Shooting the Rapids
Navigating Uncertainties in the Management and Governance of Social-Ecological Systems

Lance Gunderson
Environmental Sciences
Emory University
Atlanta GA, USA

Proposition: Different Uncertainties

MORAL
-Good/Bad

EPISTEMIC
-Knowledge
-Scientific

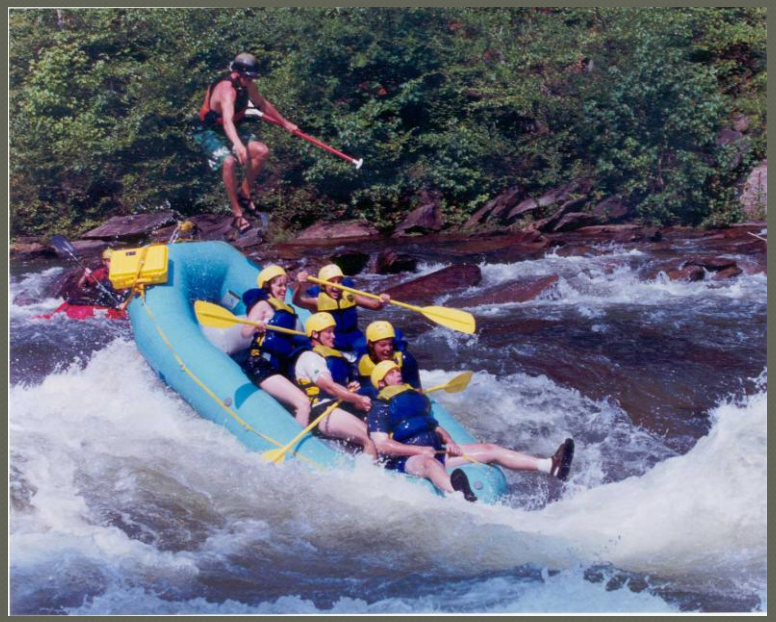
ACTIONS
-doubts and inaction
-decision models

ISSUES
-outcomes
-situation
-alternative

Temporal Uncertainty
Now ⟶ Future

SLOW
Logical
Conscious

FAST
Automatic
Subconscious



Coping with Uncertainty
(Organizational Theory)

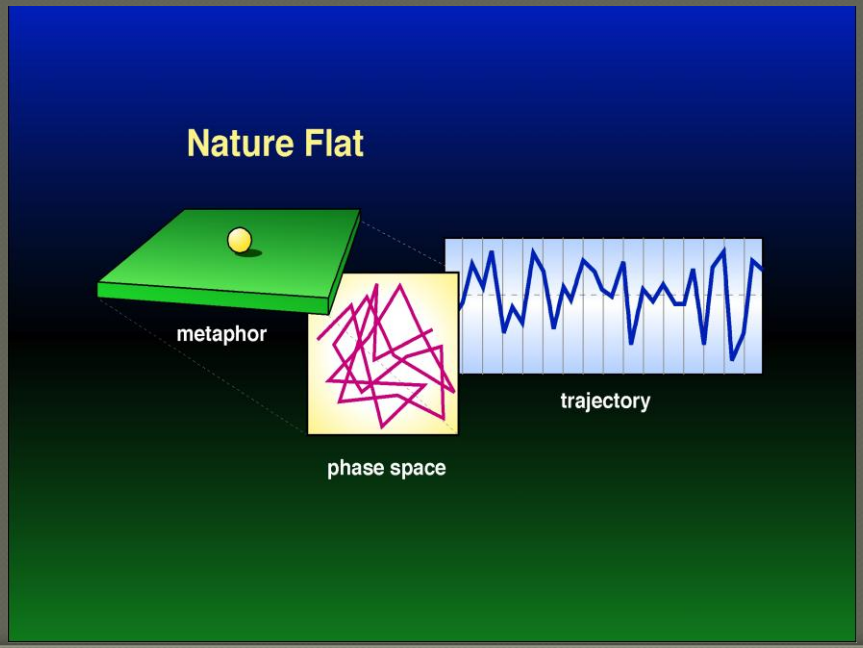
- Reduce Uncertainty
  - Seek Full Information/Understanding
  - Assumption Based Reasoning
  - Models to Predict Outcomes
    - Scenarios, Experience, Statistics, Systems
- Weigh Alternatives
- Suppress
  - Denial, Seek Spurious Certitude
- Hedge

Myths and Models of Nature

- Nature Flat - Change is random, external
- Nature Balanced – Change towards a stable state
- Nature Anarchic – Change unwelcome, irreversible
- Nature Resilient – Many possible stable states
  - (Slow changes and Fast changes)
- Nature Evolving – New configurations unfold

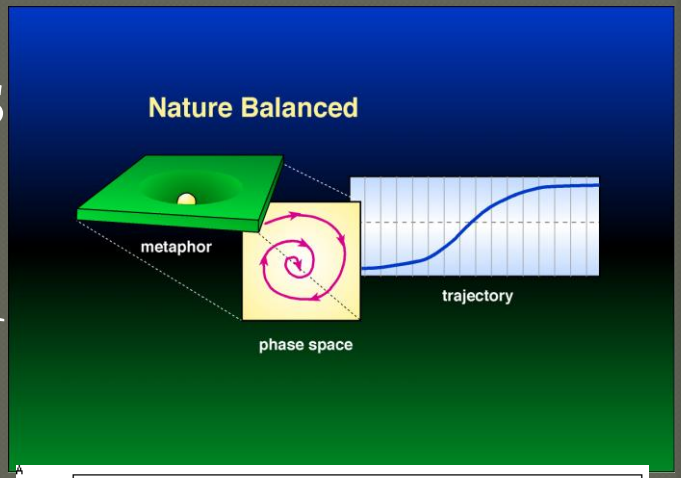
Nature Random

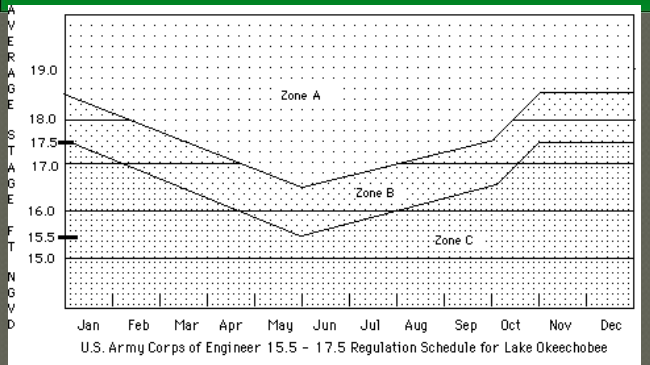
No Pattern
Little/no Feedback
System Controlled by
Larger Scale Processes



Nature Balanced

- Recovery from Disturbances
  - Harvest of fish, timber
- Manage toward Equilibrium
  - Next year like this year
- Strong feedbacks to control, recover
- Policy Effects Predictable



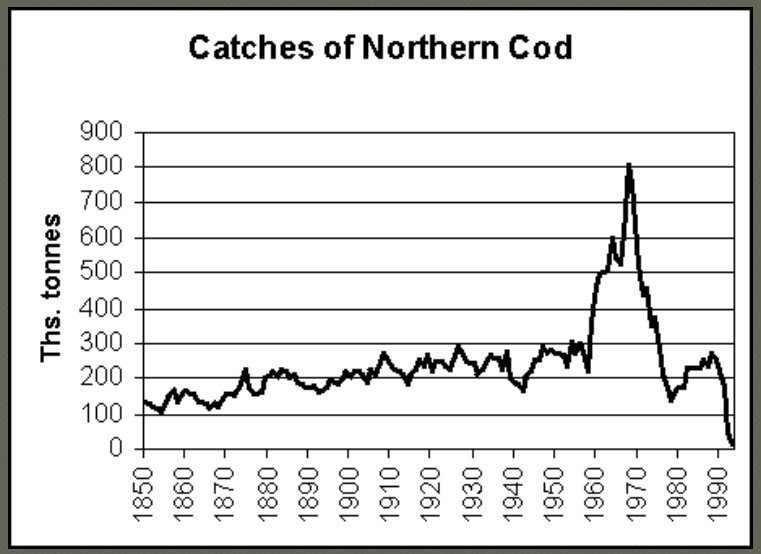


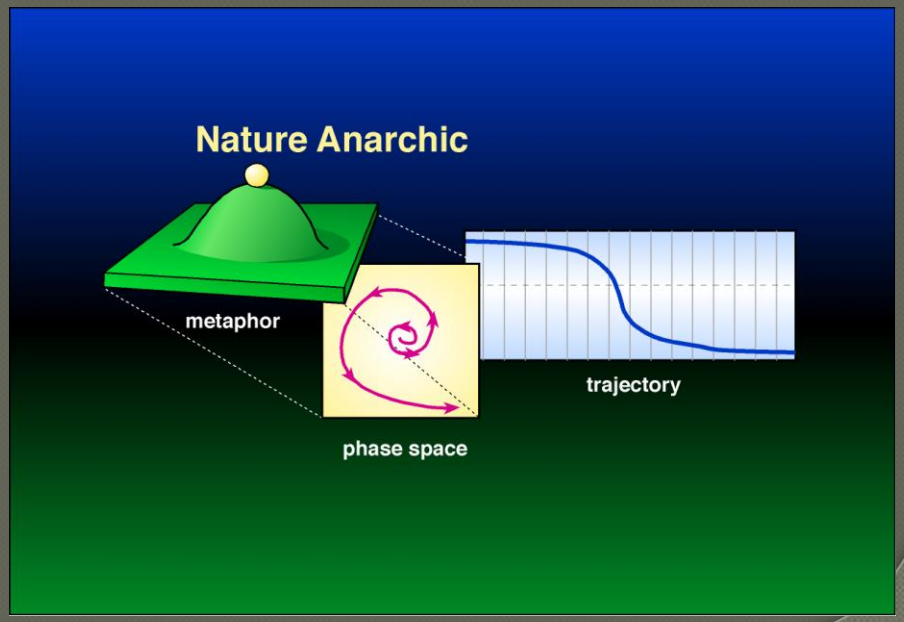
U.S. Army Corps of Engineer 15.5 - 17.5 Regulation Schedule for Lake Okeechobee

Zone	Agricultural Canals	Caloosahatchee River	St Lucie Canal
A	Pump Maximum Practicable to Water Conservation Areas for Acquisition After Removal of Local Runoff	Up to Maximum Capacity (9300 CFS at S-77) Without Local Flooding	Up to Maximum Capacity at Structure S-309C
B		Up to 4500 CFS at S-77	Up to 2500 CFS at S-80
C	No Regulatory Discharge	No Regulatory Discharge	No Regulatory Discharge

Fragile Nature

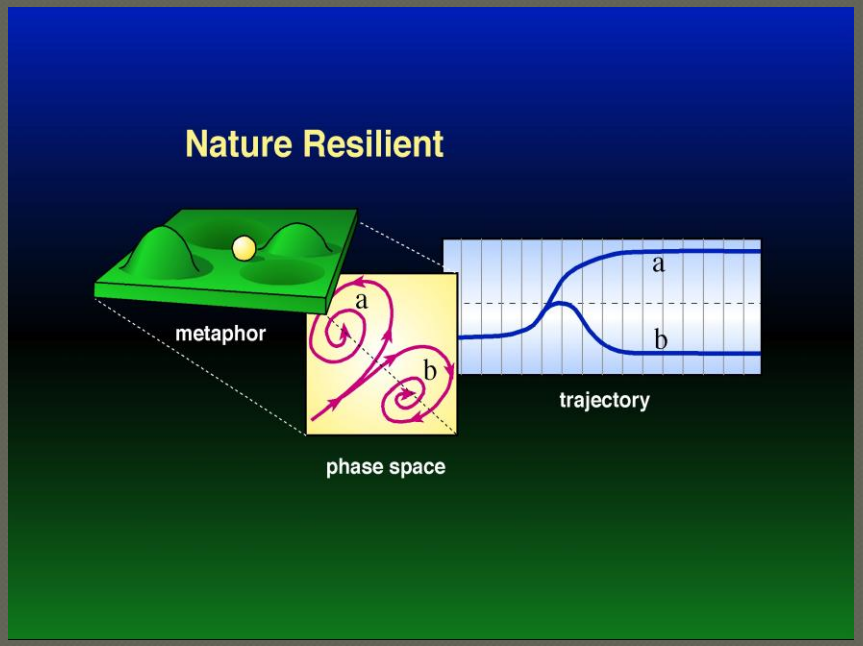
- Precautionary Principle
- Certainty before Action
- Tight Regulation
- Buffer from Disturbances

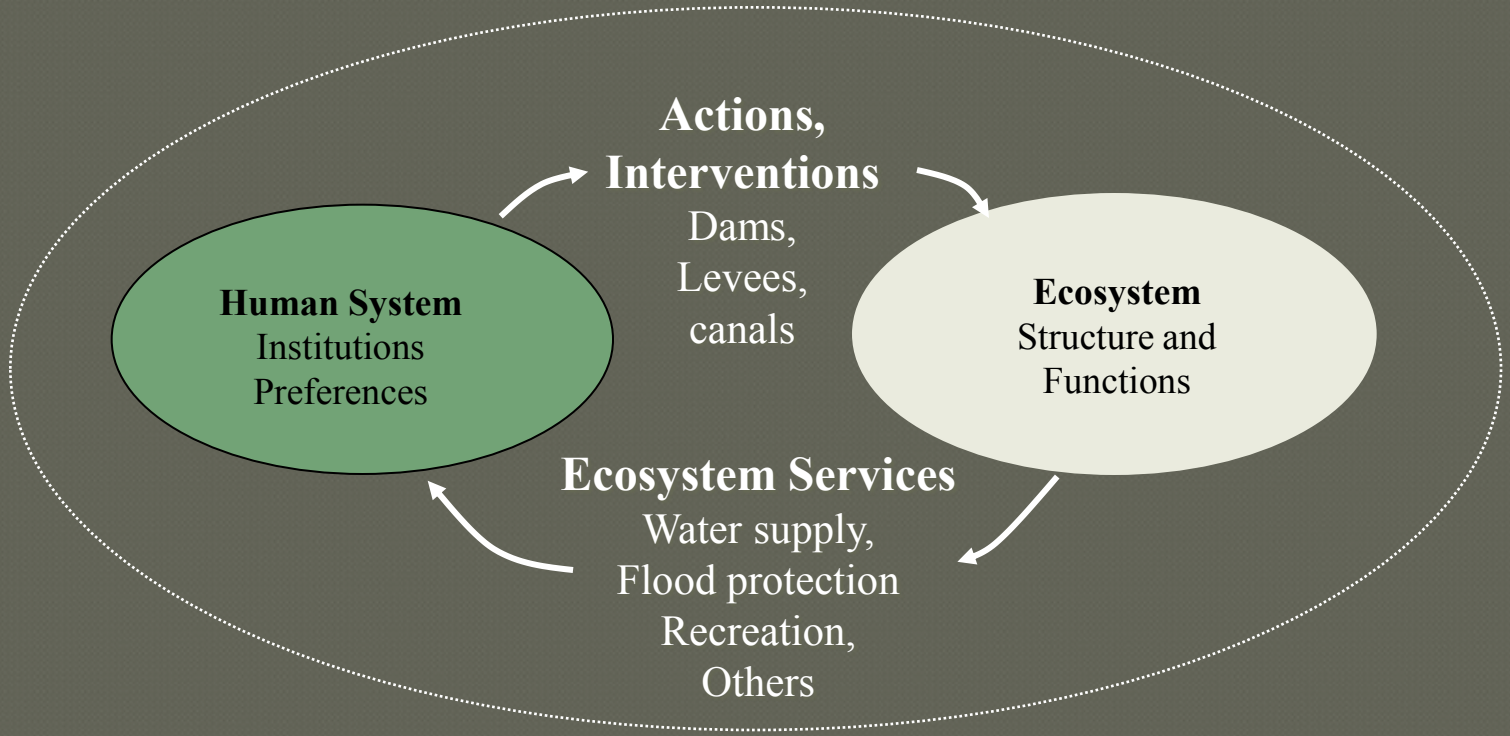




Nature Resilient

- Multiple Regimes
- Slow/Fast Dynamics





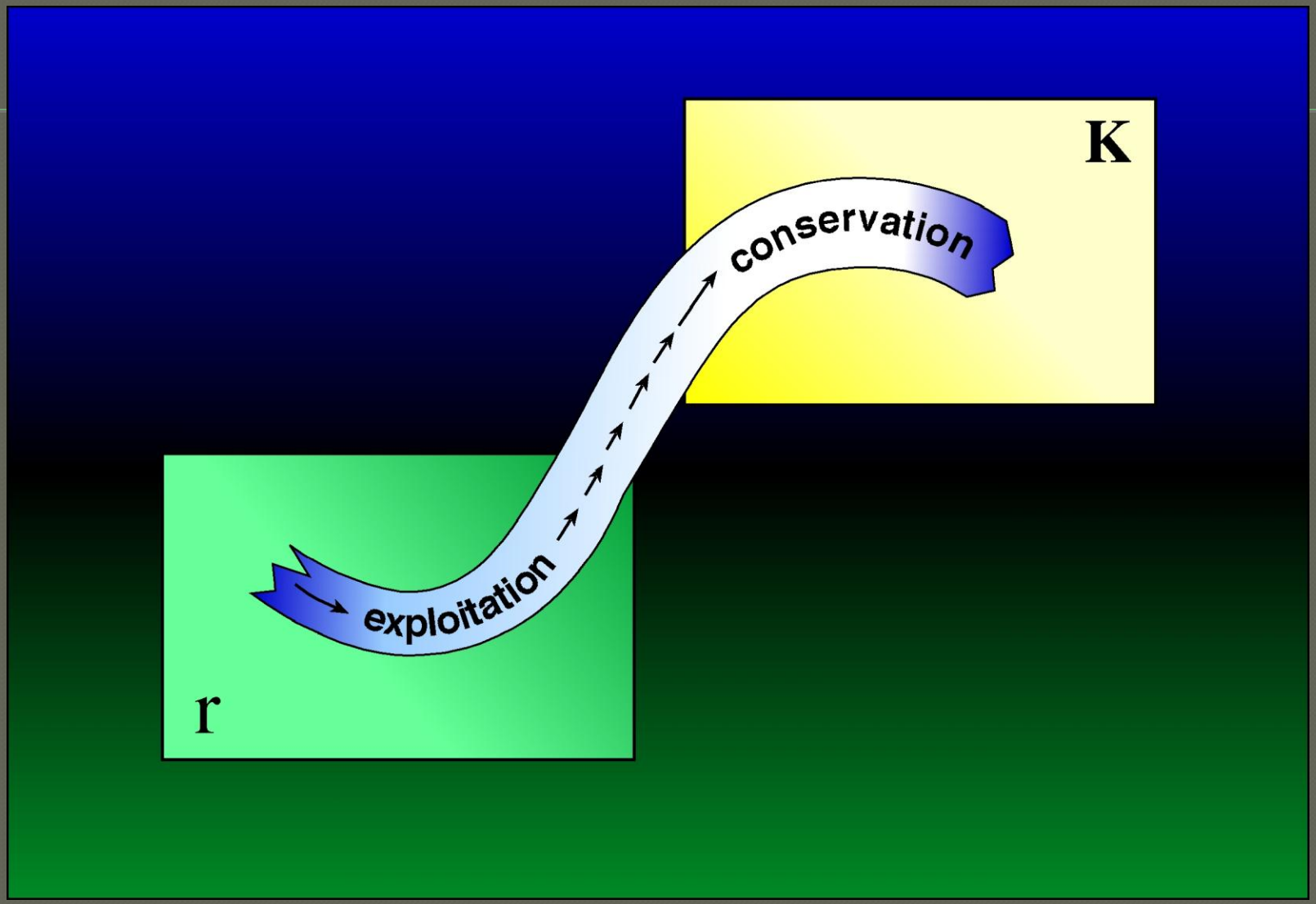
Social-Ecological System
Complex and Adaptive

Synthetic Heuristic: Cycles of Change

Forest

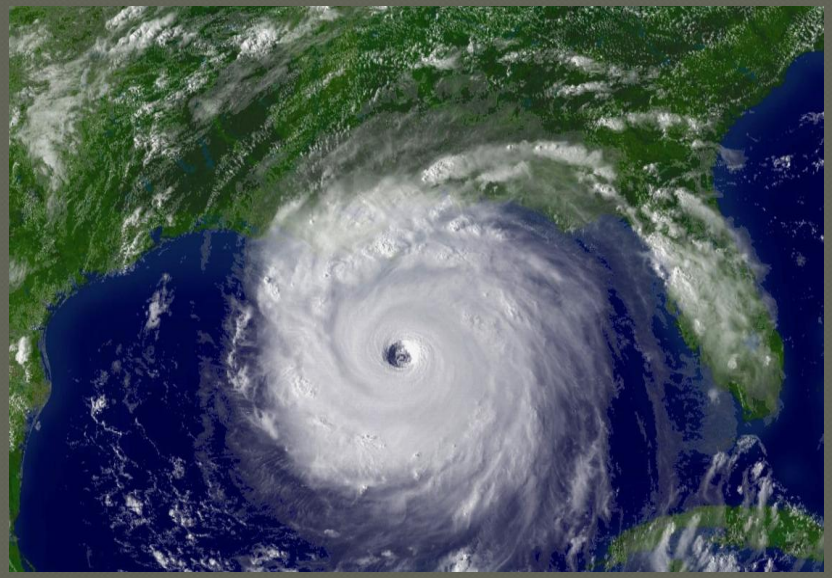
City

TIME


K
conservation
exploitation
r

Exogenous Crises

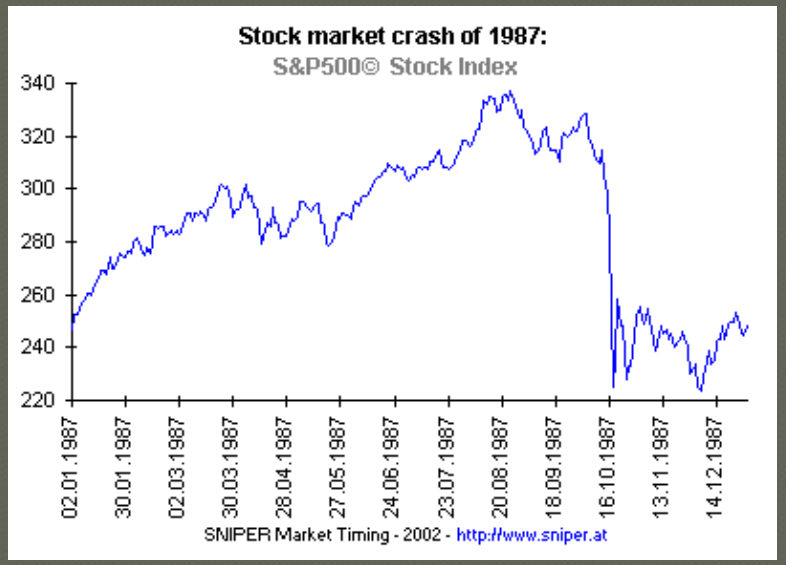
Tsunami, Japan, March 2011



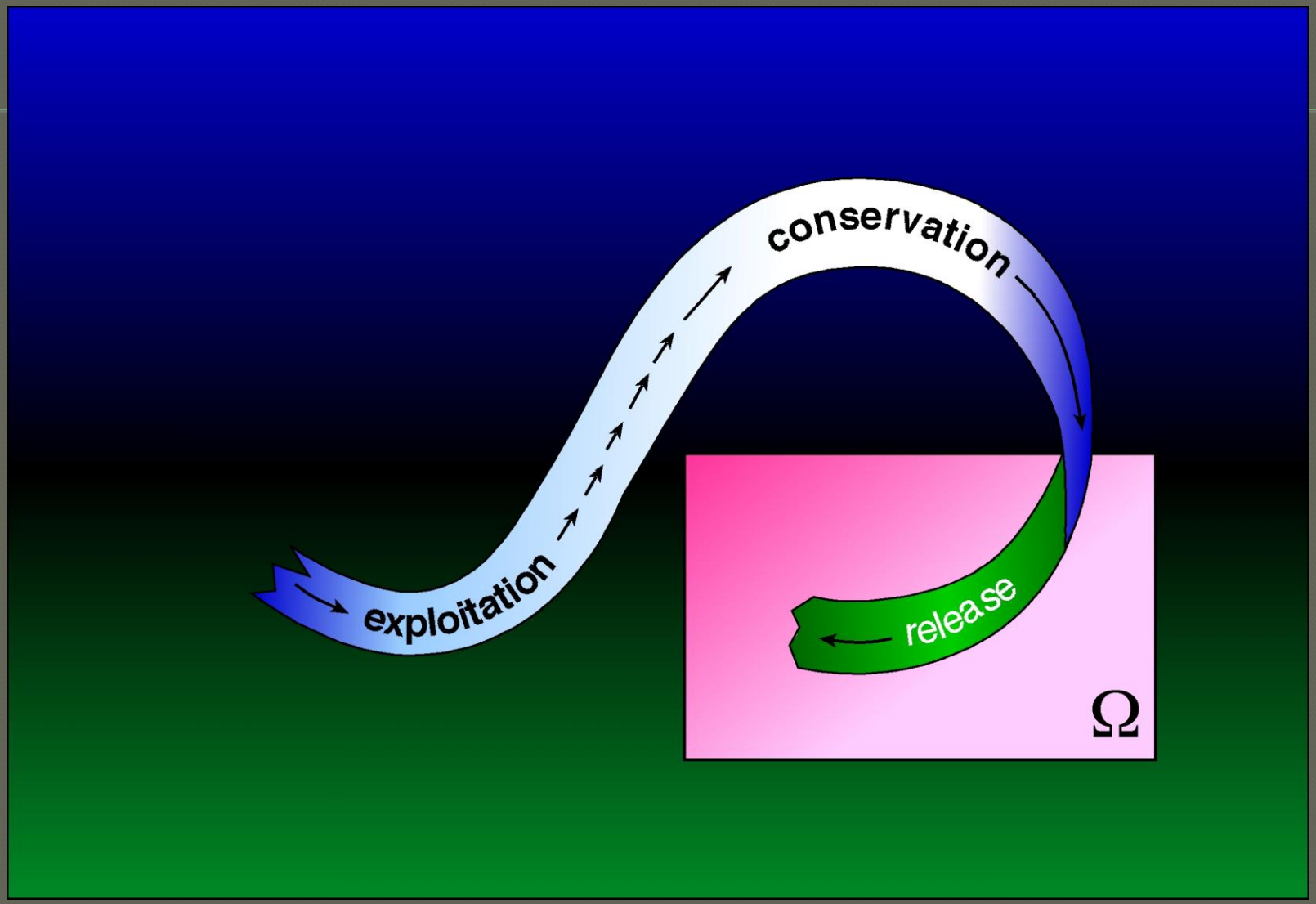
Hurricane Katrina, August 2005

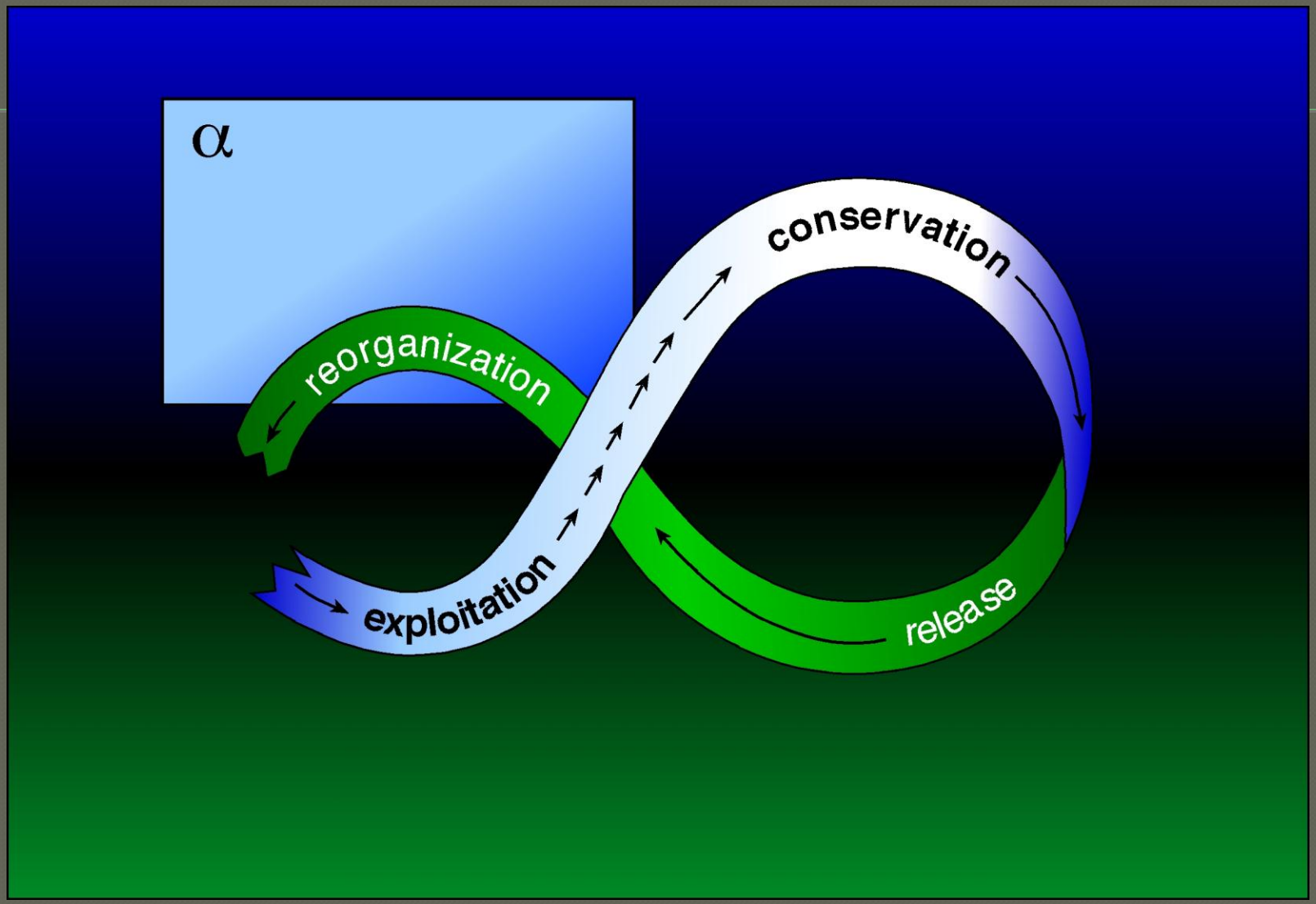
Crisis = Abrupt change, Instability, Disturbance
Variation at larger scales
Need for robust, diverse responses across scales

Endogenous Crises

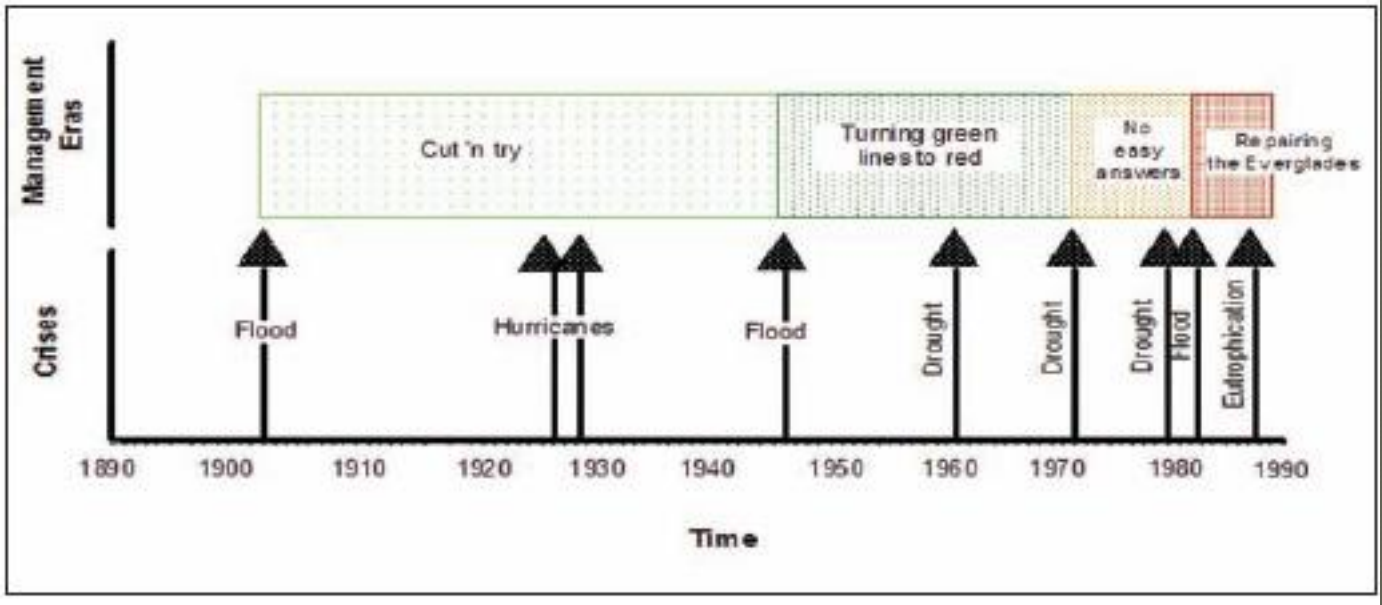


Increase vulnerability
Increased Connections
Accumulation of capital
Shifting controls- multiple factors


conservation
exploitation
release
Ω


α
conservation
reorganization
exploitation
release

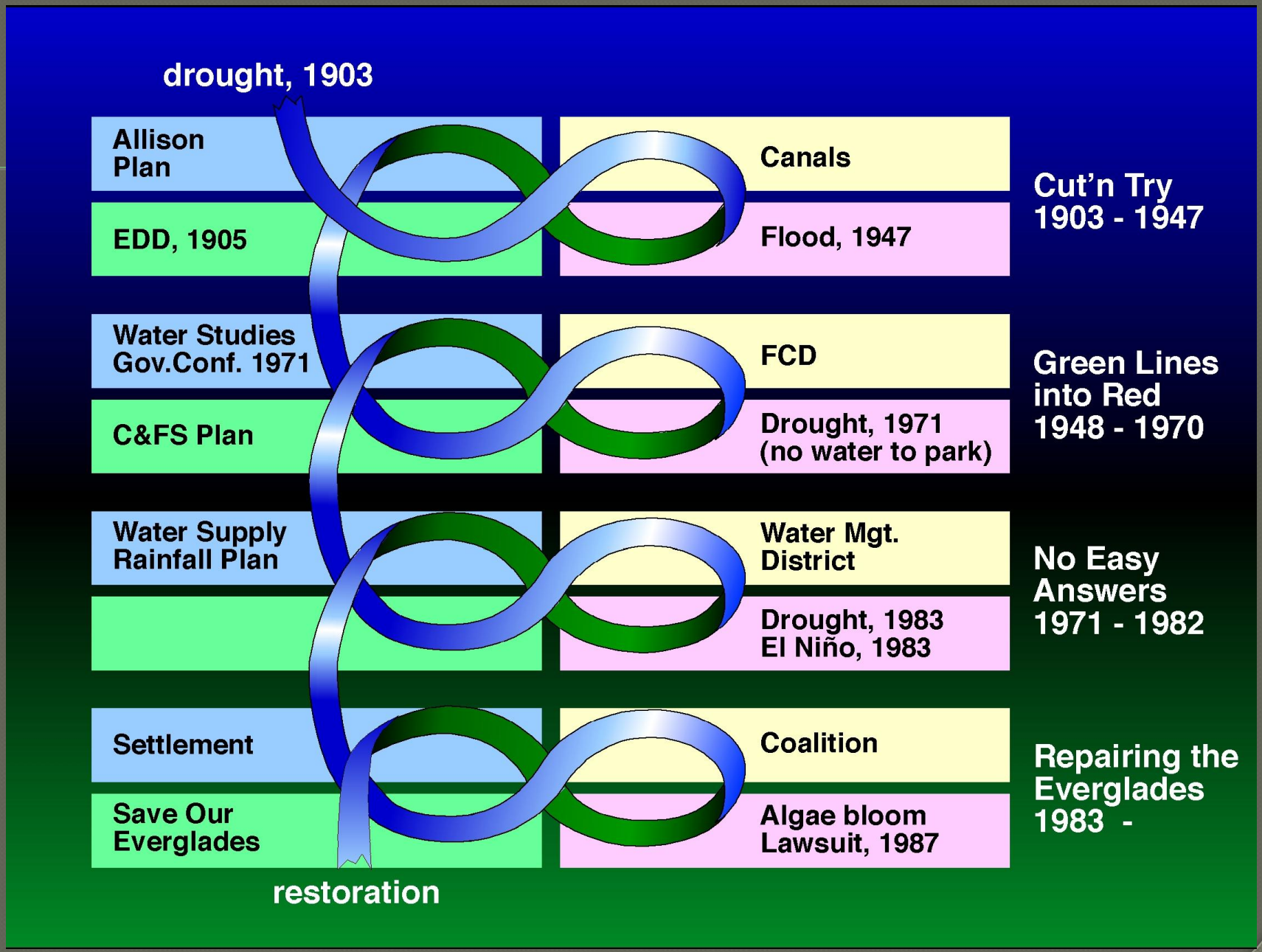
Historical Everglades Management Eras



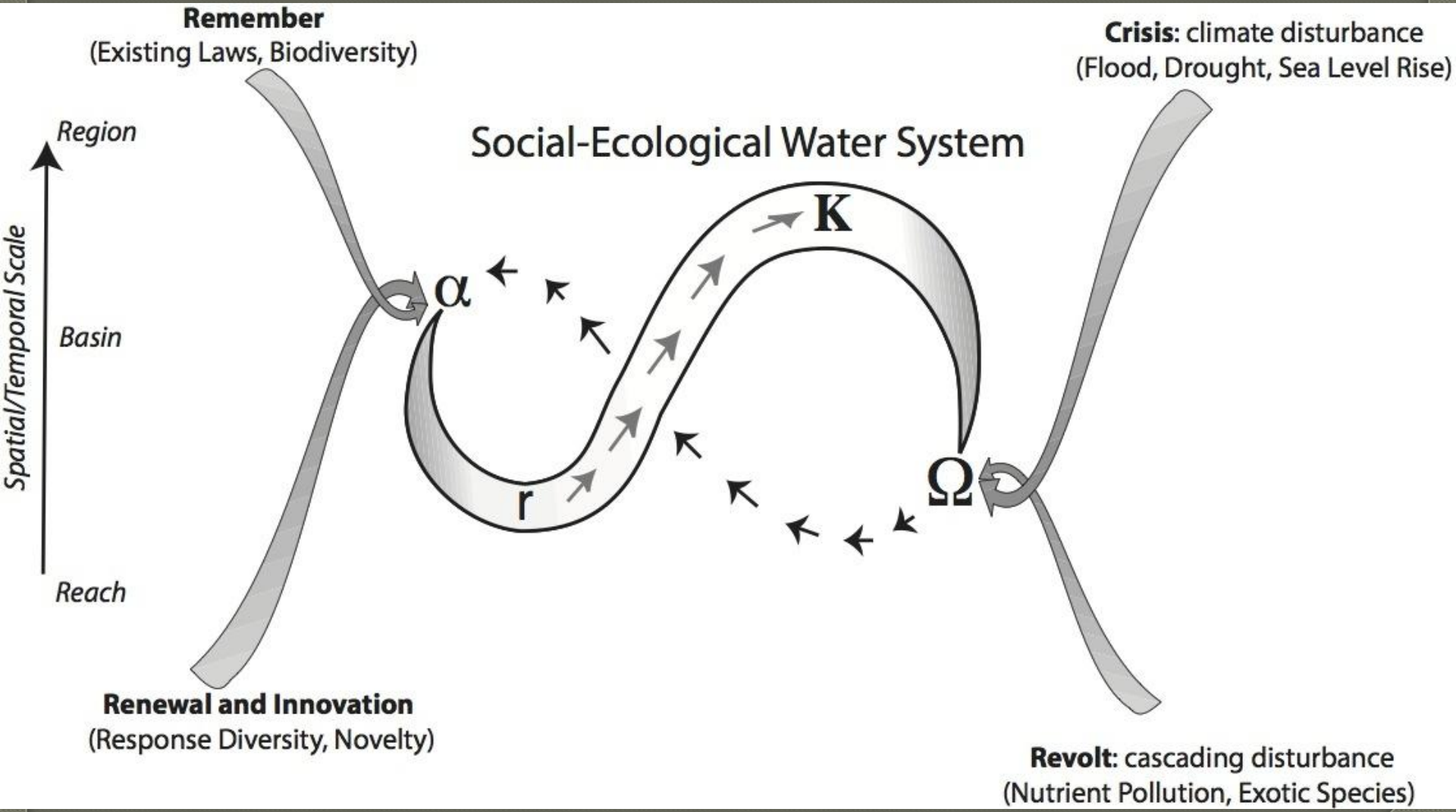
Adaptation Driven by policy failures

Everglades Adaptation and Governance

Crisis	→	Institutional Response
Flood 1903	→	Drainage District
Hurricanes 1920's	→	Corps of Engineers
Flood 1947	→	Flood Control District
Drought 1971	→	Water Management District
Crisis 1983	→	Everglades Coalition
Restoration 1999	→	Fed/State/Local Partnership


drought, 1903
Allison Plan
EDD, 1905
Canals
Flood, 1947
Cut'n Try 1903 - 1947
Water Studies Gov.Conf. 1971
C&FS Plan
FCD
Drought, 1971 (no water to park)
Green Lines into Red 1948 - 1970
Water Supply Rainfall Plan
Water Mgt. District
Drought, 1983 El Niño, 1983
No Easy Answers 1971 - 1982
Settlement
Save Our Everglades
Coalition
Algae bloom Lawsuit, 1987
Repairing the Everglades 1983 -
restoration

Complex/Cross Scale Model



Managing Uncertainty

Managers Face Different
Problem Domains

- Science
- Organizations
- Community
- Politics

Frances Westley 2002. The Devil is In the Dynamics. In Panarchy, Island Press

Scientific Uncertainty
Cultures of Ecological Science

- Analytical
  - Narrow, targeted
  - Disproof by experiment
  - Single causation
  - Single hypotheses
  - Single scale
  - Standard statistics
  - Eliminate uncertainty
  - Right answer to wrong question
- Integrative
  - Broad, exploratory
  - Multiple lines of converging evidence
  - Multiple causes/hypotheses
  - Multiple scales
  - Non-standard statistics
  - Confront uncertainty
  - Right question/useless answer

Managing Uncertainty

-Problem Domain

-science

-organizational
-community
-political

- Politics and power
- Stability of institutions
- Stakeholders
  - Advocacy groups
  - Epistemic groups
- Collective Action

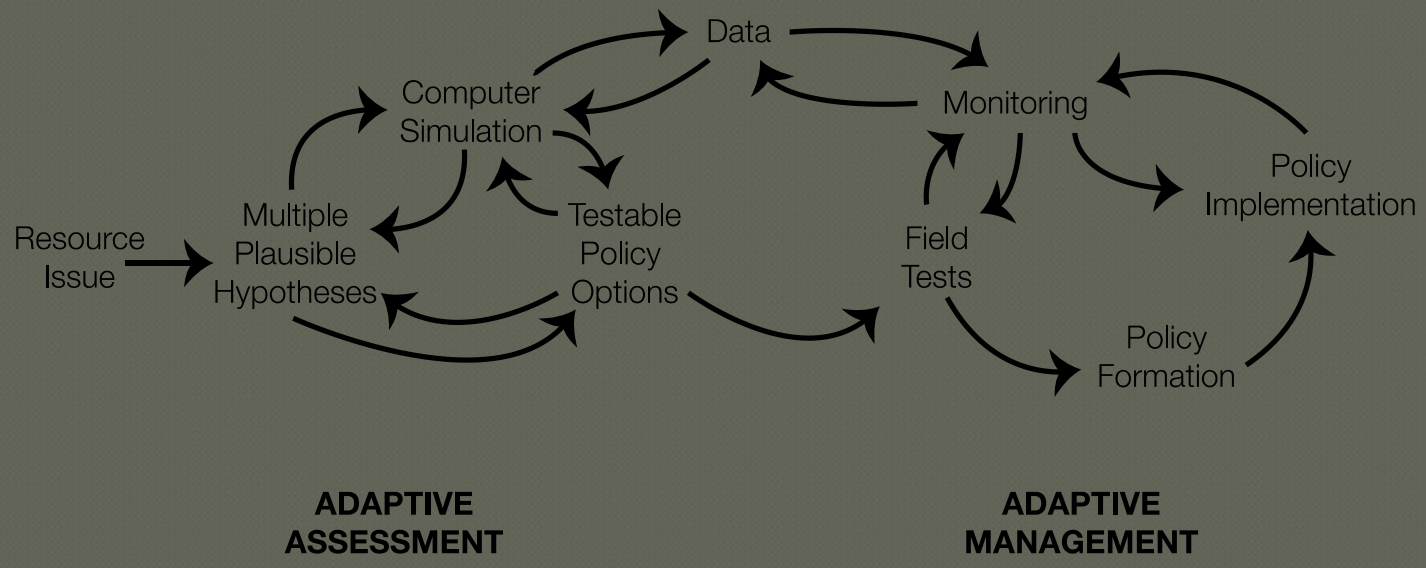
Institutional Design Principles

- Boundaries Defined
- Equity in allocation and use
- Participants can modify policies/rules
- Monitoring of both resources and users
- Graduated sanctions
- Conflict resolution
- Nested institutions

Lin Ostrom. 1990
Governing the Commons

Frameworks for Confronting Uncertainty

- Adaptive Management
- Adaptive Governance



Learning while doing
adaptive management and adaptive governance

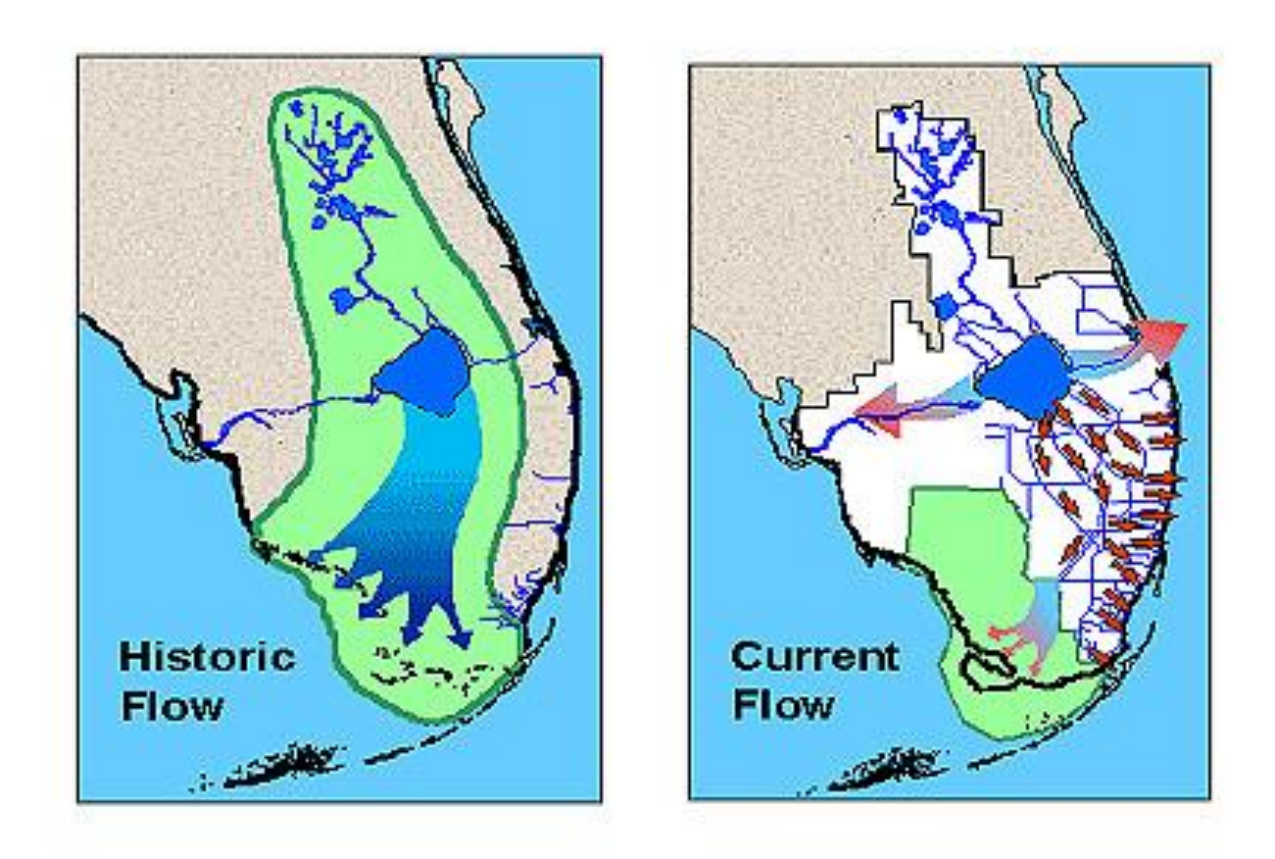
Everglades

Grand Canyon
Colorado River

Everglades Issues

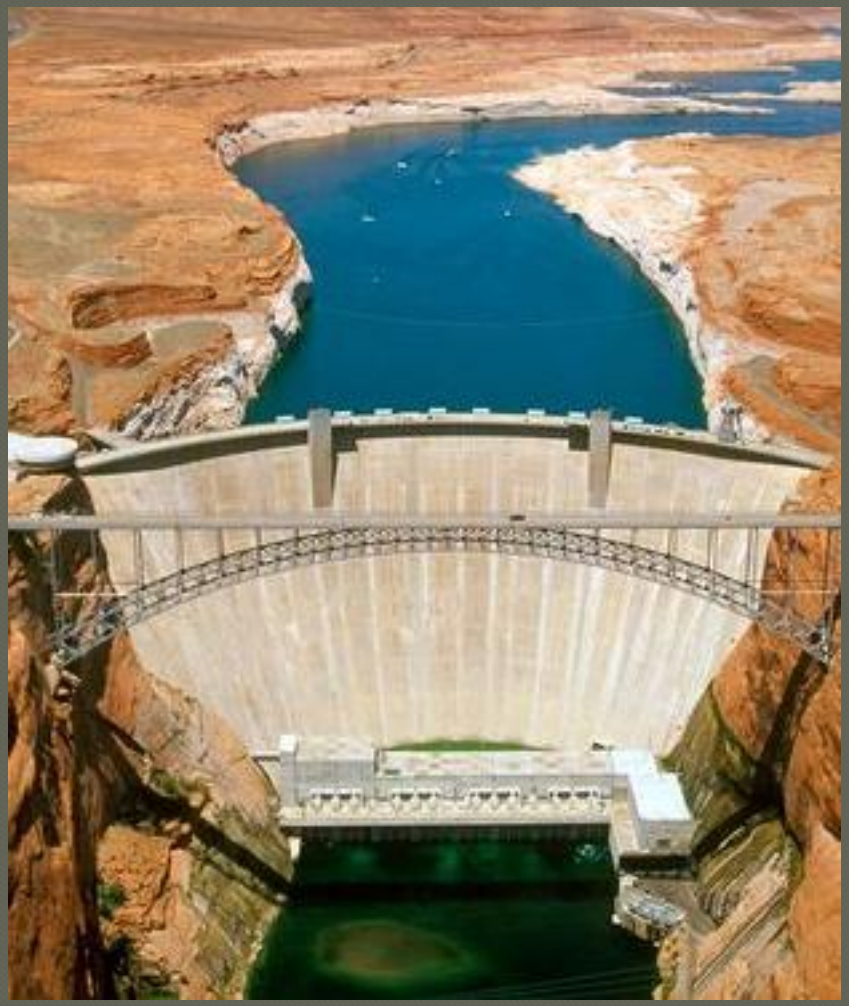
- Endangered species (20+)
- Declines in wading bird nesting
- Water supply needs/tradeoffs
- Water quality
- Invasive species

Everglades: Unwillingness to experiment and lack of adaptive governance impedes restoration progress



Grand Canyon Resource Issues

Glen Canyon Dam, N. Arizona



Sand for Beaches

Endangered species

Recreation - fishing, rafting, camping, hiking

Power generation

Non-native species

Cultural history - claims

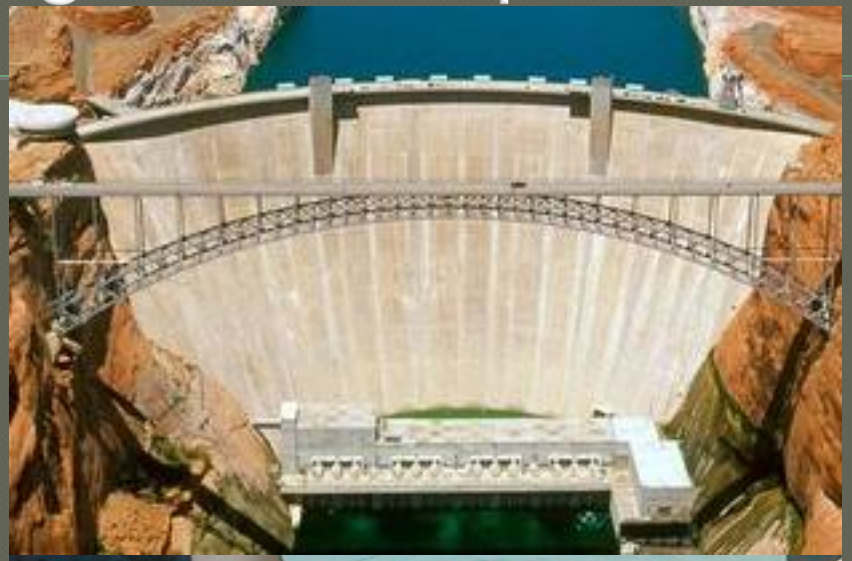
Water allocation & delivery

Adaptive Management Experiments

FLOW EXPERIMENTS
1996, 2004, 2008

Sediment, Beaches, Biology?

PREDATION CONTROL
Trout eating humpback chub



Grand Canyon: Experiments Critical to Social Learning and Restoration

- Experiments are costly
- Changed understanding
- Embedded leadership was necessary
- Forced addressing alternative hypotheses
- No long-term experimental design

Adaptive Management *and* Adaptive Governance

Integrate science, management & policy

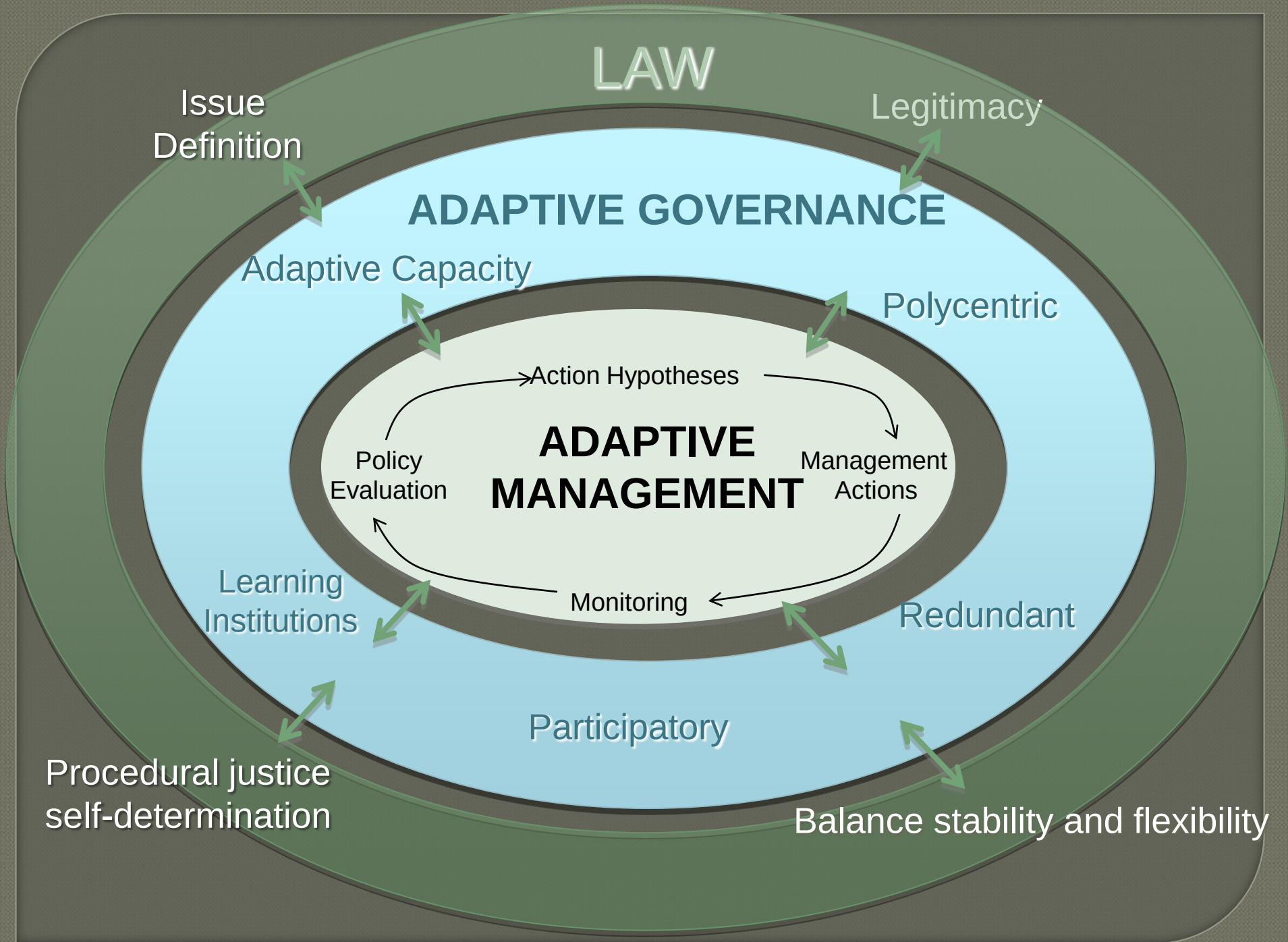
Create flexible learning networks

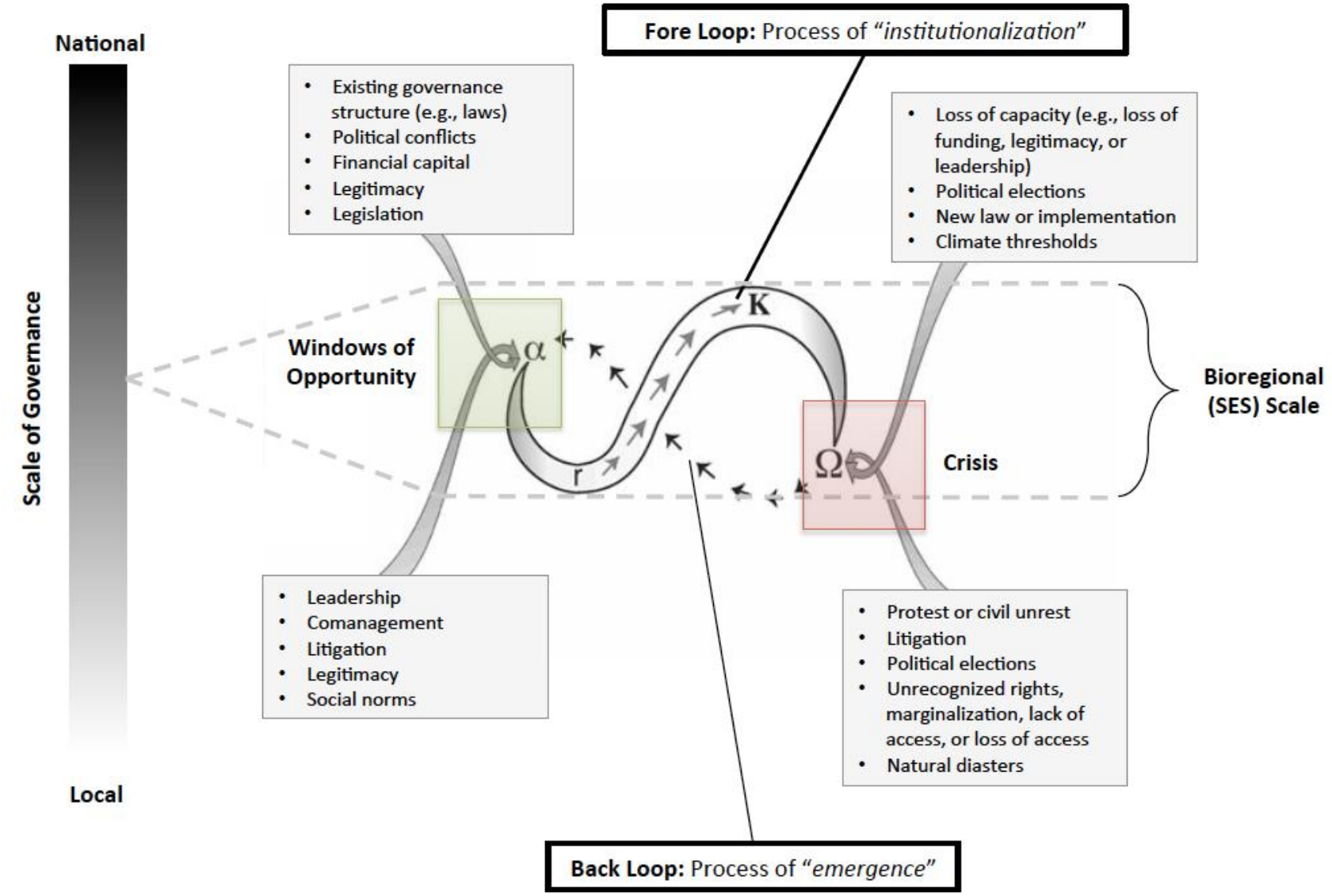
Leadership is critical to prepare for change

Bridge top-down and bottom-up scales of power

What is Adaptive Governance?

- Governance ≠ Management:
  - "governance is the process of resolving trade-offs and of providing a vision and direction" . . ., management is the operationalization..".
- Governance ≠ Government:
  - Formal structures
    - laws, policies, regulation, institutions
    - informal norms and interactions that influence decisions including those of private and nongovernmental actors.
- Adaptive Governance:
  - *governance that allows adaptation to emerge*
    - *Structures, Capacity, Process*
  - *governance that manages uncertainty*


LAW
Issue Definition
Legitimacy
ADAPTIVE GOVERNANCE
Adaptive Capacity
Polycentric
Action Hypotheses
ADAPTIVE MANAGEMENT
Policy Evaluation
Management Actions
Monitoring
Learning Institutions
Redundant
Participatory
Procedural justice self-determination
Balance stability and flexibility


National
Local
Scale of Governance
Fore Loop: Process of "institutionalization"
Back Loop: Process of "emergence"
Existing governance structure (e.g., laws)
Political conflicts
Financial capital
Legitimacy
Legislation
Loss of capacity (e.g., loss of funding, legitimacy, or leadership)
Political elections
New law or implementation
Climate thresholds
Windows of Opportunity
α
K
r
Ω
Crisis
Bioregional (SES) Scale
Leadership
Comanagement
Litigation
Legitimacy
Social norms
Protest or civil unrest
Litigation
Political elections
Unrecognized rights, marginalization, lack of access, or loss of access
Natural diasters
= important cross-scale interactions

Suggestions for navigating uncertainty

- Develop Learning Based Institutions
  - Evaluate and monitor outcomes of past interventions
  - Epistemic organizations/social learning
  - Stimulate imaginative experiments
  - Take actions that are safe to fail for individuals, institutions
- Manage across scales
  - Examine 'slow' variables
  - Link across time and space
  - Develop and maintain a portfolio of projects, waiting for opportunities to open.

Suggestions for navigating uncertainty

- Leadership
  - Create bridges across disciplines and sectors
  - Profit from change not stasis
  - Recognize opportunities for change
    - Variation in climate = opportunities for experimentation
    - Legal/social/biophysical events that open windows for change