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FINDINGS

INSIDE

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"Science affects the way we think together."
Lewis Thomas

Looking at the Big Picture: The Importance of Landbase Interactions Among Forests, Agriculture, and Climate Mitigation Policies

Ralph Alig

Information about ecological and economic impacts over the short and long term will help policymakers develop effective climate change strategies.

"What is exciting is that while farmers and forest owners are increasing their carbon storage, or reducing their production of greenhouse gasses, they can also be saving money, improving soil fertility, improving water quality, and providing wildlife habitat."
—EcoEarth News

Finding ways to constructively address the effects of climate change promises to be the greatest challenge of the modern era. The bulk of that challenge may well lie in the delayed response between cause and effect, action and change. The short-term costs of mitigation activities seem to accrue before the payoff. Without a collective sense of urgency, mitigation plans to reduce greenhouse gas emissions with costs in the short term are a hard sell. On the plus side, this lag means there is time to be proactive and develop cohesive climate change strategies. Information on likely economic and ecological impacts over the short and long term and the likely combined effect of different policies will be key to such strategies.

Land use change is a key part of global change. Deforestation, urban sprawl, agriculture, and other human influences have substantially altered natural ecosystems and fragmented the global landscape. These disturbances can change the global atmospheric concentration of carbon dioxide (CO_2), the

IN SUMMARY

Land use change is a key part of global change. Deforestation, urban sprawl, agriculture, and other human influences have substantially altered natural ecosystems and fragmented the global landscape. Slowing down deforestation and afforesting environmentally sensitive agricultural land are important steps for mitigating climate change. Because no policy operates in a vacuum, however, it's important to consider how separate climate mitigation policies might interact with each other.

Ralph Alig, a scientist with the Pacific Northwest Research Station, and his colleagues evaluated the potential impacts of policy instruments available for climate change mitigation. By using the Forest and Agriculture Sector Optimization Greenhouse Gases model, the researchers analyzed how land might shift between forestry and agriculture and to more developed uses depending on different land use policies and several carbon pricing scenarios. They also examined the likely effects on timber, crop prices, and bioenergy production if landowners were paid to sequester carbon on their land. The researchers found that projected competition for raw materials is greatest in the short term, over the first 25 years of the 50-year projections.

Climate change is occurring within a matrix of other changes. By 2050, an additional 3 billion people are expected to be living on Earth, needing food, clean water, and places to live. Incentives for landowners to maintain undeveloped land will be vital to sequestering carbon and providing other services of intact ecosystems.

principal heat-trapping gas, as well as affect local, regional, and global climate by changing the energy balance on Earth's surface.

Land use decisions will be instrumental in any climate mitigation strategy. Forest and agricultural lands, for example, can be managed to increase the amount of atmospheric carbon they sequester or to produce renewable raw materials for conversion to bioenergy, which can be substituted for fossil fuels. Collective shifts in management focus, however, create ripples throughout related economic sectors. Because large areas of land can move between forestry and agriculture, responses to climate change mitigation policies from either sector must be considered to minimize unintended outcomes.

Ralph Alig, a research economist with the Pacific Northwest (PNW) Research Station, and his colleagues have been studying some of these interconnections between the forest and agricultural sectors for years. They developed the Forest and Agriculture Sector Optimization Greenhouse Gases (FASOM GHG) model that projects changes in land uses involving forestry and agriculture under different policy scenarios. Depending on the scenario, private land suitable for either forestry or agriculture flows to the sector that promises the highest land value. To meet information needs of the Environmental Protection Agency and the U.S. Department of Agriculture, the scientists have continued to expand and enhance the model's usability for analyzing potential climate mitigation policies.

In a recent study published in the journal of *Forest Policy and Economics*, Alig and his colleagues used FASOM GHG to analyze the interactions among different policy scenarios on land use. For example, how would land use change if private landowners were paid \$25 per ton of CO_2 sequestered on their land? What if they were paid \$50 per ton of CO_2? What effect would carbon prices have on timber prices? Or corn prices?

"The value of the integrative forestry and agricultural model is you can look at different production possibilities and impacts on prices," explains Alig. "Our model is forward looking so we can look at different ways to do things to avoid less favorable impacts."

The model simulations showed that under the business-as-usual scenario, where forest land was converted to other uses as it was during the last decades, and if there were no monetary incentive for landowners to manage for carbon storage, the amount of carbon sequestered by the forest sector is projected to decline by about 20 percent by 2050.

KEY FINDINGS

- Slowing down deforestation and afforesting environmentally sensitive agricultural land are important steps for mitigating climate change. Forests sequester about 20 times more greenhouse gases than croplands. Because large areas of land can move between forestry and agriculture, responses from the agricultural sector to climate mitigation policies (such as payments to landowners for forest carbon storage) must be considered. Forestry's potential contributions will be affected by increased demand for cropland to help feed an additional 3 billion people globally by 2050 and increased demand for places for people to live and play.
- Under current conditions, with no financial incentive to increase the amount of carbon stored in trees, the amount of carbon sequestered by the forest sector declines by about 20 percent over 50 years as forest land is converted to agriculture or other more developed uses.
- Financial incentives for private land owners to sequester more forest carbon (for example, carbon dioxide prices) are likely to increase carbon in standing trees, which means lengthened intervals between timber harvests. Opportunities for landowners to gain more carbon-related revenue by sequestering forest carbon also tend to reduce the amount of deforestation for agricultural use.
- Some U.S. regions, such as the South (thru afforestation and altered forest management) and the Pacific Northwest (thru altered forest management), have a comparative advantage in sequestering lower cost forest-based carbon, leading to more carbon sequestration above a baseline.

Natural Resource Conservation Service

The Conservation Reserve Program has created incentives for landowners to plant trees. Model simulations indicate if landowners received payment for the carbon sequestered on their land, the area of forested private land would increase further.

On the other hand, under a scenario where the landowner receives \$50 per ton of stored CO_2 equivalent and a policy to reduce deforestation for developed uses, forest-based carbon is projected to increase 82 percent by 2050.

Interestingly, the analysis revealed different pathways to achieve similar outcomes. For example, combined policies to prevent loss of private forest by reducing the rate of deforestation for developed uses by half of the current rate, and not allowing any deforestation for agricultural purposes, is projected to increase forest area by 9 percent by 2050 when compared to business as usual. The simulations also showed that a similar increase in forest area would be achieved if CO_2 were selling for \$25 per ton. This assumes a baseline rate of deforestation for developed uses and that land owners will maximize their economic returns by converting some agricultural land to forest land.

THE SOCIAL DIMENSION

Forests sequester about 20 times more greenhouse gases than croplands. Between 1992 and 1997, the rate of deforestation increased and the proportion of forest converted to urban and developed uses increased to 55 percent of all land uses, with more than 988,000 acres converted annually. Slowing down deforestation is a critical step to mitigating climate change. With 56 percent of forest land in the United States privately owned, landowner decisions to maintain or not maintain tree cover has implications far beyond their property lines.

The FASOM GHG model assumes economic optimization by the landowner—that landowners make decisions that produce the best financial returns. But is that what people really do? Looking at past behavior provides some clues, says Alig. Other factors might be influencing behavior. Along with financial incentives, familiarity with a certain way of doing things can influence behavior. If landowners are more comfortable with agriculture practices, for example, they might be hesitant to switch to forestry.

Participation in the Conservation Reserve Program (CRP), begun in 1985, could provide clues about how landowners might react to a carbon payment program, says Alig. The CRP, reauthorized most recently in the 2008 Farm Bill, encourages landowners to retire marginal cropland or environmentally sensitive land from agricultural production and instead plant it with native grasses and trees to benefit migratory birds, wildlife, and water quality.

"On paper it looked like there were many, many opportunities for participation in the Conservation Reserve Program," says Alig.

Gary Wilson

In addition to contributing to climate change mitigation, forestry activities can reduce erosion and water pollution while enhancing wildlife habitat.

Ralph Alig

A better understanding of how greenhouse gas mitigation fits within a broader systems view could benefit from an integrated analysis of water, wildlife and other biodiversity, and other ecological and economic aspects of natural resources.

"State and private experts estimated that about 5 million acres would be afforested and entered into the forestry side of the program during the first 5 years of the program, but it turned out only about half that many acres were entered."

Forecasts on paper don't always pan out in the real world," he continues. "There are some real-world factors at work out there that slow down the amount of receptivity. Is it because landowners remember how hard family members worked to keep trees off the cleared land, are they just not familiar with growing trees and benefits of trees? Do they not want to commit to long-term use? Is it simply resistance to working with the federal government? If someone's neighbor has a good experience with a government subsidized program to plant trees, will that influence someone to join? This is an area where more research is needed," says Alig.

A positive indicator from the CRP, which overall is considered a conservation success story, is that most landowners did not convert the afforested land back to agriculture once

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Forest Service

they stopped receiving payments. "After 15 years, 80 to 90 percent of the land was still in trees, and in most cases, the stands were overstocked," says Alig, indicating the need for continuing education and technical forestry support throughout the length of any program.

"Any climate mitigation program would involve a portfolio of mitigation activities, ones that landowners are receptive to and which also will be cost effective to help us obtain more forest carbon sequestration," explains Alig. "If we have high enough carbon prices, we may see fairly large impacts in terms of afforestation. Even in places where we typically haven't seen a lot of afforestation, at least on paper, higher carbon prices could tip the balance in favor of forestry versus agriculture."

"There are also innovative ways to do afforestation. It doesn't need to be a monoculture, he continues. "We can restore windbreaks and provide food opportunities for wildlife and even people. There are good opportunities to at least explore what could be part of that portfolio. It is important to look at co-benefits of tree planting. We can get more carbon sequestration and also these other 'stackable' benefits and reduce some externalities associated with agricultural production such as water pollution."

ANTICIPATING THE RIPPLES

At best, effective policies complement each other; at worst they compete, creating additional problems. It can be challenging, however, to anticipate how various policies will play out across different sectors of the economy over different time scales. The policy scenarios modeled by Alig and his colleagues shed light on potential interactions over 50 years.

The modeled scenarios do not indicate any huge spikes in food prices on the horizon, although there was some upward pressure. "It's when you start imposing production requirements by certain dates, such as with the National Renewable Fuel Standard, that you see price spikes," explains Alig. "If we have enough time to adjust, we'd expect less impact on food prices and agricultural commodity prices."

Another thing to consider within a systems view is the effects that competing demands for raw materials and a larger forest inventory may have on the forest sector. What are the expected impacts on natural resource sustainability and the markets for traditional forest products if some wood goes instead to bioenergy production? Alig explains that different parts of the forest sector likely would experience differing degrees of impacts. Model projections don't indicate much impact on saw logs, which are used in home building and other construction. Pulpwood material, however, is used to make paper but also is the type of wood fiber likely to be used for bioenergy production. "The potential impacts are important enough that we want to look at them more closely," says Alig.

Although efforts to develop a cohesive climate change strategy at the federal level are now stalled in Congress, a number of state and multistate efforts are underway to develop systems to reduce CO_2 emissions from powerplants, increase renewable energy generation, track renewable energy credits, and research and establish baselines for carbon sequestration. These include the Regional Greenhouse Gas Initia-tive for Northeast and Mid-Atlantic States, the Midwestern Regional Greenhouse Gas Reduction Accord, the Western Climate Initiative, and California's greenhouse gas reduction program. In the absence of a federal program, these efforts raise the possibility of a future where greenhouse gas rules and mitigation provision vary regionally within the United States.

U.S. Forest Service

Incentives to sequester carbon could result in longer harvest rotations and thus a short-term decline in timber from private land.

The modeling done by Alig and colleagues has helped make more apparent that climate change mitigation efforts have both spatial and temporal aspects that are important to consider. In the United States, some regions have a comparative advantage in sequestering lower cost forest-based carbon. And, depending on the land management practices, could lead to more sequestered carbon above a baseline.

For example, in the South, much of the land is privately owned, so it makes sense to develop incentive programs there that would appeal to those private landowners and encourage land use decisions that sequester carbon. In the Corn Belt, there are opportunities to plant trees on marginal and environmentally sensitive agricultural land, so it makes sense to develop incentives directed at encouraging that outcome. The Rocky Mountain Region, however, has a comparatively limited amount of private land suitable for afforestation, as does the Pacific Northwest, and parts of both of these regions are already heavily forested where land is suitable for forests. In these western regions, changes in forest management resulting in longer periods between harvests would increase the amount of carbon stored.

THE CLIMATE ISN'T THE ONLY THING CHANGING

By 2050, an additional 3 billion people are expected to be living on Earth. Simply feeding everyone and maintaining adequate supplies of clean drinking water would be a significant challenge unto itself. The uncertainty that climate brings makes it imperative to enact policies that together function holistically to better lives and strengthen the resiliency of the Earth's ecosystems. "Climate change is happening within a matrix of other activities," says Alig. "Forestry's potential contributions to climate change mitigation will be affected, for example, by increasing demand for cropland to help feed the world's growing population."

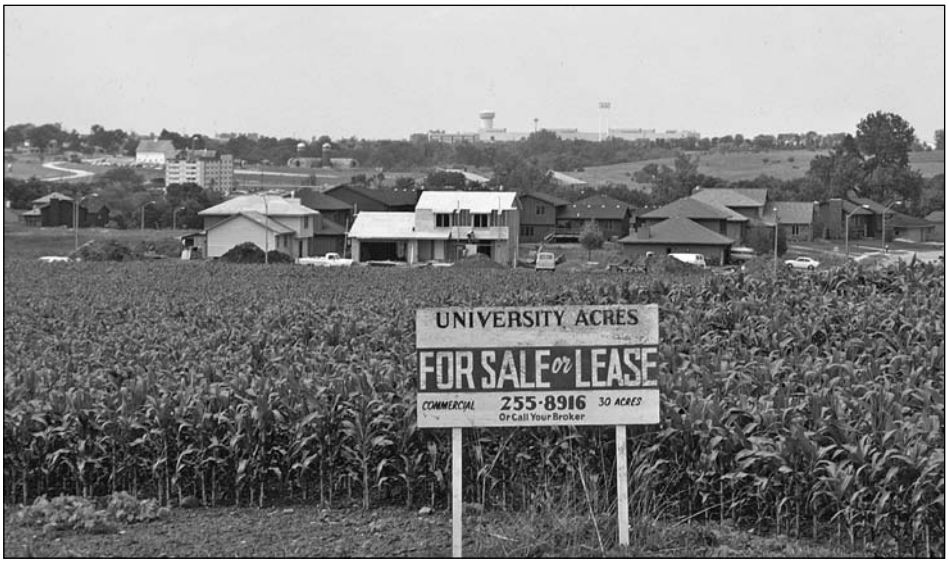
As land values increase in areas of population growth, incentives for landowners to keep undeveloped land in that state will be vital to sequestering carbon and providing other services of intact ecosystems.

Alig points out that urban and developed uses typically sit on top of the economic hierarchy of land uses, with urban land prices often at least an order of magnitude higher than those for forest land. For example, in the Pacific Northwest west of the Cascade Range, forest land on a county basis on average is valued at 25 times less than the lowest urban values and 141 times less than the highest urban value. The ratios in the Southeast are roughly similar.

An important layer of complexity in considering the use of forests to address climate change and renewable energy development is forest-land ownership. Alig and his colleagues are now working with the Environmental Protection Agency and U.S. Department of Agriculture to use the FASOM GHG model to study the potential policy interactions across public and private lands. "Private forest lands tend to be managed in response to economic incentives," explains Alig, "whereas public forests are managed under a suite of goals."

"Under baseline projections, carbon stocks are projected to decline on private forests but increase on public forests in the coming decades. When carbon is valued, private forest carbon is projected to increase because of afforestation and changes in forest management," Alig continues. "As climate change progresses and comprehensive policies are developed, consideration of public and private forest ownership in a systems view will be important."

"Defer no time, delays have dangerous ends."
—William Shakespeare, Henry VI, Part 1



Lynn Betts

Climate change is happening within a matrix of other economic and societal activities. Forestry's potential contributions to climate change mitigation will be affected by other societal demands, for example, an increased demand for cropland to feed the world's growing population.

LAND MANAGEMENT IMPLICATIONS

- Land use decisions play a key role in climate mitigation. Evaluating climate mitigation policies in terms of anticipated shifts in land use between competing uses, such as agriculture and forestry, and the environmental impacts of the policy can help avoid unintended outcomes.
- Modeled scenarios show carbon payments to land owners create incentives to delay timber harvests, thus reducing timber supply from private land in the early part of the projection.
- Carbon payments affect projected prices for raw material (corn and switchgrass, for example) used in bioenergy production. Competing demands for raw wood material, such as pulpwood, which is used to make paper and bioenergy, may increase prices.

FOR FURTHER READING

Alig, R.J. 2003. U.S. landowner behavior, land use and land cover changes, and climate change mitigation. Silva Fennica. 37(4): 511–527.

Alig, R.; Latta, G.; Adams, D.; McCarl, B. 2010. Mitigating greenhouse gases: the importance of land base interactions between forests, agriculture, and residential development in the face of changes in bioenergy and carbon prices. Forest Policy and Economics. 12: 67–75.

Depro, B.; Murray, B.; Alig, R.; Shanks, A. 2008. Public land, timber harvests, and climate mitigation: quantifying carbon sequestration potential on U.S. public timberlands. Forest Ecology and Management. 255(3-4): 1122–1134.

Intergovernmental Panel on Climate Change [IPCC]. 2007. Climate change 2007: synthesis report. Summary for policymakers. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf. (October 14, 2010).

Pataki, D.E.; Alig, R.J.; Fung, A.S. [et al.]. 2006. Urban ecosystems and the North American carbon cycle. Global Change Biology. 12: 2092–2101.

White, Eric M. 2010. Woody biomass for bioenergy and biofuels in the United States—a briefing paper. Gen. Tech. Rep. PNW-GTR-825. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 45 p.

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