MSc Sustainability

MODELLING SUSTAINABILITY

Tristan Berchoux

@TristanBerchoux

t.berchoux@soton.ac.uk

TYPES OF MODELS

TYPES OF MODELS

- Pictorial visualisation models — Venn diagrams, flow charts, drawings

  Basic, simple and powerful of reaching a broad audience.
  Emphasise the need for a transdisciplinary approach

  Static models. With limited informative value

TYPES OF MODELS

- Pictorial visualisation models

- **Quantitative models**

Based on mathematics, statistics and system analysis to systematise, measure, compare, represent various aspects of sustainable development

More informative, exact and powerful for analysis and forecasting. Support policy-making

Restricted models. Remain discipline dominated.

TYPES OF MODELS

- Pictorial visualisation models
- **Quantitative models**
- Physical models

Based on creation and/or recreation of various ecosystems.

Realistic, reduce uncertainty. Allow for a participatory approach and interdisciplinary perspectives

Very specific and predominantly local models. Their time span is quite restricted

TYPES OF MODELS

- Pictorial visualisation models
- **Quantitative models**
- Physical models
- Conceptual models

Very popular. Based on scenarios. Often narrative.

Long-term and intergenerational perspective. Cross the borders of many disciplines. Evolutionary concept. Contain a warning element and signals for alertness

Emphasis on the global, local concrete solutions rare. Often linked to a political agenda. Ideologically laden. Inability to manage uncertainty

TYPES OF MODELS

- Pictorial visualisation models
- **Quantitative models**
- Physical models
- Conceptual models
- Standardising models — Based on development and application of sustainability indicators

Attempt to develop a holistic or aggregate indicator to measure sustainability. Assign a value that describes complexity. Signal current issues

Accommodate a very specific local–global perspective. A good snapshot for the particular moment. Based on individual trends

QUANTITATIVE MODELLING

QUANTITATIVE MODELLING

- Realising the Agenda as well as the Paris Agreement on climate change requires **careful management of complex links and trade-offs**

QUANTITATIVE MODELLING

- Realising the Agenda as well as the Paris Agreement on climate change requires **careful management of complex links and trade-offs**

- **Public policies need to balance** diverse sectors, levels of government, and stakeholder interests over the **short, medium and long term**

QUANTITATIVE MODELLING

- Realising the Agenda as well as the Paris Agreement on climate change requires **careful management of complex links and trade-offs**
- **Public policies need to balance** diverse sectors, levels of government, and stakeholder interests over the **short, medium and long term**
- Success depends in part on **good planning and informed decision-making**, which can be guided by modelling tools that provide insights and analysis

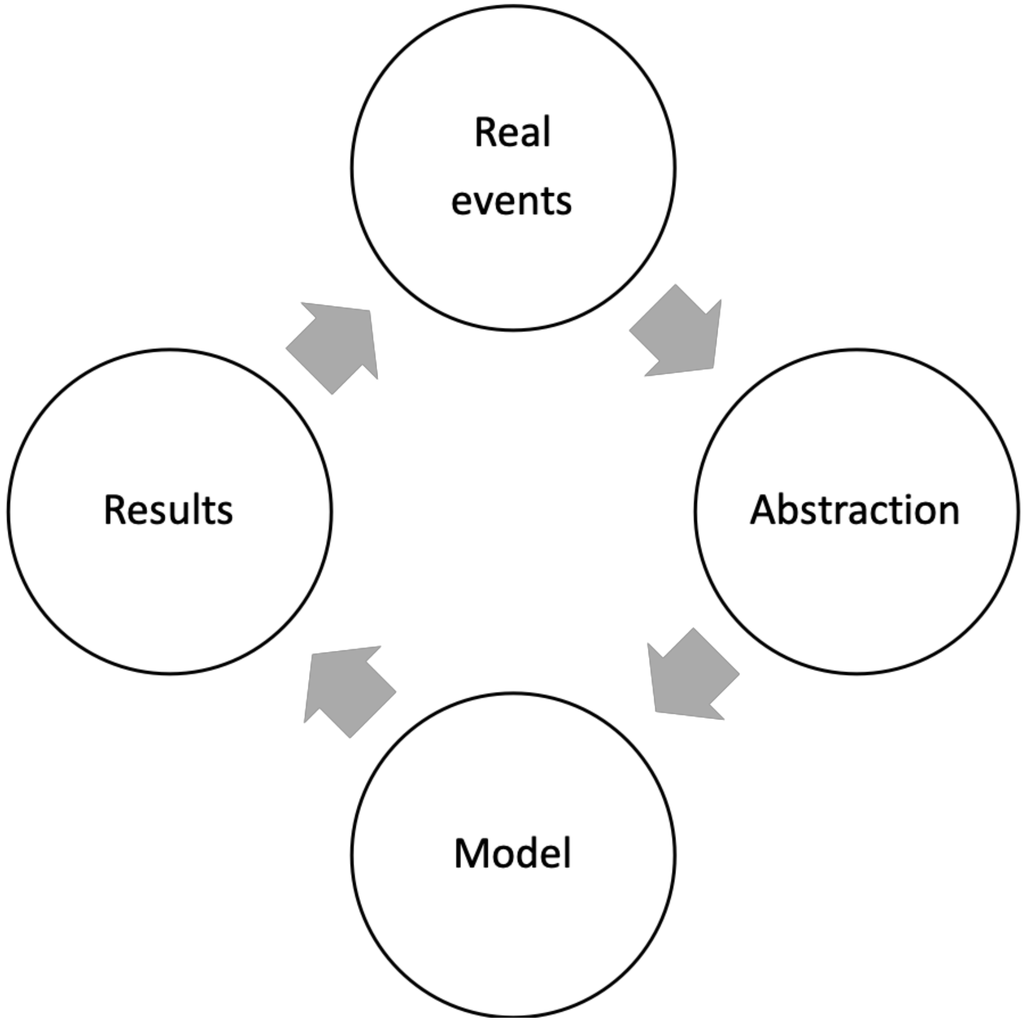
QUANTITATIVE MODELLING

- Realising the Agenda as well as the Paris Agreement on climate change requires **careful management of complex links and trade-offs**
- **Public policies need to balance** diverse sectors, levels of government, and stakeholder interests over the **short, medium and long term**
- Success depends in part on **good planning and informed decision-making**, which can be guided by modelling tools that provide insights and analysis
- Models as **thinking aids** to assimilate data and to forecast

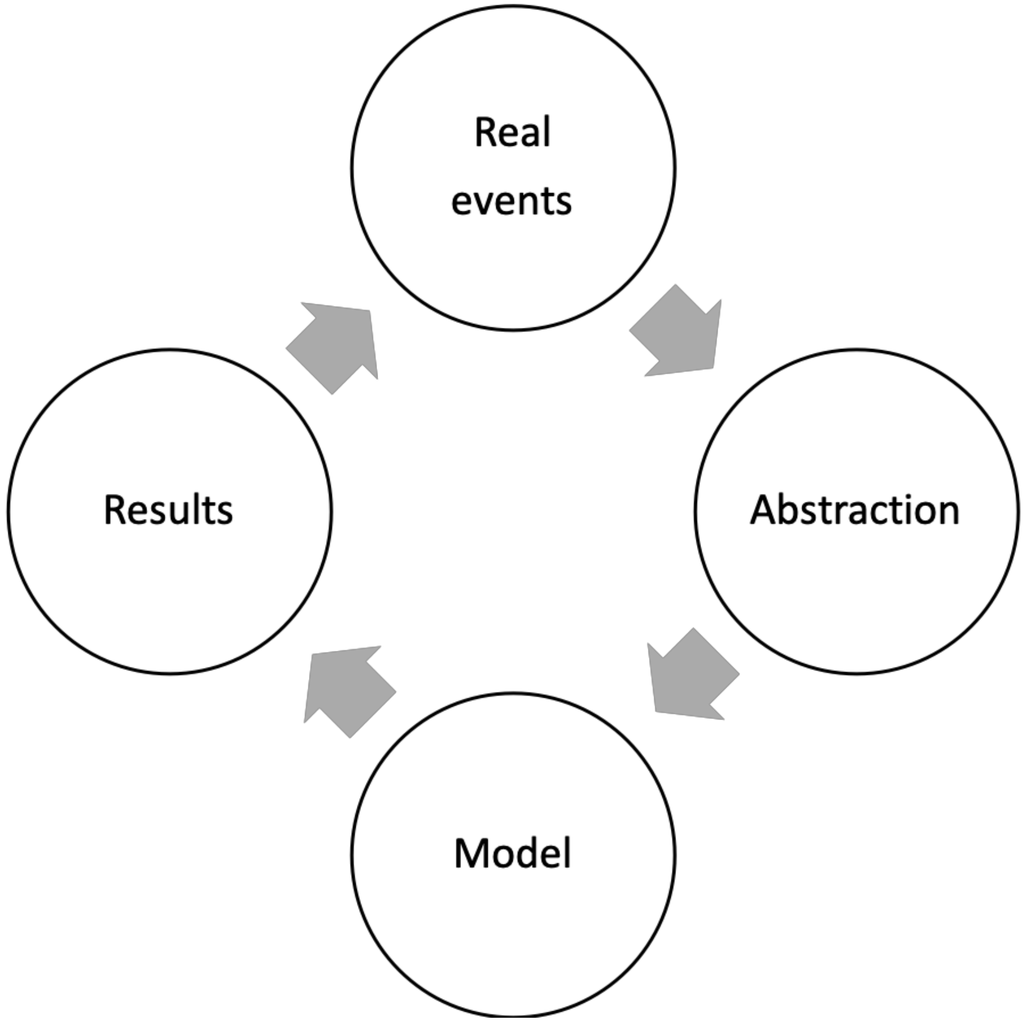
QUANTITATIVE MODELLING

- Realising the Agenda as well as the Paris Agreement on climate change requires **careful management of complex links and trade-offs**
- **Public policies need to balance** diverse sectors, levels of government, and stakeholder interests over the **short, medium and long term**
- Success depends in part on **good planning and informed decision-making**, which can be guided by modelling tools that provide insights and analysis
- Models as **thinking aids** to assimilate data and to forecast
- Usually a **combination** of model types

MODELLING PROCESS

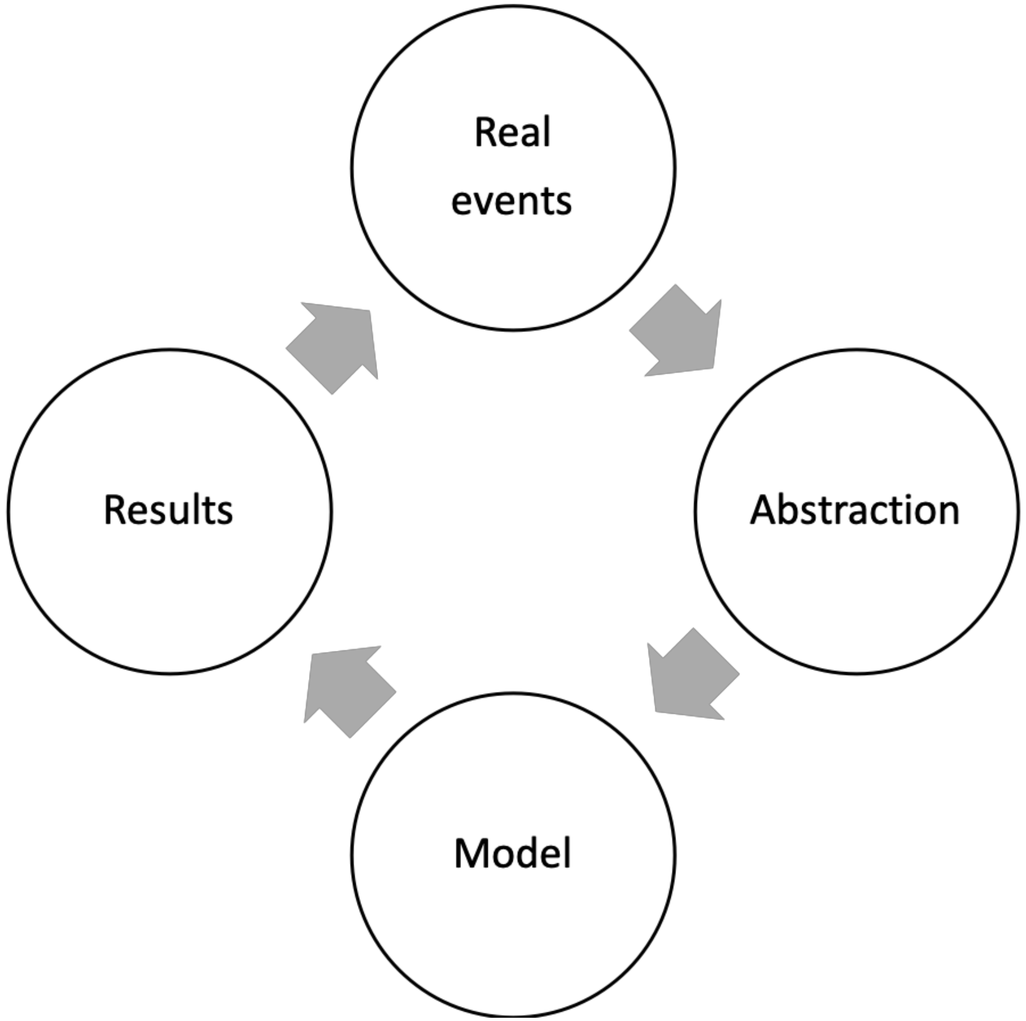


MODELLING PROCESS



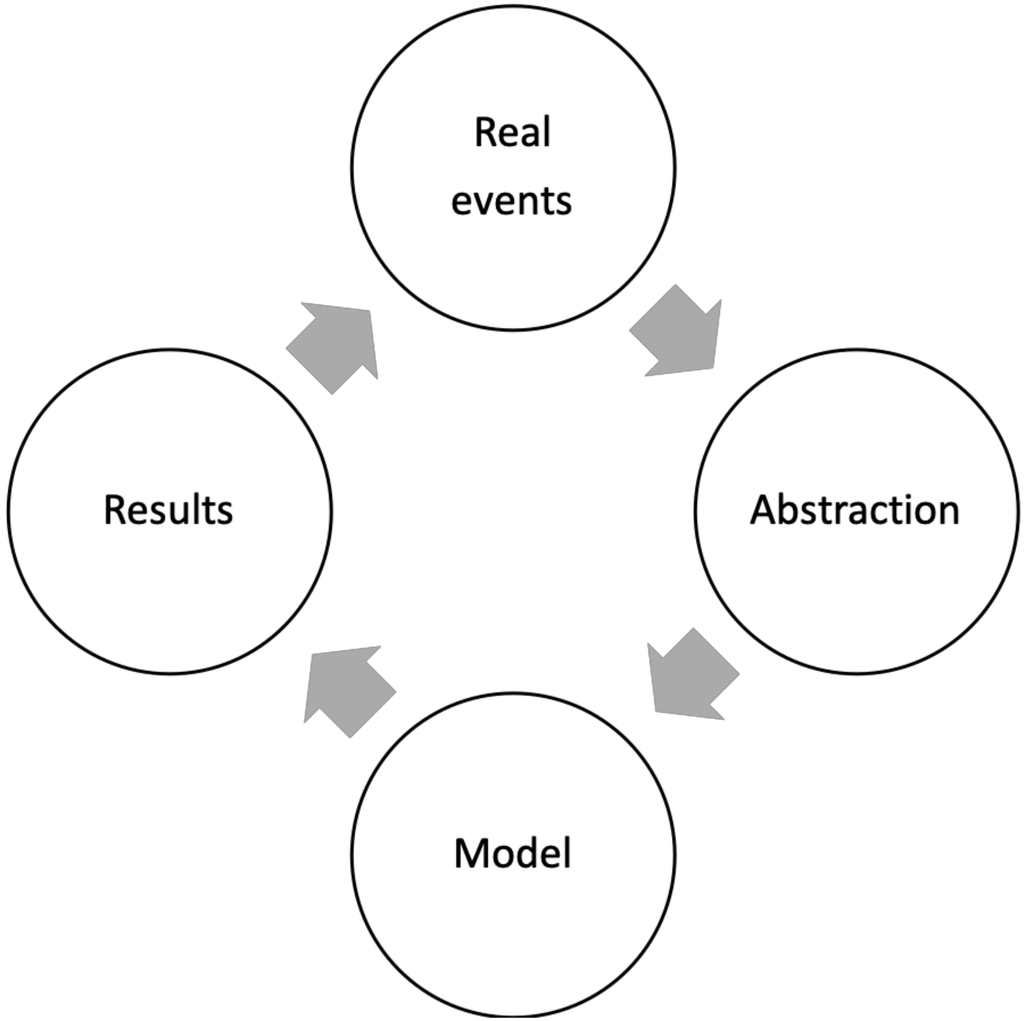
- Substitute for a real system, an **abstraction** that make **assumptions** and **simplifications**

MODELLING PROCESS



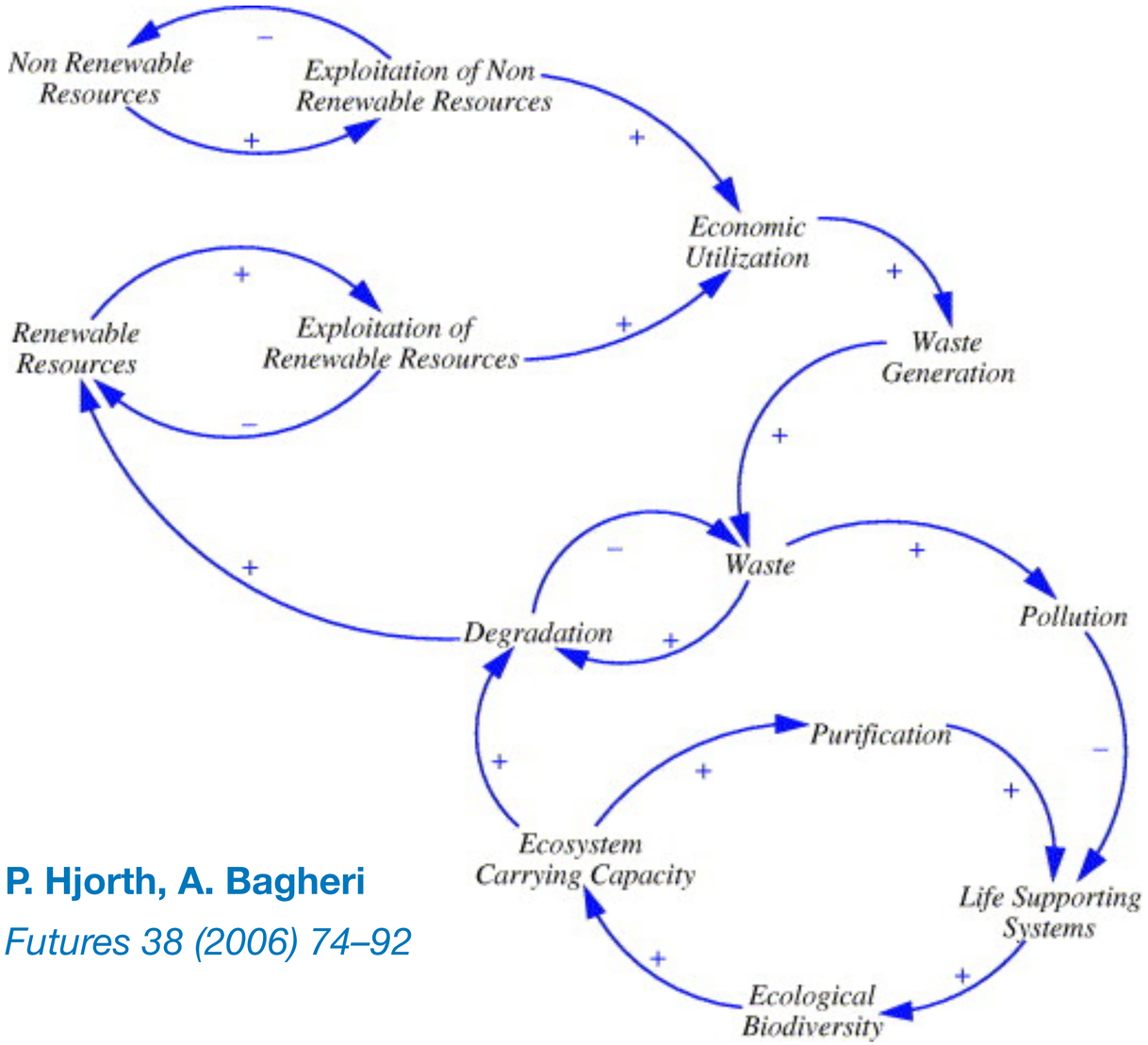
- Substitute for a real system, an **abstraction** that make **assumptions** and **simplifications**
- Used when it is easier to work with a substitute than with the actual system

MODELLING PROCESS



- Substitute for a real system, an **abstraction** that make **assumptions** and **simplifications**
- Used when it is easier to work with a substitute than with the actual system
- Never-ending process: build, revise, compare, change

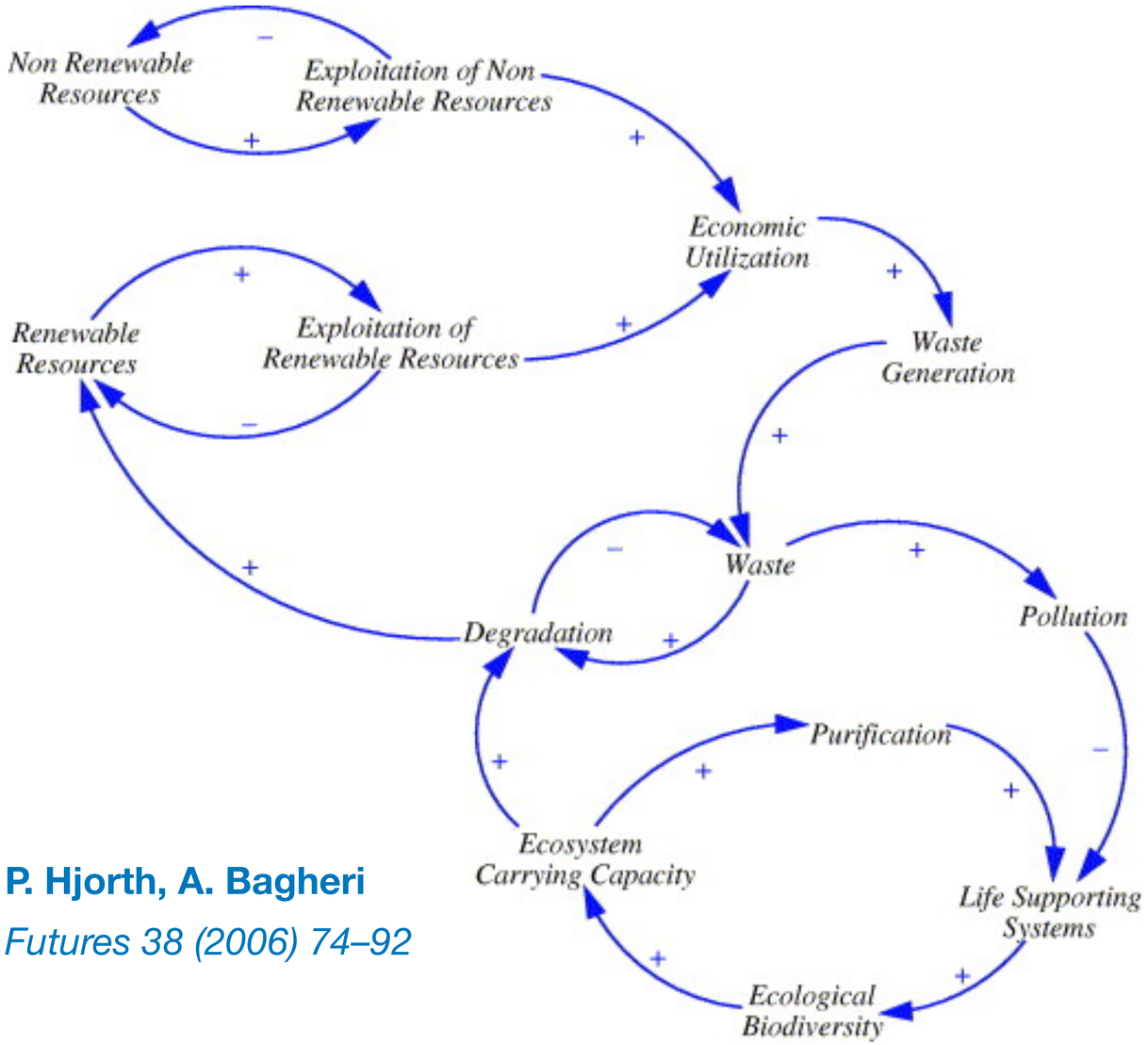
SYSTEMS



P. Hjorth, A. Bagheri

Futures 38 (2006) 74–92

SYSTEMS

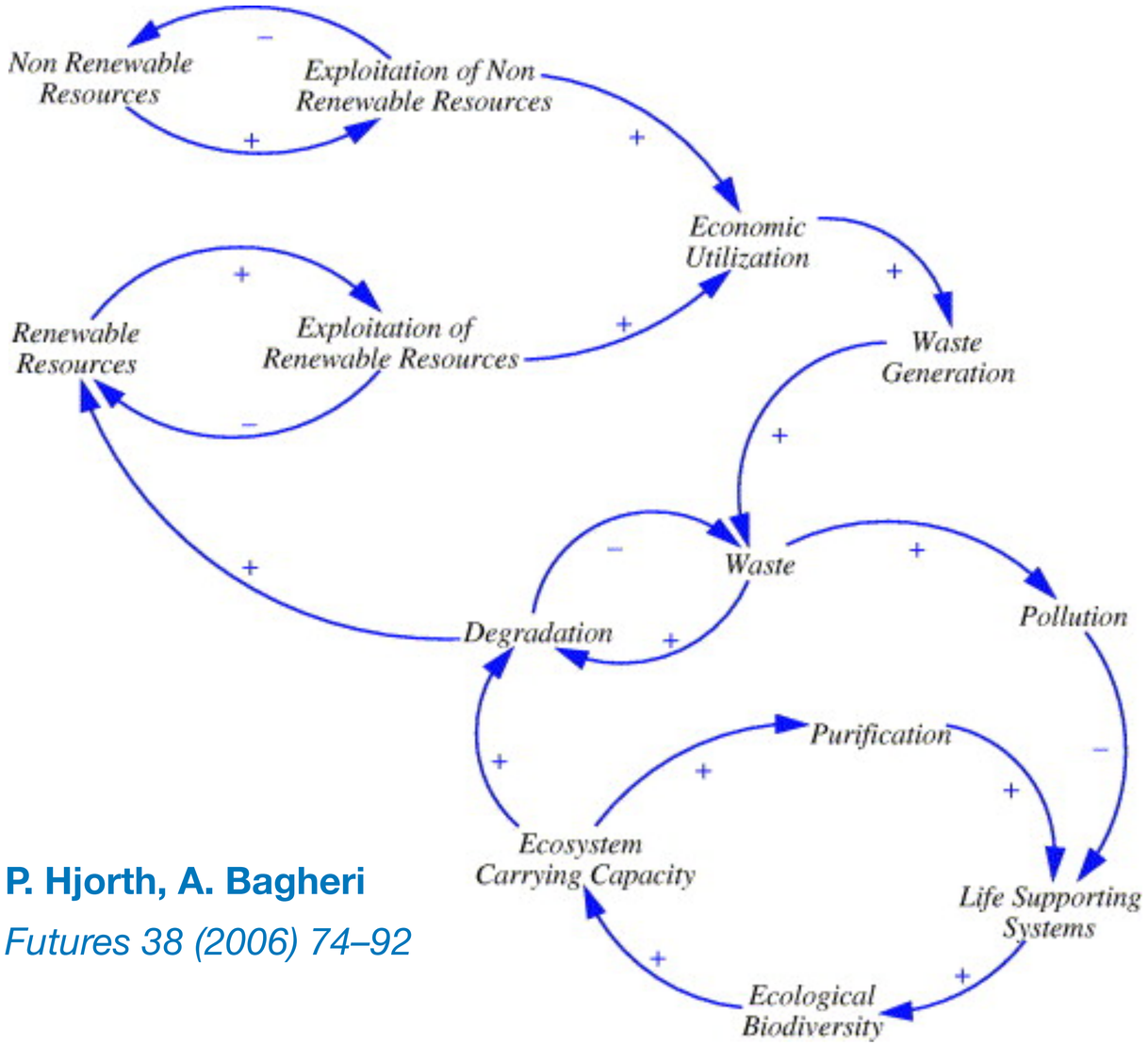


P. Hjorth, A. Bagheri

Futures 38 (2006) 74–92

- Set of **interrelated components**: any change in any component affects the set as a whole

SYSTEMS

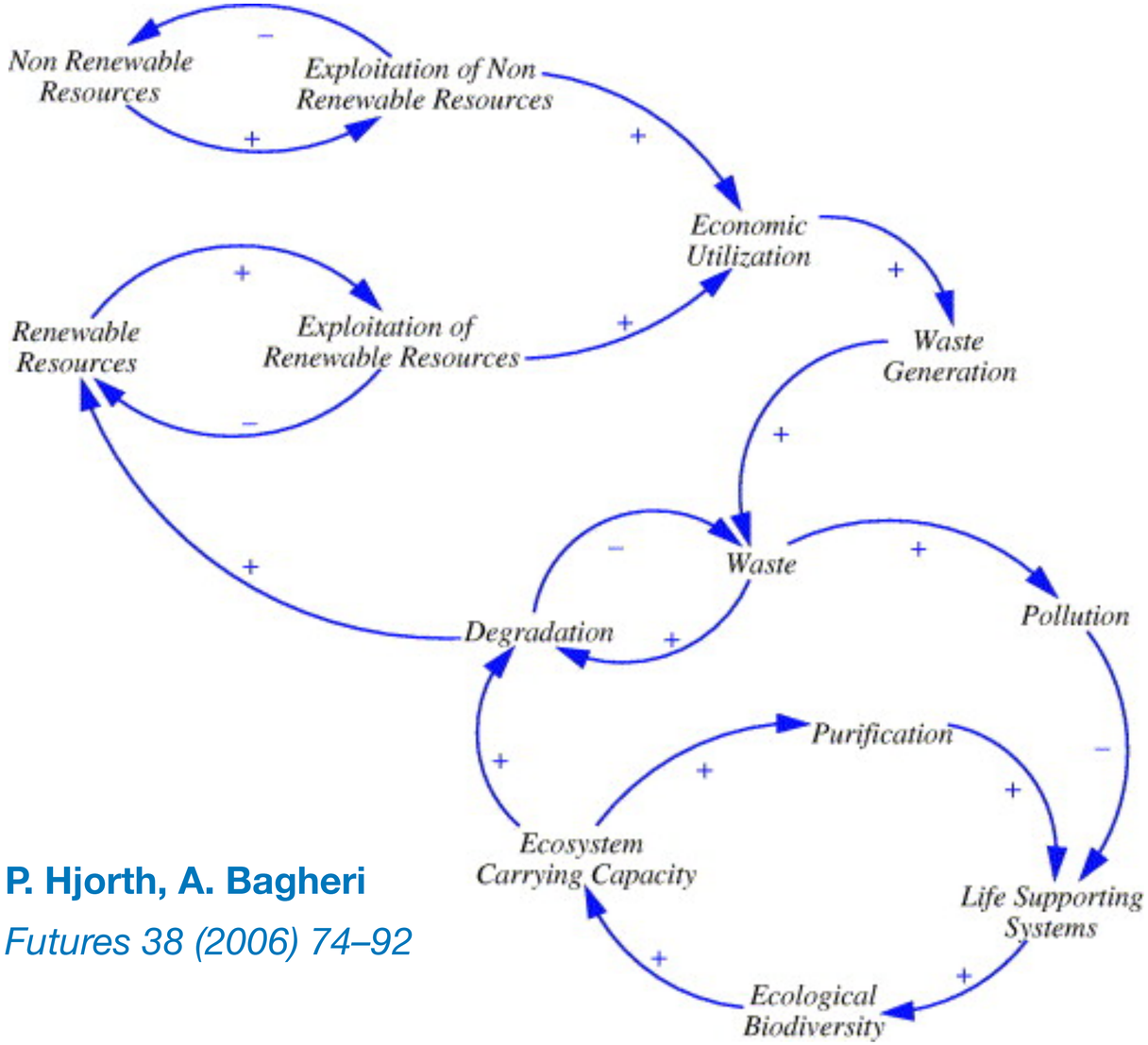


P. Hjorth, A. Bagheri

Futures 38 (2006) 74–92

- Set of **interrelated components**: any change in any component affects the set as a whole
- Must know the components that make it up and the relationships between them

SYSTEMS



P. Hjorth, A. Bagheri

Futures 38 (2006) 74–92

- Set of **interrelated components**: any change in any component affects the set as a whole
- Must know the components that make it up and the relationships between them
- The boundaries is a **key assumption** made in defining a system

EXAMPLES

https://un-modelling.github.io

MODELLING TOOLS

FOR SUSTAINABLE DEVELOPMENT

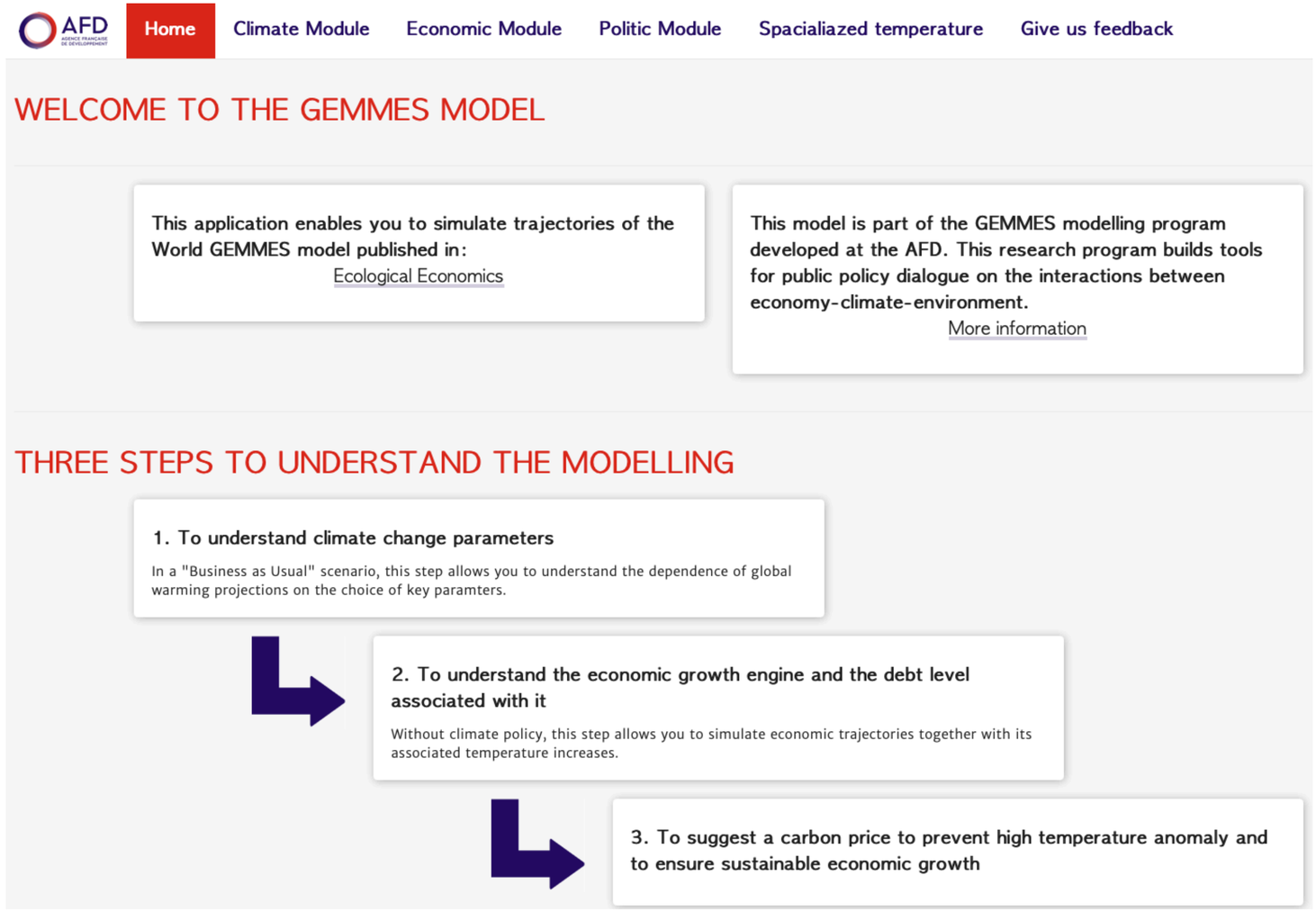
UNDP UN DESA

ABOUT	MODELLING TOOLS	COUNTRY PROJECTS	OUTREACH TRAINING	NEWS AND EVENTS
CLEWS	ECONOMY-WIDE MODELS	SOCIOECONOMIC	ENERGY SYSTEMS	GEO-SPATIAL ELECTRIFICATION

EXAMPLES

https://un-modelling.github.io

https://afdshiny.shinyapps.io/CopingWithCollapse/



EXAMPLES

https://un-modelling.github.io

https://afdshiny.shinyapps.io/CopingWithCollapse/

- **Models to understand processes**
  Example of modelling the sustainability of agricultural systems in the Mekong Delta

EXAMPLES

https://un-modelling.github.io

https://afdshiny.shinyapps.io/CopingWithCollapse/

- **Models to understand processes**
  Example of modelling the sustainability of agricultural systems in the Mekong Delta

- **Models to help planning**
  Example of modelling future land systems in the Mekong Delta

EXAMPLES

https://un-modelling.github.io

https://afdshiny.shinyapps.io/CopingWithCollapse/

- **Models to understand processes**
  Example of modelling the sustainability of agricultural systems in the Mekong Delta

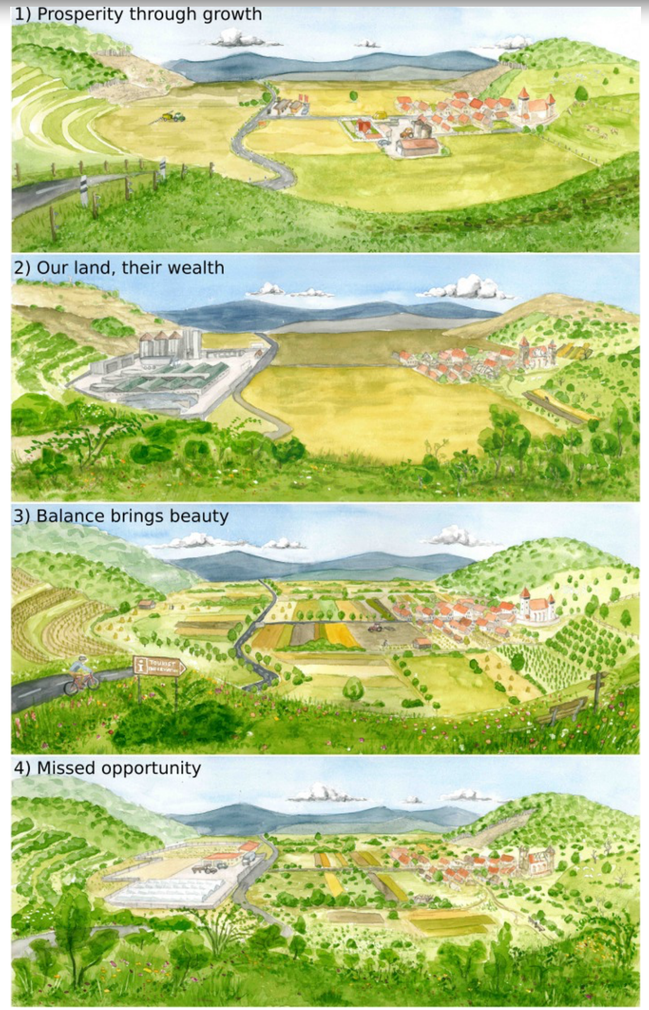
- **Models to help planning**
  Example of modelling future land systems in the Mekong Delta

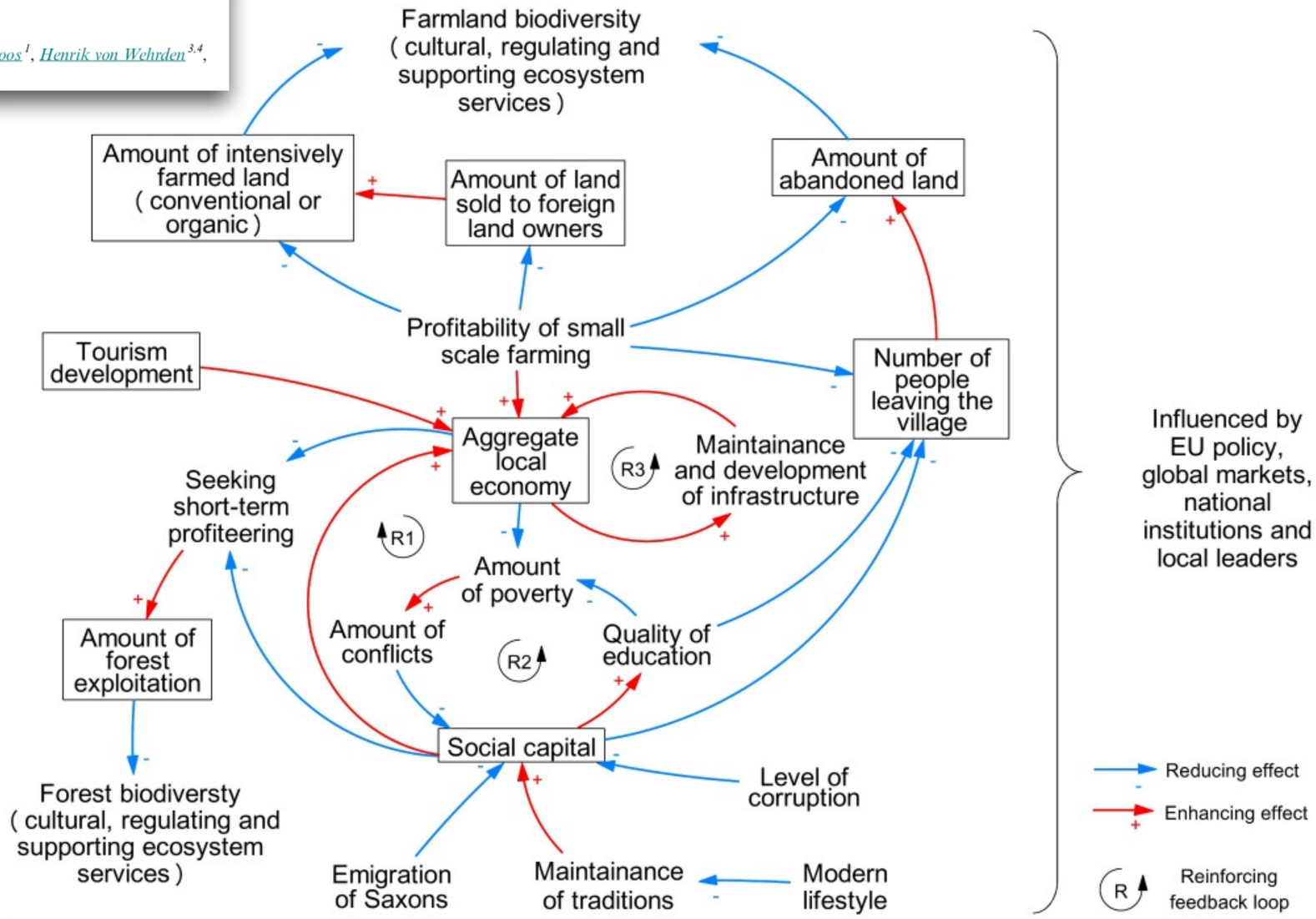
- **Models to inform policy**
  Example of modelling the drivers of precarious livelihoods in the Mahanadi Delta

EXAMPLES

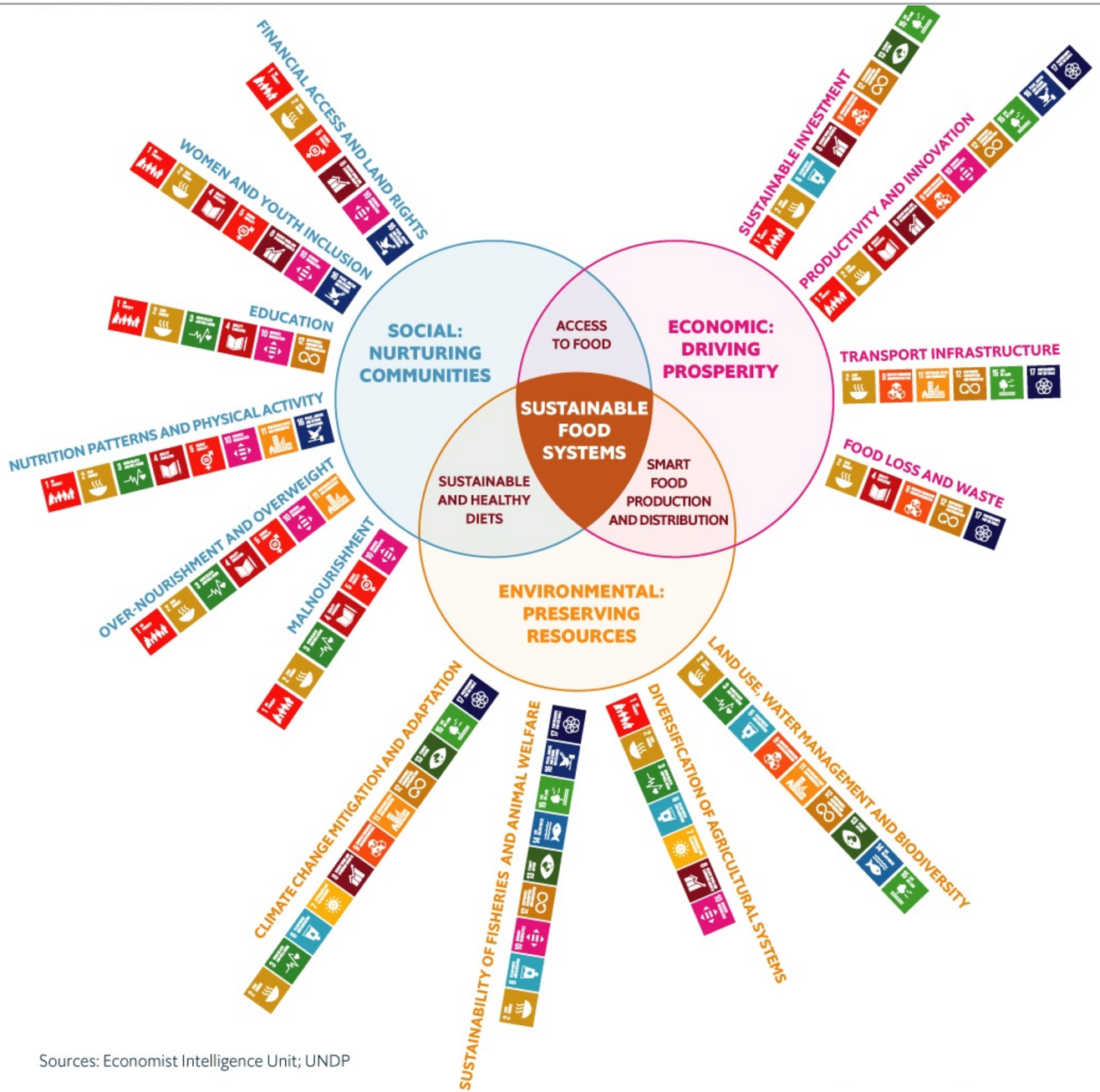
A holistic approach to studying social-ecological systems and its application to southern Transylvania

Jan Hanspach[1], Tibor Hartel[2], Andra I. Milcu[1], Friederike Mikulcak[1], Ine Dorresteijn[1], Jacqueline Loos[1], Henrik von Wehrden[3,4], Tobias Kuemmerle[5], David Abson[6], Anikó Kovács-Hostyánszki[7], András Báldi[7] and Joern Fischer[1]





EXAMPLES



Sources: Economist Intelligence Unit; UNDP

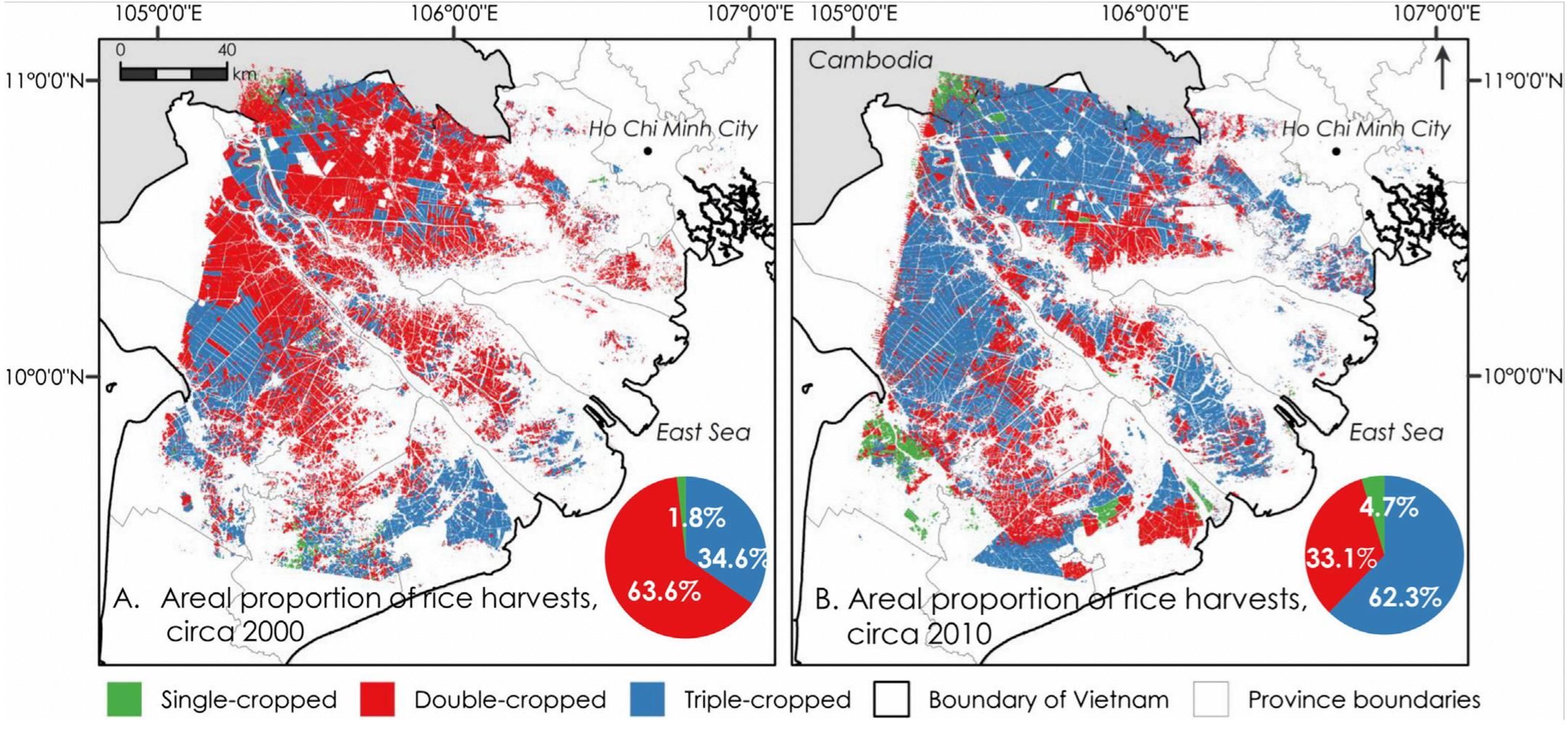
AGRICULTURAL SUSTAINABILITY

CASE STUDY

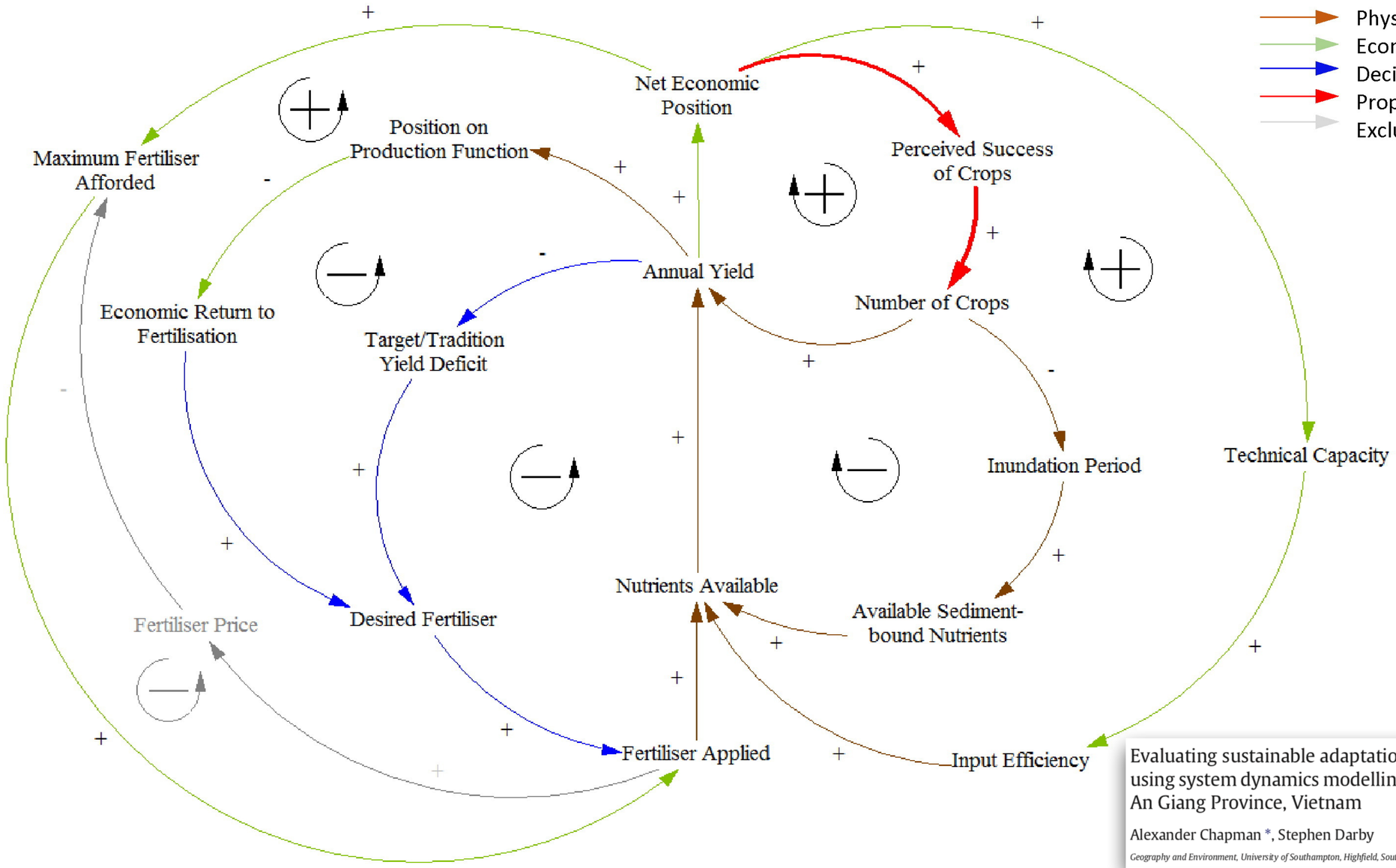
Mapping rice paddy extent and intensification in the Vietnamese Mekong River Delta with dense time stacks of Landsat data

Caitlin Kontgis [a,b,*], Annemarie Schneider [a,b], Mutlu Ozdogan [a,c]

[a] Center for Sustainability and the Global Environment, Nelson Institute for Environmental Studies, University of Wisconsin-Madison, 1710 University Avenue, Madison, WI 53726, USA
[b] Department of Geography, University of Wisconsin-Madison, 550 N. Park Street, Madison, WI 53706, USA
[c] Department of Forest and Wildlife Ecology, University of Wisconsin-Madison, 1630 Linden Drive, Madison, WI 53726, USA



CAUSAL-LOOP DIAGRAM

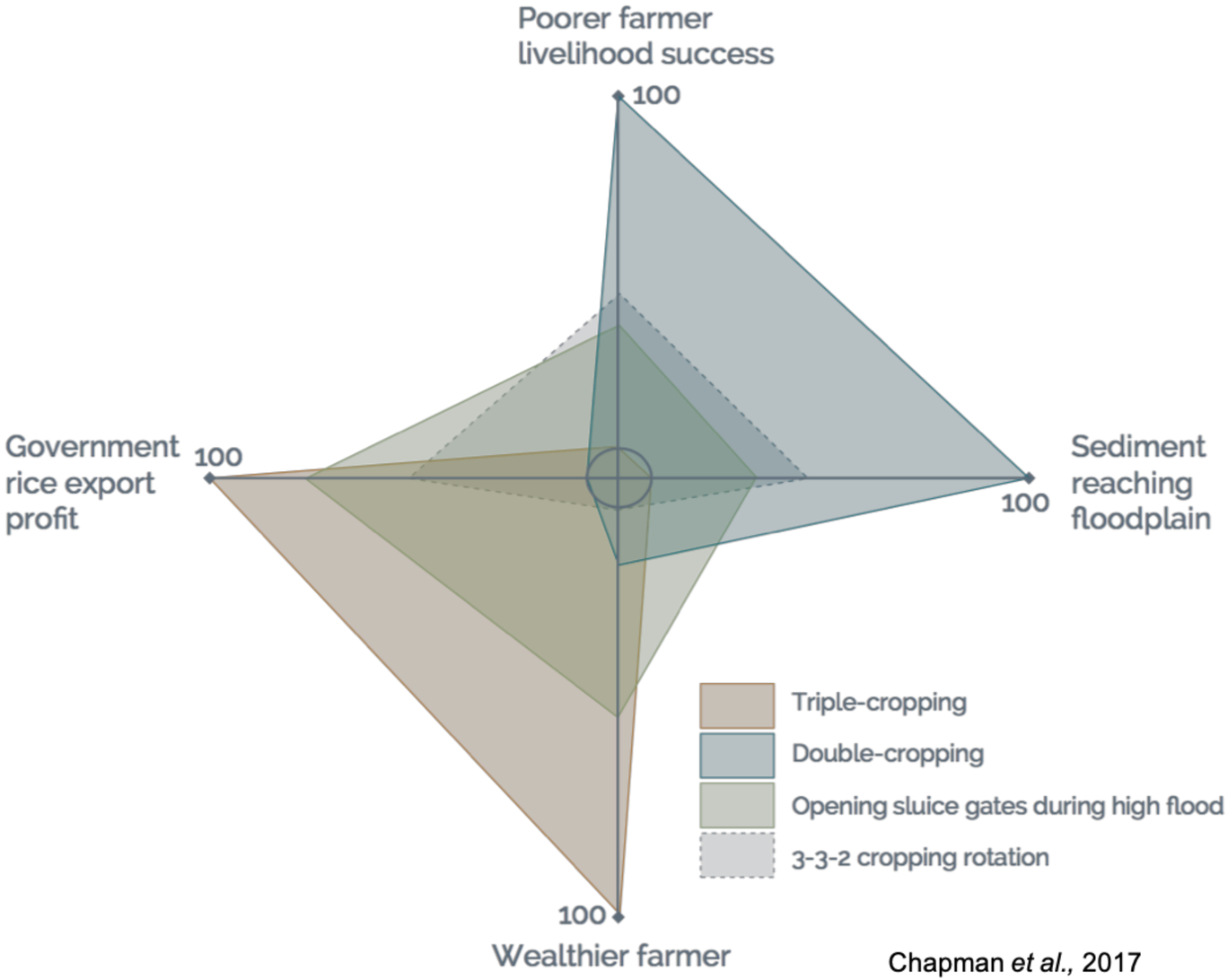


Evaluating sustainable adaptation strategies for vulnerable mega-deltas using system dynamics modelling: Rice agriculture in the Mekong Delta's An Giang Province, Vietnam

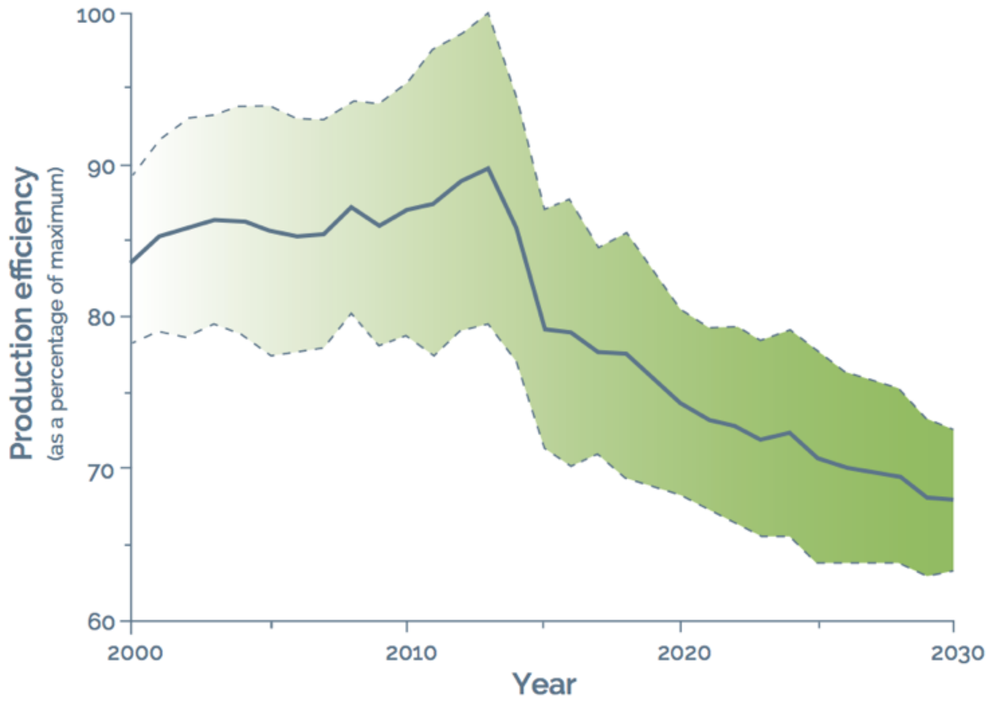
Alexander Chapman *, Stephen Darby

Geography and Environment, University of Southampton, Highfield, Southampton SO17 1BJ, UK

RESULTS



Chapman *et al.*, 2017



Model projections of agricultural input efficiency (yield achieved against fertilizer applied) between 2000-2030 assuming the continuation of uninterrupted triple- cropping

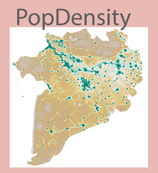
2 ZERO HUNGER

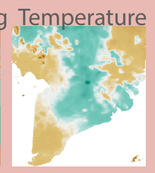
8 DECENT WORK AND ECONOMIC GROWTH

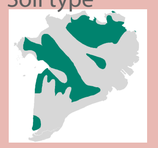
10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

SUSTAINABLE PLANNING







Suitability layers for **spatial preference**

Demand scenarios and **conversion rules**

annual crops

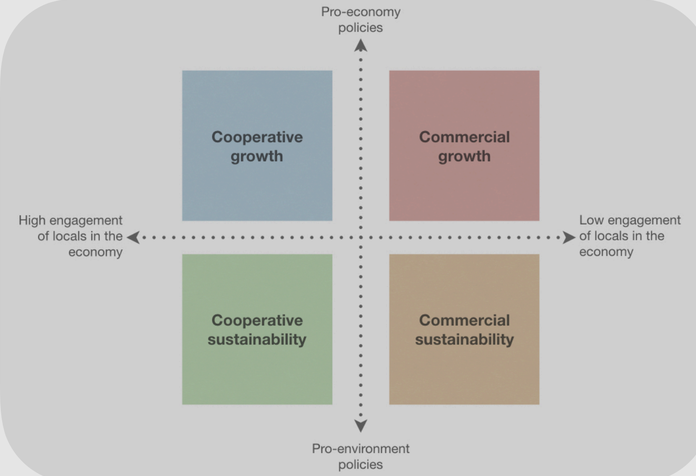
permanent crops

aquaculture

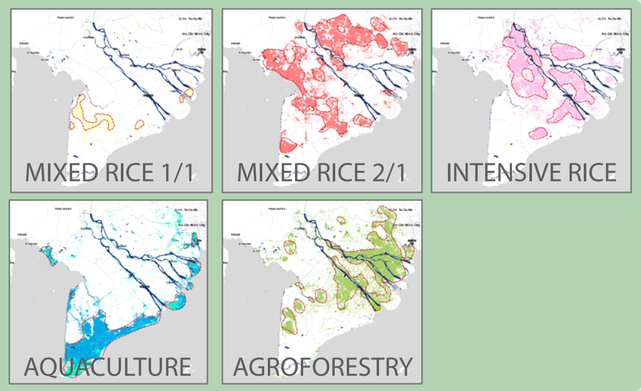
built-up

restrictions

policy



Land systems

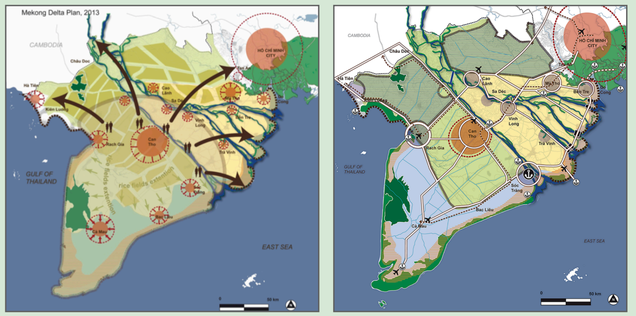


land use (%) field size livestock

fertilisers industrial zones

CLUMondo model for land system change allocation

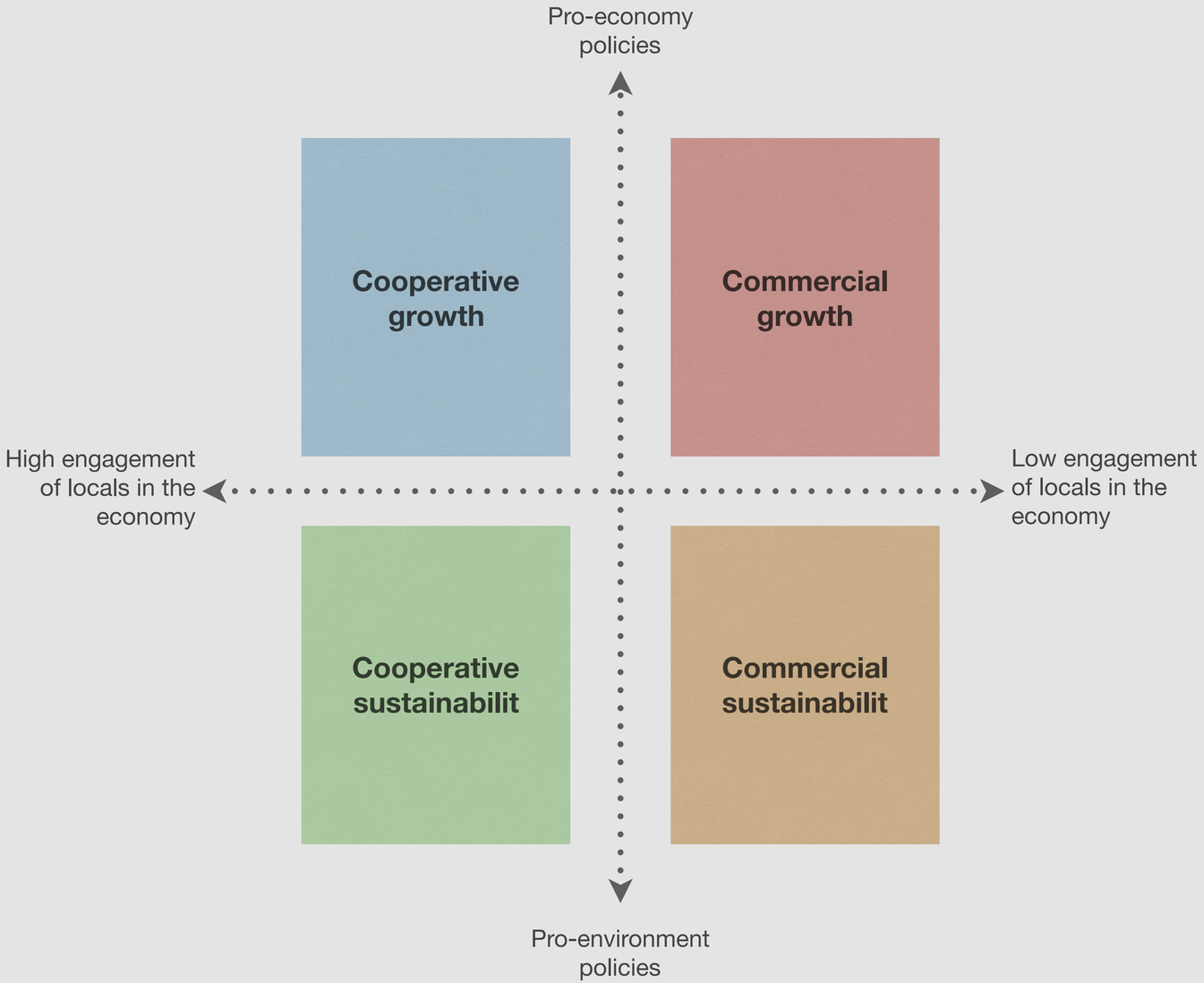
Future land systems under **different scenarios**



LIVELIHOODS

FUTURE LIVELIHOODS

SCENARIO NARRATIVES



LAND USE SHARE (%)	**2020**	**2030**
Agriculture	64.2	51.9
Forestry	0.9	0.9
Aquaculture and fishery	34.9	40.0

DEMAND	**2020**	**2030**
Rice (10^6 tons)	24.5	23-24
Aquatic products (10^6 tons)	3.5	4.2-4.3
Built-up (10^3 km^2)	1,888	2,301

SETTINGS

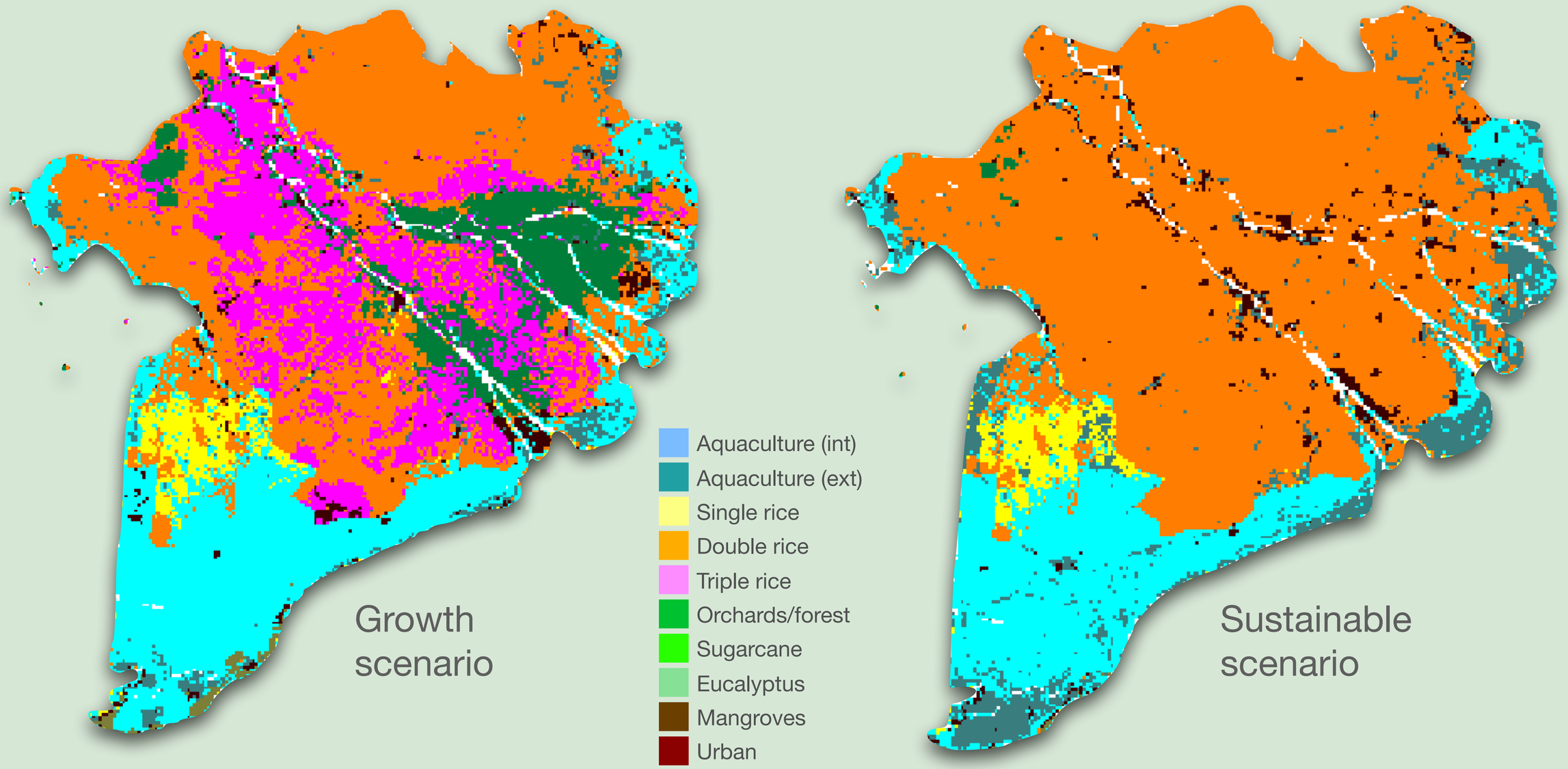
SUPPLY

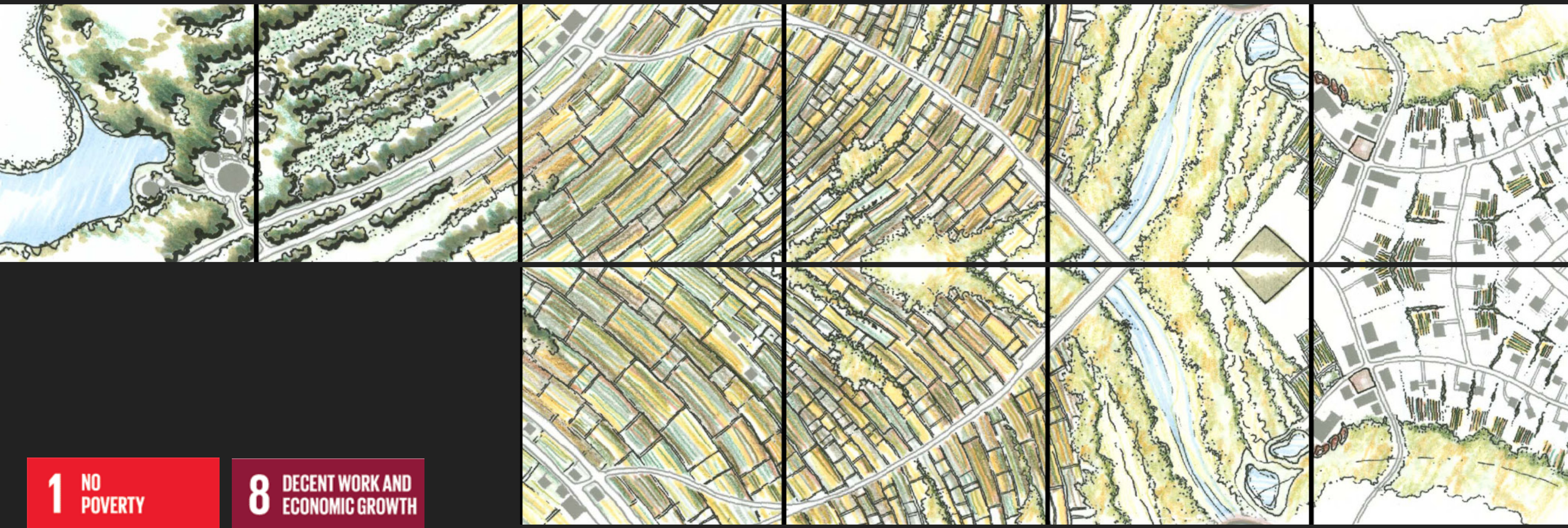
- Change in yield of triple rice if cultivated for more than *x* consecutive years?
- Increase in livestock outputs?
- Supply of built-up increase in sustainable scenario (greater density)

PLANNING PRIORITIES

- Double rice preferred to triple rice in **sustainable scenario**
- Extensive aquaculture preferred to intensive aquaculture in **sustainable scenario**
- Production overshoot and urban sprawl allowed in **growth scenario**

RESULTS


Growth scenario
Aquaculture (int)
Aquaculture (ext)
Single rice
Double rice
Triple rice
Orchards/forest
Sugarcane
Eucalyptus
Mangroves
Urban
Sustainable scenario



1 NO POVERTY

8 DECENT WORK AND ECONOMIC GROWTH

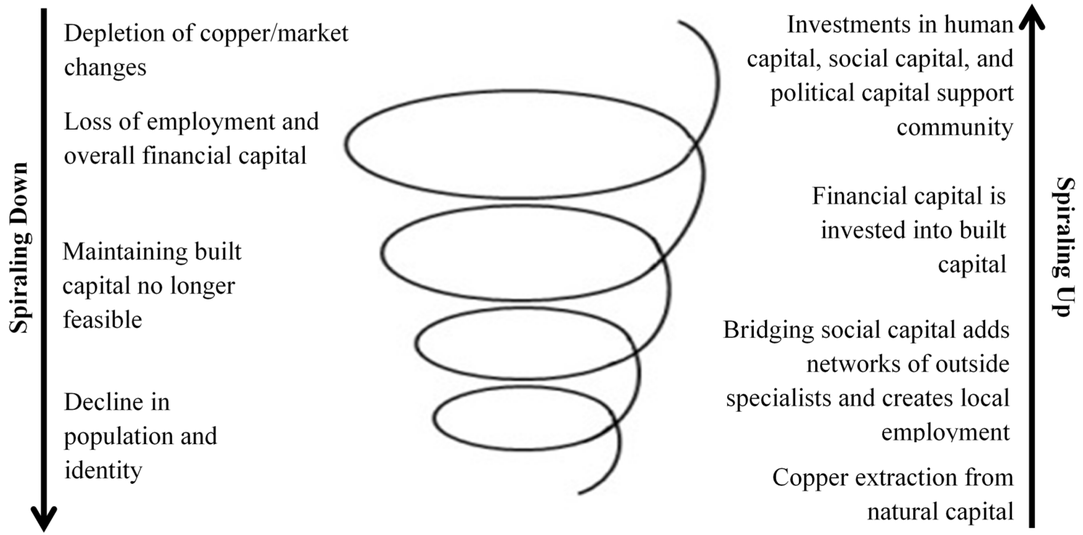
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

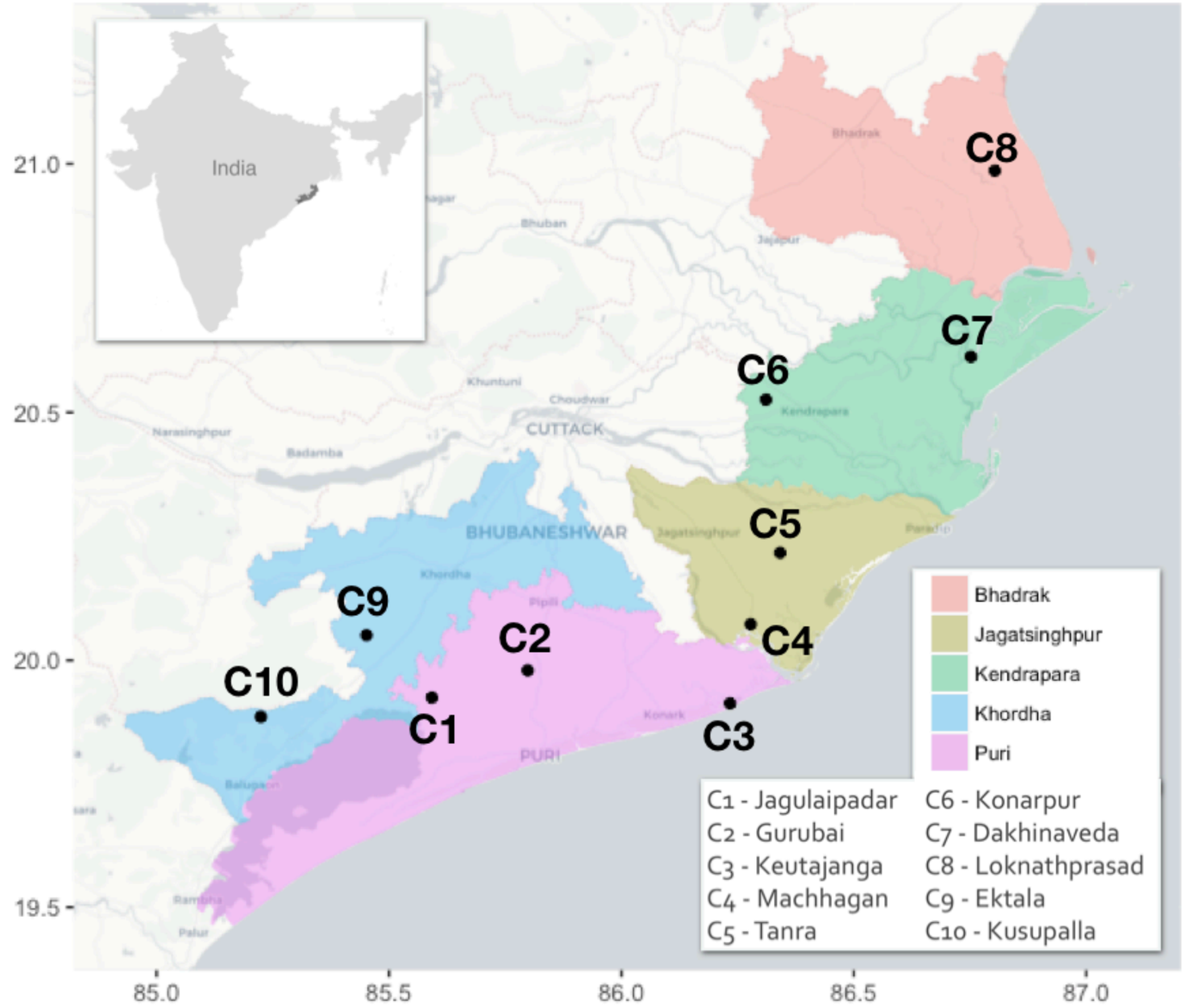
10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

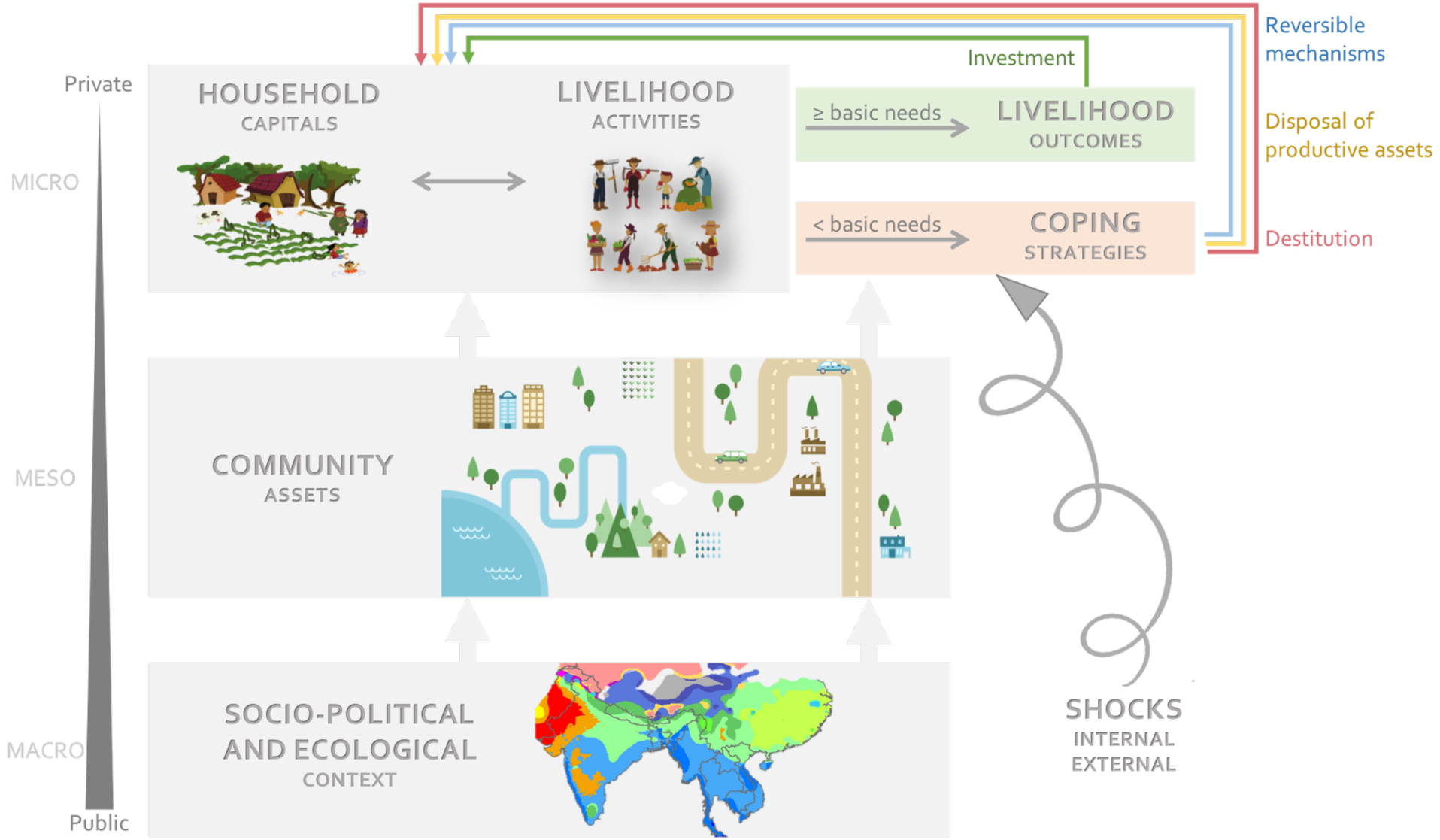
POLICY TARGETING

CASE STUDY

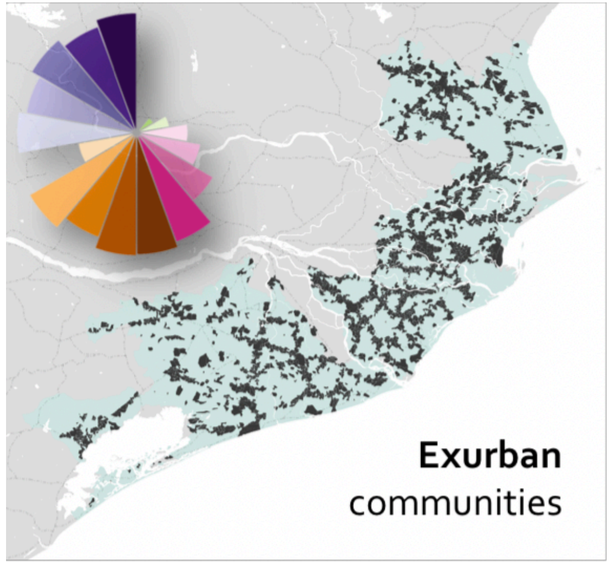

Spiraling Down
Depletion of copper/market changes
Loss of employment and overall financial capital
Maintaining built capital no longer feasible
Decline in population and identity
Investments in human capital, social capital, and political capital support community
Financial capital is invested into built capital
Bridging social capital adds networks of outside specialists and creates local employment
Copper extraction from natural capital
Spiraling Up

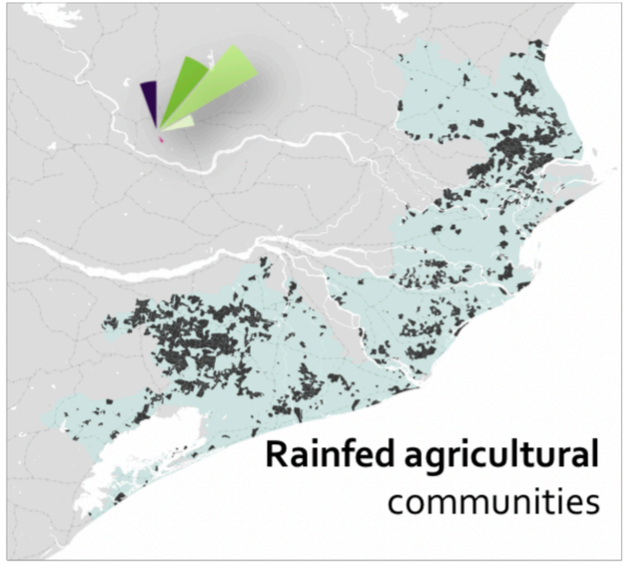

India
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
Bhadrak
Jagatsinghpur
Kendrapara
Khordha
Puri
C1 - Jagulaipadar
C2 - Gurubai
C3 - Keutajanga
C4 - Machhagan
C5 - Tanra
C6 - Konarpur
C7 - Dakhinaveda
C8 - Loknathprasad
C9 - Ektala
C10 - Kusupalla
BHUBANESHWAR
CUTTACK
PURI
21.0
20.5
20.0
19.5
85.0
85.5
86.0
86.5
87.0

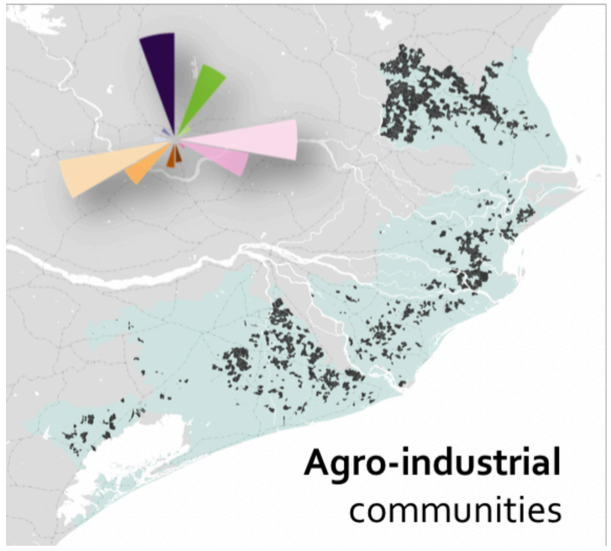
CONCEPTUAL FRAMEWORK

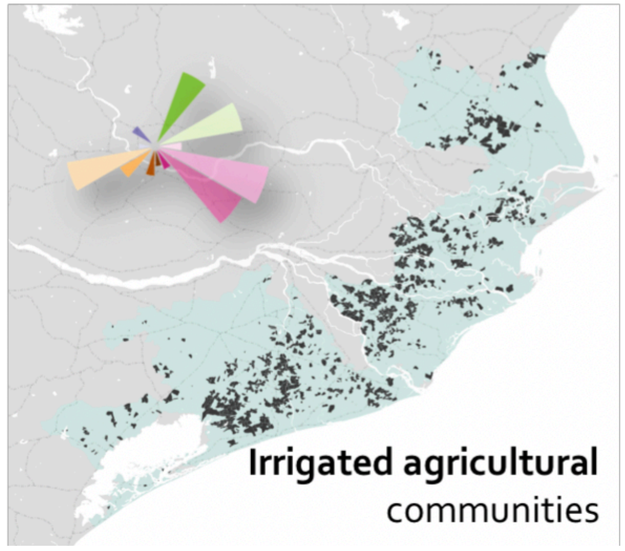


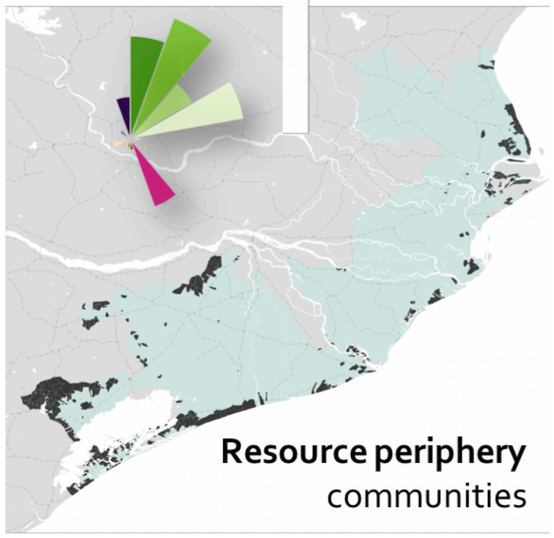
TYPOLOGIES OF COMMUNITIES

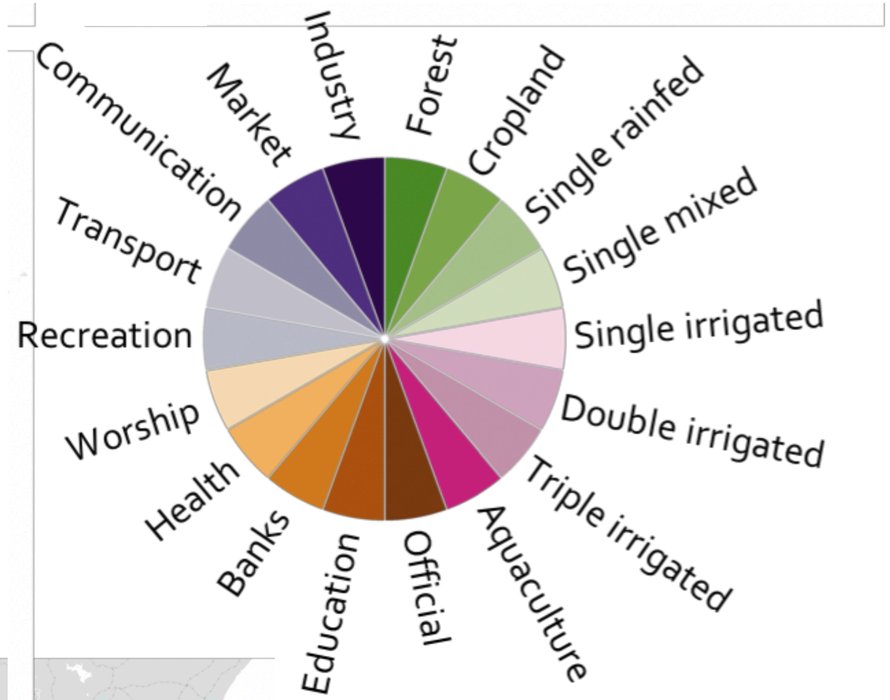




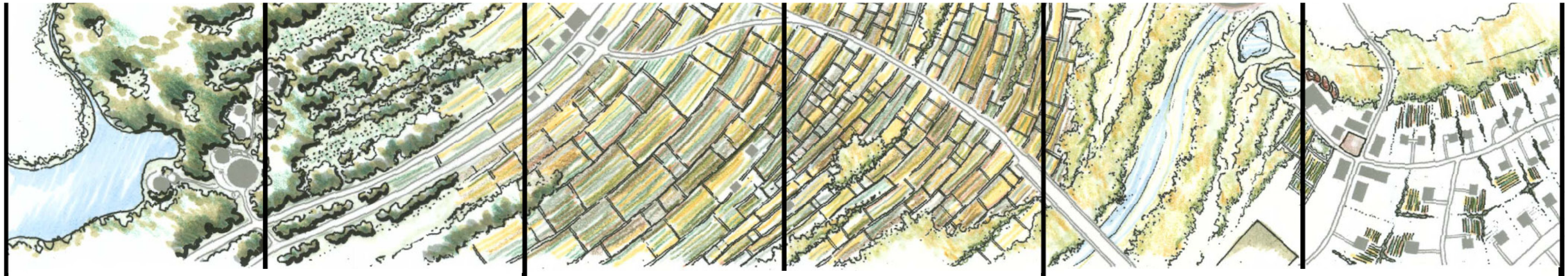








DETERMINANTS OF PRECARIOUS LIVELIHOODS



Peripheral communities

Community determinants: access to natural resources enables diversification and reduces the likelihood of precarious livelihoods

Household determinants: human and social capitals increase livelihood opportunities and provide services that are not available due to remoteness

Coping strategies: lack of off-farm livelihood opportunities due to remoteness making these communities very sensitive to multiple shocks

Agricultural communities

Community determinants: access to productive infrastructures (irrigation and markets) enables farmers to generate incomes from their production

Household determinants: natural and physical capitals increase marketing opportunities and thus improve the stability of livelihood outcomes

Coping strategies: sensitivity to climatic shocks dependent on access to the community's productive infrastructures and household's physical capital

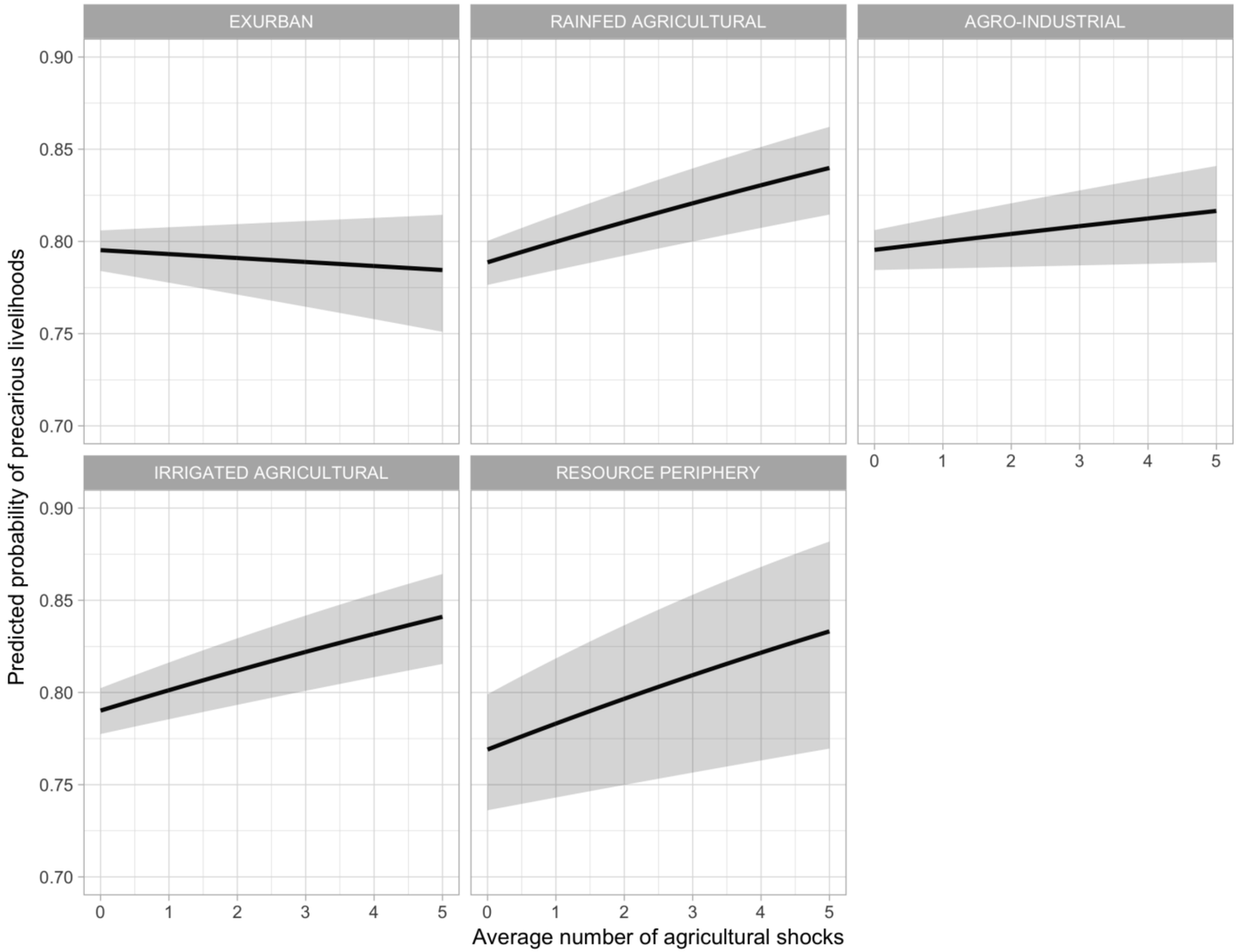
Exurban communities

Community determinants: cornering of natural resources by wealthy farmers and great population density increases the likelihood for households to engage in precarious livelihoods

Household determinants: financial and social capitals secures means of production and increase livelihood opportunities

Coping strategies: availability of off-farm employment reduces sensitivity to shocks

IMPACT OF AGRICULTURAL SHOCKS



PRACTICAL

MAKING SYSTEMS THINKING REAL

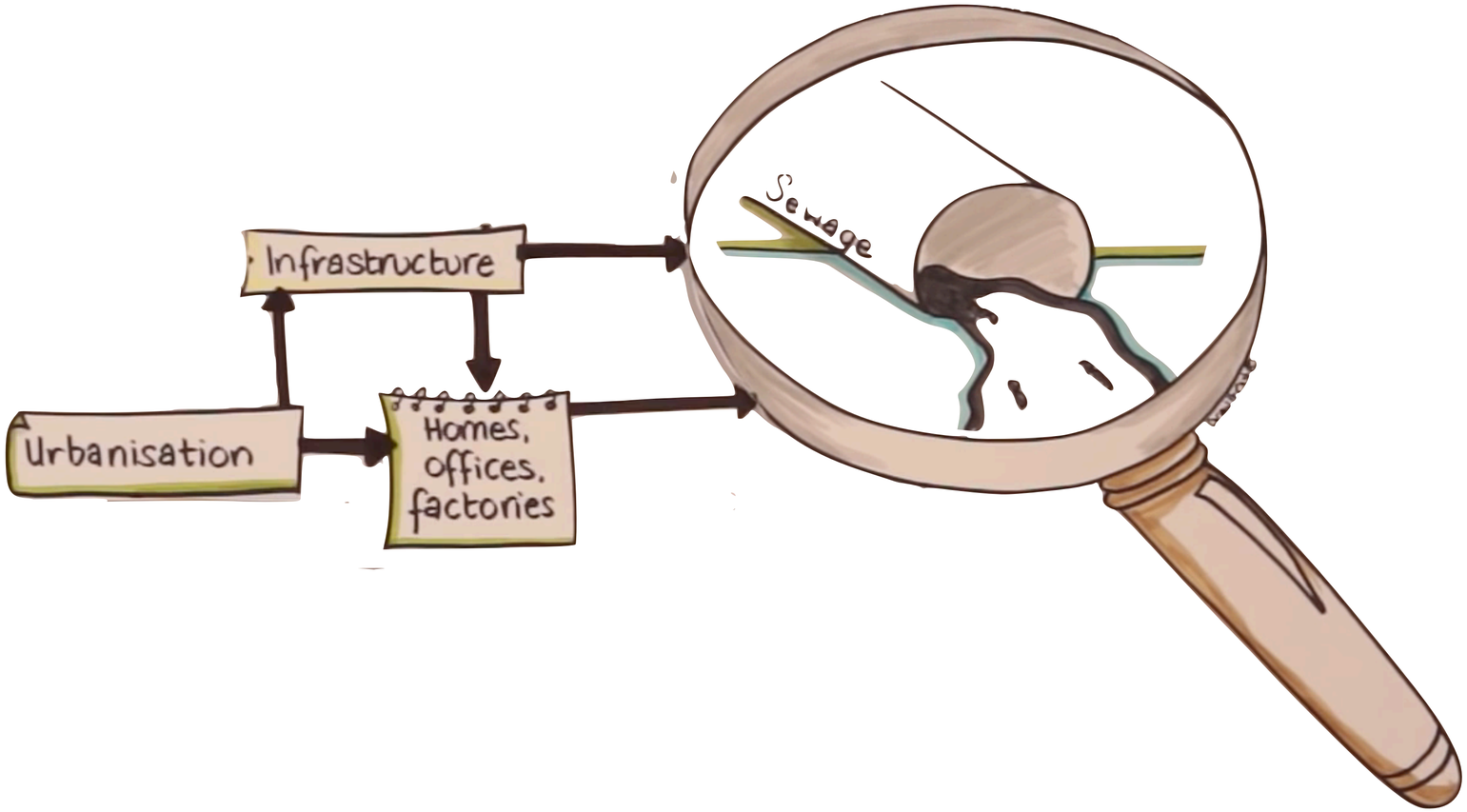
‘Give a man a fish and he will eat for a day, teach a man to fish and he will eat for a lifetime’.

Role of **underlying drivers** that might prevent or encourage the development of a fishery-based livelihood.

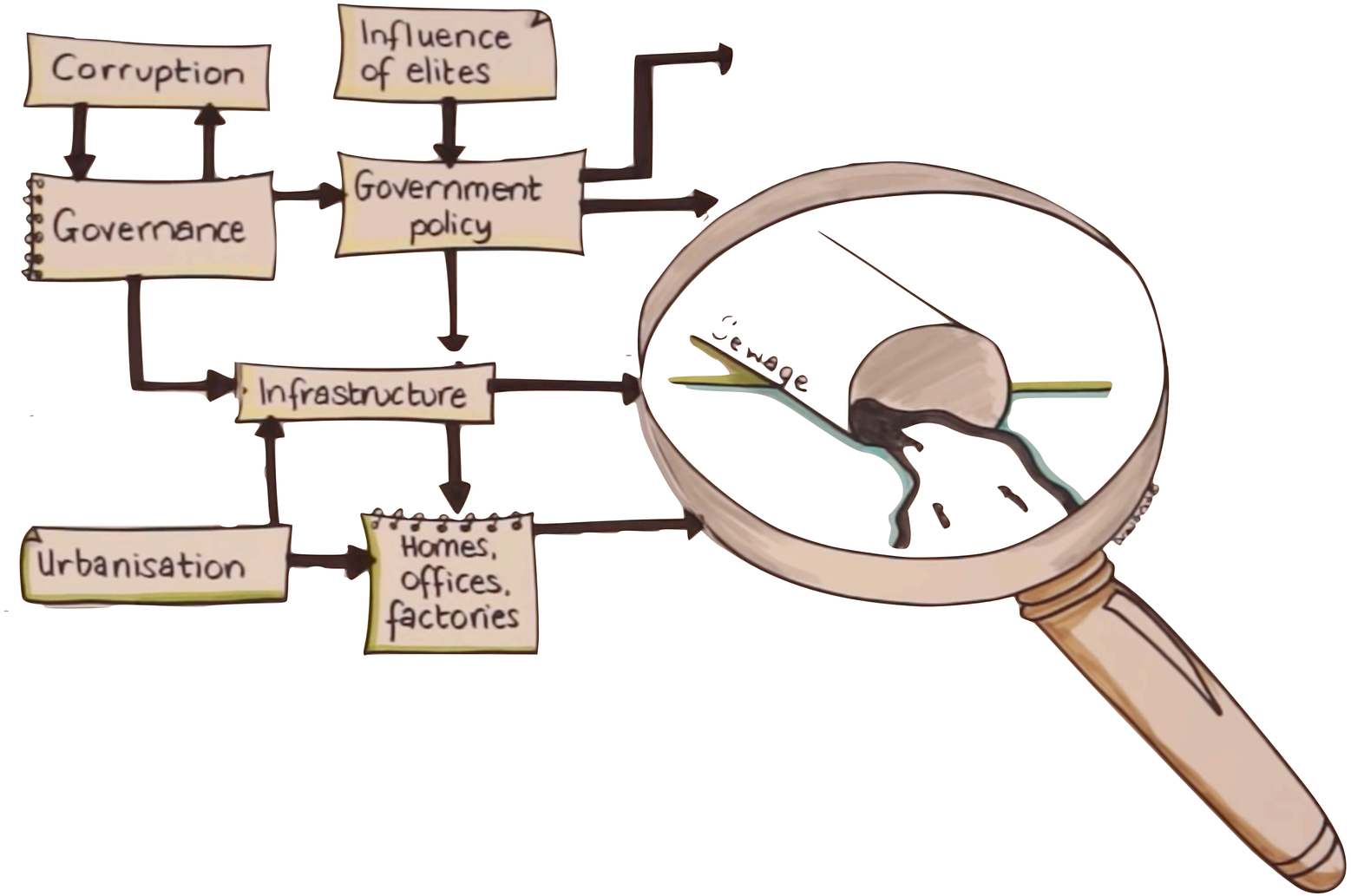
MAKING SYSTEMS THINKING REAL

MAKING SYSTEMS THINKING REAL

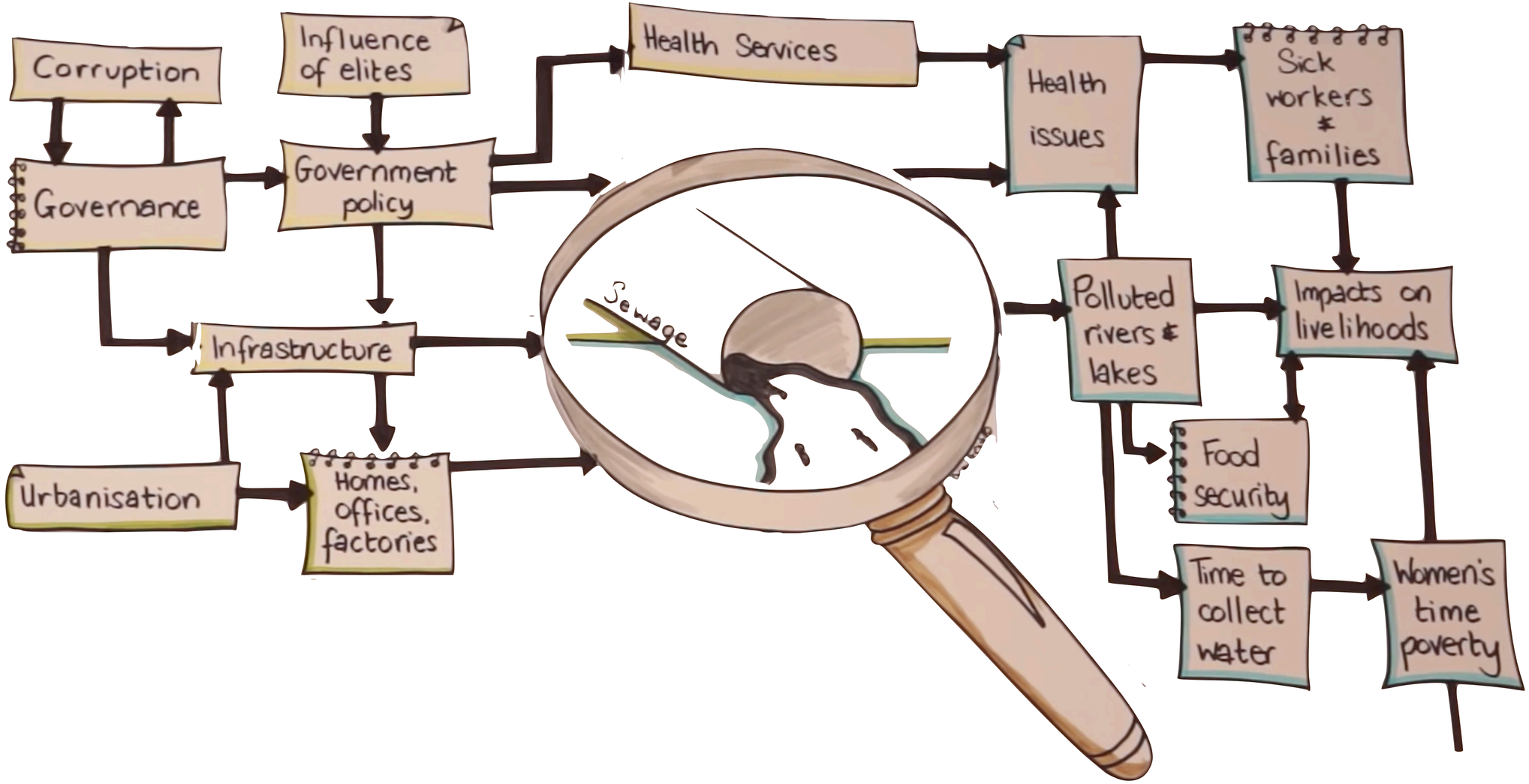
MAKING SYSTEMS THINKING REAL



MAKING SYSTEMS THINKING REAL



MAKING SYSTEMS THINKING REAL



MAKING SYSTEMS THINKING REAL