New Methods to Assess Climate Change Impacts, Vulnerability and Adaptation of Agricultural Production Systems: The experience of AgMIP's Regional Integrated Assessments in Sub-Saharan Africa and South Asia

Roberto Valdivia[1], Sabine Homann-Kee Tui[2,] Swathi Sridharan[2], John Antle[1]
[1] Department of Applied Economics, Oregon State University
[2] International Crops Research Institute for the Semi-Arid Tropics
IPCC Experts Meeting on Scenarios, 18.-20. May, 2015
Conference Center Laxemburg, Vienna

The climate change research community has recognized that new pathway and scenario concepts are needed to implement impact and vulnerability assessment that is logically consistent across global, regional and local scales (Moss et al., 2008, 2010; Kriegler, 2012; van Vuuren et al., 2012). The most common challenge is that global models do not provide context-specific answers, while scientists and decision makers require data and information about climate change, vulnerability, adaptation, mitigation and impacts at the local scale. The Agricultural Model Inter-comparison and Improvement Project (AgMIP) provides the link between global climate change projections and sector-specific and regional pathways and scenarios (Antle et al., 2015; Rosenzweig et al., 2013). AgMIP, through a trans-disciplinary process involving both scientists and stakeholders, is developing Representative Agricultural Pathways (RAPs) for agricultural systems at both global and regional scales. In addition to climate modeling, RAPs include bio-physical and socio-economic drivers, associated capabilities, challenges and opportunities (Valdivia et al., 2015). RAPs can then be translated as components of the AgMIP Regional Integrated Assessments (RIA) of climate vulnerability and impacts.

Applying RAPs brings the following major benefits: First, the approach is based on the analysis of entire agricultural systems (including farm and off-farm activities and is not focused on individual crops). This inherently trans-disciplinary approach is based on the collaboration of scientists from different disciplines, incl. climate, crops, livestock, economics, who design and implement research with a focus on agricultural systems. Second, in contrast to previous approaches that have imposed future climate on models based on current socio-economic conditions, this approach incorporates bio-physical and economic models to simulate a more plausible future world in which climate change would be occurring. Third, adaptation packages can be designed with a level of context specificity that is useful to researchers and decision makers, who influence investments in agricultural research and development. Finally, the approach takes into account the heterogeneity of farm communities, thus tailoring adaptation options to the needs and interests of specific farm types (Valdivia et al., 2015).

This presentation will illustrate the use of RAPs and preliminary RIA results by the Crop Livestock Intensification Project (AgMIP-CLIP; Masikati et al., 2015). Following this approach the team visualized scenarios and identified opportunities for the particular context of smallholder farmers in semi-arid Zimbabwe. For instance, through this approach, better integration of crops and livestock emerges as a pathway for reducing vulnerability to climate change while still allowing farmers to capitalize on other socio-economic trends. One promising technology package consists of mucuna maize rotation, micro-dosing fertilizer and drought-tolerant maize varieties. This low risk option reduces vulnerability to climate change for about three quarters of the farms in Nkayi District. Research can now assess the requirements and quantify the potential impact of more drastic interventions and pathways to inform decision makers. These benefits are not theoretical: Through RAPs we can identify tangible opportunties, generate scenarios with real benefits in a particular context that are attainable under given conditions. This can inform future ways to achieve impact in fragile socio-ecological systems such as those found in rural Zimbabwe.

References

Antle, John, Roberto O. Valdivia, Ken Boote, Jerry Hatfield, Sander Janssen, Jim Jones, Cheryl Porter, Cynthia Rosenzweig, Alex Ruane, and Peter Thorburn. 2015. *AgMIP's Trans-disciplinary Approach to Regional Integrated Assessment of Climate Impact, Vulnerability and Adaptation of Agricultural Systems*. In *Handbook of Climate Change and Agroecosystems: The Agricultural Model Intercomparison and Improvement Project (AgMIP)*. C. Rosenzweig, and D. Hillel, Eds., ICP Series on Climate Change Impacts, Adaptation, and Mitigation Vol. 3. Imperial College Press, doi:10.1142/9781783265640_0002.

Kriegler, E., O'Neill, B. C., Hallegatte, S., Kram, T., Lempert, R. J., Moss, R. H., and Wilbanks, T. (2012). The need for and use of socio-economic scenarios for climate change analysis: A new approach based on shared socio-economic pathways, *Global Environ. Change*, **22**(4), 807–822.

Masikati, Patricia, Sabine HomannKee-Tui, Katrien Descheemaeker, Olivier Crespo, Sue Walker, Chris Lennard, Lieven Claessens, Arthur Gama, Sebastiao Famba, Andre van Rooyen, and Roberto O. Valdivia. 2014. *Crop-livestock Intensification in the Face of Climate Change: Exploring Opportunities to Reduce Risk and Increase Resilience In Southern Africa Using an Integrated Multi- Modeling Approach.* In *Handbook of Climate Change and Agroecosystems: The Agricultural Model Intercomparison and Improvement Project (AgMIP), Part 2*. C. Rosenzweig, and D. Hillel, Eds., ICP Series on Climate Change Impacts, Adaptation, and Mitigation Vol. 3. Imperial College Press, 355-374, doi: 10.1142/9781783265640_0017.

Moss, R., Babiker, M., Brinkman, S., Calvo, E., Carter, T., Edmonds, J., Elgizouli, I., Emori, S., Erda, L., Hibbard, K., Jones, R., Kainuma, M., Kelleher, J., Lamarque, J. F., Manning, M., Matthews, B., Meehl, J., Meyer, L., Mitchell, J., Nakicenovic, N., O'Neill, B., Pichs, R., Riahi, K., Rose, S., Runci, P., Stouffer, R., van Vuuren, D., Weyant, J., Wilbanks, T., van Ypersele, J. P., and Zurek, M. (2008). *Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies*, Intergovernmental Panel on Climate Change, Geneva, p. 132.

Moss, R. H., Edmonds, J. A., Hibbard, K. A., Manning, M. R., Rose, S. K., van Vuuren, D. P., Carter, T. R., Emori, S., Kainuma, M., Kram, T., Meehl, G. A., Mitchell, J. F. B., Nakicenovic, N., Riahi, K., Smith, S. J., Stouffer, R. J., Thomson, A. M., Weyant J. P., and Wilbanks, T. J. (2010). The next generation of scenarios for climate change research and 1183 assessment, *Nature*, **463**, 747–756.

Rosenzweig, C., Jones, J. W., Hatfield, J. L., Ruane, A. C., Boote, K. J., Thorburn, P., Antle, J. M., Nelson, G. C., Porter, C., Janssen, S., Asseng, S., Basso, B., Ewert, F., Wallach, D., Baigorria, G., and Winter, J. M. (2013). The Agricultural Model Intercomparison and Improvement Project (AgMIP): Protocols and pilot studies, *Agric. Forest Meteorol.*, **170**, 166–182.

Valdivia, Roberto O., John M. Antle, Cynthia Rosenzweig, Alex C. Ruane, Joost Vervoort, Muhammad Ashfaq, Ibrahima Hathie, Sabine Homann-Kee Tui, Richard Mulwa, Charles Nhemachena, Paramasivam Ponnusamy, Herath Rasnayaka, Harbir Singh. 2015. *Representative Agricultural Pathways and Scenarios for Regional Integrated Assessment of Climate Change Impact, Vulnerability and Adaptation*. In *Handbook of Climate Change and Agroecosystems: The Agricultural Model Intercomparison and Improvement Project (AgMIP)*. C. Rosenzweig, and D. Hillel, Eds., ICP Series on Climate Change Impacts, Adaptation, and Mitigation Vol. 3. Imperial College Press, 101-156, doi:10.1142/9781783265640_0005.

Van Vuuren, D. P., Kok, M. T., Girod, B., Lucas, P. L., and de Vries, B. (2011). A proposal for a new scenario framework to support research and assessment in different climate research communities, *Global Environ. Change*, **22**(4), 884–895.