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Editorial

The Shared Socio-economic Pathways: Trajectories for human development and global environmental change

1. Introduction

This Special Issue presents the Shared Socioeconomic Pathways (SSPs), a set of five storylines on possible trajectories for human development and global environmental change during the 21st century. The SSPs represent an unique product, forming the most comprehensive set of scenarios for environmental and sustainable development research produced so-far. Each SSPs consists of a narrative of future socio-economic development as well as quantitative data generated by state-of-the-art demographic, economic and integrated assessment models illustrating the narratives. The quantitative information includes projections on wide range of topics such population size, urbanization rates, income, energy use and production, agriculture and land use, emissions and climate change. Together, the set provides information on a wide ranges of futures ranging from those more consistent with sustainable development trends to futures characterized by a strong increase in resource consumption rates, environmental pressure and large challenges with respect to human development. The SSPs can be used in climate change research as well as in other research areas such as biodiversity and sustainable development.

The SSPs have been developed over the last few years as a joint community effort and form part of a larger set of community scenarios for analysis of climate change, global environmental change and sustainable development issues. Together, these scenarios allow exploration of different futures with and without climate policy responses. The SSPs are intended to form a key tool to link climate change research across different disciplines, from the driving forces of climate change to the physical climate system, climate impacts and adaptation and mitigation strategies. They can also be used across different geographical scales (global, regional and local scales) (Absar and Preston, 2015) or to link different sectors. In that context, the global scenarios presented in this Special Issue can be used at the local scale or for specific sectors as a boundary condition, as a "wind tunnel" to explore consistency, or more loosely based on the storylines. The SSPs can also link different research areas to climate change projections (linking biodiversity and climate change analysis, (Kok et al., 2016)). Finally, they also have a key function as a consistent data source (e.g. for population projections, climate projections and insights into land and energy development).

In 2010, Moss et al. (2010) described a strategy to develop new community scenarios to replace the SRES scenarios, which were published in 2000 and developed in the late 1990s. A first step in this strategy involved the development of the Representative Concentration Pathways (RCPs). The RCPs consist of a set of pathways for emissions and concentrations of greenhouse gases and air pollutants as well as for land use (van Vuuren et al., 2011) and the subsequent changes in the climate system (Taylor et al., 2012). In 2014, several papers (Kriegler et al., 2014; O'Neill et al., 2014; van Vuuren et al., 2014) described the conceptual framework of how the RCPs could be combined with the SSPs. To this end, a scenario matrix approach was introduced that facilitates the research community to conduct integrated climate change assessments. This consistent framework to assess various response strategies to climate change provides the basis for the elaboration of the SSPs.

This special issue takes the next step in this process and provides a detailed description of the content of the SSPs. The overview paper by Riahi et al. (2017) describes the main characteristics of the SSPs. It focuses on how the SSPs have been designed in order to provide a description of plausible human development strategies that lead to very different future challenges with respect to mitigation and adaptation to climate change. It also summarizes the global average forcing and climate consequences as projected with a simple climate model. The overview paper is complemented by more detailed papers on different components of the SSPs, including particularly the SSP narratives (O'Neill et al., 2017), quantitative descriptions for key scenario drivers such as population (KC and Lutz, 2017), three alternative economic growth prospects (Crespo Cuaresma, 2017; Dellink et al., 2017; Leimbach et al., 2017), and urbanization (Jiang and O'Neill, 2017). Five individual papers describe the main dynamics of each SSP scenario (Calvin et al., 2017; Fricko et al., 2017; Fujimori et al., 2017; Kriegler et al., 2017; van Vuuren et al.,

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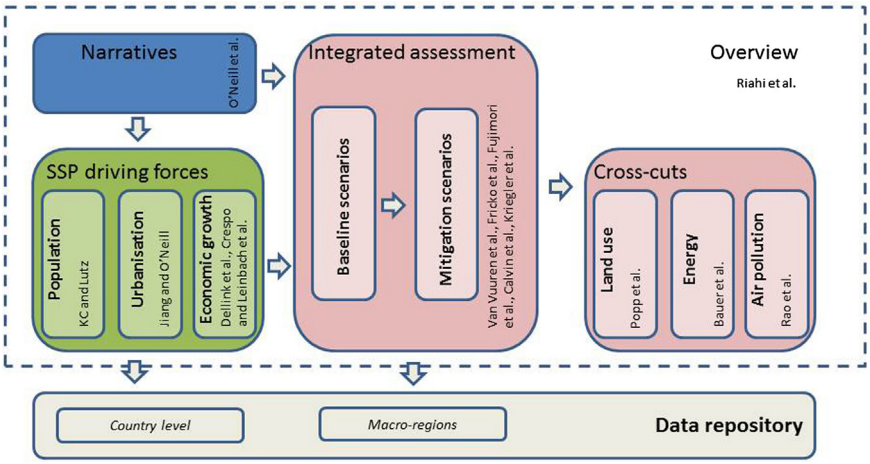

Fig. 1. Overview of the Special Issue and how the different outcomes of the SI papers feed into a community database on the SSPs.

2017). Dedicated cross-cut papers elaborate the SSPs in terms of the energy system, land-use changes, and resulting air pollutant emissions (Bauer et al., 2017; Popp et al., 2017; Rao et al., 2017). Fig. 1 shows how the papers in this Special Issue are connected in order to provide a comprehensive account of the SSPs. In the remaining part of this editorial, we discuss briefly how the different papers of the Special Issue connect to form one consistent and detailed story about the SSPs.

2. Brief introduction into the different papers

2.1. An overview of the SSPs

The paper by Riahi et al. (2017) provides an overview of the SSPs, in terms of their main characteristics, but also in terms of development process and methodology. Specifically the paper describes how the narratives were translated into quantitative descriptions for key scenario drivers, such as population, economic growth, and urbanization, which provided the foundation for the elaboration of the SSP-based scenarios in terms of energy system and land-use changes, as well as resulting air pollutant and greenhouse gas emissions, atmospheric concentrations and climate change. The SSP scenarios consist of a set of baselines, which provide a description of future developments in absence of climate change impacts or of new climate policies beyond those in place today, as well as mitigation scenarios, which explore the implications of climate change mitigation policies. An important asset of the SSP development process is the multi-model approach that was employed for the quantification of the SSP characteristics and their associated uncertainties. Among the alternative model interpretations, so-called "marker" SSPs were selected as representative of the specific SSP developments. Riahi and colleagues conclude with important implications of the SSPs for their further use in other assessments, and provide an outlook in terms of future research that might build upon the marker SSP projections provided in this special issue.

2.2. SSP narratives

The **narratives** are an important element of the SSPs. These narratives form a set of consistent, qualitative descriptions of future changes in demographics, human development, economy and lifestyle, policies and institutions, technology, and environment and natural resources. The narratives are intended as a description of plausible future conditions at the level of large world regions that can serve as a basis for integrated scenarios of emissions and land use, as well as climate mitigation, impact, adaptation and vulnerability analyses. They were designed to cover a range of socioeconomic challenges to mitigate and adapt to climate change, but also describe a set of worlds with very different development implications. The paper by O'Neill et al. provides a detailed description of these narratives (named Sustainability, Regional Rivalry, Inequality, and Fossil-fueled Development, and a Middle of the Road pathway). It shows how the development of the narratives drew on expert opinion to (1) identify key determinants of these challenges that were essential to incorporate in the narratives and (2) combine these elements in the narratives in a manner consistent with scholarship on their inter-relationships.

2.3. Demographic and economic drivers

Population and economic growth form key determinants of further changes in energy and land-use. Four papers in the Special Issue describe how quantitative scenarios for these elements were developed. First, the paper by KC et al. describes a set of national **population projections** based on alternative demographic assumptions. The population scenarios are not only differentiated by age and sex —as is conventionally done in demographic projections—but also by different levels of educational attainment, addressing a fundamental aspects of human development and social change. The scenarios show that the total world population size of the five SSPs are very similar until around 2030, but the range widens after 2030 with the SSP3 reaching 12.6 billion in 2100 and SSP1 falling to 6.9 billion in 2100.

Three different papers by Dellink et al., Crespo et al., and Leimbach et al. describe the possible **long-term economic developments.** They are developed using different economic tools. The paper by Dellink et al. describes a consistent methodology to derive GDP scenarios using the OECD ENV-Growth model. The methodology is based on a conditional convergence process and places emphasis on the key drivers of economic growth in the long run: population, total factor productivity, physical capital, employment and human capital, and energy resources. The paper by Crespo et al., instead, discusses how the