USING SYSTEM DYNAMIC MODELS FOR POLICY ANALYSIS, LAND MANAGEMENT AND ASSESSMENT OF SOIL BIOGEOCHEMICAL PROCESSES

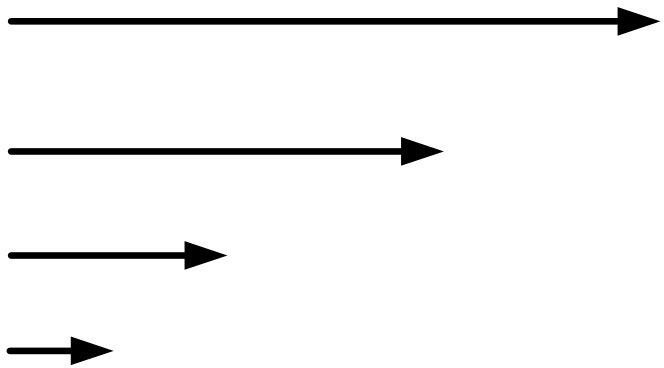
H V H
A K M E

Introduction

- Discuss connections between a policy and models
- Explain models and the development procedure
- Show examples from the Biogeochemistry-group

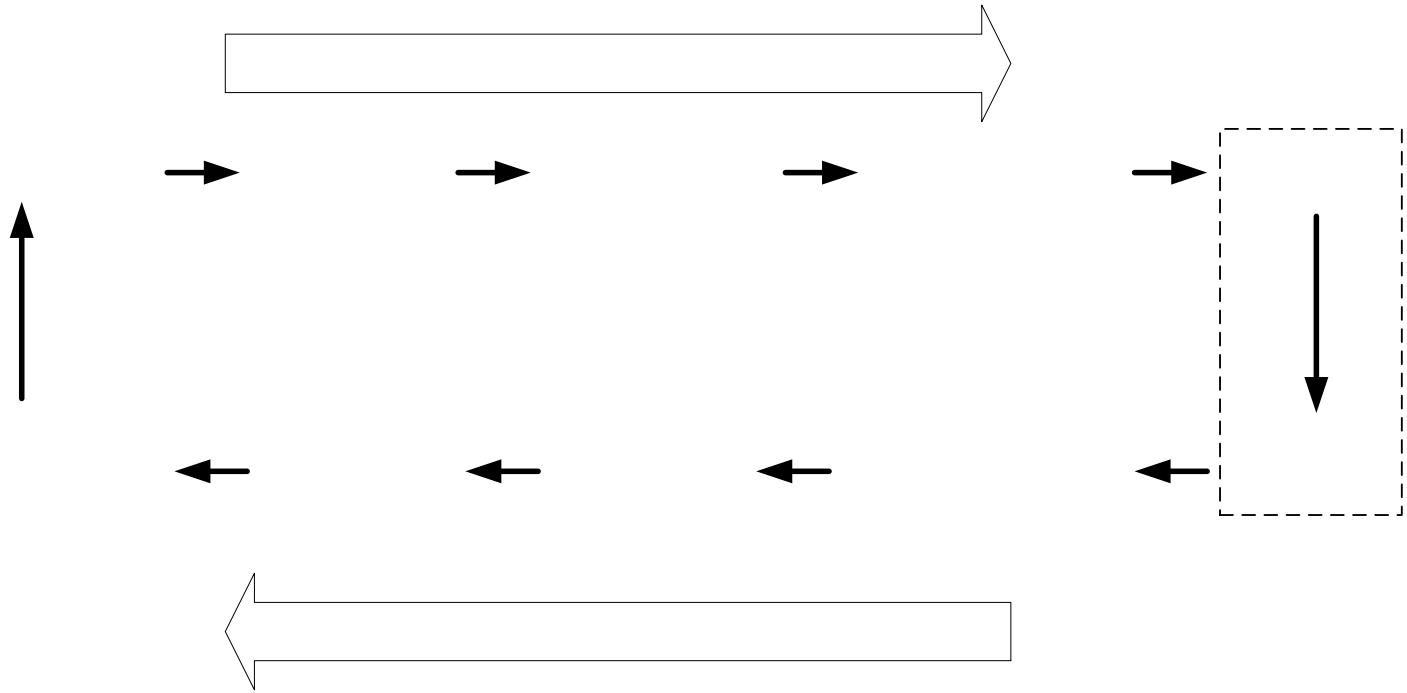
Focus and Scales

- Problems more often transcent scales
- Focus of models depends on the observation level
- Policies are seldom long-term



Modelling for a policy

- A policy is a plan of action
- A policy needs to anchored in a purpose
- The purpose must be reflected in the model



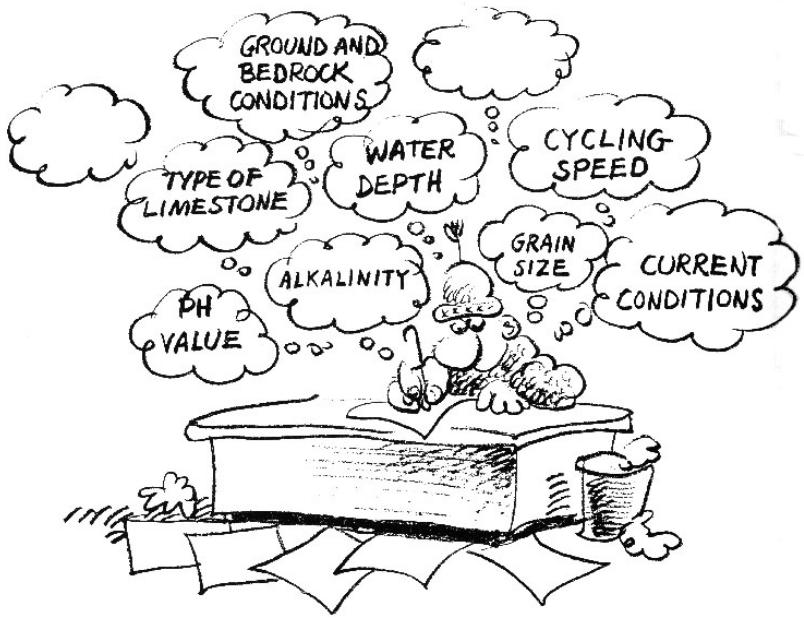
The purpose of models for policy analysis

- To gain insight into the strategies
- To organize and develop understanding
- To create purposeful decisions and strategies
- To communicate understanding

→communication and transparency of models is therefore essential

The quality of a model is determined by

- how useful it is for it's purpose
- how well users understand the model and have trust in it
- **NOT** the number of details



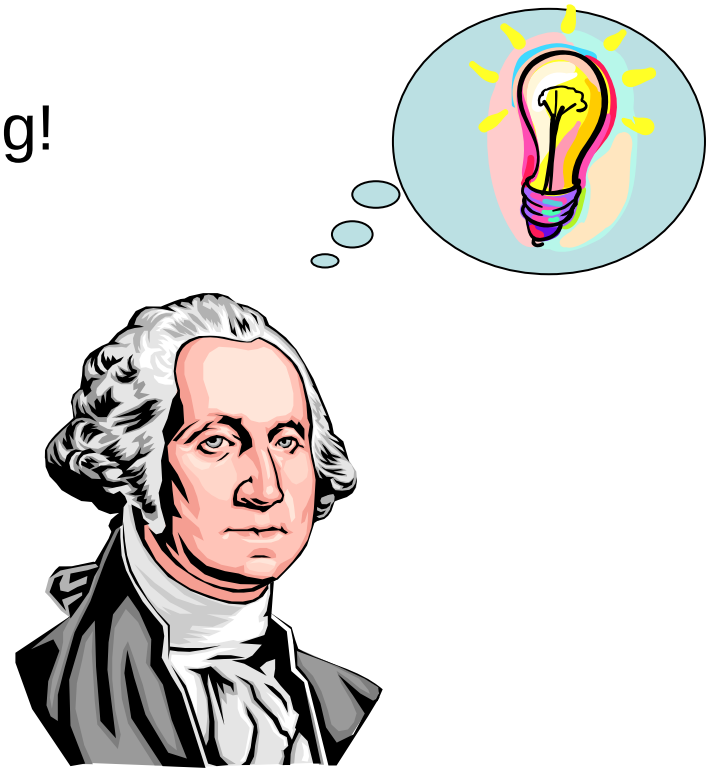
What is a model?

- Any conceptual understanding
  - used to evaluate cause and effect and
  - predict behaviour

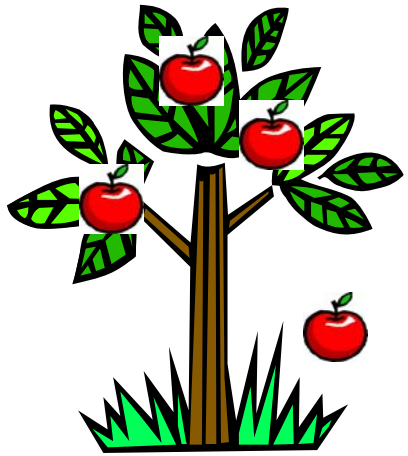
Everyone uses models

- A Model is first a Mental model
  - which can develop into a Numerical model

Thinking is modelling!

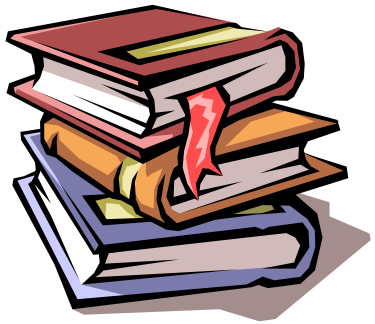


Same thing, but different descriptions



Cartographer

Humanist



Physicist

$$a = dx^2/dt^2$$

Good versus Bad

- The principles are visible, the procedures and rules are transparent
- Works with parametres which are relevant to reality
- Can be inspected and tested

- Principles and rules are not fully transparent
- Funny parametres
- Inspection and testing is difficult or not possible

Good/Bad versus performance

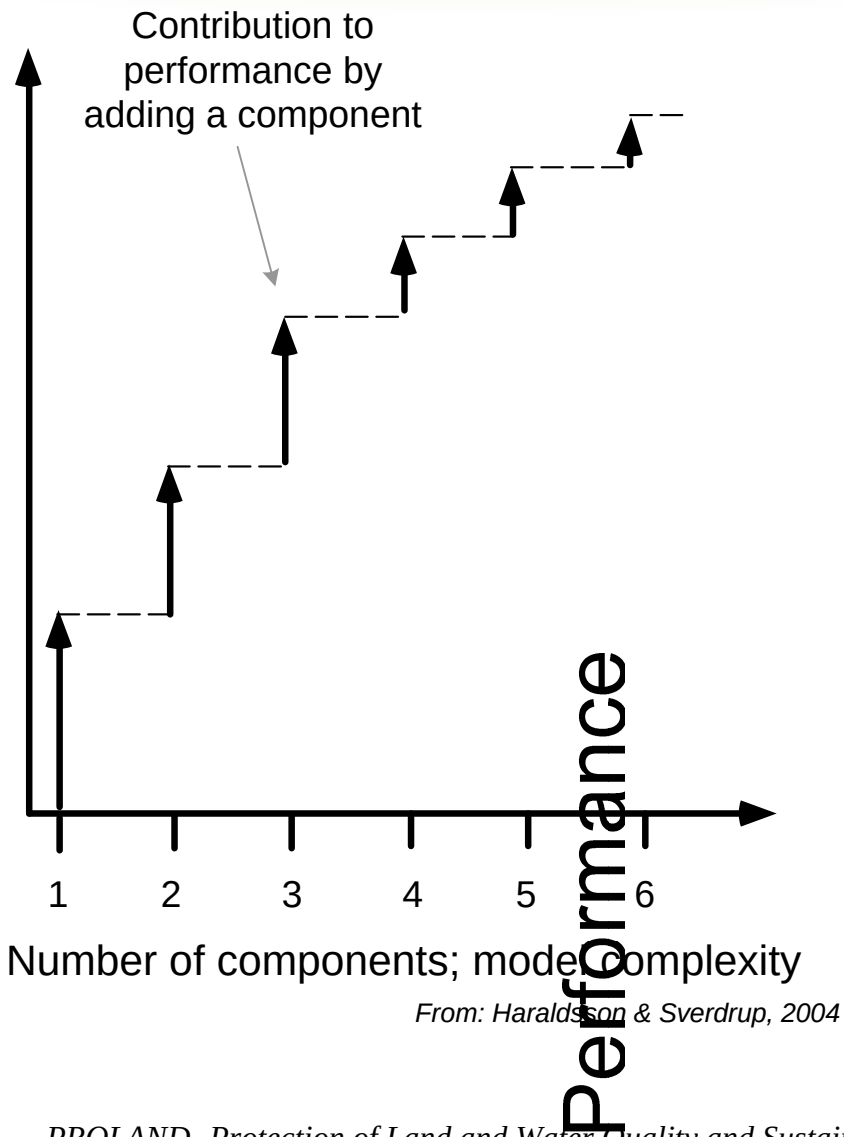
Good model performance

The model represents what is wanted with an accuracy which allows for robust descisions, it adheres to ”Good Model” principles

Poor model performance

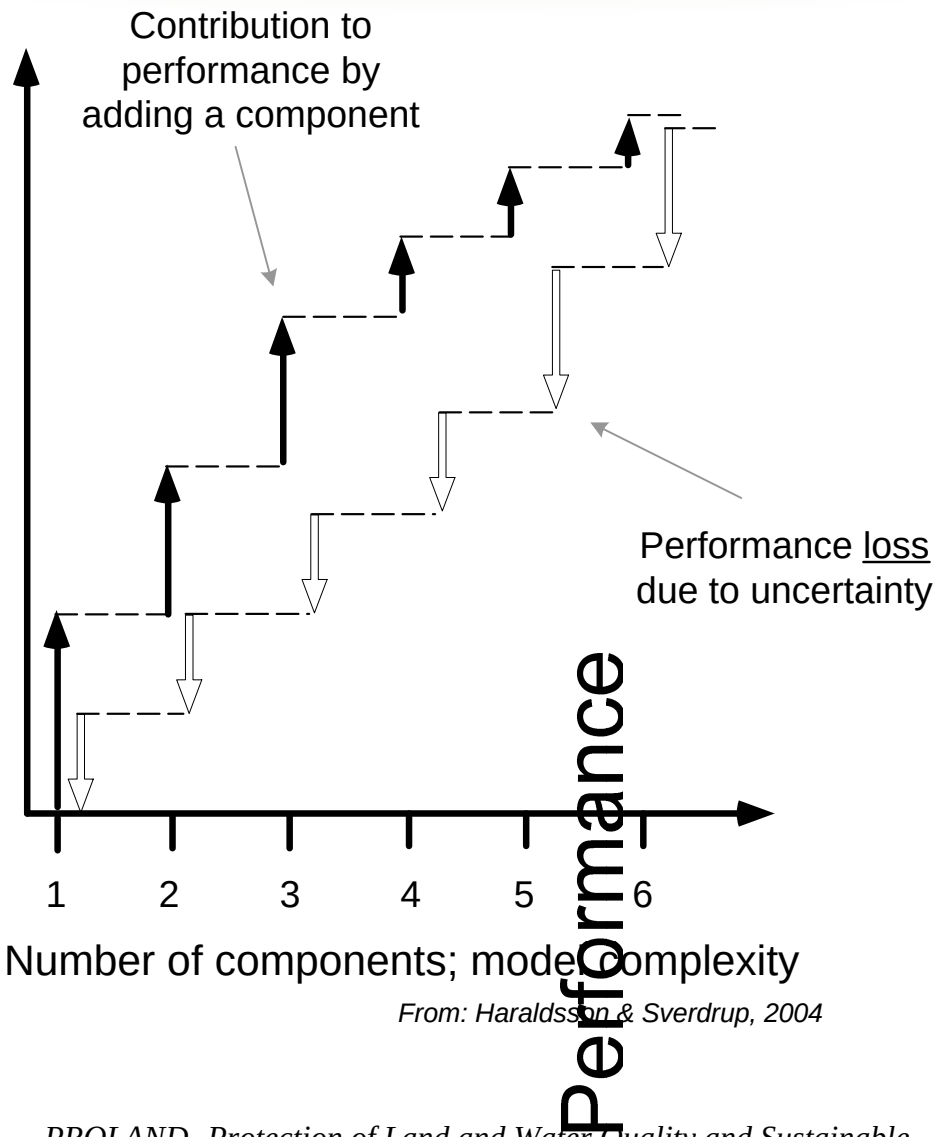
Poorly recreates observations, even if it adheres to ”Good Model” rules. Most models start like this when they are too simple

Model performance



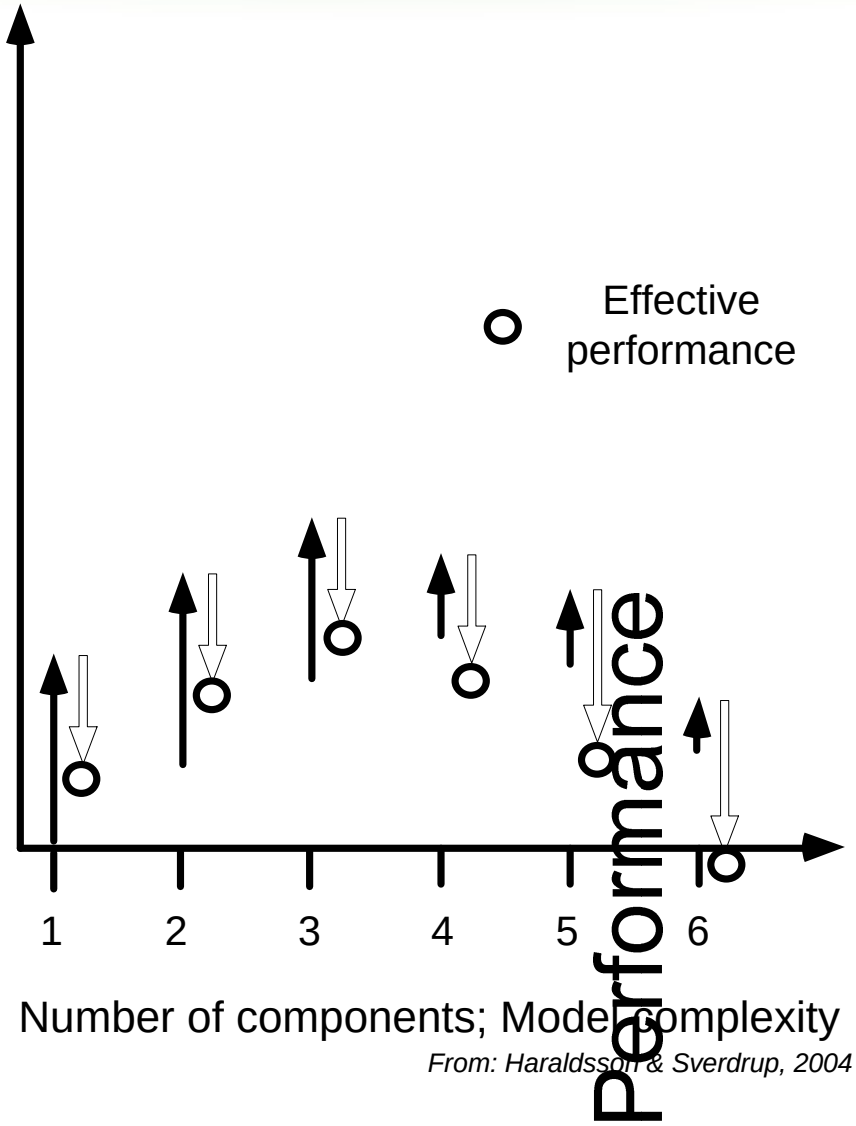
From: Haraldsson & Sverdrup, 2004

Model performance



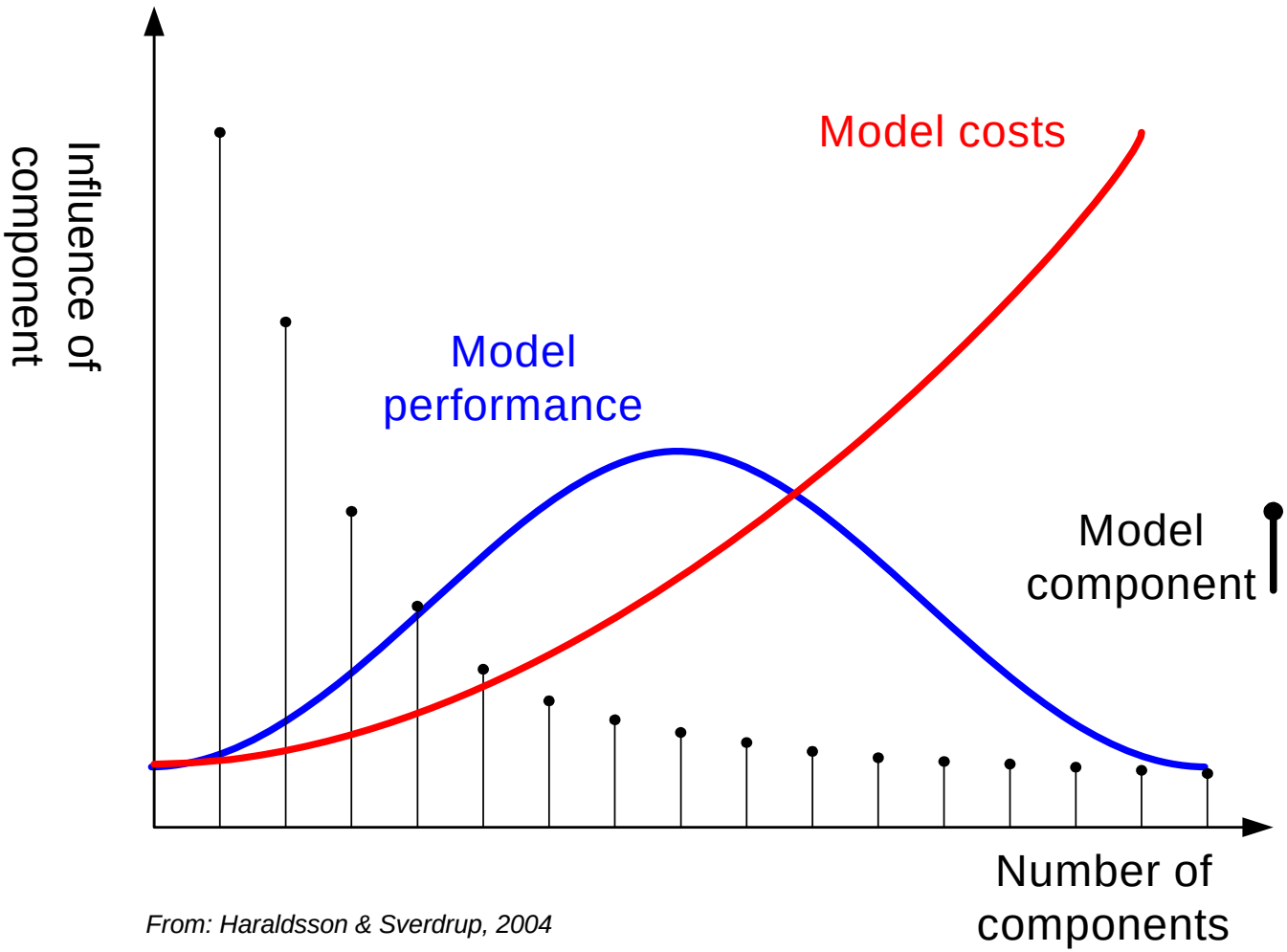
From: Haraldsson & Sverdrup, 2004

Optimum model performance



From: Haraldsson & Sverdrup, 2004

Model cost and performance



From: Haraldsson & Sverdrup, 2004

A simple model

- Must make complex assumptions
- Easy to use
- Time and cost effective

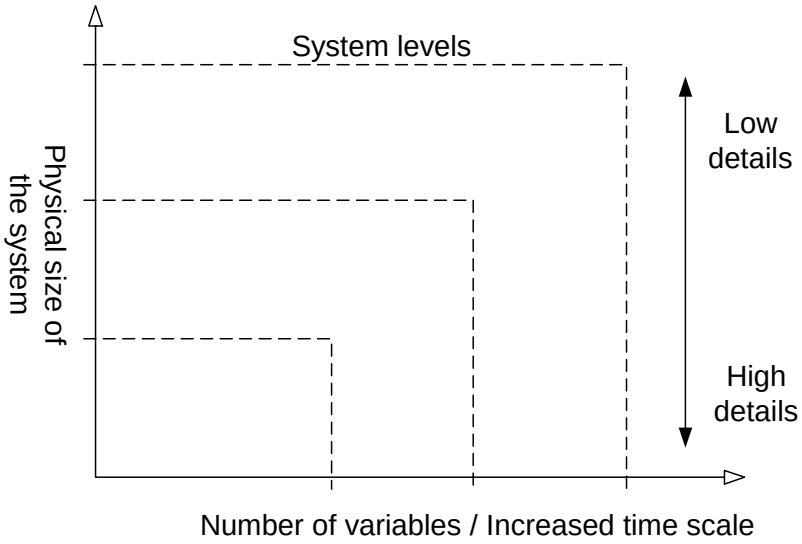
- Concerns:
- Applicability is limited
- Sensitivity of assumptions

A complex model

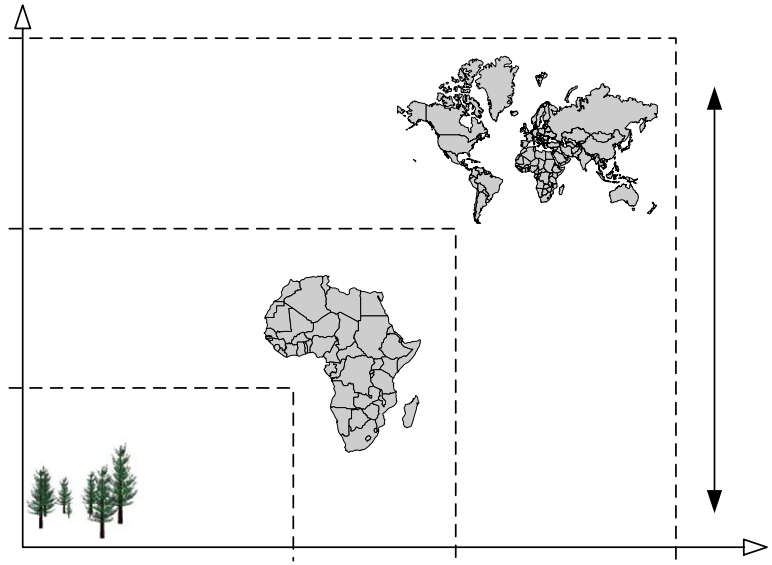
- Can make simple assumptions
- Will have better applicability
- Less restrictive on use

- Concerns:
- Requires more imput data
- Transparency is compromised
- More expensive to use

Models and scales



Depending on the question:

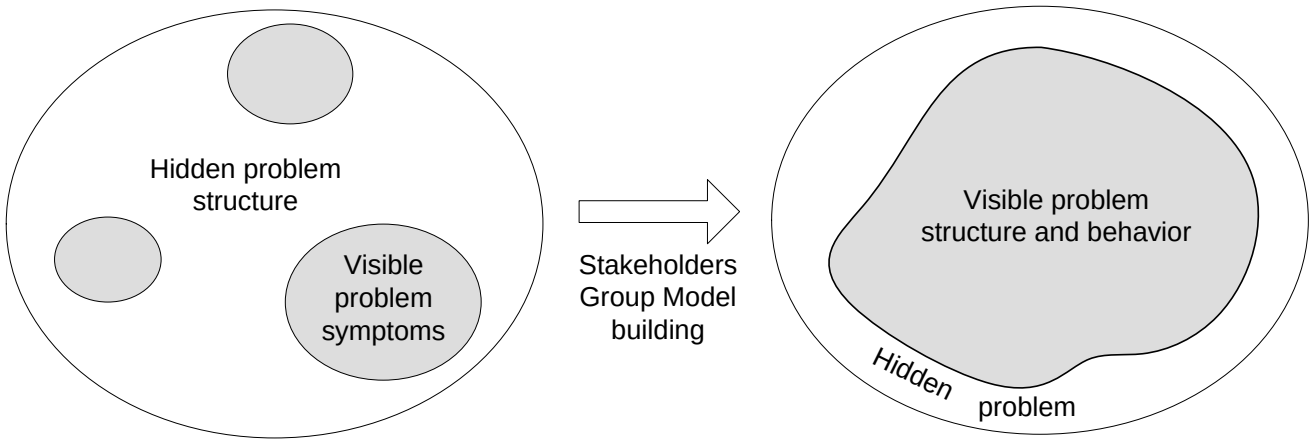


A model has a focus that addresses a specific scale

From: Haraldsson & Sverdrup, 2004

Engaging stakeholders in modelling

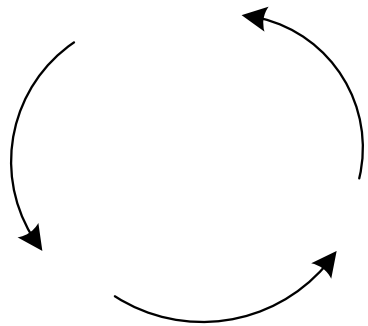
- Stakeholders assist in acquiring the research needs and prioritise the initial focus
- Enable a clear and shared focus on the issue
- Creates a shared ownership of the problem

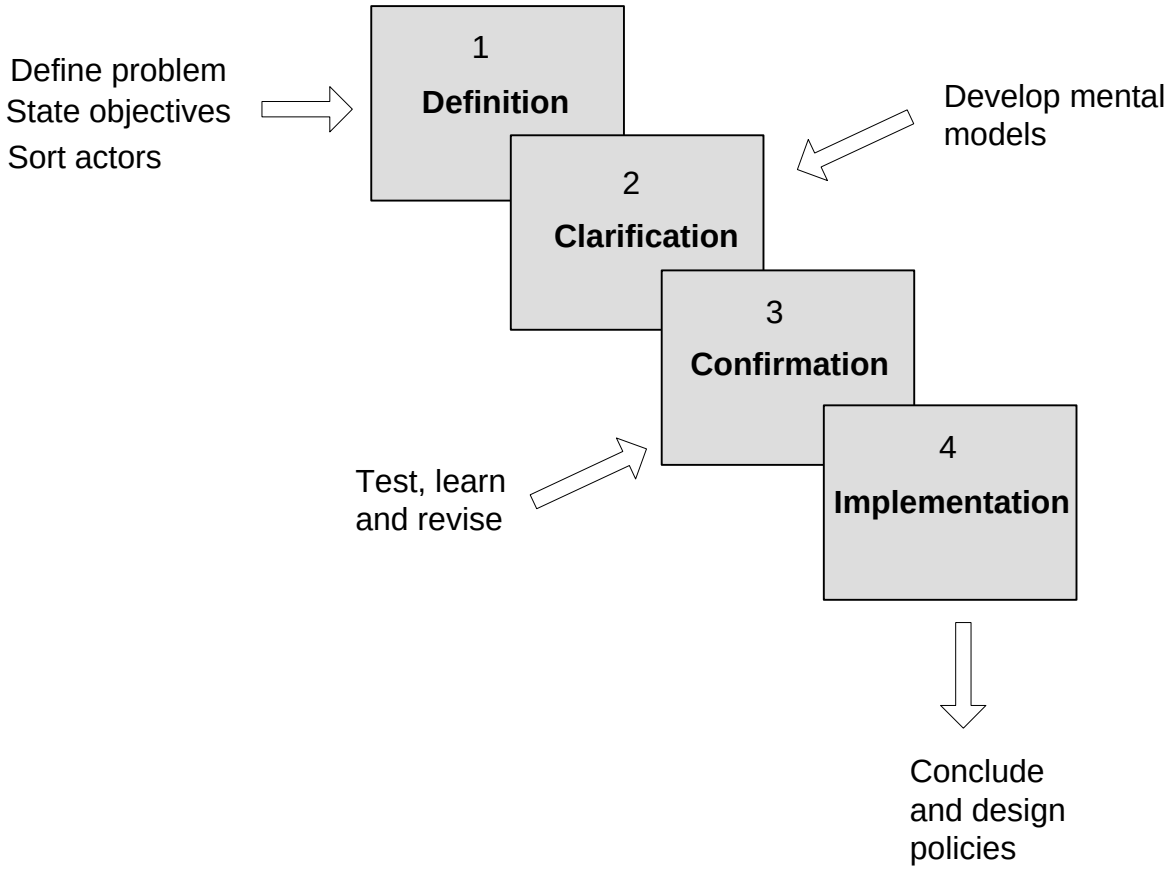


What happens in the process?

- WHY ? - what questions to answer?
- WHO wants the result - do we have the right
- team?
- Input data (to investigate with), expected output (answers, graphs)
- Simple policy model (many versions are trashed here)
- Quantification - formulas, graphs, tendencies
- Sensibility analysis - refine
- Present and spread the findings

The modelling process iterates through four phases



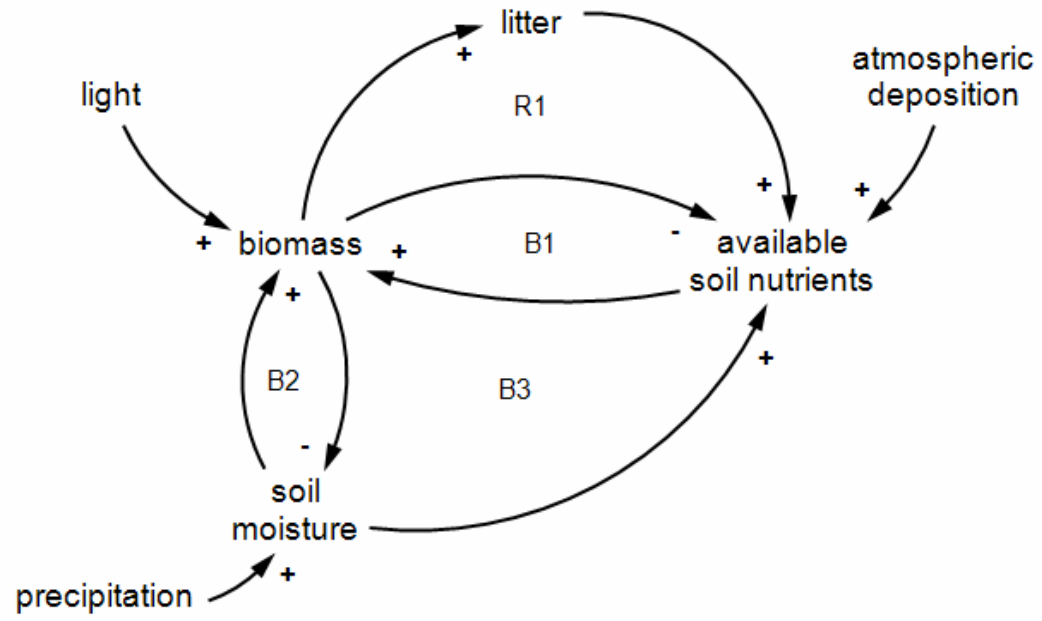


The biogeochemistry models at Lund

- SAFE
  - Predicting soil acidification and recovery in regard to critical loads of atmospheric deposition in a regional perspective
- ForSAFE
  - Predicting possible changes in forest growth and soil chemistry in responding to changes in deposition and management practice
- Farmflow
  - A dynamic nutrient- and trace element accounting model for agricultural farming systems to assess management
- Ice-Veg
  - Estimating regional forest and vegetation development

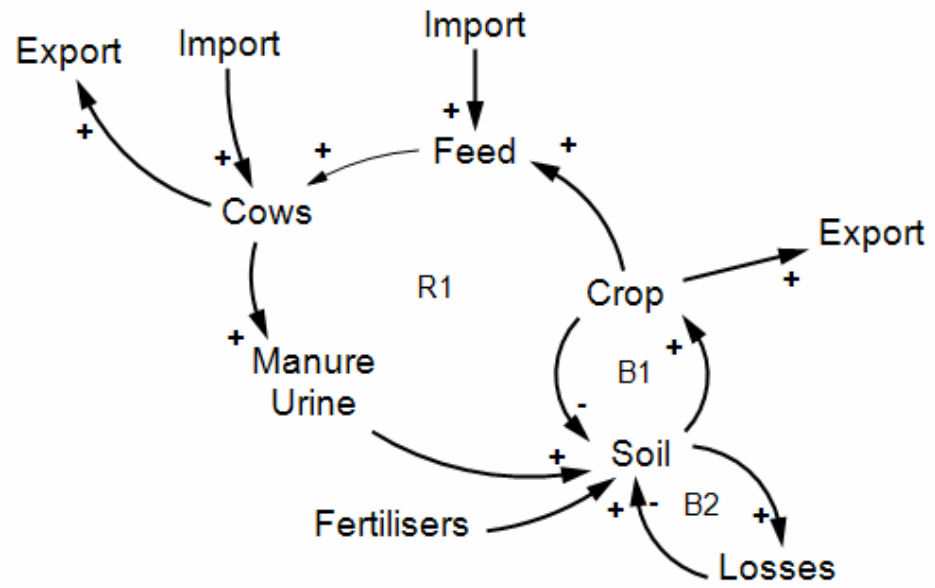
The ForSAFE model

- Main question: How does climate change, deposition and management practices affect nutrient balances in soils and Forest growth?



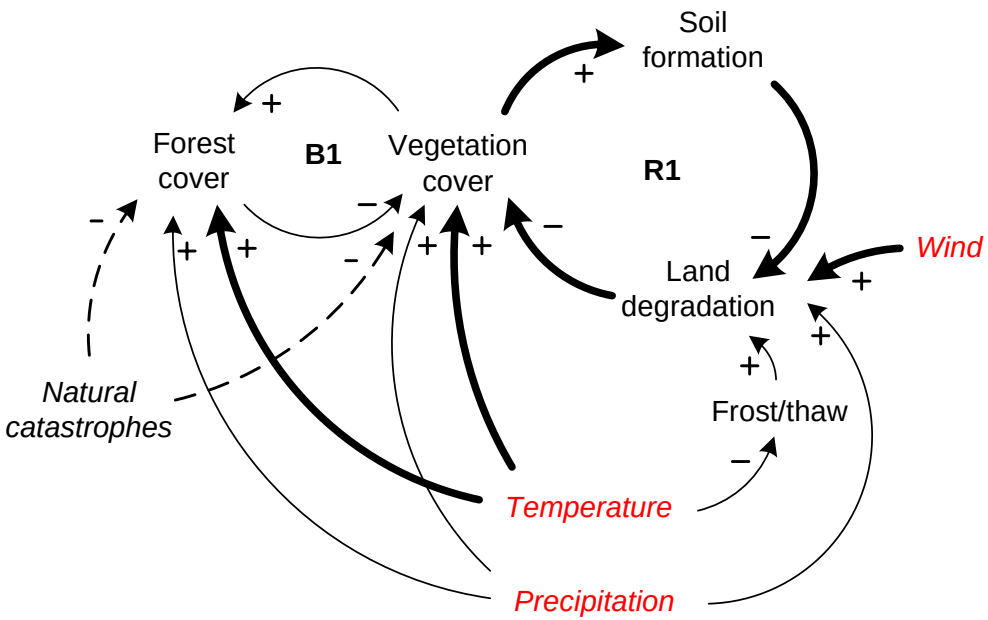
The FARMFLOW

- Main question: How does organic farming practices compare to conventional regarding nutrient- and trace element mass-balances?

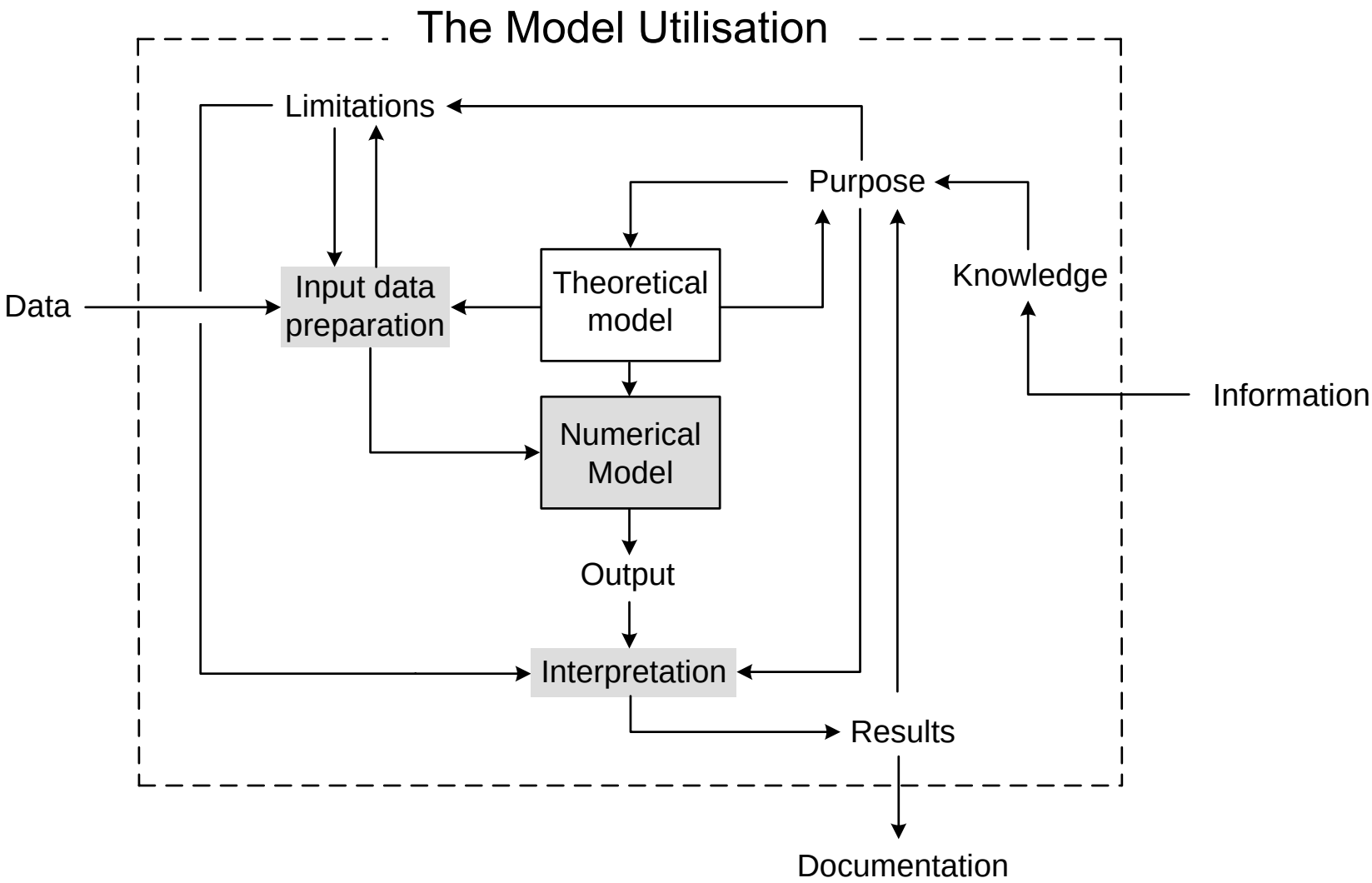


The Ice-Veg model

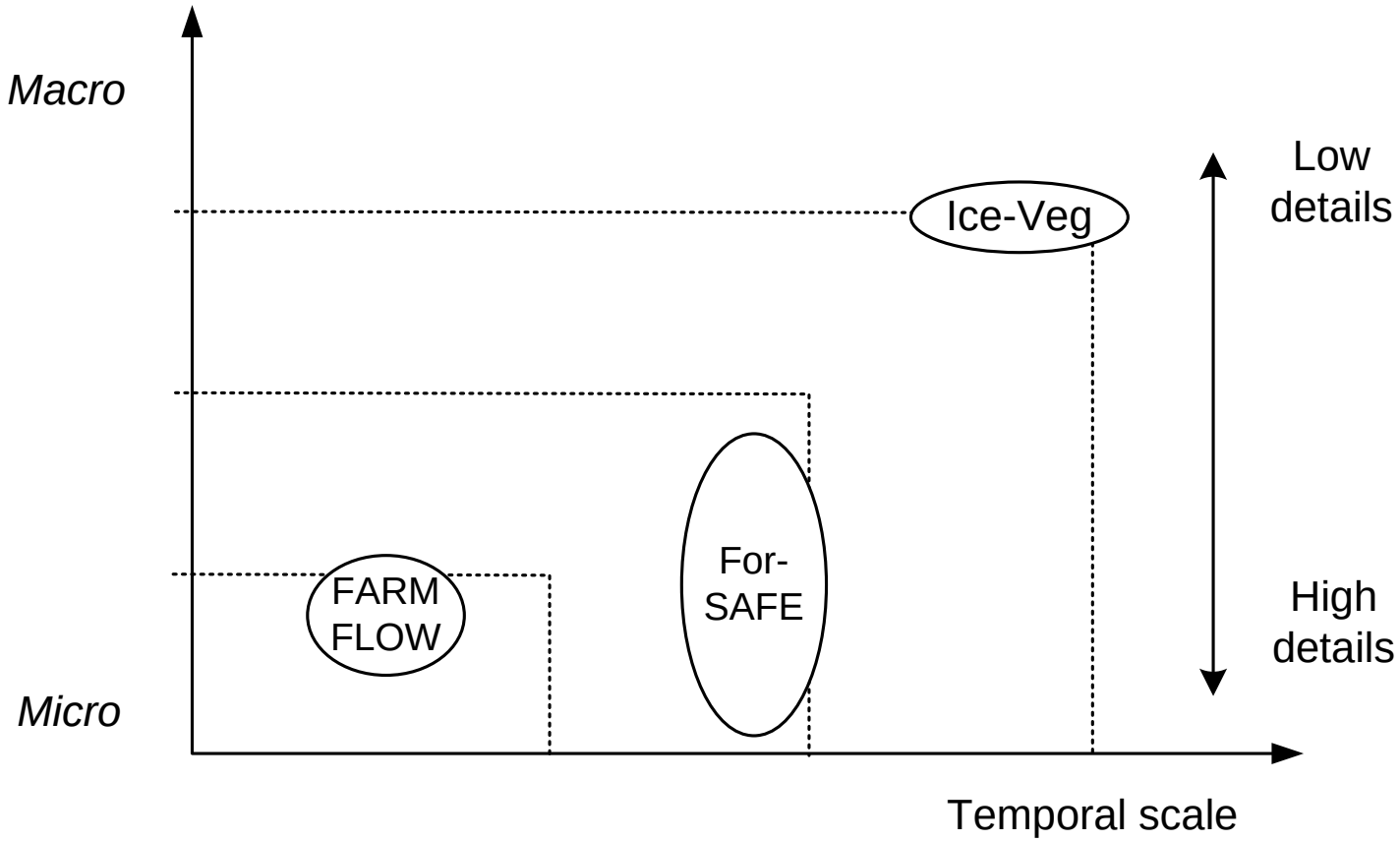
- Main question: What is the long-term effect of climate fluctuation on vegetation and forest cover?



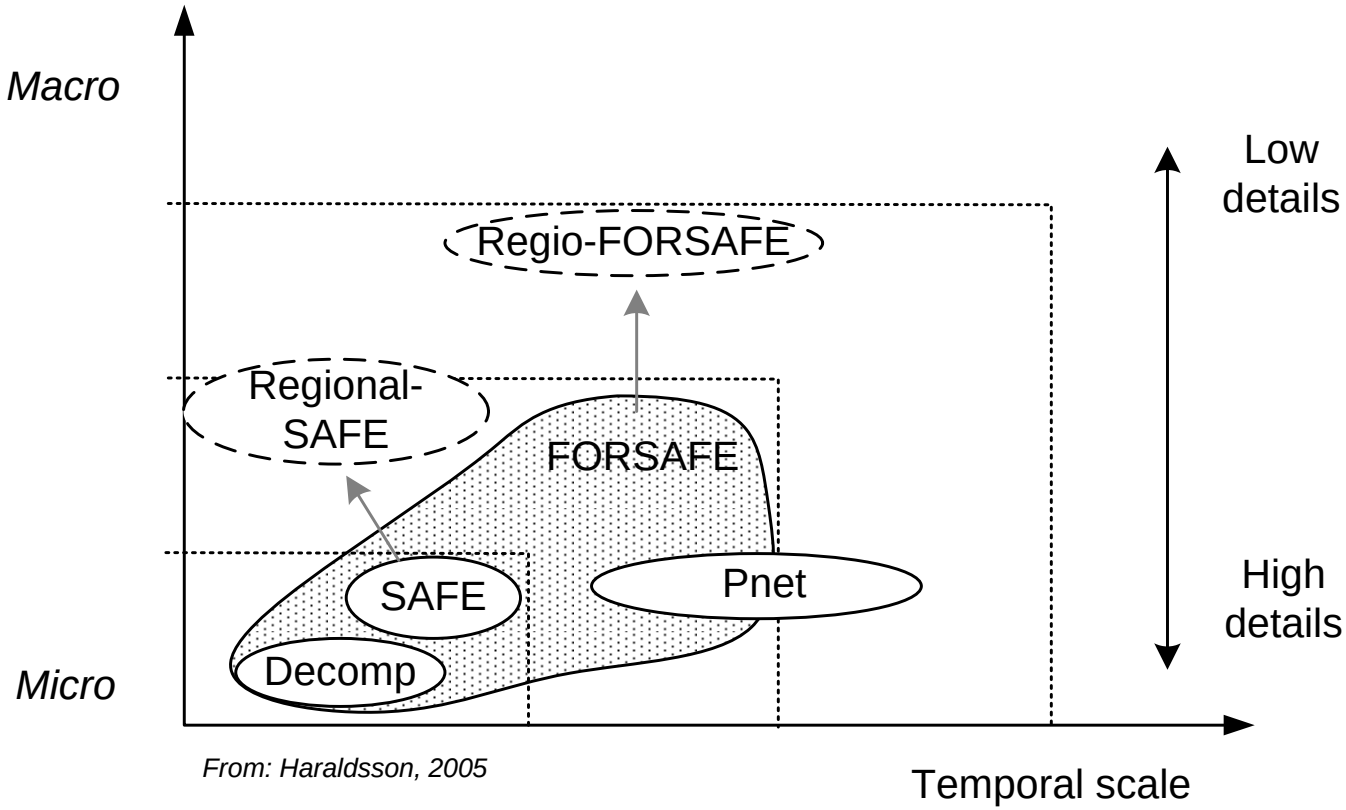
Combining models with field data



Focus and scale

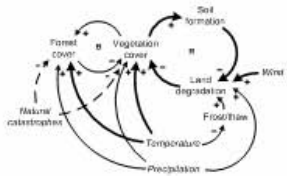
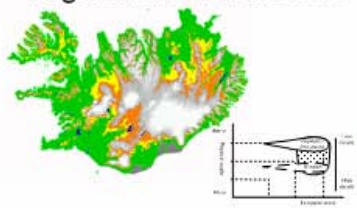
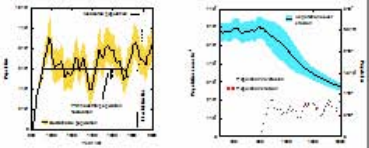
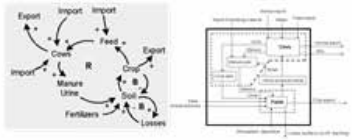
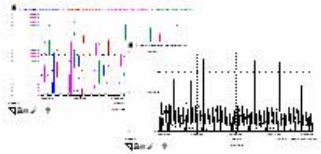
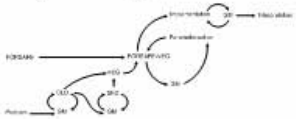
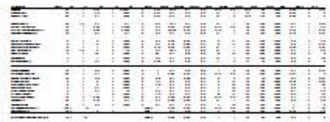
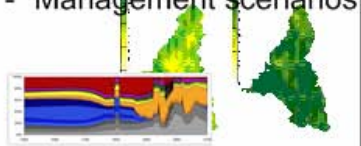


ForSAFE and its submodels



From: Haraldsson, 2005

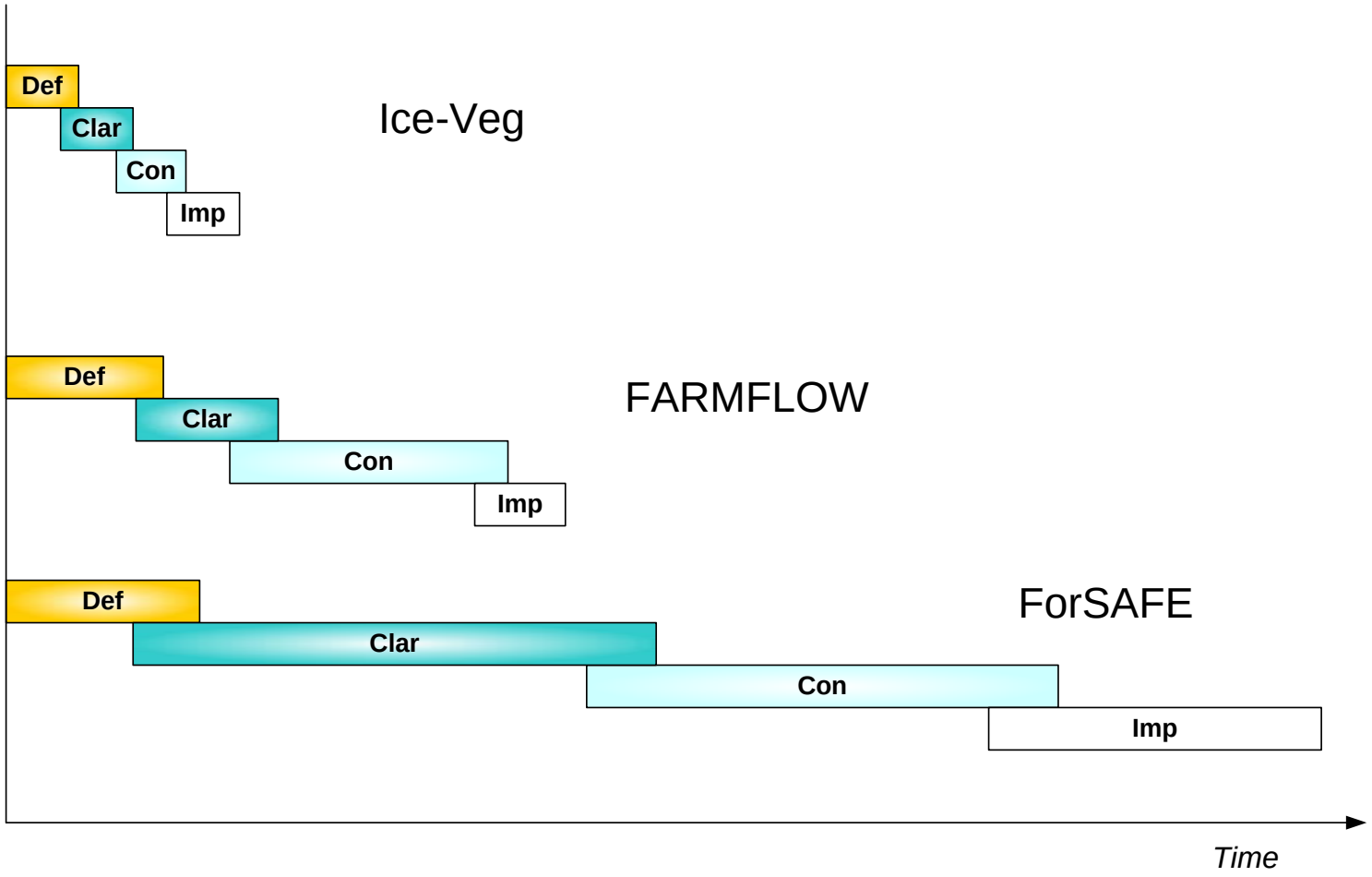
Model development procedure and results

	Definition	Clarification	Confirmation	Implementation
Ice-Veg	- Desertification - Carrying capacity 	- Basic processes 	- Vegetation and erosion 	- Answering questions - Suggest research 
FARMFLOW	- Nutrient deficiency - Nutrient accounting - Farm scale boundaries 	- Basic processes - CLD & SFD 	- Verification of results against field test 	- Preliminary results - Scaling and generalization - Adopt for heavy metals
ForSAFE	- Predict forest prod. - Soil Chemistry - Hydrology 	- Requirements - Merging models 	- Parameterization - field testing 	- Sustainable harvest - Nutrient balances - Management scenarios 

Number of meetings

Definition	Clarification	Confirmation	Implementation
3	3	2	2
3	2	5	(1)
5	15	10	(5)

procedure timeline



Conclusion

- Modelling never starts by collecting data but by defining questions!
- Communicating and transparency = understanding
- Any policy analysis (soil, forestry, agriculture) addresses a set of questions that needs to be anchored in the modeling purpose
- Stakeholders participation in group modelling helps foster an awareness and understand the research needs
  - Reduces the development time
- SAFE, ForSAFE, FARMFLOW and Ice-Veg where developed as a generic models

Acknowledgement:

- PROLAND

- SENSOR