Bio-economic simulation on bwUniCluster: The assessment of sustainable agricultural systems in Southern Amazon, Brazil

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The aims of this project is assess the trade-offs between different agricultural practices and production systems in Southern Amazon, Brazil.

1 Introduction

The focus of Brazilian Land Use policy has changed over the last decade towards sustainable agriculture. The country pledged to take domestic actions to substantially decrease its greenhouse gas (GHG) emissions, in order to balance agricultural production and environmental protection. According to this pledge, national GHG emissions shall be reduced by 36.1–38.9% until 2020. Agriculture alone is expected to reduce 166 million tons of CO2eq, or 43% of the national mitigation efforts by 2020.

2 Study Area

Mato Grosso is the third largest state of Brazil extending over 903,000 sq. km, which amounts to the area of France and Germany taken together. Favorable climatic conditions allowing for two growing seasons per year, together with the introduction of improved seeds and techniques for dealing with soil acidity transformed Mato Grosso into a major player in soybean, maize and cotton production. The state is also known for its biodiversity, holding three different biomes: Cerrado (Brazilian Savannas), Pantanal and Amazon Rainforest. Despite being a large agricultural producer, the state still preserves approximately 60% of its native forest.

3 Objective

We conducted a quantitative analysis with a farm level approach on farm systems in Mato Grosso and developed a region specific bio-economic micro-simulation model which is able to capture the interregional differences between farms, farm-based economic behavior and human-environment interactions in agriculture. The simulation results provide detailed information on how the decision variables affect the production systems.

4 Model Coupling

Its main element consists of an economic component which simulates farm-level decision making problems and is implemented in the Mathematical Programming-based Multi-Agent Systems (MPMAS), a multi-agent software for simulating land use change in agriculture. In order to link the simulated farm-based economic behavior with human-environmental interactions we implemented a second component, a dynamic, process-based biophysical simulator, which was implemented in the simulation model for nitrogen and carbon dynamics in agro-ecosystems (MONICA). The third component is a simulation model which describes the carbon and nitrogen dynamics in arable soils. This component was implemented in Carbon-Nitrogen-Dynamics (CANDY) model, a software that provides information about C stocks in soils, organic matter turnover, N uptake by crops, leaching and water quality. Further details on modeling approach, methodology and data can be accessed from Carauta et al. [1, 2].

5 Conclusions

Our simulations can provide realistic results and important insights to the problem's comprehension because: (1) it simulates farmers behavior under site-specific conditions; (2) captures real-world heterogeneity; (3) captures bio-economic conditions; (4) captures economic incentives; (5) allows farm-level as well as regional level assessments; (6) takes into consideration several agricultural practices; (7) captures key determinants on crop yield and (8) allows assessment of different policies set-ups.

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References

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