Making SSPs more Relevant to Assessments of Impacts, Adaptation and Vulnerability

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Over the past three decades, scenario analyses have occupied a central role in assessments of the potential impacts of climate change on natural and human systems at different scales during the 21st century. Whereas early studies used scenarios to explore the impacts of climate change on the physical system alone, from the late-1990s onwards there was an increasing recognition of the need to integrate the human dimensions of global change into impact studies. Social, economic, and technological changes and vulnerabilities will be fundamental determinants of future natural and human system risks and responses under a changing climate (Carter et al., 2007; Carter et al., 2001). However, extant socioeconomic scenarios are often limited by constrained time horizons, lack of spatial specificity, and limited dimensionality.

Impact studies analyze the impacts and risks of climate changes for human and natural systems, with the aim to estimate the character, magnitude and rate of impacts across a number of contrasting scenarios and to investigate the effectiveness of various mitigation or adaptation measures in reducing risks or exploiting opportunities. Studies focusing on adaptation require scenarios that characterise the conditions, incentives or barriers that affect adaptation options and adaptive capacity. Here, different socioeconomic scenarios can be combined with different climate scenarios to estimate the effectiveness of adaptation, residual damages after mitigation and adaptation, and the associated costs. In research on vulnerability, scenarios can be used to enhance understanding of the key factors predisposing systems and communities to potential adverse impacts of climate change, exploring how causal relations between those factors might develop or change in the future.

The applications of scenarios for IAV studies pose high demands on socioeconomic scenarios in terms of delivering specific information at the scale of analysis and for the number of variables required to describe future vulnerability and adaptive capacity. The selection of appropriate variables to describe the different dimensions of vulnerability and adaptive capacity is still under discussion. Factors describing vulnerability are often highly context specific, and one formidable challenge is to translate these into general variables that can be flexibly applied across different contexts. Further difficulty is introduced in attempting to quantify factors that are inherently qualitative, such as the quality of governance or levels of participation in decision-making. Several new vulnerability indices have recently

been developed, such as the indicators for susceptibility, coping capacity and adaptive capacity in the World Risk Index (WRI) (Birkmann et al., 2011) and the Global Adaptation Index (GAIN: Global Adaptation Institute, 2011). In this regard it is important to note that some of these risk, vulnerability and adaptation index approaches use various indicators that are also applied in the SSPs and global impact models, hence it would be possible to explore more intensively the usefulness of scenarios in these vulnerability and risk assessments (see Birkmann et al., in review). Nevertheless, the above challenges remain relevant and the utility and legitimacy of such indices is still contentious (Barnett et al., 2008; Hinkel, 2011).

The new scenarios provide an opportunity to reduce several of the limitations identified above for the use of scenarios in IAV work, including benefiting from lessons learned in the recent efforts. The scenarios also can include a richer set of elements more useful to projections of vulnerability and adaptive capacity. Here we briefly discuss a few considered highly important.

Income distribution

Adaptation studies take place at scales from national to household, with inequalities at each scale. Indicators that capture sub-national inequalities are important to guide location-based assessments of vulnerability and impact differentials. Past efforts to assess impacts locally have often had to rely on downscaling methods (Grübler et al., 2007; van Vuuren et al., 2007).

In response to growing demand by the IAV community for sub-national indicators, the new scenarios aim to provide quantitative projections of within-country income inequality and educational attainment. Literature on drivers of income inequalities stress the importance of structural and demographic change; physical and human capital accumulation; global trade and financial market integration and liberalization; technological progress; and policy and institutional factors (OECD, 2011).

Spatial population

Spatial population projections are highly relevant for IAV analyses, where the location of people is one factor determining climate change risk (see e.g. Balk et al., 2012). Although there is lack of coherence between present-day datasets (Seto et al., 2011; Zhang and Seto, 2011) and many different approaches exist (Angel et al., 2011), recent methods strengthened the connection between qualitative storylines and projected population outcomes. In contrast to earlier methods based on trend extrapolation and/or proportional scaling techniques, newer methods based on geographic gravity models can be calibrated to reflect spatial patterns of change in the historical data (Jones, 2012). Furthermore, these models can be adjusted to reflect varying assumptions regarding the socioeconomic conditions that may impact future spatial patterns of development. Moreover, recent models project the urban/rural components of population and separately replicate urban and rural population dynamics. Additional improvements include improved spatial resolution, inclusion of geophysical spatial data (e.g., elevation, slope, surface water, and protected land) to better model habitable land, and exploration of the relationship between national socioeconomic indicators and sub-national population distribution (e.g. Nam and Reilly, 2013).

Human health

Projections of access to public health and health care services and burdens of diseases are relevant for vulnerability and adaptation assessments (McCarthy et al., 2010; van Lieshout et al., 2004). The new scenarios could be enriched with projections based on methods such as the WHO global burden of disease (GBD) approach and the methods included in models, such as GISMO and International Futures (IFs). The GBD approach uses linear regression of mortality with GDP per capita, human capital, technological change and tobacco use for major disease clusters (Mathers and Loncar, 2006). This approach makes no specific assumptions about the relationships between more distal socioeconomic factors and more proximate determinants of morbidity and mortality, such as environment, lifestyle, and physiological risk factors. The GISMO (Hilderink and Lucas, 2008) and IFs (Hughes et al., 2011) models complement the GBD approach to address some of these issues. Both models include approaches to simulate the health system and to address morbidity and mortality as a result of exposure to distal and proximate socioeconomic and environmental health risks.

Governance

Elaborating on governance is crucial to application of the new scenarios for IAV research. The current SSP narratives include only a basic description of governance at the international and national level (O'Neill et al., forthcoming). It is difficult to include governance dimensions in global integrated assessment models, although several attempts exist (e.g. Hughes et al., 2013). For global scenario-analysis, it seems more fruitful to have different governance parameters influencing model input parameters rather than including these in the models (de Vos et al.). A key-issue for elaborating governance is not only to find quantitative indicators for governance itself, but also to elaborate on how different scientific perspectives on governance and potential future development in governance scenarios play out in terms of quantitative indicators for development, vulnerability, and adaptive capacity. A joint effort of the Earth System Governance project (Biermann et al., 2009) and the scenario process aims to provide more elaborate descriptions of governance that reflect recent trends in governance thinking, from government to governance, and distinguishing multi-actor, multi-level governance.

Conclusion

The new scenarios will be crucial for improved projections and assessments of the risks of and options to manage climate change risks. They can improve coherence in the growing body of regional scenario studies, provide global boundary conditions to regional studies, and inform large-scale impact, adaptation and vulnerability assessments. Strategies to reduce vulnerability and increase adaptive capacities of societies facing climate change risks have to account for a variety of potential changes in societal conditions. The usefulness of the new scenarios would be enhanced for IAV researchers by adding a richer set of elements to the projections – including income distribution, spatial population, human health, and governance – and by improving the application across spatial and temporal scales. This paper suggests a research agenda to start this process.

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