Land Use and Management Changes: Adaption to and Mitigation of Climate Change

Jianhong Mu, Anne Wein, and Bruce A. McCarl

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2012 AAEA Annual Meeting, Seattle, Washington, August 12-14, 2012

Land Use and Management Changes: Adaptation to and Mitigation of Climate Change

Jianhong Mu1,3, Anne Wein 2 and Bruce A. McCarl1

1 Department of Agricultural Economics, Texas A&M University; 2 U.S. Geological Survey; 3 Department of Agricultural and Resource Economics, Oregon State University

INTRODUCTION

Land use and management decisions and climate change interact. The productivity of land uses, such as forestry and grazing, will be affected by climate change, which in turn will affect the mix of land uses in the various regions (Mendelsohn and Dinar 2009). On the other hand, land use and management practices have been a major contributor to greenhouse gas emissions (IPCC 2007) although some land uses and management practices can mitigate climate change by sequestrating carbon and reducing GHG emissions.

We address two questions pertaining to the interaction between land use and management decisions and climate change:

- How might land use and management decisions respond to a changing climate (an adaptation strategy) and a carbon price (a mitigation strategy)?
- What are the effects of adaptation and/or mitigation on welfare and GHG emissions?

METHOD

Our approach is to simulate 16 scenarios up to 2090 using 2000 baseline data from alternative climate (Hadley and Canadian) and vegetation models while enabling adaptation adjustments and carbon prices in the U.S. Forest and Agricultural Optimization model with Greenhouse Gases (FASOMGHG).

FASOMGHG is a partial equilibrium economic model of the U.S. forest and agriculture sectors and is used to evaluate welfare (producer and consumer surplus) and market impacts of public policies in 63 production regions and 11 market regions including foreign countries (Adams et al. 2005). The model also incorporates changes in technology, efficiency and productivity.

Under the adaptation strategy, decision makers can predict the effects of climate change on productivity. Under the mitigation strategy, a carbon price (US$/Metric ton CO2) equals $15 with an annual 5% rate of increase. Results of 16 scenarios are relative to a base case with no climate change, adaptation and mitigation.

ACKNOWLEDGEMENTS

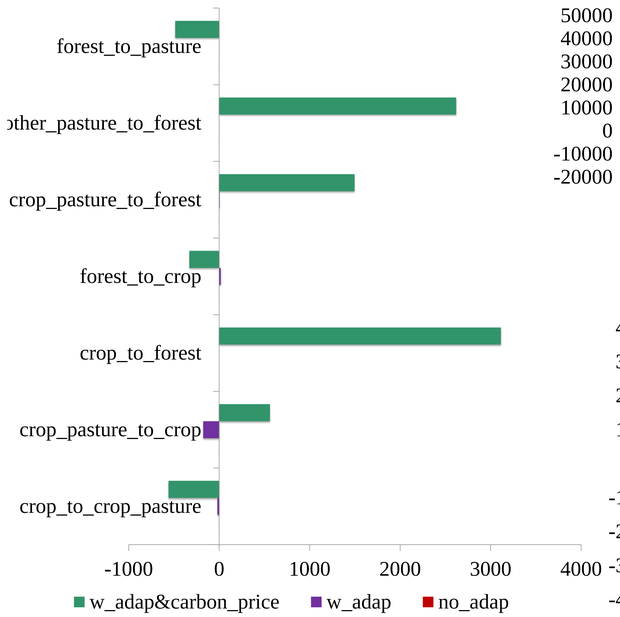
This project was funded by the U.S. Geological Survey through the Carbon Sequestration Assessment Project.

CONTACT INFORMATION

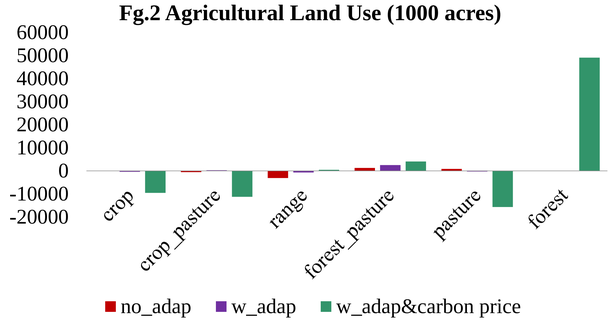
Jianhong Mu is now working as a postdoc scholar at the Deparment of Agricultural and Resource Economics, Oregon State University. Please send questions and comments to mujh1024@gmail.com.

RESULTS

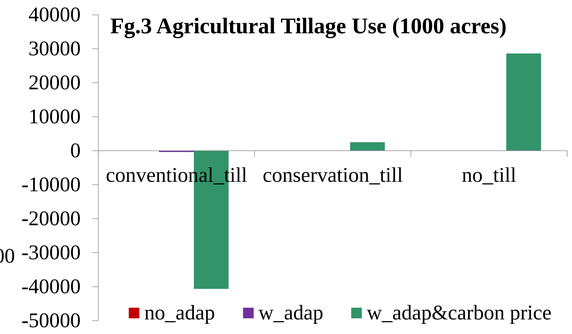
Fg.1 Agricultural Land Use Change (1000 acres)



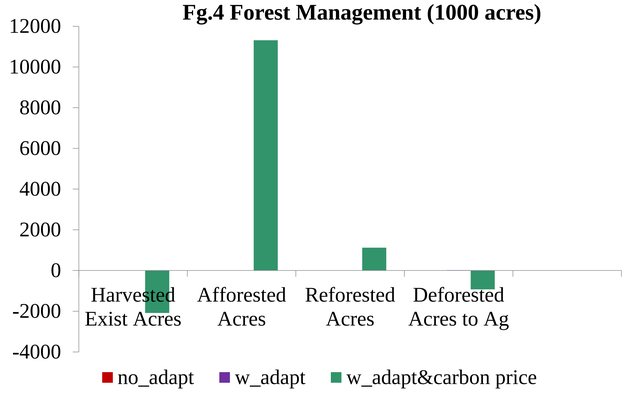
Fg.2 Agricultural Land Use (1000 acres)



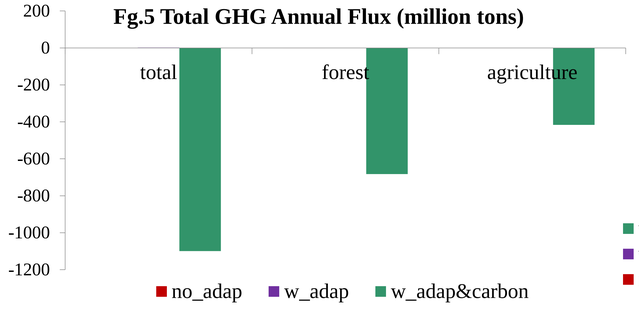
Fg.3 Agricultural Tillage Use (1000 acres)



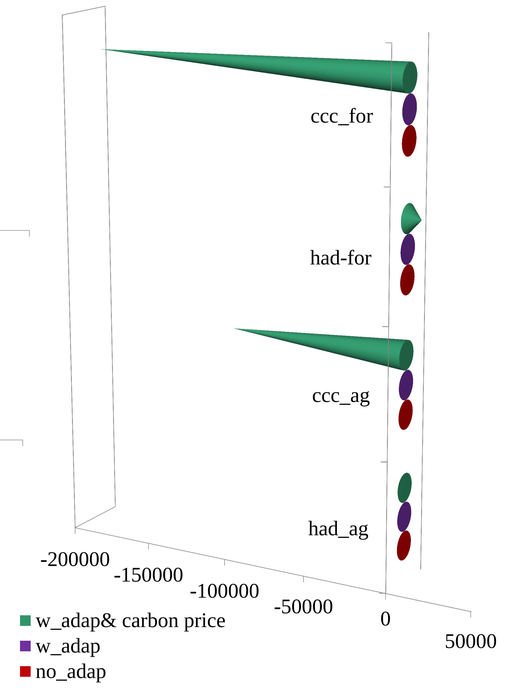
Fg.4 Forest Management (1000 acres)



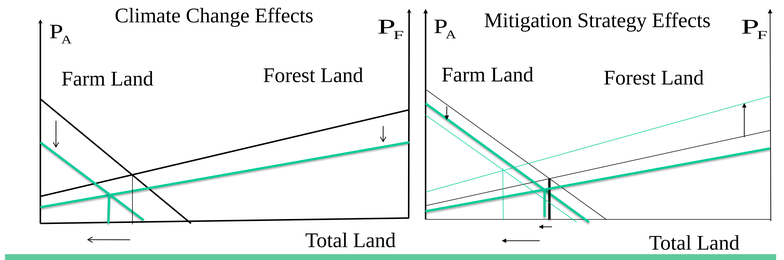
Fg.5 Total GHG Annual Flux (million tons)



Fg.6 National Welfare (millions $)



THEORETICAL INTUITION



SCENARIO DEFINITION

Scenarios	Climate Model		Vegetation Model		Adaptation	Mitigation
	CCC	HAD	TEM	CENTURY		
base						
HAD_TEM_nA_nC		X	X			
HAD_TEM_wA_nC		X	X		X	
HAD_CEN_nA_nC		X		X		
HAD_CEN_wA_nC		X		X	X	
CC C_TEM_nA_nC	X		X			
CCC_TEM_wA_nC	X		X		X	
CCC_CEN_nA_nC	X			X		
CCC_CEN_wA_nC	X			X	X	
HAD_TEM_nA_wC		X	X			X
HAD_TEM_wA_wC		X	X		X	X
HAD_CEN_nA_wC		X		X		X
HAD_CEN_wA_wC		X		X	X	X
CC C_TEM_nA_wC	X		X			X
CCC_TEM_wA_wC	X		X		X	X
CCC_CEN_nA_wC	X			X		X
CCC_CEN_wA_wC	X			X	X	X

CONCLUSIONS

- More land is converted for forestry use and less land is used for agricultural use or development under the combined adaptation and mitigation strategies (Fg.1 and Fg.2).
- Under the combined adaptation and mitigation strategy, tillage practices on agricultural lands switch from conventional to no-till (Fg.3).
- Harvested and deforested forest acres increase under adaptation, while they decrease under the combined strategy. Meanwhile, afforested acres increase dramatically with the combined strategy (Fg.4).
- Total GHG emissions from agricultural and forestry sectors increase slightly with adaptation and are reduced only when adaptation is coupled with mitigation (Fg.5).
- Changes of forest and agricultural sector welfare are insignificant under the adaption strategy. However, they change with the combined adaptation and mitigation strategy depending on the degree of climate change (Fg.6).

REFERENCES

Adams, D., et al., 2005, FASOMGHG Conceptual Structure, and Specification: Documentation. 2005. http://agecon2.tamu.edu/people/faculty/mccarl-bruce/papers/1212FASOMGHG_doc.pdf

Mendelsohn R, Dinar A., 2009, Land Use and Climate Change Interactions. Annual Review of Resource Economics. 1: 309–332.

IPCC (Intergovernmental Panel on Climate Change), 2007, Impacts, Adaptation and Vulnerability. Cambridge University Press, Cambridge, UK .