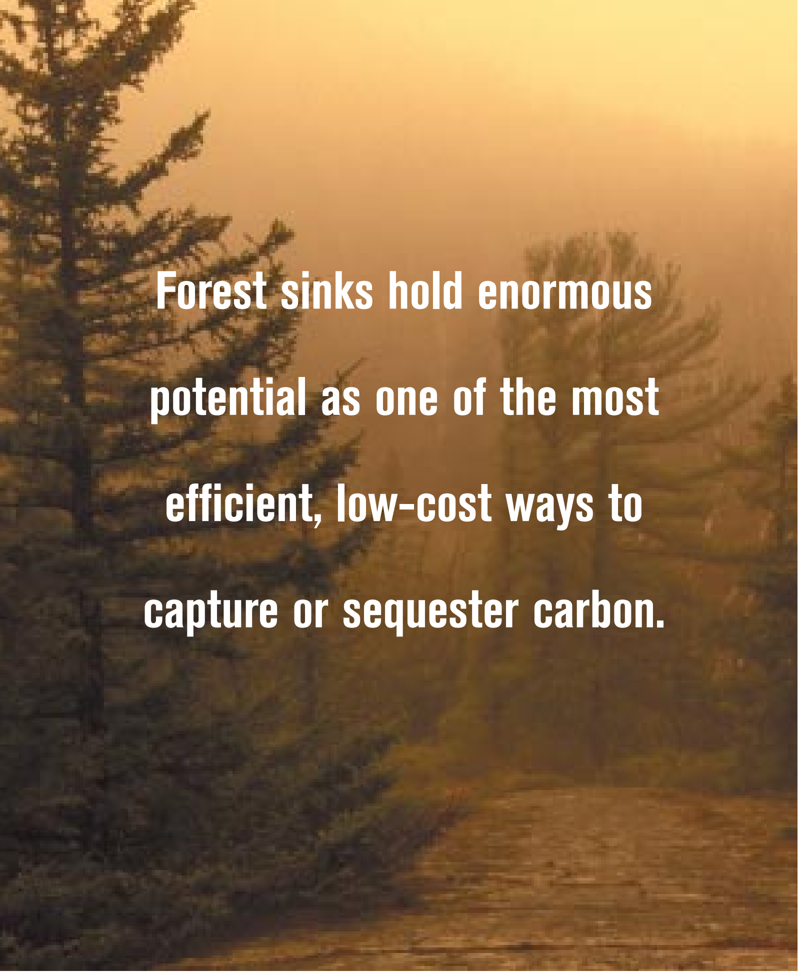
The Role of Forest Sinks in a Post-Kyoto World

By Roger A. Sedjo and Masahiro Amano

Today, most scientists, as well as the Bush administration, agree that global warming is indeed occurring and that it is a significant problem. The question of the efficacy of the Kyoto Protocol as a remedy, however, is another story. While some European countries are on schedule to meet their emissions targets, others are not. Two of the largest carbon emitters, China and India, are not even required to comply—they have no carbon targets. Two others, the United States and Australia, have chosen not to ratify the protocol, and now Canada, which did ratify, has announced that it does not expect to comply. But even if all the global Kyoto Protocol targets are met, the global temperature in the year 2100 will be only about 0.3°C lower than "business as usual," because just 7–10 percent of the expected temperature rise would be prevented if the Kyoto targets were met.

As the first compliance period (2008–2012) approaches, analysts and policymakers around the world are considering how to evaluate the protocol's effectiveness and anticipating what a post-Kyoto world will look like. Criticisms of the Kyoto Protocol are many, centering on the high cost of compliance and the lack of flexibility. There is widespread recognition that continuing the Kyoto process without the involvement of China, India, Brazil, and other major countries of the developing world would not only ensure that the United States will not participate in the future but would be fundamentally futile for meeting long-term targets because of the dominant place these countries have as emitters of carbon dioxide and other greenhouse gases.

While the diplomats continue to wrangle over emissions targets, compliance, and monitoring, one abatement tool deserves greater attention. Forest sinks hold enormous potential as one of the most efficient, low-cost ways to capture or



sequester atmospheric carbon. For example, a 2006 study organized by the Energy Modeling Forum of Stanford University found that using biological sequestration can reduce the costs of meeting certain 2100 climate objectives from 3.3 percent of the gross domestic product (GDP) to 2.3 percent, which amounts to literally trillions of dollars. And according to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), up to 20 percent of excessive emissions can be captured in forests and biological sinks over the next 50 years. The Kyoto Protocol as it now stands does not take fully into account several opportunities for biological sequestration. But what role could forest sinks play in a post-2012 world?

Global Carbon Sinks: Some Basic Concepts

Global carbon is held in a variety of different "stocks." Natural stocks include oceans, fossil-fuel deposits, the terrestrial system, and the atmosphere. In the terrestrial system, carbon is sequestered in rocks and sediments; in swamps, wetlands, and forests; and in the soils of forests, grasslands, and farmland. About two-thirds of the globe's terrestrial carbon, exclusive of that sequestered in rocks and sediments, is sequestered in the standing forests, forest understory plants, leaf and forest debris, and forest soils. In addition, there are some nonnatural stocks, such as long-lived wood products (typically wood construction and furniture) and waste dumps that constitute a separate, human-created carbon stock.

A stock that is taking up carbon is called a "sink" and one that is releasing carbon is called a "source." Shifts or flows of carbon over time from one stock to another—from the atmosphere to the forest, for example—are viewed as carbon "fluxes." Over time, carbon may be transferred from one stock to another. Fossil-fuel burning, for example, shifts carbon from fossil-fuel deposits to the atmospheric stock. Biological growth involves the shifting of carbon from one stock to another; for example, plants fix atmospheric carbon in cell tissues as they grow, thereby transforming carbon from the atmosphere to the biotic system.

Five pools of carbon are involved in a forest ecosystem: above-ground biomass, below-ground biomass, litter, dead wood, and organic carbon in soil. Carbon is sequestered in the process of plant growth: it is captured in plant cell formation and oxygen is released. As the forest biomass experiences growth, the carbon held captive in the forest stock increases. Simultaneously, plants grow on the forest floor and add to this carbon store. Over time, branches, leaves, and other materials fall to the forest floor and may store carbon until they decompose. Additionally, forest soils may sequester some of the decomposing plant litter through root-soil interactions. Carbon may also be sequestered for long periods in long-lived wood products resulting from forest harvests.

Forests in Transition

Forests are constantly in transition, being cleared for agriculture and often subsequently replanted or abandoned and left to grow in, for example. The Kyoto Protocol accounts for this in Article 3.3, which calls for the maintenance of forests by afforestation, reforestation, and controlling deforestation (ARD).

Deforestation occurs when forestland is cleared and reforestation does not take place. Commonly, land clearing is associated with the permanent conversion of forestlands to other uses, such as croplands, pasture, or development. When forestland is converted to some other use, there is a net loss of carbon in the terrestrial stock since most other land uses will sequester less carbon than the forest. Under these circumstances, net carbon transfers occur. If the site is cleared and the vegetation burned, most of the carbon is released into the atmosphere. However, to the extent that the vegetation is converted into long-lived wood products or substituted for fossil-fuel energy, only a portion of the carbon in the forest will be a net release into the atmosphere.

The creation of a forest on land never forested or not forested for a very long time is called afforestation. Often the distinction between afforestation and reforestation blurs as the period during which the forest has been absent from the land lengthens. Afforestation occurs when forests are established on grasslands never previously forested. It also may be said to occur as lands once in forests but which have been in agriculture for long periods of time, as in parts of the U.S. South, are converted into forests, due to either natural processes or tree planting. On afforested lands, the additional carbon stored in trees and other components of the forest ecosystem constitutes a net addition to the terrestrial forest stock.

Forest Sequestration and the Kyoto Protocol

Historically, humans have contributed to carbon dioxide emissions in two ways: by burning fossil-fuels and converting forestlands to other uses. Initially, land-use changes (deforestation) were the principle source of carbon emissions. However, starting in the 20th century, fossil-fuel emissions rose rapidly, while emissions due to deforestation gradually declined. One way to begin to address the issue of increasing carbon emissions is to maintain and increase the stock of sustainably managed forests.

Although it is well known that the world's tropical forests are declining, it is less widely recognized that the world's temperate and boreal forests have been expanding. Recent UN Food and Agricultural Organization estimates indicate a net global deforestation rate—that is, the conversion of forestland to other uses—for 2000 through 2005 of 7.3 million hectare (ha) per year. This is a reduction from the 8.9-million-acre net annual deforestation of the 1990 to 2000 period, when deforestation of natural forests at 14.1 million ha per year was partially offset by an afforestation rate of 5.2 million ha per year. So, while the tropical forest carbon stock has become smaller, the temperate and boreal forests have been expanding.

The Kyoto Protocol recognizes the efficacy of forests and sustainable management as a vehicle for addressing climate change in Article 2, which states that each party in Annex 1 (major industrialized nations) shall establish or expand policies and measures that promote sustainable forest management practices. Additionally, according to Article 3.3, afforestation and reforestation credits are obtained, while deforestation is associated with debits. Article 3.4 provides credits for increases in the carbon sequestered by forest management.

But the protocol fails to take full advantage of the potential of forest sinks. Looking toward a post-Kyoto world, how might the role of forest sequestration be expanded to more fully address climate change?

Several northern countries—including France, Portugal, Japan, China, some Eastern European countries, and the United States that are experiencing positive net biological growth—have a wide interpretation of forest management and of forests that are eligible for credits. Although these forests are sequestering large amounts of carbon, much of this would probably occur without a carbon program. The question is how much of the additional carbon reasonably can be viewed as additive, in the sense that they would not have occurred under business as usual.

Under Kyoto, European Union countries were given credit for 15 percent of the net growth of their managed forests, with no credits or debits associated with unmanaged forests. This approach assumes that active management is responsible for 15 percent of the incremental addition in forest growth. However, exceptions—based on political, not scientific, considerations—providing for larger amounts of credit were negotiated for some countries, such as Russia. A question for a future agreement is how much sequestration would be allowed for various countries from forest management.

In addition, as it now stands, the protocol does not give credit for protecting existing forests, although loss of forests can generate debits for countries with carbon targets. This issue becomes more complex if the countries without carbon targets undertake sequestration programs, as with the Clean Development Mechanism (CDM), in cooperation with industrial countries. Furthermore, if the current system were applied to the next compliance period, these countries could incur carbon debits for forest losses that might occur beyond a base period yet to be determined.

One approach for initially involving tropical countries might be to allow them positive carbon credits for reducing their rates of deforestation below a baseline level. The baseline could be constructed by using the estimate of the forest and its carbon at some time point. Alternatively, a baseline trend might be constructed by projecting the forest carbon through time. Credits could be provided for amounts sequestered in excess of baseline levels. Care must be taken, however, in establishing the baseline. The smaller the area involved, the larger the likely "leakage," that is, the shifting of emissions out of one geographical area and into another. When this happens, credits are obtained for emissions reductions in the one area, while emissions increases that occur simultaneously in another area do not receive debits.

A related approach would be to provide carbon credits for acceptable restoration for forests deemed degraded. This wider perspective could generate social benefits, both through carbon mitigation and through other social and environmental benefits associated with forests, such as habitat conservation.

Another element that needs further consideration is the treatment of carbon in wood products like buildings and furniture. The current assumption is that once a tree is harvested, all of its carbon is released. This approach assumes that the net stock of carbon in long-lived wood products is unchanging. In fact, about one-half of the harvested industrial wood goes into wooden products that are in use for extended periods, and so the carbon remains captive for years, decades, and even centuries. Credit could be given for the sequestration of this carbon. However, it must be recognized that while new wood materials are being added to the stock of wood products, the stock also is experiencing releases as wood decomposes, is burned, or otherwise releases carbon.

Adaptive Action

Although consensus grows that the Kyoto Protocol suffers from a number of defects, the bright spot is that the global community can learn a great deal from the Kyoto experiment. A major lesson is that an approach that is hugely expensive but generates small climate benefits is unlikely to satisfactorily resolve the problem of global climate change. The real solution is to be found in a mix of adaptive actions, as well as a host of new emissions-reducing technologies that are being developed today.

Sustainable forestry management is one such approach that can sequester a substantial portion of the surplus carbon in the atmosphere—at a much lower cost than other carbon-reducing actions. Additionally, the technology currently is available: the global community knows how to plant and grow trees. These actions can be taken over the next several decades, while improved technologies are developed to address the carbon problem over the long term. Finally, many of the proposed forest-sequestration activities, such as tree planting, provide other substantial noncarbon environmental benefits. Ignoring the sequestration potential of forest sinks would also ignore the array of potential damages from continued deforestation. ■

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