


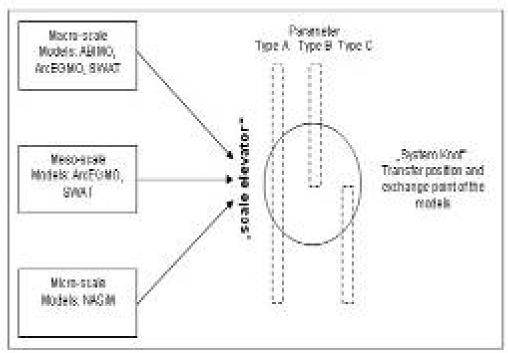



Introductory Lecture:
Landscape Management and Modeling

Martin Volk, Sven Lautenbach, Ralf Seppelt

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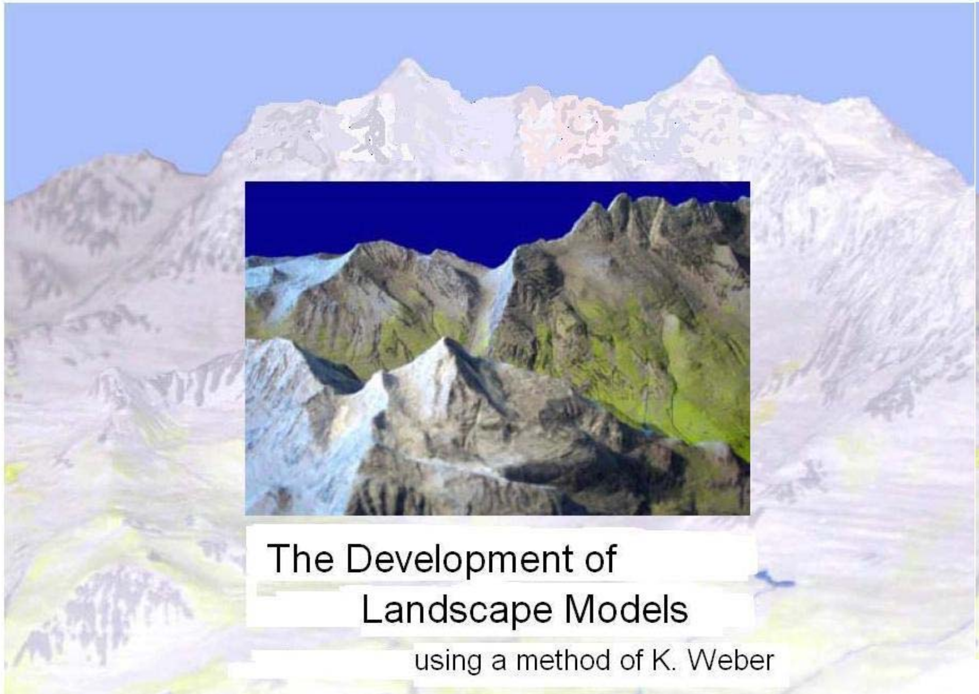
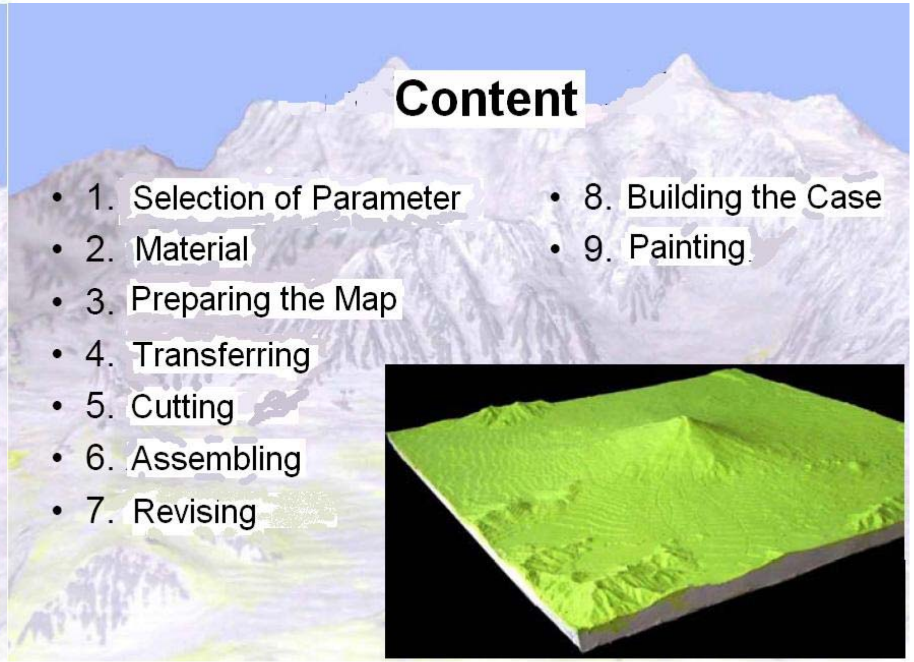
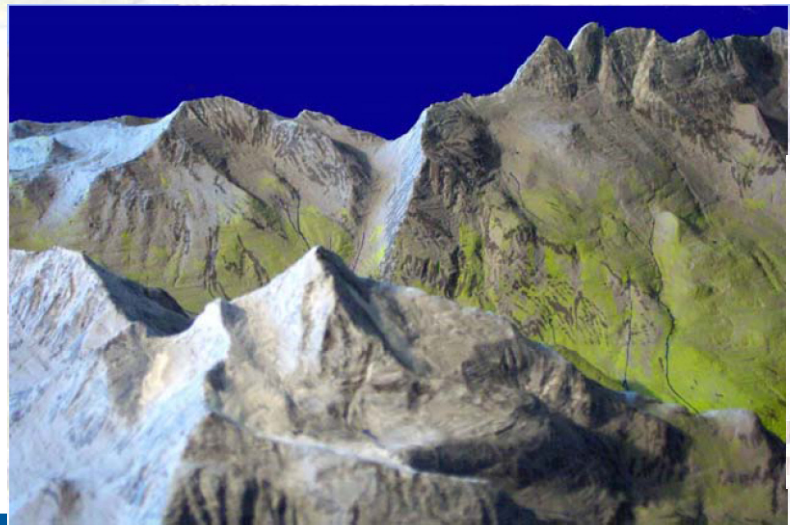
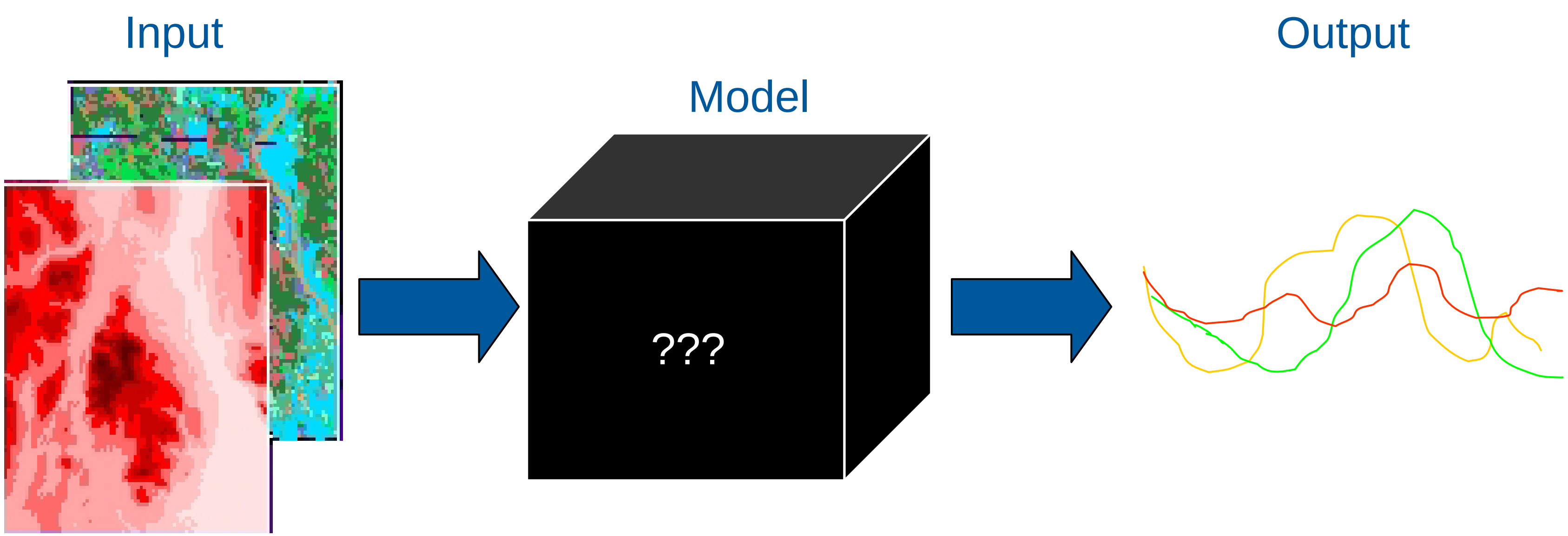
A Model Perspective…







Why use any models?

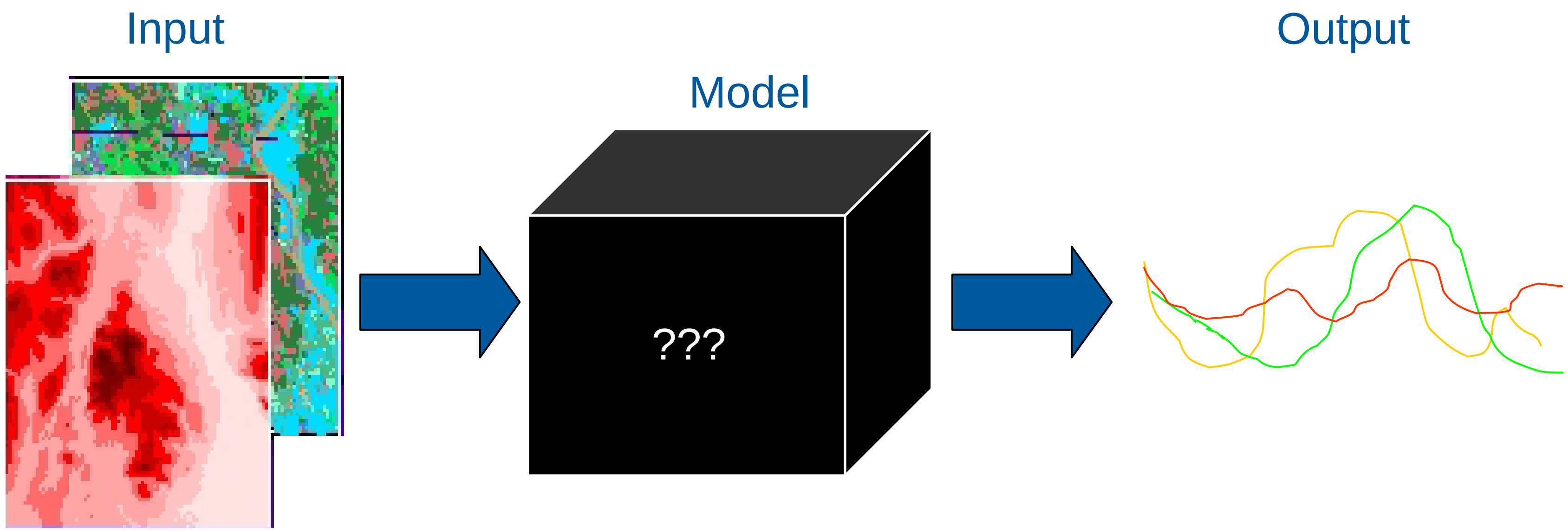


- Models help us to generate or test hypotheses.
- To formally organize ideas or data.
- To provide a framework for making comparisons.

- Identify areas of understanding
- Identify range of variability
- Identify sensitive parameters

(modified from lectures by Scheller and Mladenoff)

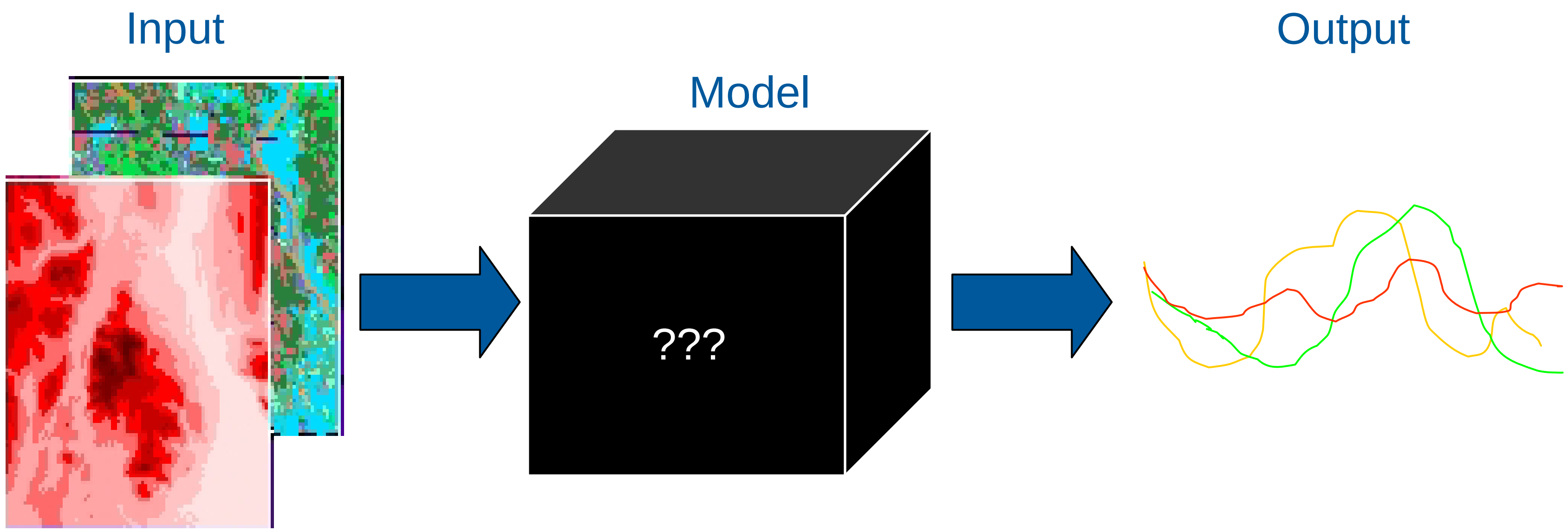
Why use any models?



- To interpolate or extrapolate understanding, often across scales.
- Management applications – make predictions or test different management scenarios.
- To explore scenarios where experiments are not easily conducted or sometimes impossible.

(modified from lectures by Scheller and Mladenoff)

Why use landscape-scale models?



Spatial and temporal constraints on landscape studies

- Experiments on large areas are difficult.
- Even more difficult to replicate experiments or even "sample" and analyze replicates.
- Many large-scale processes operate slowly, so landscapes also change slowly.

Three Model Types

Operationally, useful to think of three general types of landscape-scale models

- Neutral Models
- Landscape change models

  Land cover classes, ecosystem types, or habitats

  Influenced by natural or anthropogenic processes

  Includes *landscape process* models
- Individual-based models

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Three Model Types

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Challenges

"…lack of data.."

"...model components for land-use decision making..“

"…feedback effects on the model behaviour...“

"…processes related to urbanisation..“

"…forest and water management..“

"…open software frameworks such as OpenMI..“

„…landscape services still lacking …“, „

„…too much focused on land cover patterns .. or .. strongly sector-oriented“

„…interactive visualization tools should be used..“

„…methodology of optimization to inform scenario elaboration and evaluate trade-offs among environmental measures and management alternatives..“

"..efficiency of measures, pharmaceuticals, priority substances,.."

and

………models are not often used in „practice“…

de Groot 2010; Gaucherel and Houet 2009; Schaldach and Priess 2008; Volk et al. 2010, etc.

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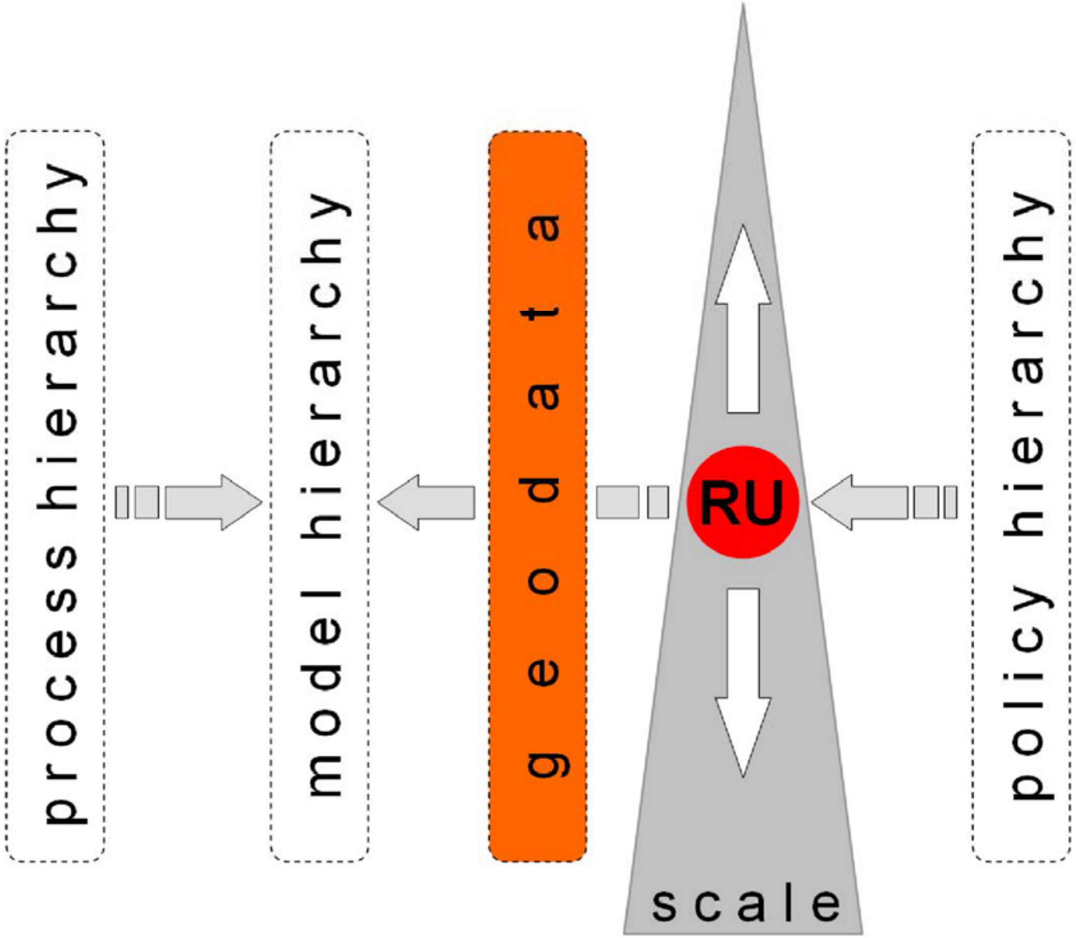
The scaling elevator



Volk et al. 2010

A conceptual framework for the scale-specific modeling of landscape related processes against the background of policy, process and model hierarchies (RU = reference unit).

Some examples

Example 1

A quantitative review of ecosystem service studies

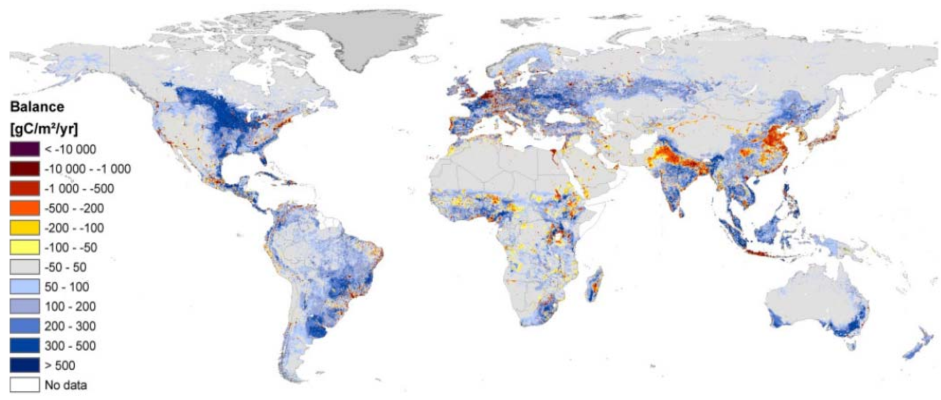
Seppelt, R. et al. (2011)

On the relation of ESS and land use conflicts

Land, as limited ressource provides

- space for living, infrastructure, protection sites
- products, food, fibre, ..
- ecosystem functions, pollination, soil fertility, bio control, water purification, habitat, ...

...always a limited set of *ecosystem service.*



Human NPP Appropriation

Haberl et al. (2007, PNAS)

- 15.6 Pg C/yr or 23.8% of potential net primary productivity
- 53% harvest,
- 40% land-use-induced productivity changes,
- 7% by human-induced fire

Agriculture (1961-1999)

Green et al. (2005, Science)

- 12% increase in cropland
- 10% rise in permanent pasture
- Increase of 106% of overall food crop yield per unit area
- 97% rise in the area of land under irrigation,
- 638%, and 854% increase, in the use of fertilizers and pestizides

Recent discussion on Ecosystem Services

Variety of regional projects:

•National Captial Project (US)

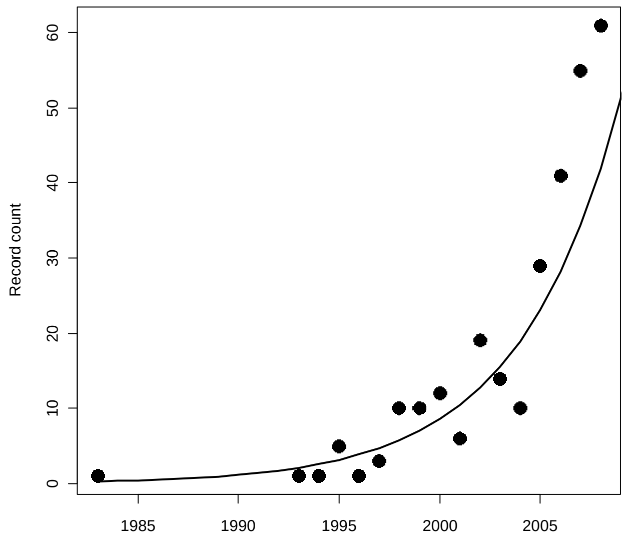
•UK Defra: Natinal ESS accounting

•Valuing the arc, Tansania

•TEEB

•Conservation International

•MA follow up



No. of studies in web of science with „ecosystem service“ only in title

Controversive discussion

•Biodiversity – Ecosystem services

•Ecosystem Services – Human Well being

Variety of methods, models, tools and aproaches…

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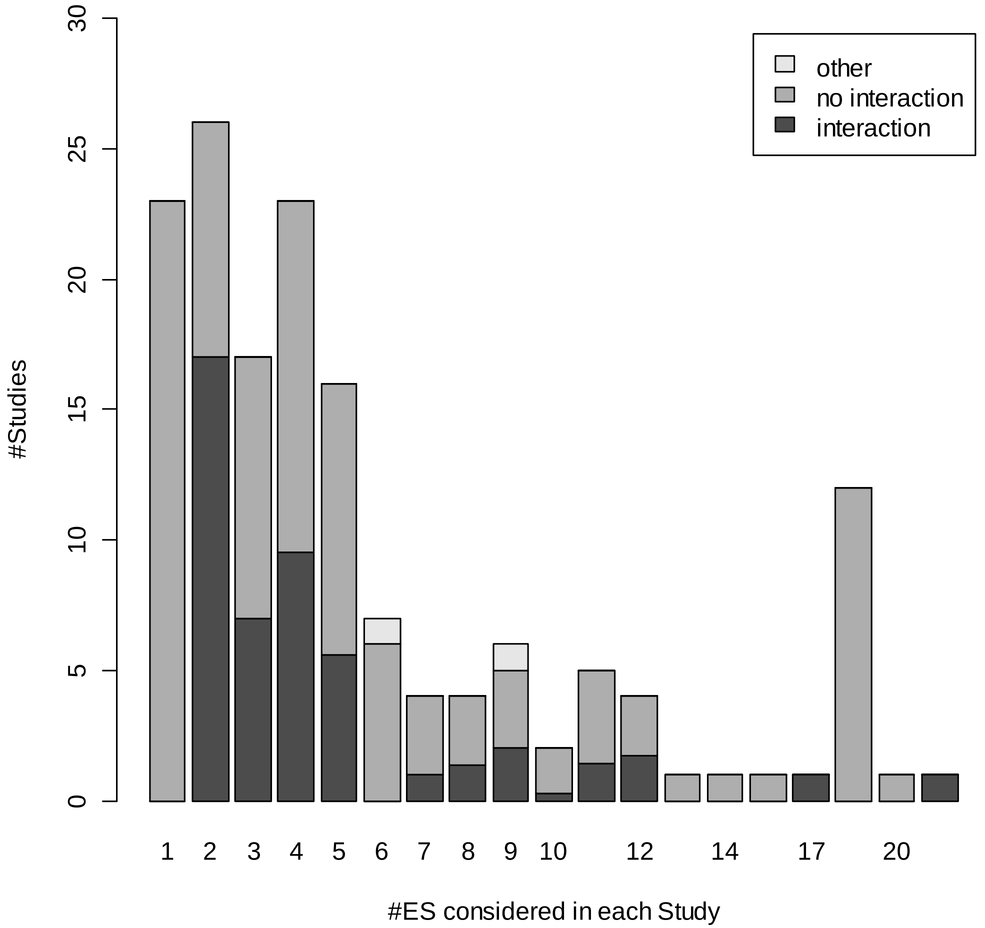
Quantitative Review: Ecosystem Service Studies

- wide variety of approaches
- lack of consistent methodology
- frequent use proxy variables
- observations or measurements (< 40%)
- secondary data (>60%)
- models based assessments (<25%)
- without considering any feedbacks (>50%)
- scenarios (30%)



Seppelt et al. (2011, JApplEcol)

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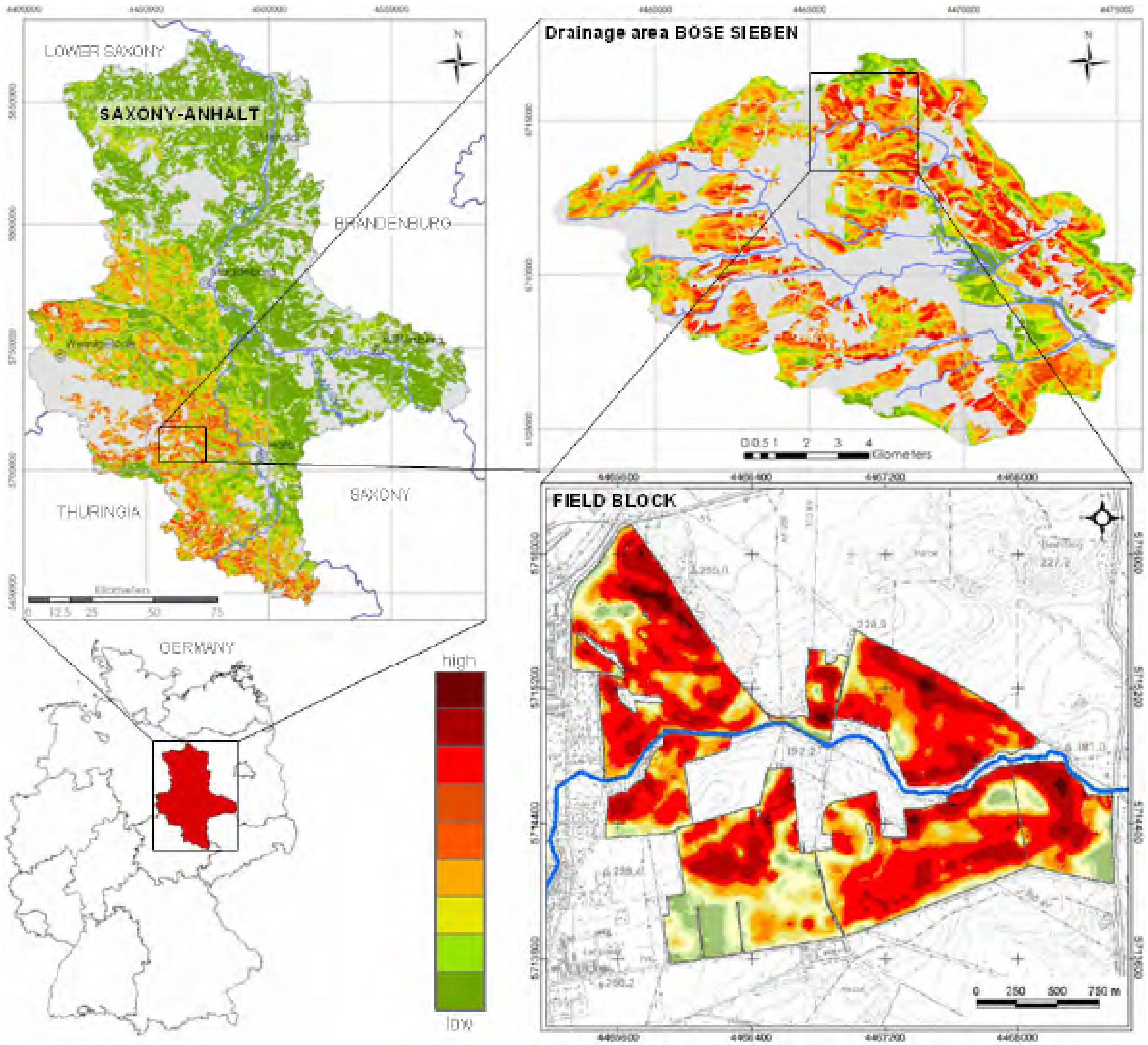
Example 2

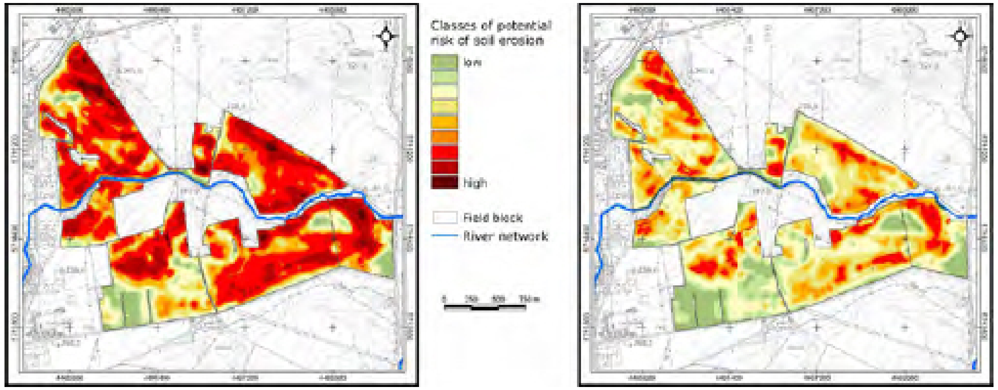
A pragmatic approach for soil erosion risk assessment within policy hierarchies

(ESS: Soil protection, water availability, food production)

Volk, M. et al. (2010)
Möller, M., Volk, M. (2010)
Wurbs, D. et al. (2010)

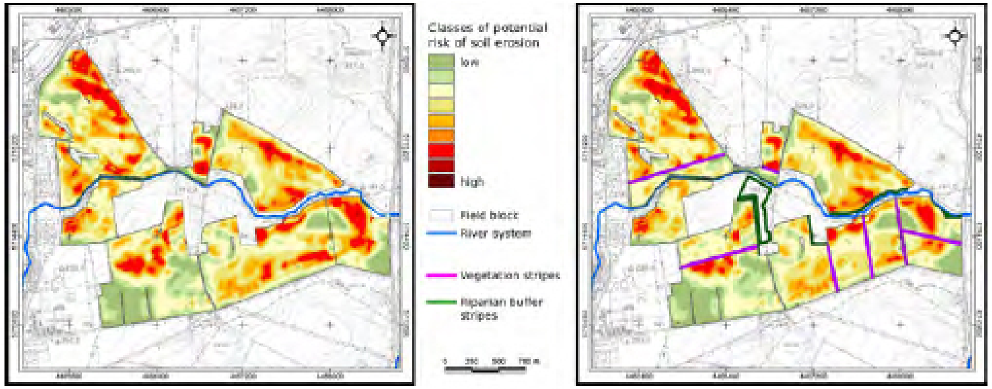
Potential soil erosion risk (hierachical approach)



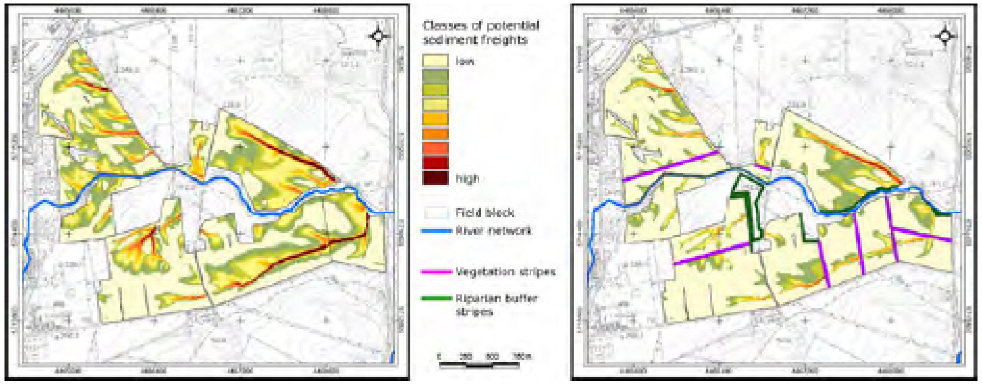


1a. Reduction of soil loss:

Change of conventional (left)
to conservation tillage (right)



1b. Conservation tillage (left) and additional establishing of vegetation strips and riparian buffer strips (left)



2. Reduction of sediment loads and sediment entries:

Conservation tillage (left) and additional establishing of vegetation strips and riparian buffer strips (left)

Example 3

Integrated ecological-economic modelling of water pollution abatement management options (RBM)

Volk, M. et al. (2007)
Volk, M. et al. (2008)
Volk, M., Liersch, S., Schmidt, G. (2009)
Volk et al. (2010)

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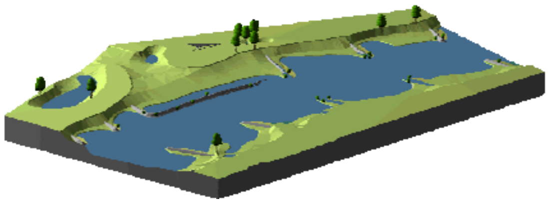
Interactive Landscape Models

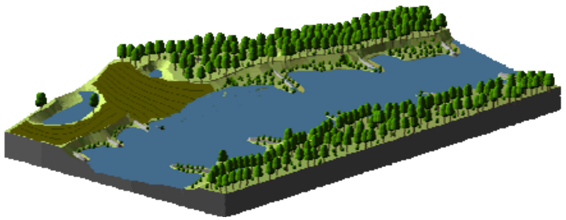
Development of land use and management scenarios on three different scales in the Ems catchment, Germany

Scale-specific models (and measures), knowledge base, visualisation

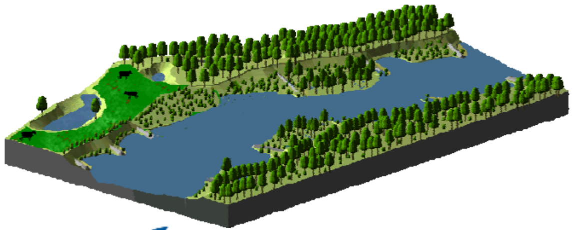
Recent



Scenario A



Scenario B



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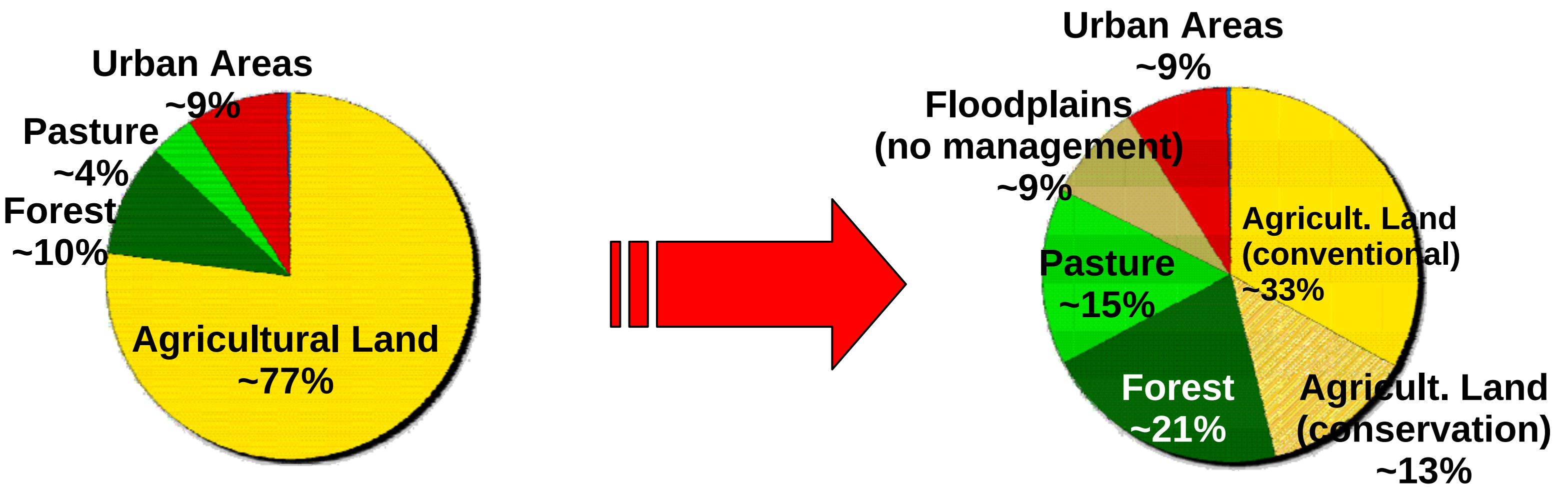
Recent State and final Scenario

Drastic land use and management changes are necessary to achieve the objectives of the WFD in the region



→ **Implementation unrealistic**

(To take the management out of the floodplains would cost around 500 Euro/ha ~ 30 Mio. Euro)

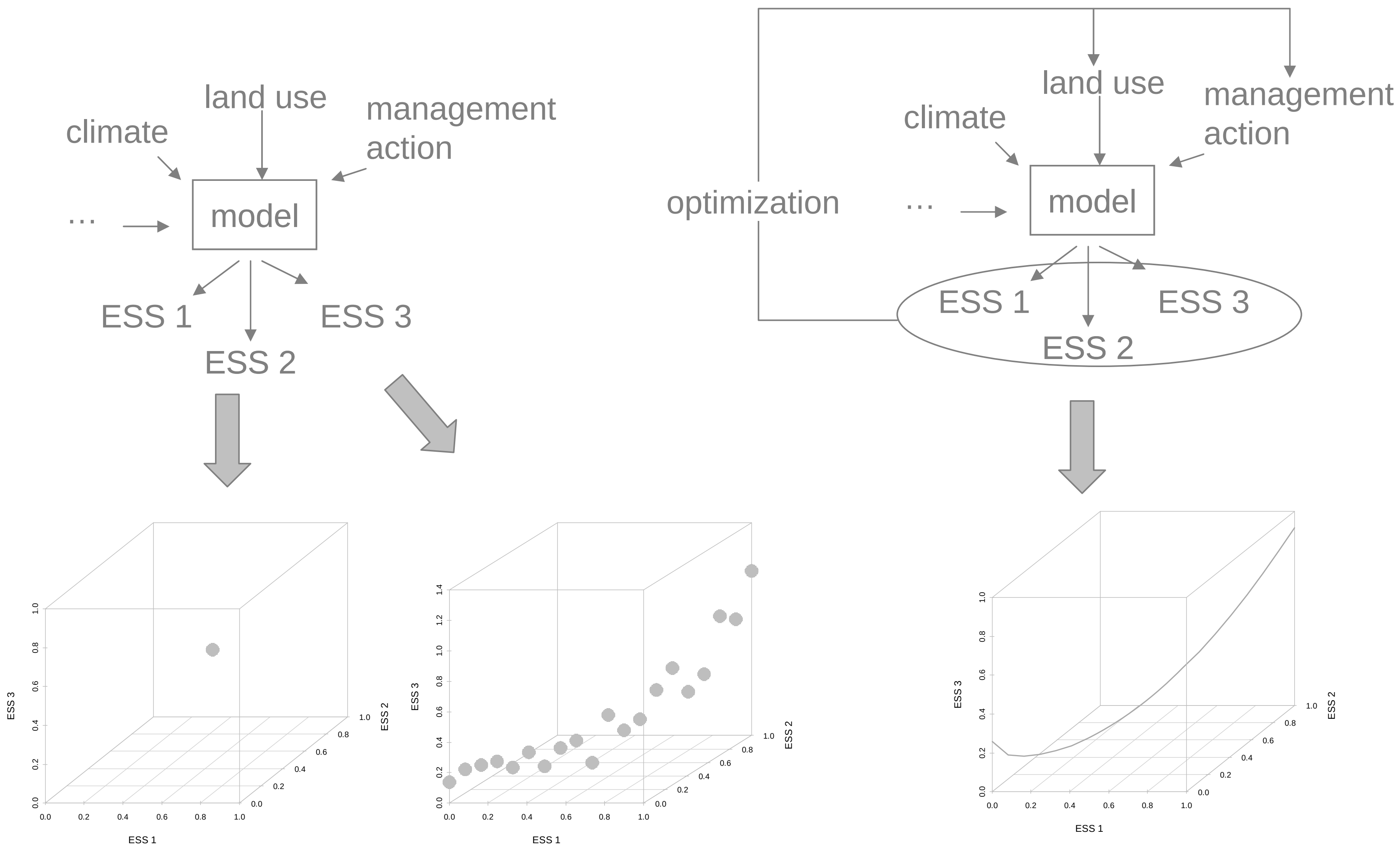
→ Designation as heavily modified and artificial water body

Example 4

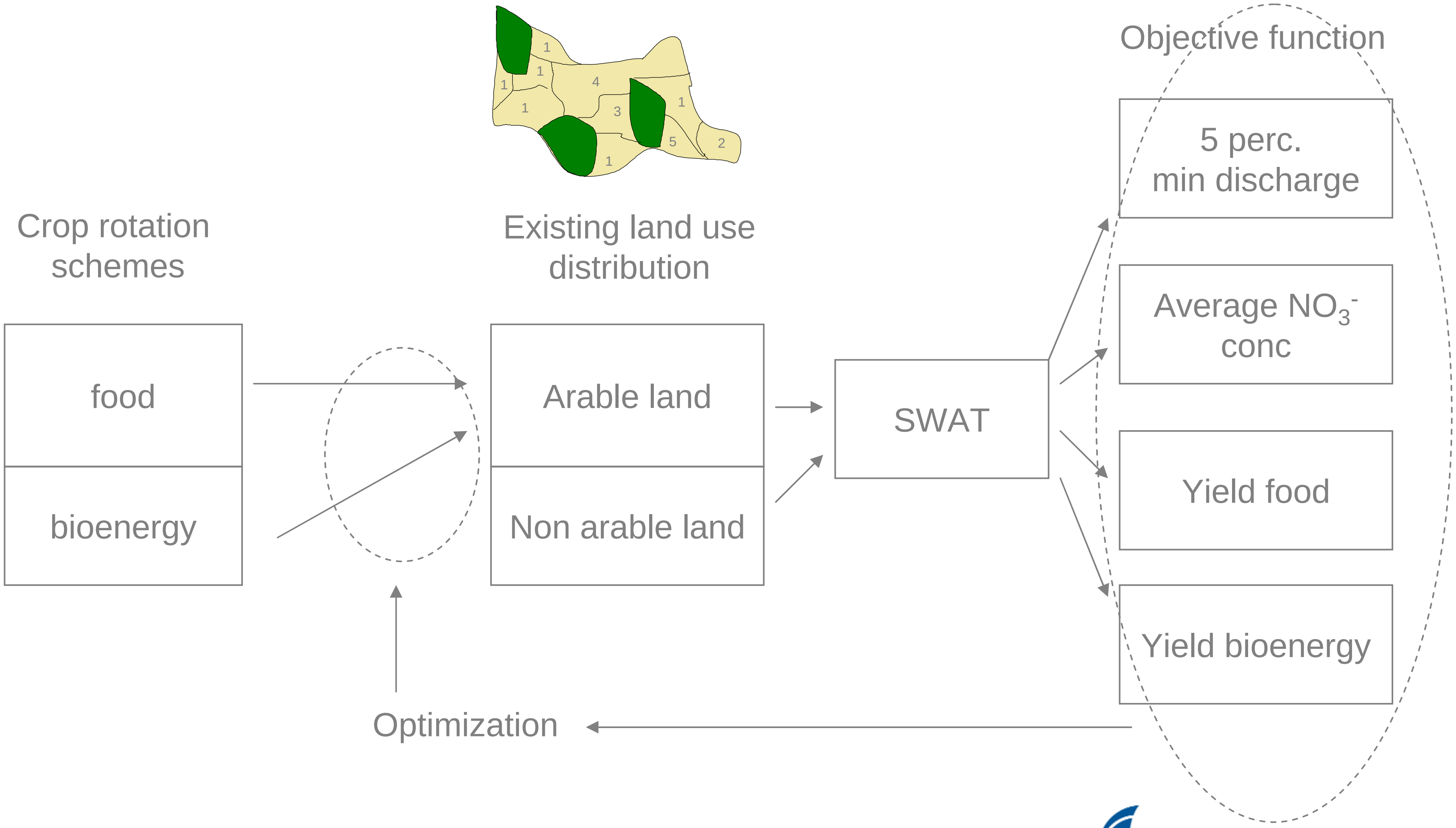
Quantifying trade-offs between bioenergy production, food production, water quality and water quantity

Lautenbach, S., Volk, M., Strauch, M., Whittaker, G. (2011)
Lautenbach, S., Whittaker, G., Volk, M., et al. (in prep.)
Whittaker, G. et al. (2010)

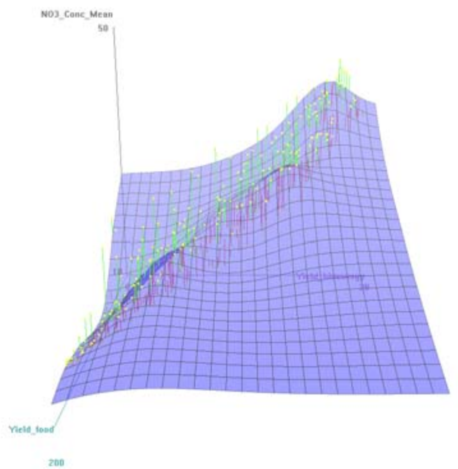
From model results to management support?

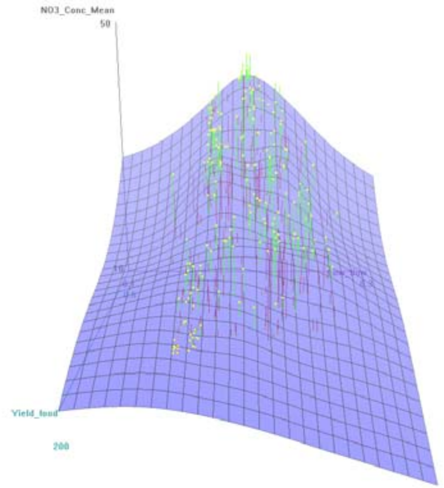


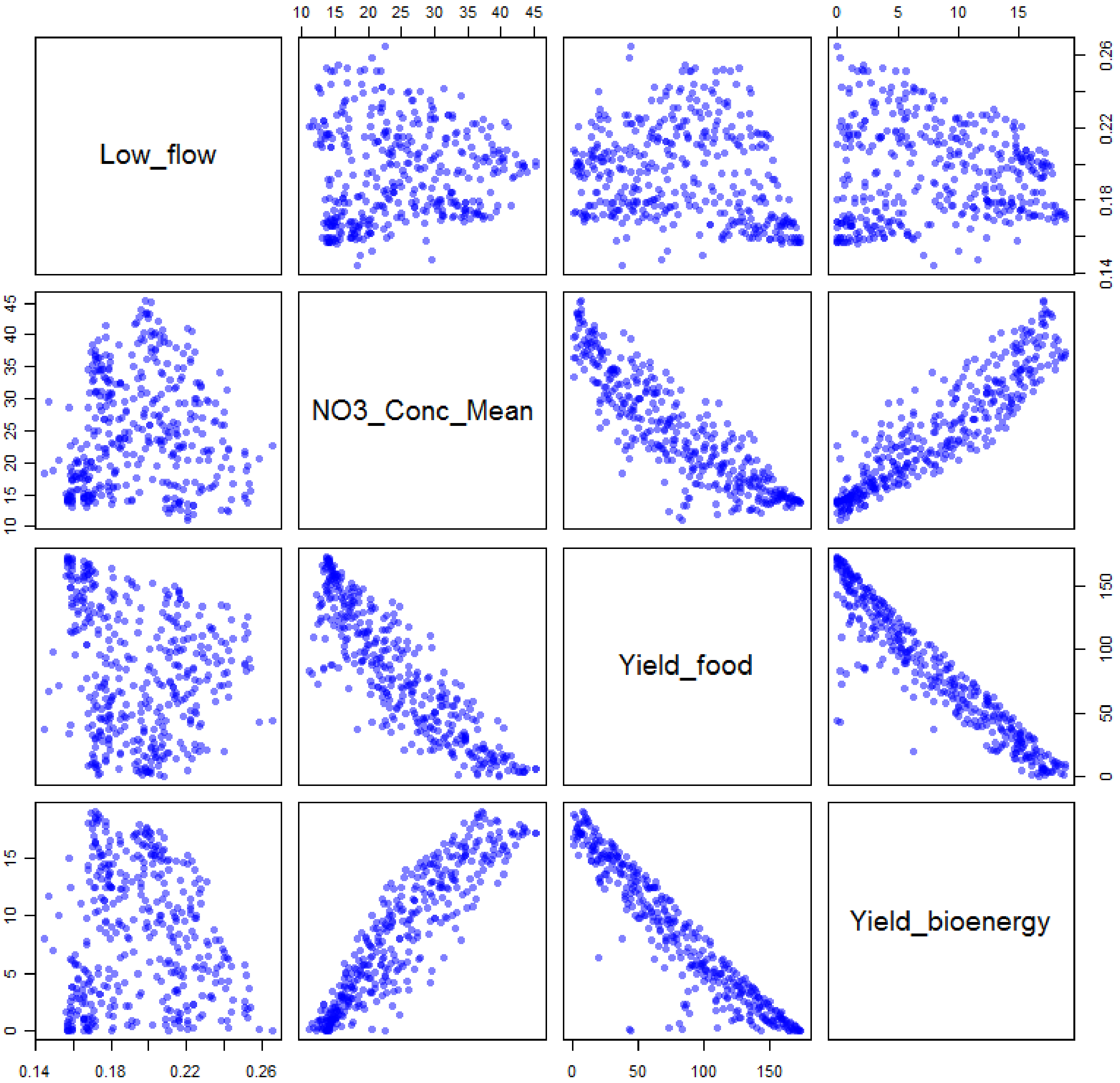
Trade-offs for bioenergy/food production (Parthe basin)



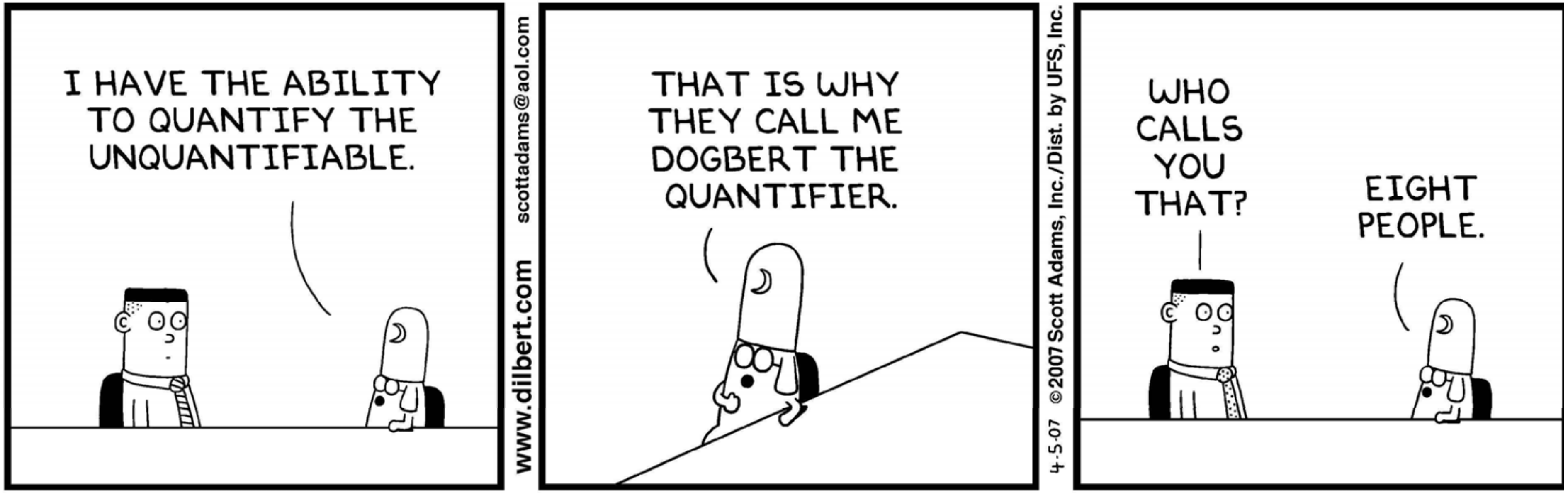
Results


NO3_Conc_Mean
50
Yield_food
200


NO3_Conc_Mean
50
Yield_food
200


Low_flow
NO3_Conc_Mean
Yield_food
Yield_bioenergy
10 15 20 25 30 35 40 45
0 5 10 15
0.14 0.18 0.22 0.26
0 50 100 150

What did we learn from the projects?



Conclusions

Example 1: ESS
++ increasing awareness of importance (management..)
-- buzzword, quantification, trade-offs

Example 2: Soil erosion
++ Pragmatic, accepted, applied
-- No “real” improvement of process knowledge

Example 3: Interactive landscape model (RBM)
++ Visualisation, Participation, Model linkage, scales/measures
-- Data availability and standards, variety of models, prototype

Example 4: Multi-objective optimisation (ESS)
++ Comprehensive, integrative, quantification of trade-offs
-- High level of uncertainty, “applicability”

Remarks

Preparing input data is the most arduous task.
Garbage in, garbage out (?).

You can never include everything.

Always focus on the questions first, tools last.

Scientists are not landscape managers, but "Early Warning System"

Remarks

Technical limitations remain

Increase in computer capability in past decade is not a panacea.

Challenge of appropriate complexity in spatial models remains

- Spatial data availability
- Spatial and temporal scale limitations
- Resolution—Extent tradeoff

(modified from lectures by Scheller and Mladenoff)

Building model confidence: data validation

Traditional validation: compare model data with empirical data. However, there is rarely independent landscape data collected at same scales. Data solutions include:

Fine-scale data

Problem: wrong scale

Reconstruct past responses

Problem: unknown starting conditions

lack of human behavior model

lack of climate data

Compare to other models

e.g. GCMs

Problem: few other models applied at regional scale

Both models wrong or right? Model autocorrelation.

(modified from lectures by Scheller and Mladenoff)

Building model confidence: alternatives to validation

Landscape validation is not always possible - need to judge by different standards.

Process validation

Independent application, assessment, and review

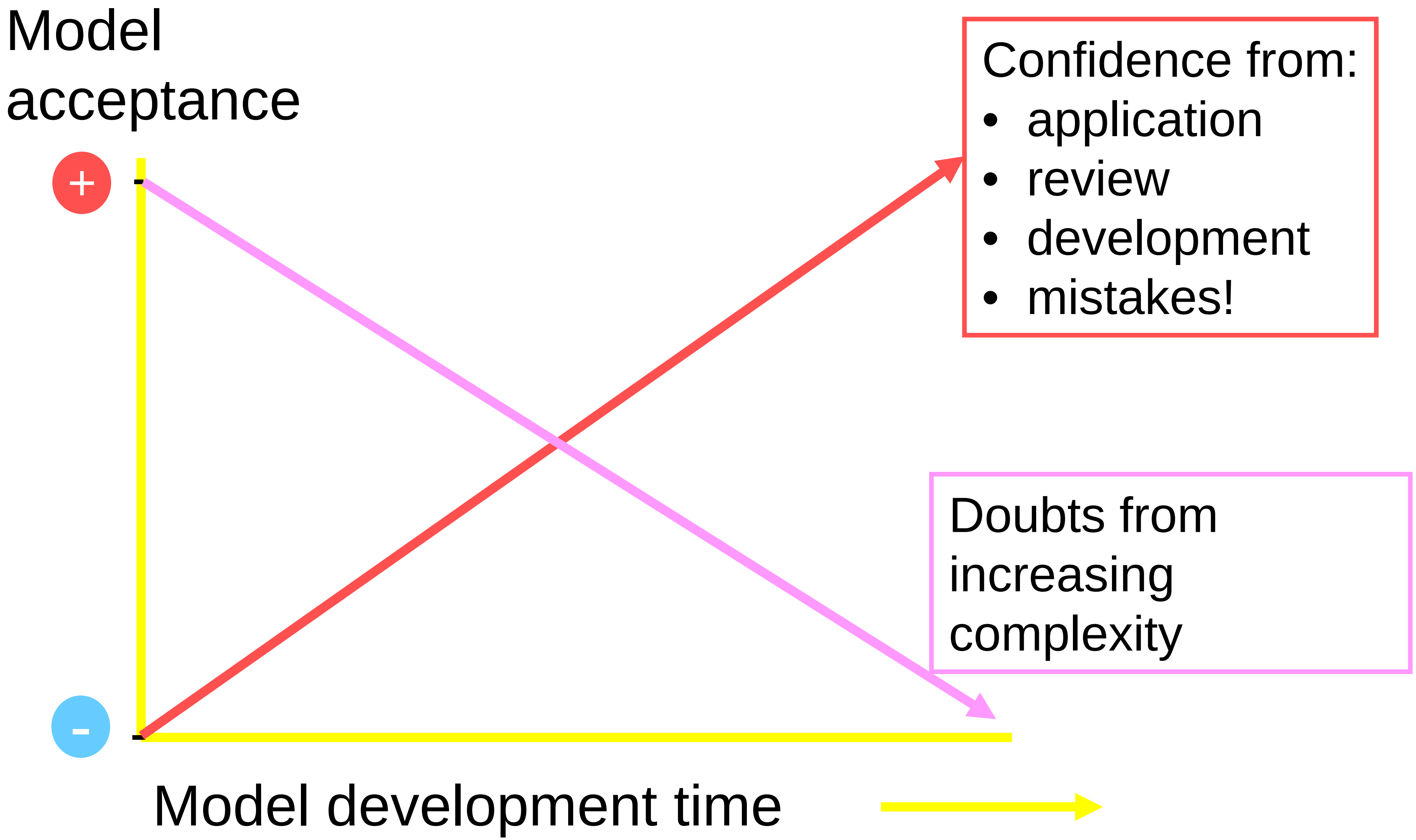
Development over time

Model transparency:

- open code
- generous comments

(modified from lectures by Scheller and Mladenoff)

Building model confidence: summary



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Thank you!

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