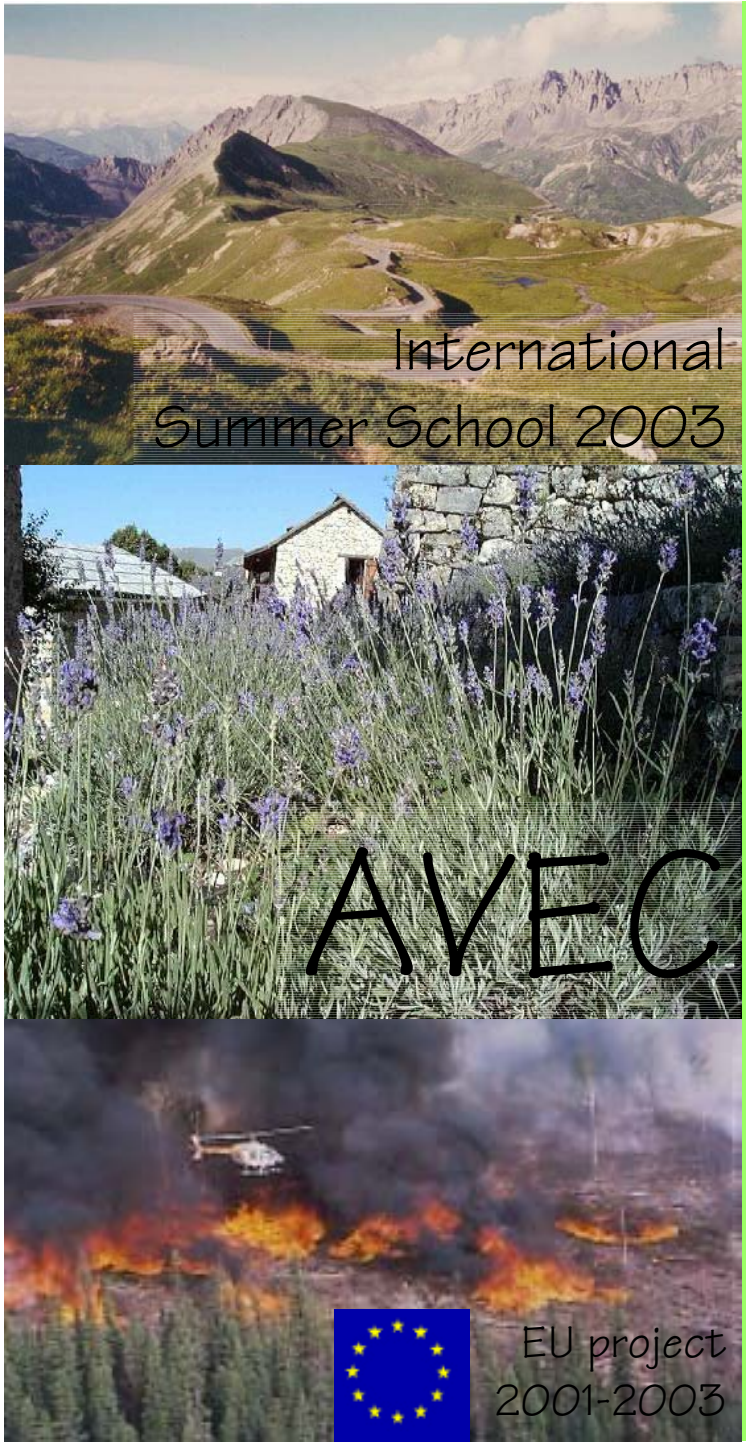

Introduction to the vulnerability concept

Dagmar Schröter

P I K

Potsdam Institute for Climate Impact Research

Uta Fritsch and her daughter
Anna Milena
– born September 5th 2003.

Overview

1 The elements of vulnerability
  - Objective
  - Vulnerable? Who, to what?
  - Exposure, sensitivity, adaptive capacity
  - Stakeholder dialogue
  - Integration

<break>

2 Framework for vulnerability assessment
  - Five criteria to satisfy
  - An eight step approach

Vulnerability: potential for harm

Vulnerability is the likelihood of a **system** to experience harm due to **exposure** to perturbations.

Vulnerability = f(Exposure, Sensitivity, Adaptive Capacity)

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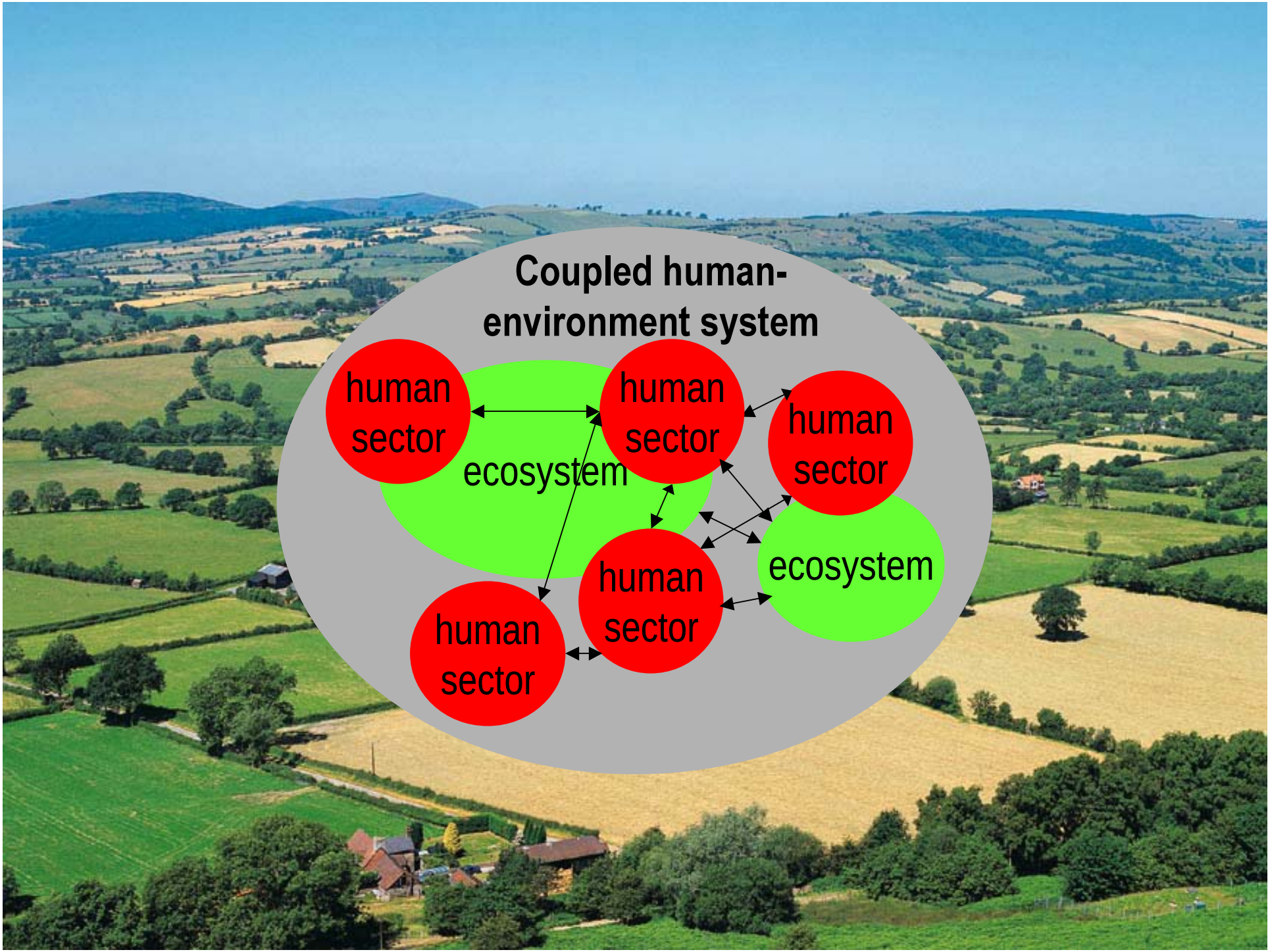
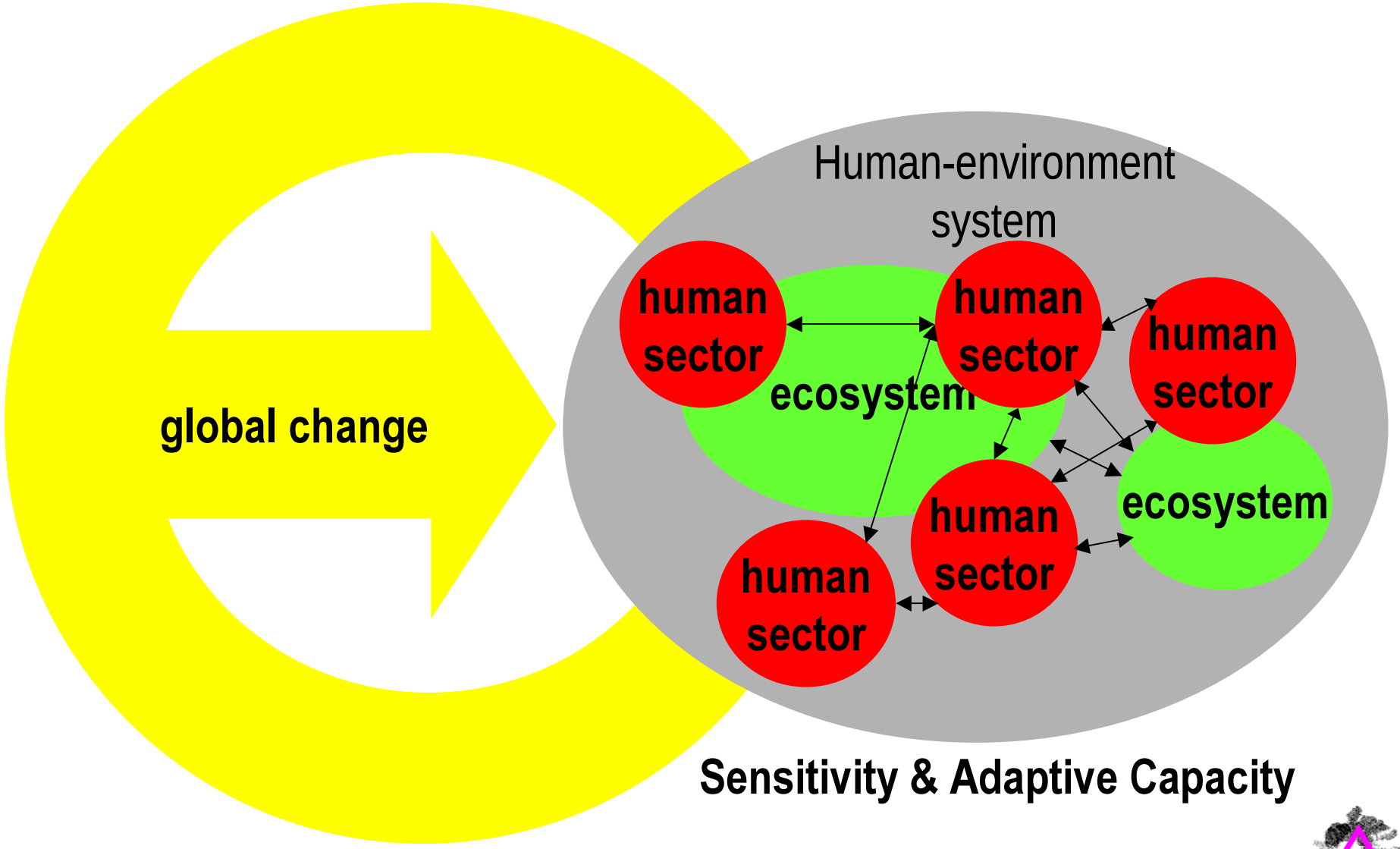
COLLECTABLES
WHSmith


Coupled human-environment system
human sector
human sector
human sector
ecosystem
human sector
human sector
ecosystem

Vulnerability: Who, to what?



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Examples of ecosystem services


food production


slope stability


tourist attraction


fire prevention


water storage


biodiversity


pollination


fibre production


fodder production


flood protection


carbon sequestration


beauty


recreation


stabilising micro-climate


game reserve


shelter for life stock

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A common, general goal of vulnerability assessment

- to inform the decision-making of **stakeholders** about options for **adapting** to the effects of **global change**

→ facilitate sustainable development

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Exposure – multiple stresses

- Atmospheric greenhouse gas and aerosol concentration changes (e.g. CO_2, methane, soot, water vapour)
- Climatic change (e.g. temperature rise, change in precipitation pattern)
- Sea-level rise
- Pollution (e.g. deposition of nitrogen, phosphorus, sulphur)
- Land use change (e.g. abandonment of land)
- Socio-economic change (e.g. population growth, lifestyle changes, demand changes, markets & welfare)

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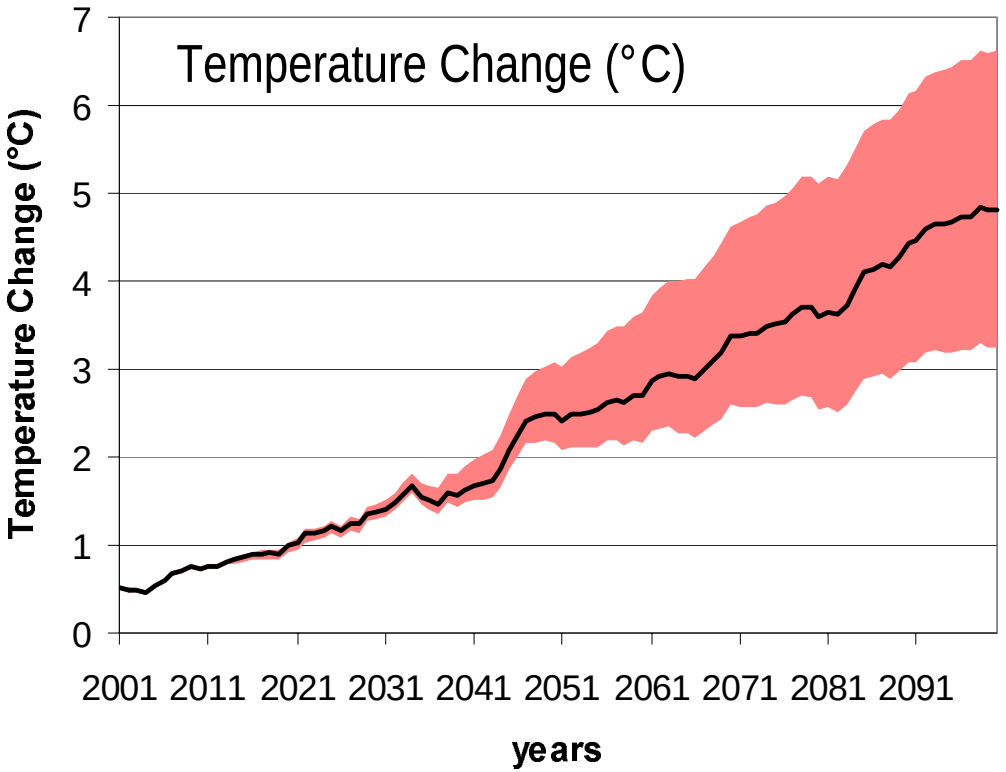
Exposure - what do we need to know?

- degree and rate of change
- degree and rate of variation
- extreme events: severity, frequency, time of occurence



Europe, 4 GCMs,
4 SRES
relative to 1961-1990

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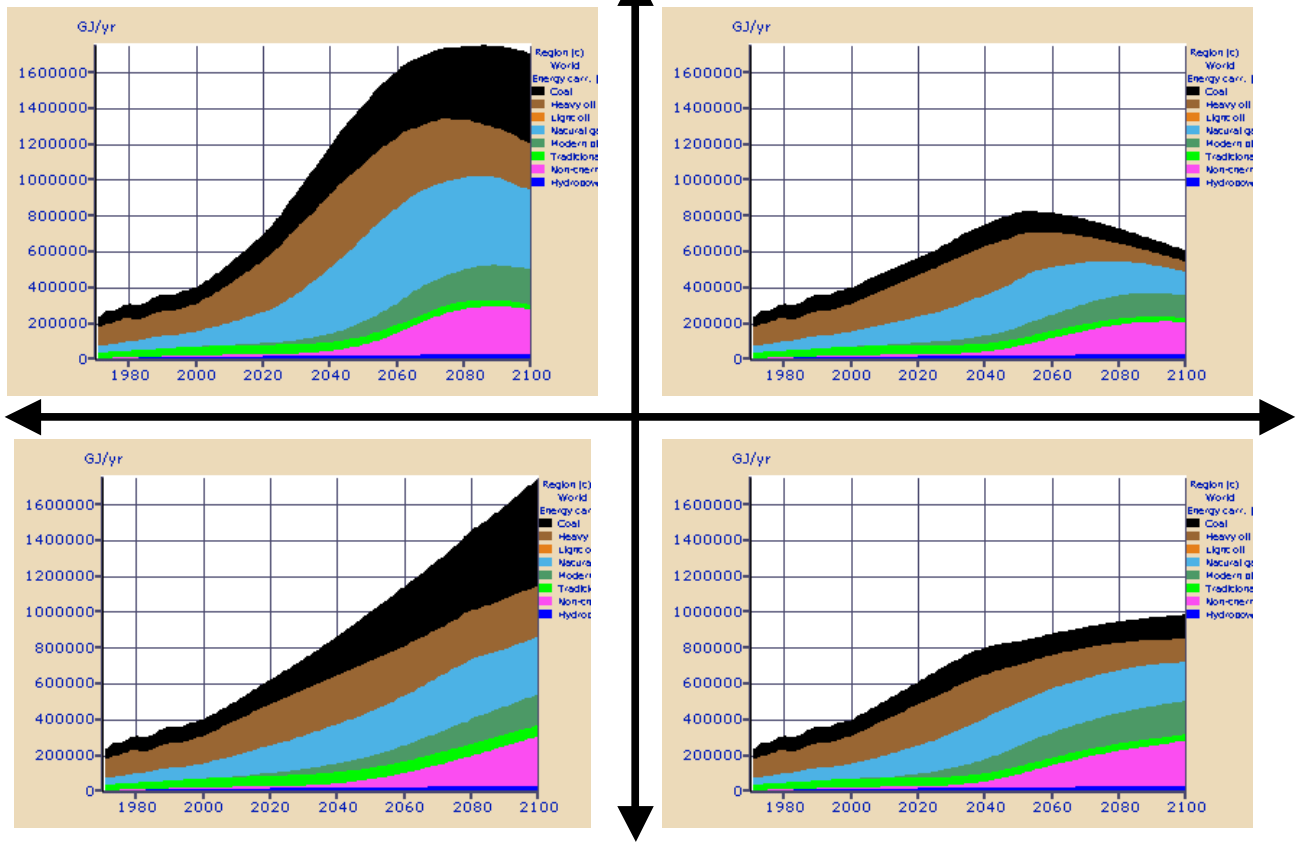
The IPCC/SRES reference scenarios

Complete globalisation

Emphasis on material wealth



Emphasis on sustainability and equity

Strong regionalisation

e.g. energy use

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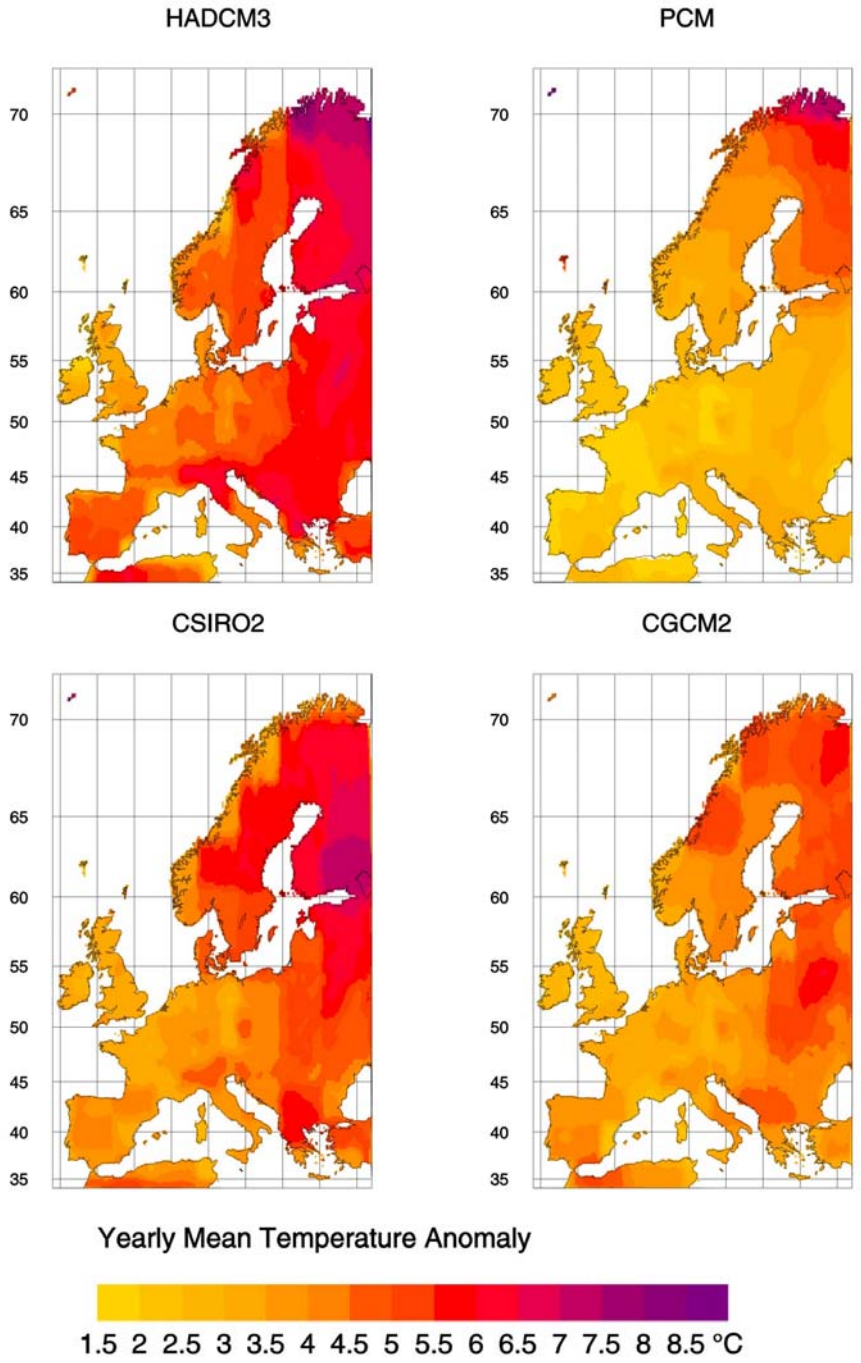
Climate change scenario – temperature

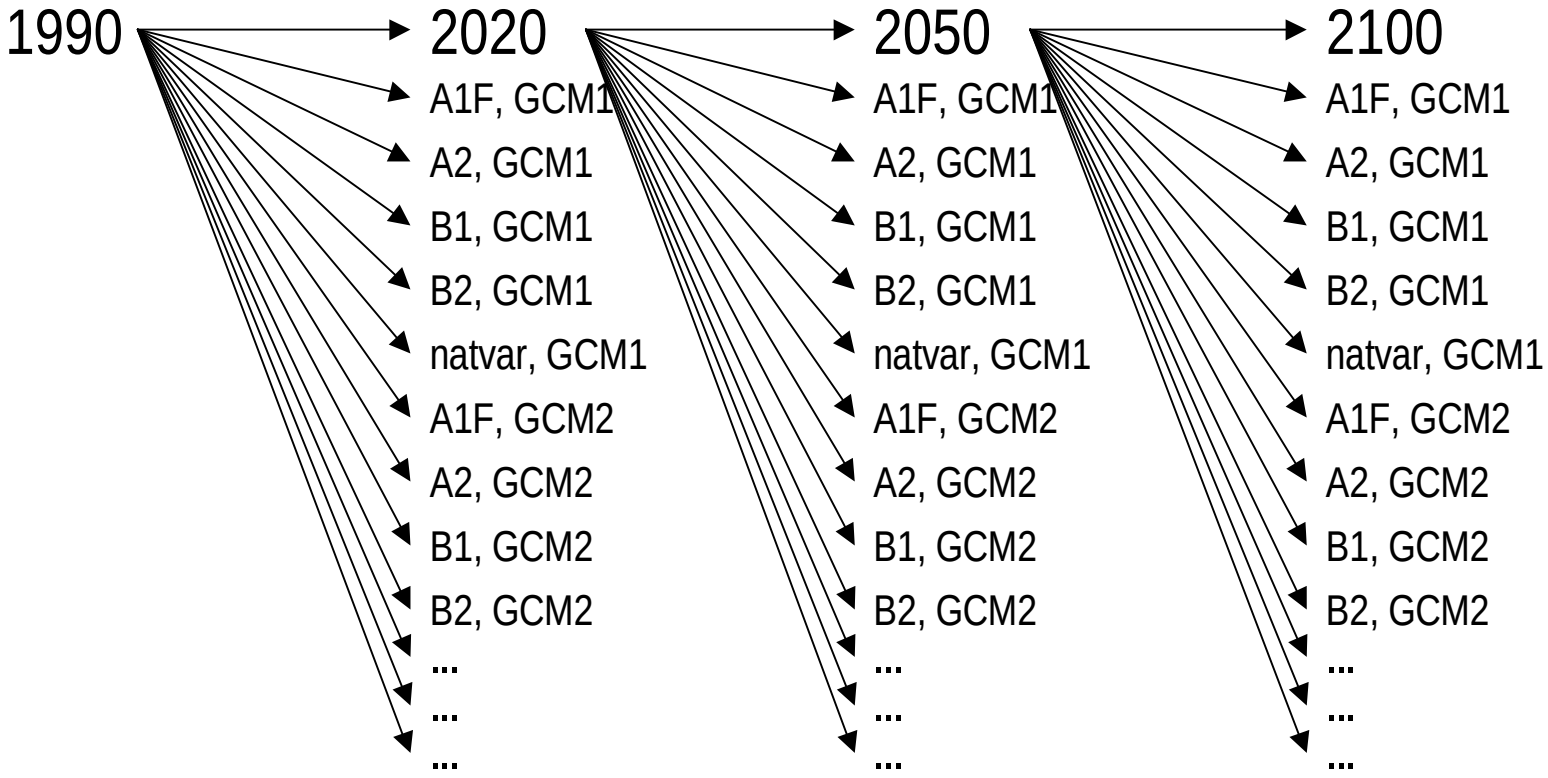
Regional variability.
Comparison of different climate models (GCMs).

Anomaly
2091-2100 vs. 1991-2000
(SRES A2)



Multiple scenarios

to span a large range of possible futures



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Exposure

Sensitivity

Adaptation

Sensitivity – multiple sectors

The degree to which a human-environment system is affected, either adversely or beneficially, by global change.

- Water sector
- Agricultural sector: Food resources (e.g. quality, quantity, security)
- Human health sector
- Biodiversity
- Beauty (cultural, natural)
- etc...

Translating exposure and sensitivity into impacts: *models of the human-environment system*

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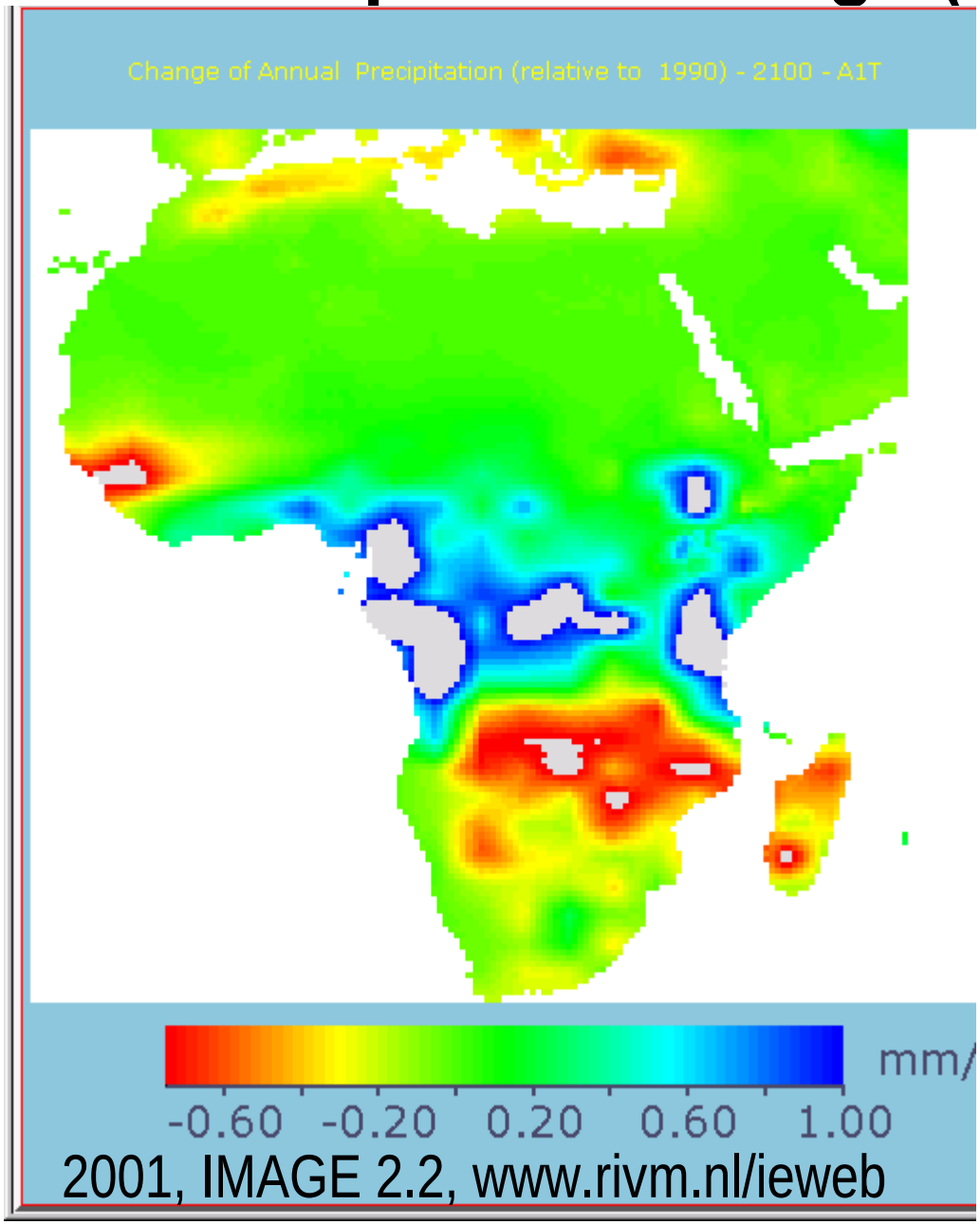
Exposure: Precipitation change (mm/d)



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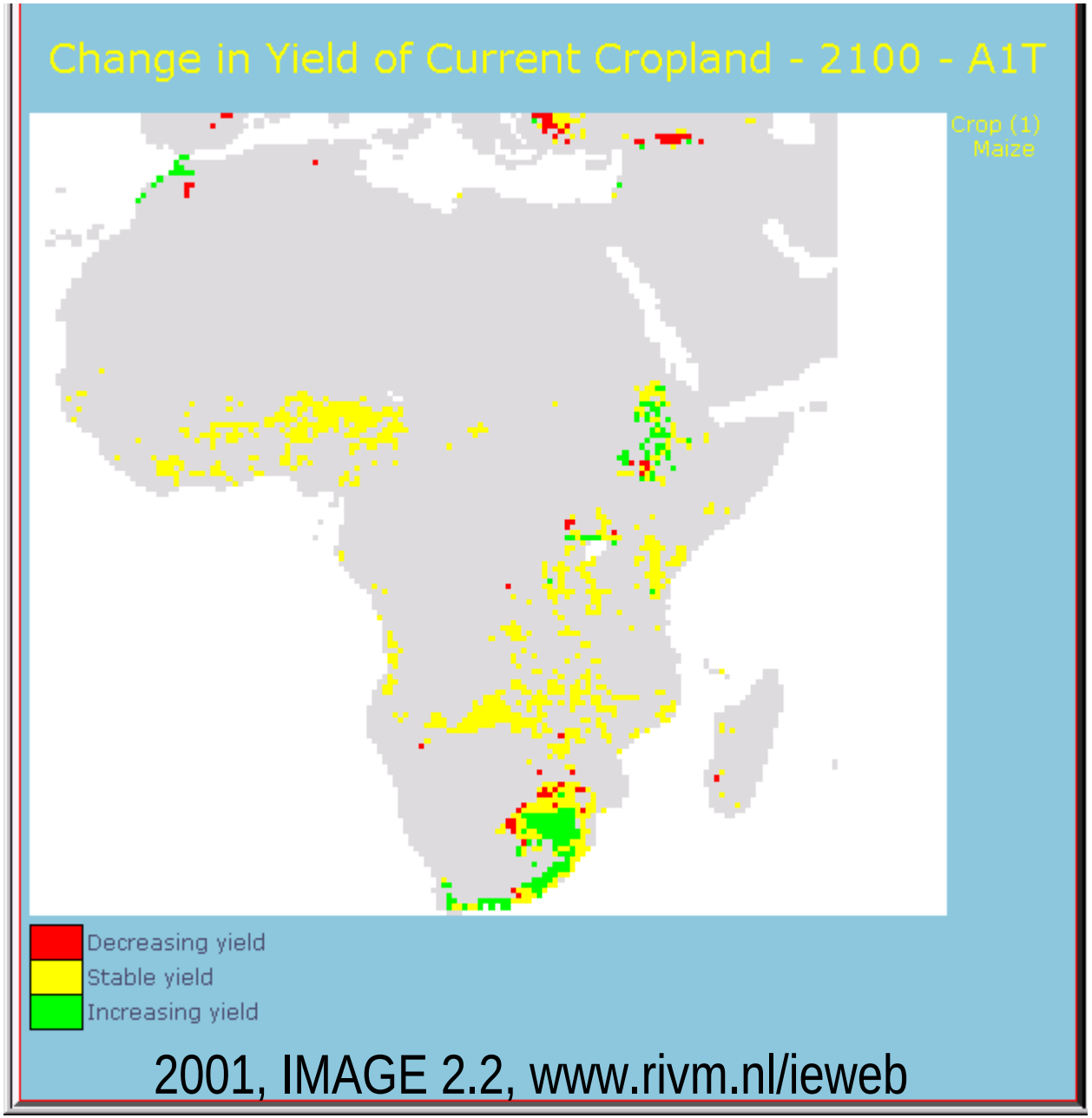
Sensitivity → Changes in yield: Maize



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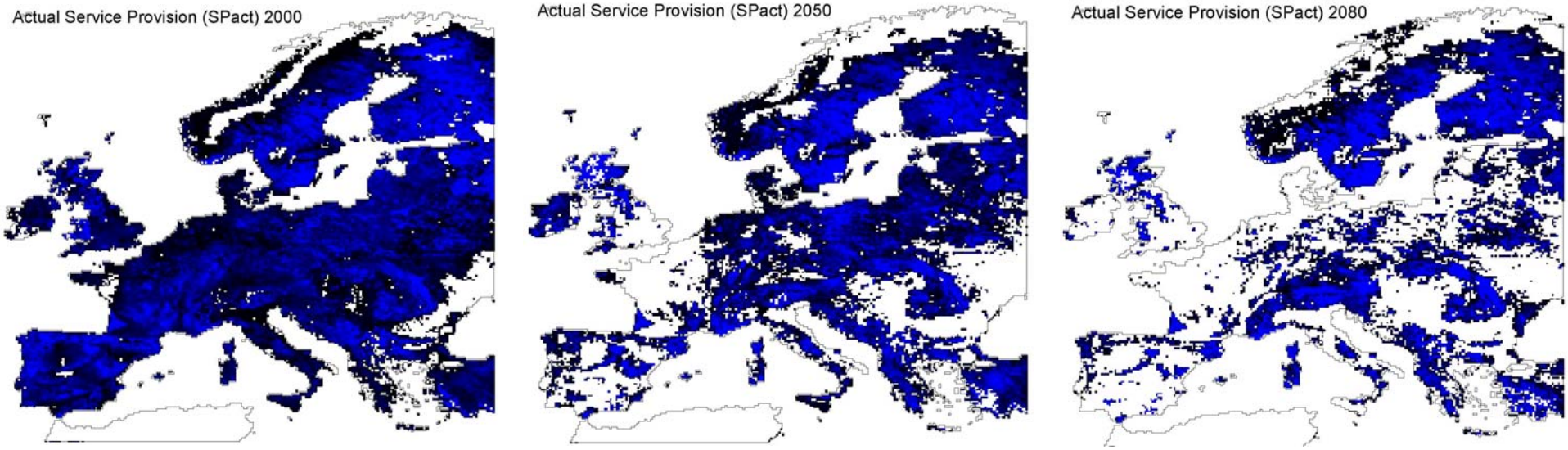
Ecosystem service
e.g. C storage

Driven by climate, CO_2 concentration and land use change



2000 2050 2080

high low

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Exposure

Sensitivity

Adaptation

Adaptive Capacity – multiple actors

The ability to implement
planned adaptation measures.

Planned adaptation:
The result of a **deliberate decision** based on an **awareness** that conditions have changed or are about to **change** and that **action is required** to return to, maintain or achieve a desired state.

Adaptive capacity

- Knowledge
  - Awareness
  - Understanding
- Will
  - Trust
  - Motivation
  - Values
  - Urgency
- Power
  - Freedom
  - Equity
  - Technology
  - Wealth

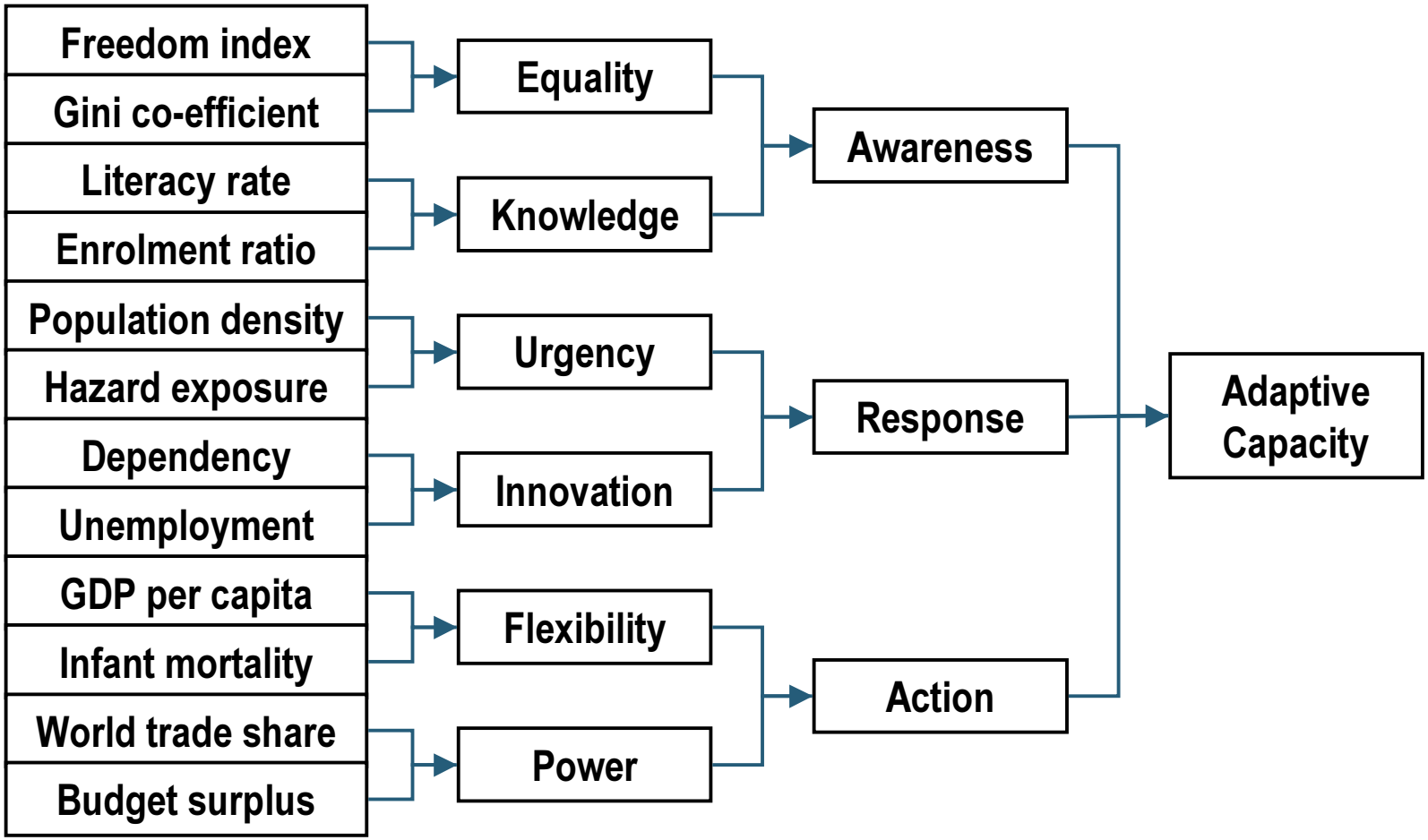
Countries
Provinces
Cities
Villages
Sectors
Groups
Individuals

ATEAM – **regional adaptive capacity**

Macro-scale indicator

- quantitative
- spatially explicit (NUTS2, provinces)
- SRES based

Fuzzy Logic Approach



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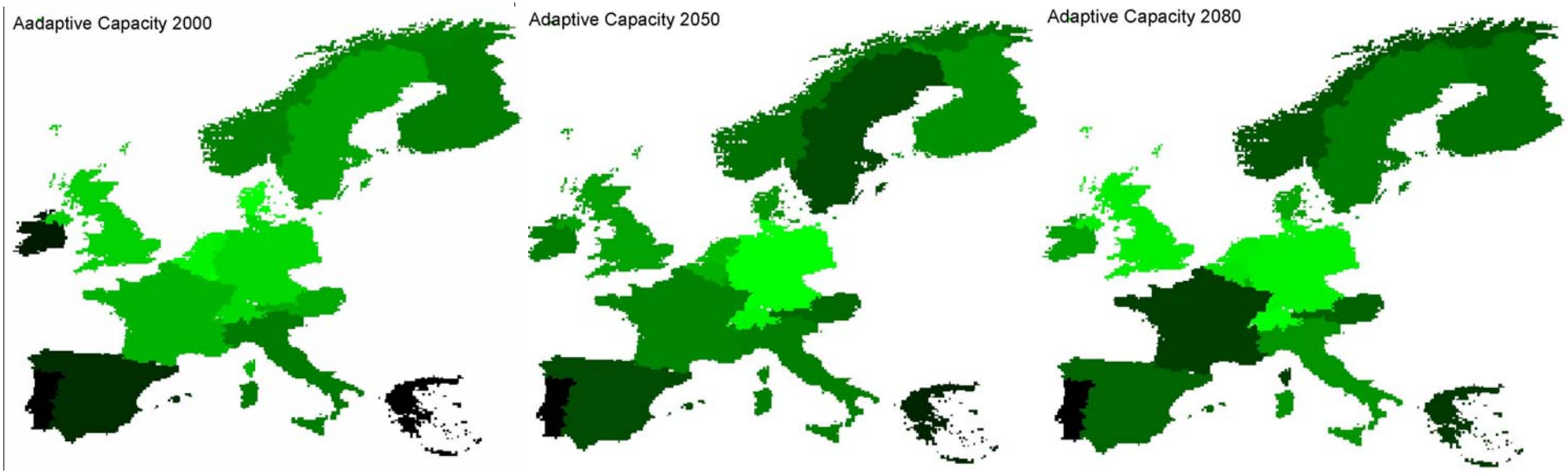
Adaptive Capacity



2000 2050 2080

low high

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Stakeholder Dialogue

Why talk to Stakeholders?

- To identify **relevant sensitivities** (e.g. of ecosystem services) and indicators
- To learn about useful **temporal** and **spatial scales**
- To learn about their **ways to adapt** and the determinants and boundaries of adaptive capacity
- To discuss **interactions** between sectors
- To facilitate **sustainable management**, to improve our **research agenda**, to raise **awareness** of our results

Vulnerability measures: Integration

- Should allow for **causal analysis**
- Should allow **comparison of regions and scenarios**
- Scale: low, medium, high
- Are **sector/user specific** (e.g. may be different for agricultural consumers and suppliers)
- Should be **transparent** to scientists and non-scientists

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Summary part 1: Elements of VA

- **Exposure:** Multiple scenarios of global change, **all relevant drivers** (Climate, Atmospheric Comp., Land use, N deposition)
- **Sensitivity** of the human-environment system: models, e.g. to estimate **changes in ecosystem services**
- **Adaptive capacity:** indicators of people's knowledge, will and power to innovate
- **Stakeholder dialogue**: reality check with users, social learning
- Integration into **vulnerability measures** that allow for causal analysis, comparison of regions and scenarios

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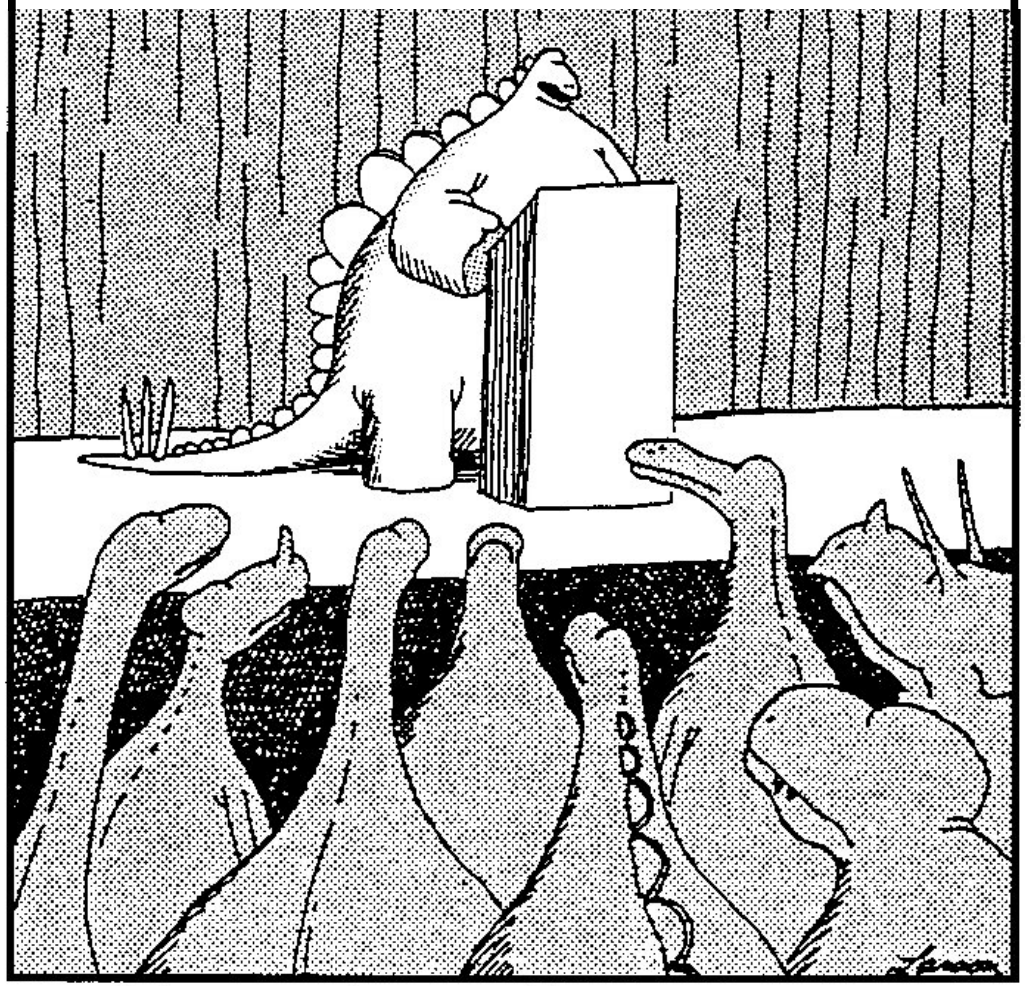
ATEAM Stakeholder Dialogue

September 12-13, 2002, Potsdam



"The picture's pretty bleak, gentlemen. ...
The world's climates are changing, the mammals
are taking over, and we all have a brain
about the size of a walnut."

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Vulnerability assessment

Vulnerable? Who, to what?

- Vulnerability of the human-environment system to global change

General aims

- to inform the decision-making of stakeholders about options for adapting to the effects of global change

Success is measured by **scientific validity** of results and **usefulness to stakeholders**.
Usefulness to stakeholders alone is not a sufficient sign of success, nor is scientific validity.

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Five criteria to satisfy

Vulnerability assessment
(rooted in *impact assessment, risk/hazard research, food security studies*)

1. should have a knowledge base from various disciplines and stakeholder participation
2. be place-based
3. consider multiple interacting stresses
4. examine differential adaptive capacity
5. be prospective as well as historical

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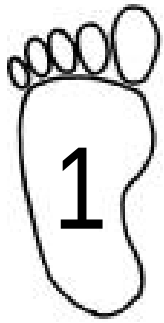
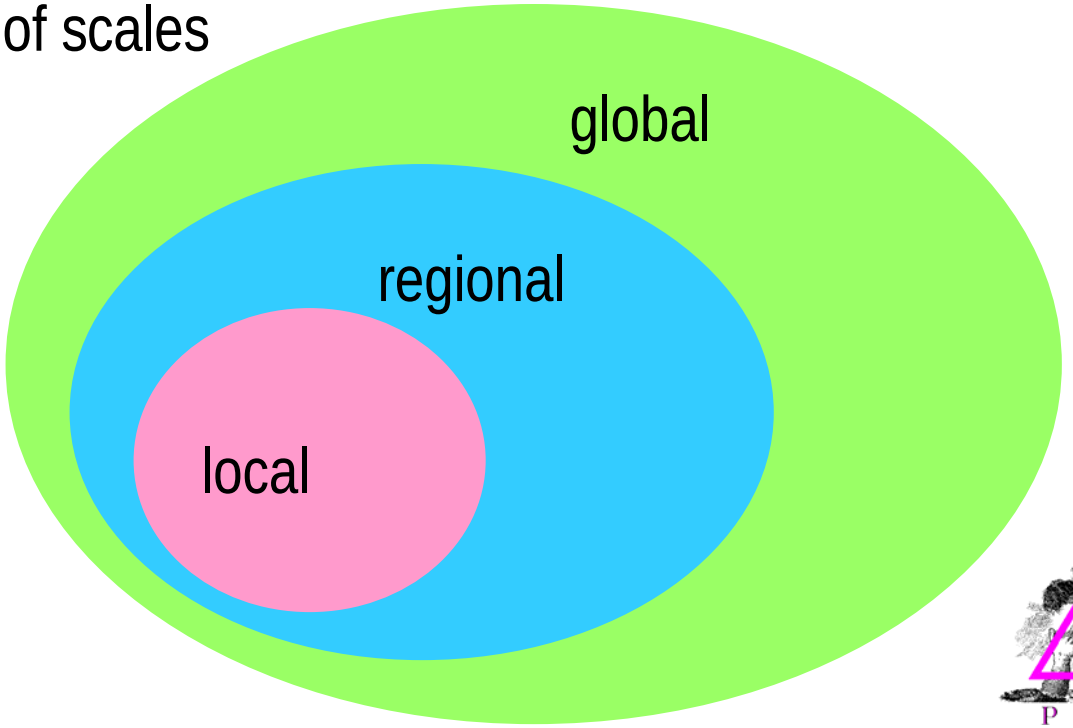
An eight step approach to
vulnerability assessment



Define study area together with stakeholders

- Place-based (rather than generic for a whole country)
- Involve stakeholders from the start
- Be aware of the nesting of scales



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Get to know place over time

- Develop knowledge on stakeholders and system, ecosystem services, drivers
- Options for action: Which drivers lie inside, which outside influence?
- Awareness of previous studies
- Spend time in the area, with people (*Much of what is important does not exist in written form)*

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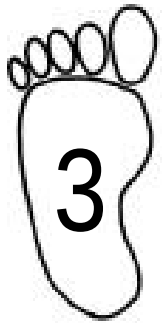

Hypothesize who is vulnerable to what

- **Focus** by hypothesizing: which stresses pose a risk to which people
- Don' t try to analyse too much
- Transparency of criteria for focus:

"We assessed the vulnerability of these stakeholders, because they paid our salaries..."

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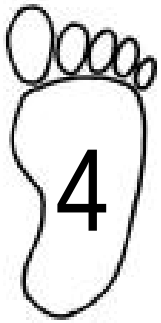
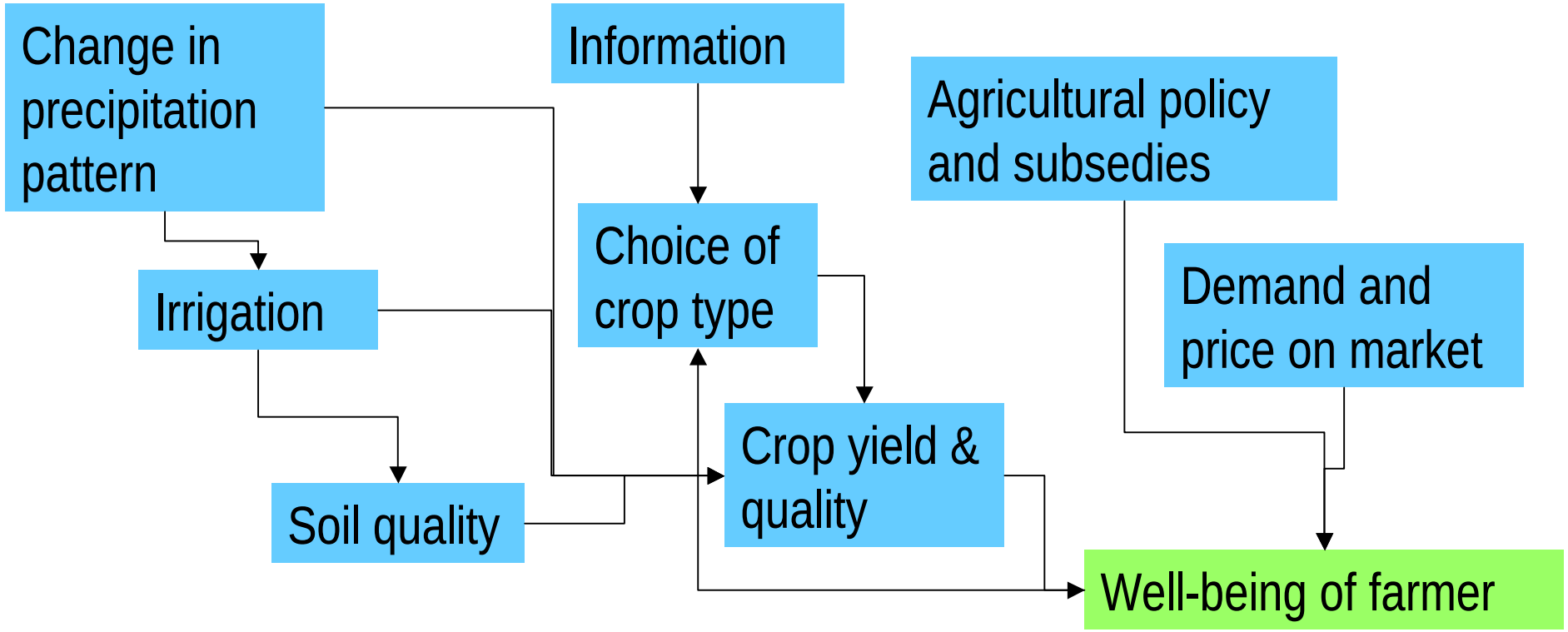


Develop a causal model of vulnerability



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Find indicators for the elements of vulnerability

- Develop set of indicators for exposure, sensitivity and adaptive capacity
- There is no universally applicable metric for vulnerability
- Transparency: missing or problematic indicators

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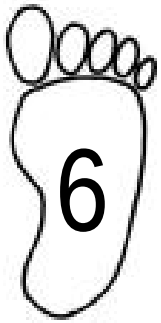

Operationalize model(s) of vulnerability

- Numerical model(s), e.g. ecosystem models for sensitivity, socio-economic models for adaptive capacity
- Models should be spatially explicit and handle time series data
- Models should be validated (phoooey!)
- **Integration into vulnerability**: weight and combine indicators

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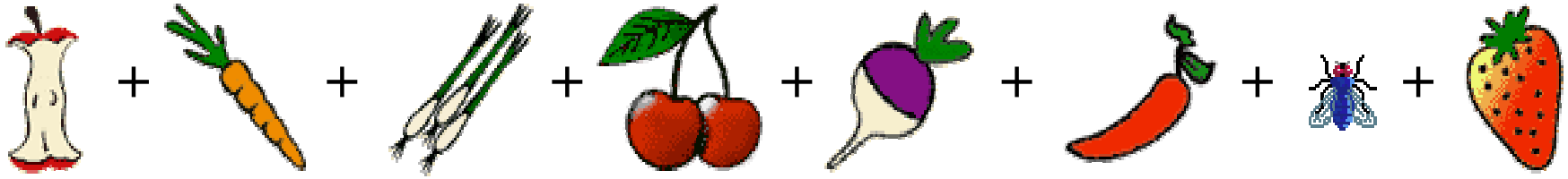
Integration into vulnerability

- V = f (E, S, AC)
  - Quantitative information, projections of indicators
  - Qualitative information (stakeholder dialogue)
- Overlaying of indicator maps
- Causal model → trends in indicators → qualitative differential equations
- ....<void>...



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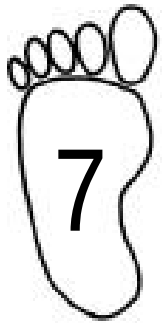

Project future vulnerability

- Run model(s) with multiple scenarios of driving variables
- Projections should correspond to time horizon of decision making of stakeholders
- Stakeholders influence scenario development (targeted if-then-analysis)

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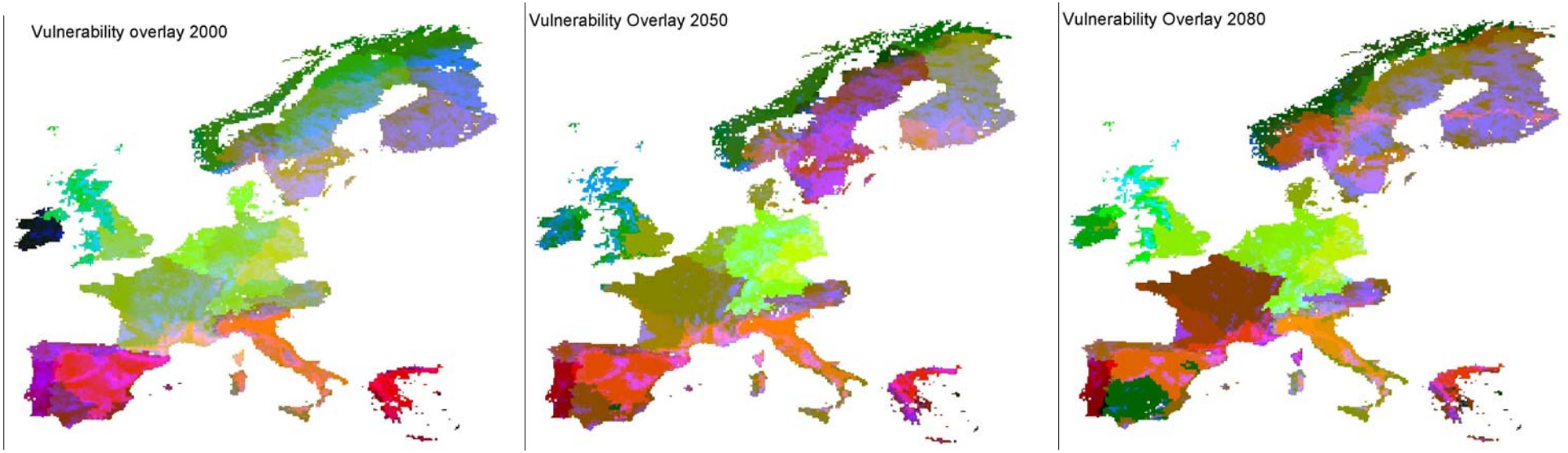
Vulnerability - overlaid maps



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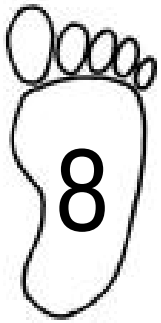

Communicate vulnerability creatively

- *This is not the last step*: continuous, long-term dialogue
- Two-way flow of information, interactive tools, social learning
- Communicate uncertainty openly, provide guidance on understanding of probabilities
- Development of learning mechanisms
  (*Our assessment will be wrong.*)

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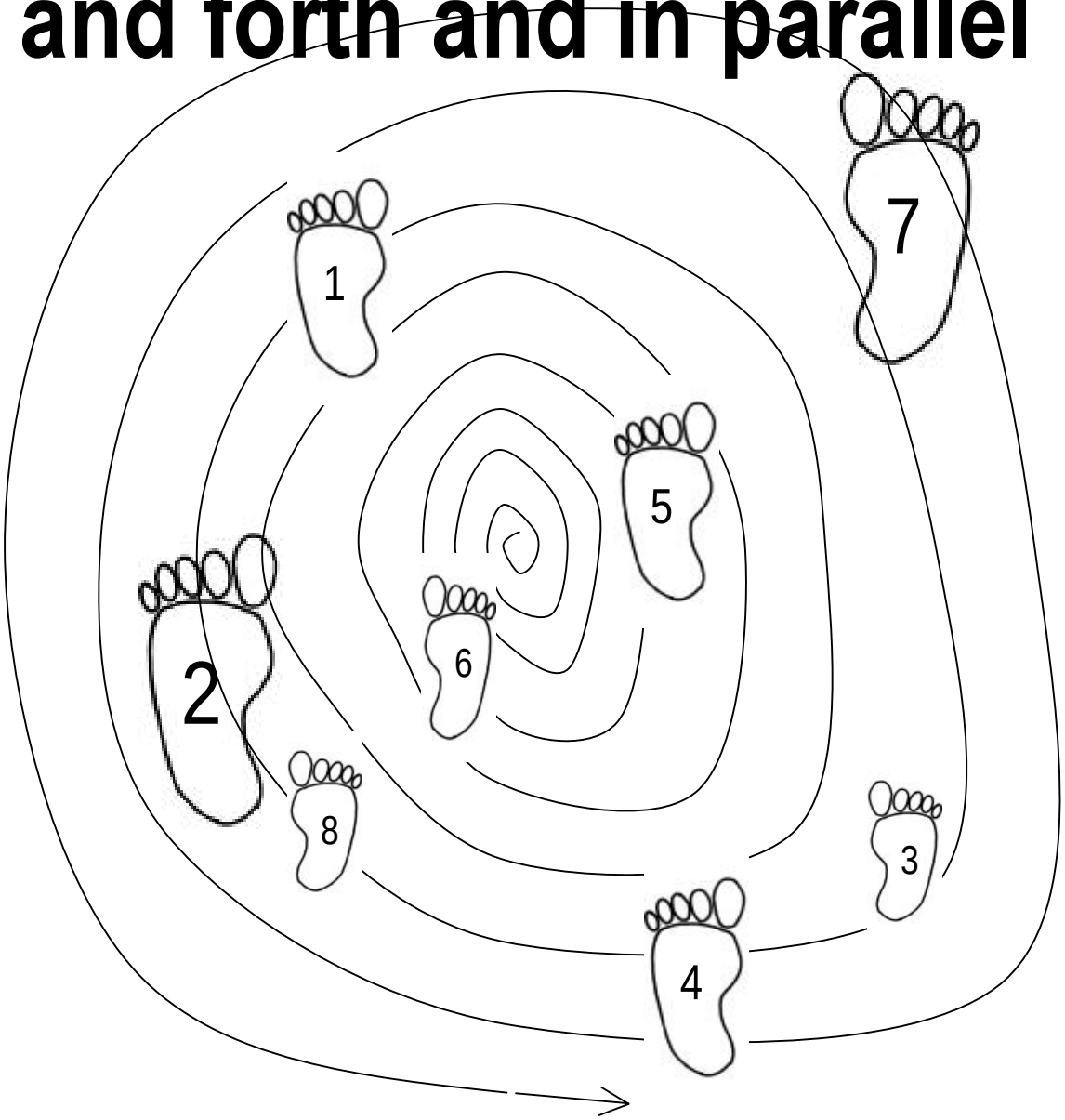
Team up, coordinate well, go back and forth and in parallel



Common framework, "Public good"

Generalisation through cross site comparison

- ATEAM, AVEC and EVA
  www.pik-potsdam.de/ateam (resp. avec, eva)
- Millennium Ecosystem Assessment (MA)
  www.millenniumassessment.org
- IPCC / SRES
  www.ipcc-ddc.cru.uea.ac.uk/
  www.sres.ciesin.columbia.edu/tgcia
- Research and Assessment Systems for Sustainability (RASSP)
  http://sust.harvard.edu

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Summary

- Vulnerability is the **likelihood of harm** of the **human-environment system** due to global change
- Vulnerability = f(Exposure, Sensitivity, Adaptive Capacity)
- General aim: to **inform the decision-making of stakeholders** about options for **adapting** to the effects of *global change*
- Assessing vulnerability: **interdisciplinary team** and **continuous dialogue with stakeholders**
- Exposure: **multiple stresses, uncertainty, multiple scenarios**
- Sensitivity: **people rely on ecosystem services**
- Adaptive capacity: **depends on scale, people, context**
- Estimates of vulnerability will be wrong: caution, flexibility, learning mechanisms

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THANK YOU
Summerschool 2003, for your attention!
Marc Metzger, Sönke Zaehle, Anne de la Vega-Leinert, Wolfgang Cramer, Rik Leemans, Richard Klein, Lilibeth Acosta-Michlik, Colin Polsky, Tony Patt

Common framework, "Public good"

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