Tools for Geospatial and Agent Based Modeling to Evaluate Climate Change in an Agricultural Watershed in Transition to Organic Agriculture.

A. Ghaffari*, M. Bunch, R. MacRae and J. Zhao
Faculty of Environmental Studies, York University, 4700 Keele St. Toronto, ON M3J 1P3.
* aghaffar@yorku.ca

Background:
Research confirms that converting from conventional to organic farming reduces GHG emissions on a per ha and per kg basis. These changes are associated with changes in cropping patterns, animal densities and reductions in application of synthetic inputs (Lynch et al., 2011). However, on a regional scale this conversion is a complex process. Outcomes on a landscape level are difficult to predict. The policy and program changes required to support such landscape level changes, and the resulting reductions in GHG emissions, are poorly articulated in Canada.

Project Overview:
Land-use changes are typically modeled using geographic information systems because of the spatial nature of the data. But, the complexity of coupled human and natural systems and the fourth dimension of change over time and time-series data, expose some limitations of GIS tools when used on their own. In this paper, we present the application of a free and open source geospatial Agent-based Model or ABM (also known as a multi-agent model), to the dynamic simulation of key factors required for, and GHG changes associated with, theoretical wholesale conversion of farms to organic production. The model is demonstrated using data from the Middle Maitland Valley, in southern Ontario, a subwatershed with predominantly agricultural land use. We used the RePast platform to develop the ABM. The core of the model is dynamic simulation of small farm enterprise "agents" and their decisions in relation to individual characteristics (e.g., fiscal history and experience with conventional agriculture, willingness to innovate), the agriculture governance environment (e.g., the existence of support for transition) and the economic environment (e.g., market prices for agricultural inputs and products). Small farm enterprises are identified as agents, who make decisions based on individual and environmental parameters and their effects.

Parameters (Driving Forces for organic adoption)		
Farm Agents	***Environment***	***Variables***
Personal Conviction (Social equity, Health)	Farm Finance (Ent. Bud.)	Support for Org. Mkt. Infrast. And Marketing
Personal Experiences of Negative Conventional Negative Effects	Subsidy for Transition	Extension of Transition Advisory Services
Financial Difficulties in Conventional	Avoided Cost Payment	Access to Information-Extension Services
Willingness to innovate to Organic		
Personal Exp. of Successful Org. Farming Model in Watersheds		
Social Network Positive Attention Toward Adoption		

Conclusions:
ABM is a suitable approach to model complex phenomena having both spatial and temporal dimensions. The RePast platform can be used to develop an ABM-GIS model to identify key factors in influencing and supporting small holder farm enterprises to convert their operations to organic agriculture and at the same time estimate the impact on GHG emissions resulting from such conversion. Such a model will be used to develop scenarios representing multiple pathways to organic transition. Parametization of the model can be improved in the future through focus group and collaborative work with farm enterprise stakeholders.

Acknowledgments: Ministry of Agriculture, Food and Rural Affairs, Maitland Valley Conservation Authority, Lake Simcoe Region Conservation Authority.