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Multi-factor, multi-state, multi-model scenarios: Exploring food and climate futures for Southeast Asia

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ABSTRACT

Decision-makers aiming to improve food security, livelihoods and resilience are faced with an uncertain future. To develop robust policies they need tools to explore the potential effects of uncertain climatic, socioeconomic, and environmental changes. Methods have been developed to use scenarios to present alternative futures to inform policy. Nevertheless, many of these can limit the possibility space with which decision-makers engage. This paper will present a participatory scenario process that maintains a large possibility space through the use of multiple factors and factor-states and a multi-model ensemble to create and quantify four regional scenarios for Southeast Asia. To do this we will explain 1) the process of multi-factor, multi-state building was done in a stakeholder workshop in Vietnam, 2) the scenario quantification and model results from GLOBIOM and IMPACT, two economic models, and 3) how the scenarios have already been applied to diverse policy processes in Cambodia, Laos, and Vietnam.

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Software and data availability

The following models were used in this study. The table below lists the institutions and co-author who should be contacted with respect to the specific model.

Models Cited.

http://dx.doi.org/10.1016/j.envsoft.2016.05.008
1364-8152/

Model	Supporting Institution	Author to contact for more information	Email
GLOBIOM	IIASA	Amanda Palazzo	palazzo@iiasa.ac.at
IMPACT 3	IFPRI	Daniel Mason-D'Croz	d.mason-dcroz@cgiar.org
OLDFAR		Steven Lord	steven.lord@adelaide.edu.au
LANDSHIFT	University of Kassel	Benjamin Stuch	stuch@cesr.de

GLOBIOM and IMPACT 3 are described in some detail in the paper. Full documentation for both models is available online.

- GLOBIOM (Havlik et al., 2014): www.pnas.org/content/suppl/2014/02/19/1308044111.DCSupplemental
- IMPACT 3 (Robinson et al., 2015): http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/129825

OLDFAR is available upon request in English and Spanish for Windows (32 and 64 bit), MacOS, and Linux.

A description of the LANDSHIFT model is provided in Appendix A of the Supplement.

1. Introduction

Policy-makers and planners in all sectors related to socioeconomic development, environmental change, and the water-food-energy nexus are faced with unprecedented challenges as they plan for a rapidly changing world (Ericksen et al., 2009). The challenges of fundamental uncertainty and the impossibility of gaining full knowledge about system dynamics are compounded by human cognitive biases (Tversky and Kahneman, 1974) and the diversity of world views and interests that exists among system actors (Dryzek, 1997).

Forecasting a 'most likely' future and planning accordingly is often impossible and potentially dangerous in complex systems. Yet, decision-makers must respond to current pressures while also engaging with future uncertainty in a meaningful way to devise robust and flexible policies that will function in a variety of future contexts (Kok, 2007; Vermeulen et al., 2013). In response to these needs, new tools and methodologies have been developed, which incorporate an improved understanding of the decision-making process when faced with uncertainty. Such tools and methodologies can create a varied possibility space, where decision-makers can consider the potential effects of future stressors, such as climate change, socioeconomic development, environmental degradation, and political instability. The development and use of multiple scenarios is one approach to create this possibility space and apply it to planning (van der Sluijs, 2005; Vervoort et al., 2014; Herrero et al., 2014; Trutnevyte et al., 2016). Well-designed scenarios have the potential to combine many factors of change into comprehensible and integrated narratives (Xiang and Clarke, 2003; van der Heijden, 2005).

Many methods to develop and use scenarios to inform decision-making exist. The challenge is to ensure a highly diverse set of scenarios to supply decision-makers with a broad range of alternative futures in which to test policies (van der Heijden, 2005). This is challenging, as scenario development, even when involving diverse stakeholders, can be limited in scope. To create a broad possibility space, we must start with a broad range of perspectives, expertise, and opinions of how the future may unfold. To ensure this breadth is maintained, an extended group of stakeholders should be involved throughout the scenarios' development and use (Petersen et al., 2011). However, this diversity can threaten to overwhelm scenario development before it even starts. In order for the scenarios to be applicable in models and useful to decision-makers, this diversity must be channeled into a manageable number of alternative futures.

Quantifying scenarios for use in models risks losing scenario richness, as models will need to streamline and summarize the scenario narrative (Siebenhüner and Barth, 2005). Funneling scenarios through a single model especially risks reducing the range of possibilities in the quantification of the scenarios through a single interpretation of future stressors (Volkery et al., 2008). Despite this, models are powerful tools that allow quantitative ex-ante scenario analysis, a feature valued by decision-makers. Therefore, to maintain scenario diversity while providing valuable quantification, scenarios should be simulated across a multi-model ensemble.

This paper presents a participatory scenario development process conducted for Cambodia, Viet Nam, and Laos, which focuses on the exploration of a large scenario possibility space. We discuss the challenges and tradeoffs associated with creating and maintaining this possibility space through a case study. This case study presents how four regional socioeconomic scenarios were created in an interactive and inclusive scenario development process. We then describe how multiple models were used to quantify these scenarios and link them to the IPCC community's Shared Socioeconomic Pathways (SSPs) and Representative Concentration Pathways (RCPs, Moss et al., 2010; O'Neill et al., 2014), while maintaining scenario diversity. Finally, we summarize the results of these quantified scenarios, and describe how they have guided policy and investment plans in Southeast Asia.

2. Case study: scenarios for policy development in Southeast Asia

November 2013, in Ha Long, Viet Nam, 30 stakeholders from government agencies, NGOs, academia, the private sector, and the media, from Cambodia, Laos, and Viet Nam explored key regional drivers of change as part of a regional scenario building process. This process, one of 7 regional efforts led by the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS, Palazzo et al., 2014; Vervoort et al., 2014), was done in collaboration with the United Nations Environment Programme's World Conservation Monitoring Centre (UNEP WCMC). It had the objective of creating diverse, stakeholder-driven scenarios to test and develop regional policies and investment strategies on climate-resilient agriculture and food systems, while exploring potential environmental tradeoffs. Taking a regional approach allowed for the creation of a common framework that could be applied to different policy development processes at regional and national levels. The regional scale also served as an ideal bridge between the global and national perspective, and is often the most appropriate scale of analysis for transboundary environmental and development issues.

The decision to focus the regional work on Cambodia, Laos, and Viet Nam was made for several reasons. Limiting participation to stakeholders from a few countries ensured there was a wide range of stakeholders representing each country, allowing for a robust and multi-disciplinary discussion. These three countries share extensive land borders, and have coordinated across boundaries in the past as a part of ASEAN and the Mekong River Commission. These past experiences facilitated conversations surrounding the