PEER

MARIE CURIE ACTIONS

METIER Graduate Training Course
"Ecological Modelling"
22 May – 2 June 2008, Leipzig & Bad Schandau (Germany)

Lecture 1: Introduction into Ecological Modelling

Part II: The "cooking recipe" of rule-based modelling

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I. The cooking recipe of rule-based modelling

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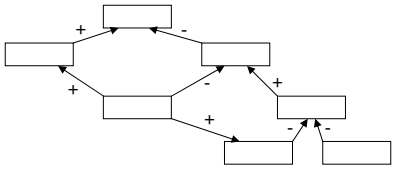
Step	Characterization	Remark
1.	**Specification of the question to be answered** prediction, understanding, management (?); scales	general or specific (?)
2.	**Collection of factor and mechanisms which are potentially relevant for the question**	state variables (?) parameters (?)
3.	**Causal diagram** explicit description of causal inter-relationships between the different factors (+/-, feedbacks, amplification / compensation of effects) 	▪ decision on the level of detail ▪ search for appropriate interfaces (modular, hierarchical)

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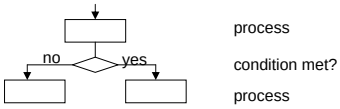
Step	Characterization	Remark
4.	**Flow chart** Visualization of the temporal order of the different processes 	
5.	**Formulation of the model rules** formal description of the functional relationships/processes: - mathematical equations - if – then – rules Causal diagram is basis	rule-based models -> flexibility! Probability distributions as possible input
6.	**Implementation of the model + parameterization** Conversion of flow chart and model rules in computer code	See the „game of life"

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Step	Characterization	Remark
7.	**Calibration / Validation / Verification…**	depending on the aim
8.	**Model analysis** - parameter variation; comparison of scenarios - generalization: robustness against changes in parameter values, model assumptions - managing complexity: hierarchical model analysis (ignoring / consecutive integration of details)	towards generalization
9.	**Interpretation of the results** from the perspective of the question / existing hypotheses; derivation of rules of thumb; If necessary – modification of the question/model structure *description* empirical data, hypotheses ⇄ model *interpretation*	iterative process

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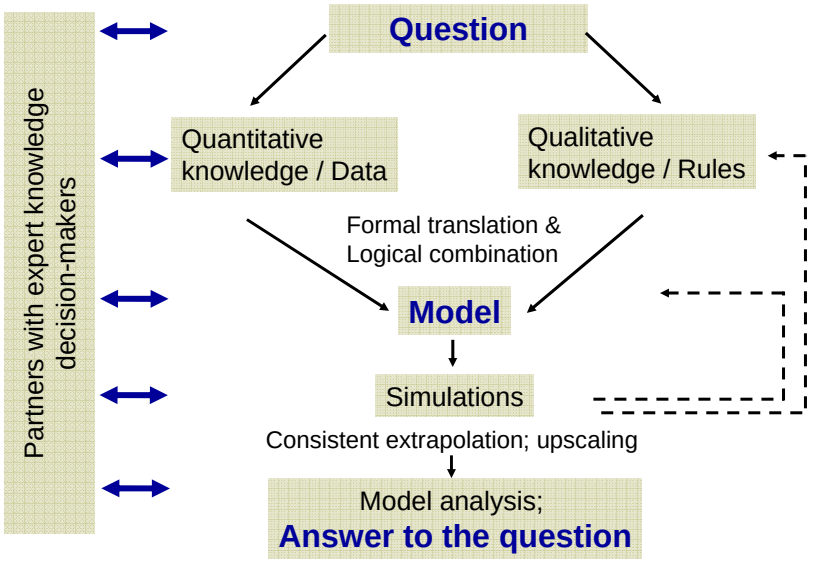

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II. Possible model input & outcomes

Possible model input

- Hard data
- Weak data
- Estimations (lower and upper limits)
- Scenarios
- Hypotheses

Most important: Qualitative knowledge

Modeller

Expert

Possible model outcomes

- Dynamics and quantification of effects
- System understanding
- Simulation, assessment & ranking of scenarios
  => critical trends, management options
- Tools for decision-support

Modelling supports inter- and transdisciplinarity (central in environmental research!)

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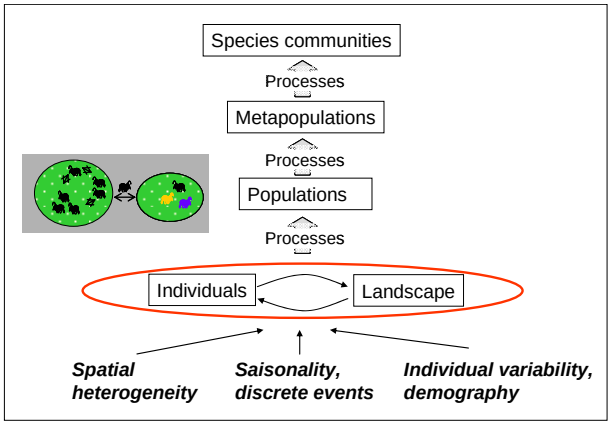
III. Types of ecological models

Remember: There were particular challenges



Complex organismic interactions, processes across scales & biological variability

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III. Types of ecological models

Consequences:

No single standard approach of model building!

Instead: various types of ecological models!

Isn't this a desaster when organising a course in Ecological Modelling?

Don't worry, there is a systematizing model type scheme…

… according to the question addressed

- Questions without biological variability → Homogeneous models
- Questions with spatial structure → Spatial models
- Questions with temporal variability → E.g. stochastic models
- Question with individual variability → Individual-based models

Range & limits of application; potential of combining approaches

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IV. Useful readers

On the philosophical foundation of modelling

Baumgärtner, S., Becker C., Frank, K., Müller, B. & Quaas, M. (2008) Relating the Philosophy and Practice of Ecological Economics. The Role of Concepts, Models, and Case Studies in Inter- and Trans-disciplinary Sustainability Research. *UFZ-Discussion Papers* 1/2008

Starfield, A.M. (1997) A Pragmatic Approach to Modeling for Wildlife Management (Seven common misconception about modelling): *The Journal of Wildlife Management*, 61: 261-270

On the methodology of ecological modelling

Grimm, V. & Railsback, S.R. (2006) Individual-based Modeling and Ecology, Princeton University Press

Jeltsch, F. & Moloney; KA (2003). Spatially-explicit vegetation models: what have we learned? *Progress in Botany* 63:326-343.

Wissel, C. (2000). Grid-based models as tools for ecological research. 94-115 *in* U. Dieckmann, Law, R. & Metz´, JAJ (eds). The Geometry of Ecological Interactions: Simplifying Spatial Complexity. Cambridge UP