Simulation at the science-policy interface

Communication about prospects and limitations of simulation results for policy makers (COPLOS)

Dirk Scheer
University of Stuttgart
Institute of Social Sciences V - Research Unit Risk and Sustainability

CDMC Seminars – 2009 - Oktober 22, 2009

at Carnegie Mellon University - Pittsburgh/US

content

1. My background

2. Simulation

general observations from a social science perspective

3. Simulation

at the science-policy interface – (COPLOS) project

4. Conclusions

Short presentation

- **Education**
  - Background political science & roman literature
- **Profession**
  - 2001-2008: senior reseracher at Institut for Ecological Economy Research (www.ioew.de)
  - Since 2009 at University of Stuttgart (www.zirn.info.de)
- **Reserach projects on:**
  - Integrated Product Policy & environmental governance
  - Sustainability Impact Assessment
  - Risk communication & assessment
  - Simulation & Carbon Capture and Storage

2. Simulation – general observations from a social science perspective

Role of simulation in evolution

- **Different knowledge selection strategies in evolution**
  - Learning by coincidence
  - Magic knowledge
  - Trial and Error (unsystematic)
  - Trial and Error (by theory)
  - conscious experimenting (model building)
  - Simulation

- **Increasing tendency to virtualize selection strategies**
  - Error is less painful

Elements & instruments of future knowledge

Components

Trends and rules
- cyclical or linear
- Functional
- causal

Decisions
- individual
- collektive

Background (Noise)
- Random fluctuation
- surprises

Instruments

- Trend analyses
- Modelling
- scenarios
- Simulations
- Systematic future analsyses

Simulations

- **Casual, functional or sequential style of modelling consisting of dynamic process aming at the prediction**
  - Natural phenomena
  - Technological impact chains
  - Consequences of human action

- **Interdisciplinary approach applying different tools & methods**
  - aiming at setting up a formalised, mathematical code

- **Integration of observed and/or modelled rules, decisions and random fluctuations**

Characteristics of simulation

- Aligned to predict processes and their consequences under fixed conditions
- Based on a combination of functional defined relations between variables
- Based on complex and often uncertain relations; single (bivariate) connections must be known and be able to formulize
- Integrated simulatioin focus on trade-offs between technological, economic and social development

Simulation - three problems

- **Complexity (cause and effect)**

- **Uncertainty**
  - Range of variation
  - Meassuring error & extrapolation
  - Stochastic patterns
  - System boundaries and ignorance

- **Ambiguity**

3. Simulation at the science-policy interface – (COPLOS) project

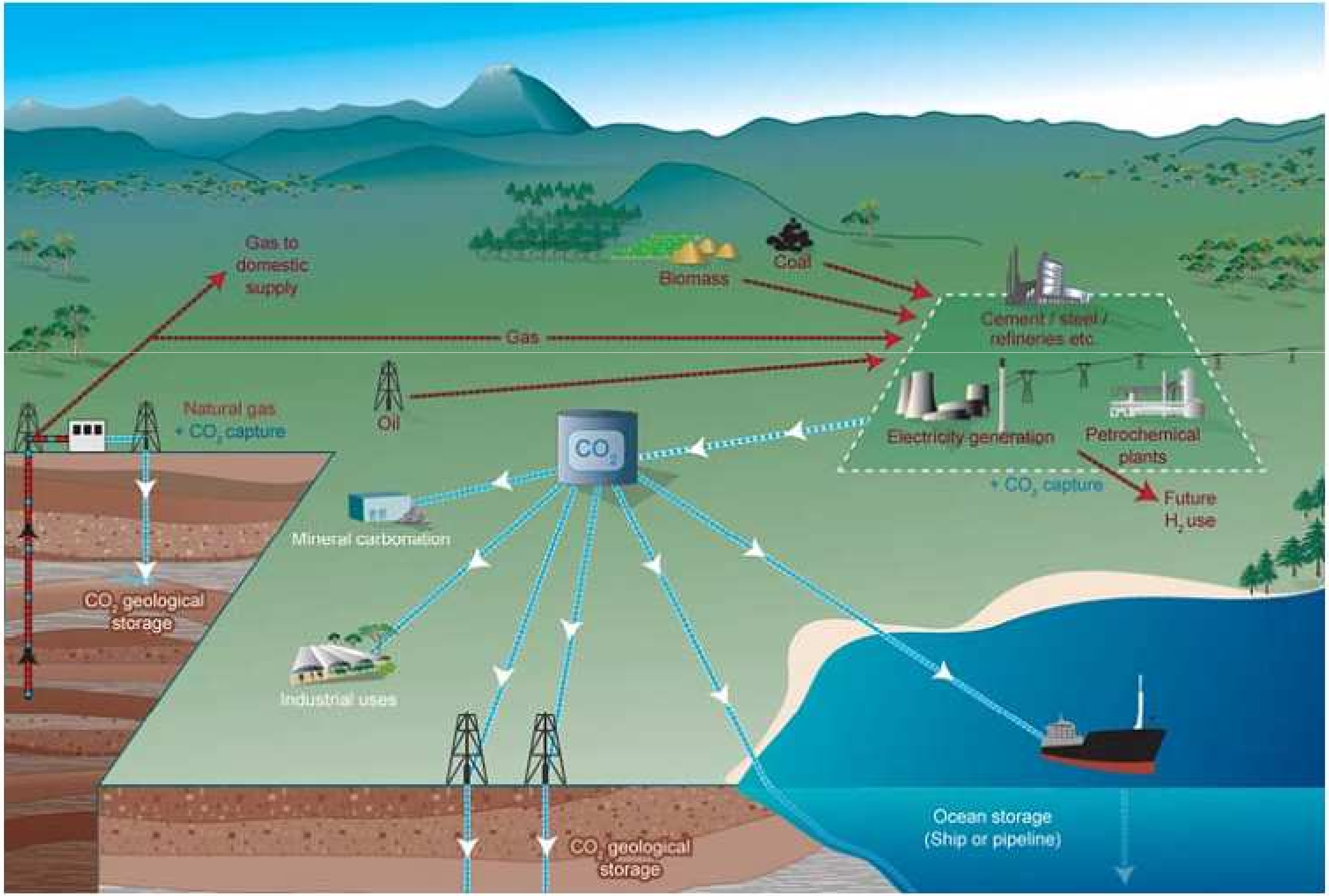
Project cornerstones

- **Title:**
  – Communication about prospects and limitations of simulation results for policy makers
- **Duration of the project:**
  – 01.11.2008 – 30.10.2011
- **Scientific staff:**
  – Ortwin Renn, Dirk Scheer
- **Funded by:**
  – National Science Foundation

Project design

- **Main objective:**
  - to elicit the **dominant expectation's and requirements from the policy side** and match this input with the **specific performance and reliability of the simulation** processes under investigation.
- **Case study approach**
  - Simulation in the field of **carbon capture and storage**
- **Methodology**
  - Literature review
  - explorative survey with policy decision-makers (15-20 interviews)

CCS – what is it?



Source: Special Report IPPC 2005

The research leading packages

1. Systematisation: the role of SIM in CCS

2. Mapping SIM communication

3. Transformation of SIM-results

4. Requirements from policy side

Package 1 – Literature topics

- **Science-policy interface**
  - Ideal-type approach, support role science, functionalism
  - Paradigm shift (mode 2, post-normal science)
- **Interaction patterns science-policy**
  - Policy cycle approach,
  - advocay coalition appraoch
- **Communication of models & simulation**
  - foreign language character of simulation
  - certainty vs. uncertainty

desk research

Package 1 – classification ideas

- **Aim: identify differences among SIM regarding their role for policy-making**

SIM topic	SIM results
Paths of developments - Technological - economic - social	**explaining** - natural phenomena - Technological impact chains - Consequences of human action

SIM Policy-making input

1. Optimization of knowledge basis
2. Objectification of the debate
3. Contributing to informed implementation of policy decisions
4. Contributing to ‘socially robust’ decisions
5. Contributing to avoiding or to resolving conflicts
6. Providing reflexive knowledge

Simulation & CCS – finding SIM-families

Framing & context SIM

- Energy system analysis
- Future energy mix
- GHG emission scenario
- climate models

Technology SIM I (feasability)

- capture strategies
- absorption, membran, chemical

Technology SIM II (implementation)

- CO_2 pipeline transportation
- cost estimation & spatial planning

Consequence Analysis SIM

- subterranean CO_2 behaviour
- site investigation & selection
- leackages
- CO_2 injection
- life-cycle analysis
-…

Framing SIM – future energy scenarios

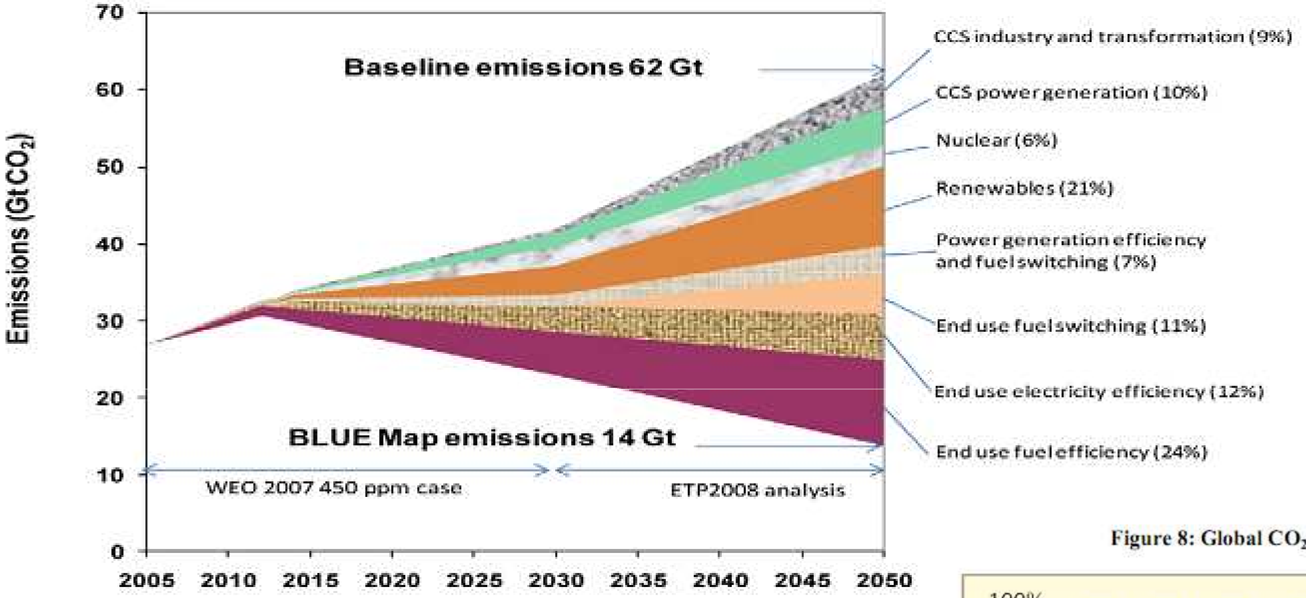
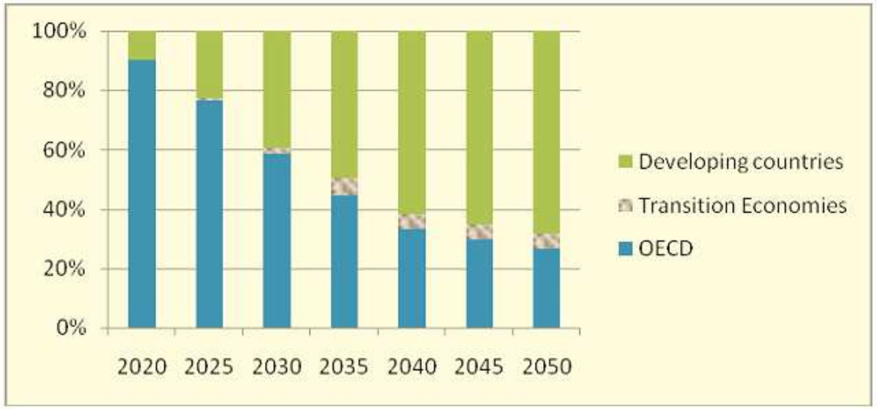


Figure 8: Global CO_2 Capture by Region, ACT Map Scenario



Source: Bennaceur Kamel, Gielen Dolf (2009) in: Energy Procedia 1 (2009) 4297–4306

Technology I Sim – capture efficiency

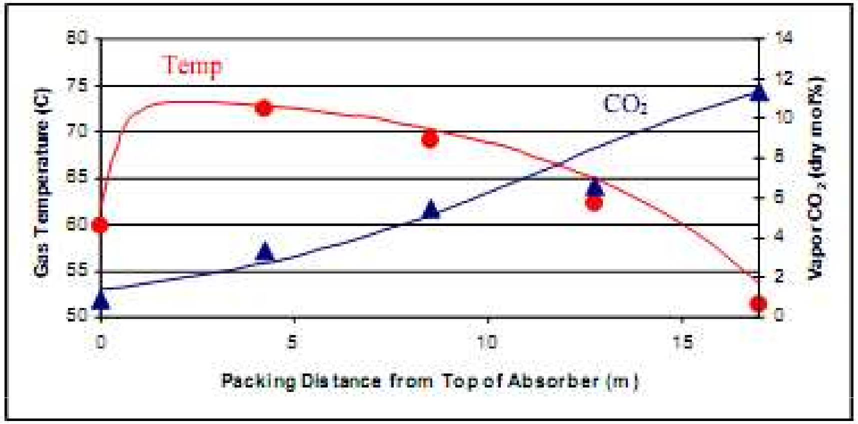
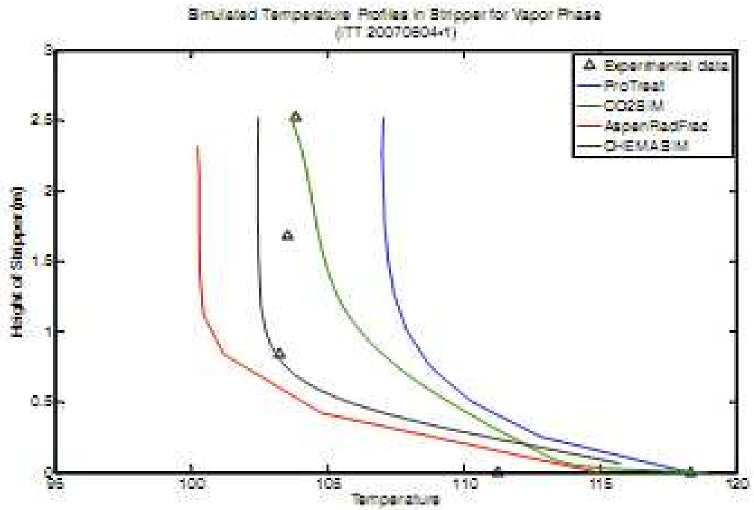


Figure 11. Run 3C – Absorber Gas Temperature and CO_2 Concentration Profile

Ross Dugas et al (2009), in: Energy Procedia 1, 103-107



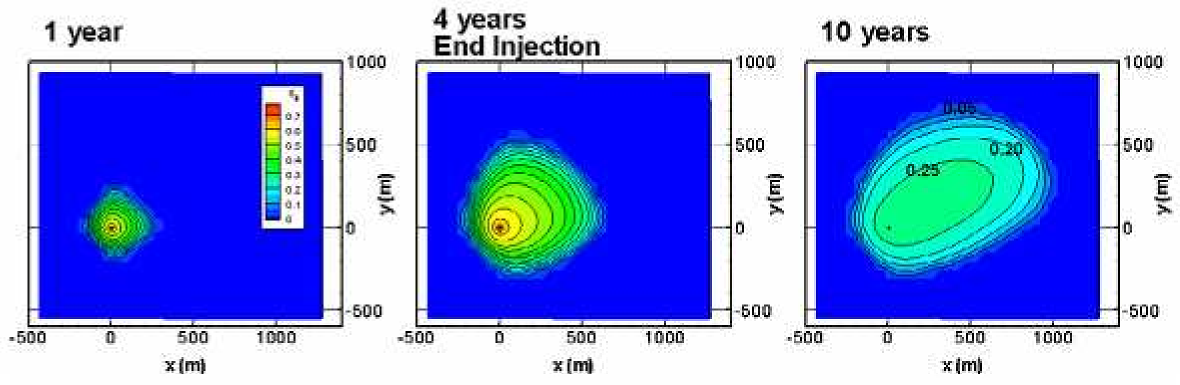
X. Luo et al (2009): in: Energy Procedia 1, 249-1256,

Technology II Sim – spatial pipeline planning

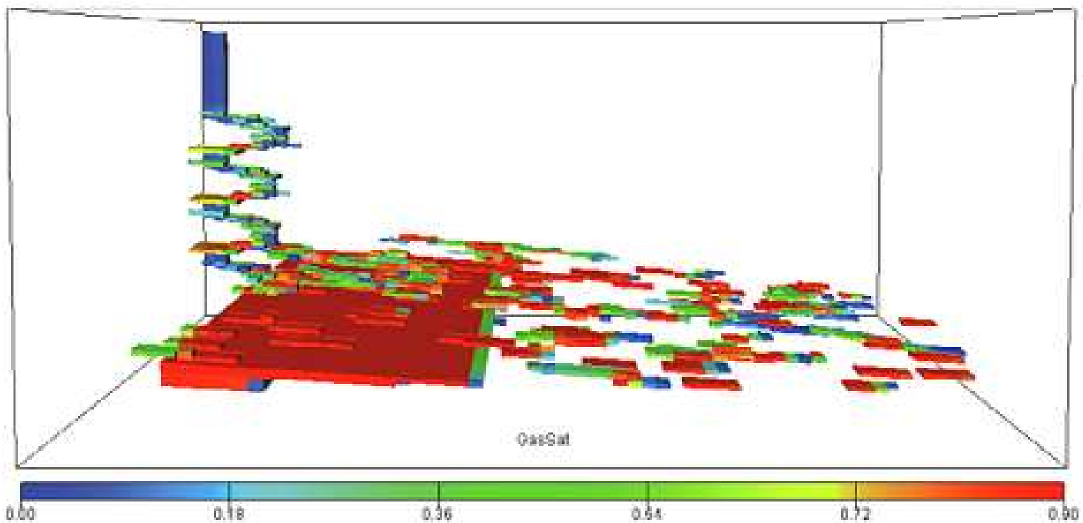
Figure 1: Model applied to CO_2 sources in the US Pacific Northwest: Potential sources, reservoirs, and candidate network route s (left), with optimized deployment for 15 Mt CO_2/year system (right), set againstcost surface

Richard S. Middleton, Jeffrey M. Bielicki (2009), in: Energy Procedia 1, 611-1616

Consequence analysis SIM



Christine Doughty et al. (2009), in: Energy Procedia 1, 3291-3298,



Alv-Arne Grimstad et al. (2009), in: Energy Procedia 1, 2511-2518,

Package 2 – 3 - 4

- **2. Mapping SIM communication**
  - What are the communication patterns of SIM towards policy?
  - Which actors are relevant (role of knowledge broker, intermediate agencies)
- **3. Transformation of SIM-results**
  - Transformation process of SIM results towards policy-makers?
  - If yes, are there general rules for explaining these changes?
- **4. Requirements from policy side**
  - What are the requirements from policy side to more efficiently/effectively use SIM results

Survey based

Conclusions

- **Promising results:**
  - Classification framework,
  - communication & transformation patterns
  - policy requirements

  >> improving the communication capabilities along science-policy

- **Challenges**
  - Integration of social, technological and natural conditions necessary for good results in predicting consequences of action in complex human-technique-nature interactions
  - Connectivity between rules, decision and noise is a challenge
  - To deal with complexity, uncertainty, ambiguity requires different methods
  - integration of ambiguity leads to a loss of accuracy

Thank you!

Contact:
Dirk Scheer
Email: dirk.scheer@sowi.uni-stuttgart.de
Tel: ++49 (0)6221-432391