COMPLEXITY 101

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With help from:
Lynam and Stafford Smith 2004, African J Range and Forage Science 21: 69
Holling (2001) Ecosystems 4: 390-405
John Finnegan, CSIRO Australia
Sharon Pollard, AWARD

COMPLEXITY 101

1. Why the fuss about complexity?
2. What is a complex system?
3. How do we approach complexity?

1. Why the fuss about complexity?

The Science – Management Divide

When tackling NRM issues, managers often complain that the scientists:

- need too much information
- produce results too specific for general use, and
- predictions of considerable uncertainty
- and take too long

Science does not always 'deliver'

Mostly excellent delivery in	Mixed success in
Computing & Communications	Agriculture
Transport & Aerospace	NRM
Medicine	Ecology
These are complicated problems – predictable when understood	These problems often throw up (nasty) surprises
	They are COMPLEX systems

Danger of fragmented information

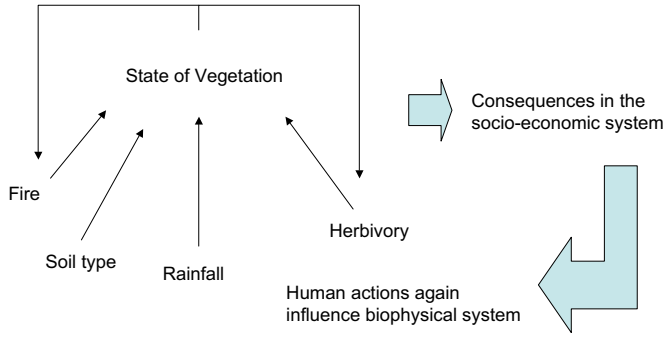
- Will the intervention have the intended effect?
- Will it be durable?
- What about unintended side-effects?

Are we using the wrong thinking?

"You cannot solve a problem with the thinking that created it" (Einstein)

2. What is a complex system?

Better illustrated by an example rather than a definition



Complicated and complex

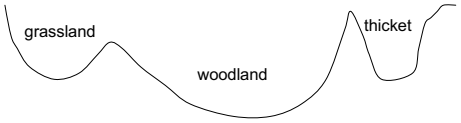
COMPLICATED SYSTEM	COMPLEX SYSTEM
Clear cause and effect	Multiple drivers
Understand system by studying the parts	Different ways to get to the same end point
System predictable: surprises considered undesirable, regarded as unfortunate, or eliminated	Interactions and surprises expected and should be embraced
Findings at one scale believed to apply at all scales	Varying effects at different scales: Often counterintuitive

Complicated and complex (2)

COMPLICATED SYSTEM	COMPLEX SYSTEM
Lags either not significant or exactly predictable	Lags add uncertainty
System or subunits treated as homogenous	Inherent variation over space and time essential to system function.
Feedbacks either absent or predictable	Feedbacks invariably present Counterbalancing and reinforcing loops lead to multiple states.

Complex system science

……..is about predicting behaviour that cannot be understood from a purely 'reductionist' point of view.



Alternate states seen as cup-and-ridge model

"Well-mixed" averaging models miss out local heterogeneity which is universal in complex systems and drives complexity e.g. DISEASE – STOCKMARKET – HURRICANES. Socio-ecological systems (SES's) are invariably complex.

The Problems involve systems that

- Comprise many elements or subsystems connected together in various ways, including non-linear ways;
- Span a large range of dimensions or scales;
- Exhibit hysteretic or irreversible behaviour;

And where

- The interaction between simpler elements allows *self-organization*, that is the emergence of complex behaviour that is not determined by information or controls imposed externally.

3. How to approach complexity?

Management interventions are designed to be informative experiments (pushing and probing the system to see how it responds)

which requires

An initial mental model (always imperfect), and 'clever' monitoring that challenges the model and builds ongoing better understanding of causation

where

Because of complexity….

Management is then seen as a series of experiments rather than the application of a "cookbook" solution

and

should thus be structured in such as way as to learn about the complexities of the system ("What will we learn together from this?")

NOT

just "try something, and if it doesn't work try

Future Building

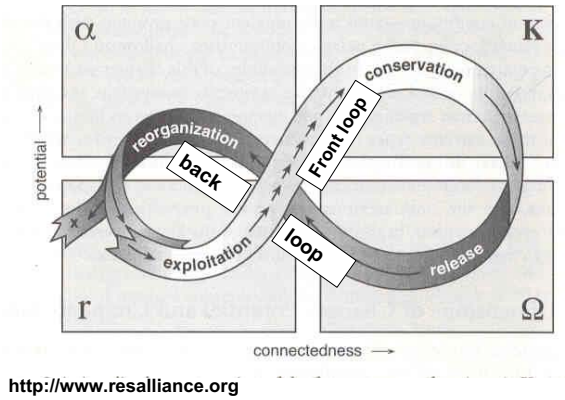
Define clear goals based on how the system is believed to work from a ***variety of perspectives***

Agree on where we are, where we want to be, and the monitoring to show if we are getting there

with the important proviso that

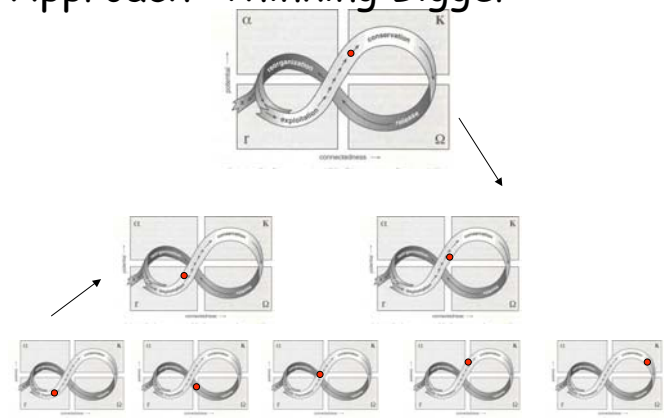
the above goals are dealt with in a spirit of joint **future-building**, which often causes the usual conflicts between different stakeholders to become a less important issue

Approach: Thinking big



http://www.resalliance.org

Approach: Thinking Bigger



Inter-linkages between scales, and downward & upward propagation

A firm place to stand……

When searching for simplicity upon which to take action we face two dangers:

Naïve simplicity – because we choose to ignore complexity

Deceptive simplicity – blinded by agendas (ours or our organisation's or funding body's)

So

We must wrestle with complexity and distill……

Profound simplicity – a place to stand, take action and deepen our understanding of the system

"As simple as possible but not simpler" - Einstein

Complexity: just one road……..

Know your problem and use the appropriate methods to understand and manage it

Strategy	*For use in*
Command-and-control	Predictable systems; externalities often carried at next scale up
Optimisation	Maximises production with trade-offs against resilience
Strategic adaptive management	Complex systems; maximises heterogeneity and resilience