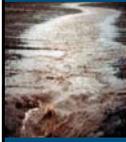


Advances in Land Models



Tom (A) Veldkamp
Head Landscape Centre
Wageningen university and Alterra



With many contributions of chair group



Land Dynamics:

The winding road to sustainable development

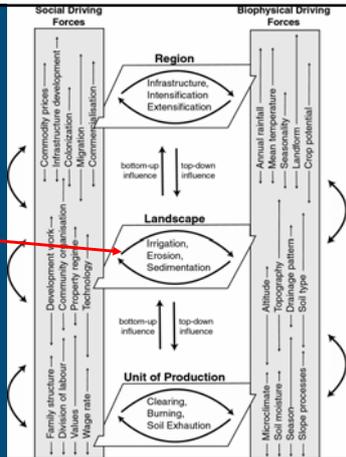
Investigates the spatial and temporal dynamics of coupled human environmental (social ecological) systems. It requires:

- Integrated β - γ approaches with stakeholders.
- Spatially explicit system approaches
- Exploration of temporal dynamics
- Methodologies that allow stakeholder participation (scenarios with trade-off's, visualizations for decision support, etc)

LAND as coupled human-environmental system

Alternatively 'Socio-Ecological Systems' is used

- Relationships contain feedback loops
- Not only human response
- Also biophysical response



Coupled human-environmental systems



- Human decisions and actions affect the environment. This typically happens at landscape level

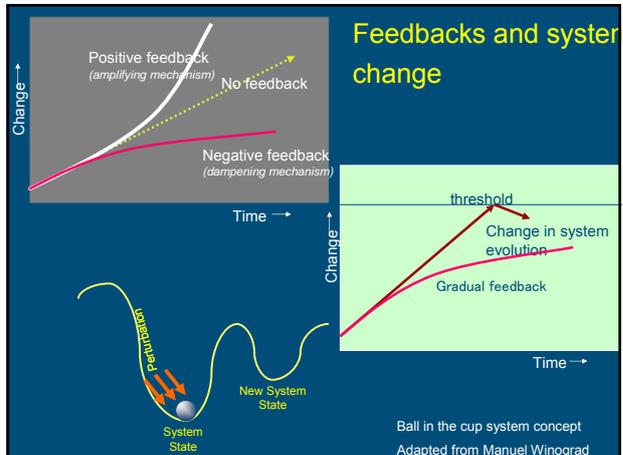


Coupled human-environmental systems



- Changed environmental properties affect decisions future use
- Perceived changes in the environment are at least equally important .

Feedbacks and system change



Ball in the cup system concept
Adapted from Manuel Winograd

Studying the interaction of soil-landscape and land use/cover systems

- First modeling experiments
- Linking a land use/cover change model (CLUE) and a dynamics soil-landscape model (LAPSUS)

What is CLUE?

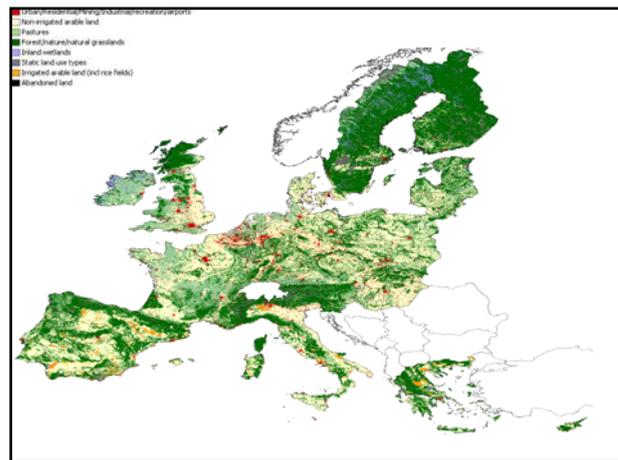
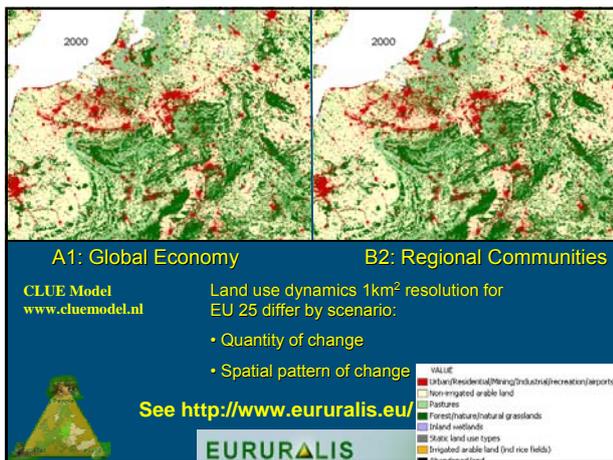
CLUE is methodology to model near-future changes in land use patterns

CLUE is a hybrid methodology, combination of:

- Cellular Automata
- Markov Chains
- Decision Rules
- Statistical Analysis

Specification dependent on scale processes, case study

<http://www.cluemodel.nl>



LAPSUS Modelling framework

'Landscape Process modelling at multi dimensions and scales'

→ Simulation of erosion and sedimentation:

- surface water run-off -on
- tillage translocation
- land slides and mudflows

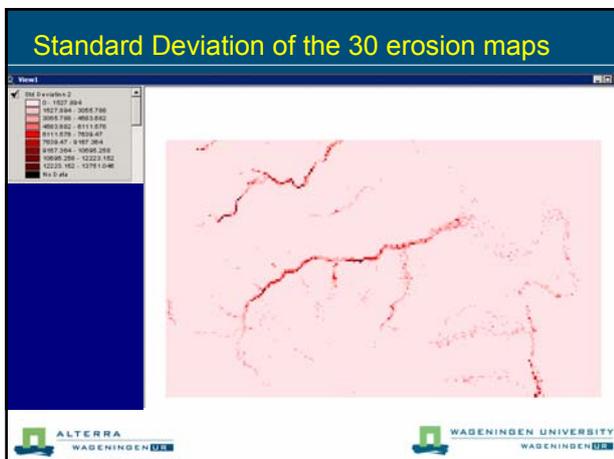
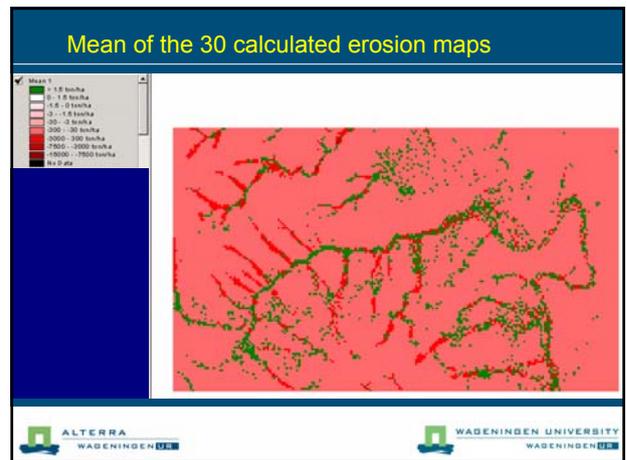
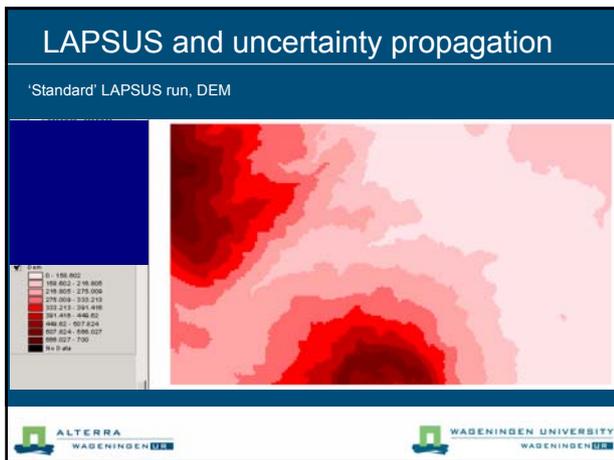
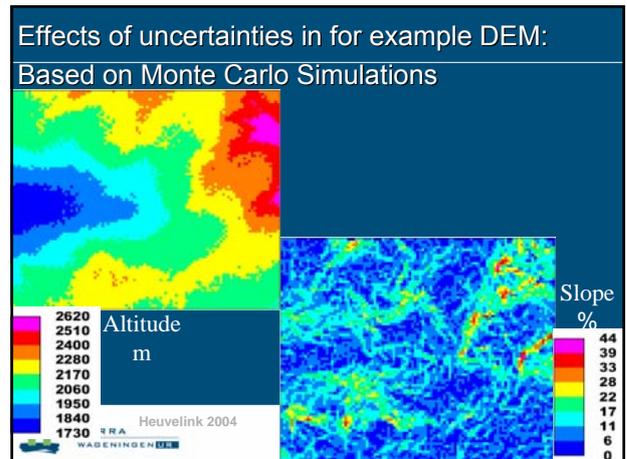
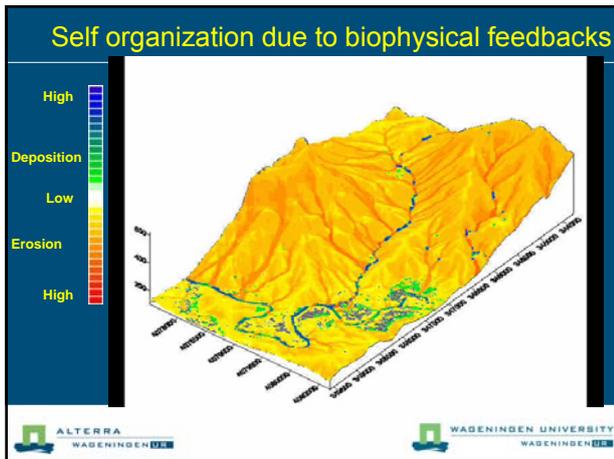
Dynamic, adaptation of DEM and soil properties between time steps



Laboratory of Soil Science & Geology

Overland flow erosion, tillage, and landslides in a field

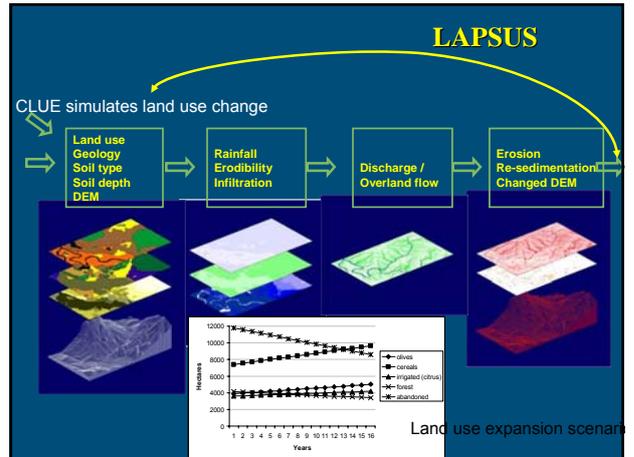
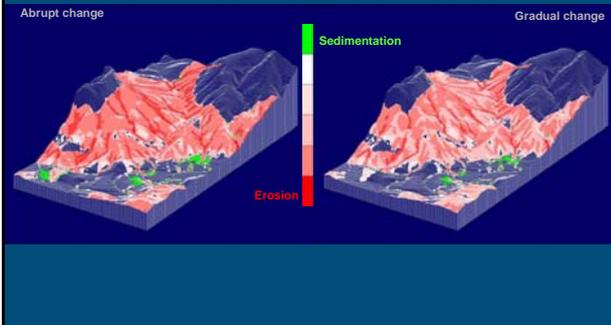




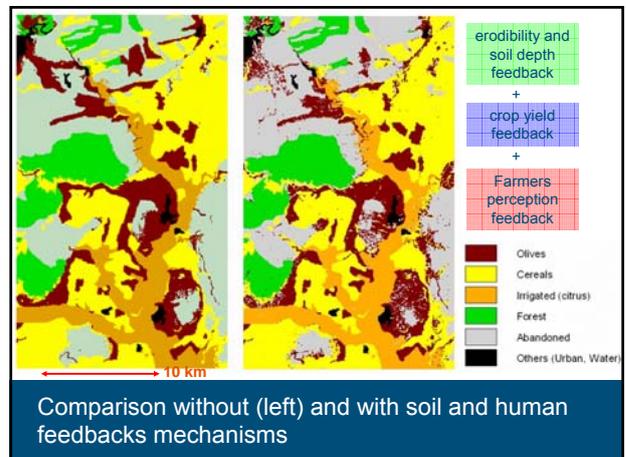
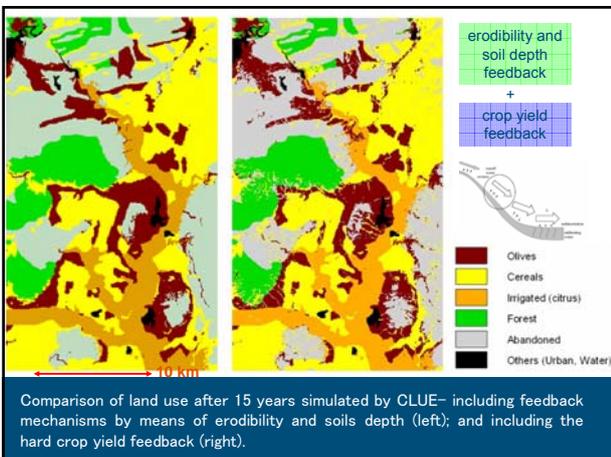
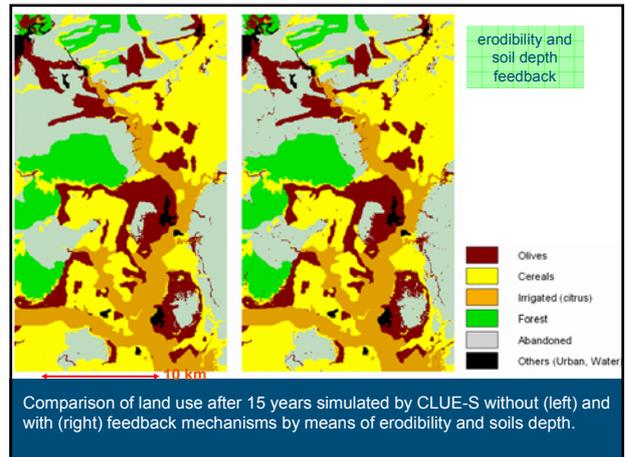
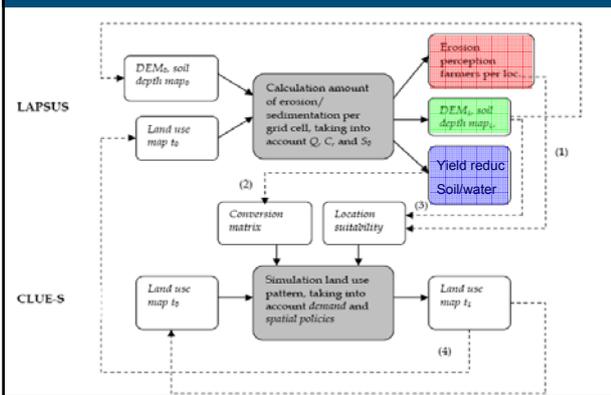
Preliminary results

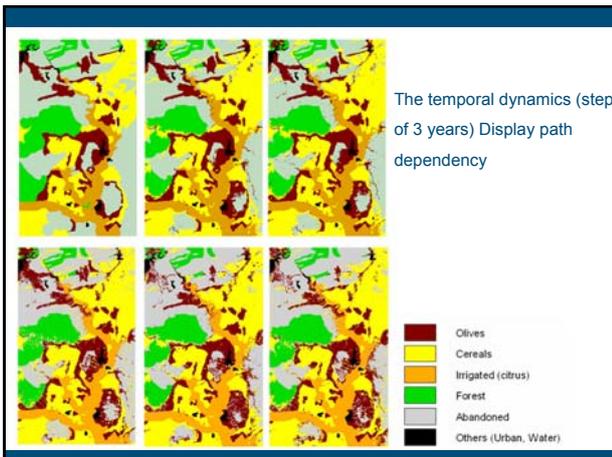
- Endogenous feedbacks can be very important in determining the spatial pattern of land and soils
- This enhances the path dependency
- Uncertainty and error propagation matters
- Research is needed to research these endogenous feedbacks in the land system

Dealing with temporal dynamics: Effect of rate of land use change

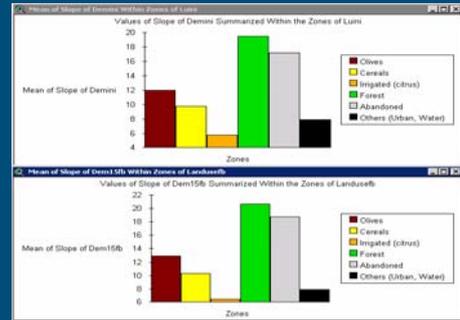


Coupling LAPSUS and CLUE model





Did the adaptation (feedback) led to better land manager

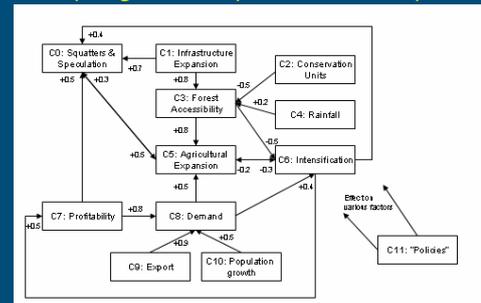


No: The mean slopes for the agricultural land use types which are expanding according to the scenario, are steeper after 15 years, despite adaptation strategy of farmers. Quantity push/pull matters!!!

Validation is a still unresolved problem for self organizing models

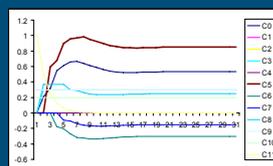
- Feedback simulation is complex and requires ensemble approaches
- Interactions and behavior are difficult to quantify and validate (in space and time)
- Feedbacks are essential, causing path dependence -> **New scenario approaches**

Scenario development with feedbacks: Fuzzy Cognitive Maps - Brazil example

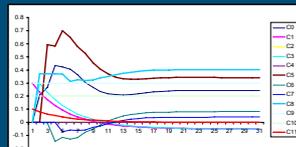


FCM - Brazil example

No policies:



Termination
Infrastructural plans:



Fuzzy Cognitive Maps - 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.

When the focus is on participation:

- *Too much attention on numbers.*
- *Being concrete requires expert opinions.*



Conclusions & recommendations

- *"All models are wrong, but some are useful" – W. Edwards Deming*
- We have to explore non-linearities and feedbacks more explicit
- FCM is a promising scenario development tool
- Still many 'model translation' problems
- Ultimately we need increased model legitimacy as support multiple stakeholders 'Scaling and Governance' dilemma.



<http://www.lad.wur.nl>

Thank you



E. Cocher

Land Dynamics:

The winding road to sustainable development

