Integration of decadal climate predictions, ecological models and decision-making models to support climate-resilient agriculture in the Argentine Pampas

Presenter: Guillermo Podestá, University of Miami (gpodesta@rsmas.miami.edu)

Co-authors: P. Arora, W. Baethgen, F. Bert, V. Brescia, L. Goddard, R. Katz, B. Kirtman, D. Krantz, D. Lema, C. Macal, M. Marino, L. Mearns, M. North, B. Rajagopalan, F. Ruiz Toranzo, C. Saulo, M. Skansi, P. Sydelko, and C. Vera

Summary

Decadal prediction – a "cutting-edge" field in climate science – is attracting growing interest because of its potential societal applications. We describe a project that involves:

- Pilot research to gain hands-on experience in the effective use of decadal climate predictions in agricultural production in the context of uncertainties about the future; and
- A sustained scientist-stakeholder dialog where climate experts discuss capabilities, limitations and uncertainties of their predictions, and stakeholders detail their decision-making processes and associated information needs.

Motivation

The prediction of regional climate conditions 20-30 years from present is receiving much attention because this time scale is relevant to major investments and infrastructure planning (e.g., buying a farm, building a dam).

But... to derive societal benefits from decadal prediction, advances in climate prediction science must be matched by a better understanding of how to integrate climate information into societal structures to support decisions in climate-sensitive sectors.

We describe a project (just started) aimed at facilitating adaptation to a shifting climate and informing resilient decision-making in agricultural production – the human activity most vulnerable to climate and the main land use.

Our overarching goal is to enhance society's capacity to act on regional projections of decadal climate.

Case study: the Pampas

We focus on the Pampas of central eastern Argentina, one of the main agricultural regions in the world. The Pampas show marked decadal climate variability, with dry and wet epochs. A rainfall increase in the last few decades expanded rainfed agriculture towards drier regions and contributed to major changes in land use.

Production systems that evolved in response to increased rainfall may not be sustainable if climate reverts to a drier epoch.

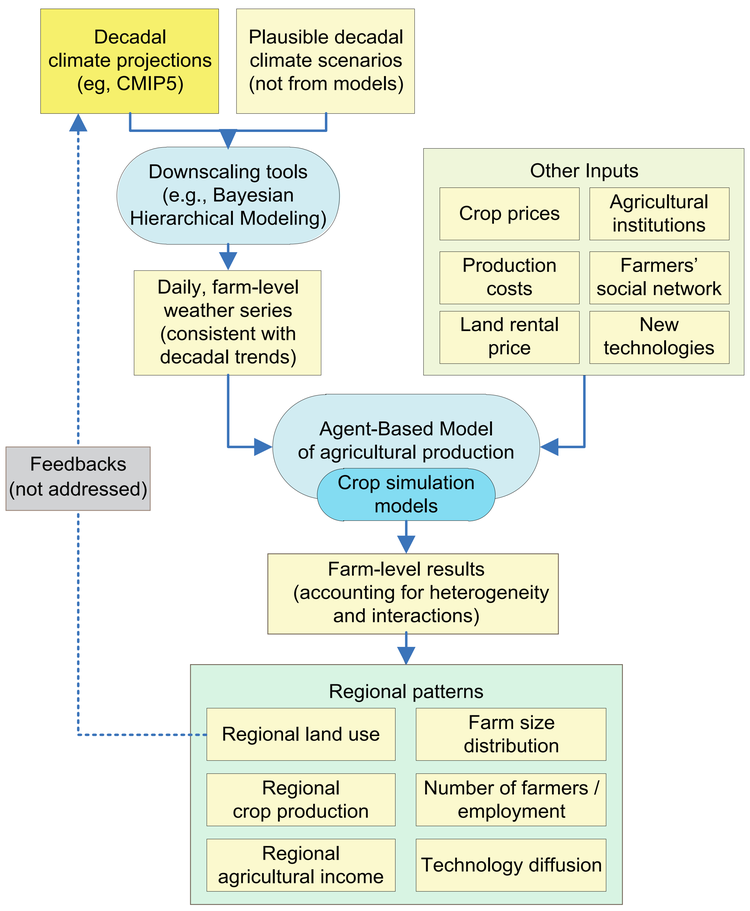
Therefore, the agricultural sector wants actionable information on climate conditions in the Pampas 20-30 years from now.

Approach

We do not focus on producing decadal climate predictions. Instead, we link climate projections (from models or other sources) with sector-specific tools and other approaches to "translate" projected decadal climate into quantitative assessments of:

- the likelihood of impacts on regional climate (including extreme events),
- their associated agricultural consequences (crop yields, profits), and
- the outcomes of feasible adaptation actions.

An overview of the project's linked modeling framework is shown below:



Elements of the linked modeling framework:

- State-of-the-art decadal climate projections produced by the Coupled Model Intercomparison Project Phase 5.
- A Hidden Markov Model (HMM) to assess evidence for, and simulate shifts in climate regimes in the Pampas. The HMM aproach is combined with Extreme Value Theory to deal with possible shifts in weather extremes associated with different climate regimes.
- A multi-site stochastic weather generator that can reproduce projected decadal climate trajectories.
- An agent-based model (ABM) of agricultural production that produces regional land use pattens. The ABM...

(1) considers heterogeneity among decision-makers (e.g., in personality, goals and attitudes);

(2) explicitly incorporates human decision-making and responses to climate, including processes like imitation, learning, and adaptation; and

(3) includes social interactions among decision-makers and institutions, relevant to dissemination of climate information.

Uncertain climate projections and agricultural adaptation

There is much uncertainty about the form that decadal climate information may take or its prediction skill. But decision-makers cannot postpone actions until improved models come along... thus we explore these questions:

- Can plausible scenarios of regional climate be used to explore adaptation strategies, *even before the skill of decadal projections is demonstrated?*
- What risk management strategies (e.g., adaptive management) allow iterative assessment of decisions and learning?

Even without accurate predictions of future climate, we will identify robust adaptation strategies. These are strategies that perform sufficiently well across a range of alternative futures (including uncertainty about the future states of both climate and socio-economic drivers).

The performance of robust strategies is iteratively assessed and adjusted (e.g., every 5 years) in a continuous process of learning and adaptation.

Scientists/stakeholders dialog

Barriers to the use of climate knowledge are rooted on a misfit between the capabilities of climate science and the expectations, needs and beliefs of decision-makers.

To address this issue, a second project component involves a continuous participatory dialog among project researchers, climate modelers and agricultural stakeholders. The dialog will address questions such as:

- What are the potential needs of decadal climate information by different types of agricultural stakeholders (policy-makers, resource managers, individual farmers)?
- What knowledge or technology gaps must be addressed?
- What institutional arrangements are needed to ensure effective co-production and equitable transfer of useful climate knowledge?

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