CIELAP's 4th Partnering for Sustainability Workshop
Achieving Resilient Agricultural Systems: Innovation, People and Partnerships

A workshop to foreshadow and feed into the United Nation's Commission for Sustainable Development (CSD)

Resilient Agricultural Systems

Dr. Jean-Charles Le Vallée

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Agenda

- What is resilience?
- What are resilient agricultural systems and what do they look like?
- What factors are present in resilient systems?
- Why are they desirable?

Resilience

- It is the capacity of a system to experience change while retaining essentially the same function, structure, feedbacks, and therefore identity, e.g. agricultural system properties and services.

Agricultural System Resilience

- It is process-driven, dynamic and strives to maintain system functionality and therefore, food system outcomes.
- Such resilience lessens acute, transitional, seasonal, cyclical and chronic variations in food availability, access and consumption, as well as longer-term efforts to preserve stability and means of production.

Adaptive Cycles

- Over time, the structures and functions of systems change as a result of (1) internal dynamics and (2) external influences, result in four characteristic phases which constitute the adaptive cycle: growth, conservation, release and reorganisation.
- As adaptive cycles are subject to small constant and large acute changes, they must continuously fight to maintain system services and functionality through the aid of homeostatic mechanisms.

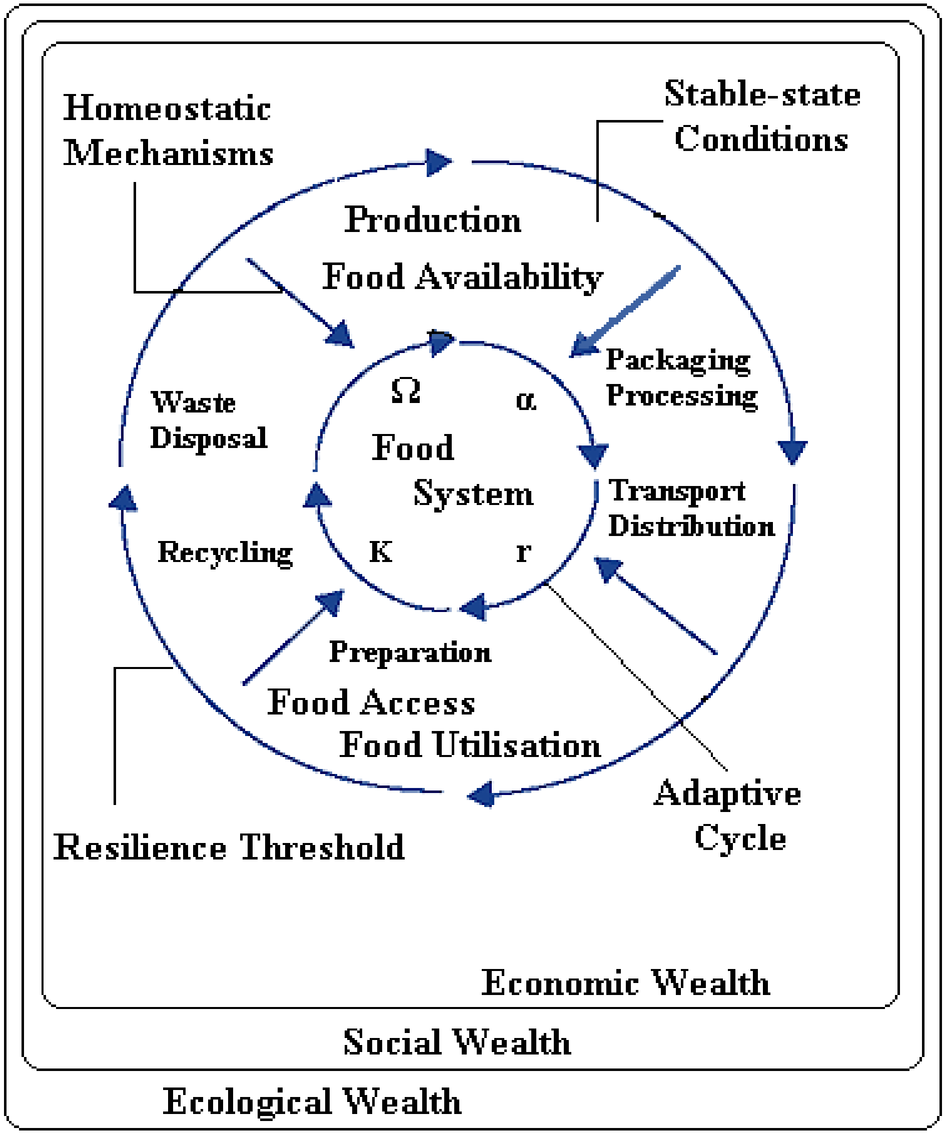
Homeostatic Mechanisms

- Systems have mechanisms of response to change, generating internal forces or resilience, opposing and adapting to change, called homeostatic mechanisms.
- These forces are responsible for system stability, maintaining system goods and services.
- Increased or amplified changes to functional components may push them beyond a certain threshold, outside a system's resilience band, and take the system and thus the adaptive cycle away from steady-state conditions.

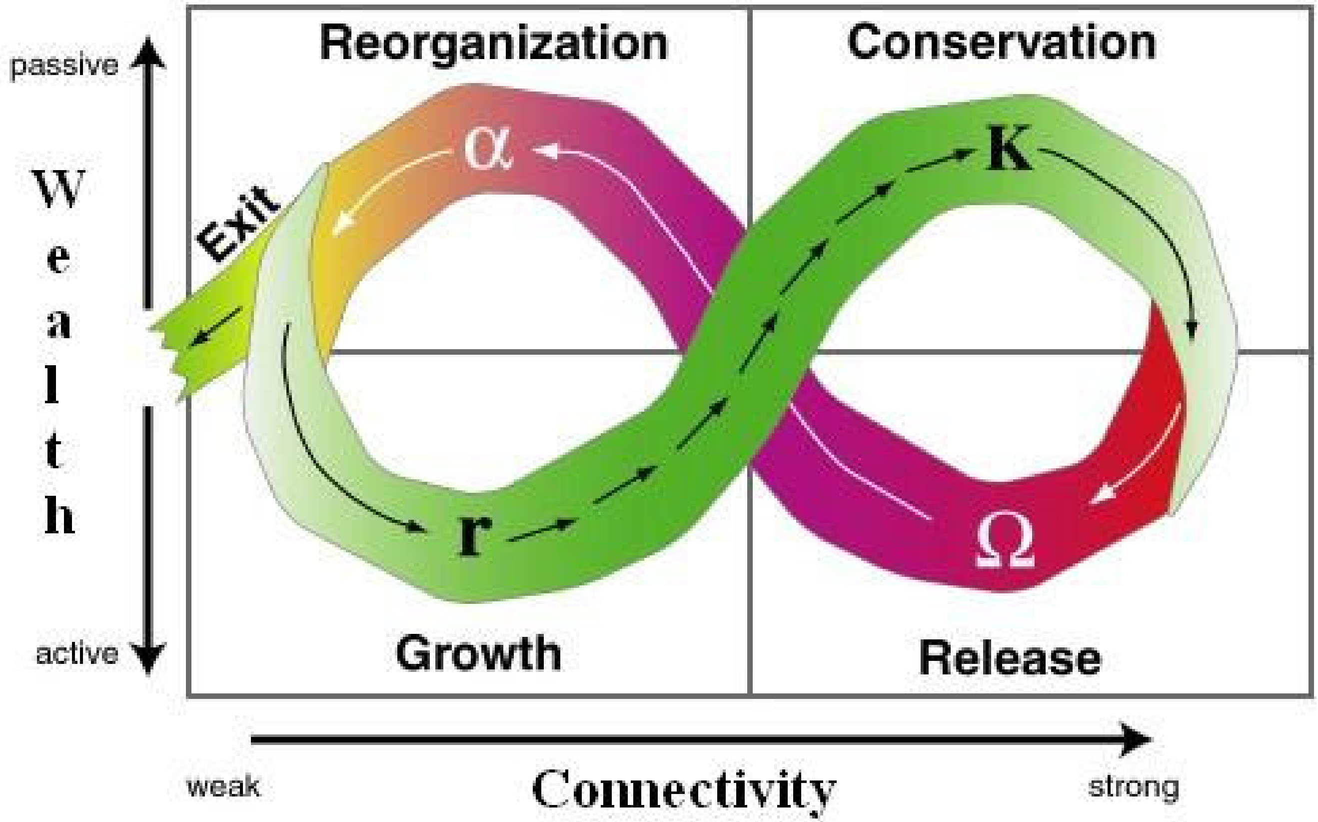
Steady-state Conditions

- Given any previous state, the structural properties of a given system (adaptive cycle) tend to evolve towards steady-state conditions (SSC).
- The adaptive cycle configuration and its properties do not change with time, within normal conditions, that is, the system maintains its functions, services and structure.
- Notion of resilience is the amount of disturbance a system can absorb without shifting into an alternate self-organised system. If a disturbance is large enough, however, an adaptive cycle may cross over resilience thresholds, departing from normal SSC.

What does it look like?



Adaptive Cycle



Wealth

- Wealth is inherent in the accumulated adaptive cycle and includes (1) economic wealth, e.g. monetary, assets/entitlements, labour; (2) social wealth, e.g. political and cultural; and (3) ecological wealth, e.g. physical, natural wealth.
- The difference in wealth activity in the adaptive cycle varies as with decreasing absolute wealth, wealth activity intensifies.

Connectivity

- Low connectivity is associated with diffuse elements loosely connected to each other whose behaviour is dominated by outward relations and affected by outside variability.
- High connectivity is associated with the concentration of system components whose behaviour is dominated by inward relations among components, relations that control or mediate the influence of external variability.

Phases

- Release
- Reorganisation
- Growth
- Conservation

Release

- Disturbances in the conservation (K) phase and the crossing of thresholds lead to this phase, a period of release (Ω) of bound-up resources in which the accumulated structure collapses. With the reorganisation phase, these two phases, Ω and α, are referred to as the backloop.

Reorganisation

- This (α) phase, in which novelty can take hold, leads eventually to another growth phase in a new adaptive cycle.
- The new growth phase may be very similar to the previous growth phase, or it may be quite different.
- With the release phase, these two phases, Ω and α, are referred to as the backloop.

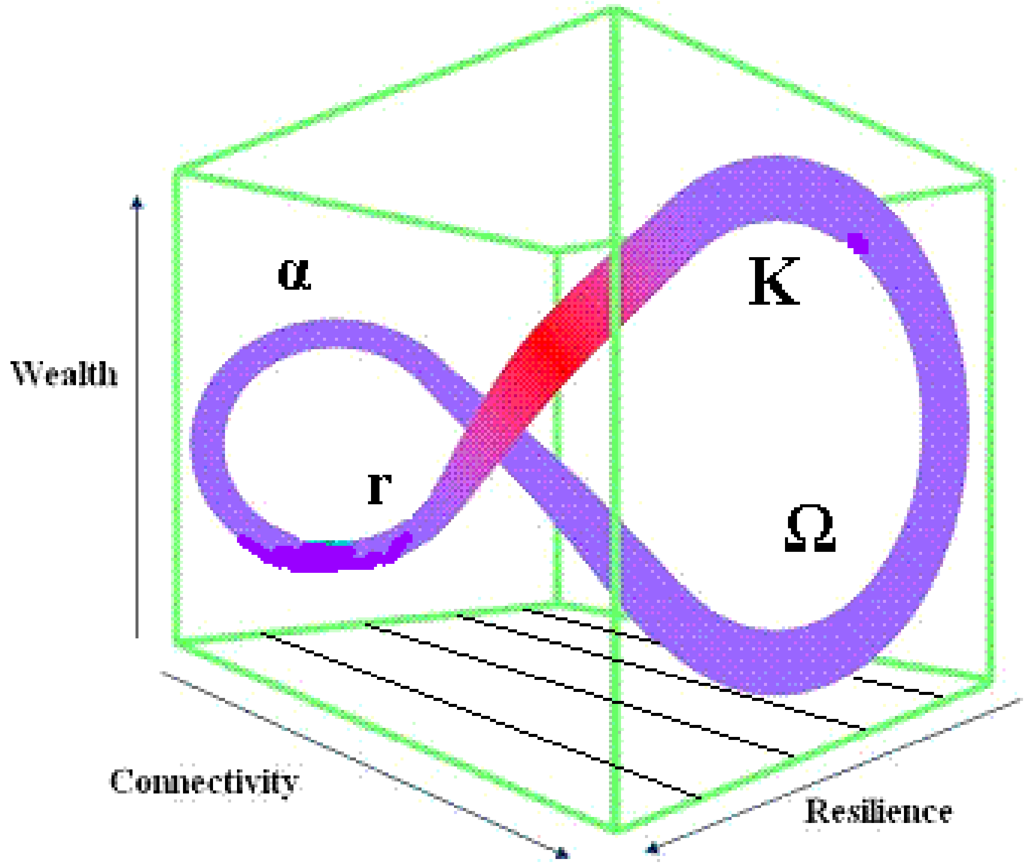
Growth

- r phase, characterised by readily available resources, the accumulation of structure, and high resilience, i.e. greater food system ability to resist change, maintain food system properties and services.
- It is the first phase of the foreloop, along with conservation, corresponding to ecological succession in ecosystems and constitutes a development mode in organisations and societies.

Conservation

- As structure and connections among system components increase, more resources and energy are required to maintain them.
- The second phase of the foreloop is one in which net growth slows and the system becomes increasingly interconnected, less flexible, and more vulnerable to external change. This is described as the conservation (K) phase.
- These two phases, r and K, called the foreloop, correspond to ecological succession in ecosystems and constitute a development mode in organisations and societies.

3D Adaptive Cycle



Normal Cycle

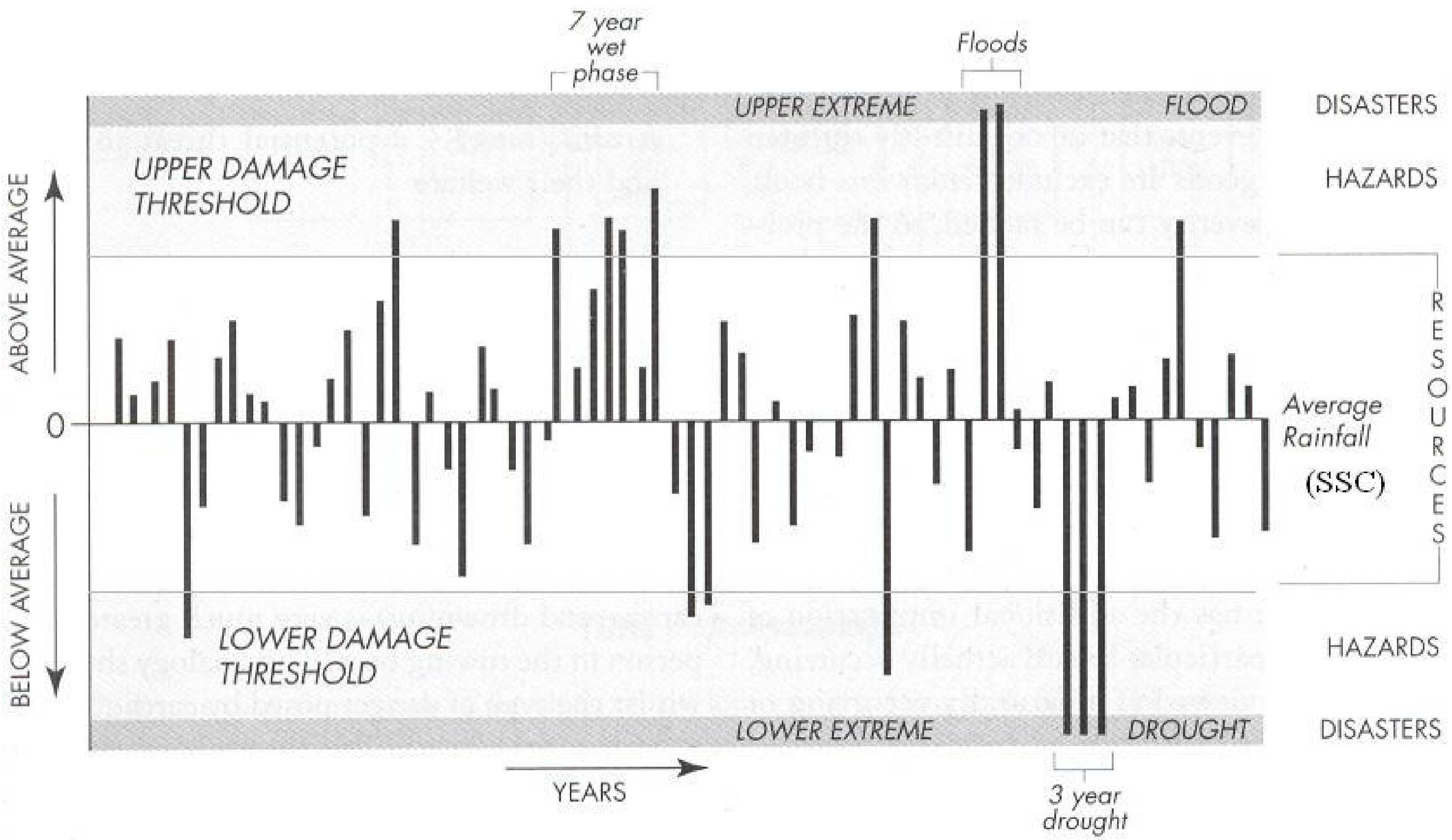
Reorganisation (α)		Conservation (K)	
Wealth	High	Wealth	High
Connectivity	Low	Connectivity	High
Resilience	High	Resilience	Low
Growth (r)		**Release (Ω)**	
Wealth	Low	Wealth	Low
Connectivity	Low	Connectivity	High
Resilience	High	Resilience	Low

Source: Gunderson and Holling (2002)

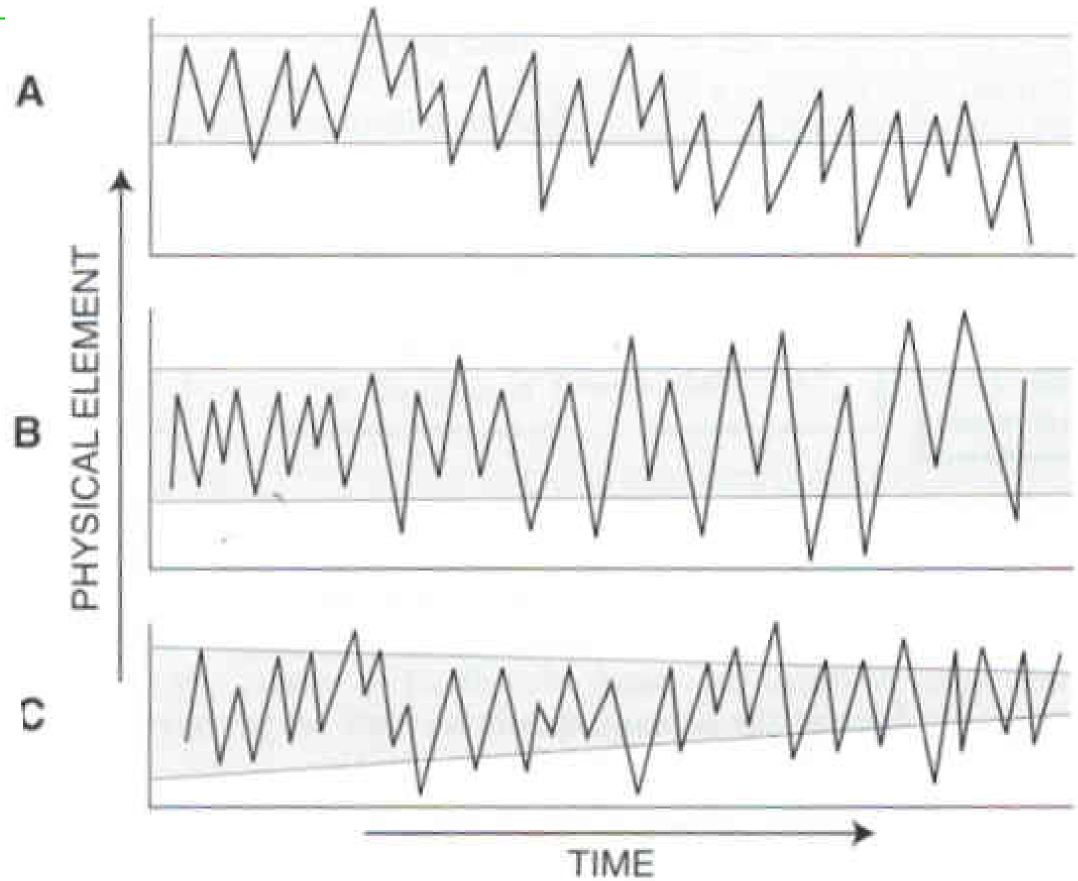
Resilience Thresholds

- Resilience is a dynamic readjusting pattern that is characterised by multiple directions and magnitudes, as it changes with transformations to and within the adaptive cycle.
- Steady-state conditions within these changing levels of resilience fading and increasing, fall within upper and lower thresholds of the resilience band.

Band of Tolerance



Bands of Tolerance over Time



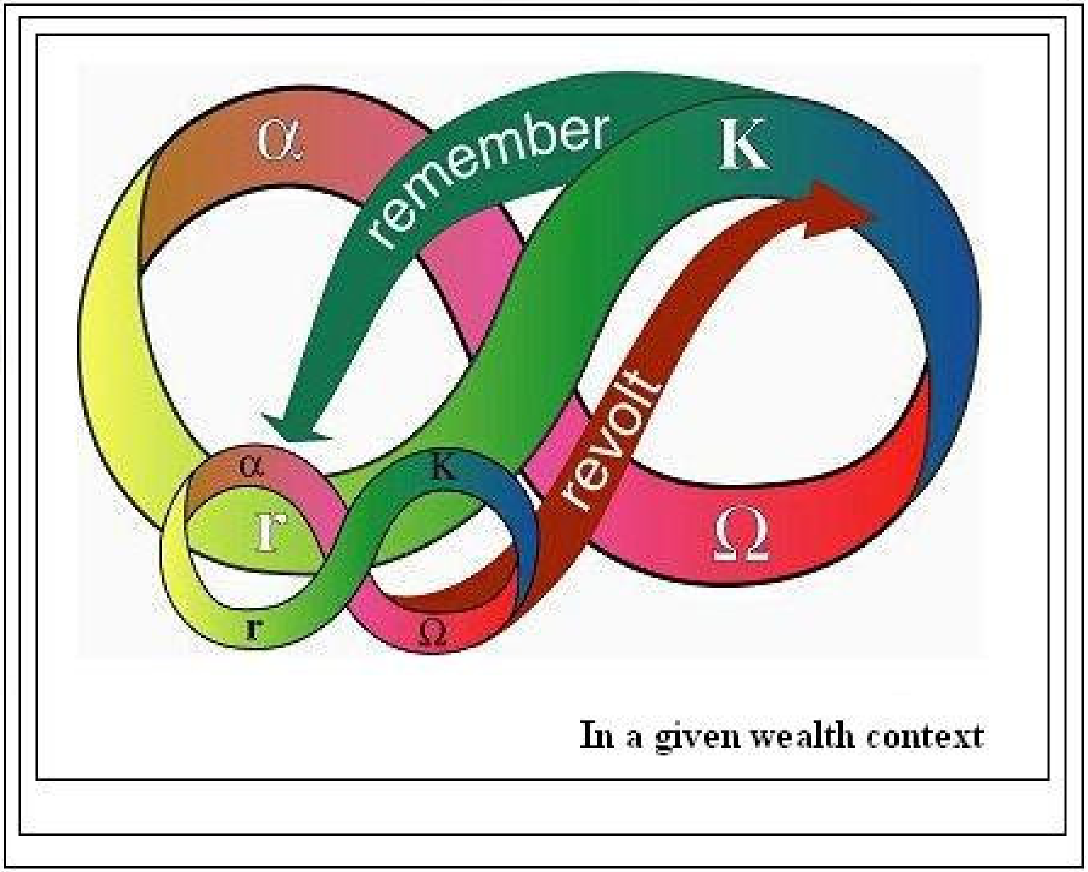
Panarchy

- Adaptive cycles and agricultural system processes are linked across scales based on the interactions between two or more sets of adaptive cycles: (1) higher-level, broader but slower structures and processes, and (2) lower-level structures and processes that are faster and smaller.
- These interactions between sets of adaptive cycles can be characterised as either hierarchical confinement or panarchical relations.

Panarchy

- It is known as a subset of resilience theory applied to cross-scale relationships between adaptive cycles and dissipative states.
- Panarchical relations suggest that both top-down and bottom-up interactions occur while hierarchical confinement is demonstrated when slow, broad features constrain and shape the smaller, faster structures.

Panarchy



Dissipative Change

- Agricultural systems exhibit economic, ecological and social thresholds that, when exceeded, result in changes in system properties and services, thus impacting sustainability and food security.
- The system is thus said to have undergone a dissipative change: the more resilient the system, the larger the disturbance it can absorb without shifting into a new dissipative state.
- Dissipative change represents an entire shift of the adaptive cycle, an entirely novel self-organising system.

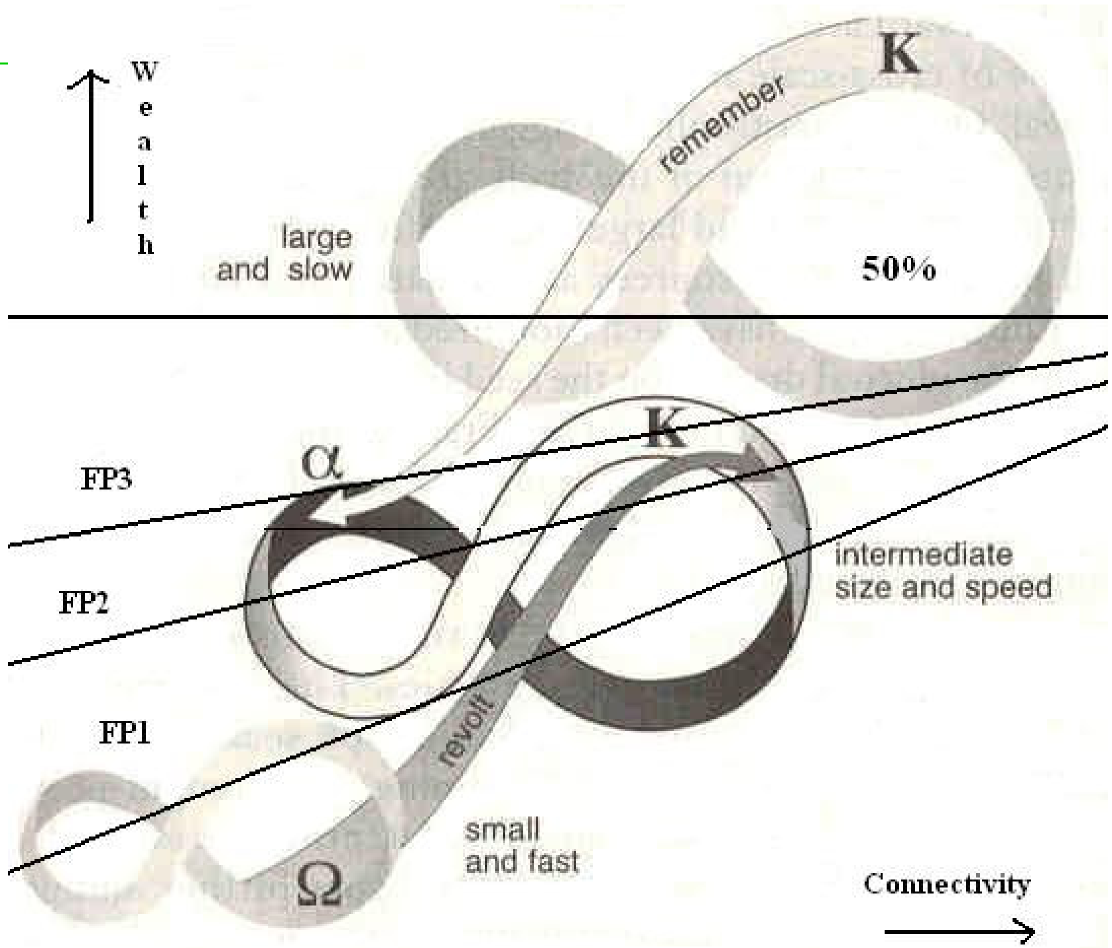
Self-organising System

- Resilience of a system requires some capacity for memory, which enables it to be self-organising and return to a steady state.
- Adaptive cycles at one level can be repeated if higher-level adaptive cycles of the Panarchy provide memory.
- The role of memory is strongest when the higher-level adaptive cycle is in the conservation (K) phase.

Self-organising Systems

- Such Panarchical linkages across scales between sets of adaptive cycles provide opportunities for memory from the higher-level adaptive cycles to influence and renew lower-level adaptive cycles, and facilitate or inhibit innovation and adaptive cycle configurations.
- Dissipative adaptive cycles can emerge when memory is disrupted because higher-level adaptive cycles are themselves in a backloop, or even in an early growth phase (r), with many system trajectories still possible.

System Thresholds



What factors are present in resilient systems?

- Functionality
- Structure
- Services
- Feedback
- Stable states
- Thresholds
- Dissipative shifts
- Sustainability

Multiple Aspects of Resilience

	Functional (Sense, Respond)	Structural (Organize, Build)
Strategic (Robustness)	Adaptation Innovation Transformation	**Fortification** **Centralisation** **Diversification**
Tactical or Operational (Continuity)	Recognition Resistance Recovery	Redundancy Flexibility Security

Why are they desirable?

- Ecological resilience
- Social resilience
- Economic resilience
- Pathological traps

Ecological Resilience

- Land-change use in physical and natural wealth.
- Effectiveness in terms of resource utilisation and waste minimisation.
- Ability to support social and economic resilience, as well as food utilisation, without undermining ecological conditions and the natural ecosystems in which it operates.
- Food availability is largely coupled to this base.

Social Resilience

- Designated as human, political, and cultural wealth of the system, including safety-nets, levels of education, institutional stability, social cohesion regarding agricultural objectives, e.g. food safety, food security.

Economic Resilience

- Financial wealth of the system, economic growth and diversity in which it operates, the food provision chain that it rests on, its labour and capital productivity, and increasing incomes over time and the markets that it serves.
- Food access strongly related.

Pathological Traps

- Pathological traps can take on four combinations of adaptive cycle properties (wealth, connectivity, and resilience) having deviated from normal agricultural system flows and conditions.
- They are departures from the adaptive cycle and are nested in a poverty, rigidity, lock-in, or structural trap.
- They are undesirable.

Pathological States

Pathological State	Wealth	Connectivity	Resilience
Poverty trap	Low	Low	Low
Rigidity trap	High	High	High
Lock-in trap	Low	High	High
Structural trap	High	Low	Low

Lock-in

- Agricultural intensification involving changes in technology largely masking the degradation of natural resources though perceived stability of the system.
- Low potential for change, high connectivity, and high resilience - meaning a great ability for the system to resist external disturbances and persist due to, and remaining as, a degraded ecological system.

Rigidity

- Resilience is achieved by substituting direct reliance on regional factors with institutional intervention and sophisticated technology, often generated at the global scale, with substitution giving the perception of an adaptive resilient system.
- Technological advances making single variable interventions, or creating interventions without regard for their impacts on other parts of the system.

Structural Trap

- Available wealth forms are either not accessible, e.g. either through untapped ecological wealth due to the lack of physical access, or currently appropriated land from higher-level adaptive cycles; or undervalued, e.g. economic wealth such as labour, knowledge;
- Highly affected by outwards relations and variability;
- Supporting repeated losses of system functions and little if any absorption capacity to externalities; unable to develop novelty, nor system relationships.
- Lack of inputs can render the system unable to build economic wealth through time and across generations, perpetuating the trap.

In Sum

- Motivation
  - Search for an adequate framework to explain food-based system dynamics
- Contributions to science
  - Panarchical configurations of such systems
  - Resilience dimensions
- Key results
  - Pathological states
  - Panarchical relationships between systems
- Next
  - Revolts, memory, social cohesion around agriculture, investments in productivity, sustainability and social protection