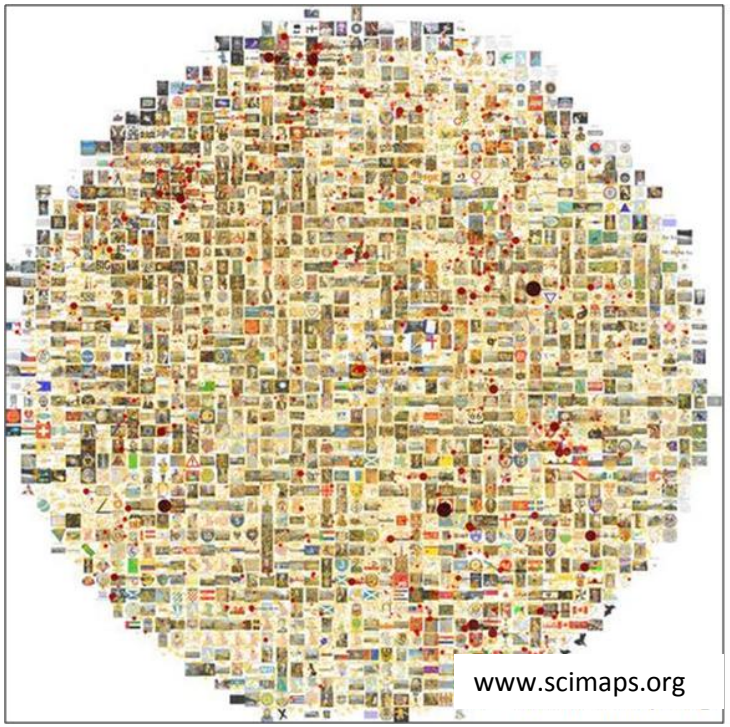
Complexity Science & Global Change Workshop



Sybille Haeussler

President, BV Research Centre

UNBC Research Coordinator for Climate Change Adaptation

Smithers, BC

Bulkley Valley Centre for Natural Resources Research & Management www.bvcentre.ca

NRESi

Workshop Agenda & Format

Discussion Sessions:

8:45 Sybille – Introduction to Complexity
9:15 Jim Pojar – Genetic Complexity
9:45 Break
10:00 Marie-Lou Le Francois – Functional diversity in tropical forests
10:30 Richard Overstall – Self-organization in legal systems
11:00 Don Morgan – Modeling and managing for uncertainty
11:30 – 12:00 Synthesis & Applications
12:00 – 1 pm Unstructured discussion & cleanup

- Informal , Semi self-organized discussion – Feel free to speak up.
- Volunteer note-takers, Sybille will prepare a summary report.
- Questions?

Global Change

- Anthropogenic climate change
- Worldwide economic crisis
- Cultural integration & homogenization
- Invasive species & emerging diseases
- Collapse of marine foodwebs
- ??

Rapid growth in human populations and increased use & exchange of energy, matter & information

Outline?

- What is a complex system?
- Definitions of complexity
- Relationship between complexity, diversity & stability or resilience
- Some tools & techniques of complexity science
- Why does it matter?

A Complex System

- Has many parts (components)
- The parts **interact**
- Can’t be described using a linear model
- Interaction among the parts causes the behaviour of the whole to be more than the sum of its parts.

Traditional Science: reductionist, disciplinary, linear

Complexity Science: holistic, interdisciplinary

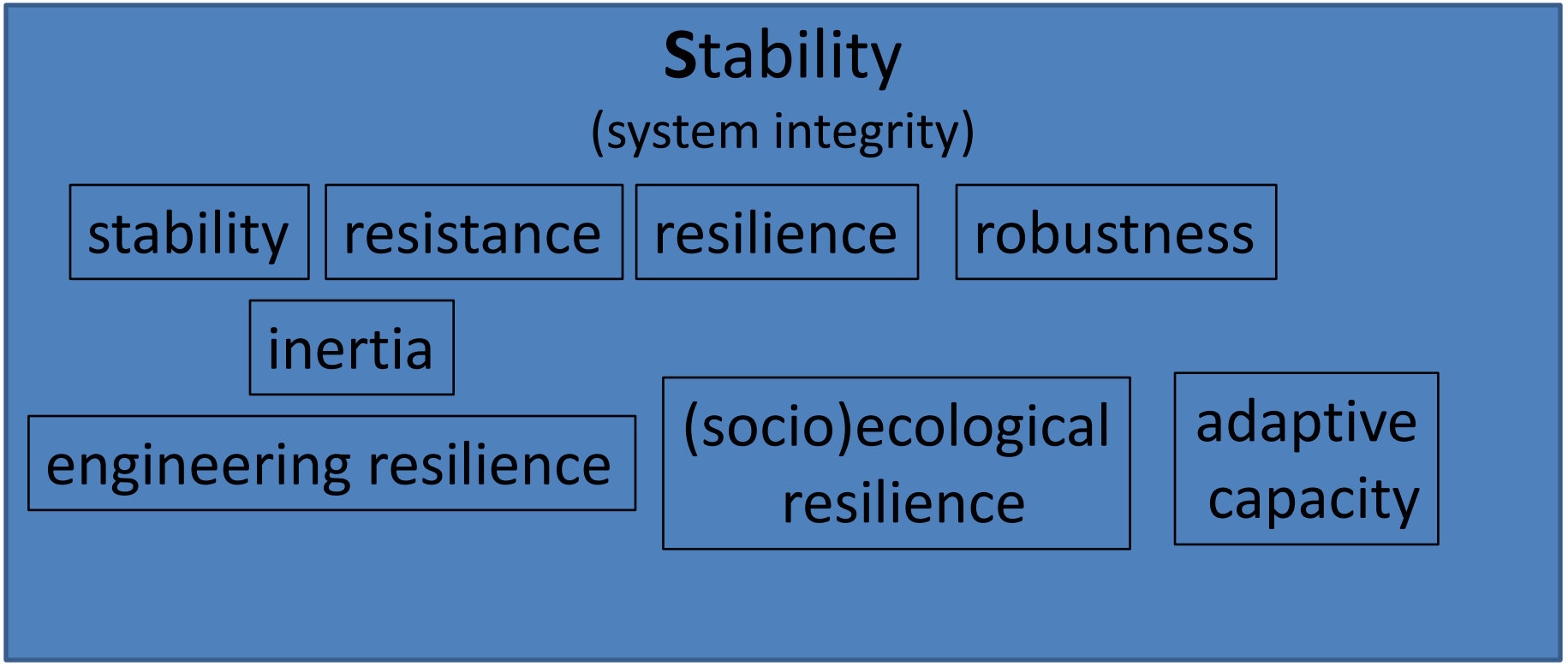
(both are quantitative & evidence-based)

What is Complexity?

Scientific definitions:

- Phenomena that arise due to interactions among the parts of a complex system (emergence and self-organization)
- The hidden order that lies between order and randomness
- The amount of information needed to fully describe or recreate the system

Stability Concepts



Equilibrium concepts
Small amount of Change

Non-Equilibrium Concepts
Large amount of change

What about Vulnerability?

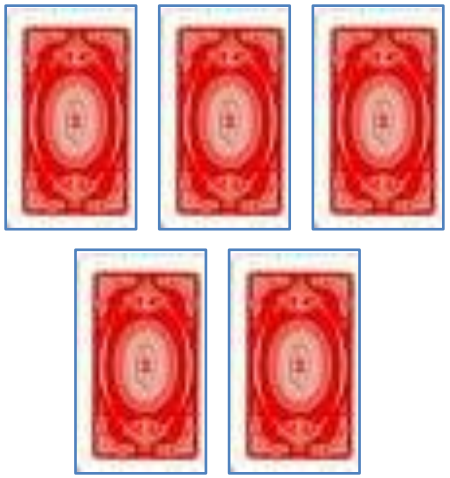
Differences between:

- Complexity
- Diversity
- Stability or Resilience

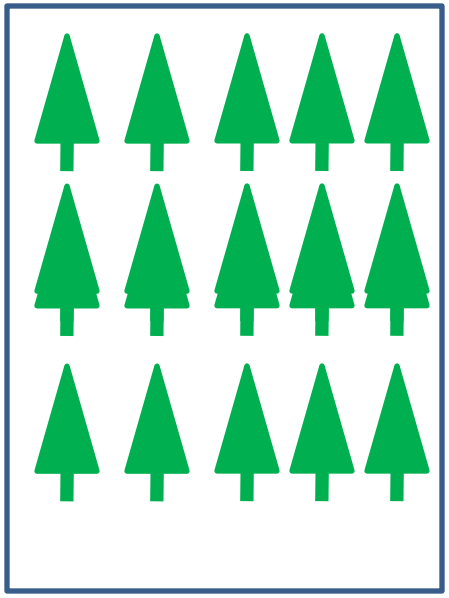
Just because System A is more diverse than System B doesn't necessarily mean System A is more complex (it's all about the interactions & the feedbacks)

Complexity doesn't necessarily give rise to stability or resilience (e.g., positive feedbacks can be destabilizing; critical dependencies can make a system vulnerable)

Diversity often (but not always) gives rise to stability or resilience

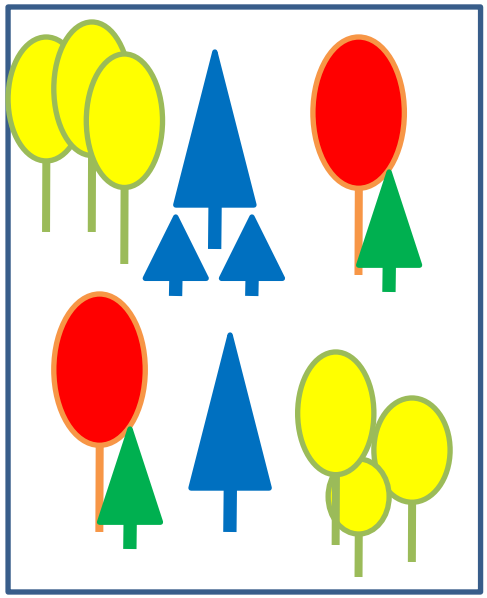


Order



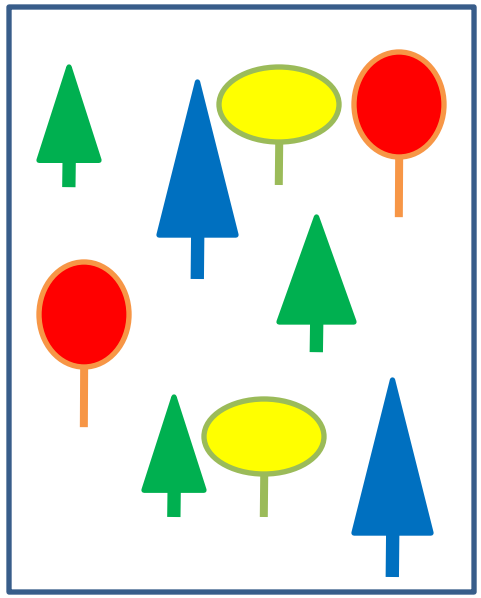
Pine plantation
Diverse?
Complex?
Resilient?

Managing for Complexity



Mixed species plantation
Diverse?
Complex?
Resilient?

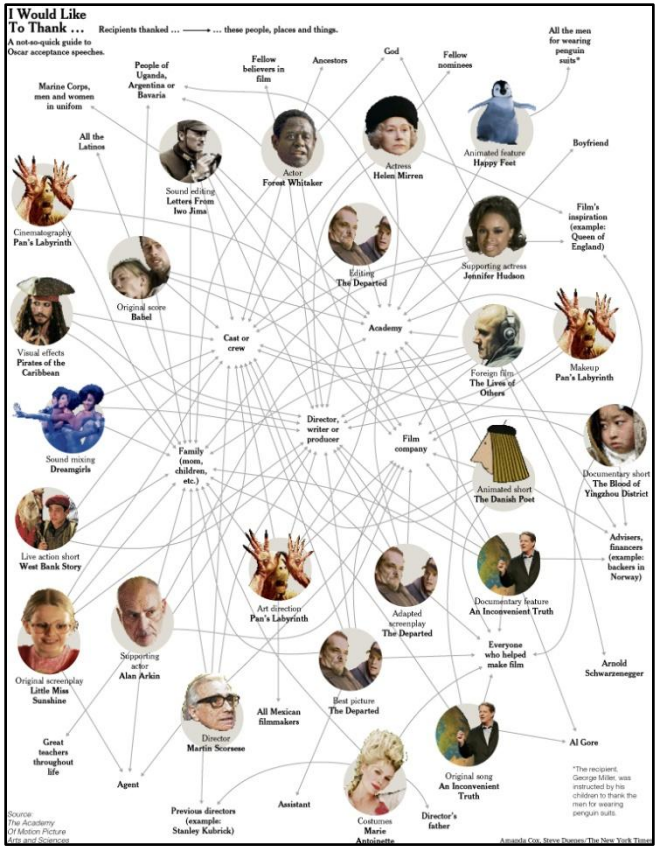
Random

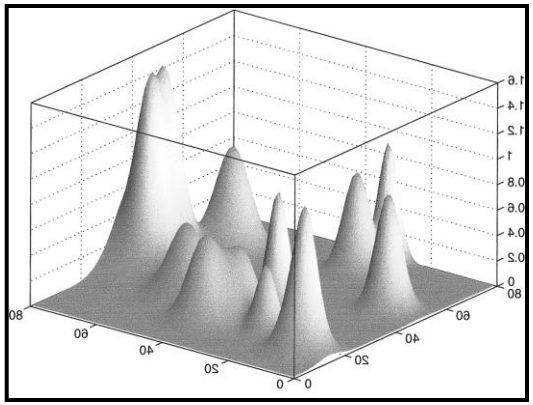


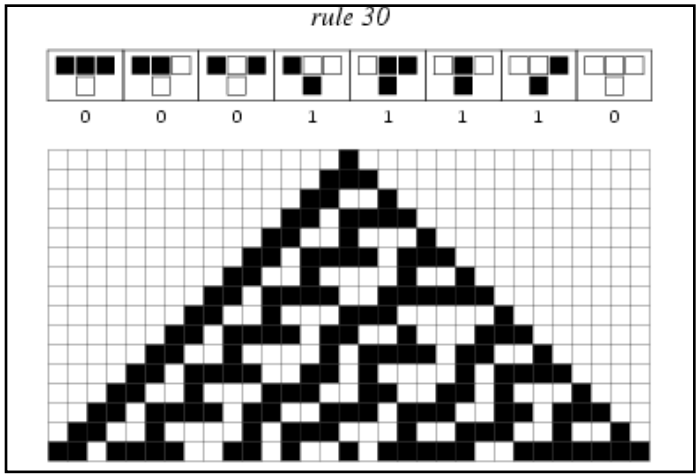
Mixed species plantation
Diverse?
Complex?
Resilient?

Tools & Techniques

- Nonlinear Equations
- Cellular Automata
- Agent−Based Models
- Information Theory
- Network Analysis
- Fitness Landscape Models (adaptive walks)
- Game Theory
- Symbolic Dynamics
- Machine Learning
- Statistical Mechanics







Why does it Matter?

- Integration of natural and social sciences
- Reconciliation of scientists and non-scientists (e.g., environmentalists, holistic health practitioners, artists)
- Focus shifts from predictability & control to exploring alternatives and adapting to uncertainty
- Explains how everything we do is interconnected and why the status quo isn't working

Discussion Questions

1. What are some ways that we in the Bulkley Valley (northern BC) can best use the tools & techniques of complexity science to ensure a more sustainable future for all?
2. Is Complexity Science is making it easier or more difficult to communicate complex problems to non-scientists, including decision-makers? How do we improve communication?