WHAT IS RESILIENCE, AND WHAT DOES IT MEAN FOR POLICY AND MANAGEMENT?

Brian Walker

1999 Foot-and-Mouth Disease outbreak in the UK

i) economic rationalization of number of abattoirs ($<\frac{1}{2}$)

ii) bizarre EU subsidies

- increased the connections between herds

iii) changes to F&M reporting rules delayed isolation of infectious animals

enhanced the elements for spread of an epidemic disease, and greatly reduced the capacity to cope with it

Vulnerability of Europe to disruption of its gas supply system

(EU workshop at ISPRA, 2006)

Thousands of cross-border pipelines; vulnerable nodes

3-day threshold effect

i) physical restoration of pumps/pipes

ii) mortality

Adaptability is crucial - leadership, trust, governance

(suspend legal contract rules)

- UK F&M outbreak -- a social-ecological system

- European gas pipe problem -- a social-technical system

A 'system' ?

your body, a car, a farm, the GB catchment, a company, a factory

component parts that are linked up and inter-dependent
governed by **feedbacks** between them

A system is defined by the problem being examined

The "rule of hand"

At any one scale, the critical changes in ecosystems and social-ecological systems are determined by a few (3-5) controlling variables.

Living systems - like your body, an ecosystem, a society, a farming region - are ***self-organising*** systems
('complex adaptive systems')

Hold one part of the system constant – the other parts will respond, and begin to change

In social-ecological systems, crucial feedbacks are often between:

- social and ecological sub-systems
- different scales (farm, catchment, State)

There are *limits* to how much a system can be changed and still recover.
Beyond those limits there is a change in feedbacks, and the system changes to some other state

Unwelcome surprises in such systems come from exceeding the amount of change the system can absorb – ie, from loss of **resilience**

Resilience

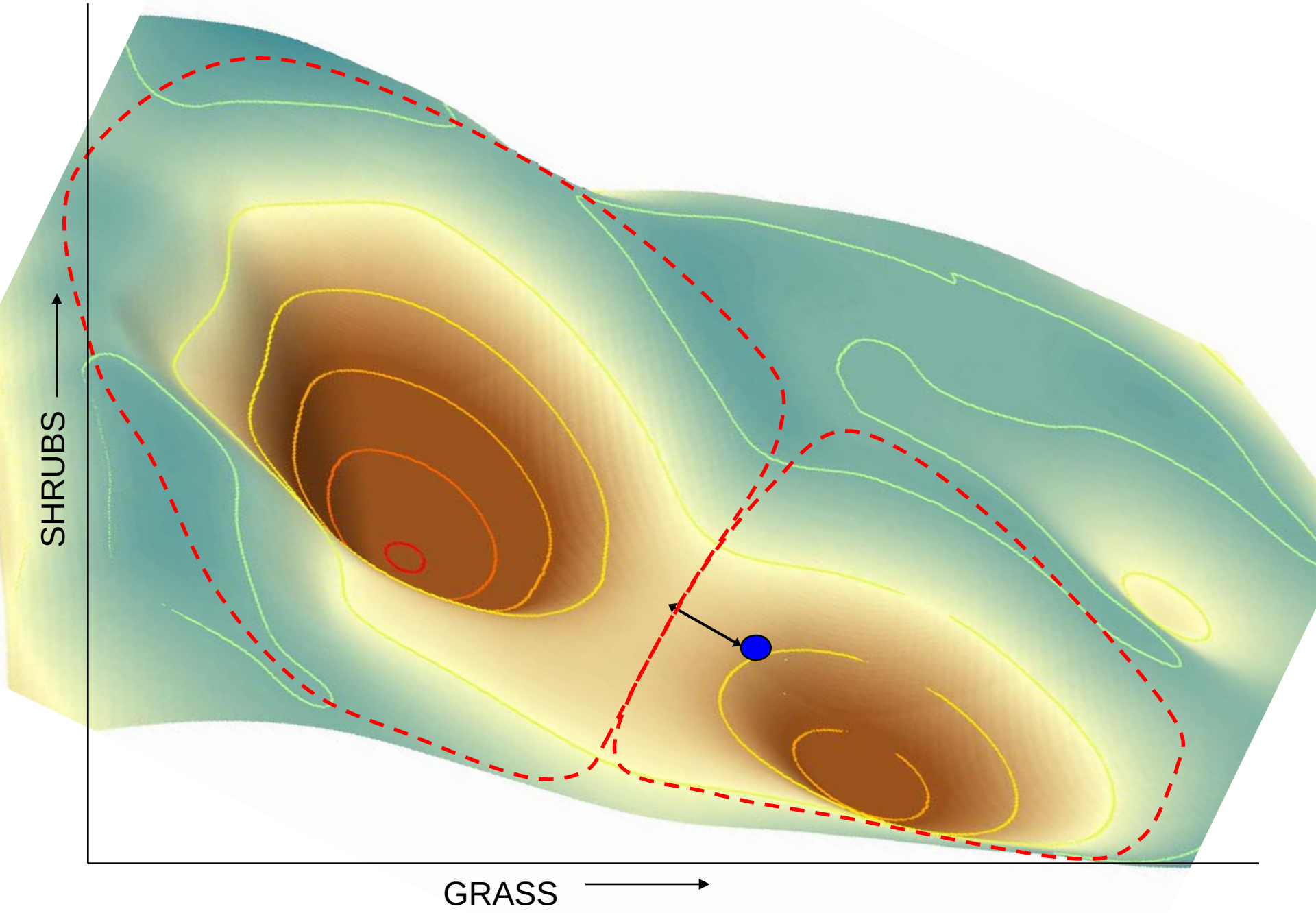
Definition:

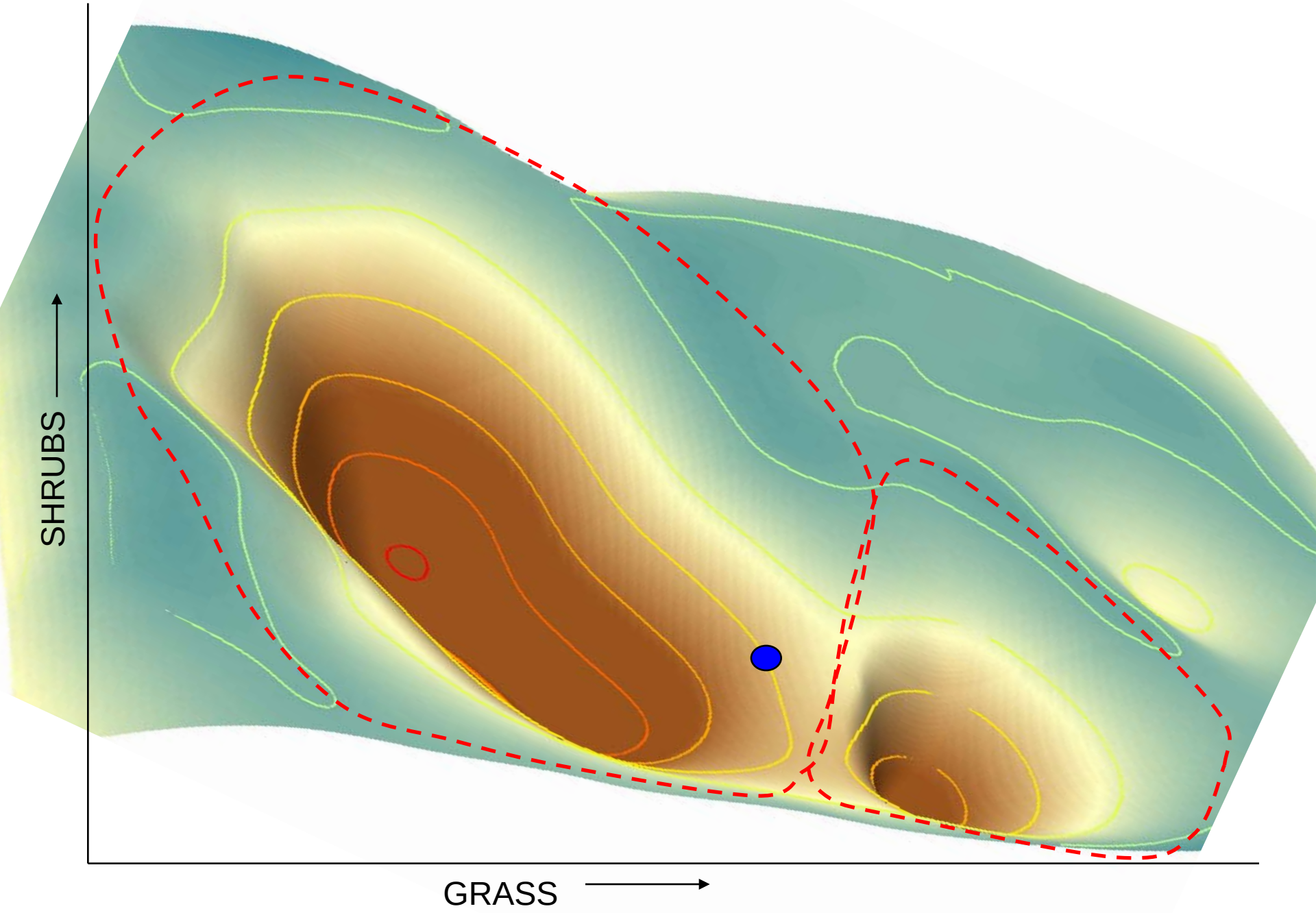
"the capacity of a system to absorb disturbance and re-organise so as to retain essentially the same function, structure and feedbacks – to have the same identity"

How much a system can be changed and still continue to function in the same kind of way

resilience puts a focus on *thresholds* ('tipping points') between alternate states, or 'regimes', of a system

Rangeland in western NSW


SHRUBS
GRASS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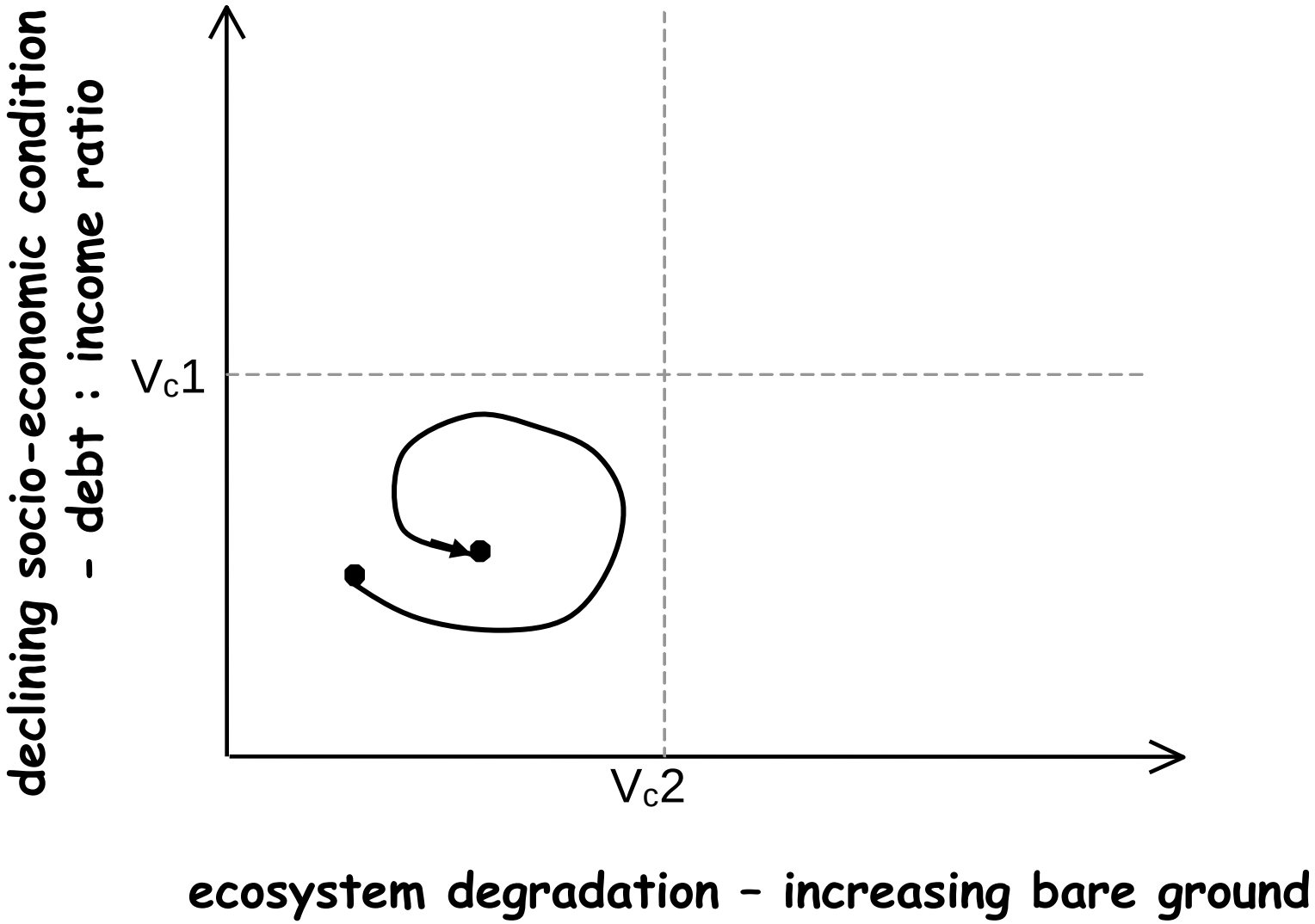
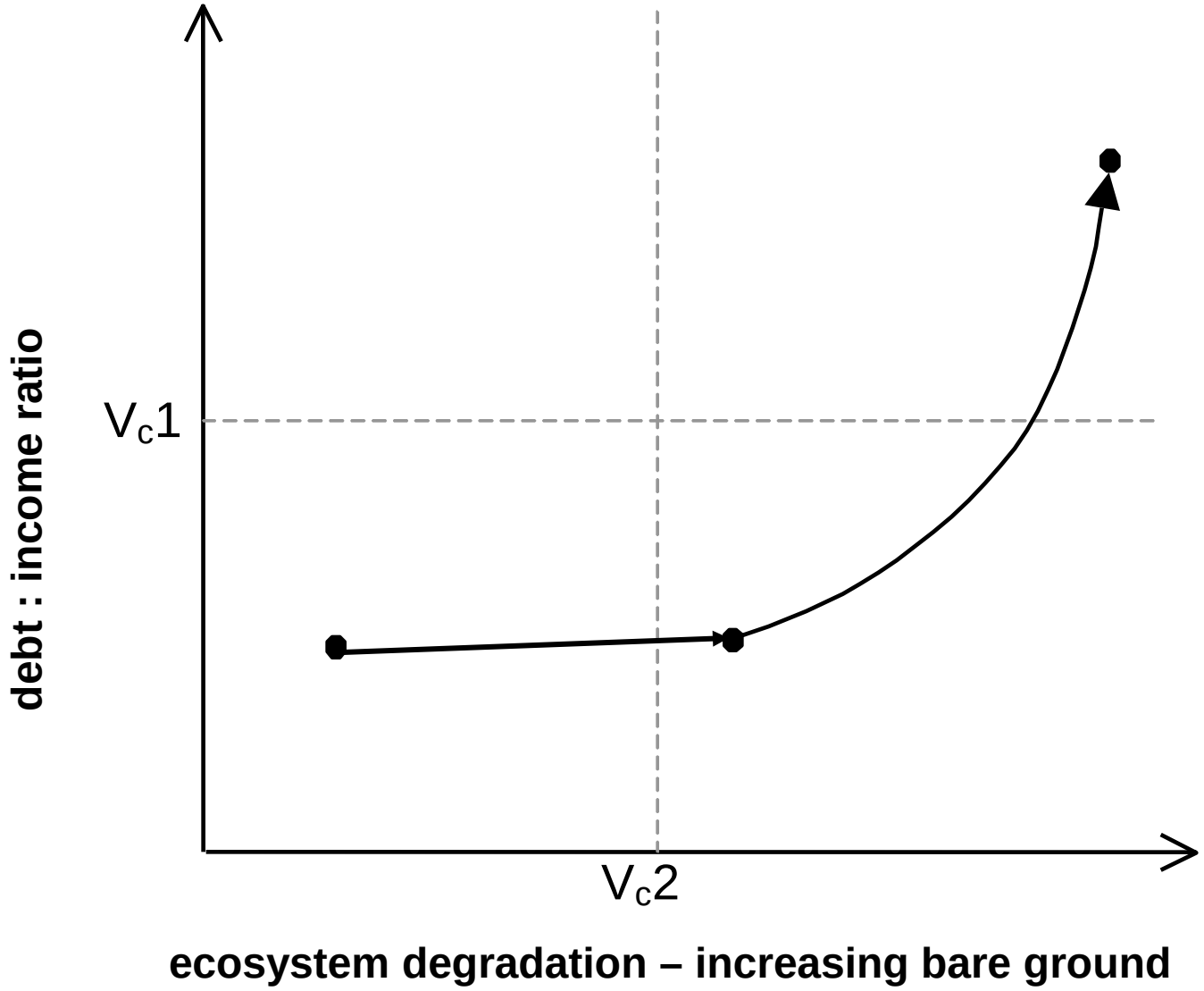
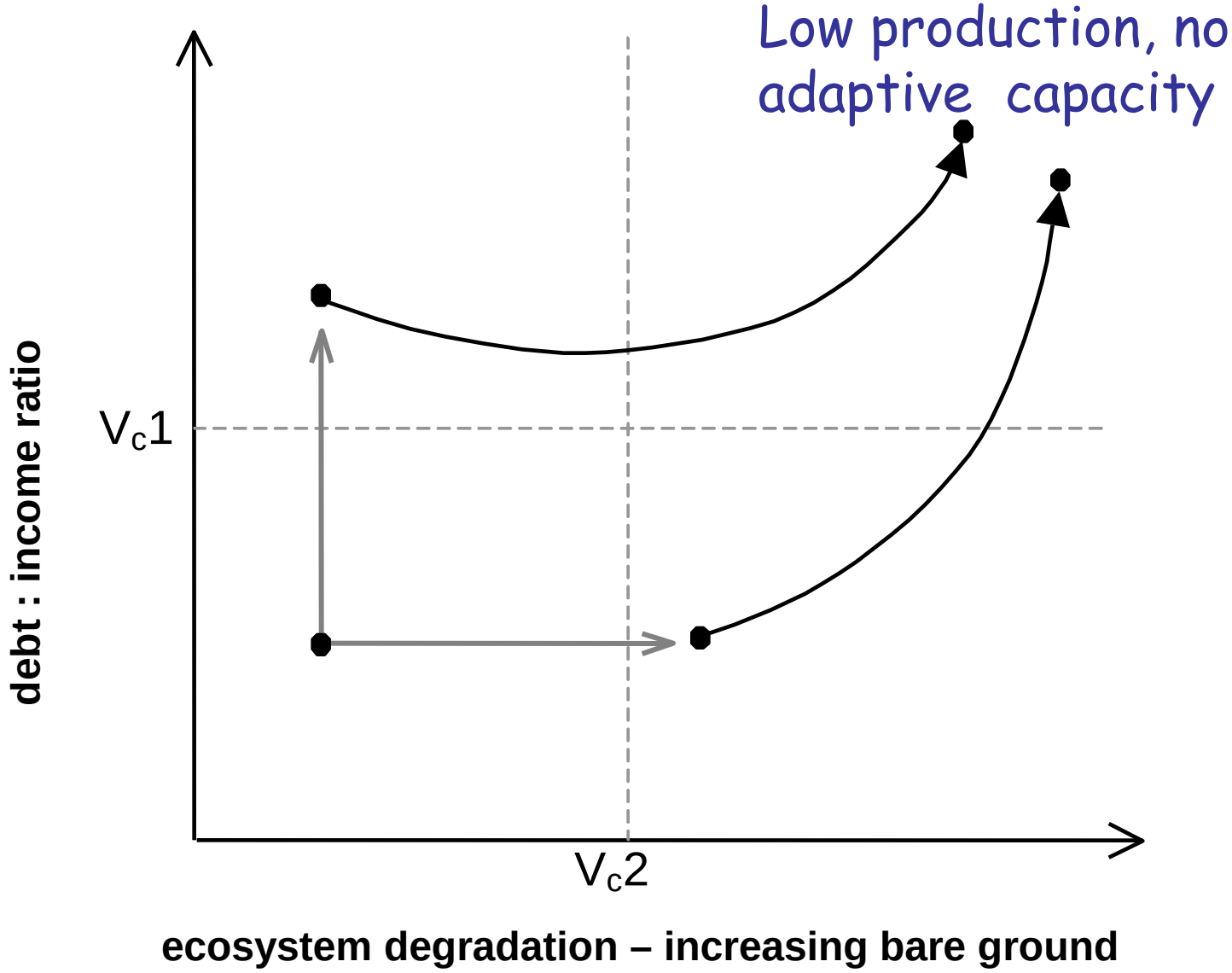
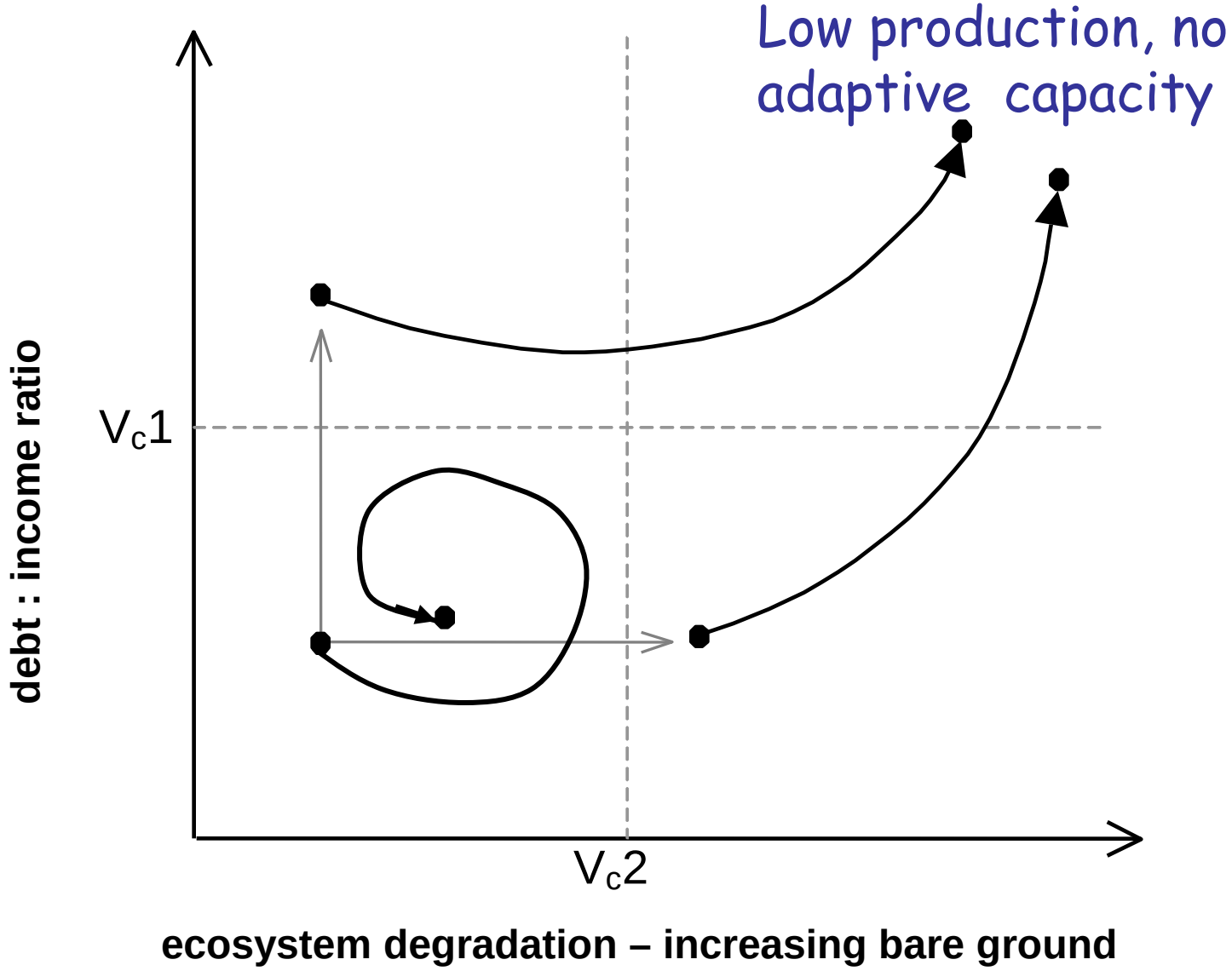
Semi-arid region farming – Sahel example



(Fernandez RJ, et al. 2002. Do Humans Cause Deserts?)


debt : income ratio
V_c1
V_c2
ecosystem degradation – increasing bare ground


Low production, no adaptive capacity
debt : income ratio
V_c1
V_c2
ecosystem degradation – increasing bare ground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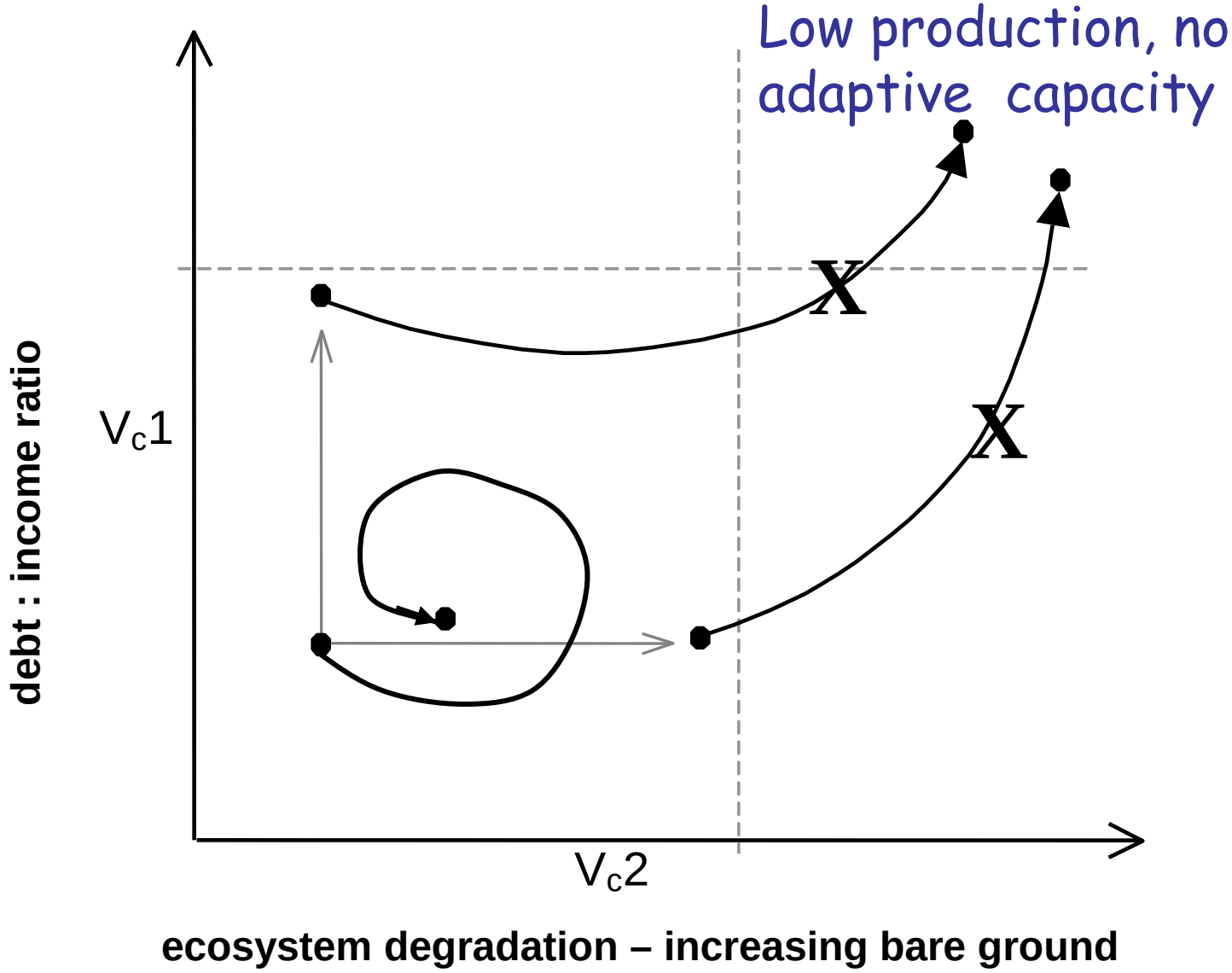

Low production, no adaptive capacity
X
X
debt : income ratio
V_c1
V_c2
ecosystem degradation – increasing bare ground

- self-organising systems remain resilient through being able to change and probe their boundaries

- constraints from a higher level can prevent adaptive developments

The Longford gas explosion

efficiency drive:

- supervisors reduced from 4 to 1
- all engineers relocated to head office
- single manning of control panel

2 people killed, no gas for a week, etc.

(Hopkins 2000)

in Shepparton,
25 million litres of milk poured away
- no alternate power source for pasteurisation machinery

(no "response diversity")

- **system performance** is promoted by high functional diversity (complementarity)

- **resilience** is promoted by high response diversity - in ecosystems (rainforests, coral reefs, lakes, rangelands) and social systems

inherent trade-offs in resilience

i) resilience ('redundancy') vs. efficiency
- the cost of *being* resilient vs. the cost of *not* being resilient

cost of *being* resilient = foregone extra economic benefit (easy to estimate)

cost of *not* being resilient = cost x probability of being in an alternate regime (hard to estimate)

ii) 'specified' (targeted) resilience, vs. 'general' resilience

iii) cross-scale effects

(ii) "specified" vs. "general" resilience

specified = resilience "of what" , "to what"

- danger of falling into the optimisation trap

general resilience

Determinants of general resilience

- diversity
- modularity
- tightness of feedbacks
- openness – immigration, inflows, outflows
- reserves and other reservoirs (memory, seedbanks, nutrient pools)
- overlapping governance/institutions

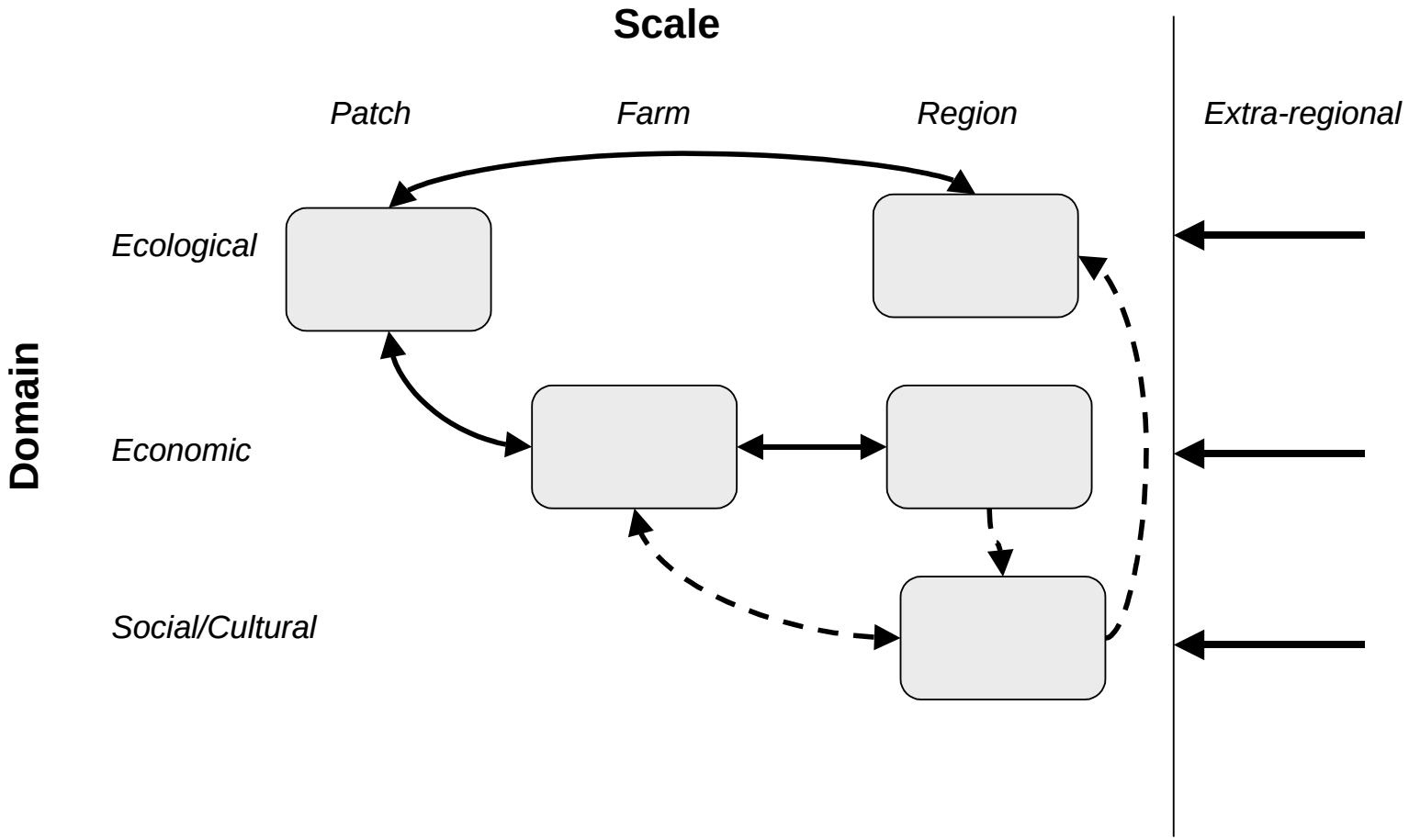
(iii) cross-scale effects:
you cannot understand or manage a system by focussing on one scale.

need at least 3 scales – the focal scale, one above and one below

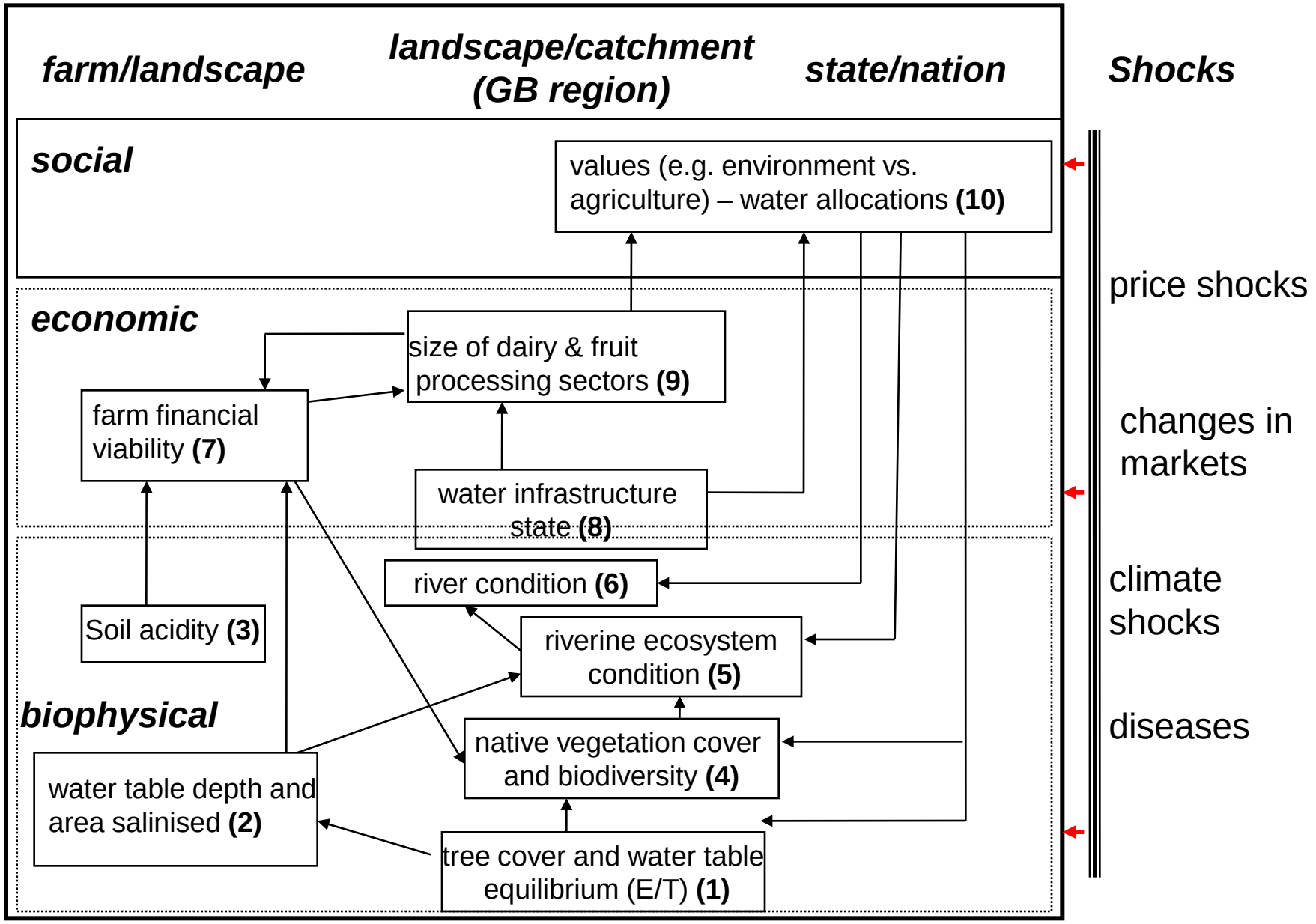
Increasing resilience at one scale (or pursuing efficiency at one scale) can reduce resilience at other scales

Multiple, interacting thresholds

(Causse Mejan in France, a catchment in SE Australia, southern Madagascar, Western Australia wheatbelt)



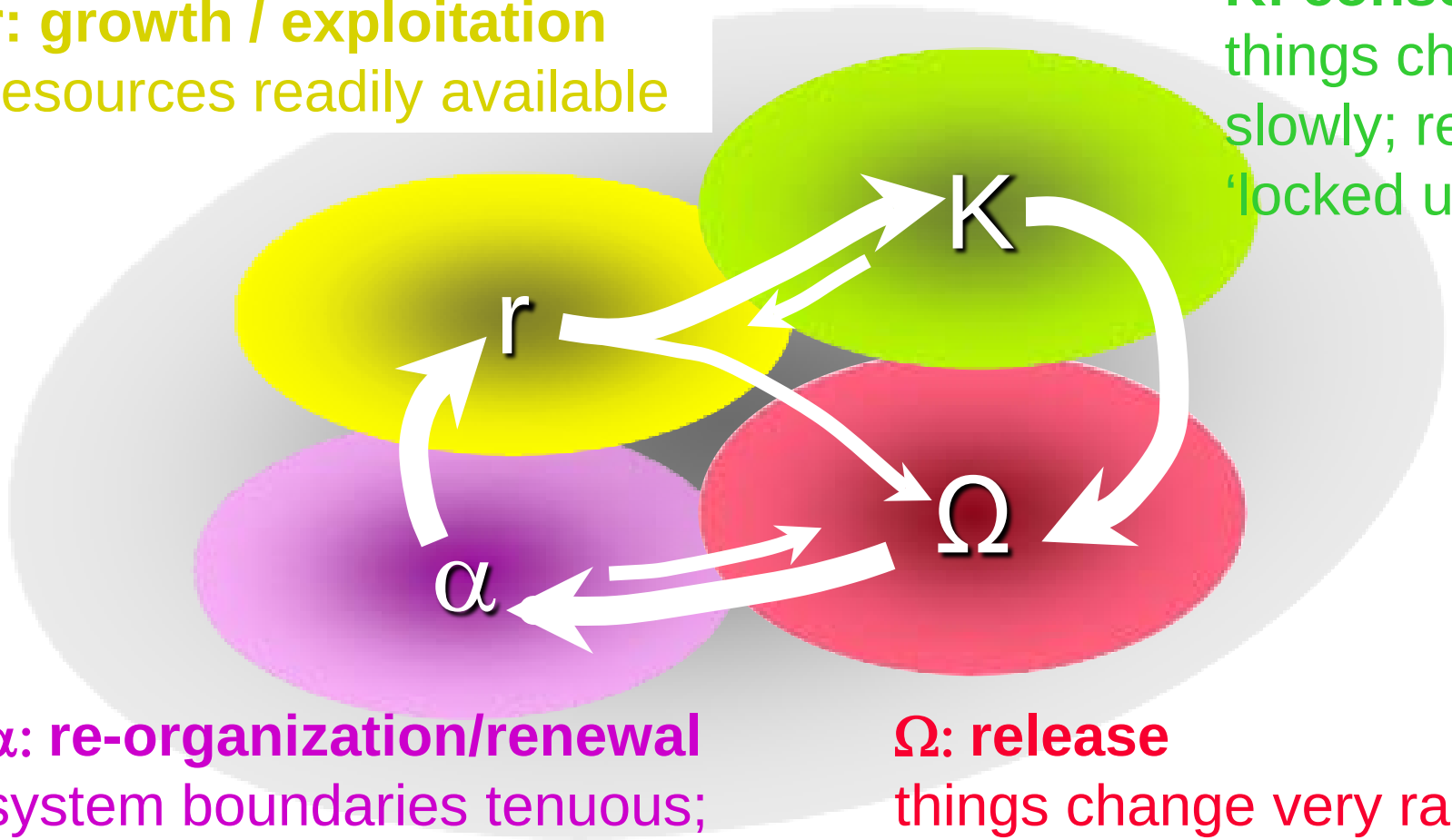
10 thresholds in the Goulburn-Broken catchment



Changes in social-ecological systems over time

r: growth / exploitation
resources readily available

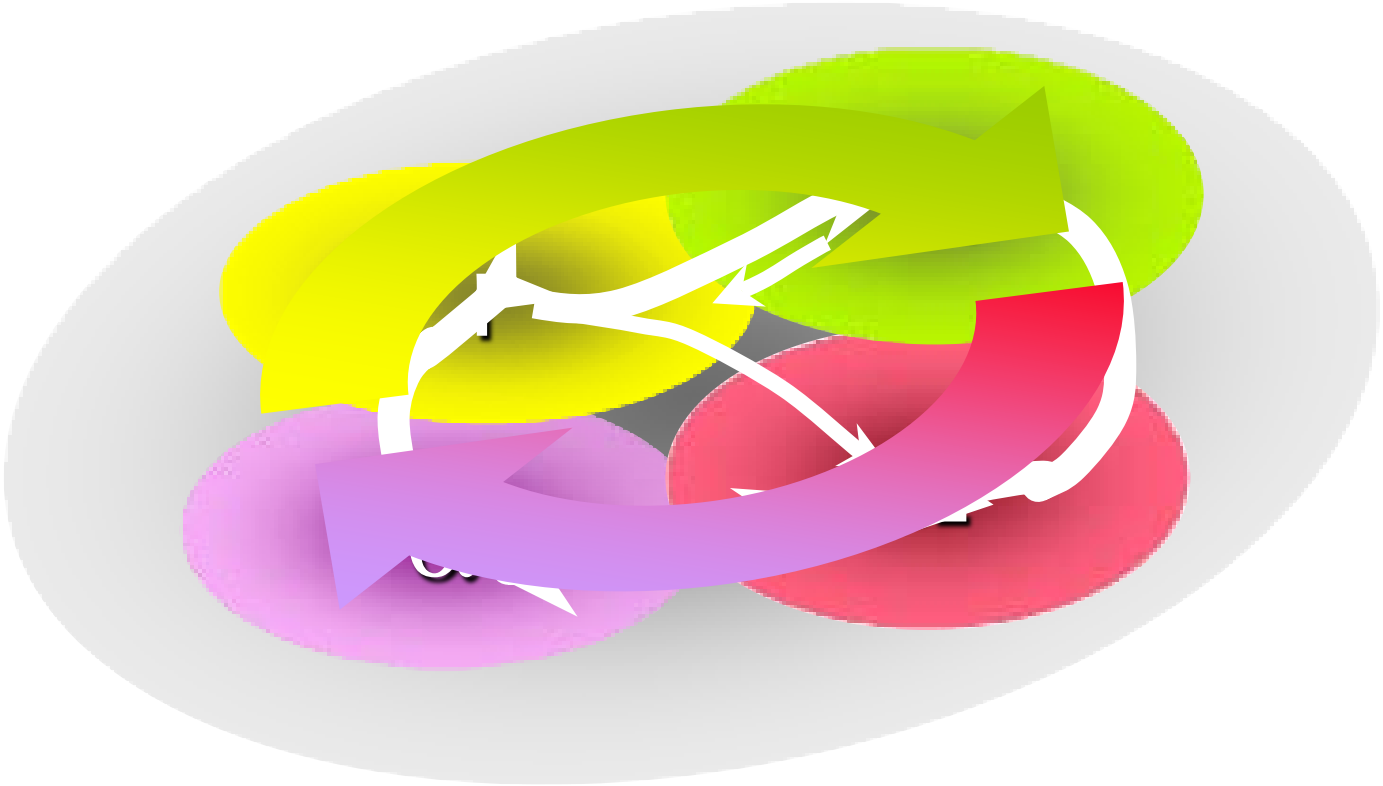
K: conservation
things change slowly; resources 'locked up'



α: re-organization/renewal
system boundaries tenuous; innovations are possible

Ω: release
things change very rapidly; 'locked up' resources suddenly released

The adaptive cycle
in ecosystems, social systems and SESs



Transaction costs rise during a K phase

-in ecosystems, the proportion of production used for metabolism (respiration) increases

-in social systems, the proportion of energy, time and inputs used for running the system increases

How much of a system's intake (income) is being used for metabolism?

Dangers of K-phase behaviour

- increases in "efficiency" (remove apparent redundancies, OSFA solutions)
- subsidies not to change (rather than *to* change)
- sunk costs effects
- increased command-and-control (less and less flexibility)
- pre-occupation with process (more and more rules)
- novelty suppressed, little support for experimentation
- rising transaction costs
- increasing consequences of partial solutions

resilience declines

“resilience” –

“adaptability” – capacity to manage resilience

What determines adaptability?

- social capacity (capital)
  - leadership
  - trust
  - networks

- human capital (skills, education, health)
- financial resources
- natural capital

-ongoing learning

-?

There is a cost to resilience

short term cost of foregone extra 'yield'

vs.

cost of being in an alternate regime
(cost x prob. of a regime shift)

cost of maintaining resilience (relatively easy to estimate)

vs.

cost of *not* maintaining it (difficult to estimate)

Resilience in practice – lessons from comparative studies

1. the rule of hand
2. systems need to be allowed to probe their resilience boundaries
3. 'specified' and/vs. 'general ' resilience
4. cross-scale and cross-domain effects are crucial – need to manage a SES at 3 scales (at least)
5. pushing problems up-scale makes a system less resilient at higher scales
6. pursuing efficiency (narrowly) reduces resilience
7. partial solutions don't work for very long
8. help *to* change, rather than subsidies *not to* change
9. encourage learning, innovation and experiments
10. promote resilience, or transformation?

Resilience, *per se*, is not 'good' or 'bad'

Undesirable states of systems can be very resilient (woody weeds, Stalin's regime, saline landscapes)

A system state that once was considered to be a 'desired' state can become 'undesirable' through changes in external conditions (context)

if a shift into a "bad" state has happened or is inevitable, or if the current state is no longer a desirable one, the only option is *transformation*

"**transformability**" - capacity to transform into a different kind of system; a new way of living, and making a living

determinants of transformability

- preparedness to change (state of denial)
- capacity to change
- options for change

resilience and adaptation or transformation?

In which parts of a region / country do we need to build resilience, and which parts need transformational change?