The state of the new scenarios process

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NCAR
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AGCI AgMIP Workshop
The New Scenario Process (Parallel Process)

RCPs, Updated RCPs, new pathways

SSPs

IAM scenarios

RCPs, Updated RCPs, new pathways

CMIP5, CMIP6

O’Neill & Schweizer, 2011; based on Moss et al. (2010).
Shared Socioeconomic Pathways (SSPs)

**Narrative**
Qualitative description of broad patterns of development
Logic relating elements of narrative to each other

**Quantitative elements**
National:
- Population
- Education
- Urbanization
- GDP

Subnational (under development):
- Spatial population
- Income distribution

- SSP 1: (Low Challenges)
  - Sustainability
  - Taking the Green Road

- SSP 2: (Intermediate Challenges)
  - Fossil-fueled Development
  - Taking the Highway
  - Middle of the Road

- SSP 3: (High Challenges)
  - Regional Rivalry
  - A Rocky Road

- SSP 4: (Adapt. Challenges Dominate)
  - Inequality
  - A Road Divided

- SSP 5: (Mit. Challenges Dominate)
  - Development

[Diagram showing SSP 2 and associated challenges]
ICONICS

International Committee On New Integrated Climate change assessment Scenarios

See website hosted at NCAR for SSP information, publications database, mailing list
Summary of SSP Status

Conceptual framework established

Special issue of *Climatic Change* published (2013/4)

Narratives and quantification of key drivers completed

Published online, Special issue of *Glob. Envtl. Change*

Quantitative drivers available online, IIASA SSP database
SSPs are not scenarios!

Hypothetical reference development pathway

“Development”:
Does not include explicit emissions, land use, etc.

“Reference”:
No climate policy (mitigation or adaptation)
No effects of climate change
Linking Global and Regional scenarios (or pathways)

Regional scenarios informed by SSPs underway
- Arctic Council scenarios
- European projects (e.g., IMPRESSIONS)
- Multi-region CCAFS study (Palazzo, Vervoort, et al.)
- Provia regional workshop?

Types of linkage
- Use conceptual framework alone
- Develop regional scenarios, map to SSPs later
- Nest regional pathways within global SSPs
- Quantitative (not just qualitative) consistency
SSP-based IAM scenarios:
Energy, agriculture, land use, emissions, concentrations, radiative forcing

No climate impact
With and without mitigation policy

Status:
Preliminary results for all scenarios available on IIASA SSP database
Final versions expected by end of 2015
CO2 Emissions, All Marker Scenarios

Emissions|CO2

Mt CO2/yr

© SSP Database (Version 1.0)

Preliminary Results, IIASA SSP Database, September 2015
CO2 Emissions, SSP5 Marker Scenarios

Preliminary Results, IIASA SSP Database, September 2015
Radiative Forcing, Reference Marker Scenarios

SSP5-Ref
SSP2,3-Ref
SSP4-Ref
SSP1-Ref

Preliminary Results, IIASA SSP Database, September 2015
Shared Socioeconomic Pathways

- **SSP1**: Sustainability
- **SSP2**: Middle of the Road
- **SSP3**: Regional Rivalry
- **SSP4**: Inequality
- **SSP5**: Fossil-fueled Development

**Climate (RCPs)**:

- **2100 forcing level (W/m²)**
  - 8.5
  - 6.0
  - 4.5
  - 2.6

**CMIP5 simulations (RCPs)**:

- A2, B1, B2

**Range of IAM baseline scenarios**

- SSP1
- SSP2
- SSP3
- SSP4
- SSP5

**Notes**:

- Shared Socioeconomic Pathways (SSPs) are different representations of how society might develop in the future, each with its own set of assumptions about economic, social, and environmental trends.
- **RCPs**: Representative Concentration Pathways, which are used to represent different climate scenarios.
- **CMIP5**: Coupled Model Intercomparison Project Phase 5, a framework for comparing different climate models.
Biomass energy

Primary Energy|Biomass

SSP5-2.6
SSP4-2.6
Reference scenarios

© SSP Database (Version 1.0)
Preliminary Results, IIASA SSP Database, September 2015
Food Energy Supply Per Capita, Reference Marker Scenarios

Preliminary Results, IIASA SSP Database, September 2015
Socioeconomic development effects on the risk of hunger (no climate impacts)

Hasegawa et al., 2015.
Shared Socioeconomic Pathways

- SSP1: Sustainability
- SSP2: Middle of the Road
- SSP3: Regional Rivalry
- SSP4: Inequality
- SSP5: Fossil-fueled Development

Climate (RCPs)

2100 forcing level (W/m²)

Range of IAM baseline scenarios

SRES A2, B1, B2

CMIP5 simulations (RCPs)
Recommendations

• Design should follow directly from questions driving the assessment
  – Is it about sustainability?
  – About bounding the range of uncertainty?
  – About evaluating specific options?

• Closer look at SSP narratives and preliminary IAM scenarios to inform design choices

• More interaction with SSP and IAM process going forward
ScenarioMIP design

Shared Socioeconomic Pathways

<table>
<thead>
<tr>
<th>Climate (RCPs)</th>
<th>2100 forcing level (W/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>~7</td>
</tr>
<tr>
<td></td>
<td>~3.7</td>
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<td></td>
<td>2.6</td>
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SRES A2, B1, B2

CMIP5 simulations (RCPs)

Tier 1
ScenarioMIP design

Shared Socioeconomic Pathways

SSP1
Sustainability
SSP2
Middle of the Road
SSP3
Regional Rivalry
SSP4
Inequality
SSP5
Fossil-fueled Development

SRES
A2, B1, B2

CMIP5 simulations (RCPs)

Climate (RCPs)

2100 forcing level (W/m²)

Ensemble
Long-term ext.

Range of IAM baseline scenarios

Tier 1
Tier 2
Tier 3

Overshoot

Long-term ext.

~7
~3.7
~2.0?

Tier 2
Why use this framework?

Save time and effort in developing new scenarios

Avoid reinventing the wheel

Improve comparability across studies of different sectors and scales, and therefore improve assessment

But: don’t feel locked in, especially to the details
Basic vs Extended SSPs

Broad trends in development, limited in regional and sectoral detail

Regional Extension

Sectoral Extension

Global Extension
SSP1: Sustainability

The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries.

- Increasingly effective cooperation of local, national, and international institutions.
- Commitment to development goals. Reduction of inequality across and within countries.
- Educational and health investments accelerate demographic transition, leading to low population.
- Emphasis on economic growth shifts toward a broader human well-being.
- Consumption oriented toward resource and energy efficiency.

Low challenges to mitigation: Development of environmental & renewable energy technologies, international cooperation, and low energy demand.

Low challenges to adaptation: Improvements in human well-being, strong institutions.
SSP5: Fossil-fueled development

This world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development

- Rapid human development, technological progress and economic growth
- Resource intensive lifestyles and extensive fossil fuel use
- Strongly globalizing world with high mobility and peak & decline in population

**High challenges to mitigation:**
Strong reliance on fossil fuels and lack of global environmental concern

**Low challenges to adaptation:**
Attainment of human development goals, robust economic growth, and highly engineered infrastructure
SSP4: Inequality

Increasing disparities in education, economic opportunity and political power lead to growing inequalities across and within countries. A gap widens between a well educated international society supporting a high-tech global economy, and fragmented lower-income, poorly educated societies that work in regional low-tech economies.

- Power becomes more concentrated in a political and business elite. Vulnerable groups have little representation.
- Economic growth is moderate in industrialized and middle-income countries, while low income countries lag behind. Social cohesion degrades and unrest becomes common.
- Technology development is high in the high-tech economy. Uncertainty in fossil fuel markets leads to a diversification of energy sources, incl. investment in low-carbon energy.

Low challenges to mitigation: Some development of low carbon options. Well-integrated international political and business class capable of acting quickly and decisively

High challenges to adaptation: Large population groups have low levels of development and limited access to institutions for coping with economic or environmental stresses.
SSP3: Regional Rivalry

A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on national and regional security issues, including energy and food security.

- Move toward more authoritarian forms of government with highly regulated economies. Trade barriers are raised as the world deglobalizes.
- Investments in education and technology decline. Economic development is slow, consumption is material-intensive, inequalities persist or worsen.
- Population growth is low in industrialized and high in developing countries.
- Low priority for environmental concerns

**High challenges to mitigation:** Growing resource intensity and fossil fuel dependency. Difficulty in achieving international cooperation. Slow technological change.

**High challenges to adaptation:** Limited progress on human development, slow income growth, lack of effective institutions.
The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns.

- Development and income growth proceeds unevenly, and income inequality persists. Globally connected markets function imperfectly.
- Global and national institutions make slow progress in achieving sustainable development goals.
- Technological development proceeds apace, but without fundamental breakthroughs.
- Environmental systems experience degradation, although the overall intensity of resource and energy use declines. Fossil fuel dependency decreases slowly.
- Global population growth is moderate and levels off in the second half of the century.

These moderate development trends leave the world, on average, facing moderate challenges to mitigation and adaptation, but with significant heterogeneities across and within countries.
SSP differences in challenges to mitigation

- SSP 1: Environmental awareness
- SSP 1, 4: Actual or potential low-carbon tech. change; Effective institutions and int'l cooperation
- SSP 3: Slow tech. change
- SSP 3, 5: Fossil-dominated energy supply; Lack of international cooperation
- SSP 5: High energy demand
SSP differences in challenges to adaptation

Adaptation Challenges

SSP 5:
- Highly engineered infrastructure

SSP 1, 5:
- Rapid development
- High human capital
- Reduced inequality

SSP 1:
- Policy orientation toward sustainability

SSP 3:
- Institutions ineffective
- Barriers to trade

SSP 3, 4:
- Slow development
- Low human capital
- Increased inequality

SSP 4:
- Development, institutions unequal within countries

Socioeconomic challenges for mitigation

Socioeconomic challenges for adaptation