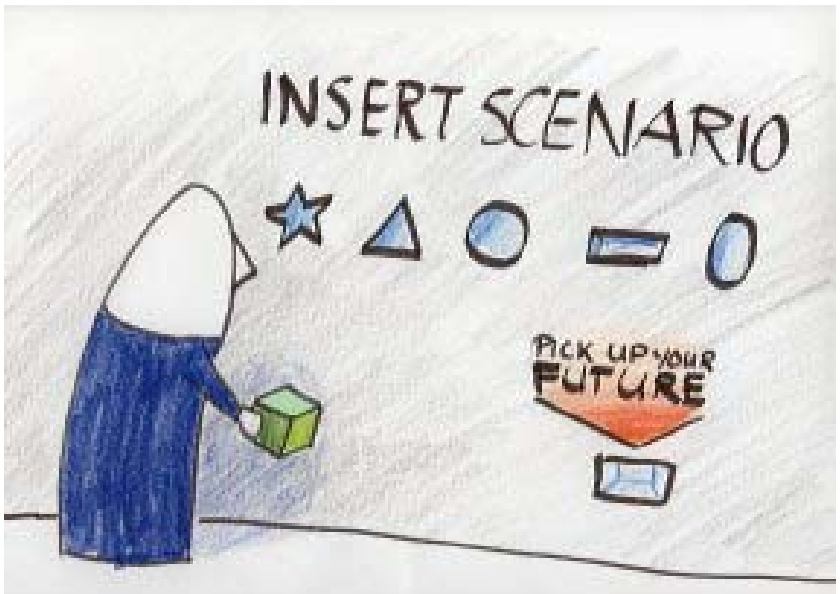
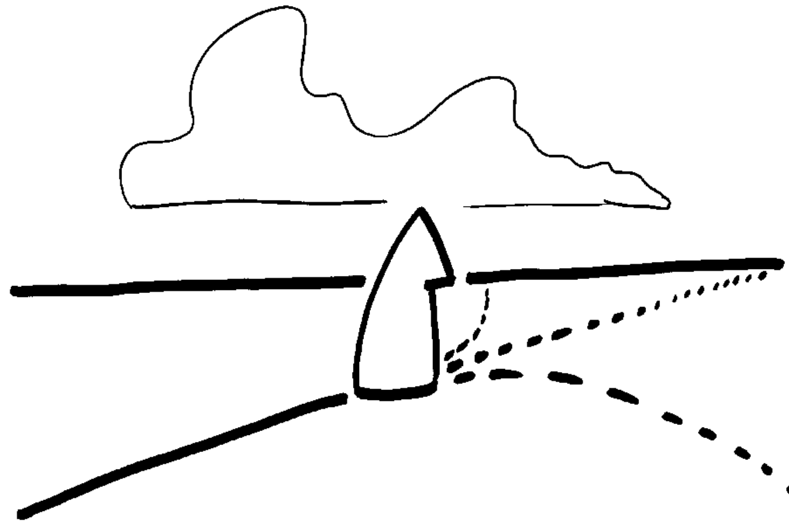
Scenario development

Concept and examples





Kasper Kok – Wageningen University, the Netherlands

NONAM PhD course - Copenhagen, 22-26 August 2011

Scenario development in two lectures

Lecture 1 – Monday 22 August, 13:00-14:15
Background, overarching issues, concepts, definitions, tools

- Complex Systems
- Tools and methods to analyse complex systems
- Scenarios

Lecture 2 – Wednesday 24 August, 10:15-11:30
Practical examples + conclusions

- Exploratory scenario development – SAS approach
- Group model building - Fuzzy Cognitive Maps
- Normative scenario development - Backcasting

Conclusions

LECTURE 2

Scenario development

In practice

Content

Lecture 2: scenario development in practice

- Story-And-Simulation approach
- Fuzzy Cognitive Mapping
- Backcasting

Scenarios - types

A Project goal - exploration vs decision support:

I. Inclusion of norms? : descriptive vs normative

II. Vantage point: forecasting vs backcasting

III. Subject: issue-based, area-based, institution-based

IV. Time scale: long term vs short term

V. Spatial scale: global/supranational vs national/local

B Process design – intuitive vs formal:

VI. Data: qualitative vs quantitative

VII. Method of data collection: participatory vs desk research

VIII. Resources: extensive vs limited

IX. Institutional conditions: open vs constrained

C Scenario content - complex vs simple:

X. Temporal nature: chain vs snapshot

XI. Variables: heterogeneous vs homogenous

XII. Dynamics: peripheral vs trend

XIII. Level of deviation: alternative vs conventional

XIV. Level of integration: high vs low

EXAMPLE 1 – EXPLORATORY SCENARIOS

Example 1a – Qualitative and quantitative scenarios

Example 1b – Quantitative models

Example 1c – Qualitative scenarios

Example 1a:

The Millennium Ecosystem Assessment

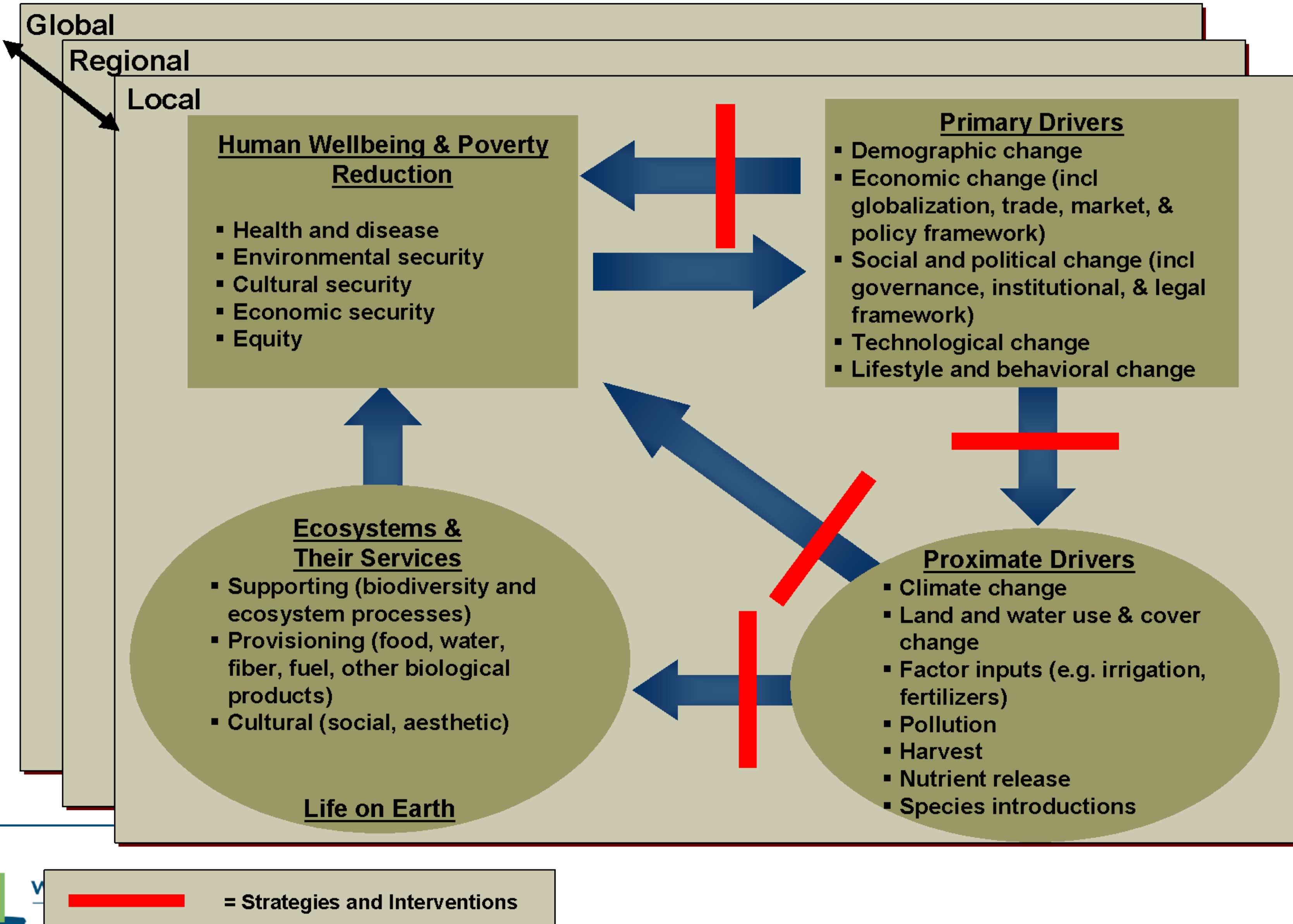
(full Story-And-Simulation approach)

Millennium Ecosystem Assessment

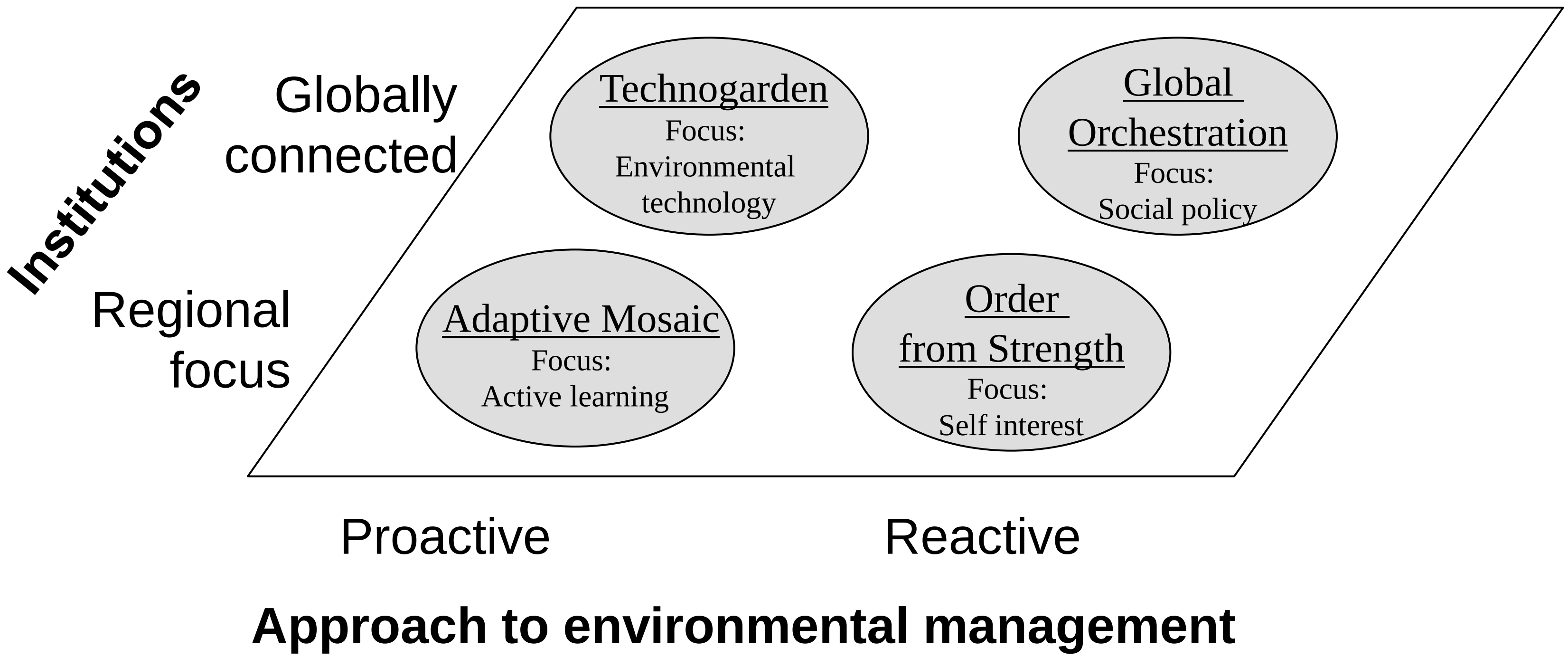
An international scientific assessment of the consequences of ecosystem changes for human well-being:

- **Modeled on the IPCC**
- **Providing information requested by:**
  - Convention on Biological Diversity (CBD)
  - Convention to Combat Desertification (CCD)
  - Ramsar Convention on Wetlands
  - Convention on Migratory Species (CMS)
  - other partners including the private sector and civil society
- **With the goals of:**
  - stimulating and guiding action
  - building capacity

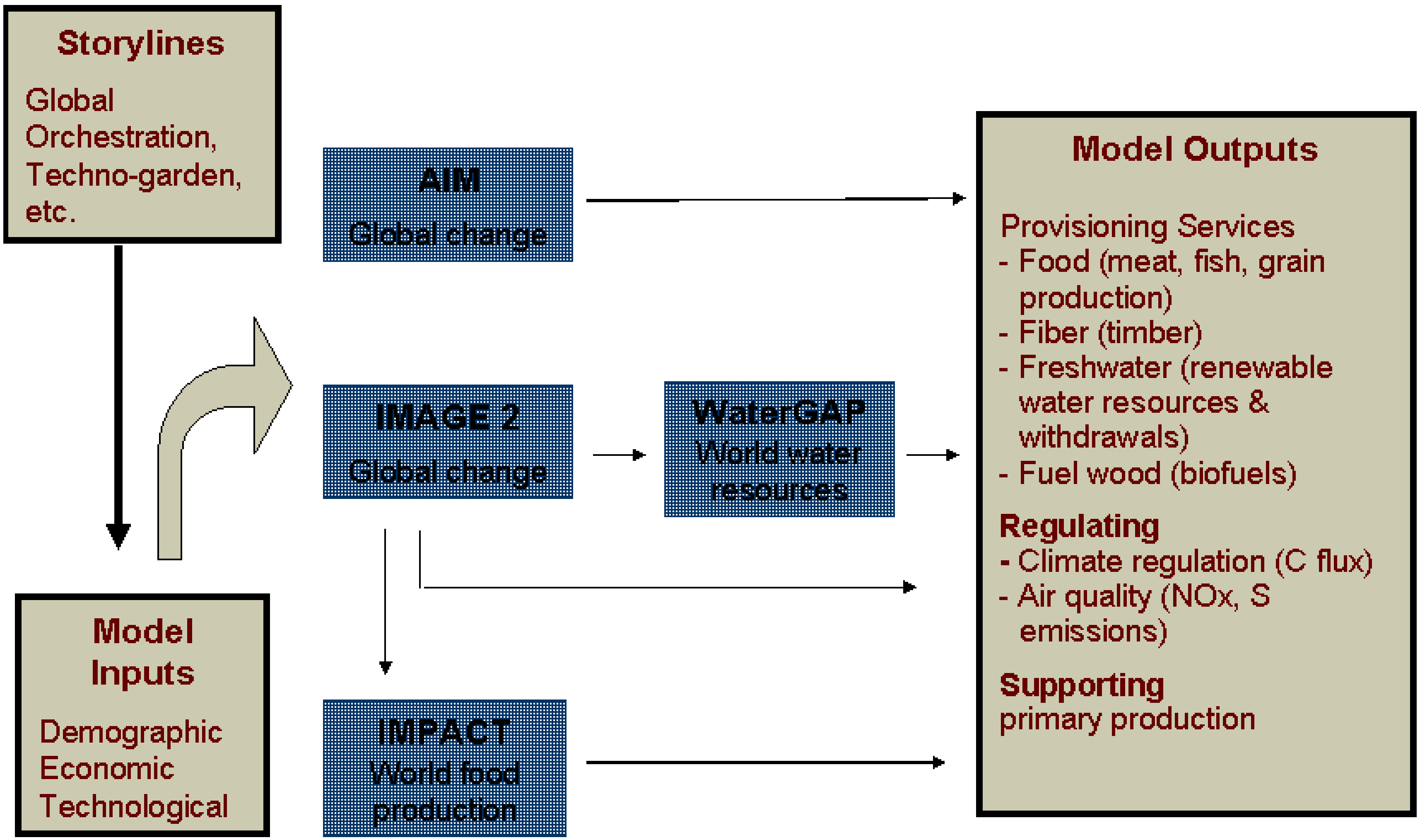
MA Conceptual Framework



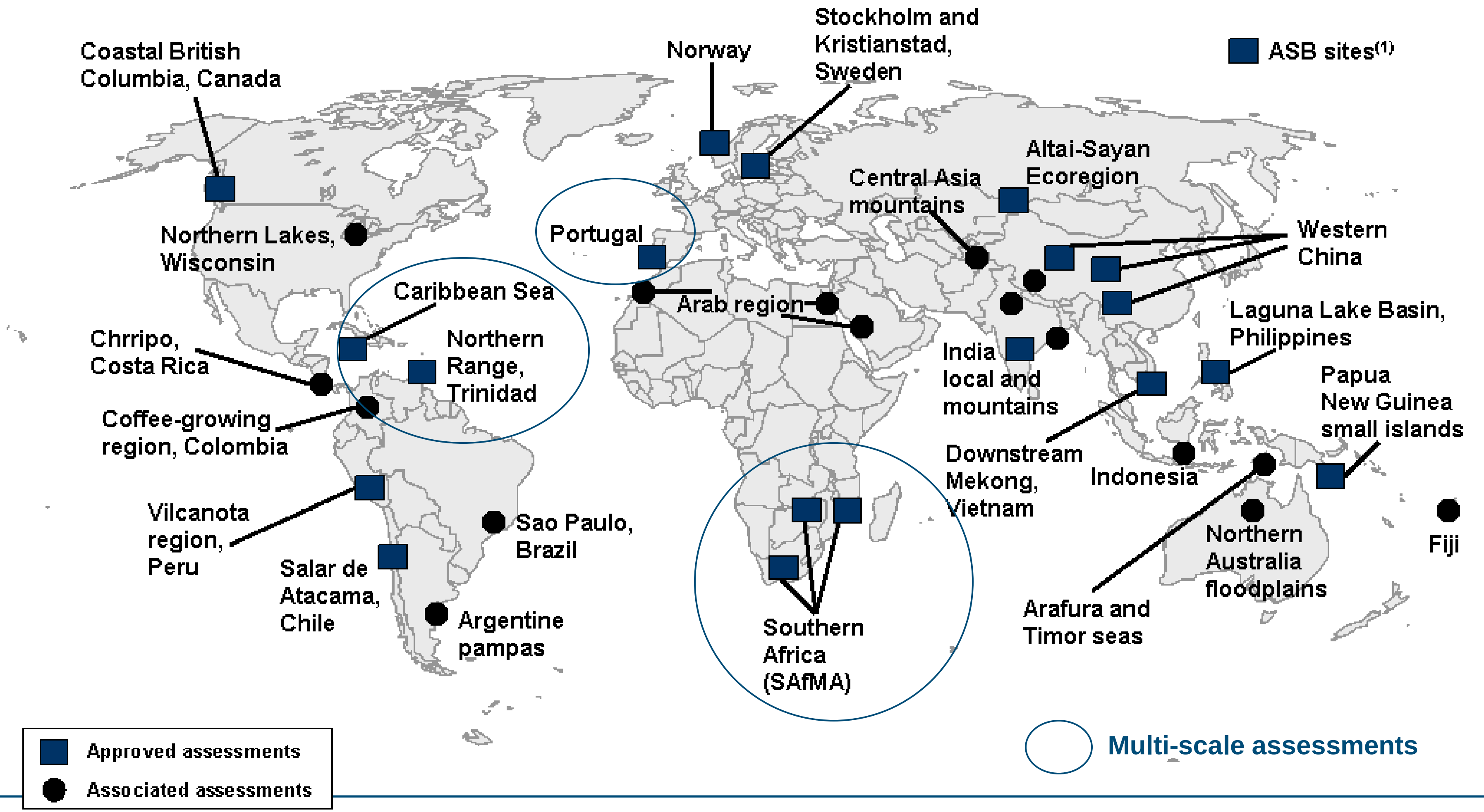
Four global storylines



Approach to quantifying the scenarios



Locations of Sub Global Assessments (SGAs). 17 Approved and 16 Associated SGAs.



Communicating scenarios: community theatre

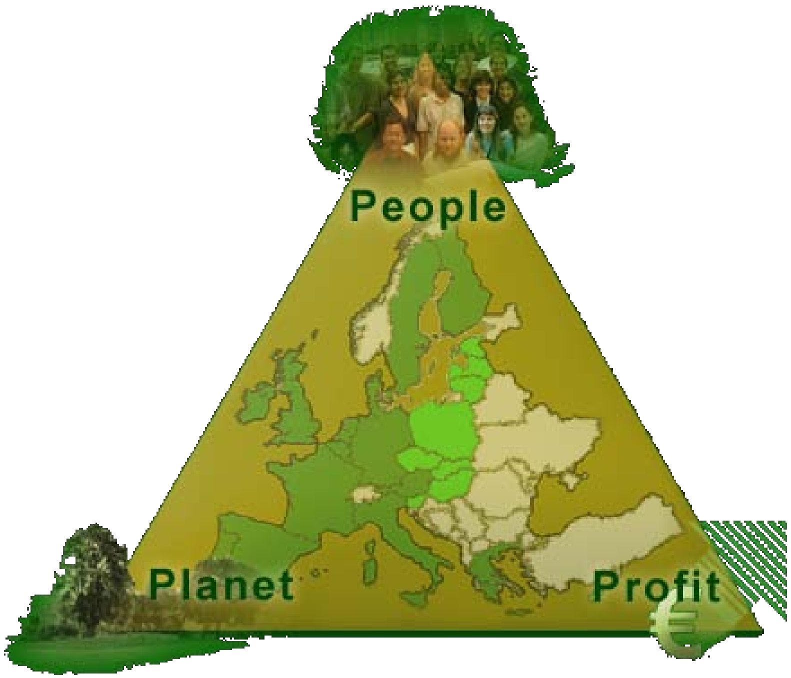
Example 1b:

EURURALIS

Focus on models

EURURALIS

EUropean **RUR**al **A**rea **L**and Use **I**nteractive Discussion **S**upport System



- Commissioned by the Ministry of Agriculture, the Netherlands
- Jan Klijn, Teunis van Rheenen, Jan Bakkes, Henk Westhoek, Hans van Meijl, Tom Veldkamp, Maurits van den Berg, Bas Eickhout, Wies Vullings, Peter Verburg, Nynke Schulp, Nol Witte, Ron van Lammeren
- RIVM & Wageningen UR, the Netherlands

EURURALIS: Methodology

Multi-scale modelling of **scenarios** of land use change

Multi-scale

• Address mu
land use sys

• Link global

• Address dif
discussions

Modelling

• Structured an

• Explore dyna

• Projections o

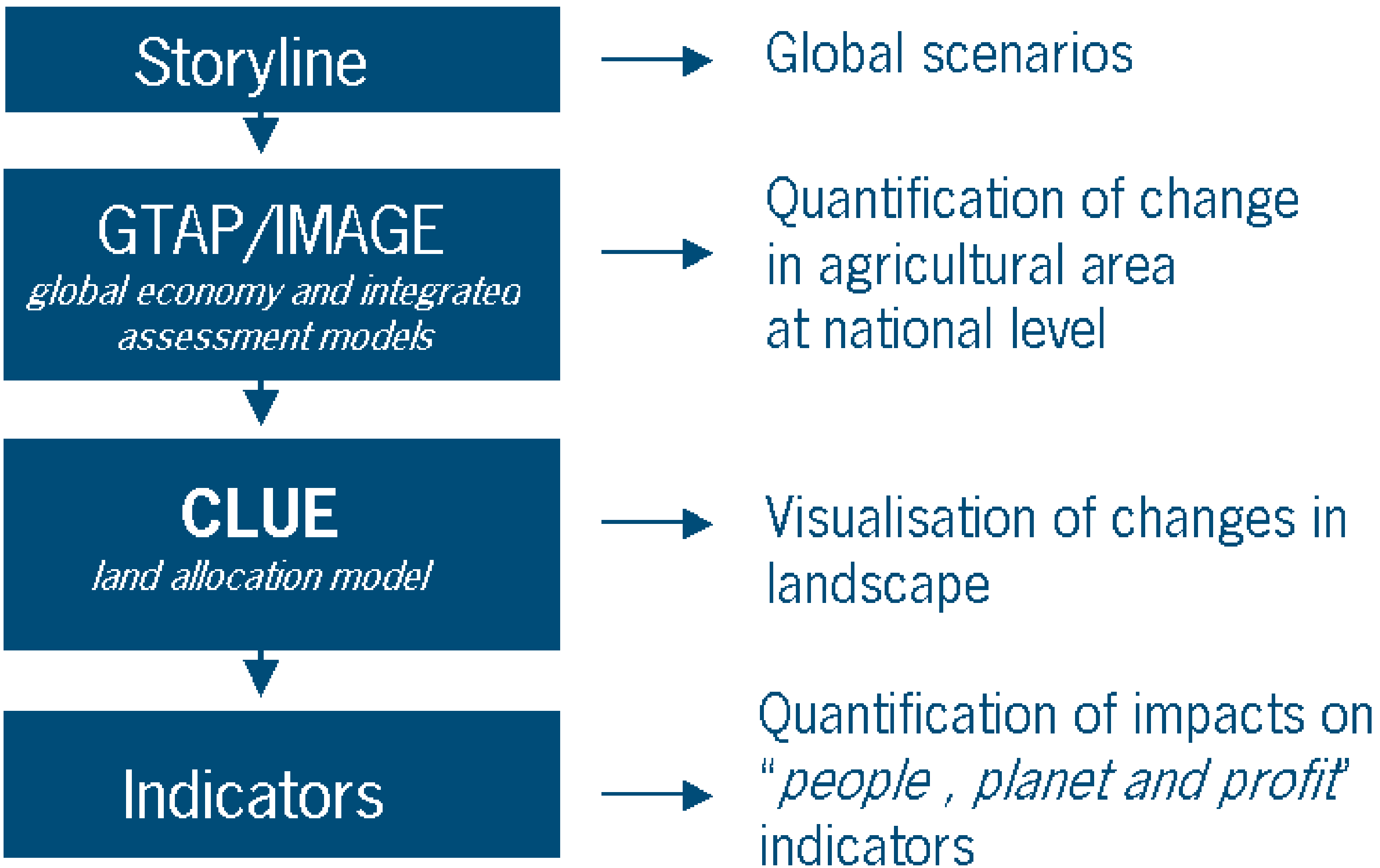
Scenarios

• Deal with uncertainty in development/policy

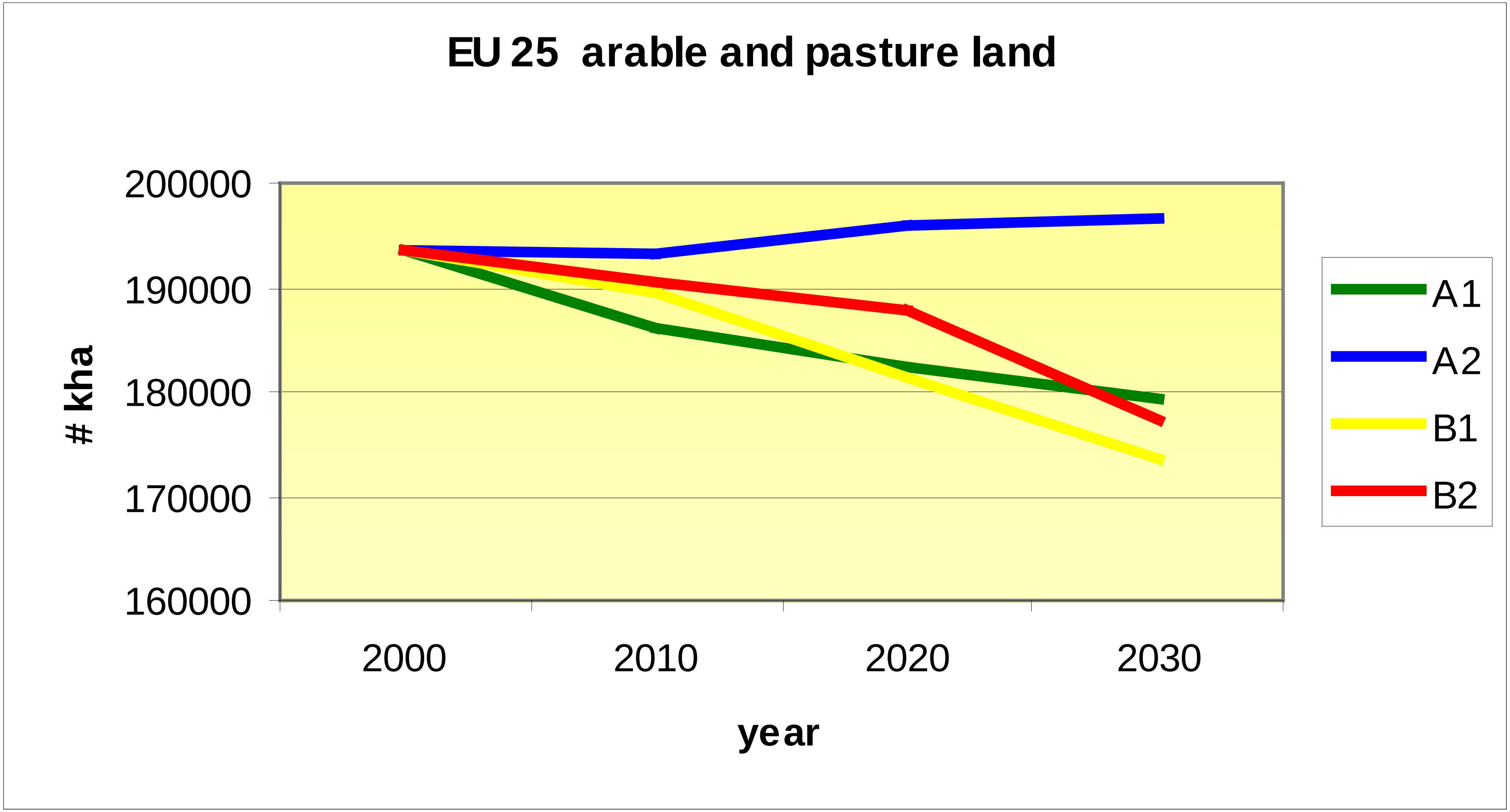
• Plausible futures

• No 'desired' future (no 'doom or gloom')

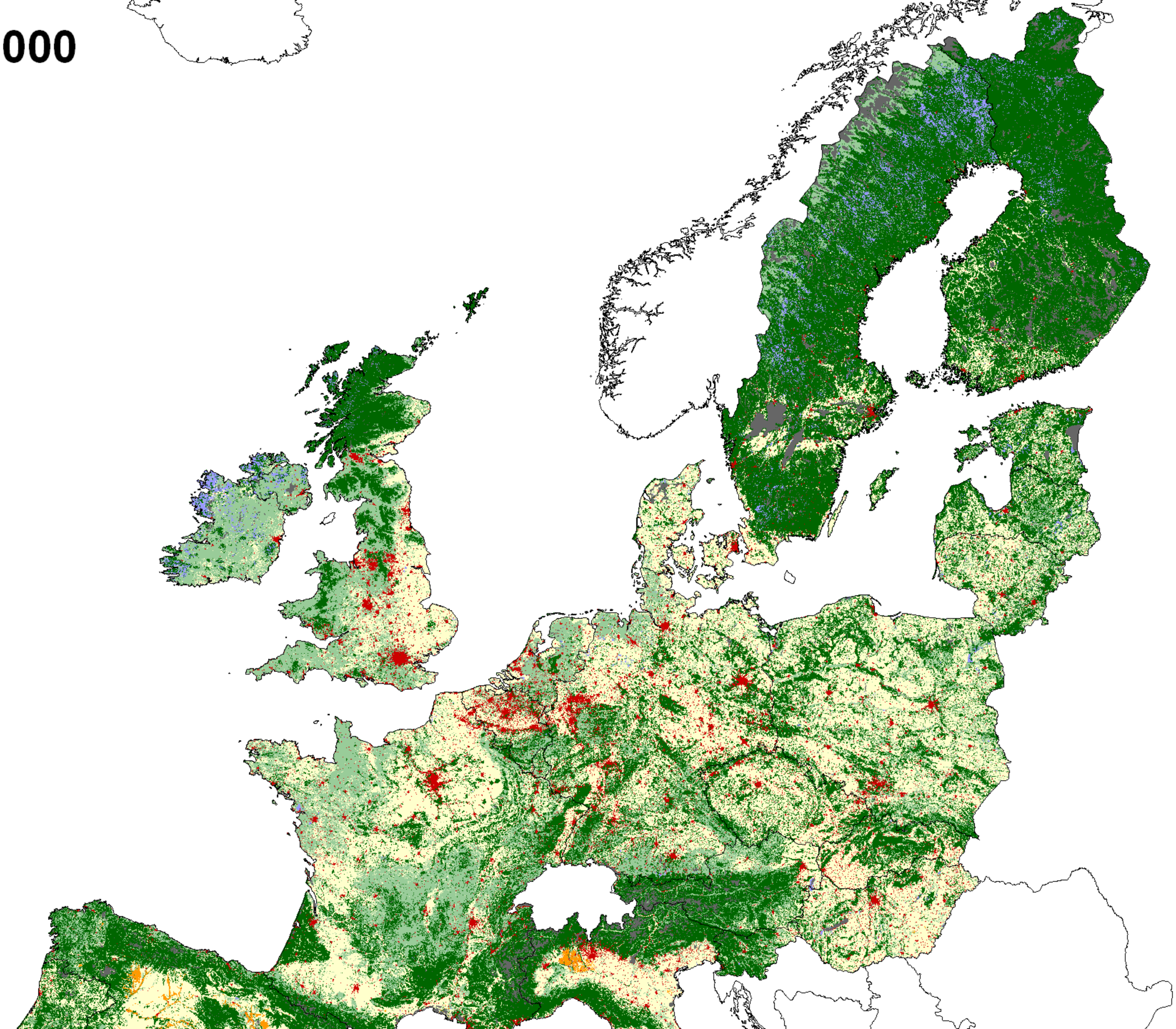
EURURALIS: Model chain



EURURALIS: GTAP/IMAGE model



2000



Example 1c:

MedAction

Focus on participation and storylines

Example 3: MedAction

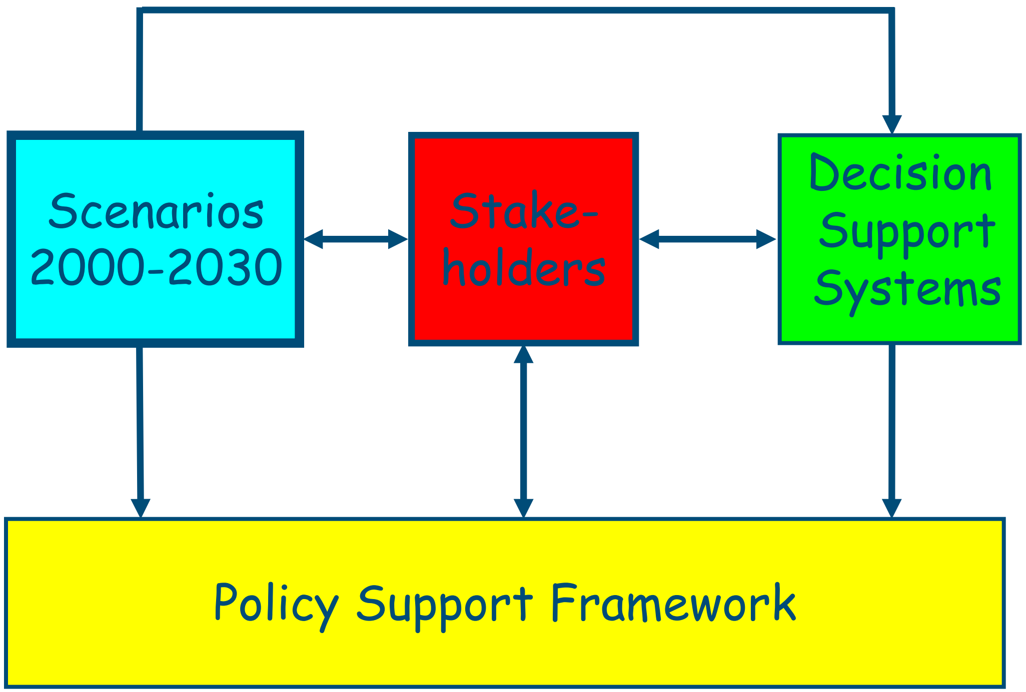
Land use change scenarios at various scales

*To better understand the driving forces leading to **land degradation** and desertification in the Northern **Mediterranean** and to contribute to **policy-making** to address these issues*

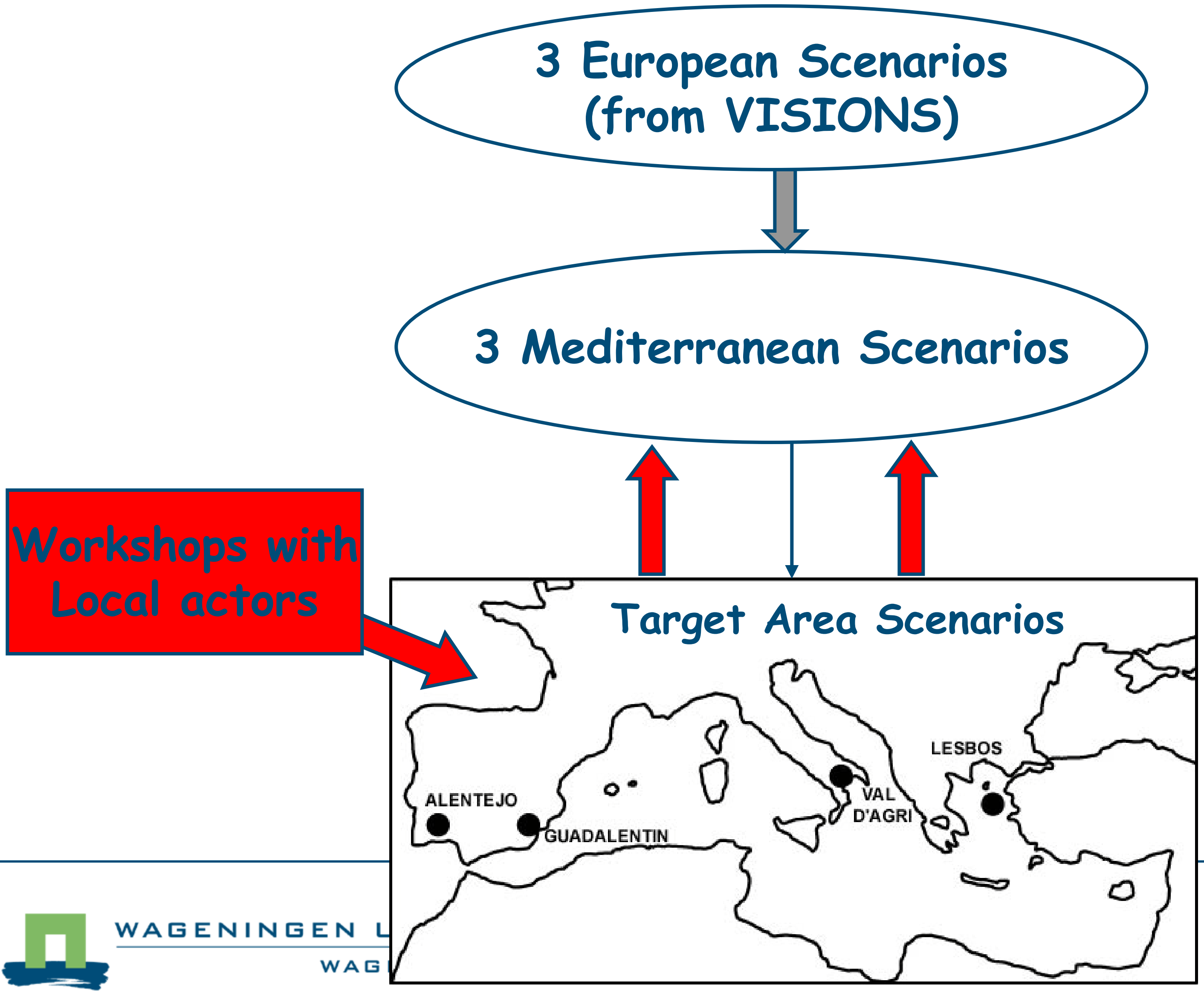
WAGENINGEN UNIVERSITY
WAGENINGEN UR

International Centre for Integrative Studies (ICIS)

Main products of MedAction

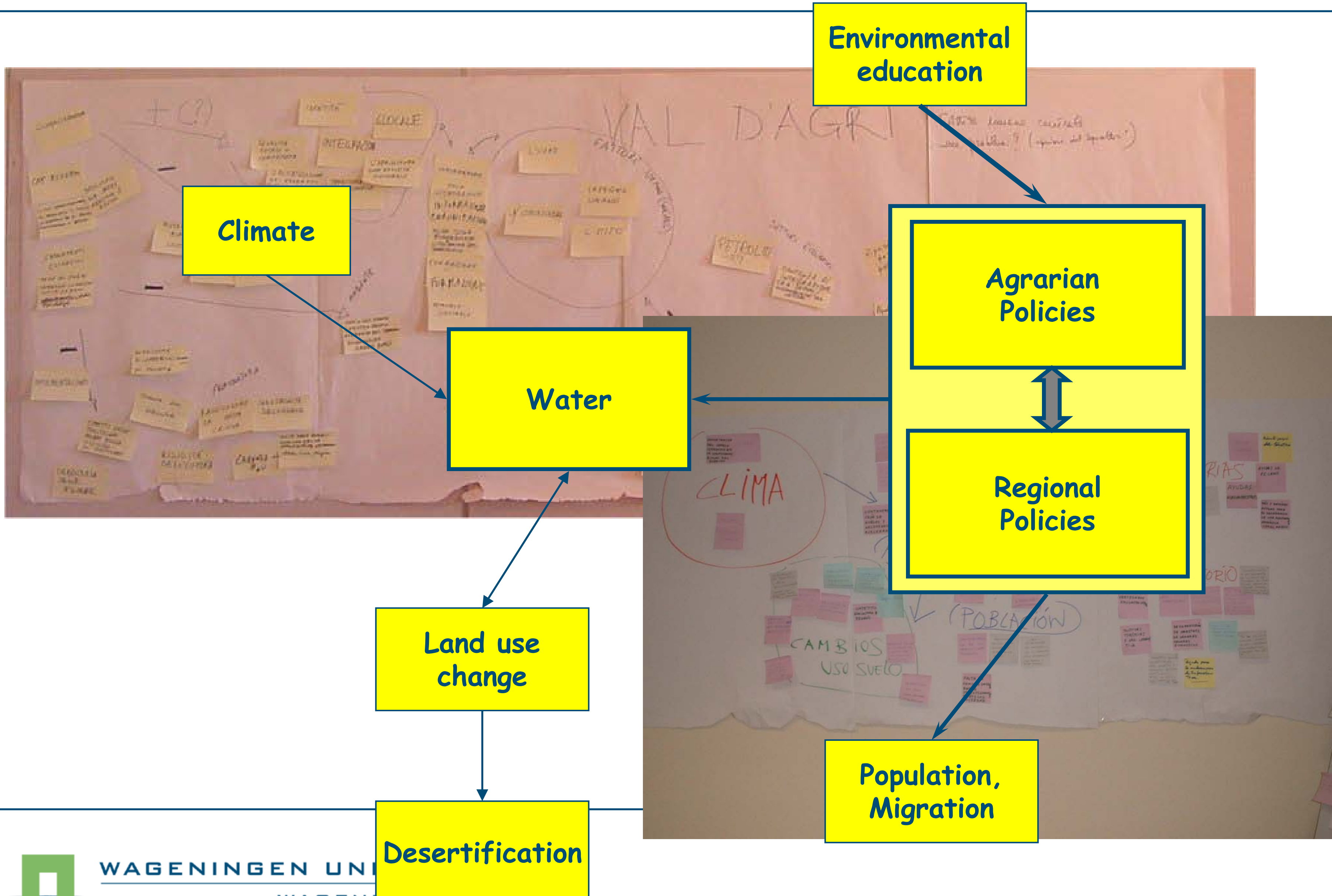


Multi-scale scenario development



Story of the present: Writing post-its

Final product



Three European scenarios

Knowledge is King

Information Technology dominates

Inventions

Convulsive Change

Flooding

Drought
Desert formation

Big is Beautiful

Merger Mania

+

+

Creating the scenarios

The collages

EXAMPLE 2 – GROUP MODEL BUILDING

Example project

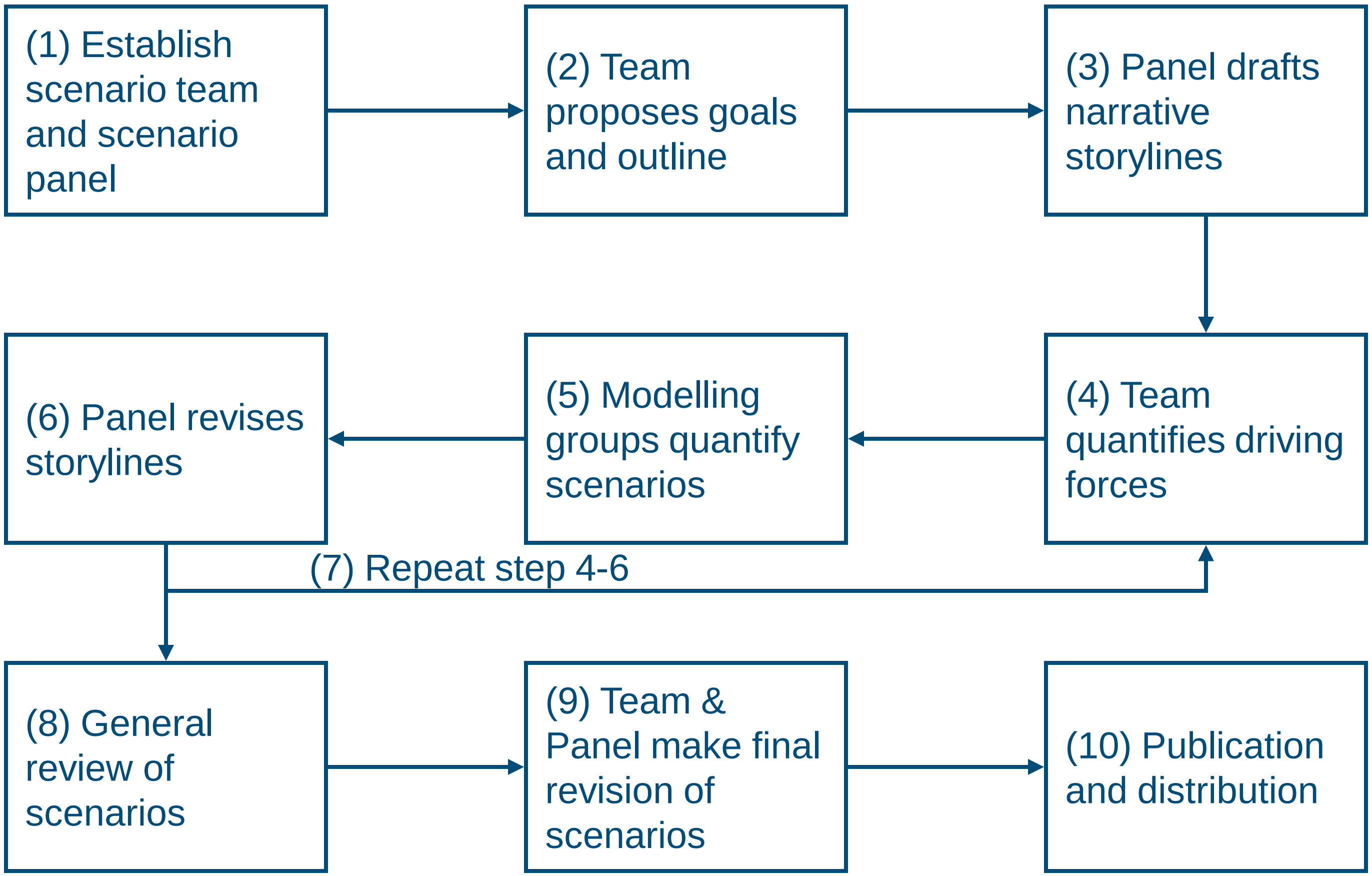
SCENES: Water scenarios for Europe

SCENES: Water scenarios for Europe

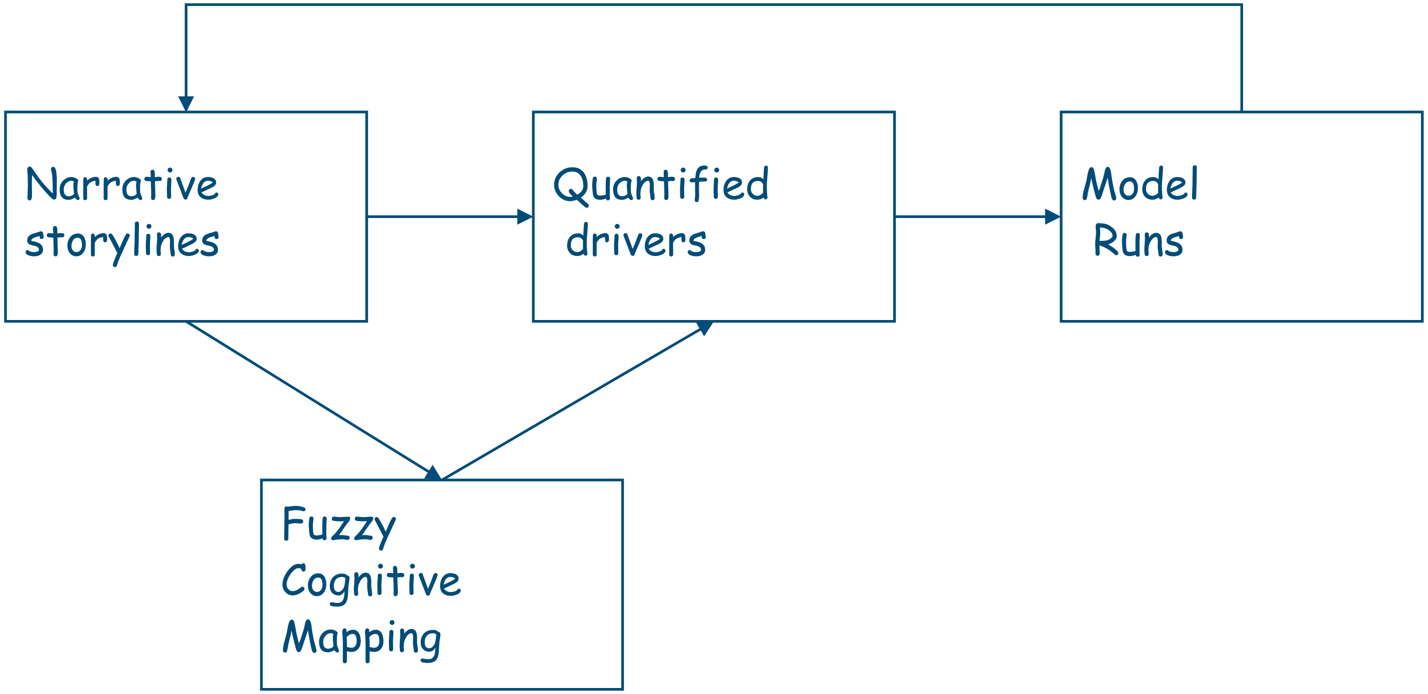
Overall aim:

To develop and analyse a set of scenarios of Europe's freshwater futures up to 2050, providing a reference point for long-term strategic planning; alert policy makers and stakeholders; and allow river basin managers to test water plans

Story-And-Simulation approach

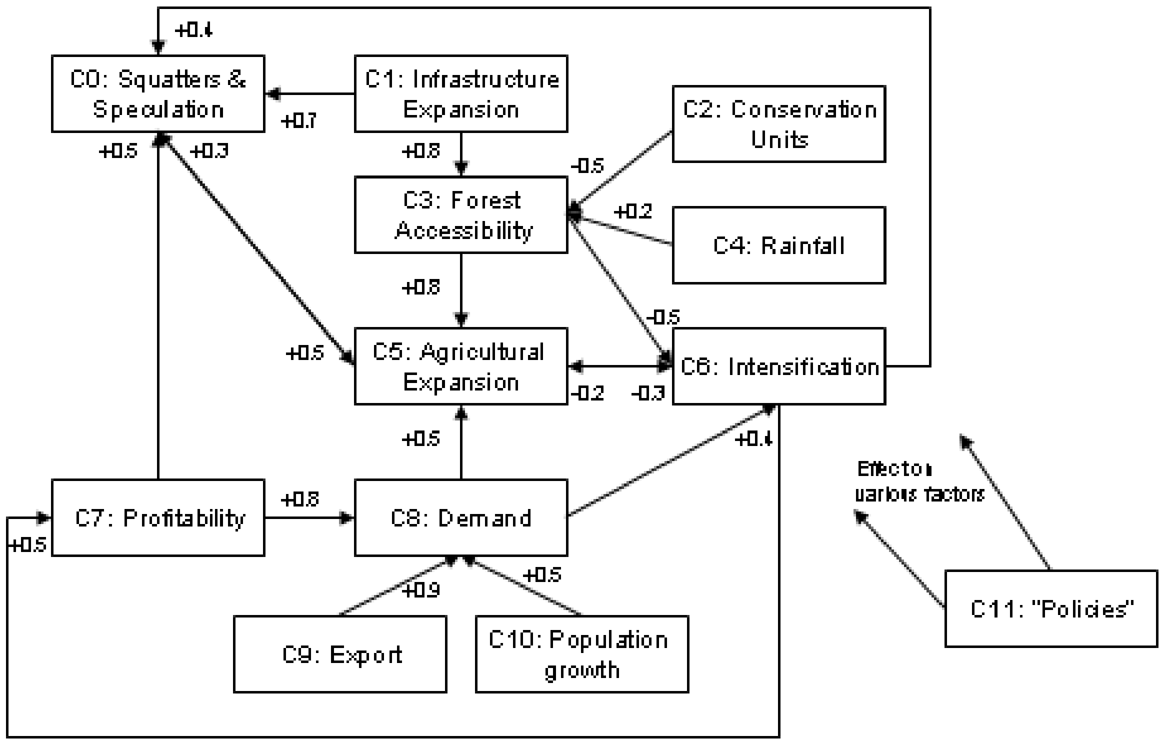


From scenarios to models
Fuzzy Cognitive Mapping: the missing link?



Fuzzy Cognitive Mapping

a semi-quantitative approach to participation



Fuzzy Cognitive Mapping

A **Cognitive Map** is the graphical representation of a system, where components are represented as boxes and relationships as arrows.

Cognitive: The **Map** is a cognitive interpretation of the system.

Fuzzy: The state of a system component is not exact but rather represented in a number of classes ('strong' or 'weak'), that are relative to each other.

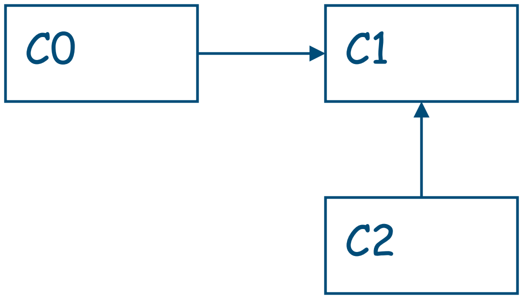
FCM – purpose and goals

1. *Gain insight in the system*. By incorporating multiple **feedbacks** that are difficult to reason through, new insights on the behaviour of the system can be acquired. (System)

2. *Gain insight in the perspectives of the stakeholders*. By using a semi-quantitative tool, **perspectives are made explicit**. (Perspectives)

3. *Stimulate mutual understanding*. By using FCM in a participatory setting, it can be used a tool to **deliberate and negotiate**. (Process)

FCM - hypothetical example



Assume that C0 and C2 drive C1

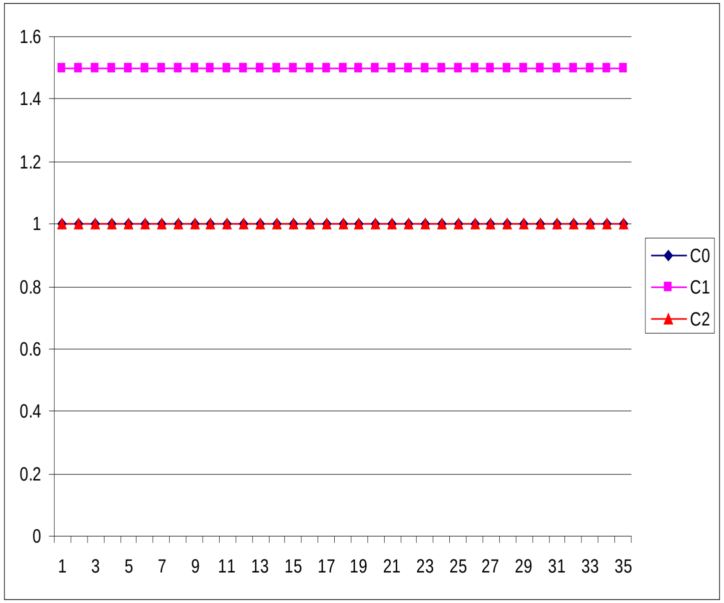
Input vector $\begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$

Assume relation C0→C1 +1

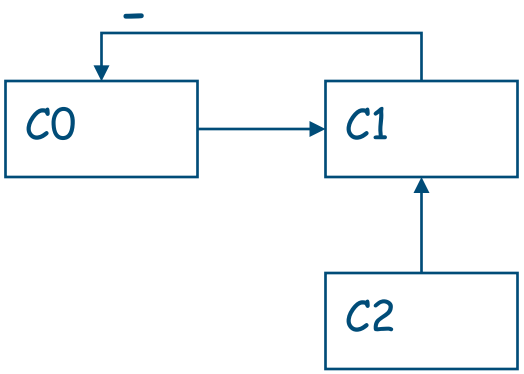
C2→C1 +0.5

Start Matrix:

$$\begin{pmatrix} 1 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0.5 & 1 \end{pmatrix}$$

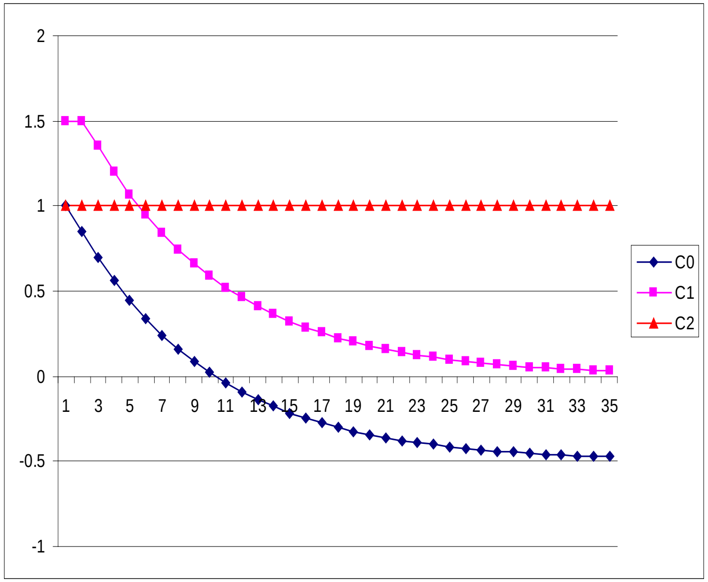


FCM – hypothetical example II



Assume that C0 and C2 drive C1

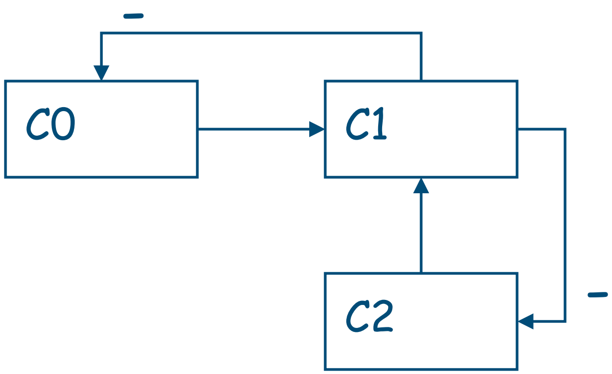
Input vector $\begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$



Assume extra relation:

$$\begin{pmatrix} 1 & 1 & 0 \\ -0.1 & 0 & 0 \\ 0 & 0.5 & 1 \end{pmatrix}$$

FCM – hypothetical example IV

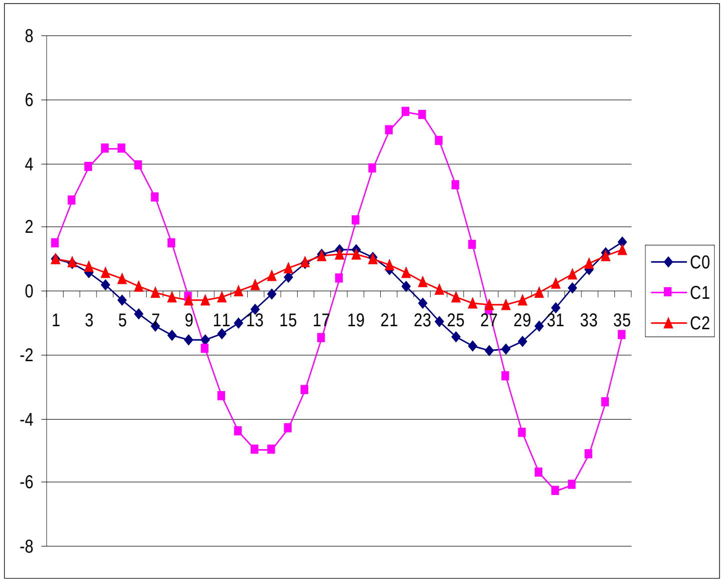


Assume that C0 and C2 drive C1

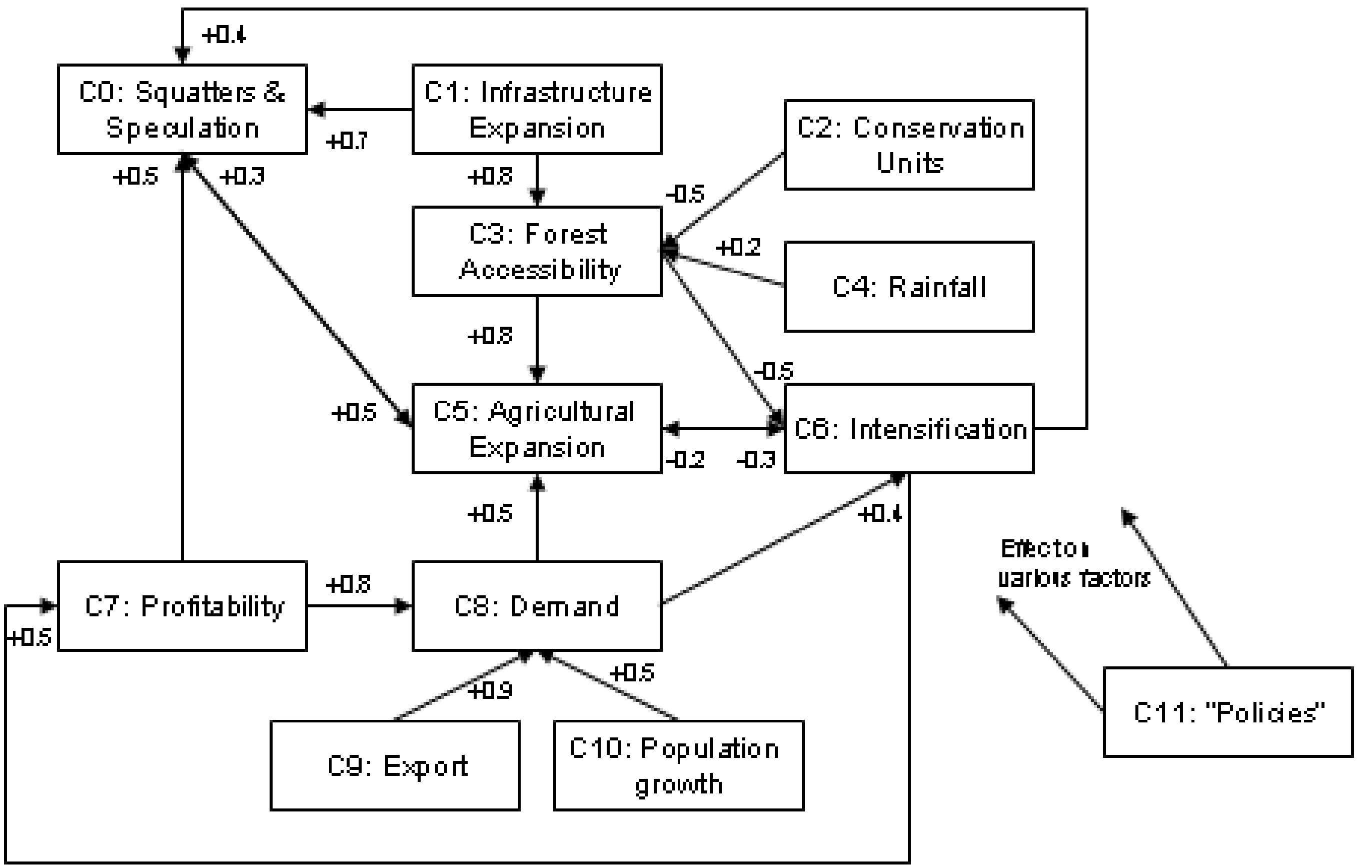
Input vector $\begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$

Assume that C1 drives itself:

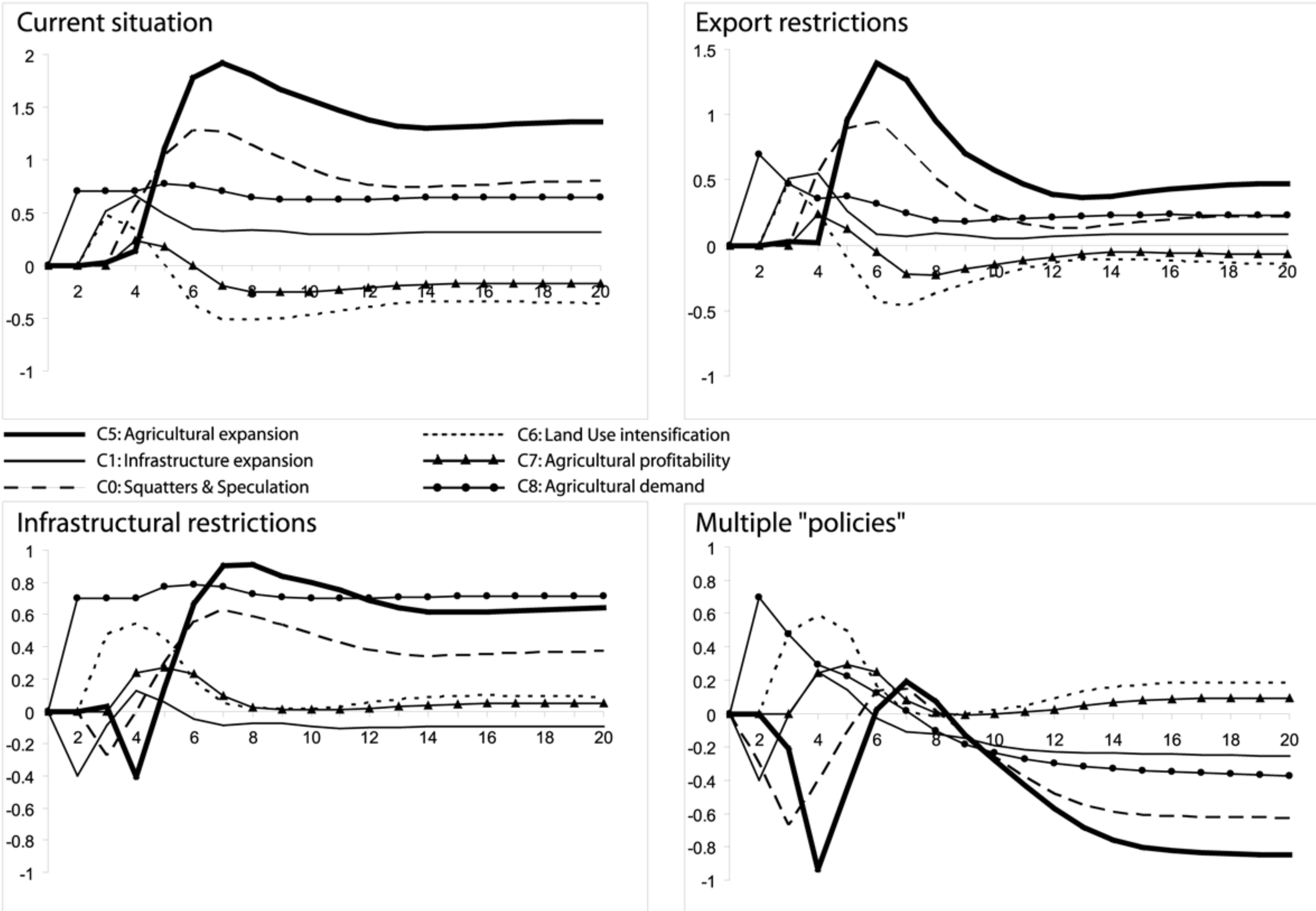
$$\begin{bmatrix} 1 & 1 & 0 \\ -0.1 & \mathbf{0.9} & -0.1 \\ 0 & 0.5 & 1 \end{bmatrix}$$



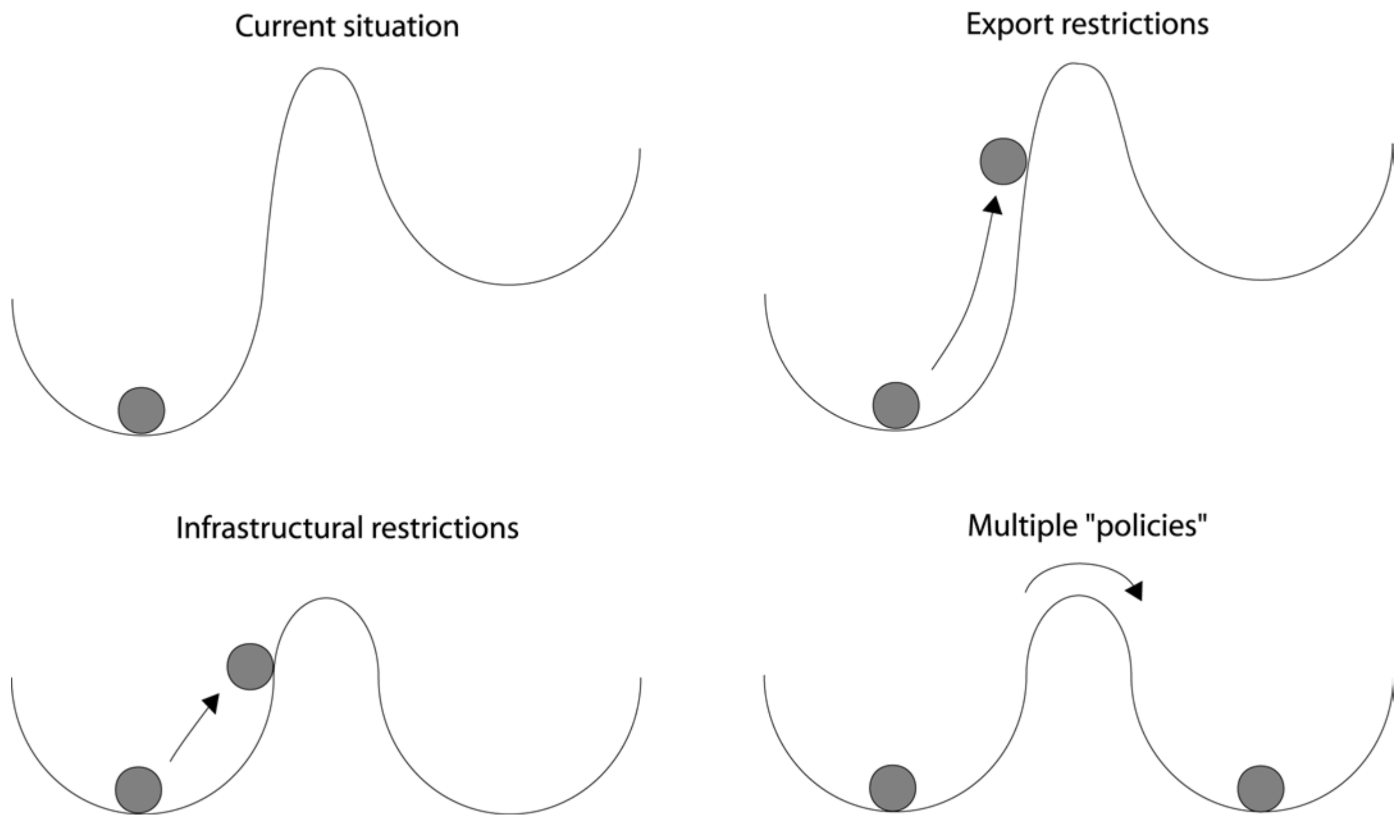
FCM - Brazil example (graph)



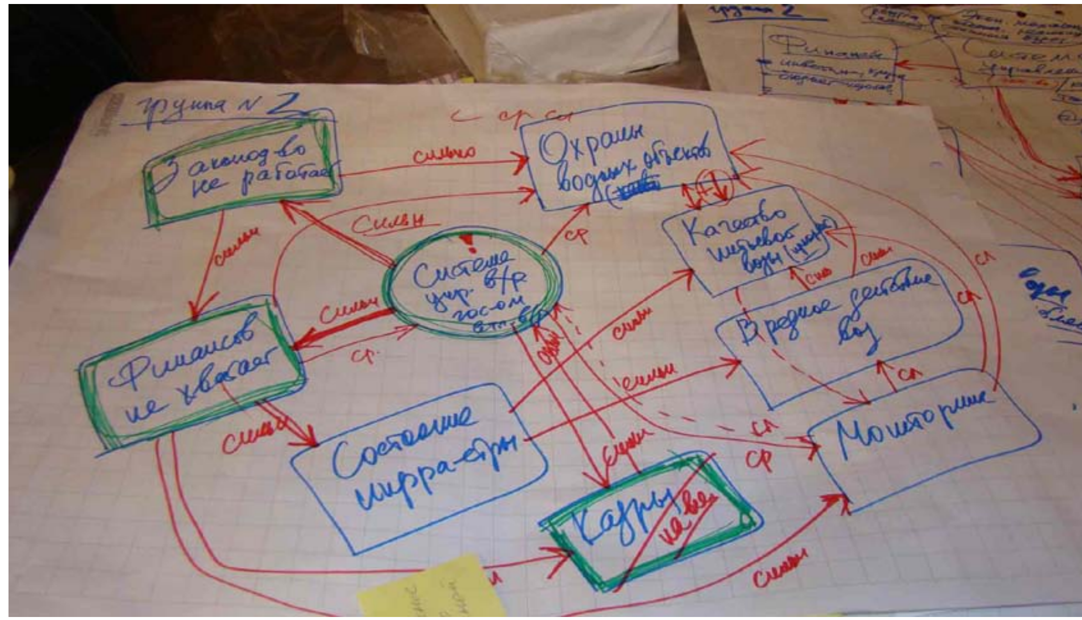
FCM – Brazil example (dynamics)



FCM – Brazil example (link to resilience)



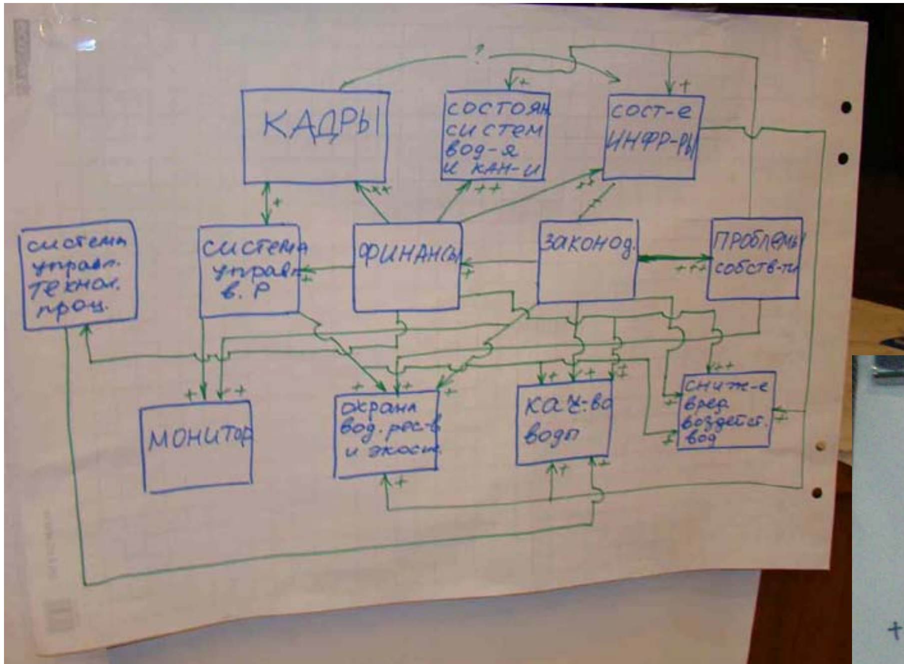
Participatory FCMs – creative process



Crimea - Ukraine

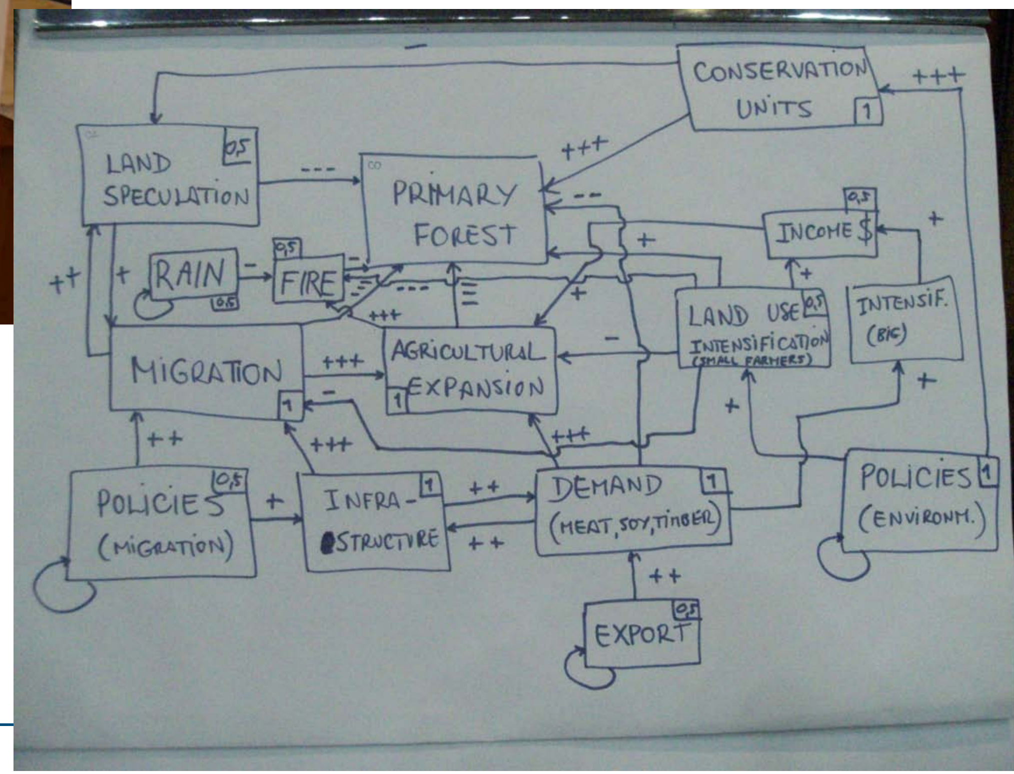
Guadiana - Spain

Participatory FCMs – structured consensus



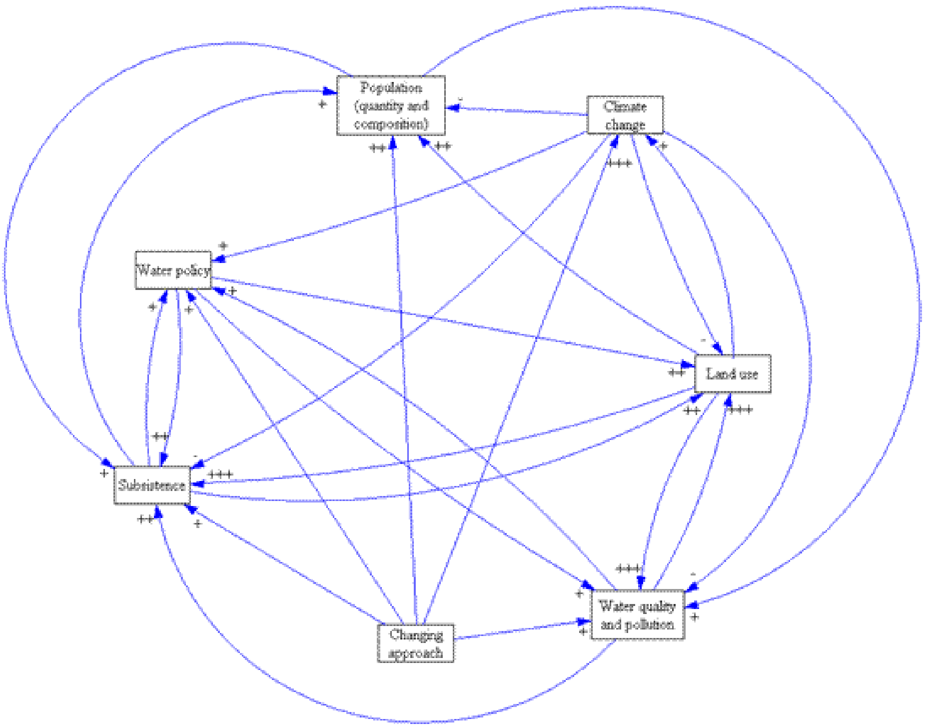
Crimea - Ukraine

Manaus - Brazil

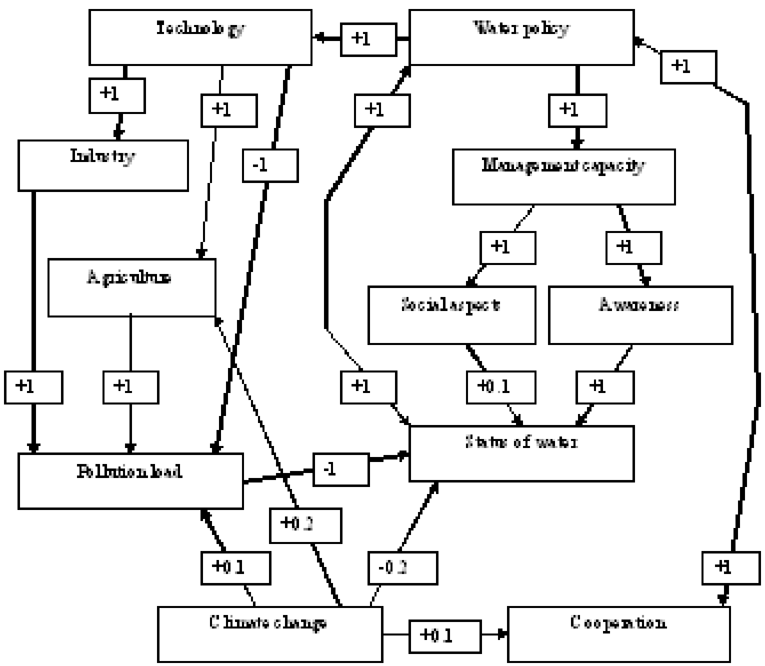


WAGENINGEN UNIVERSITY
WAGENINGEN UR

Participatory FCMs – group model building

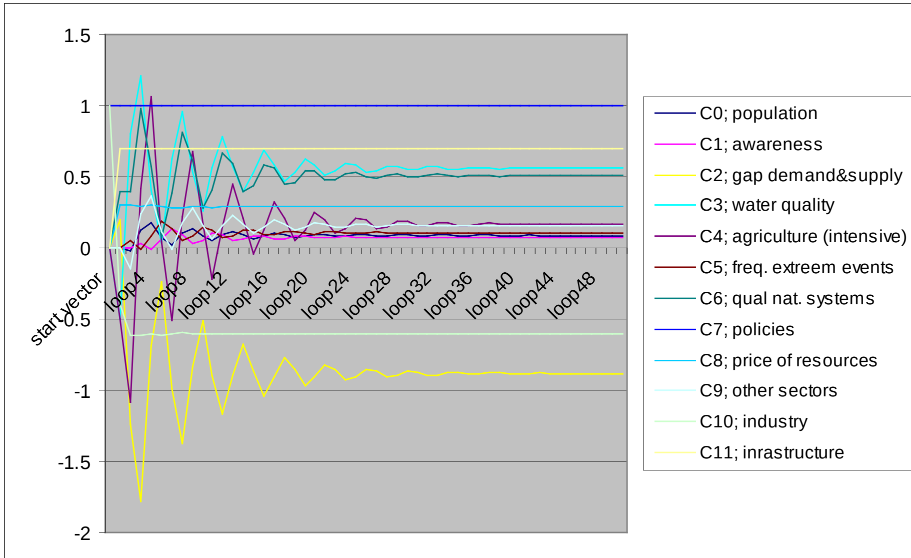


Lower Tisza - Hungary



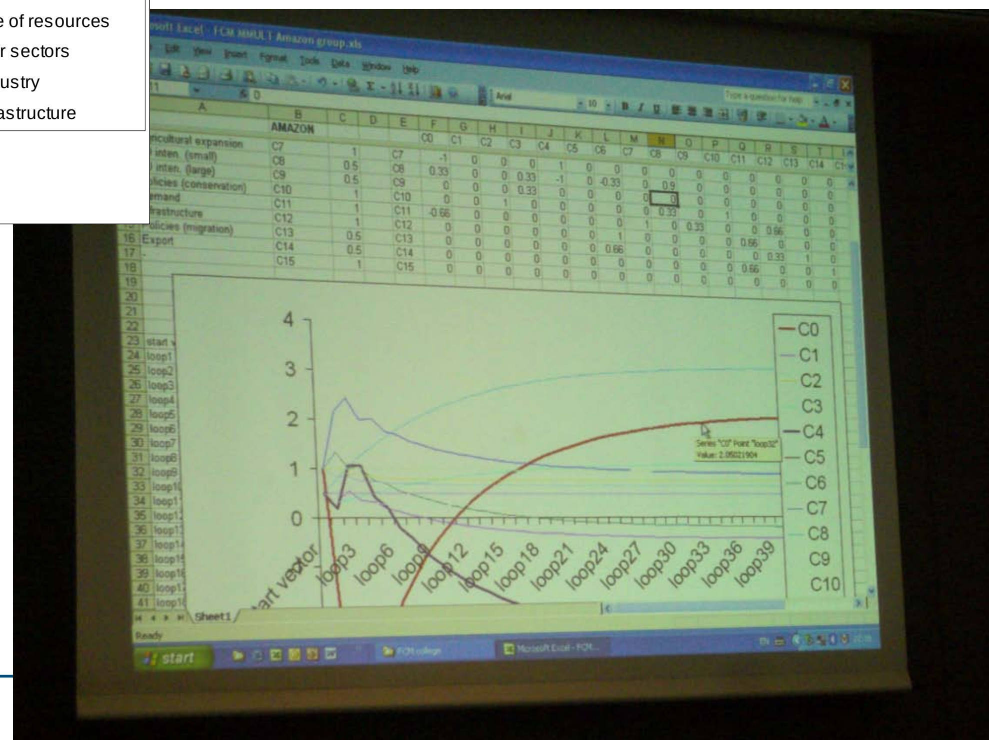
Lake Peipsi - Estonia

Participatory FCMs – dynamic output



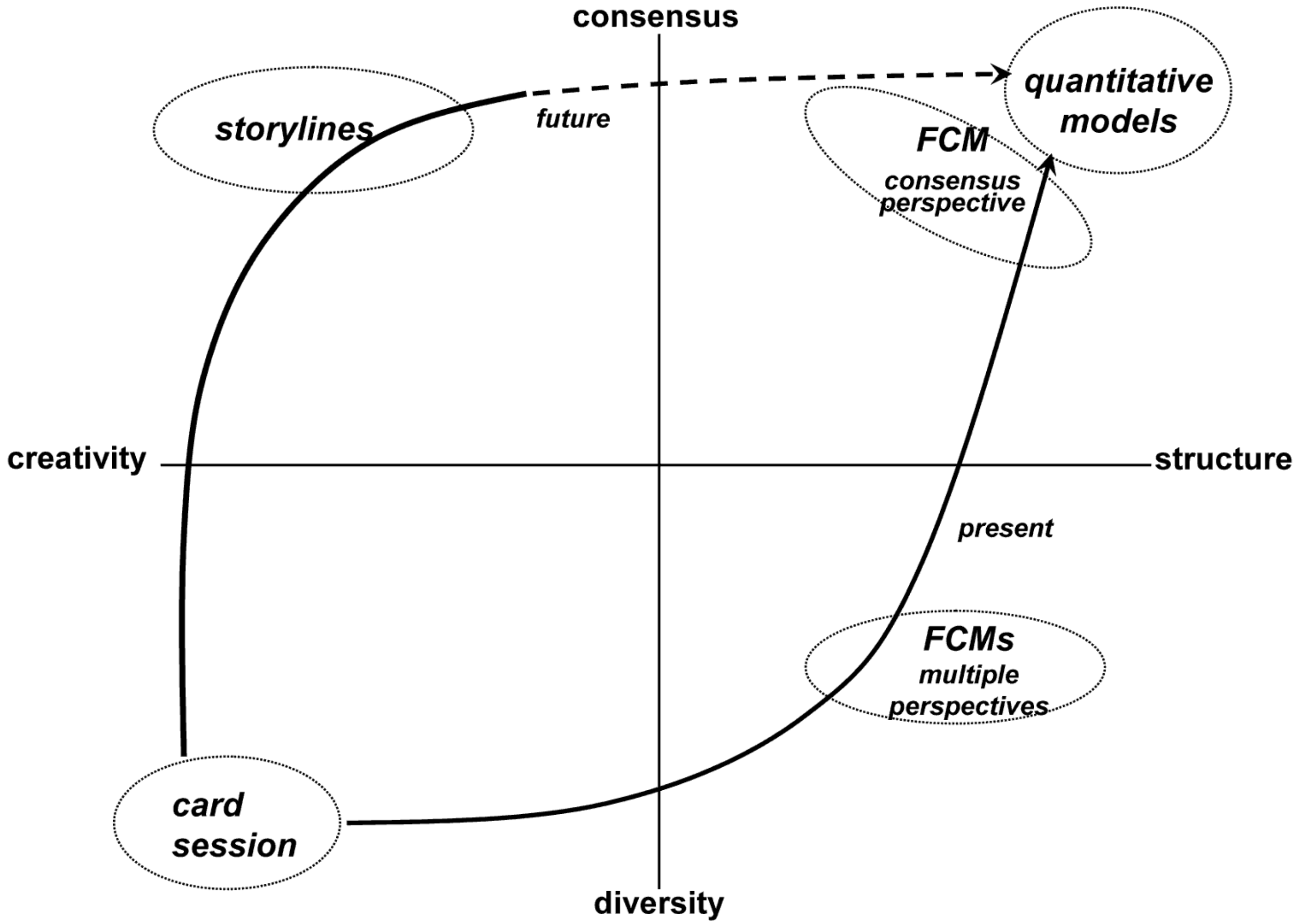
Crimea - Ukraine

Manaus - Brazil



WAGENINGEN UNIVERSITY
WAGENINGEN UR

From FCM to model input



FCM – strong points

- *Easy to develop and apply*. The approach is highly intuitive, it can quickly be explained and applied to any new situation.
- *High level of integration*. A FCM can contain any type of information at any scale.
- *Forces users to be explicit* and facilitates a concrete discussion.
- *Easy insight on effect of impacts*.
- *Focus on feedbacks*. This explicit focus on feedbacks and non-linearities can uncover previously hidden key characteristics of the system.

FCM – weak points

- *Relationships are only semi-quantified*. It is difficult to interpret the output in absolute terms.
- *Incomparable factors are compared*. Comparing social, environmental, and institutional factors with equally weighted semi-quantitative measures is not always possible.
- *Time is ill-defined*. Factors included in the system do not usually all operate at the same temporal scale. FCM does not adequately deal with these time-mismatches.

When the focus is on participation:

- *Too much attention on numbers*. Discussion on weighing factors might hamper the creative process.
- *Being concrete requires expert opinions*. Especially when developing a FCM from scratch requires a high level of understanding of all participants.

Further reading

Kok, K. 2009. The potential of Fuzzy Cognitive Maps for semi-quantitative scenario development, with an example from Brazil. Global Environmental Change 19: 122-133

Van Vliet, M., Kok, K., Veldkamp, T. 2010. Linking stakeholders and modellers in scenario studies; the use of Fuzzy Cognitive Maps as a communication and learning tool. Futures 42(1): 000-000. In press.

Souza Soler de, L., Kok, K., Câmara, G., Veldkamp, T. In prep. Using Fuzzy Cognitive Maps to describe current system dynamics and develop land cover scenarios: a case study in the Brazilian Amazon. Journal of Land Use Science. In press.

Van Vliet, M., Kok, K., Veldkamp, T., Sarkki, S. In prep. Structure in Creativity: Effects of structuring tools on results of participatory scenario development workshops. Environmental Science and Policy. To be submitted.

Kok, K. et al. In prep. Fuzzy Cognitive Maps as a tool to operationalise Competing Claims in Brazil.

Cole, J.R. and Perichitte, K.A. (2000) Fuzzy Cognitive Mapping: applications in education. International Journal of Intelligent Systems 15, 1-25.

Khan, M.S. and Quaddus, M. (2004) Group decision support using Fuzzy Cognitive Maps for causal reasoning. Group Decision and Negotiation 13, 463-480.

Kosko, B. (1986) Fuzzy cognitive maps. International Journal of Man-Machine Studies 24, 65-75.

Özesmi, U. and Özesmi, S.L. (2003) A participatory approach to ecosystem conservation: Fuzzy Cognitive Maps and stakeholder group analysis in Uluabat Lake, Turkey. Environmental Management 31(4), 518-531.

EXAMPLE 3 – NORMATIVE SCENARIOS

Example project
SCENES: revisited

Scenarios: Exploratory and normative

Scenario development in four steps:

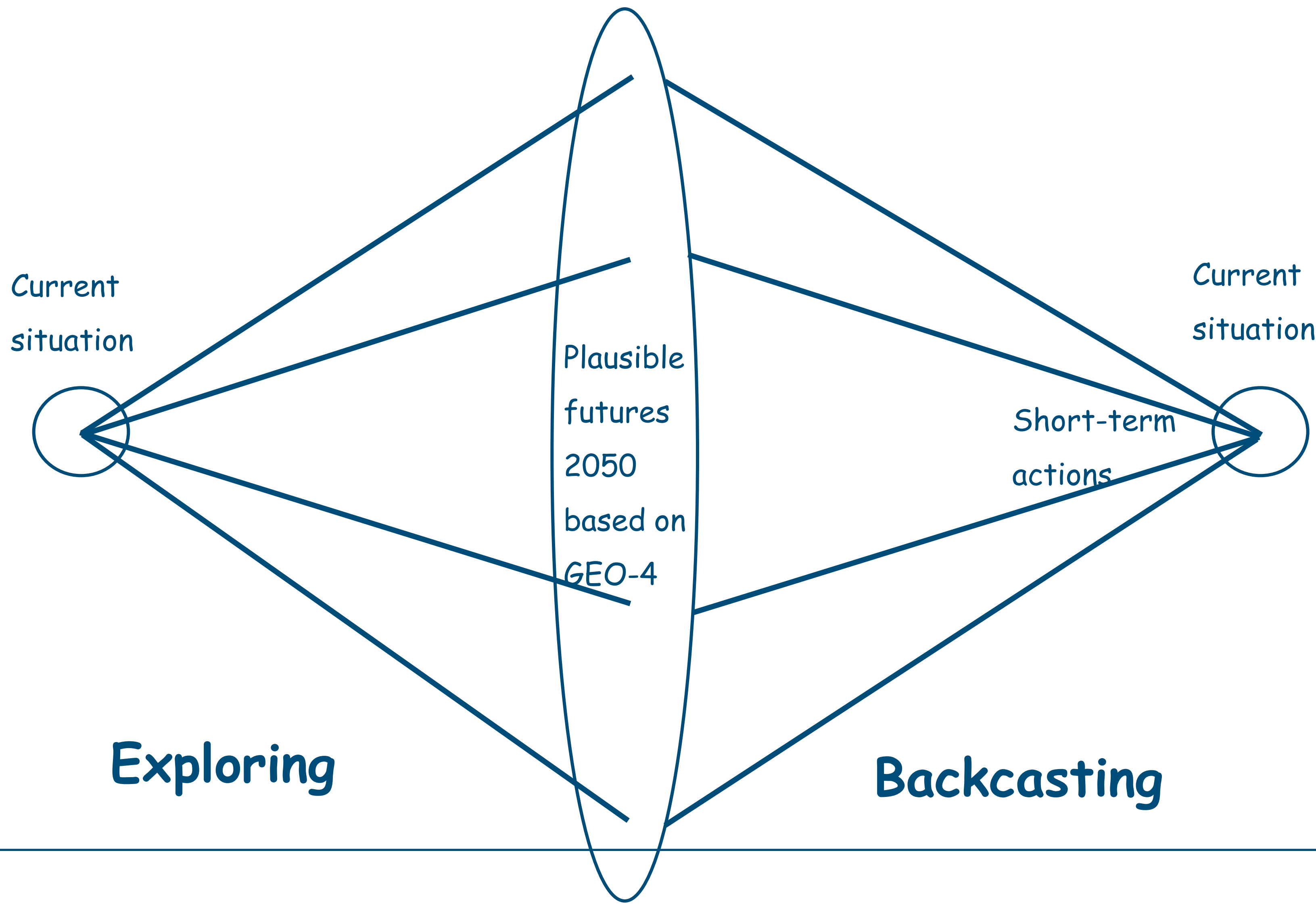
Step 1: agree on main drivers and uncertainties

Step 2: first-order draft of *long-term, diverging* storylines

Step 3: final draft with info from *models*

Step 4: create a set of *short-term, converging* strategies

Scenarios: Exploring and backcasting



Backcasting: a definition

Definition:

Backcasting "involves working backwards from a particular desired future end-point or set of goals to the present, in order to determine the physical feasibility of that future and the policy measures that would be required to reach that point." (Robinson, 2003)

"The emphasis in backcastsing is upon determining the freedom of action, in a policy sense, with respect to possible futures." (Robinson, 2003)

Backcasting: background

AT&T in the 1950s proto-backcasting

Developed in the 1970s for business planning

First successful example Shell in scenario planning end 1970s

Current method developed by John Robinson in the mid 1980s; method has not fundamentally changed since

Robinson sees participative backcasting as the second generation of backcasting studies.

Typically address a perceived societal problem with the aim of finding a real solution → normative

Recent examples of backcasting studies are all related to sustainable transport and/or energy.

Application in SCENES is innovative

Backcasting: background

Method bears similarities with SCENES overall method

(1. develop long-term visions; 2. do backcasting; 3. define action agenda and implementation)

Focus much less on forecasting, stories, and models

Forecasting part is usually 'only' a vision

Vision mostly has normative aspects

Backcasting: key concepts

Test how effective policy measures or other actions are, by evaluating them in a number of plausible futures

Evaluate the plausibility of the storylines that have been used (can the future endstate envisioned in the story be reached with a set of concrete policy measures?)

Identify ultimately a set of (policy) actions that will lead to a more desirable future, independent from the future that is portrayed, i.e. that form a robust strategy.

In other words, translate 4 diverging long term scenarios to one set of robust policy actions.

Backcasting: methodology

A backcasting exercise consists of the following steps in group work:

1. Define a **desirable endpoint**
2. Define desirable intermediate **milestones and objectives**
3. Define **obstacles and opportunities** given the storyline that you find yourself in.
4. Iterate 2 and 3
5. Identify and specify **(policy) actions** that need to be taken
6. Iterate 2-5

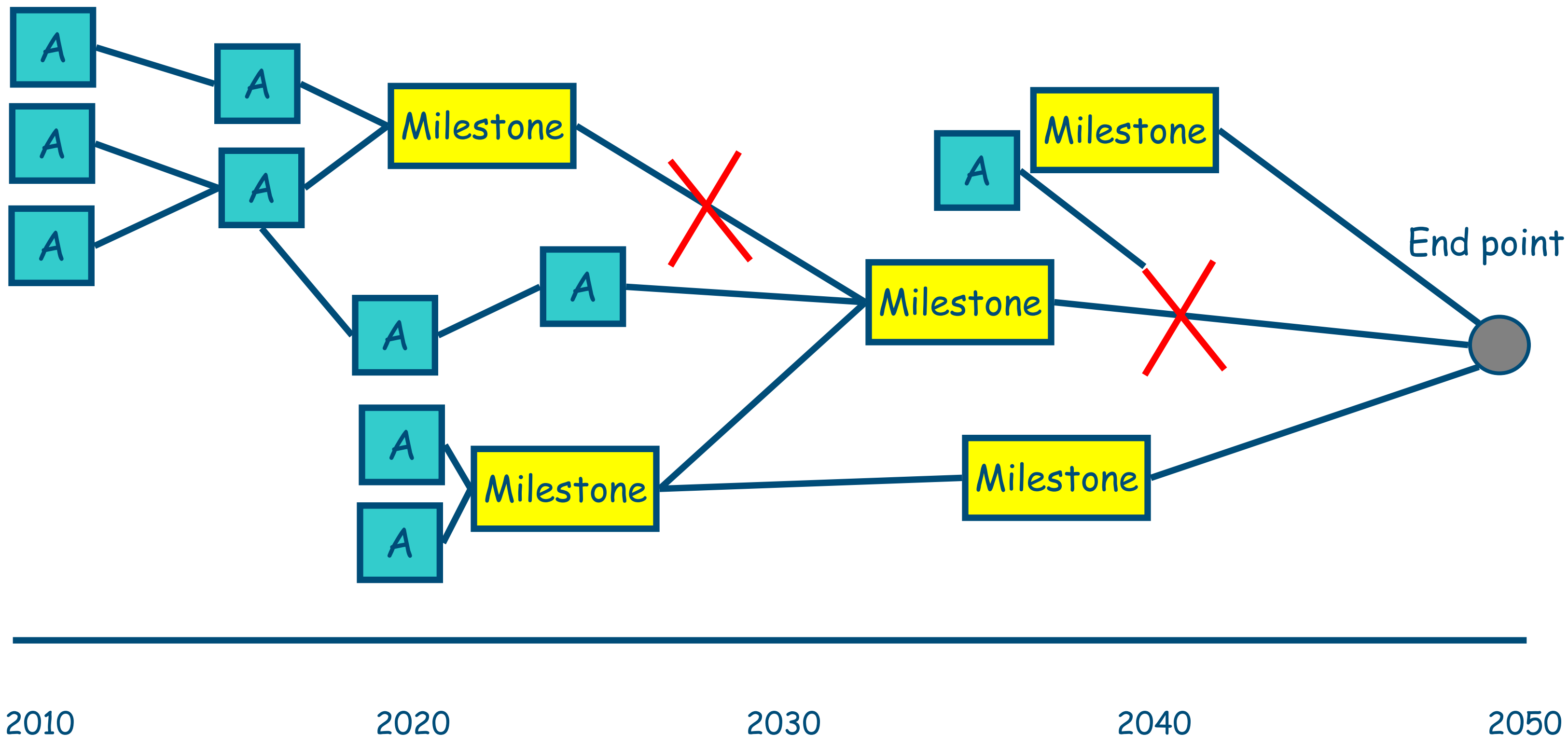
Backcasting: methodology

A backcasting exercise consists of the following steps in plenary:

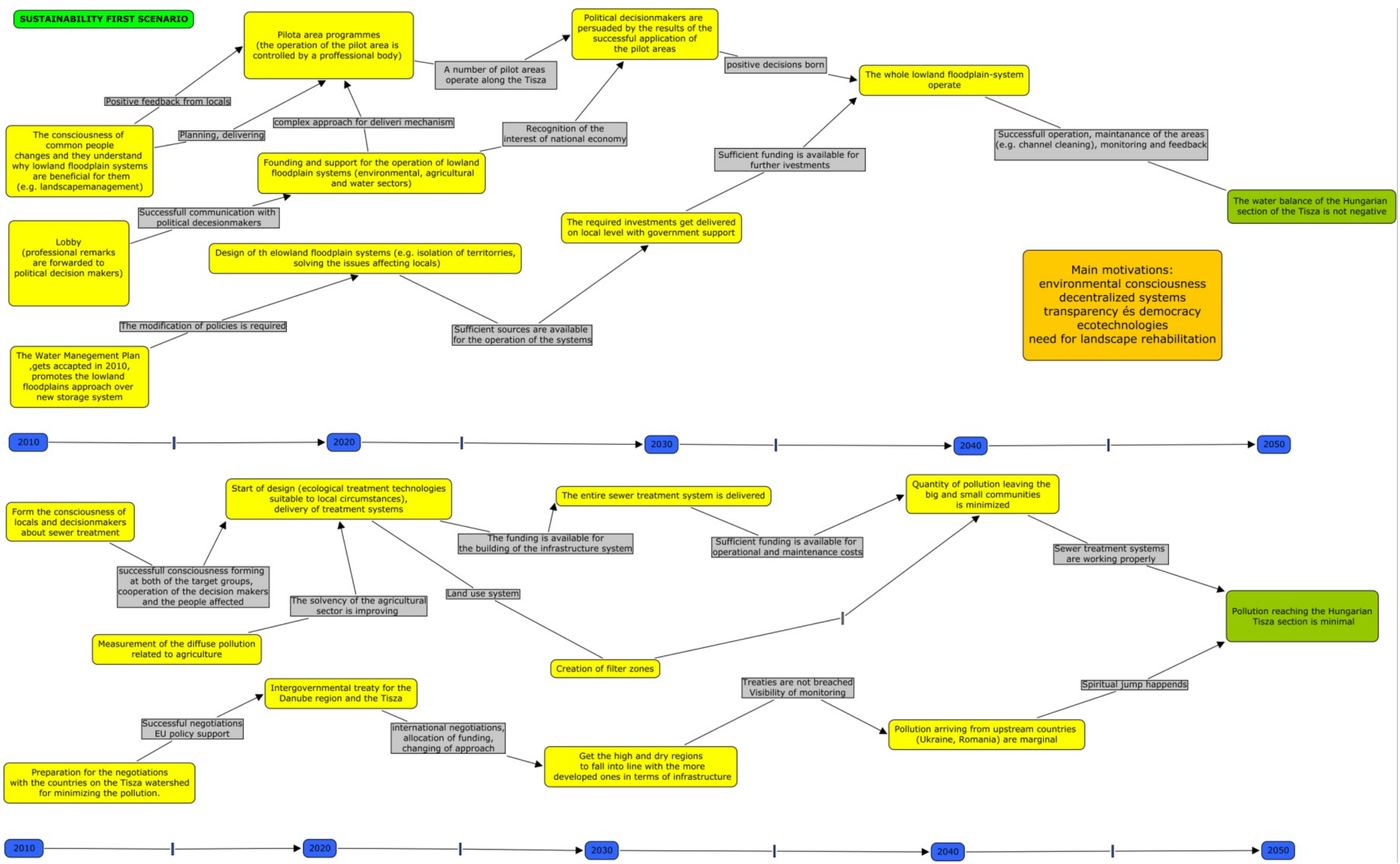
7. **Compare actions** across 4 scenarios and identify similarities and differences

8. **Construct a robust strategy** consisting of (policy) actions that are effective in a large number of backcasting exercises.

Example (hypothetical)



Example Cmap (Lower Tisza)



Conclusions

Conclusions (methods)

- Interdisciplinarity

  Conceptually: always consider multiple disciplines

  Practice: be T-shaped (expertise on certain aspect)

- Multi-scale

  Conceptually: always think multi-scale

  Practice: only when specific research question is multi-scale

- Participation

  Only when specific research questions asks for stakeholder involvement

Conclusions (the role of scenarios)

- Scenarios are crucial in understanding and structuring uncertainty, and therefore in addressing complex problems
- Scale issues are considered but not particularly upscaling of local scenarios deserves more attention
- Scenarios are usually integrated, but the domination of environmental sciences is worrying
- Most exercises include stakeholders
- Models and qualitative products are increasingly combined

Conclusions (tools)

- Models (quantitative scenarios)

  Is an excellent tool, but realise the limitations in flexibility, data availability, involvement of non-experts

- Scenarios (qualitative storylines)

  Is an excellent tool with growing interest, but realise limitations in quantitative results.

- Story-And-Simulation (models and narratives)

  Very resource demanding (time and money). This is normally impossible in any smaller project.

  A growing set of tools is becoming available to maintain level of creativity and diversity without sacrificing structure and exactness

Conclusions (postmodern science)

- We have developed a large number of tools, methods, and approaches
- We have very little knowledge of the actual impact of scientific work. In terms of scenarios, we need to focus research on the scenario quality indicators, particularly
    - Legitimacy (do justice to a wide range of ideas and perspectives)
    - Credibility (recognisable from the present and how plausible is it?)
    - Relevance (to end users; are concerns addressed?)

Background information

Example 1a: www.millenniumassessment.org

Example 1b: www.eururalis.eu; www.cluemodel.nl

Example 2&3: www.environment.fi/syke/scenes

Further reading:

Kok. K. 2009. The potential of Fuzzy Cognitive Maps for semi-quantitative scenario development, with an example from Brazil. Global Environmental Change 19: 122-133

Kok, K., Van Delden, H. 2009. Combining two approaches of integrated scenario development to combat desertification in the Guadalentín watershed, Spain. Environment and Planning B 36: 49-66.

Kok, K., Biggs, R., Zurek, M. 2007. Multi-scale scenario development methodologies. Experiences from Southern Africa and the Mediterranean. 2007. Ecology and Society. 12 (1): 8. [online] URL: http://www.ecologyandsociety.org/vol12/iss1/art8/

Kok, K., Verburg, P.H., Veldkamp, A. 2007. Integrated assessment of the land system: The future of land use. Guest editorial Special Issue Land Use Policy 24(3): 517-520.

Patel, M., Kok, K., Rothman, D.S. 2007. Participatory planning in land use analysis. An insight into the experiences and opportunities created by stakeholder involvement in scenario construction in the Northern Mediterranean. Land Use Policy 24(3): 546-561.

Kok, K., Patel, M., Rothman, D.S., Quaranta, G. 2006. Multi-scale narratives from an IA perspective: Part II. Participatory local scenario development. Futures 38(3): 285-311.

Lebel, L., Thongbai, P., Kok, K. et al. 2006. Sub-global scenarios. Pp. 229-259 in: Capistrano, D., Samper, C.K., Lee, M.J., Rauseppe-Hearne, C. (Eds.), Ecosystems and Human Well-being (Volume 4): Multiscale assessments. Findings of the sub-global assessments working group of the Millennium Ecosystem Assessment, Island Press, Washington.

Questions?