

COMPLEXITY & SOCIO-ECOLOGICAL SYSTEMS

Presented by Harry Biggs

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and some serious help from:

John Finnegan, Oonsie and Duan Biggs

Key Refs:

Lynam and Stafford Smith 2004, African J Range and Forage Science 21: 69

Holling (2001) Ecosystems 4: 390-405

Part I : 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

Computing & Communications

Transport & Aerospace

Medicine

These are complicated problems
- predictable when understood

Mixed success in

Agriculture

NRM

Ecology

These problems often throw
up (nasty) surprises

They are COMPLEX systems

Danger of fragmented information

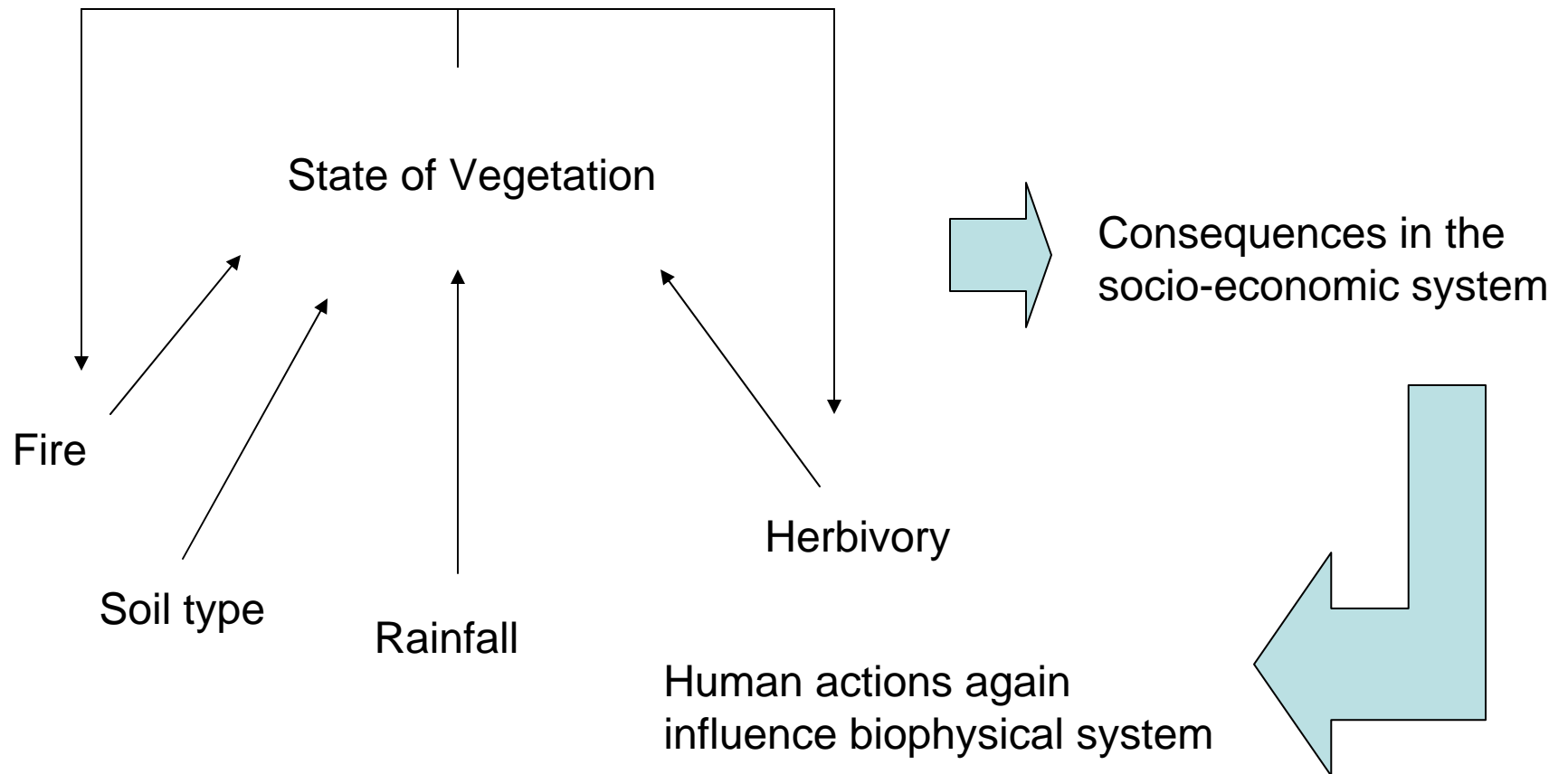
- Will the intervention have the intended effect?
- Will it be durable?
- What about unintended side-effects?

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

Clear cause and effect

Understand system by studying the parts

System predictable: surprises considered undesirable, regarded as unfortunate, or eliminated

Findings at one scale believed to apply at all scales

COMPLEX SYSTEM

Multiple drivers

Different ways to get to the same end point

Interactions and surprises expected and should be embraced

Varying effects at different scales: Often counterintuitive

Complicated and complex (2)

COMPLICATED SYSTEM

Lags either not significant or exactly predictable

System or subunits treated as homogenous

Feedbacks either absent or predictable

COMPLEX SYSTEM

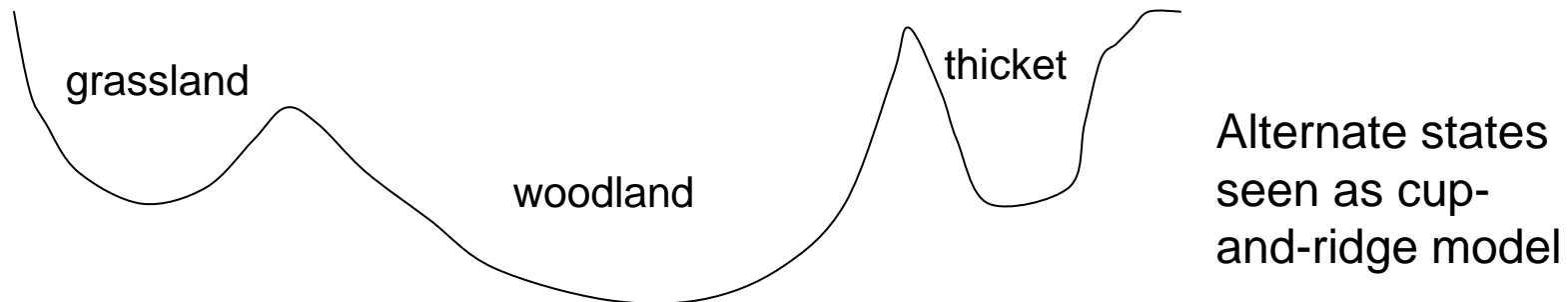
Lags add uncertainty

Inherent variation over space and time essential to system function.

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.



"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

Each step is a learning iteration, such that even the goals are experimental

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 a 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 something else"

Future Building

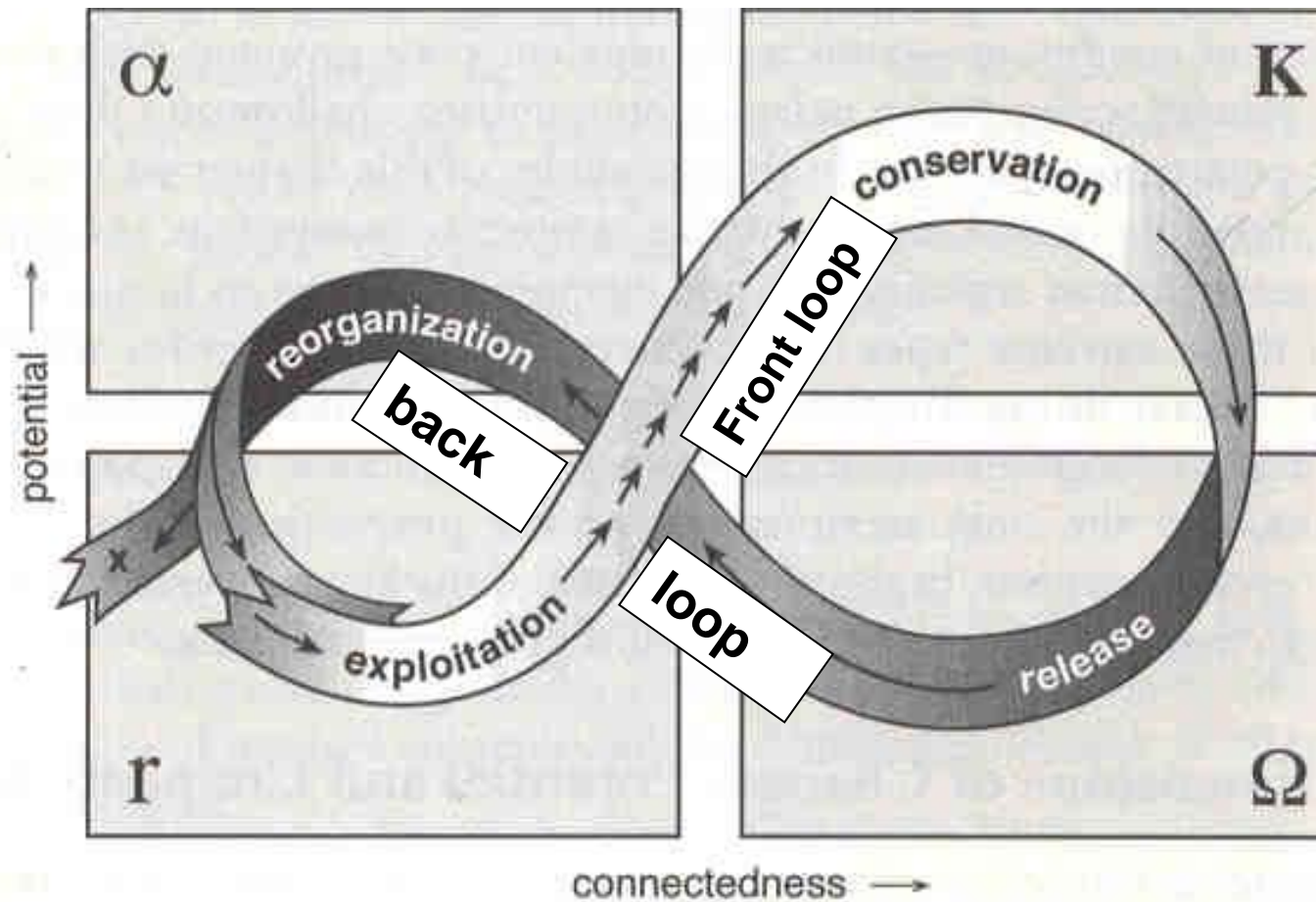
Define clear goals based on how the system is believed to work from a *variety of perspectives*

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

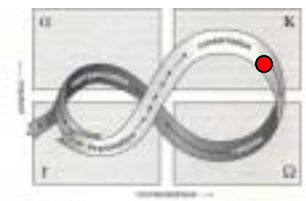
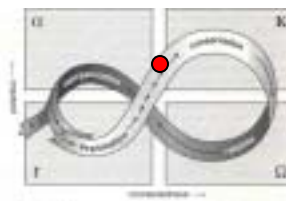
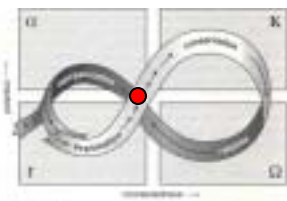
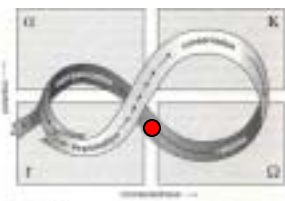
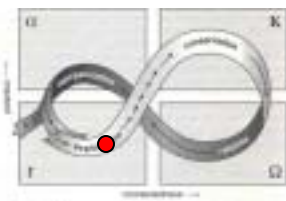
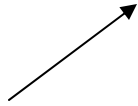
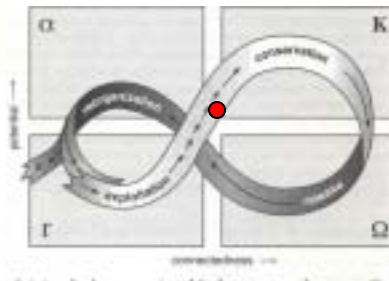
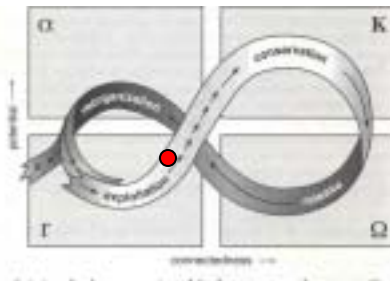
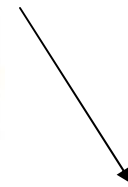
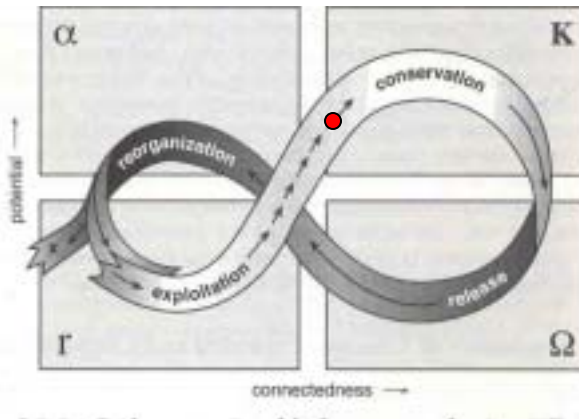
the above goals are dealt with in a spirit of joint **future-building**, which often causes the usual conflicts between different stakeholders to become a less important issue

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.....

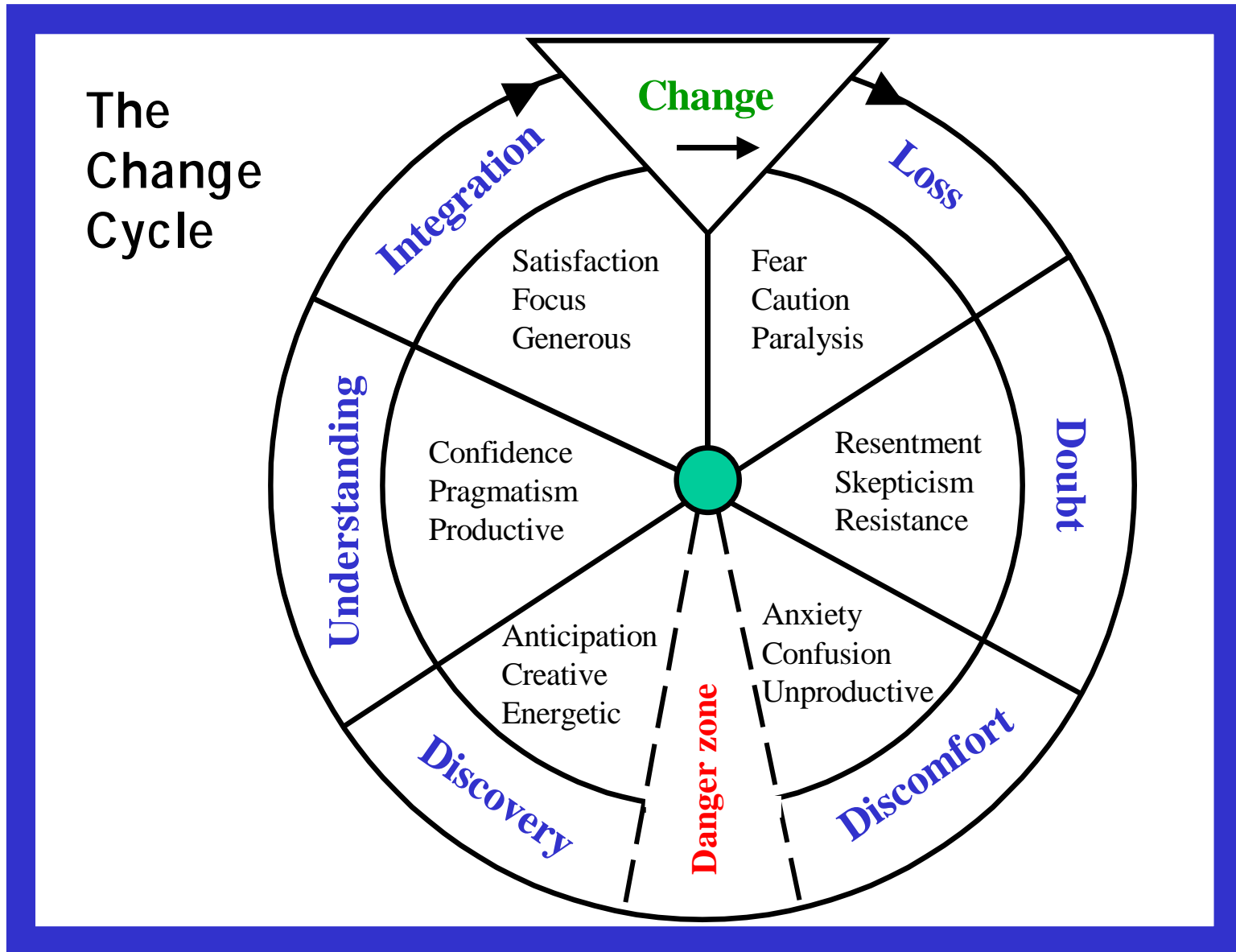
Profound simplicity – a place to stand, take action and deepen our understanding of the system

“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

<u>Strategy</u>	<u>For use in</u>
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



Brock L R and Salerno M A (1998) *The secret to getting through life's difficult changes*. Bridge Builder Media, Washington DC/Durban RSA

Part II :

some snippets (hopefully in logical sequence)

from:

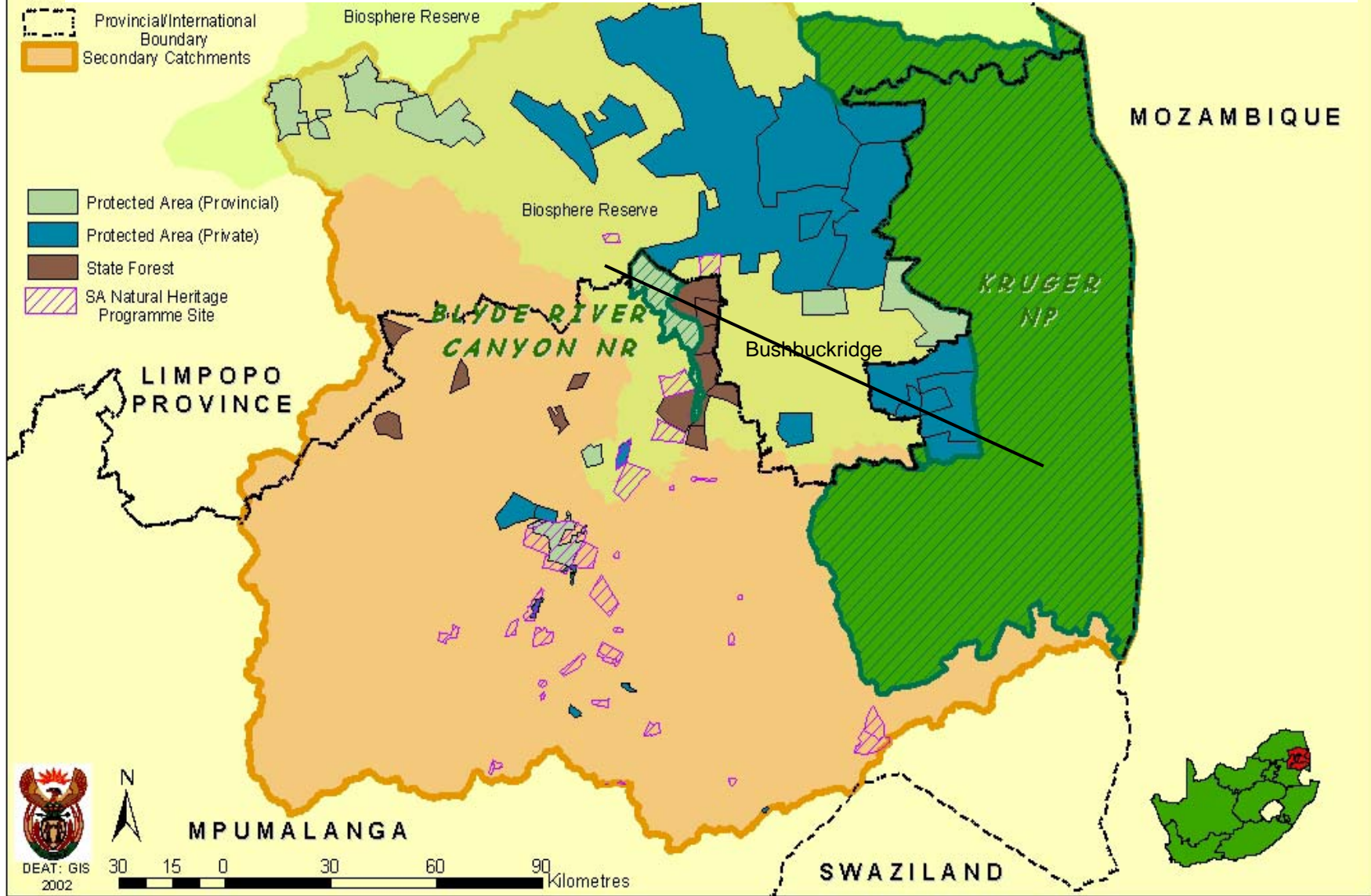
Building a socio-ecological view of
Wetlands, ecosystem services, livelihoods in
Bushbuckridge

-context

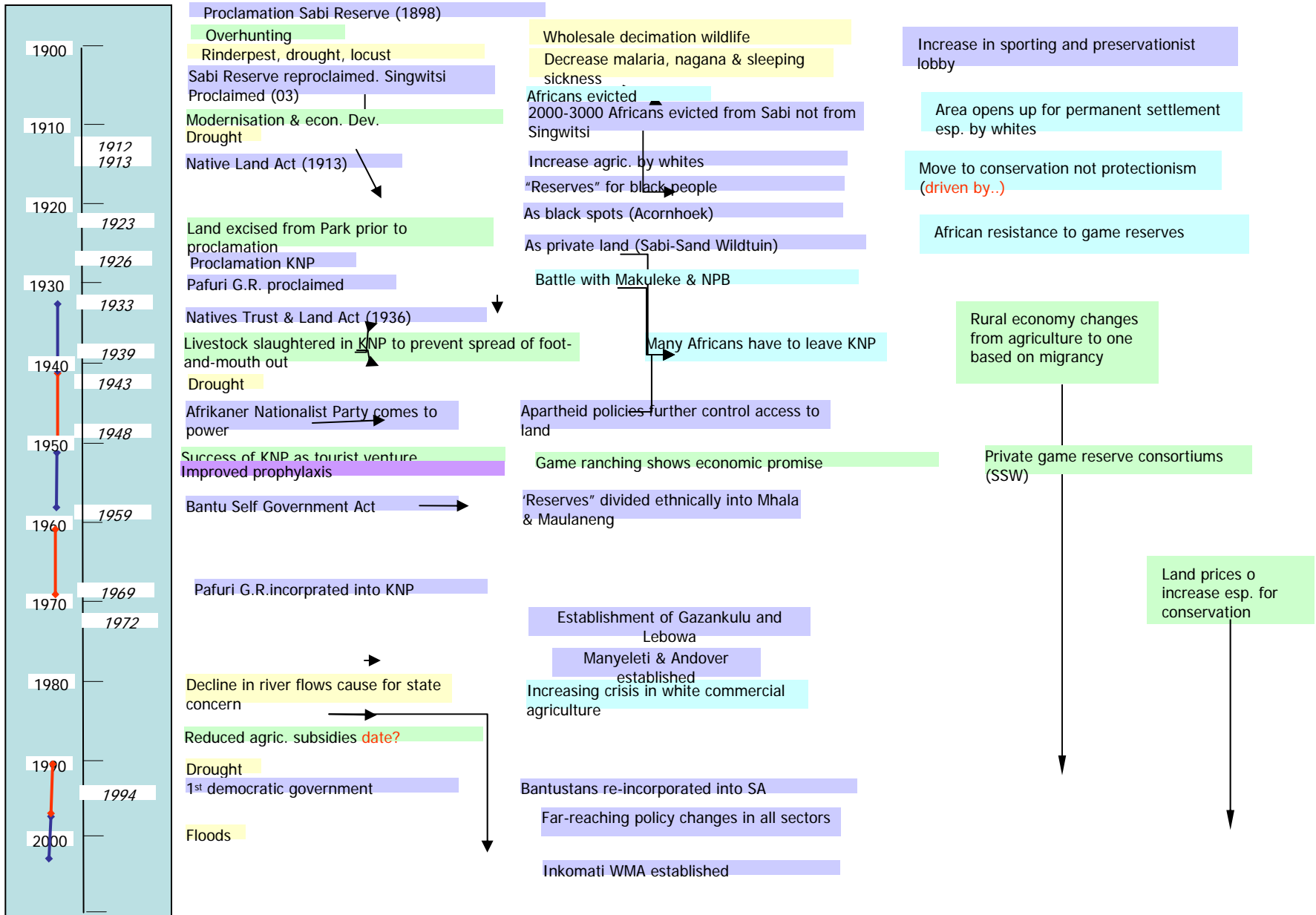
-tools e.g. timelines, system dynamics diagrams

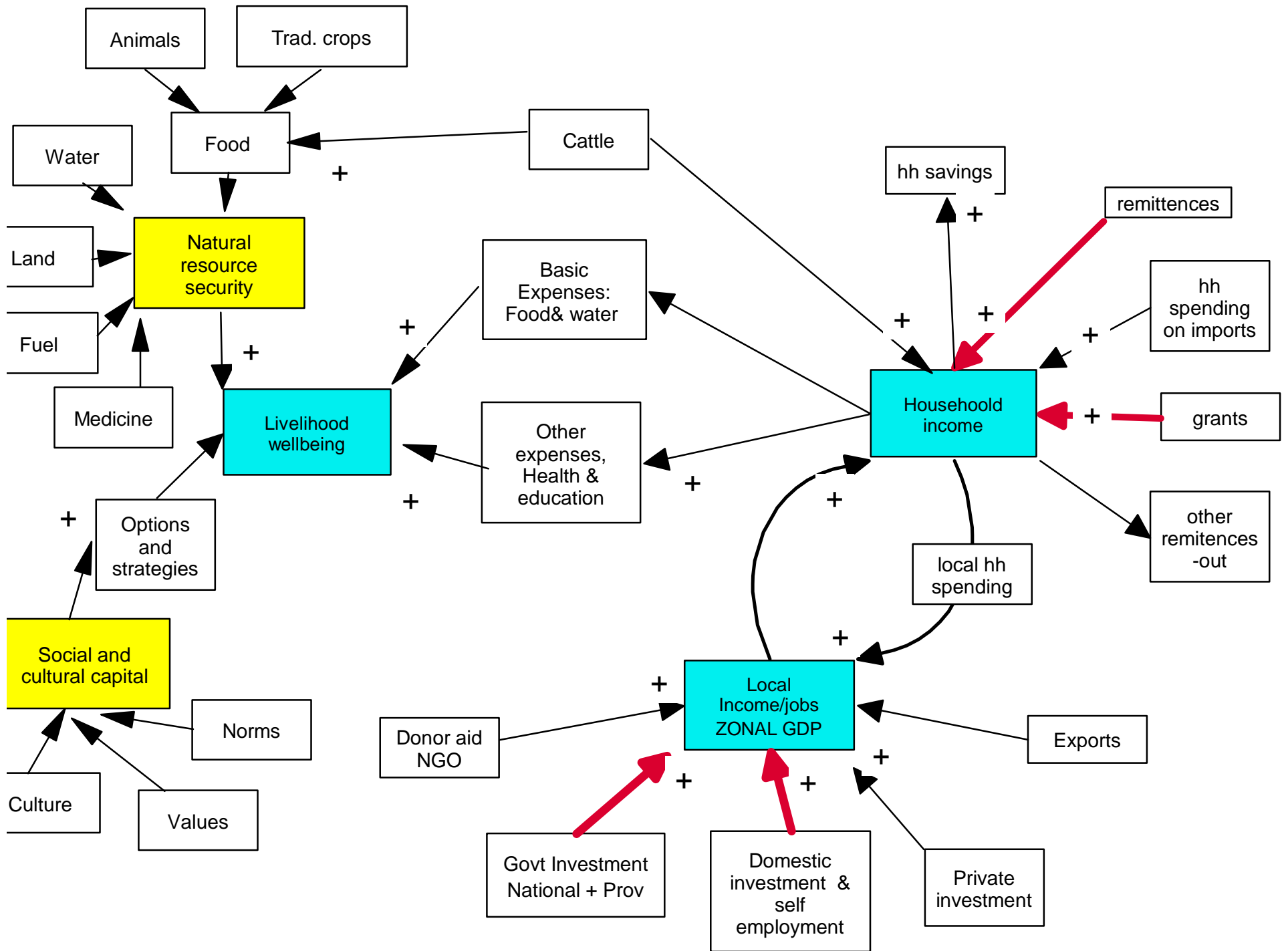
- some novel useful questions

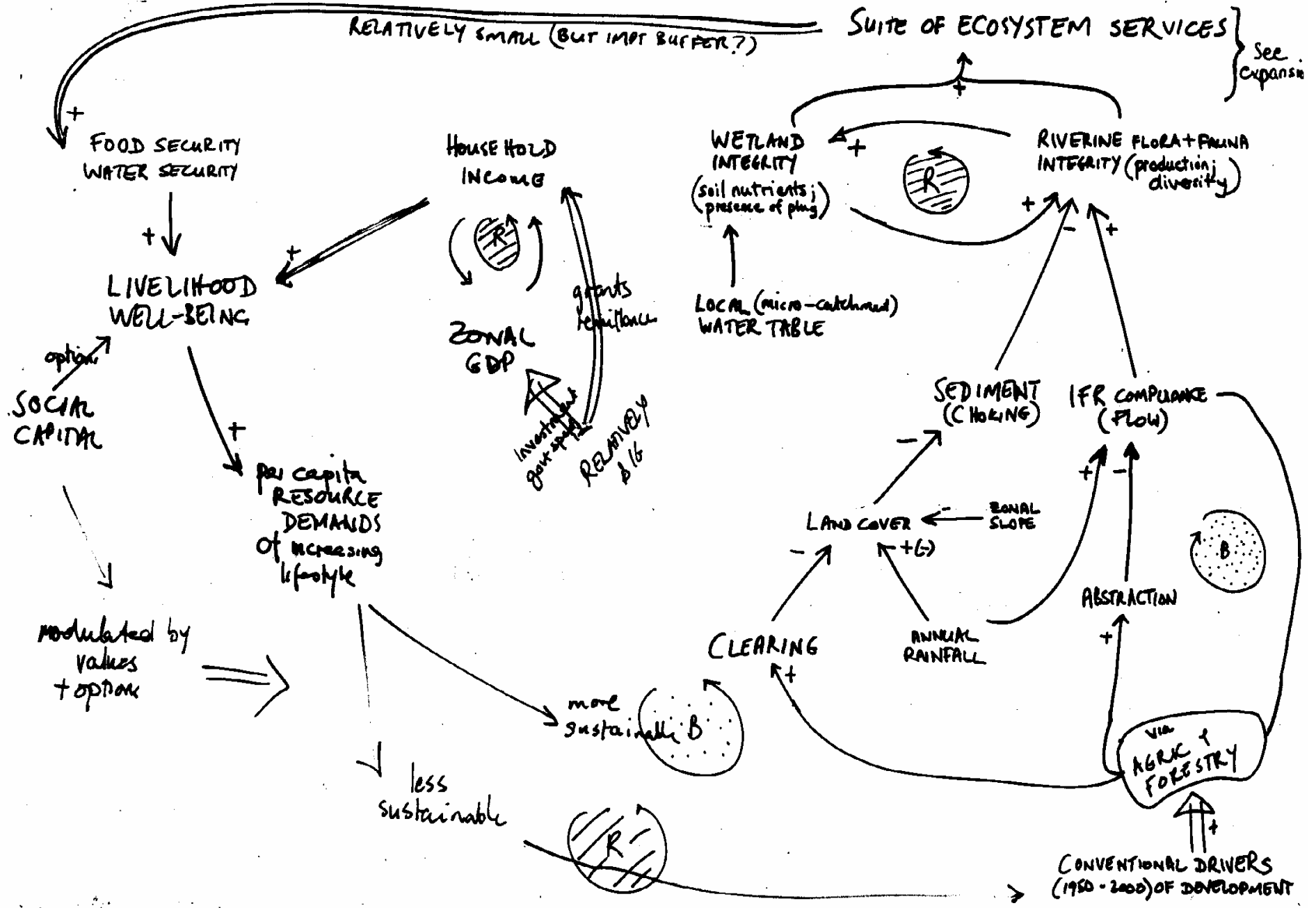
Communities and Protected Areas : North-eastern escarpment bioregion



TIMELINE OF MAJOR EVENTS IN ZONE C: 1900 - PRESENT







Examples of novel useful questions

Effect of governance patterns on resilience ?

What are sources of **leadership, empowerment & action-learning** ?

Which prevailing mental models are in use ?

What are the **states and thresholds**?

- are managers modifying disturbances?
- is threshold expansion happening?

Which are the **fast and the slow variables**?

Where is the **social and ecological redundancy**

---- Thank you