SSP/RCP-based scenarios: Implementation

Detlef van Vuuren
Starting point: Causal chain

SSPs

Drivers (population, GDP)

Energy use, Land use

Emissions

Conc./forcing

Exposed population, ability to adapt

Impact

Climate

RCPs
The Scenario Matrix Architecture

**Forcing level (W/m²)**
- 8.5
- 6.0
- 4.5
- 2.6

**SSPs**
- SSP1
- SSP2
- SSP3
- SSP4
- SSP5

**RCPs**

**Shared Socio-economic Pathways**

**Narratives**
- IAM reference scenario (e.g., SSP3-Ref)
- IAM SSP-RCP scenario (e.g., SSP3-4.5)

**Quantitative drivers**
- Socioeconomic information
- Climate information

**Socioeconomic information**

**Climate information**

**IAV study**
The Scenario Matrix Architecture

SPA = description of mitigation (to move down a column) and adaptation policies (to deal with climate policy)
The Scenario Matrix Architecture

<table>
<thead>
<tr>
<th>Shared Socio-economic Pathways</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSP1</td>
</tr>
</tbody>
</table>

Challenge to mitigation

Challenge to adaptation
**SSP1: Sustainability**
- Rapid technology
- High environmental awareness
- Low energy demand
- Medium-high economic growth
- Low population

**SSP2: Middle of the Road**

**SSP3: Fragmentation**
- Slow technology
- Development (dev-ing)
- Reduced trade
- Very slow economic growth
- Very high population

**SSP4: Inequality**
- Slow technology
- High inequality
- Low energy demand
- Slow economic growth
- High population

**SSP5: Conventional dev.**
- Rapid technology for fossil
- High demand
- High economic growth
- Low population
Key SSP elements
(three main products + IAV variables)

SSP Storylines

Iterative Process

Quantitative drivers

1. Population
   (age, sex, mortality, fertility, education)
2. Urbanization
   (national)
3. Economic development
   (regional/national)

IAM Scenarios

1. Energy
   (technology, resources, etc)
2. Emissions
   (forcing, temperature)
3. Land-use
   (productivity, diets, etc)
Qualitative / quantitative (population)

<table>
<thead>
<tr>
<th>Variable</th>
<th>SSP5</th>
<th>SSP3</th>
<th>SSP2</th>
<th>SSP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertility</td>
<td>D: low</td>
<td>D: high</td>
<td>D: Med</td>
<td>D: Low</td>
</tr>
<tr>
<td></td>
<td>I: High</td>
<td>I: low</td>
<td>I: Med</td>
<td>I: medium</td>
</tr>
<tr>
<td>Mortality</td>
<td>D: low</td>
<td>D: high</td>
<td>D: Med</td>
<td>D: Low</td>
</tr>
<tr>
<td></td>
<td>I: low</td>
<td>I: high</td>
<td>I: Med</td>
<td>I: Low</td>
</tr>
<tr>
<td>Migration</td>
<td>high</td>
<td>low</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

High economic growth and education of women leads to drop of fertility.

High economic growth and investment into health services leads to drop of mortality.

Globalised world has high migration rates.

Global population
Urbanization Projection Results

Western Europe
Latin America
China
Eastern Africa

SSP 1: Fast
SSP 2: Central
SSP 3: Slow
SSP 4: Fast/Central
SSP 5: Fast

Source: O’Neill & Jiang,
Economic projections

GDP per capita ($/cap - PPP)

- SSP5
- SSP1
- SSP2
- SSP4
- SSP3

Planbureau voor de Leefomgeving
<table>
<thead>
<tr>
<th>Energy demand</th>
<th>Global Orchestration</th>
<th>Order from Strength</th>
<th>Adapting Mosaic</th>
<th>TechnoGarden</th>
</tr>
</thead>
<tbody>
<tr>
<td>lifestyle assumptions and energy efficiency investments based on current North American values</td>
<td>regionalized assumptions</td>
<td>regionalized assumptions</td>
<td>lifestyle assumptions and energy efficiency investments based on current Japan and West European values</td>
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</table>

<table>
<thead>
<tr>
<th>Energy supply</th>
<th>Energy demand assumptions and energy efficiency investments based on current North American values</th>
<th>focus on domestic energy resources</th>
<th>some preference for clean energy resources</th>
<th>preference for renewable energy resources and rapid technology change</th>
</tr>
</thead>
</table>

| Climate policy | No | no | no | yes, |

Figure 3.3 Global Energy Consumption in the MA Scenarios (IMAGE2.2)

Mitigation, including land-based mitigation
Challenge to mitigation

Sulphur emissions

baseline

4.5 W/m²

Challenge to adaptation
Reconciling the old and the new:

Van Vuuren, Carter, 2014
<table>
<thead>
<tr>
<th>Archetype</th>
<th>Global sustainable development</th>
<th>Business as usual</th>
<th>Regional competition</th>
<th>Economic optimism</th>
<th>Reformed markets</th>
<th>Regional sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSP mapping</td>
<td>SSP1, SSP2</td>
<td>SSP3, SSP4</td>
<td>SSP5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic development</td>
<td>Ranging from slow to rapid</td>
<td>Medium</td>
<td>Slow</td>
<td>Very rapid</td>
<td>Rapid</td>
<td>Medium</td>
</tr>
<tr>
<td>Population growth</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Technology development</td>
<td>Ranging from medium to rapid</td>
<td>Medium</td>
<td>Slow</td>
<td>Rapid</td>
<td>Rapid</td>
<td>Ranging from slow to rapid</td>
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<tr>
<td>Main objectives</td>
<td>Global sustainability</td>
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<td>Security</td>
<td>Economic growth</td>
<td>Various goals</td>
<td>Local sustainability</td>
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<tr>
<td>Environmental protection</td>
<td>Proactive</td>
<td>Both reactive and proactive</td>
<td>Reactive</td>
<td>Reactive</td>
<td>Both reactive and proactive</td>
<td>Proactive</td>
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<tr>
<td>Trade</td>
<td>Globalisation</td>
<td>Weak globalisation</td>
<td>Trade barriers</td>
<td>Globalisation</td>
<td>Globalisation</td>
<td>Trade barriers</td>
</tr>
<tr>
<td>Policies and institutions</td>
<td>Strong global governance</td>
<td>Mixed</td>
<td>Strong national governments</td>
<td>Policies create open markets</td>
<td>Policies target market failures</td>
<td>Local actors</td>
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<tr>
<td>Vulnerability to climate change</td>
<td>Low</td>
<td>Medium</td>
<td>Mixed – varies regionally</td>
<td>Medium-high</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Other mappings:</td>
<td>SRES B1 (A1T)</td>
<td>B2(*)</td>
<td>A2</td>
<td>A1FI</td>
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<tr>
<td>GEO3/GEO4</td>
<td>Sustainability First</td>
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<td>Security First</td>
<td>Markets First</td>
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<td>Global Scenario Group</td>
<td>New Sustainability Paradigm</td>
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<td>Barbarisation</td>
<td>Conventional World</td>
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<tr>
<td>Millennium Assessment</td>
<td>Technogarden</td>
<td></td>
<td>Order from Strength</td>
<td>Global Orchestration</td>
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<td></td>
</tr>
</tbody>
</table>

*The B2 storyline emphasized a focus on environmental and social issues from a regional perspective; in the quantitative elaboration, however, the choice was made to use medium projections for all relevant variables. Therefore, the B2 scenario is listed here in two columns. Note: This table summarises key assumptions in very general terms. Where differences within a set of scenario families exist, broad ranges are indicated. For references to scenario exercises, see text.*
Process of the quantification group

- GDP and population data: finished March 2013 (IIASA, OECD, PIK)
- IAM teams elaborating scenarios (IIASA, PIK, PBL, GCAM, NIES, FEEM...). June/July 2014: final submission
- Special Issue on SSPs in GEC (storylines, GDP, population, IAMs)
- From Summer 2014: Data available for impact/mitigation studies
- Summer 2014?: Decisions on use of scenarios in CMIP6
Conclusions

- SSPs: combination of storylines and initial, global, quantification
- Storylines can be the basis of downscaling / use outside original domain:
  - SSP1: Sustainable dev. world (env. tech, good governance, low population, wealthy, social/env goals important)
  - SSP2: Medium
  - SSP3: Fragmented world (regional competition, low tech., little trade, poor)
  - SSP4: Fragmentation in regions (strong rich/poor divide, poor on average)
  - SSP5: High economic growth (strong technology, fossil fuel driven, consumption, human development)