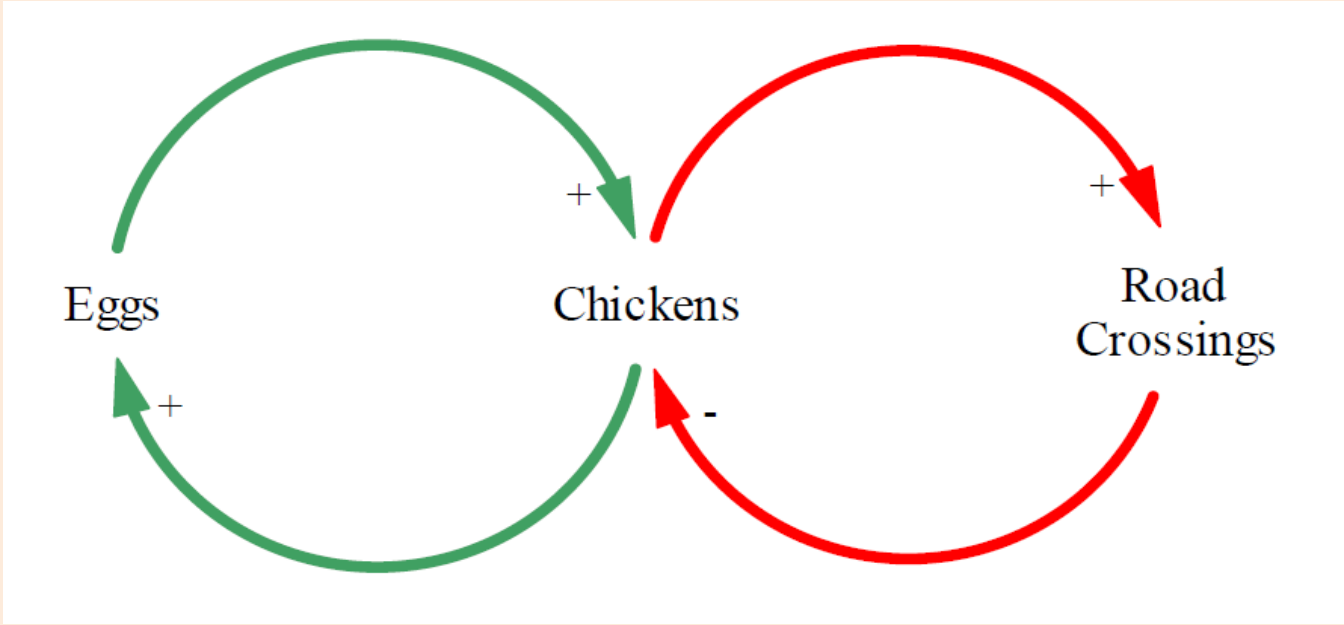


Photo credit: Protracted learning

Test: Balancing or Reinforcing Loops?

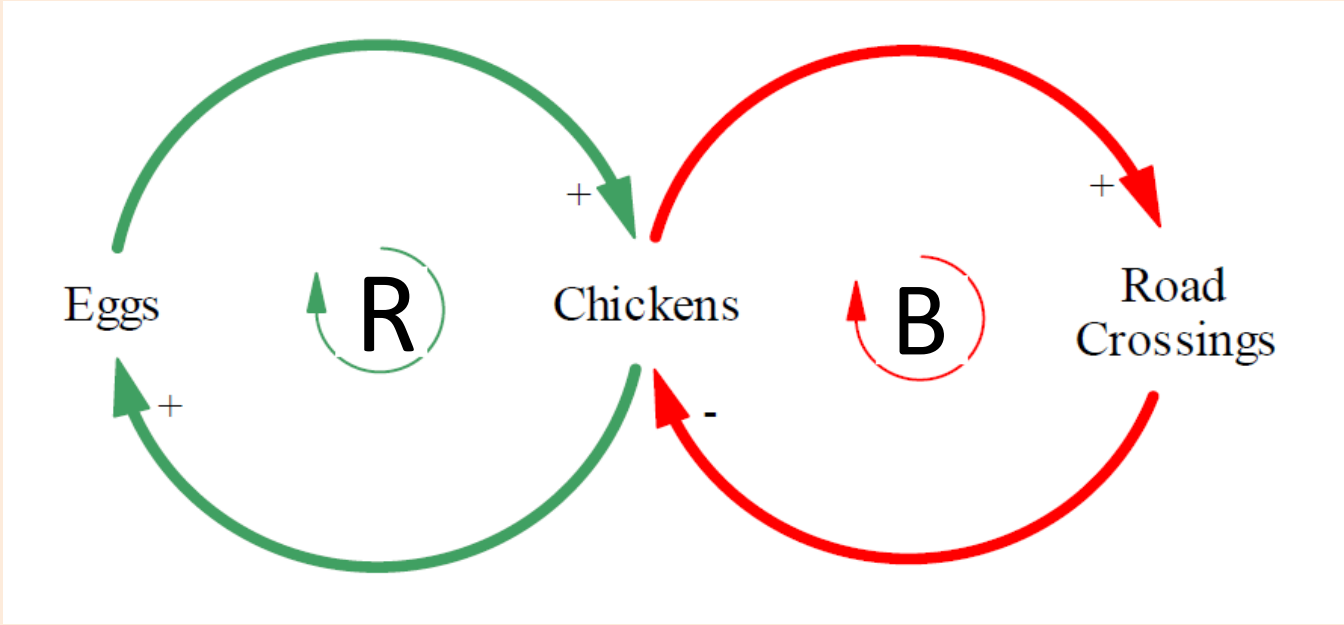
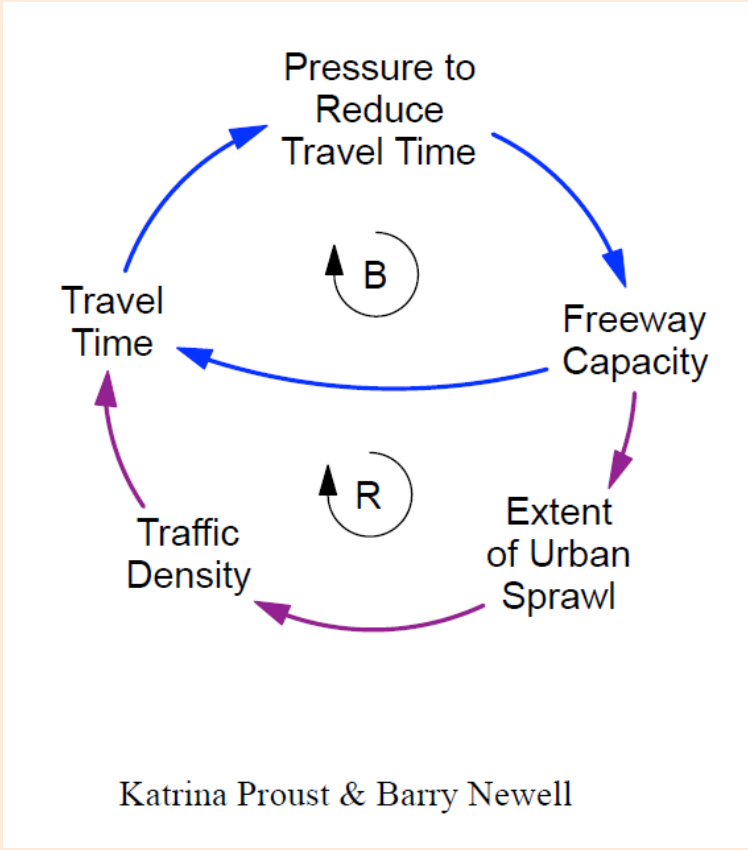


Photo credit: Protracted learning

System Delays

- System delays occur because it takes time to
  - Recognize the current state
  - Decide which actions to take
  - Implement actions
  - Change the current state by an action
- System delays create unintended consequences



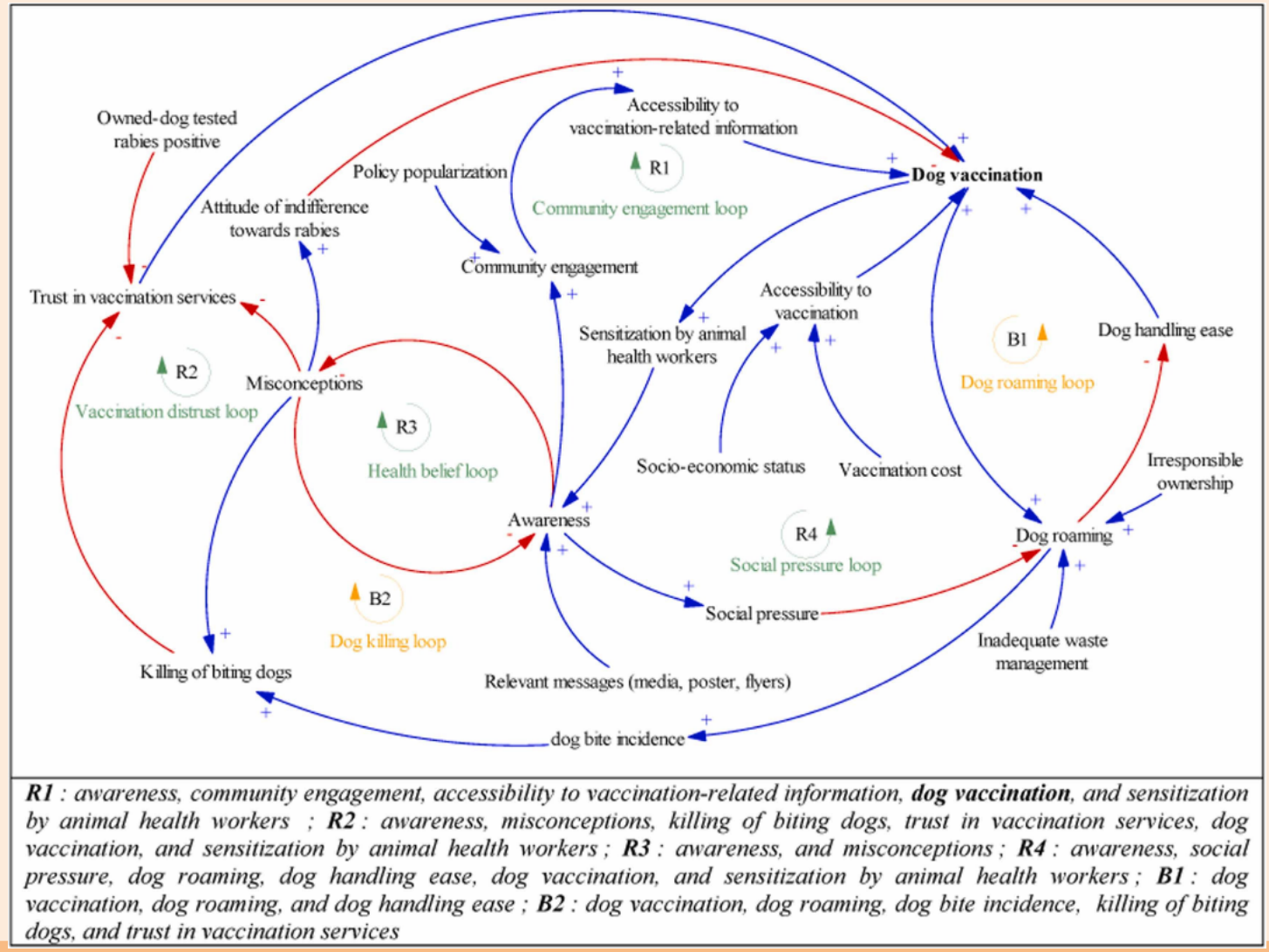
Case example: Rabies

ELSEVIER

Preventive Veterinary Medicine
Volume 203, June 2022, 105623

Using causal loop analysis to explore pathways for zoonosis control in low-income setting: The case of dog rabies vaccination in Burkina Faso

Madi Savadogo [a, c, d], Dimitri Renmans [b], Rianatou Bada Alambedji [c], Zékiba Tarnagda [d], Nicolas Antoine-Moussiaux [a]



***R1** : awareness, community engagement, accessibility to vaccination-related information, **dog vaccination**, and sensitization by animal health workers ; **R2** : awareness, misconceptions, killing of biting dogs, trust in vaccination services, dog vaccination, and sensitization by animal health workers ; **R3** : awareness, and misconceptions ; **R4** : awareness, social pressure, dog roaming, dog handling ease, dog vaccination, and sensitization by animal health workers ; **B1** : dog vaccination, dog roaming, and dog handling ease ; **B2** : dog vaccination, dog roaming, dog bite incidence, killing of biting dogs, and trust in vaccination services*

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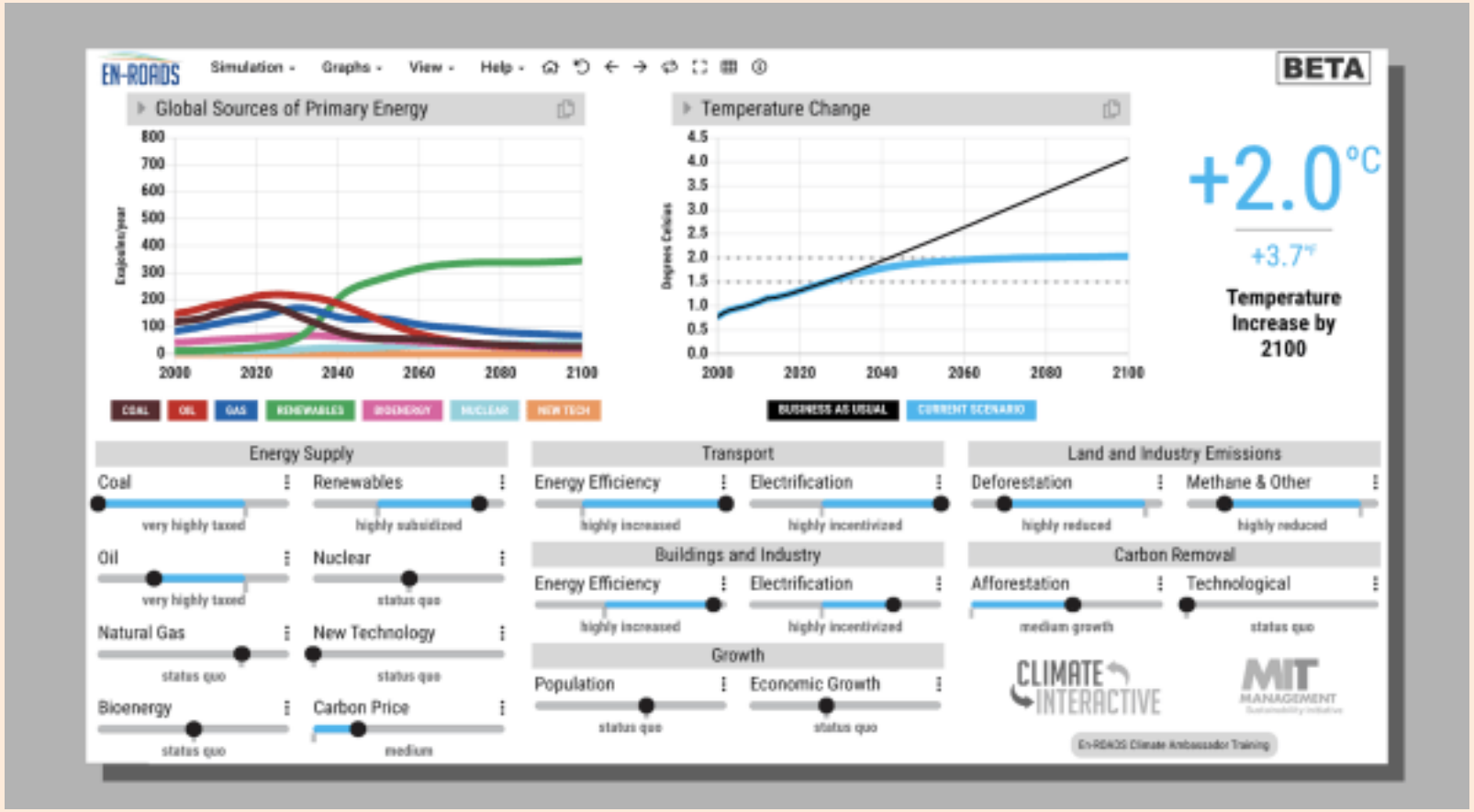
Tool #3: Mangement Flight Simulator

- Simulated environment based on quantitative systems mapping
- Explore consequences of different strategies
- Learn from experience



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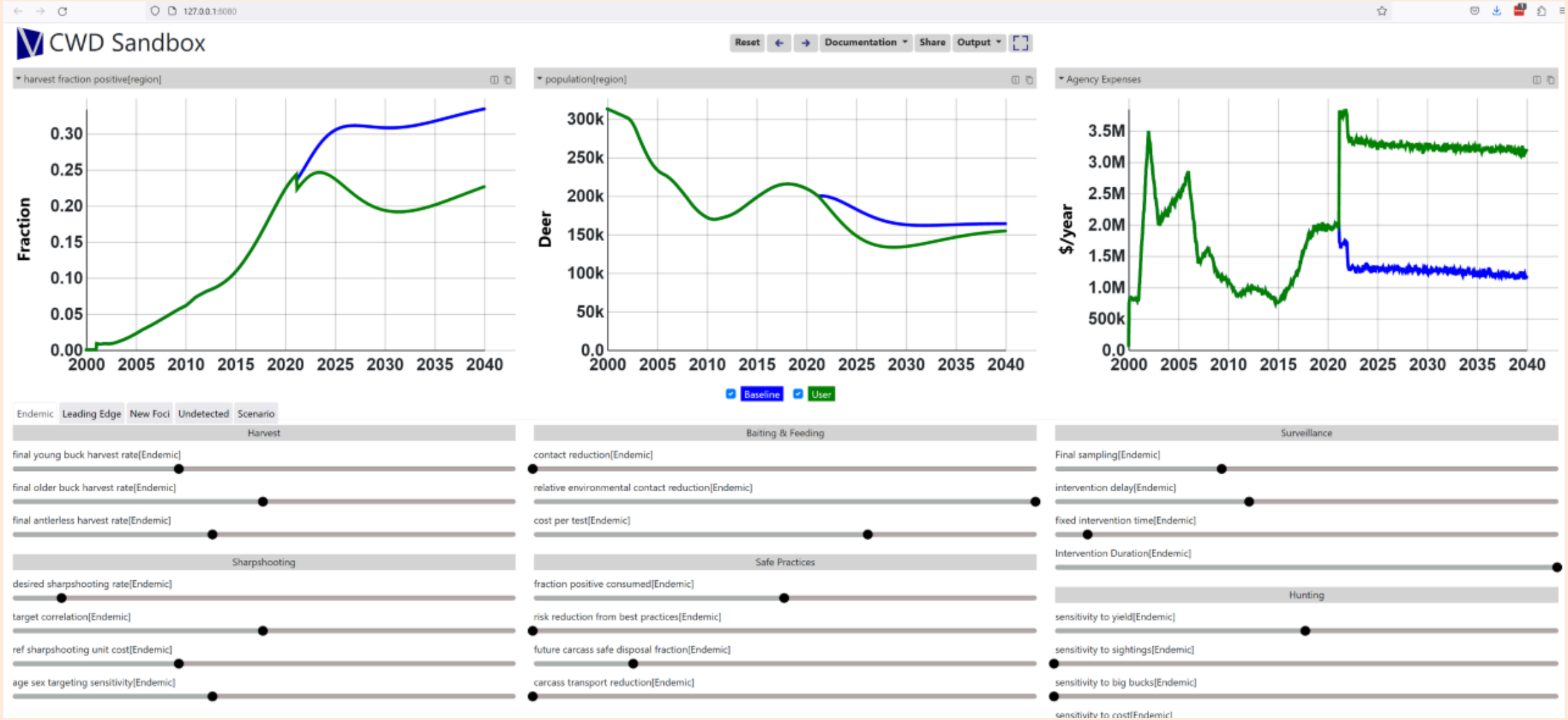

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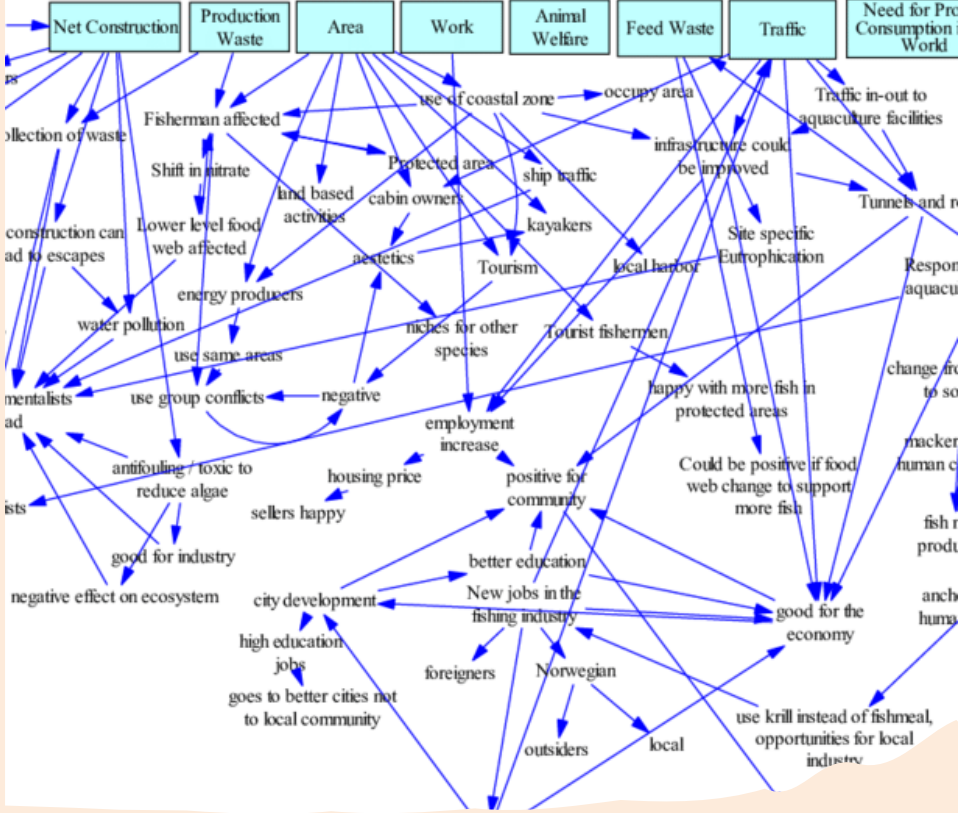
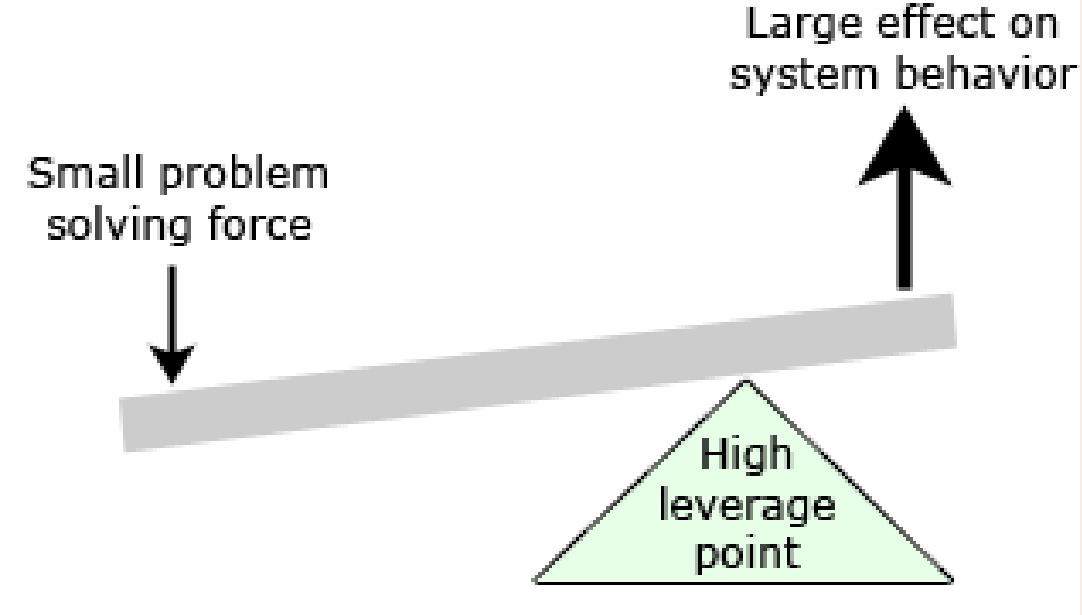


Assessing tradeoffs and making decisions in complex systems

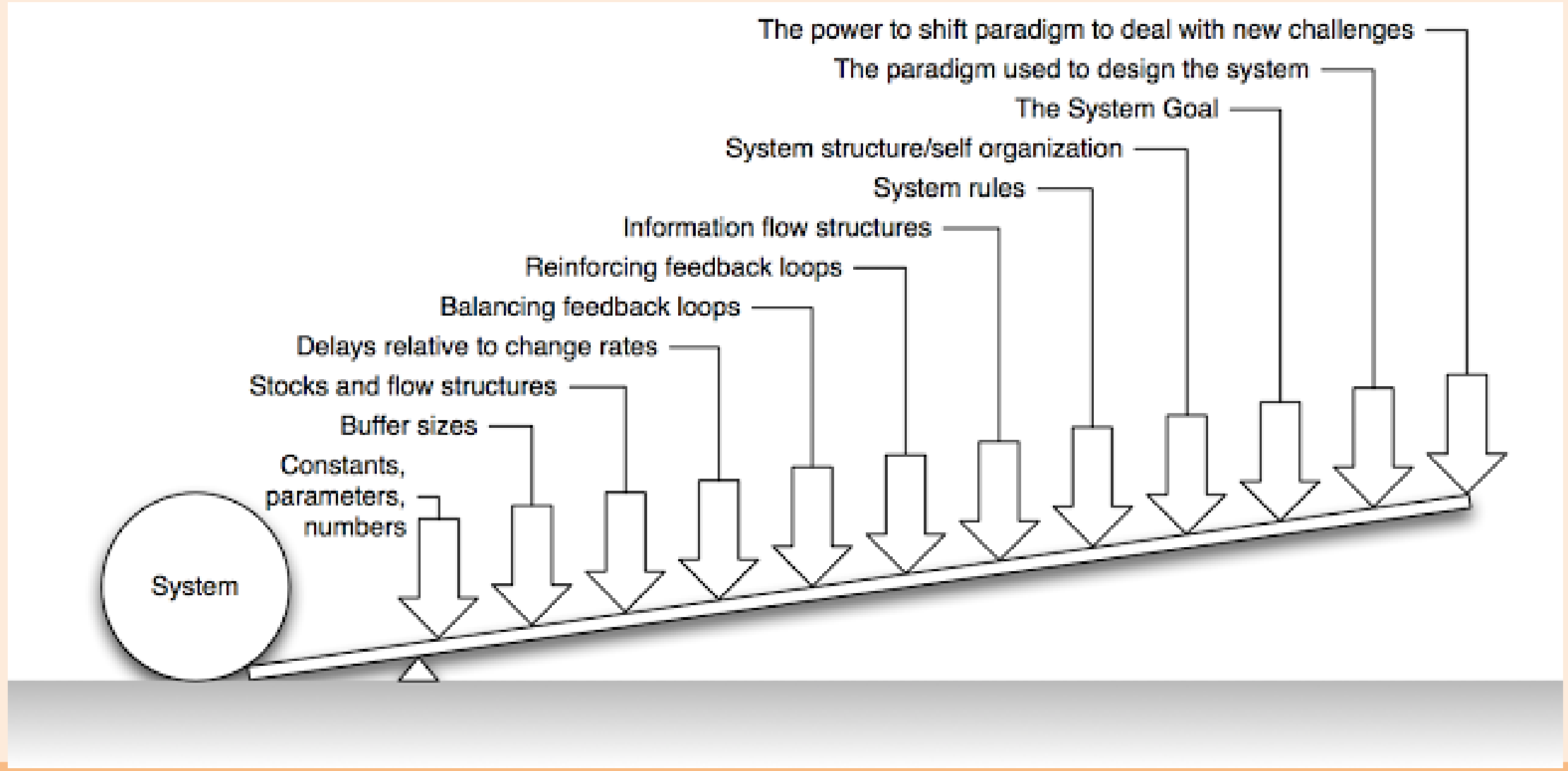
Leverage points

Interventions in the system capable of changing trends and patterns



Leverage Points

- Located towards the bottom of the iceberg model
- Identifying them can lead to
  - Changing cause-effect relationships
  - Aligning system behavior with desired purpose
- Possible actions
  - Stopping or doing less of something
  - Starting or doing more of something
  - Addressing significant delays


The power to shift paradigm to deal with new challenges
The paradigm used to design the system
The System Goal
System structure/self organization
System rules
Information flow structures
Reinforcing feedback loops
Balancing feedback loops
Delays relative to change rates
Stocks and flow structures
Buffer sizes
Constants, parameters, numbers
System

Adaptive Management

- Adjust policies and practices by learning from the outcome of previously used policies and practices
- Crucial for addressing wicked problems!

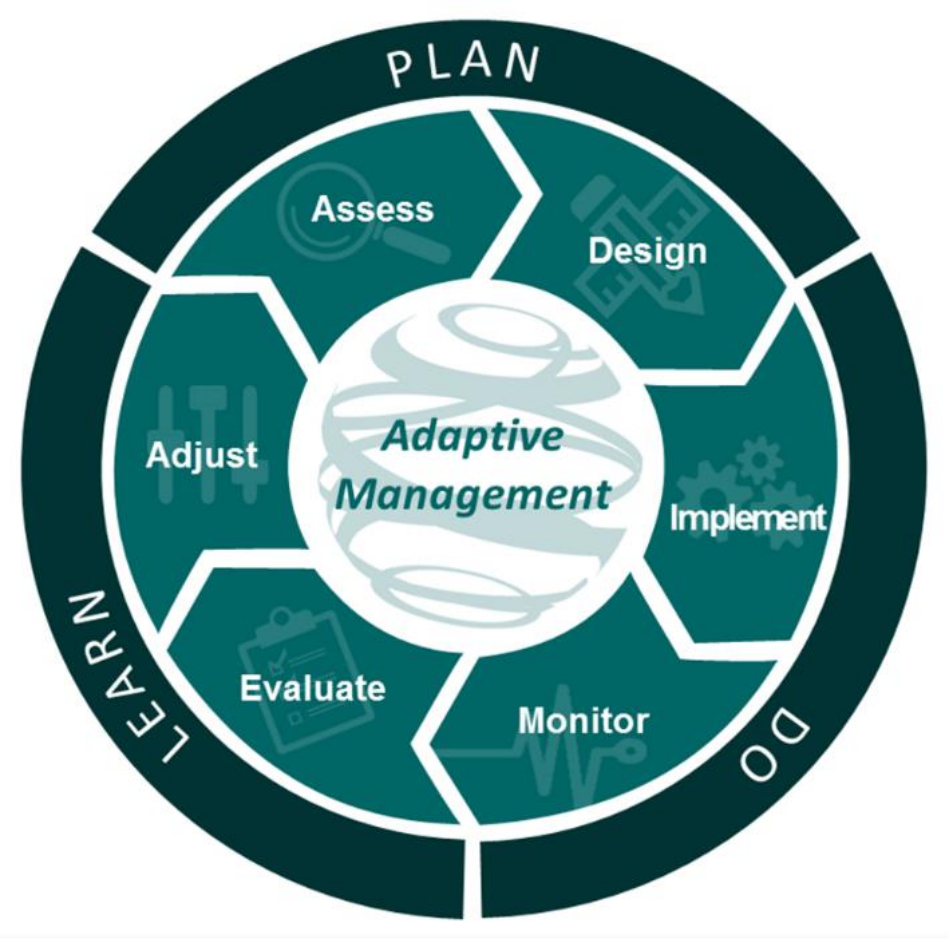


Image credit: https://www.essa.com/approach/

Questions?