The new scenarios process – the way toward a more integrated assessment of climate change

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The New Scenarios Process

Since 2006 the climate research community has been collaborating under the so-called *Parallel Process* to develop a new set of scenarios that would become a basis for future climate modeling, impacts, vulnerability and adaptation studies and mitigation assessments.

In a first phase the climate and integrated assessment modeling communities collaborated to provide emissions projections, the *Representative Concentration Pathways* (RCPs), that are used as inputs for earth system and climate models. The RCPs comprise a set of four new pathways that span a wide range of year 2100 radiative forcing, from 2.6 to 8.5 W/m^2. Using the IIASA Integrated Assessment Framework the RCP with the highest climate signal (RCP8.5) was developed. The RCPs were successfully completed in 2011.

The currently ongoing second phase of the parallel process elaborates the socio-economic dimension of the new community scenarios. The primary goal of this phase is the development of the so-called *Shared Socioeconomic Pathways* (SSPs). The SSPs are part of the new framework that the climate change research community has adopted to facilitate the integrated analysis of future climate impacts, vulnerabilities, adaptation, and mitigation. Narratives for five different SSPs have been identified in a series of workshops with wide participation of scientists from the different research communities (see Figure 1).

Several groups at IIASA are actively involved in the development of the SSPs with the World Population (POP) program developing population and economic projections, the Ecosystems Services and Management (ESM) program food demand and land use, agriculture and forestry scenarios and the Energy (ENE) program energy system transformations, including energy service demands, resource and technology assumptions. The SSP development is work in progress.

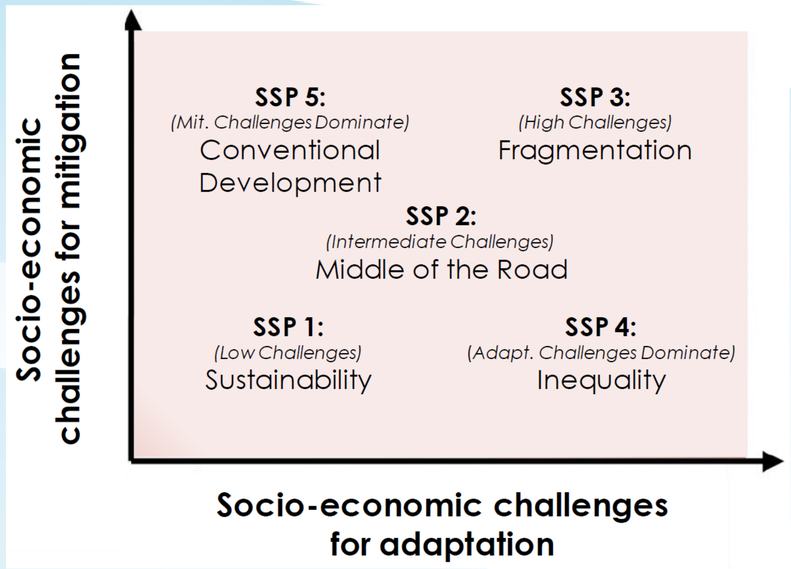

Figure 1: Five SSPs for which basic narratives were developed at the SSP meeting in Boulder.
Source: O'Neill et al. (2012) Draft SSP Narratives, NCAR, Boulder, CO.

Population Projections

IIASA's POP program has developed alternative projections of national populations by age, sex and level of educational attainment. It is doing so by using the methods of multi-state projections that were developed at IIASA since the 1970s and that allow consideration of the fact that men and women with different level of education also have different fertility and mortality rates. Four different education scenarios as defined in the IIASA/Vienna Institute of Demography education projections build the basis for SSP population projections.

- The fast track (FT) scenario assumes that all countries expand their school systems at the fastest rate observed in the past.
- The global education trend (GET) scenario assumes that countries will follow the path of school expansion observed in other countries.
- The constant enrollment rate (CER) scenario assumes that countries keep the proportions of cohorts attending school at current levels.
- The constant enrollment numbers (CEN), assumes that the absolute number of students is kept constant.

Based on these population projections a set of urbanization scenarios was developed at the National Center for Atmospheric Research (NCAR).

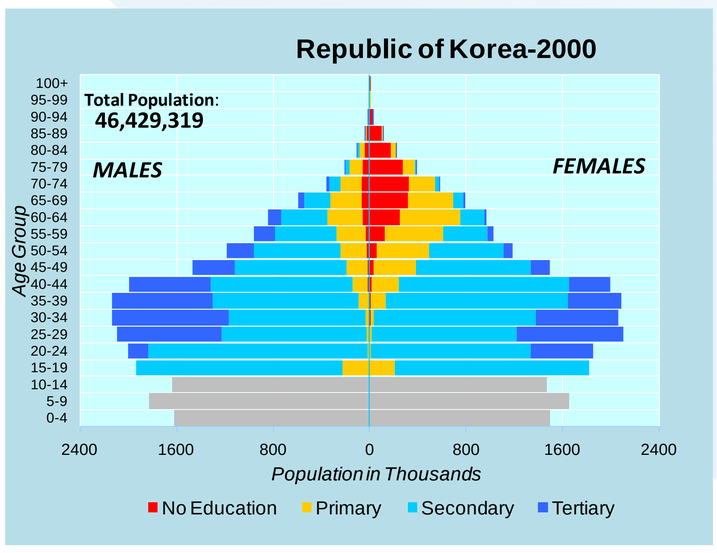

Figure 3: Age pyramid of the Republic of Korea in the year 2000 with different levels of education separated out.

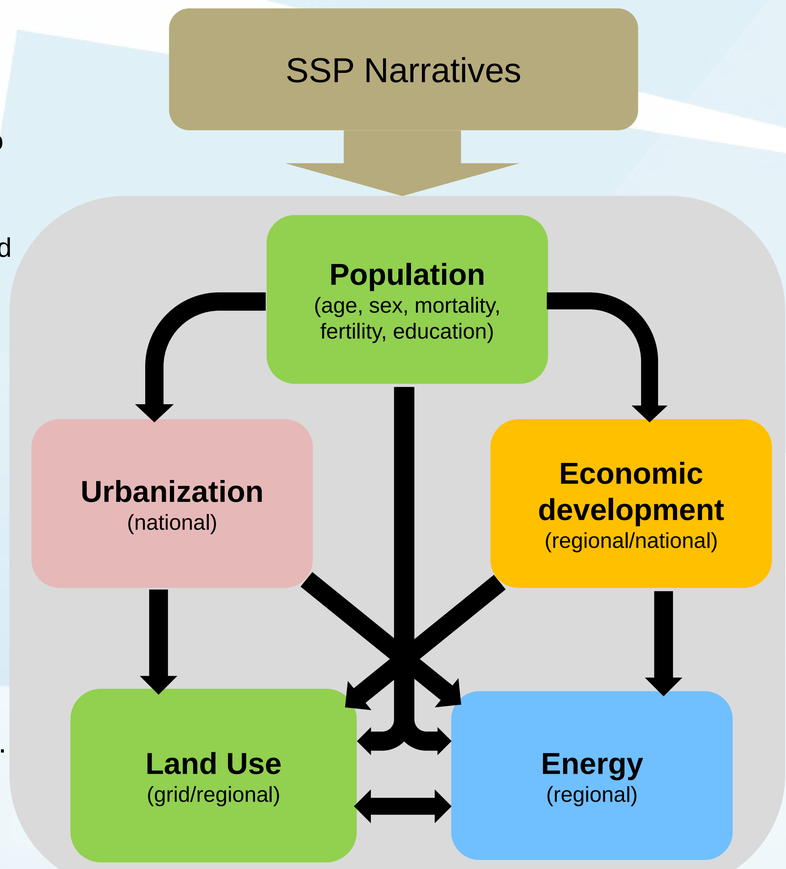

Figure 2: Schematic linkage between the different SSP components developed at IIASA and elsewhere.

The Land-Energy Nexus

The GLOBIOM-G4M and MESSAGE models have been soft-linked to ensure consistency of the land and energy components of the new scenarios being developed within the SSP process. The linkage between the models includes bioenergy potentials and GHG mitigation options for the land use sectors.

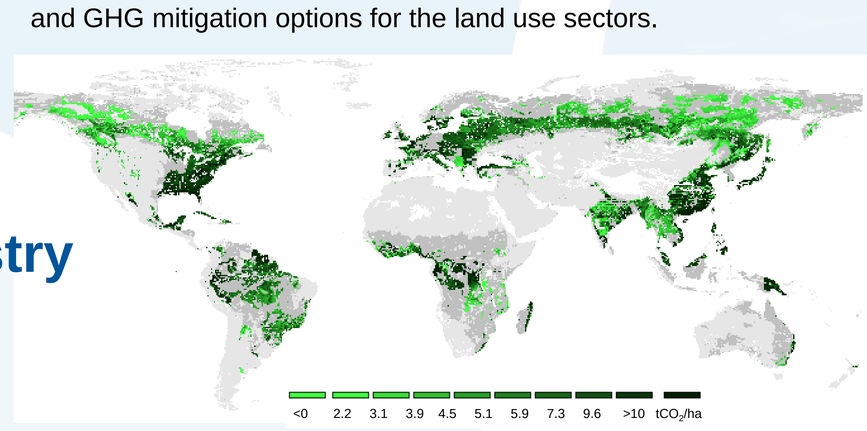

Figure 5: Map of CO_2 removals from the atmosphere due to afforestation in a preliminary SSP2 by 2050.

Land Use, Agriculture and Forestry

IIASA's GLOBIOM model is used to analyze the competition for land use between agriculture, forestry, and bioenergy, which are the main land-based production sectors. As such, the model can provide scientists and policymakers with the means to assess, on a global basis, the rational production of food, forest fiber, and bio-fuels, all of which are vital for human welfare. GLOBIOM is coupled to the Global Forest Model (G4M) which estimates the amount of net income being derived from forests at the grid scale. The production of food, forest fiber, and bioenergy are jointly analyzed in the GLOBIOM-G4M framework to ensure an integrated way of dealing with conflicts in the agriculture, forestry, and bioenergy sectors.

Economic Projections

Economic projections in the SSP process have been developed by three different groups, one of which is based at IIASA. IIASA's GDP growth projection model is based on a simple aggregate production function with heterogeneous labor input (differentiated by educational attainment and age group). The growth rate of total output depends on the growth rate of each one of the factors of production – total factor productivity, the capital stock and each one of the population groups by age group and education level.

Human capital dynamics as implied by projections of population by age and educational attainment are used as the main driving factor of economic growth over the projection horizon. This implies that the economic growth model together with the IIASA's population projections provide a coherent framework in which to assess quantitatively the dynamics of human capital and their effect on economic performance in long-term projections.

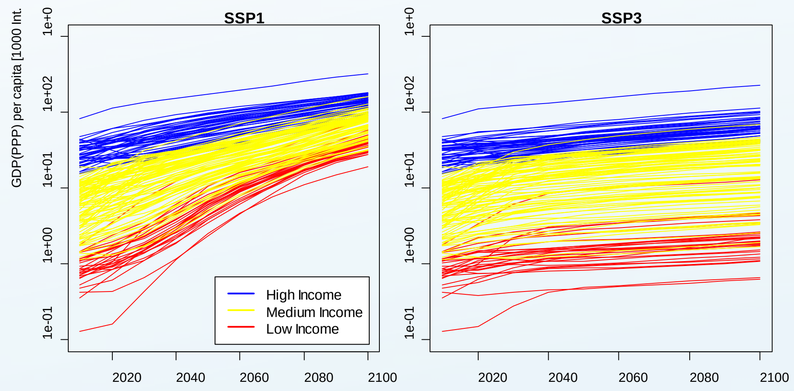

Figure 4: Development of per capita income in SSPs 1 and 3 across 173 countries.

Energy Transformations

Based on the SSP narratives, a set of energy service demand projections, energy resource and technology assumptions has been developed. IIASA's MESSAGE model provides a flexible framework for the comprehensive assessment of the major energy challenges, including energy access, energy security, health and climate change, and is applied for the development of energy-emissions scenarios and the identification of socio-economic and technological response strategies to these challenges. An illustration of primary energy transformations in three preliminary SSPs is shown in Figure 6 with SSP1 developing toward a renewable energy based system, SSP3 relying heavily on coal and SSP2 being a mixture of the two.

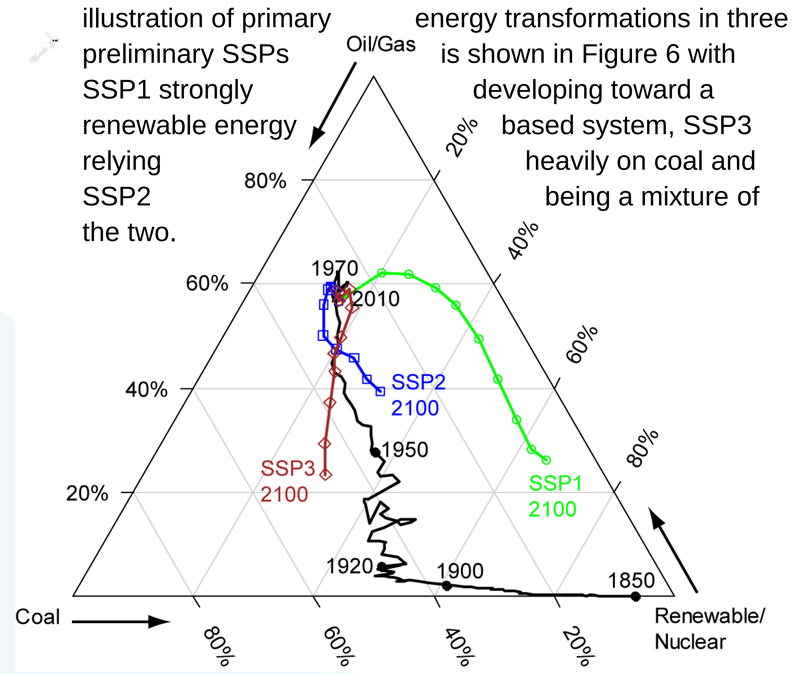

Figure 6: Primary energy transformations across preliminary SSPs developed at IIASA.

Further Reading

- New scenarios process: Moss et al. (2010) The next generation of scenarios for climate change research and assessment. Nature 463:747-756.
- RCPs: van Vuuren et al. (2011) The representative concentration pathways: An overview. Climatic Change 109:5-31.
- Population: Lutz and KC (2011) Global human capital: Integrating education and population. Science 333:587-592.
- Economics: Lutz et al. (2008) Economics: The demography of educational attainment and economic growth. Science 319:1047-1048.
- Land Use: Havlik et al. (2011) Global land-use implications of first and second generation biofuel targets. *Energy Policy* 39:5690-5702.
- Energy: Riahi et al. (2011) RCP 8.5 - A scenario of comparatively high greenhouse gas emissions. Climatic Change 109:33-57.
- Databases – RCP: http://www.iiasa.ac.at/web-apps/tnt/RcpDb, SSP: https://secure.iiasa.ac.at/web-apps/ene/SspDb