



FACCE-MACSUR

D-C3.3 Report of scaling methods that have been compared in case studies

Uncertainties in Scaling-Up Crop Models for Large-Area Climate Change Impact Assessments

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Abstract/Executive summary

Problems related to food security and sustainable development are complex (Ericksen et al., 2009) and require consideration of biophysical, economic, political, and social factors, as well as their interactions, at the level of farms, regions, nations, and globally. While the solution to such societal problems may be largely political, there is a growing recognition of the need for science to provide sound information to decision-makers (Meinke et al., 2009). Achieving this, particularly in light of largely uncertain future climate and socio-economic changes, will necessitate integrated assessment approaches and appropriate integrated assessment modeling (IAM) tools to perform them. Recent (Ewert et al., 2009; van Ittersum et al., 2008) and ongoing (Rosenzweig et al., 2013) studies have tried to advance the integrated use of biophysical and economic models to represent better the complex interactions in agricultural systems that largely determine food supply and sustainable resource use. Nonetheless, the challenges for model integration across disciplines are substantial and range from methodological and technical details to an often still-weak conceptual basis on which to ground model integration (Ewert et al., 2009; Janssen et al., 2011). New generations of integrated assessment models based on well-understood, general relationships that are applicable to different agricultural systems across the world are still to be developed. Initial efforts are underway towards this advancement (Nelson et al., 2014; Rosenzweig et al., 2013). Together with economic and climate models, crop models constitute an essential model group in IAM for large-area cropping systems climate change impact assessments. However, in addition to challenges associated with model integration, inadequate representation of many crops and crop management systems, as well as a lack of data for model initialization and calibration, limit the integration of crop models with climate and economic models (Ewert et al., 2014). A particular obstacle is the mismatch between the temporal and spatial scale of input/output variables required and delivered by the various models in the IAM model chain. Crop models are typically developed, tested, and calibrated for field-scale application (Boote et al., 2013; see also Part 1, Chapter 4 in this volume) and short time-series limited to one or few seasons. Although crop models are increasingly used for larger areas and longer time-periods (Bondeau et al., 2007; Deryng et al., 2011; Elliott et al., 2014) rigorous evaluation of such applications is pending. Among the different sources of uncertainty related to climate and soil data, model parameters, and structure, the uncertainty from methods used to scale-up crop models has received little attention, though recent evaluations indicate that upscaling of crop models for climate change impact assessment and the resulting errors and uncertainties deserve attention in order to advance crop modeling for climate change assessment (Ewert et al., 2014; Rotter et al., 2011). This reality is now reflected in the scientific agendas of new international research projects and programs such as the Agricultural Model Intercomparison and Improvement Project (AgMIP; Rosenzweig et al., 2013) and MACSUR (MACSUR, 2014). In this chapter, progress in evaluation of scaling methods with their related uncertainties is reviewed. Specific emphasis is on examining the results of systematic studies recently established in AgMIP and MACSUR. Main features of the respective simulation studies are presented together with preliminary results. Insights from these studies are summarized and conclusions for further work are drawn.

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Methods of Scaling-Up Crop Models

Error versus uncertainty in scaling-up crop models

Scales – resolution, extent, and coverage

Upscaling methods

Data aggregation, sampling, and extrapolation

Evaluating Uncertainty from Scaling Methods

Simulation exercises

Impact of Scaling Method

Effect of sampling size(AgMIP study)

Effect of grid cell size(MACSUR study)

Spatial variability

Knowledge Gaps and Future Activities

Knowledge gaps

Future activities

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