

The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century



Brian C. O'Neill^{a,*}, Elmar Kriegler^b, Kristie L. Ebi^c, Eric Kemp-Benedict^d, Keywan Riahi^{e,f}, Dale S. Rothman^g, Bas J. van Ruijven^a, Detlef P. van Vuuren^{h,i}, Joern Birkmann^j, Kasper Kok^k, Marc Levy^l, William Solecki^m

^a National Center for Atmospheric Research (NCAR), PO Box 3000, Boulder, CO 80305, USA

^b Potsdam Institute for Climate Impact Research, PO Box 601203, 14412 Potsdam, Germany

^c University of Washington, Seattle, WA, USA

^d Stockholm Environment Institute, 15th Floor, Witthayakit Building, 254 Chulalongkorn University, Chulalongkorn Soi 64, Phayathai Road, Pathumwan, Bangkok 10330, Thailand

^e International Institute for Applied Systems Analysis, Laxenburg, Austria

^f Graz University of Technology, Graz, Austria

^g Frederick S. Pardee Center for International Futures, Josef Korbel School of International Studies, University of Denver, 2201 South Gaylord Street, Denver, CO 80208-0500, USA

^h PBL Netherlands Environmental Assessment Agency, Bilthoven, The Netherlands

ⁱ Copernicus Institute for Sustainable Development, Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands

^j Institute for Spatial and Regional Planning, University of Stuttgart, Pfaffenwaldring 7, 70569 Stuttgart, Germany

^k Soil Geography and Landscape Group, Wageningen University, Wageningen, The Netherlands

^l Center for International Earth Science Information Network (CIESIN), Columbia University, 61 Route 9W, PO Box 1000, Palisades, NY 10964, USA

^m CUNY Institute for Sustainable Cities and Department of Geography, Hunter College—City of New York, 695 Park Avenue, New York, NY 10021, USA

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ABSTRACT

Long-term scenarios play an important role in research on global environmental change. The climate change research community is developing new scenarios integrating future changes in climate and society to investigate climate impacts as well as options for mitigation and adaptation. One component of these new scenarios is a set of alternative futures of societal development known as the shared socioeconomic pathways (SSPs). The conceptual framework for the design and use of the SSPs calls for the development of global pathways describing the future evolution of key aspects of society that would together imply a range of challenges for mitigating and adapting to climate change. Here we present one component of these pathways: the SSP narratives, a set of five qualitative descriptions of future changes in demographics, human development, economy and lifestyle, policies and institutions, technology, and environment and natural resources. We describe the methods used to develop the narratives as well as how these pathways are hypothesized to produce particular combinations of challenges to mitigation and adaptation. 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. 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 impact, adaptation and vulnerability analyses.

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1. Introduction and background

Long-term global scenarios have played a key role in climate change analysis for more than 20 years (Leggett et al., 1992; Nakicenovic et al., 2000; Raskin et al., 2005; van Vuuren et al., 2012). While other approaches to characterizing the future exist (Lempert et al., 2004; Webster et al., 2003), alternative scenarios

* Corresponding author. Tel.: +1 303 497 8118; fax: +1 303 497 1333.

E-mail addresses: boneill@ucar.edu (B.C. O'Neill), kriegler@pik-potsdam.de (E. Kriegler), krisebi@essllc.org (K.L. Ebi), eric.kemp-benedict@sei-international.org (E. Kemp-Benedict), riahi@iiasa.ac.at (K. Riahi), drothman@du.edu (D.S. Rothman), vruijven@ucar.edu (B.J. van Ruijven), detlef.vanvuuren@pbl.nl (D.P. van Vuuren), joern.birkmann@ireus.uni-stuttgart.de (J. Birkmann), kasper.kok@wur.nl (K. Kok), mlevy@columbia.edu (M. Levy), wsolecki@hunter.cuny.edu (W. Solecki).

are an important method for exploring uncertainty in future societal and climate conditions (Jones et al., 2014). Scenarios of global development focus on the uncertainty in future societal conditions, describing societal futures that can be combined with climate change projections and climate policy assumptions to produce integrated scenarios to explore mitigation, adaptation and residual climate impacts in a consistent framework.

Often, societal development scenarios consist of qualitative and quantitative components (Raskin et al., 2005; Rothman et al., 2007; Ash et al., 2010; van Vuuren et al., 2012). Quantitative components provide common assumptions for elements such as population, economic growth, or rates of technological change that can be meaningfully quantified and that can serve as inputs to models of energy use, land use, emissions, and other outcomes. Qualitative narratives (or storylines) describe the evolution of aspects of society that are difficult to project quantitatively (such as the quality of institutions, political stability, environmental awareness, etc.), provide the logic underlying those elements of scenarios that are quantifiable (and their relationships to each other), and provide a basis for further elaboration of the scenarios by users.

A process is under way in the climate change research community to develop a new set of integrated scenarios describing future climate, societal, and environmental change (Moss et al., 2010). This process started with the development of representative concentration pathways (RCPs) that describe a set of alternative trajectories for the atmospheric concentrations of key greenhouse gases (Van Vuuren et al., 2011). Based on these, climate modelers produced a number of simulations of possible future climates over the 21st century (Taylor et al., 2012). In parallel, other researchers are producing a new set of alternative pathways of future societal development, described as shared socioeconomic pathways (SSPs), and using integrated assessment models (IAMs) to produce additional quantitative elements based on them, including future emissions and land use change. A conceptual framework has been produced for the development of SSPs (O'Neill et al., 2014) and for how to combine IAM scenarios based on them with future climate change outcomes and climate policy assumptions to produce integrated scenarios (Ebi et al., 2014; van Vuuren et al., 2014; Kriegler et al., 2014) and support other kinds of integrated climate change analysis.

However, the specific content (as opposed to the conceptual framework) of the SSPs and associated IAM scenarios has, until now, not been presented in the peer-reviewed literature. The focus of this special issue is to present that content. The SSPs describe plausible alternative changes in aspects of society such as demographic, economic, technological, social, governance and environmental factors. Like many previous characterizations of future societal development, they include both qualitative descriptions of broad trends in development over large world regions (narratives) as well as quantification of key variables that can serve as inputs to integrated assessment models, large-scale impact models and vulnerability assessments (Alcamo, 2001). In this paper we present the SSP narratives, describing the methods used to develop them, their main features, and open questions regarding their design and use. Along with the narratives, we provide tables that summarize trends in key elements of the SSPs. Other papers in this special issue describe the quantitative elements of the SSPs, including population and educational composition (KC and Lutz, 2014), urbanization (Jiang and O'Neill, 2014), and economic growth pathways (Crespo Cuaresma, 2014; Leimbach et al., 2014; Dellink et al., 2014). An additional set of papers focus on the integration of the narratives and quantitative elements of the SSPs into IAM simulations describing the possible evolution of land use, energy and agricultural systems and

resulting GHG emissions under different SSPs and climate policy assumptions.

Within the conceptual framework for integrated scenarios, the SSPs are designed to span a relevant range of uncertainty in societal futures. Unlike most global scenario exercises, the relevant uncertainty space that the SSPs are intended to span is defined primarily by the nature of the *outcomes*, rather than the *inputs* or *elements* that lead to these outcomes (O'Neill et al., 2014). As such, the design process begins with identifying a particular outcome and then identifies the key elements of society that could determine this outcome. This approach is typically associated with backcasting, where an end state is already in mind as the pathways are being developed, although not necessarily assuming that these states are all desirable (Vergragt and Quist, 2011). Such a backcasting scenario approach has proven effective in focusing on those areas of the uncertainty space that are most important in choosing among alternative options (Groves and Lempert, 2007). Although the domain of application of climate change scenarios includes a large range of specific decision-making situations, they generally cover options to mitigate or adapt to climate change. Therefore, the SSP outcomes are specific combinations of socioeconomic challenges to mitigation and socioeconomic challenges to adaptation (Fig. 1). That is, the SSPs are intended to describe worlds in which societal trends result in making mitigation of, or adaptation to, climate change harder or easier, without explicitly considering climate change itself.

While the focus on challenges to mitigation and adaptation allows for a more systematic exploration of uncertainties relating to climate policies, the SSPs can also be useful in other contexts relating more broadly to sustainable development. This is due to the fact that socio-economic challenges to mitigation and adaptation are closely linked to different degrees of socio-economic development and sustainability, a topic we discuss in Section 4. Thus, the SSPs can be applied to the analysis of sustainable development problems without specific reference to mitigation and adaptation challenges even though these challenges were the starting point for their design. It is, of course, possible that a backcasting approach that took broader sustainable development rather than climate change challenges as a starting point would yield a somewhat different set of SSPs. To this end, the approach taken here for climate change research may provide a useful example for the development and use of new scenarios in sustainable development research.

While the SSPs, and the scenario process more broadly, are intended to be policy relevant (hence the framing in terms of challenges to two types of policy responses), the intended direct

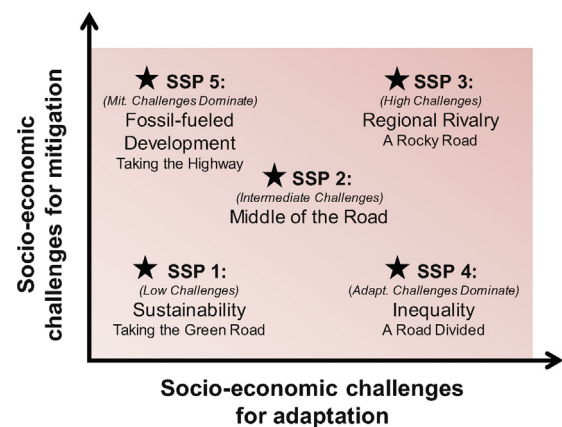


Fig. 1. Five shared socioeconomic pathways (SSPs) representing different combinations of challenges to mitigation and to adaptation. Based on Fig. 1 from O'Neill et al. (2014), but with the addition of specific SSPs.

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