Internal consistency of assumption and projection of demographic factors in the SSPs scenarios

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The Shared Socioeconomic Pathways (SSPs) include for the first time a comprehensive set of demographic factors on population, urbanization, and education, along with other aspects of socioeconomic conditions, such as GDP, technology, and governance. It presents a major step forward as compared to the earlier IPCC socioeconomic scenarios (e.g. Special Report on Emission Scenarios (SRES, Nakicenovic N. et al. 2000), which only includes projections of total population growth, being mainly considered as a scaling factor for assessing the challenges to and options of climate change mitigation.

In the process of developing the SSPs, the climate change research communities identify a small number of important and quantifiable demographic (population, education, and urbanization) and economic (GDP) factors as basic elements (Scheweizer and O'Neill, in press), and project the changes of these elements for the 21st century under scenarios of each SSPs (available through https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=welcome).

While this new set of alternative socioeconomic scenarios and the quantitative projections of their basic elements will facilitate better assessments of challenges to both climate change mitigation and adaptation, it also raises a new question about the internal consistency of assumptions and projections about the demographic and economic trends between different SSPs and across different regions/countries within a SSP, because the projections are conducted using different model tools.

There are usually two types of internal consistency test for validating the model results in such as case: (1) the test of consistency for individual projections and (2) the consistency test for combination of group of projections. While the first type of consistency test had been conducted by each model team whose assumptions and projection results are proved to be consistent with either the observed data, or empirical analysis, or existing theories (KC and Lutz, submitted; Jiang and O'Neill, submitted; Dellink and Chateau, in preparation; Cuaresma in preparation; Kriegler and Leimbach in preparation), we also need to do the second type of consistency test. In particular, the models used to generate the projection results do not explicitly consider the interactions of all the basic elements or the indirect influences between each factor. For instance, the interactions between population/education and urbanization are

not specifically modeled in either the population/education or urbanization projections. Although the economic projection uses population and education as input, the direct impact of urbanization is not included.

Therefore, it is important to examine whether the assumptions on the changes in the basic elements are consistent with the qualitative narratives for different SSPs (Figure 1), and whether the quantitative projection results of the demographic and economic factors in the SSPs (Figure 2) resemble the patterns of interactions between these factors that are observed in the past or suggested by demographic and economic theories.

A systematic review of the literature on correlation and causation between these demographic and economic factors, based on empirical analysis of historical statistics and quantitative economic or demographic modeling, is helpful. The findings from the existing studies on the interactions between the SSPs basic elements vary considerably depending on which factors are under consideration. For instance, a large number of studies on the effect of urbanization on population change provides a robust evidence and reach a high agreement that there is a generally negative correlation between the two elements. However, there are very limited published works examining the impact of education on urbanization, which also reach a high agreement that increasing education contributes to high urban growth. Moreover, studies on the interactions between these variables also reveal that some relationships such as the one between population and economic growth vary at different stages of socioeconomic development. These findings is especially useful for examining the assumptions on the alternative trends in changes of these demographic factors for countries of different income group under each SSP.
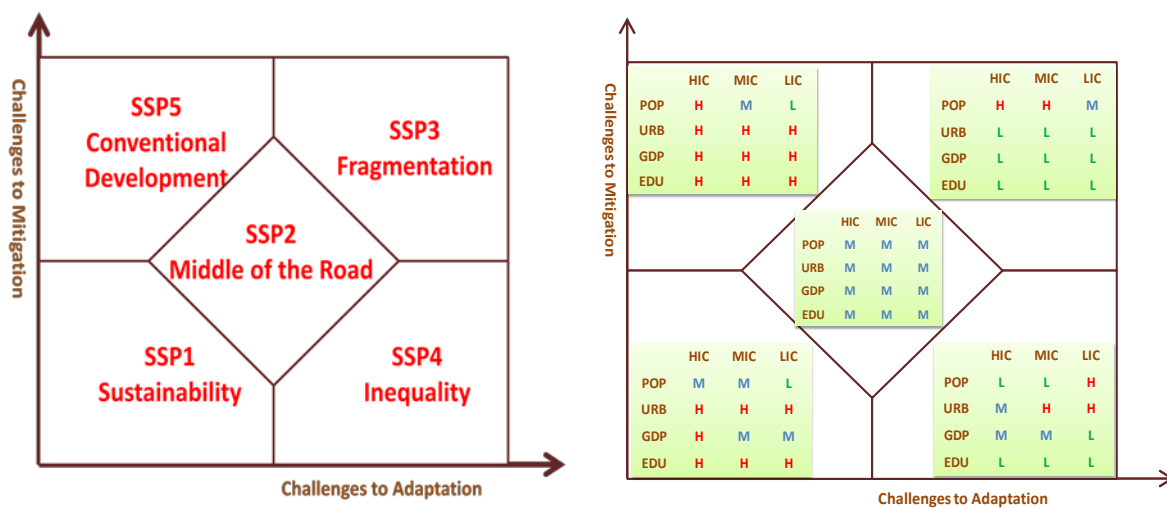

Figure 1. The qualitative narratives and the assumptions on future changes in the basic elements across countries of different income group of the SSPs

Note: the basic elements are POP – population, URB – urbanization, GDP, EDU – education; the income groups are HIC – high income, MIC—medium income, LIC – low income; assumption on future changes are H – high scenario, M – medium scenario, L – low scenario.
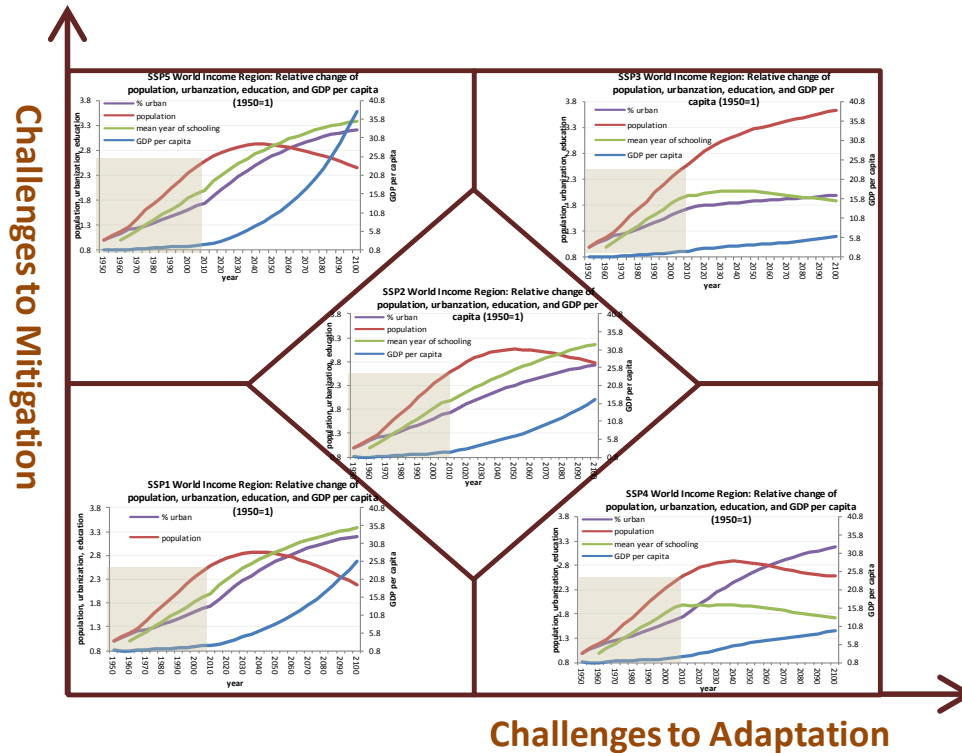

Figure 2. Projected global changes in population (red line), urbanization (purple), education (green), and per capita GDP (blue) for the SSPs: aggregated from national projection results

More importantly, while statistical analysis of the projected results may prove that the implied relationships between the basic elements of the SSPs be consistent with the qualitative narratives and the empirical evidences found in certain part of the world during certain time periods, further researches on demographic and socioeconomic development pathways from case studies will help to identify additional important elements and explore other patterns of interactions that are not included yet in the global basic SSPs but more fit regional or local settings in the process of developing the extended SSPs.

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