Qualitative (and quantitative) scenarios

Methods for regional development

Kasper Kok - Wageningen University

UNEP expert meeting REDD scenarios
20-21 September 2011
Methods:
- Scenarios
- Some words on the SAS approach

Examples:
- Millennium Ecosystem Assessment - multi-scale
- Scenes - FCMs and SAS
- CLIMSAVE - SAS

Conclusions:
- use of methods in context of REDD
Scenarios - when to use?

<table>
<thead>
<tr>
<th>Controllability</th>
<th>Low uncertainty</th>
<th>High uncertainty</th>
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<td>High causality</td>
<td>Predictive</td>
<td><strong>Explorative</strong></td>
</tr>
<tr>
<td>Low causality</td>
<td>Projective</td>
<td>Speculative</td>
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</table>
Scenarios - when to use?

Scenarios are (perhaps) the best tool when:
- Uncertainty is high, and
- Controllability is low, or
- Complexity is high, or
- Causality is high

Note: climate change is highly uncertain; REDD is highly complex; (global) implementation is difficult to control
Scenarios - types

A Project goal - exploration vs decision support:
I. Inclusion of norms?: descriptive vs normative
II. Vantage point: forecasting vs backcasting
III. Subject: issue-based, area-based, institution-based
IV. Time scale: long term vs short term
V. Spatial scale: global/supranational vs national/local

B Process design - intuitive vs formal:
VI. Data: qualitative vs quantitative
VII. Method of data collection: participatory vs desk research
VIII. Resources: extensive vs limited
IX. Institutional conditions: open vs constrained

C Scenario content - complex vs simple:
X. Temporal nature: trend vs snapshot
XI. Variables: heterogeneous vs homogenous
XII. Dynamics: peripheral vs trend
XIII. Level of deviation: alternative vs conventional
XIV. Level of integration: high vs low
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XIV. Level of integration: high vs low
(1) Establish scenario team and scenario panel
(2) Team proposes goals and outline
(3) Panel drafts narrative storylines
(4) Team quantifies driving forces
(5) Modelling groups quantify scenarios
(6) Panel revises storylines
(7) Repeat step 4-6
(8) General review of scenarios
(9) Team & Panel make final revision of scenarios
(10) Publication and distribution
## Scenarios - a toolbox of methods

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<th>Quantitative</th>
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Example 1: The Millennium Ecosystem Assessment

(multi-scale scenario development)
Millennium Ecosystem Assessment

- **Aim**: international scientific assessment of the consequences of ecosystem changes for human well-being

- Modeled on the IPCC

- Providing information requested by:
  - Convention on Biological Diversity (CBD)
  - Convention to Combat Desertification (CCD)
  - Ramsar Convention on Wetlands
  - Convention on Migratory Species (CMS)
  - other partners including the private sector and civil society

- With the goals of:
  - stimulating and guiding action
  - building capacity
MA working groups were assessing global conditions, scenarios and responses

<table>
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<tr>
<th>Conditions Working Group</th>
<th>Scenarios Working Group</th>
<th>Responses Working Group</th>
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<tr>
<td>• What is the current condition and historical trends of ecosystems and their services?</td>
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<tr>
<td>• What have been the consequences of changes in ecosystems for human well-being?</td>
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<tr>
<td>• Given plausible changes in primary drivers: what will be the consequences for ecosystems, their services, and human well-being?</td>
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<tr>
<td>• What can we do about it?</td>
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Sub-Global Working Group: all of the above... at sub-global scales
Approach to environmental management

Four global stories

- **Technogarden**
  - Focus: Environmental technology
- **Global Orchestration**
  - Focus: Social policy
- **Adaptive Mosaic**
  - Focus: Active learning
- **Order from Strength**
  - Focus: Self interest

Institutions:
- Globally connected
- Regional focus

Proactive

Reactive

Approach to environmental management
Approach to quantifying the scenarios

**Storylines**
- Global Orchestration, Techno-garden, etc.

**AIM**
- Global change

**IMAGE 2**
- Global change

**WaterGAP**
- World water resources

**IMPACT**
- World food production

**Model Outputs**
- **Provisioning Services**
  - Food (meat, fish, grain production)
  - Fiber (timber)
  - Freshwater (renewable water resources & withdrawals)
  - Fuel wood (biofuels)

- **Regulating**
  - Climate regulation (C flux)
  - Air quality (NOx, S emissions)

- **Supporting**
  - primary production

**Model Inputs**
- Demographic
- Economic
- Technological
Locations of Sub Global Assessments (SGAs). (17 Approved and 16 Associated SGAs)
Examples of different multi-scale designs

Southern Africa MA (SAfMA)
- Global storylines
- SADC
  - Gariep
  - Zambezi

Portugal MA (PtMA)
- Global storylines
- Portugal
  - Mondego
  - Mira

Caribbean Sea (CARSEA)
- Global storylines
- Caribbean Sea
  - Trinidad
- Northern Range Trinidad

Global
Regional/National
Basin
Local
Examples of scenarios

Wisconsin

Local growth

Ecological crisis

External growth

Gradual change

Scenario 1

Scenario 2

Scenario 3

SAfMA
Communicating scenarios

Salar de Atacama, Chile

Vilcanota, Peru

SAfMA
<table>
<thead>
<tr>
<th>Ecosystem Service</th>
<th>Sub-global Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity</td>
<td>SAfMA, Caribbean Sea, Portugal, Bajo Chirripo, India Local</td>
</tr>
<tr>
<td>Water quality and quantity</td>
<td>Goulburn-Broken Catchment, Wisconsin, SAfMA, Portugal,</td>
</tr>
<tr>
<td>Soil protection</td>
<td>Portugal</td>
</tr>
<tr>
<td>Landscape aesthetics</td>
<td>Wisconsin, Portugal, San Pedro de Atacama</td>
</tr>
<tr>
<td>Recreation/Tourism</td>
<td>San Pedro de Atacama, Caribbean Sea</td>
</tr>
</tbody>
</table>
Conclusions from MA

- MA was the first global assessment to explore the SAS approach in all its detail
- MA additionally extensively tackled the multi-scale issue
- MA was very successful in developing stories; models; and multi-scale results
- The MA still stands out as one of the best examples
Further reading


Example 2:

SCENES: Envisioning the Future of Water in Europe
Project set-up

- WP1: Drivers and Policy Measures
- WP2: Scenario Development
- WP4: Analysis of Impacts
- WP3: Tools and Methods
- WP5: Support for Policies
- IA1: Coordination and Management
- IA2: Case Studies
Multi-scale scenario development

Pan-European

Regional

Baltic states

(Mediterranean
(upscaling of PA
results by experts)

Lower Danube
(upscaling of PA
results by experts)

Black Sea
(upscaling of PA
results by experts)

Pilot Area*

*Stakeholder panels and workshops in all Pilot Areas
Scenario characteristics

Common:
- Participatory with stakeholder workshops
- Co-production of knowledge

Pan-European (PEP):
- Story-And-Simulation
- Main products: stories and model results/indicators

Pilot Areas
- Conceptual modelling
- Main products: FCMs and stories
**PEP - Scenario method**

*Explorative scenarios:*
Based on fast-track scenarios for Europe (GEO-4)
Four storylines 2005-2050 in three periods
Focusing on the socio-economic, institutional and cultural system
Input for WaterGap model
Part of the Story-And-Simulation approach

*Backcasting scenarios:*
Linked to explorative scenarios
Four backcasts 2050-2005 (timelines)
Focusing on short-term (policy) actions

*Combination:*
Robust strategies and actions
Input for policy recommendations
PEP scenarios – flow of information

PEP meetings

- **PEP0**
  - Agree on method

- **PEP1**
  - First draft stories
  - Fuzzy Sets

- **PEP2**
  - 2nd draft stories
  - Fuzzy Sets rev.

- **PEP3**
  - Backcasting
  - short-term actions

Other activities

- **Selection of GEO-4 stories + models**
- **WaterGAP model runs**
- **WaterGAP model runs**
- **Red Thread Story summaries**
- **Drivers Indicators**
Resulting scenario families

- A1: Markets First (Economy First)
- A2: Security First (Fortress Europe)
- B1: Policy Rules (Sustainability First)
- B2: Sustainability Eventually

GEO-4 IPCC

K. Kok, I. Bärlund, M. Flörke
Results - Stories

No subsidies for agriculture
Population movement to urban areas with abandonment of rural areas
Manufacturing - increasing scandals of water pollution (removal of government)
Electricity - Continuing trend from middle period (some new innovations)
Widespread privatisation of water supply & treatment
Agriculture - Enanchement of industrial agriculture in Europe
    Pockets of high pressure on water resources
    Locally agriculture out-compete other sectors
    Increasing inter-basin water transfer (now economically viable)
Mass low-level treatment of ag wastes to make ecologically attractive products
Domestic - Continuing increase in price of water
Intensive local competition between domestic & agricultural sectors
Increasing economic incentives to improve water use efficiency & new water saving technologies.
“After years of agricultural intensification and declining extensive agriculture, the population moves from rural to urban areas causing urban sprawl. One result is the fragmentation of agricultural land and natural areas near urban centres. The impact of these changes is very diverse across Europe.”

(taken from Markets First; 2025-2050)
Results – Conceptual models

[Diagram with various relationships and processes, such as economic growth, water use efficiency, public ownership, and environmental impacts.]
## Results - Quantified parameters

### Table: Regional Markets First

<table>
<thead>
<tr>
<th>Region</th>
<th>2005-2025</th>
<th>2025-2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>WE</td>
<td>Medium increase</td>
<td>Low increase</td>
</tr>
<tr>
<td>CE</td>
<td>Medium increase</td>
<td>Low increase</td>
</tr>
<tr>
<td>EE</td>
<td>Medium increase</td>
<td>Medium to high increase</td>
</tr>
</tbody>
</table>

### Graph: Change of GDP per capita [% per year]

- **Medium increase**: 4.5%

### Table: Target year manufacturing GVA per total GDP

<table>
<thead>
<tr>
<th>Region</th>
<th>2005-2025</th>
<th>2025-2050</th>
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</thead>
<tbody>
<tr>
<td>WE</td>
<td>+4.5</td>
<td>+2.3</td>
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<tr>
<td>CE</td>
<td>+4.5</td>
<td>+2.3</td>
</tr>
<tr>
<td>EE</td>
<td>+4.5</td>
<td>-4.5</td>
</tr>
</tbody>
</table>

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**Gross Value Added - what will be the share of manufacturing industry of total GDP**

<table>
<thead>
<tr>
<th>Year</th>
<th>NA</th>
<th>WE</th>
<th>RE</th>
<th>EE</th>
<th>EM</th>
<th>DM</th>
<th>GA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>2006</td>
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</tbody>
</table>

What is the share?

- High = h, Medium = m, Low = l

Figure 3. Share of manufacturing industry output of GDP in 1984-2002 and in 2006 in the regions.

**Share of manufacturing GVA of total GDP in the year 2006**

- Low = l, Medium = m, High = h

**OVERLAPPING OF CLASSES POSSIBLE**

- Low = l, Medium = m, High = h

Results – Model output
Pilot area scenarios

The role of Fuzzy Cognitive Maps

- Narrative storylines
- Quantified drivers
- Model Runs
- FCMs
Participatory FCMs - creative process

Guadiana - Spain

Crimea - Ukraine
Participatory FCMs - structured consensus

Manaus - Brazil

Crimea - Ukraine
Participatory FCMs – group model building

Lower Tisza - Hungary

Lake Peipsi - Estonia
Participatory FCMs – dynamic output

Crimea - Ukraine

Manaus - Brazil
Advantages ("QUICK"): 

- *Easy to develop and apply.* The approach is highly intuitive, it can quickly be explained and applied to any new situation.
- *High level of integration.*
- *Forces users to be explicit* and facilitates a concrete discussion.

Disadvantages ("DIRTY"): 

- *Relationships are only semi-quantified.* It is difficult to interpret the output in absolute terms.
- *Time is ill-defined.* Factors included in the system do not usually all operate at the same temporal scale. FCM does not adequately deal with these time-mismatches.
- *Being concrete requires expert opinions.* Especially when developing a FCM from scratch requires a high level of understanding of all participants.
Conclusions from Scenes

- Scenes was an important test-case of the SAS approach.
- In terms of scenario development, Scenes was successful on almost all accounts.
- It showed that it was possible to increase the number of iterations, and increase consistency between models and stories.
- It furthermore showed the importance of additional tools to strengthen the link between qual and quan: Fuzzy Sets and a number of Conceptual Modelling techniques.
Example 3:

CLIMSAVE - adaptation to climate change
Scenario development framework

- Adaptation options
- Climate change impacts
- Story-And-Simulation
- Socio-economic stories
- Roadmapping
- Adaptation needs
Scenario development framework

Similar to SCENES:
- Participatory with stakeholder workshops
- SAS approach with stories and models

Novel aspects:
- Development of online Integrated Assessment Platform
- More focus on normative (adaptation) options and robust strategies
The IAP development process

- Initial design of IAP
- Construction of metamodels

Workshop 1: Quantification of scenarios

Workshop 2: Assess futures/impacts

Workshop 2: Quantify adaptation options

Workshop 3: Explore adaptation responses

Final CLIMSAVE IAP
### Scenario selection

- **Timeslice:** 2050s
- **Emission scenario:** A1
- **Climate model:** HadCM3
- **Climate sensitivity:** High
- **Socio-economic scenario:** Green & happy

### Socio-economic settings

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population change</td>
<td>100% of current</td>
</tr>
<tr>
<td>GDP change</td>
<td>180% of current</td>
</tr>
<tr>
<td>Change in costs</td>
<td>1</td>
</tr>
<tr>
<td>Technological effectiveness</td>
<td>1</td>
</tr>
<tr>
<td>Change in labour costs</td>
<td>1</td>
</tr>
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### Map

- **Sector:** Agriculture
- **Indicator:** YAv_Potatoes

**YAv_Potatoes:**
- 0 to 3.74 t/ha
- 3.74 to 7.47 t/ha
- 7.47 to 11.21 t/ha
- 11.21 to 14.94 t/ha

**Map Information:**
- **Lat:** 35.79
- **Lon:** -3.15
- **Opacity:** 0.5
**The CLIMSAVE project**

**Climate Change Integrated Assessment Methodology for Cross-Sectoral Adaptation and Vulnerability in Europe**

**Scenario settings**
- **2020s**
- **A2**
- **HadCM3**
- **High**
- **Green & happy**

**Responses**
- **Rural planning**
- **Urban planning**
- **Biodiversity planning**
- **Water planning**

**Sector / Ecosystem service**
- **Cultural**

**Indicator**
- **Charismatic species**

**Biophysical Impacts**
- **Adaptation**
- **Vulnerability**

**Yield change due to technology (15%)**
- Value: 30

**Irrigation efficiency = 0% increase**
- Value: 30

**Irrigation price = 280% of current**
- Value: 50

**Change in bioenergy production (560 PJ)**
- Value: 1000

**Capital meter**
- **Very Low**
- **Natural**
- **Manufactured**
- **Human**
- **Social**
- **Financial**
- **High**

**To baseline**
- **Run for 2020s**
- **To 2050s**

**Biodiversity**
- **Food**
- **Water**

**Flooding**
- **Forest**
- **Aggregated indicators**
Conclusions from examples

- Scenarios come in many shapes and forms
- The Story-And-Simulation approach has emerged as the state-of-the-art and has proven its functionality
- The approach has spurred to development and adoption of a growing number of tools and methods
- Testing continues in a number of projects
- Focus is shifting from the 'classic' SAS to the role of Conceptual Models, Fuzzy Sets, and online platforms.
- In short, SAS has been operationalised
## Scenarios - a toolbox of methods

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Scenarios and REDD

1. How could scenarios support the progress of REDD+?
   Type of scenario: Existing stories and models
   Role:
   • Identify links with REDD and mapped uncertainties to steer direction.
   • Identify feedbacks and connections of REDD with others aspects (conservation; rural livelihoods; climate)

2. How can scenarios help stakeholders plan a REDD programme?
   Type of scenario: qualitative or semi-quantitative; backcasting; national(?)
   Role:
   • Excellent tool for stakeholder engagement & co-production of knowledge
   • Explore socio-economic and institutional steps that are needed for planning REDD programmes
3. How can scenarios help stakeholders analyse/visualise the benefits and impacts of a REDD program in a country?

Type of scenario: full Story-And-Simulation, preferably multi-scale, and perhaps linking exploratory and backcasting scenarios

Roles:

Exploratory scenarios structure fundamental uncertainties

Exploratory scenarios can demonstrate the plausible window of deforestation etc.

Backcasting can help making robust decisions in the face of these uncertainties

A mix of qual/quan can help building an integrated picture of future changes including deforestation, degradation and afforestation and its socio-economic and institutional drivers.
Final conclusions

- The issues related to REDD are very complex and therefore inherently and fundamentally uncertain.
- Scenarios are an essential tool to structure uncertainties and facilitate making decisions in the light of those uncertainties.
- The tools and methods (e.g. SAS) are available, operational, and (partly) tested.
- Scenario development should be an essential part of any effort to set up REDD programmes.
Background information

Example 1: www.millenniumassessment.org
Example 2: www.environment.fi/syke/scenes
Example 3: www.climsave.eu

Further reading:


Kok, K. 2009. The potential of Fuzzy Cognitive Maps for semi-quantitative scenario development, with an example from Brazil. Global Environmental Change 19: 122-133


Questions?