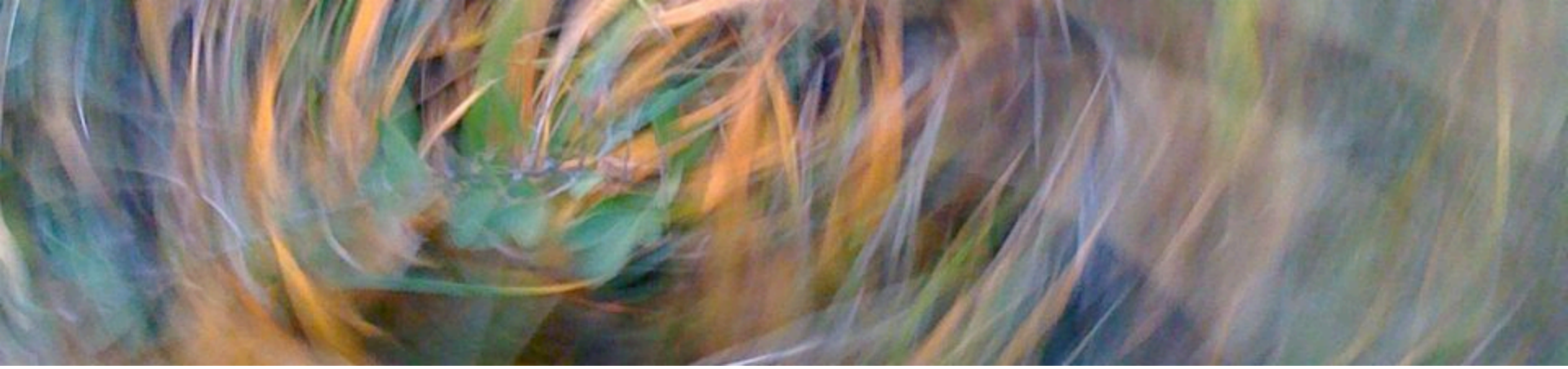
TS-02 Part 2: Focusing on scenarios of change

This afternoon

- 30 min: Scenario building (Dagmar)
- 30 min: Climate uncertainty (Dagmar for Stephan)
- 30 min: Exercise, Reporting back
- 5min: Wiki Introduction (http://changes-scenarios.wikispaces.com/)

Tomorrow morning

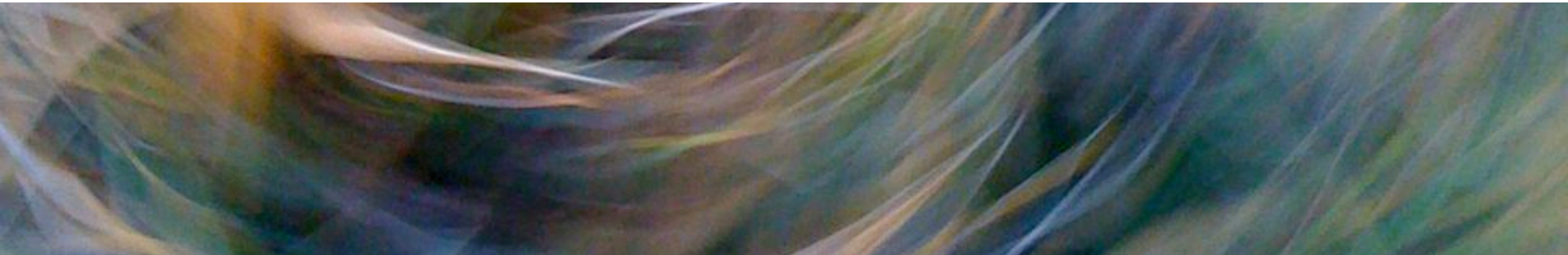
- 45 min: Modeling land use change (Sophie)
- 45 min: Discussion: Challenges of projections and scenarios



Scenario building – narratives as an integral part of preparing for the future

Dagmar Schröter

Risk, Policy and Vulnerability,
International Institute of Applied Systems Analysis (IIASA),
Sept. 2012

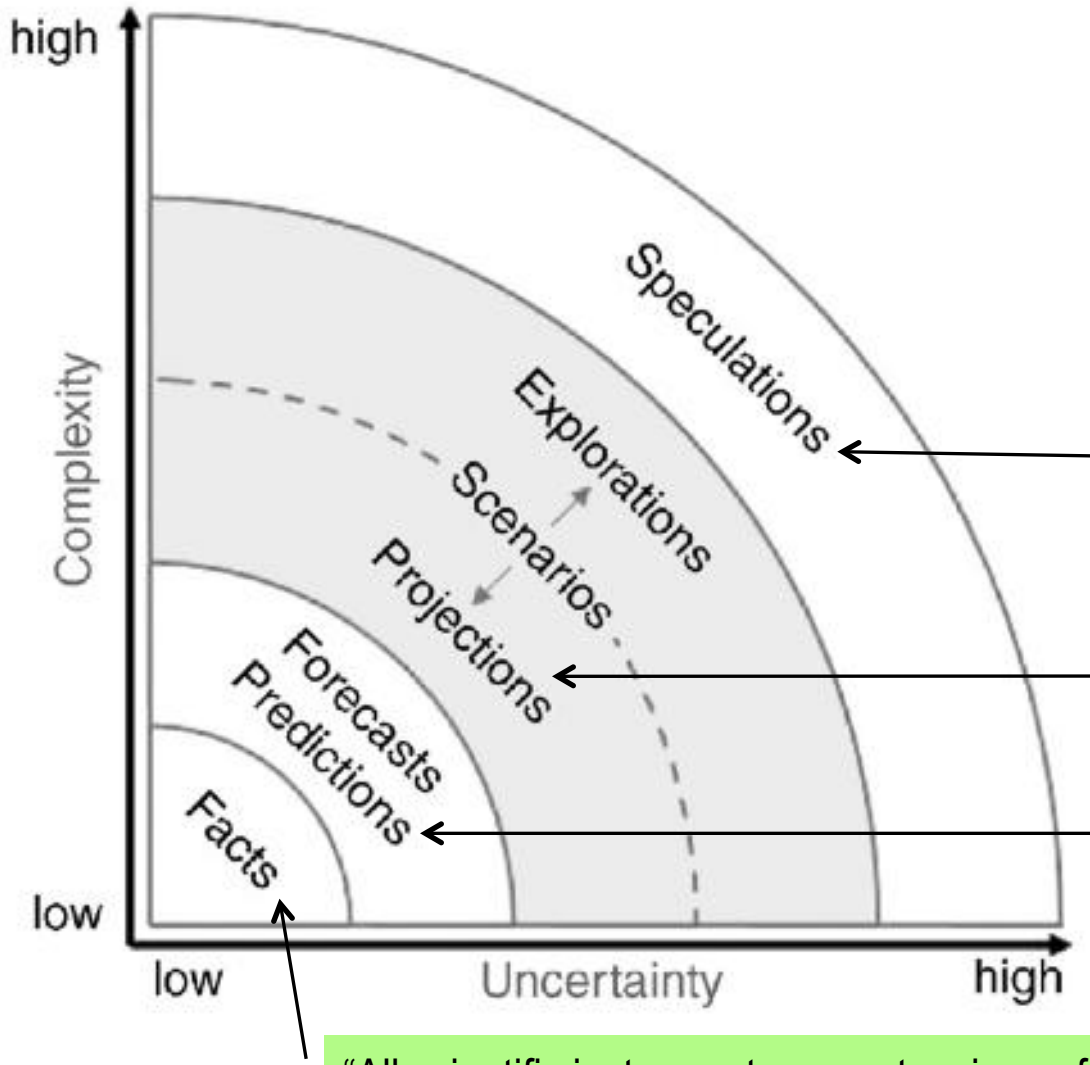


What are scenarios?

- Scenarios are plausible descriptions of how the future may unfold based on 'if-then' propositions.

- Scenarios are **not** extrapolations, forecasts or predictions.

Complex and uncertain: Scenarios



y-axis: Understanding of system's complexity/causalities;
x-axis: Uncertainty about development of key drivers

e.g. price of kWh electricity in 20 years

e.g. climate system

e.g. aquarium in a lab

"All scientific instruments are extensions of our senses." (J. Kabat-Zinn)

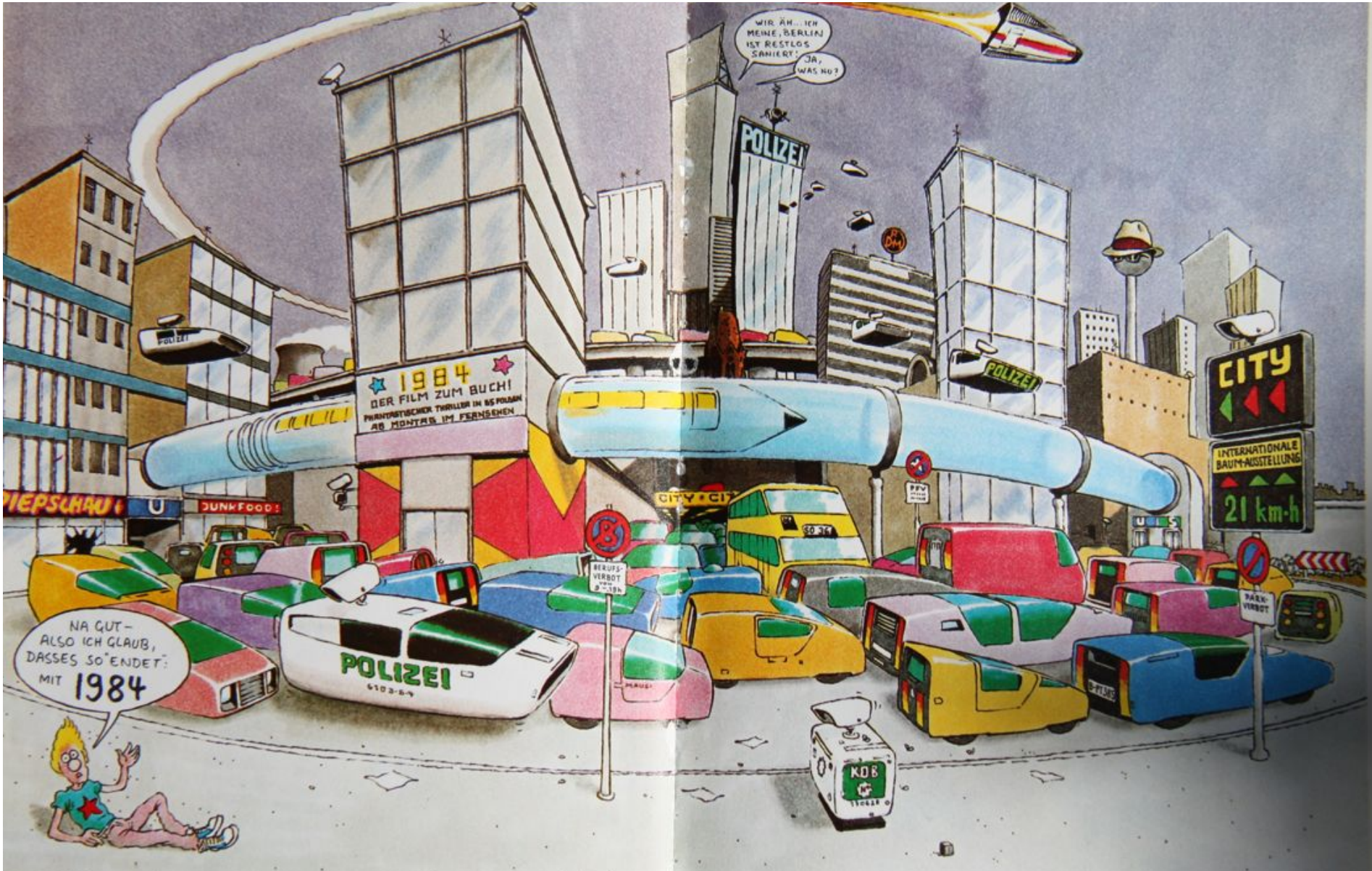
Zurek, M., Henrichs, T., 2007. *Technological Forecasting and Social Change.*

History of Scenario Use

- Scenarios: part of the arts (theater production, film, …)
- Scenario analysis: part of military planning, e.g Cold War
- In 1967, Herman Kahn brought scenario analysis to the attention of the US public and scientific community ("The year 2000"), Gaston Berger did the same in Europe ("La Prospective")
- Big corporations start using scenario analysis, leader in this: Shell Oil (started 1971, helped in oil shock of 1973)
- Currently, scenarios are used for environmental studies (IPCC* AR5** will use the third generation of scenarios)

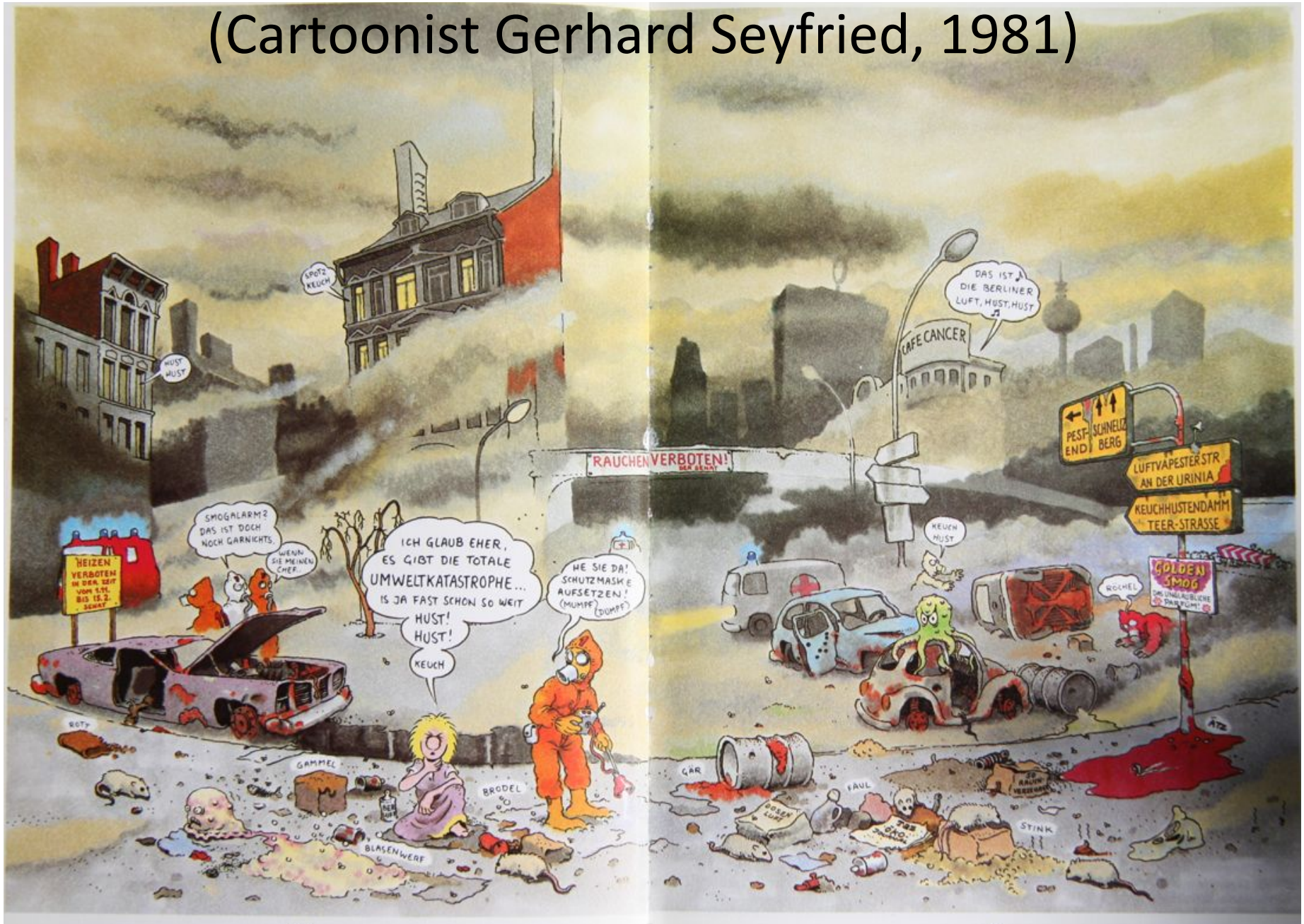
*Intergovernmental Panel on Climate Change,
**Assessment Report

Techno-Optimist
(Cartoonist Gerhard Seyfried, 1981)



Eco-Pessimist

(Cartoonist Gerhard Seyfried, 1981)



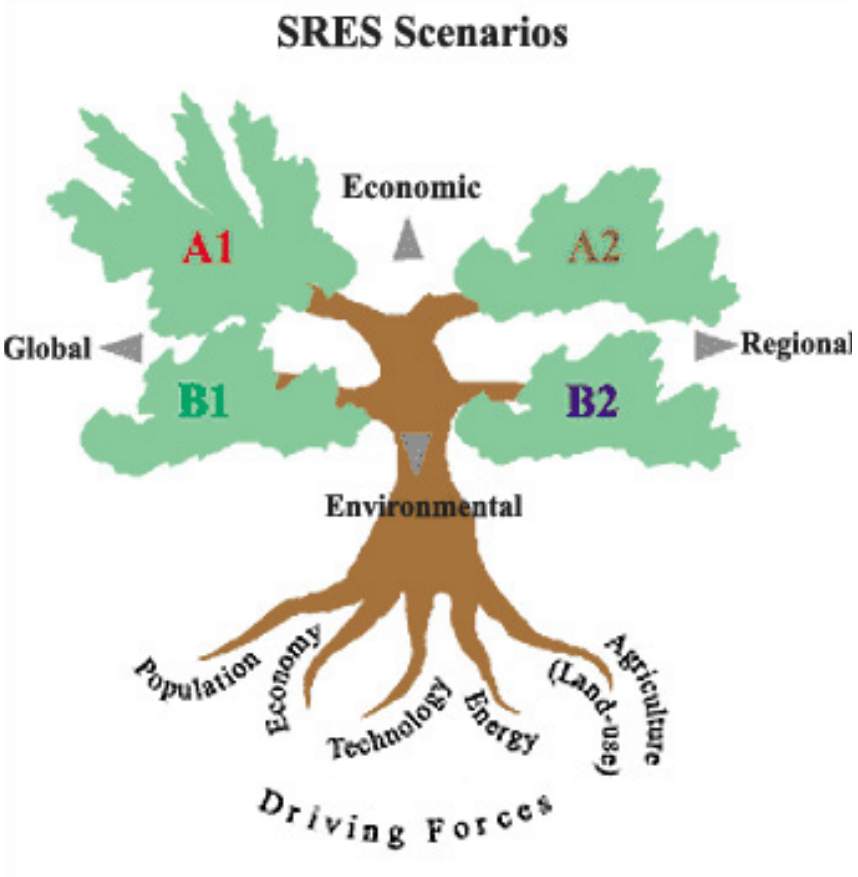
Romantic Eco-Optimist

(Cartoonist Gerhard Seyfried, 1981)

Film maker Francois Truffaut 1966

Fahrenheit 451, film (Truffaut 1966),
based on a novel by Ray Bradbury 1953.

Expert panel, more than 50 members from 18 different countries, 2000.



Special Report on Emissions Scenarios (IPCC SRES), Nakicenovic et al. 2000.

Scenario analysis

- Explores alternative futures. Two main objectives:

1. To imagine/estimate the future environment and society.
2. To test strategies of sustainable development against the backdrop of future developments, and to find robust strategies.

If we see something
worrisome coming...

…we might be able to dodge it.

Other objectives of scenario analysis

- Raise awareness of decision makers about the uncertainty of the future.
- Alert decision makers to emerging problems.
- Alert decision makers to possible surprises.
- To help everyone to "think big" about a problem – creative, comprehensive, open.

Qualitative vs. quantitative scenarios

Qualitative Scenarios	**Quantitative Scenarios**
Understandable, interesting.	"Scientific" (based on explicit models)
Lack of exactness leads to exploration.	Exactness gives illusion of certainty.
Can represent views and complexity of many different interests.	Limited view of the world, often not transparent.
Arbitrary, tough to identify and test underlying assumptions, no numerical information.	Underlying assumptions can be identified and tested, information is numerical.

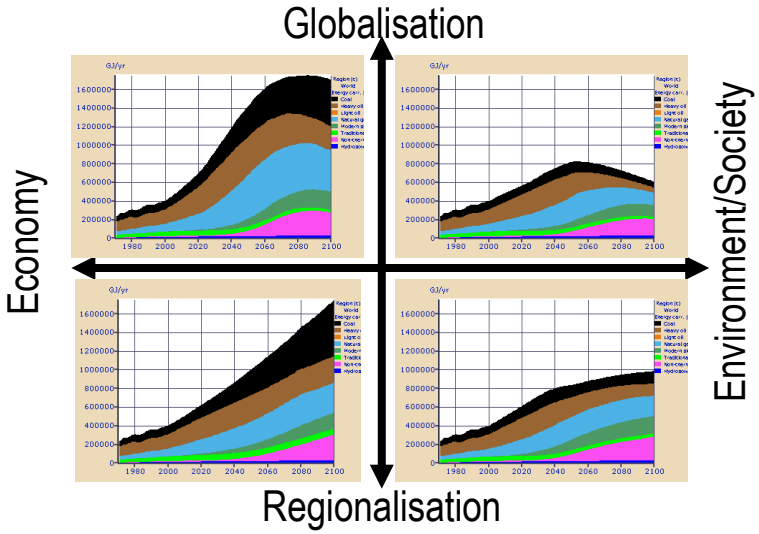
Enjoy both and use both with caution.

Story-and-Simulation Approach

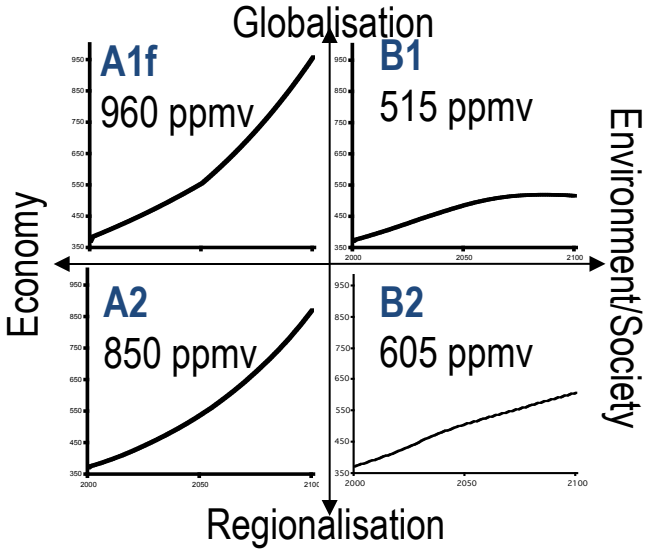
- Produces both storylines (qualitative) and numbers (quantitative information)
- Storylines: understandable, express complex dimensions of a problem.
- Quantification: consistency check of different assumptions of qualitative scenarios, provides numbers
- Is an iterative process engaging both stakeholders and scientists/modelers

Examples of Story-and-Simulation Approach

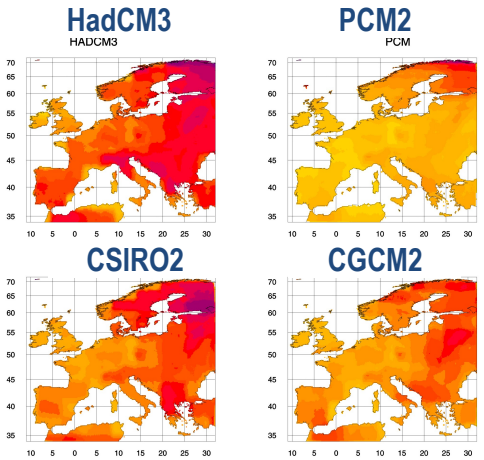
- Millennium Ecosystem Assessment
- UNEP Environmental Outlook
- World Water Commission
- Intergovernmental Panel on Climate Change (IPCC)
  - First IS92 scenarios
  - Second SRES (Special Report on Emissions Scenarios)
  - now RCP (Representative Concentration Pathways), SSP (Shared Socio-economic reference Pathways), and SPA (Shared Climate Policy Assumptions)



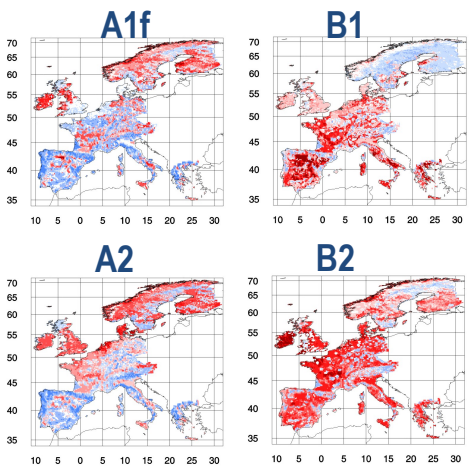
SRES quantification: Energy use
(integrated assessment model IMAGE)



Atmospheric greenhouse gas concentration



Climate Scenarios
(four general circulation models, GCM)



Landuse Change Scenarios
(agriculture, forest, grassland, urban, protected area)

Latest scenarios for the Intergovernmental Panel on Climate Change (IPCC)

- RCP forward (quantitative): emissions/ greenhouse gas concentrations, atmospheric pollution, crude land use > climate
- RCP backward (quantitative and qualitative): emissions/greenhouse gas concentrations, atmospheric pollution, crude land use > SSP (Shared Socio-economic reference Pathways), and SPA (Shared Climate Policy Assumptions)
- Detailed land use based on both above processes

Elements of a Scenario

1. A base year (or period) and a description of the state of things then
2. A time horizon (or period) and time steps. A description of the state of things at the end point of the scenario
3. A geographic coverage
4. A description of stepwise change
5. Driving forces or uncertainties – the main factors that influence the step wise changes of the scenario
6. A storyline – a narrative that presents the important aspects of a scenario, including the relationship between driving forces and events of the scenario

Steps in Qualitative Scenario Development

1. Select objective and boundary conditions
2. Select theme
3. Select actors and factor
4. Develop mini-scenarios for each theme
5. Reduce number of mini scenarios
6. Write full scenario – storylines

A transdisciplinary, long-term, iterative process.

Step 1: Select objectives and boundary conditions

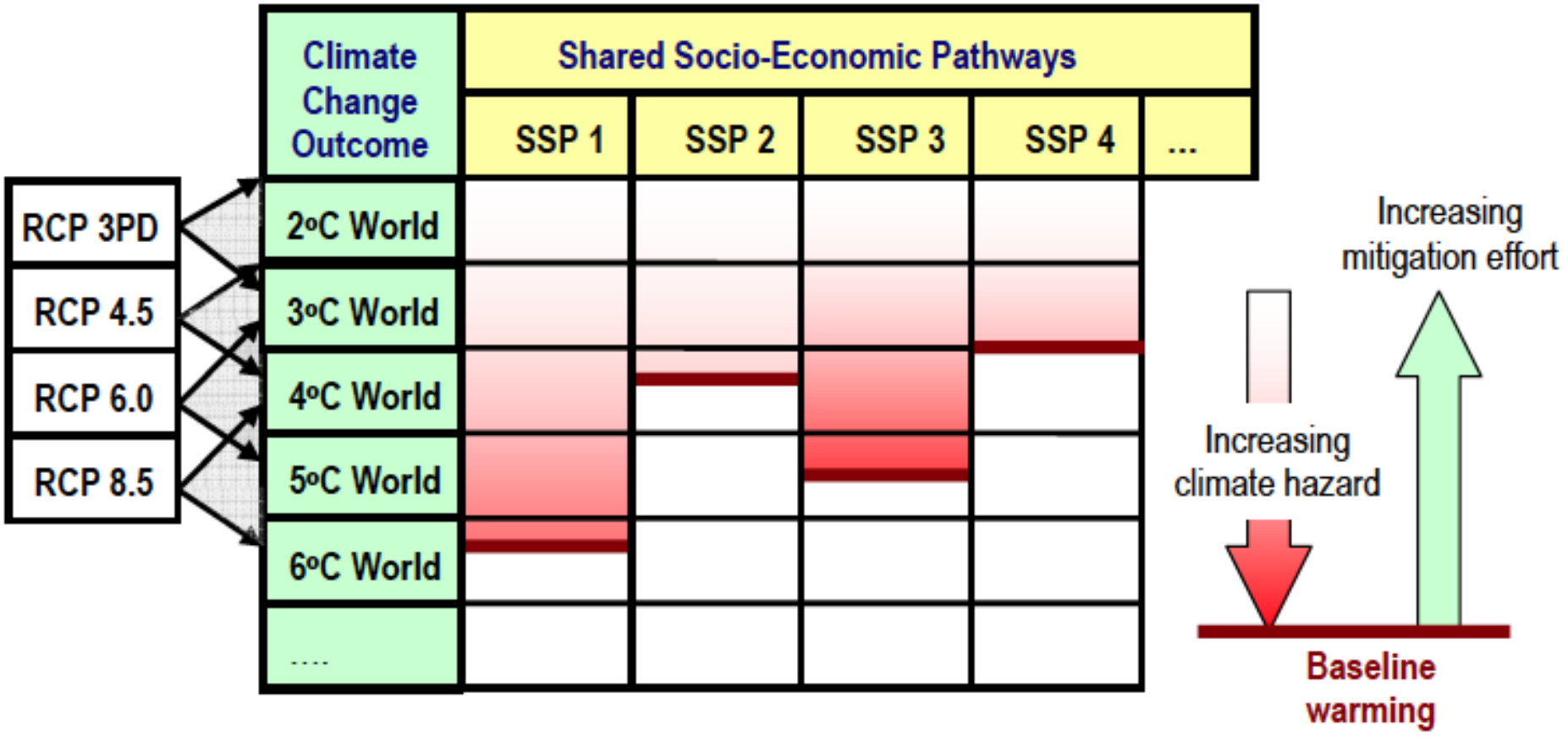
- Objectives – What should our scenarios accomplish?
  - E.g. examine major demographic, institutional, economic and social changes
- Boundary Conditions
  - Base year – today? 1990?
  - Time horizon – up to 2035? Further?
  - Time steps – 5 to 10 y steps?
  - Geographic coverage – Buzău county and how far byond?

Step 2: Select Themes

- Each scenario should have a main theme or message.
- Themes are based on main uncertainties or questions about the future.
  - E.g. should we work with the four main SRES themes? Or a subset (e.g. A1B, B1, B2)?
  - Or something linked to the latest RCPs* (8.5, 6.0, 4.5, 2.6 Wm^{-2})?
  - Or should we create some originals?

* RCPs = Representative Concentration Pathways. Moss et al. 2009. *The next generation of scenarios for climate change research and assessment*. Nature.

RCP forcing, SSP matrix framework



Kriegler et al. 2010. *Socio-economic Scenario Development for Climate Change Analysis.* C.I.R.E.D. Working Paper No. 23.

Themes: 4 dimensions often used

1. Economic change,
   e.g. rapid growth vs. modest growth;
   globalized markets vs. localized markets.
2. Governmental/institutional change,
   e.g. effective in reaching goals vs. ineffective;
   democratic vs. authoritarian;
   participative vs. top-down
3. Direction of change in social values,
   e.g. economic consumption vs. slow life;
   social cooperation vs. conflict
4. Technological change,
   e.g. significant, transformational and green vs. slow and unequally distributed

Example 1 of 2: MA Themes

Global Orchestration

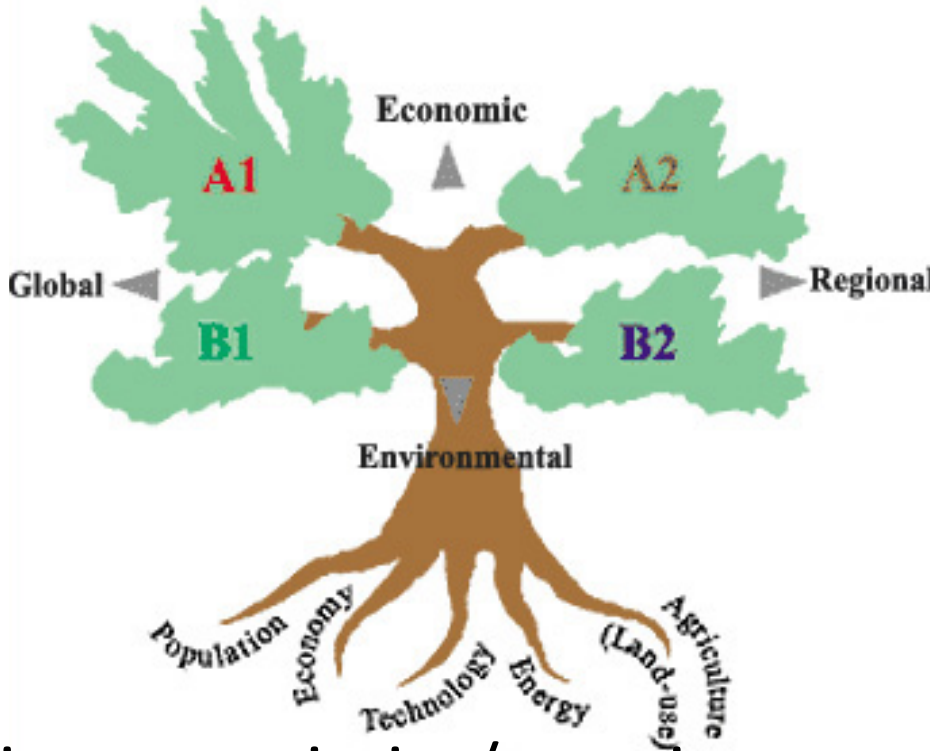
Order from Strength

TechnoGarden

Adapting Mosaic

Millennium Ecosystem Assessment, Carpenter et al. 2005.

Example 2 of 2: SRES Themes



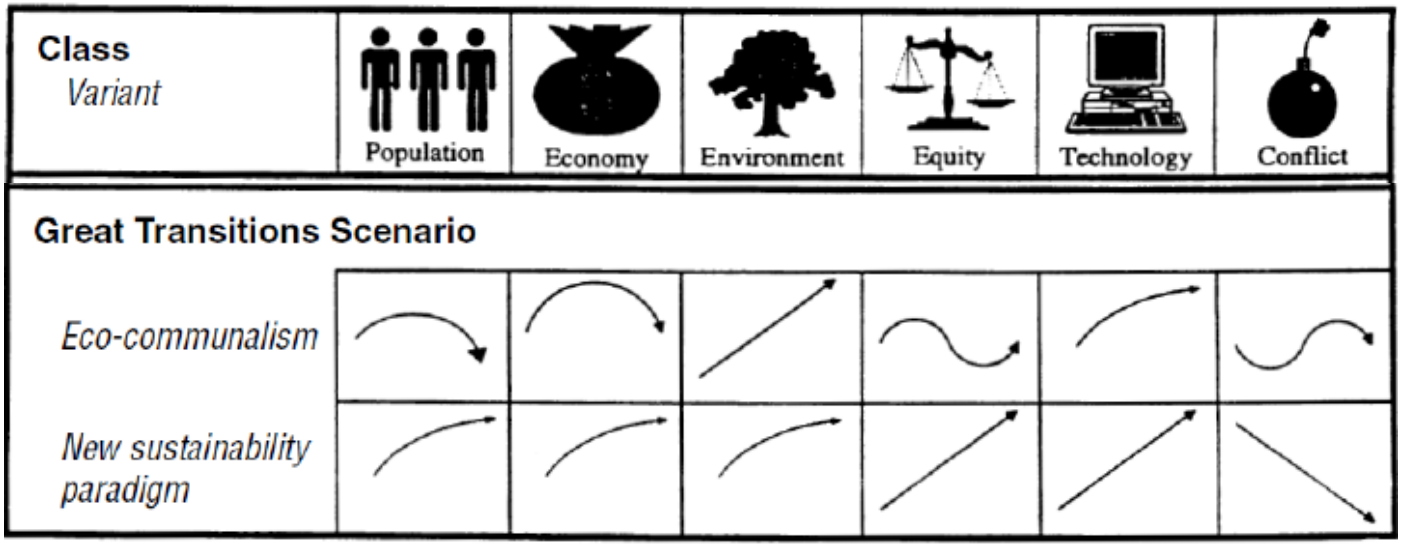
- Two main uncertainties/questions :
  - Will the world economy **globalize** or **regionalize** (e.g. Will there be fewer or more trade barriers?)
  - Will society lean towards **economic** or **environmental** values?
    (**Caution:** false dichotomy here…)

Step 3: Select actors and factors

- Main actors – people and institutions that will play an important role
  – e.g. farmers, foresters, several levels of government, citizens...
- Main factors – main variables that will play an important role
  – e.g. global market, land availability, financial incentives, the diversity of values of the main actors, their communication, power structure between them...

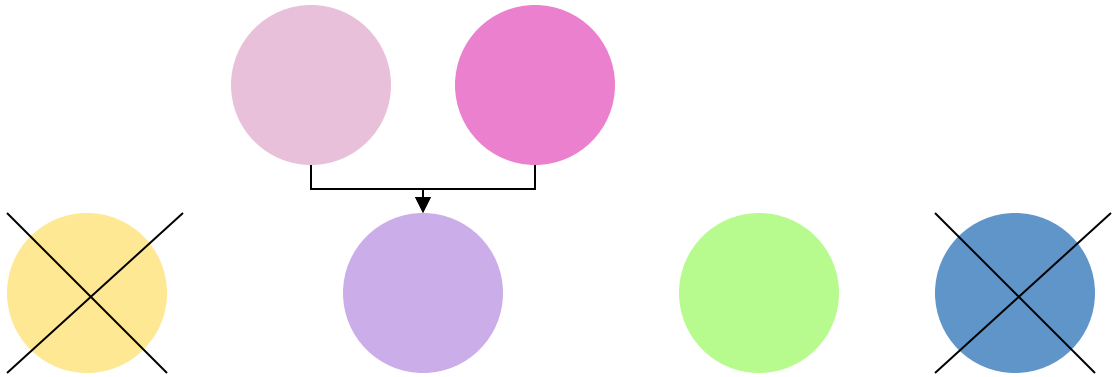
Step 4: Develop mini-scenarios

- For each theme, construct an outline – a "mini-scenario". Narrative or tabular form.
- Describe step-wise changes – explain how the future situation evolved from the present. Contains the driving forces of the scenario.
- In this process maintain internal consistency, include main actors and factors.



Step 5: Reduce number of mini-scenarios

- Reduce total number of mini-scenarios to a manageable number.
- Eliminate implausible mini-scenarios.
- Combine similar mini-scenarios.



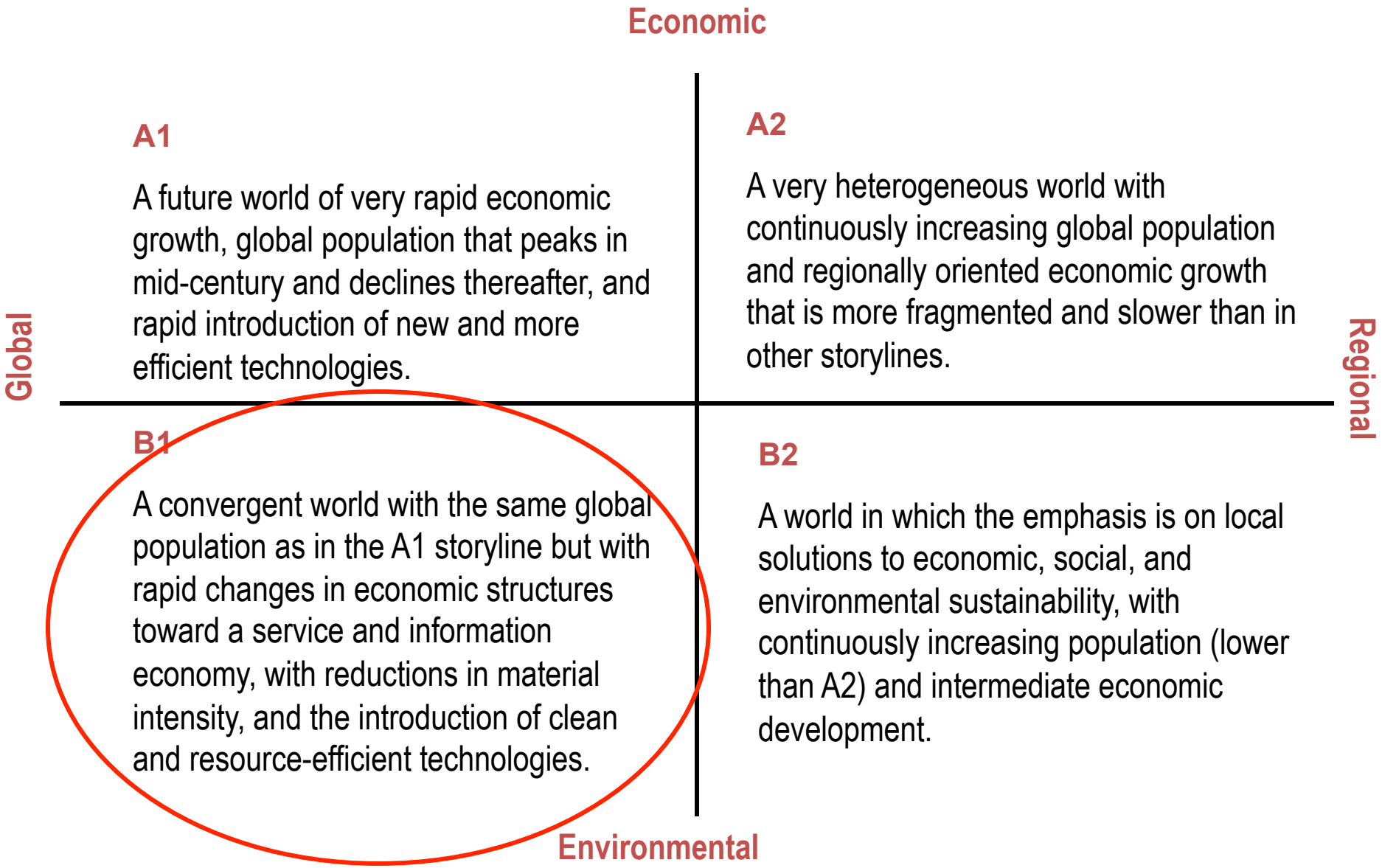
What is the Ideal Number of Scenarios?

- As many as possible?
  - To represent many views of the future,
  - To represent many possibilities of the future.
- As few as possible?
  - To facilitate communication,
  - To restrict the potentially unlimited amount of scenarios,
  - To reduce effort in producing and analysing scenarios.
- Recommendation for strategic studies: 2 to 4 scenarios.

Step 6: Write full scenarios – storylines

- Elaborate the mini-scenarios, step-by-step.
- Use influence diagram.
- Add boxes to communicate important or additional information.
- Use anecdotes/stories to illustrate main messages (e.g. MA created characters for each theme and had small stories of their lives).

Example: summary of the SRES storylines



Economic

Global

Regional

Environmental

A1FI

- **Agricultural** area for food production declines substantially by 2080. Some is used for bioenergy production.
- Production concentrated in optimal locations.
- **Forest** area increases only slightly.
- **Urban** area increases due to non-restrictive planning.
- **Protecte**d area increases. Emphasis on recreational use.

A2

- **Agricultural** area for food production declines substantially by 2080. Some is used for bioenergy production.
- Changes are distributed equally across Europe.
- **Forest** area increases only slightly.
- **Urban** area increases due to rising population and incomes.
- **Protected** area increases. Conservation networks strongly fragmented.

B1

- **Agricultural** area for food production declines substantially by 2080. Some is used for bioenergy production.
- Cropland is concentrated in optimal locations.Grassland is protected by policy.
- **Forest** area increases. New forests are located on surplus agricultural land.
- **Urban** land use pressure is low. Restrictive planning leads to compact cities.
- **Protected** area increases. Strict protection of biodiversity.

B2

- Rural development policies maintain **agriculture** in most places. Changes reflect switch from food to bioenergy production or forestry.
- **Forest** area increases more than in all other scenarios.
- **Urban** area increases only slightly due to stable population and slow growth in income. Restrictive planning leads to compact cities.
- **Protected** area increases. Strict protection at local level.

Rounsevell et al. 2005. *Agric. Ecosyst. Environ.*

Summary Scenario Development

1. Narratives are part of any workable scenario for environmental assessments.
2. Developing scenarios is a transdisciplinary, long-term, iterative process.
3. The process of scenario development can be the starting point of a transdisciplinary effort to prepare for the future.
4. Whenever we talk about quantitative scenarios, we implicitly talk about qualitative scenarios that go along with them.

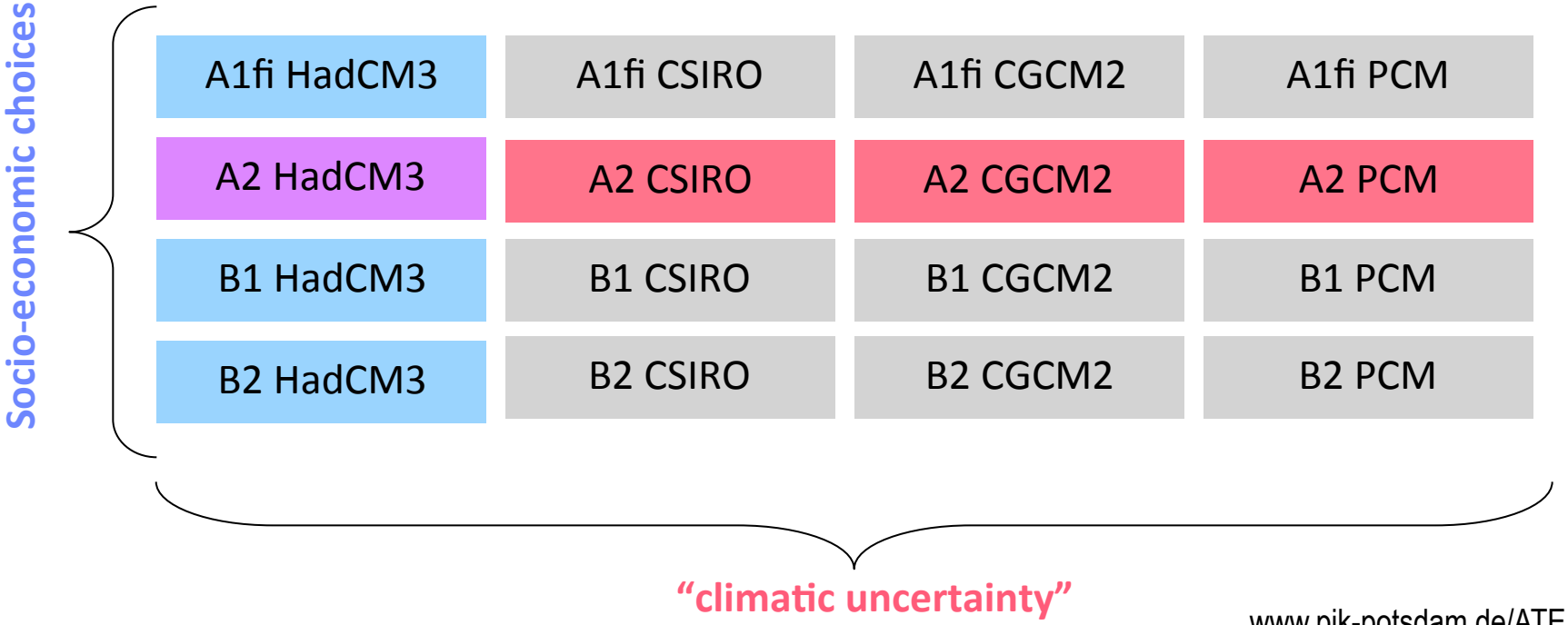

this is it

Types of scenarios

- Deductive – deduce from a framework
- Inductive – induce "bottom up" from data
- Exploratory – present to future
- Anticipatory (prescriptive, normative) – start with a vision, then work backwards
- Qualitative – visual or words, most common form: narrative (storyline)
- Quantitative – numerical, commonly computed using models

Different kinds of uncertainty

- **Multiple scenarios**
  - Focus on **priority scenarios**
  - Variation across storylines reflects **socio-economic choices**
  - Variation across GCMs reflects **"climatic uncertainty"**



If you want to make god laugh,

tell him about your plans.

Woody Allen

When to use scenario analysis?

- Best for long-term uncertain situations, with scarcity of data and large number of non-quantifiable factors.
- Alternatives to scenario analysis:
  - Technical reports that evaluate different alternative policies
  - Computer simulations that extrapolate current trends
  - Reports from expert panels
  - Public hearings and/or expert hearings
  - Participative methods such as the Delphi studies, focus group studies that may include decision-makers, stakeholders and/or experts

… some of the above would complement, some would replace scenario analysis.