



Forests and Climate: The Crucial Role of Forest Carbon in Combating Climate Change*

Tropical forests are *disappearing* rapidly—a process that accounts for some 17% of global greenhouse gas (GHG) emissions. Saving tropical forests thus represents a *significant, cost-effective, timely, and multiple-benefit opportunity* for the United States and the international community in the fight against climate change. Seizing this opportunity will require *leadership* by the United States working in concert with tropical forest countries and the international community.

Disappearing—Tropical forests are disappearing at a rate of 5% each decade as a result of agricultural, timber, and road expansion.^{1,2} By 2050 40% of the Amazon will be gone.³ When these forests are cleared, most of the carbon is released into the atmosphere either through burning or decay of organic matter.⁴ Once cleared, the opportunity to avoid emissions is permanently lost, making future mitigation targets more difficult to achieve.

Significant—Land use change in the tropics accounts for roughly 17% of GHG emissions, more than the entire global transportation sector.⁵ The vast majority of these emissions come from deforestation⁶ (see Figure 1). Focusing mitigation efforts exclusively on fossil fuel emissions will not avoid dangerous levels of climate change; forests must also be included in climate mitigation strategies.⁷

Cost-effective—Including forests will lower costs of achieving a given climate change mitigation target. Initial emission reductions from forest and land use activities are expected to cost substantially less than further reductions from other climate mitigation activities, such as decarbonizing the electric power sector. Thus including forest carbon reductions in the portfolio of options can reduce the costs of and increase the flexibility associated

with emissions reductions efforts in the U.S. and globally. One recent estimate indicates that including international forest carbon in global climate policy could save US\$2 trillion over the century.¹¹ Such flexibility to reduce emissions more cost-effectively also provides a means for taking deeper cuts in emissions—by as much as 10% with a corresponding reduction in expected warming of 0.25°C over the 21st century at no additional cost.^{12,13}

Economic models suggest that over the next 20 years, carbon prices of \$10–\$30 per ton CO₂ could generate about 2–3 billion tons of CO₂ reductions per year through avoided deforestation. The models suggest that this could be roughly doubled if other options such as afforestation and forest management were credited.¹⁴ Forest carbon emission reductions, like other forms of mitigation, produce rising cost curves. Initial reductions can be quite inexpensive, perhaps as low as US\$2–5 per tCO₂ to reduce deforestation by the first 10% below baseline levels.¹⁵ Additional reductions, however, become progressively more expensive.

Timely—Reducing emissions from the forest sector does not require technological breakthroughs, new physical infrastructure or facility

How do forests affect climate change?

Forests are the most significant terrestrial carbon reservoir, containing 77% of all carbon stored in vegetation and storing roughly twice as much carbon as the atmosphere.⁸ Forests also constantly cycle carbon: photosynthesis turns atmospheric carbon into biomass and sugars, while respiration burns up some of these sugars, returning carbon back to the atmosphere.

Globally, forests are a net sink, meaning that they absorb more carbon from the atmosphere than they emit. However, 60% of all of the carbon absorbed by forests is emitted back into the atmosphere as a result of deforestation.⁹

Deforestation leads directly to carbon emissions in the same manner as a coal-fired power plant or any other emissions source. Further, if forests are converted to non-forest land uses, the new land cover will absorb less carbon from the atmosphere. Even if forests are allowed to regenerate after clearing occurs, it will take decades for the new forest to rebuild the carbon once stored in the original forest—and the loss of biodiversity and indigenous forest cultures is irreversible.¹⁰

* This brief is a pre-review version of the introduction to a primer on international forest carbon for U.S. policymakers, which will be posted on the Nicholas Institute website (<http://www.nicholas.duke.edu/institute/>) in April 2009. Authors of the primer are Lydia Olander, Nicholas Institute, Duke University (coordinating), and (in alphabetical order) William Boyd, University of Colorado Law School; Kathleen Lawlor, Nicholas Institute; Erin Myers Madeira, Resources for the Future; and John O. Niles, Tropical Forest Group. Erin Myers Madeira is the primary author of the introduction. The authors acknowledge the support of the Packard Foundation and the helpful comments of Packard's Dan Zarin and those of Brian Murray and Paul Brantley from the Nicholas Institute.

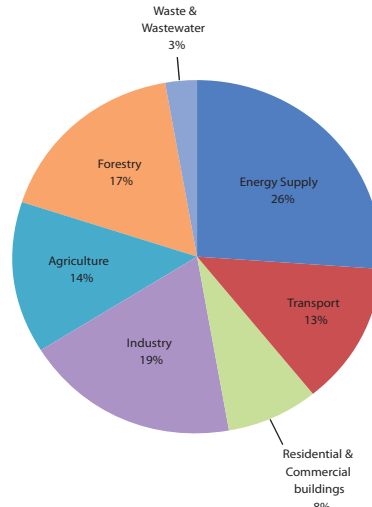
construction. Keeping forest carbon out of the atmosphere and enhancing forests' natural carbon capture and storage services can make a significant contribution to climate mitigation—and it is based on a “technology” that is proven and already widely deployed. To be sure, reforming forest and land use policies to promote reduced emissions will require new governance institutions, greater administrative capacity, and creative solutions to clarifying property rights. These steps will not be easy but some actions can be taken immediately to begin curbing deforestation.¹⁶

Multiple-Benefit— In addition to regulating climate, forests provide a number of important local services that can reduce communities' vulnerabilities to climate change. Forests are rich in biodiversity: they are home to the majority of terrestrial species.¹⁷ They regulate water flow; reduce runoff, erosion, siltation, and flooding; and provide food, medicine, building materials, fuelwood, and income sources for local communities. These ecosystem services are critical to many rural and urban economies, provide environmental security, and are of heightened importance in adapting to climate change. The services provided by forest ecosystems can be thought of as the “natural insurance” that help buffer vulnerable communities against the negative impacts of climate change. Developing countries are projected to encounter some of the most severe impacts of climate change and are least able to cope.¹⁸ Losing forests could further destabilize societies that climate change may make vulnerable to political upheaval, migration, and conflict.¹⁹

Opportunity— At a time when the world is seeking to broaden international participation in the global effort to reduce emissions, addressing deforestation is the most meaningful way for many developing countries to mitigate their own emissions (See Figure 2). Forest carbon provides an opportunity for the U.S. and the international community to foster active collaboration with developing countries in abating climate change. Although developing countries may not be prepared to make economy-wide emissions commitments at this time, some are considering taking emissions targets in their forest sectors given the right incentives.

Leadership— The United States has an opportunity to lead on tropical deforestation through the incorporation of forest carbon activities in domestic climate change policies and involvement in the international climate negotiations. U.S. leadership on forest carbon is likely critical for broad international acceptance and sufficient global funding. A number of countries are currently funding capacity

Figure 1. Global GHG emissions by sector.



Reproduced from the IPCC Climate Change 2007: Synthesis Report Summary for Policy Makers (Fourth Assessment Report).

building, and some are considering setting aside a portion of proceeds from their climate programs, but only the U.S. is actively exploring ways to allow international forest carbon credits to trade (like allowances) in a national emissions trading system.^{20,21} Such leadership would build on the United States government's historic interest in tropical forest conservation demonstrated by the long-term efforts by USAID, the U.S. Forest Service, the State Department, and the Department of Treasury to conserve tropical forests.²² Furthermore, California, Illinois, and Wisconsin are already leading the way on forests and climate change by working with governors from Brazil and Indonesia to develop rules and incentives for generating compliance-grade international forest carbon.²³

What might the U.S. do?

The U.S. will be one of the largest buyers of all types of carbon credits if it moves forward with an economy-wide cap-and-trade policy, which appears to be the policy of choice. If the U.S. decides to include international forest carbon in its cap-and-trade policy, there are several options for how to do so. The U.S. can allow capped entities to use international forest carbon allowances to meet compliance obligations. It can also use revenue generated from auctioning of allowances to support forest carbon as part of a strategic reserve or as an independent program. Whichever policy approach is ultimately used is likely to generate substantial demand and financing for reducing deforestation. This will have a major impact on the market globally, and the U.S. approach will be closely watched internationally.

What would these international forest carbon credits look like? They can be generated by a range of activities and approaches, given the significant variation in the drivers of deforestation and forest degradation. Site-specific approaches could create and support forest reserves that protect threatened forests and maintain carbon stocks in specific forested areas. National- or regional-scale approaches could change land use and infrastructure policies, improve forest governance, reform agricultural subsidies, and inject sustainability into development policy.

Measurement, monitoring, and verification of changes in forest carbon will be essential to track the success of international forest carbon activities. Recent advances in remote sensing and continuing work on forest carbon measurement have greatly enhanced the ability to measure and monitor emissions from deforestation. This confidence has allowed forest carbon to move beyond

Terminology

Recently introduced legislation in the U.S. has used the term **international forest carbon** to describe the activities that would be eligible to generate compliance grade assets for a U.S. program to reduce greenhouse gas emissions.²⁴ International forest carbon is defined broadly to include activities directed at reducing emissions from deforestation and degradation, as well as those aimed at increasing sequestration through afforestation, reforestation, and sustainable forest management. The international community is also actively working to develop policy mechanisms that will incorporate tropical forests into a post-2012 climate regime. The current terminology in that process uses the phrase **reduced emissions from deforestation and forest degradation, or REDD**. Negotiations are under way regarding whether this will include other forest sector and land use activities.

a technical question: international forest carbon is now seen as a valuable climate mitigation policy approach, one that is gaining significant momentum internationally and domestically.

The devil is in the details

This paper, the first in a primer series on international forest carbon, has introduced why forests are a critical part of climate change policy discussions. The following papers will provide details about the outstanding questions regarding forest carbon policy design, the status of and next steps for U.S. and international policy efforts, and ongoing efforts to reduce deforestation and associated carbon emissions in developing countries.

Paper 2 examines the drivers of forest loss and lessons from past efforts to conserve forests. The lesson here is that international forest carbon policy and programs may be more likely to succeed if they address the major drivers of deforestation (agriculture,

timber, and infrastructure), and if rewards are contingent on performance. The carbon market could provide an unprecedented level of funding for forest conservation, greatly increasing its potential impact beyond those of previous efforts.

Paper 3 summarizes the critical policy design issues for international forest carbon. Several lessons are apparent: (1) expanding the scope of forest carbon to include other forest and land use activities could generate additional participation and deliver more emissions reductions, but it substantially increases the difficulty of measurement and monitoring; (2) the carbon market can provide significant levels of financing for proven reductions in deforestation emissions, while fund-based approaches may be better matched to support capacity-building activities and conservation of forests that are not under threat; (3) national-level accounting of forest carbon can go a long way toward addressing leakage and additionality concerns, and in the short term sub-national projects and programs play an important role in capacity building and learning; and (4) risks to environmental integrity, such as leakage, impermanence, and accurate baselines, can be minimized through careful policy design.

Paper 4 reviews current efforts to bring international forest carbon into the post-2012 international climate regime, the European

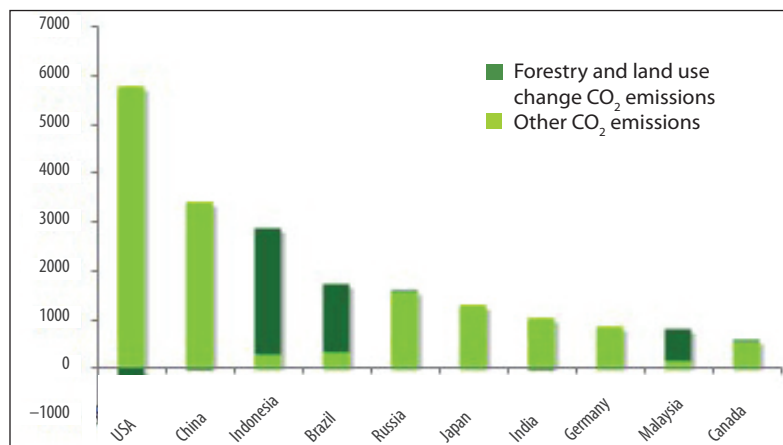
Emissions Trading Scheme, and emerging compliance regimes in the United States. The lesson here is that while international forest carbon is gaining traction at multiple levels of governance, there is urgent need (because forest are disappearing rapidly) for the U.S. to lead by including robust international forest carbon provisions in its own cap-and-trade system and by challenging the international negotiations to move beyond the current stalemate on policy mechanisms and methodologies.

Paper 5 explores the recent proliferation of early international forest carbon activities by the public and private sectors, which are providing valuable lessons for the policy process. The lesson here is that there is tremendous interest from investors and donor governments to build capacity and invest in pilot projects throughout the tropics, but that scaling up such investment will require resolution of uncertainty in three key areas: carbon rights, the nature and direction of future policy mechanisms, and the criteria and standards for compliance grade assets.

Paper 6 addresses some of the commonly voiced concerns about including international forest carbon in climate policy, including governance, capacity, equity, technical concerns, property rights, and impacts on indigenous and other forest-dependent peoples.

International forest carbon is critical to the success of international climate policy. It represents a significant mitigation opportunity that must be used if we want to stay below dangerous levels of climate change. And it provides the only meaningful avenue for bringing many developing nations into international climate policy.

Figure 2. Forestry and land use change emissions as a portion of total emissions.



Emissions from deforestation and degradation are not evenly spread around the world, but are concentrated in a few forest-rich developing countries. For some of these countries, emissions from deforestation account for the vast majority of total domestic emissions. Brazil, Indonesia, and Malaysia are among the top ten CO₂-emitting countries in the world because of their emissions from deforestation.

References

- 1 Chomitz, K. 2007. *At Loggerheads? Agricultural Expansion, Poverty Reduction, and Environment in the Tropical Forests*. Washington, D.C.: World Bank.
- 2 Geist, H.J., and E.F. Lambin. 2002. Proximate Causes and Underlying Driving Forces of Tropical Deforestation. *BioScience* 52(2): 143–150; UNFCCC. 2006. Background Paper for the Workshop on Reducing Emissions from Deforestation in Developing Countries, Part I: Scientific, Socio-Economic, Technical and Methodological Issues Related to Deforestation in Developing Countries.
- 3 B.S. Soares-Filo et al. 2006. Modeling Conservation in the Amazon Basin. *Nature* 520 (2006) (predicting that by 2050, under business as usual, projected deforestation trends will eliminate 40% of the current 540 million ha of Amazon forests, releasing approximately 117 ± 30 Gt CO₂ to the atmosphere).
- 4 Houghton, R. A. 2005. Tropical Deforestation as a Source of Greenhouse Gas Emissions. In *Tropical Deforestation and Climate Change*. Eds. Moutinho, P. and Schwartzman, S. Instituto de Pesquisa Ambiental da Amazônia (IPAM) and Environmental Defense: Washington, D.C.: 13–22.
- 5 Estimates of deforestation's contribution to total emissions range from 10% to 25%. We use a midpoint estimate of about 17%, which roughly corresponds with the calculations used by the IPCC Fourth Assessment Report Synthesis Report Summary for Policy Makers, shown in Figure 1.
- 6 Baumert, K.A. et al. 2005. *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy*. Washington, D.C.: World Resources Institute.
- 7 Eliasch, J. 2008. *Climate Change: Financing Global Forests*. The Stationery Office Limited, UK, 250 p. Dangerous levels of climate change is defined by warming greater than 2°C by the end of the century in order to stabilize levels of atmospheric CO₂e at 445–490 ppm. CIFOR: Ruben N. Lubowski. "The Role of REDD in Stabilizing Greenhouse Gas Concentrations: Lessons from Economic Models," No.18, November 2008, and IPCC 2007 Synthesis Report.
- 8 Ibid.
- 9 Forests and other terrestrial sinks annually absorb 2.6 GtC from the atmosphere; however, deforestation and other land use activities annually emit 1.6 GtC into the atmosphere. As a result, net carbon absorption rates are only 1.0 GtC, 40% of what they could be in the absence of emissions from deforestation and land use change. From: Denman, K.L., G. Brasseur, A. Chidthaisong, P. Ciais, P.M. Cox, R.E. Dickinson, D. Hauglustaine, C. Heinze, E. Holland, D. Jacob, U. Lohmann, S. Ramachandran, P.L. da Silva Dias, S.C. Wofsy, and X. Zhang, 2007: Couplings Between Changes in the Climate System and Biogeochemistry. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- 10 Hirsch, A.I. et al. 2004. "The Net Carbon Flux Due to Deforestation and Forest Re-Growth in the Brazilian Amazon: Analysis Using a Process-Based Model," *Global Change Biology* 10, 908–924 and Steining, M.K., 2004. "Net Carbon Flux from Forest Clearance and Regrowth in the Amazon," *Ecological Applications* 14, S313–S322.
- 11 Eliasch J. 2008; Tavoni, M. et al. 2007. Forestry and the Carbon Market Response to Stabilize Climate. *Climate Change Modeling and Policy Working Papers*, Fondazione Eni Enrico Mattei (FEEM): 17; Lubowski, R.N. 2008. What are the Costs and Potentials of REDD? In *Moving Ahead with REDD: Issues, Options and Implications* ed. A. Angelsen. CIFOR, Bogor, Indonesia.
- 12 Lubowski, R.N. 2008.
- 13 Tavoni, M. et al. 2007.
- 14 Murray, B., R. Lubowski, and B. Sohngen. 2009. Including Reduced Emissions from International Forest Carbon in Climate Policy: Understanding the Economics, Nicholas Institute for Environmental Policy Solutions, Duke University. Different studies use different economic modeling approaches to estimate costs. "Bottom-up" models employ local information on opportunity costs and emission factors to estimate costs per ton under different conditions. "Top-down" models are more aggregated (e.g., national or regional level) and often capture market feedback. "Bottom-up" studies often produce lower cost estimates than top-down studies, which is the case with the studies referenced here.
- 15 Kindermann, G. et al. 2008.
- 16 For example, some countries could realize significant emissions reductions if they can strengthen enforcement of existing conservation areas.
- 17 World Resources Institute (WRI), The World Conservation Union (IUCN), and United Nations Environmental Programme (UNEP) 1992. *Global Biodiversity Strategy: Guidelines for Action to Save, Study, and Use Earth's Biotic Wealth Sustainably and Equitably*. WRI, IUCN, UNEP: 244 pp. http://archive.wri.org/publication_detail.cfm?pubid=2550.
- 18 IPCC, Contribution of Working Group II (Climate Change Impacts, Adaptation, and Vulnerability) to the Fourth Assessment Report, April 2007; CNA 2007. National Security and the Threat of Climate Change. The CNA Corporation, Alexandria, Virginia: 35 pp.
- 19 CNA 2007. National Security and the Threat of Climate Change. The CNA Corporation, Alexandria, Virginia: 35 pp.
- 20 Lieberman-Warner S. 2191 set-aside 5% in the range of US\$3–9 billion/yr. depending on C price; EU set-aside 5% in the range of US\$2.0–2.7 billion/yr.
- 21 See upcoming primer paper 4 for more information.
- 22 See upcoming primer paper 2 for more information on U.S. interest in tropical forests.
- 23 The governors from California, Wisconsin, and Illinois and six governors from Brazil and Indonesia signed a Memorandum of Understanding to reduce forestry-related greenhouse gas emission by collaborating to develop rules, incentives, and tools to ensure reduced emissions from deforestation and land degradation.
- 24 S. 3036; Dingell-Boucher draft.

The **Nicholas Institute for Environmental Policy Solutions** at Duke University is a nonpartisan institute founded in 2005 to engage with decision makers in government, the private sector, and the nonprofit community to develop innovative proposals that address critical environmental challenges. The Institute seeks to act as an "honest broker" in policy debates by fostering open, ongoing dialogue between stakeholders on all sides of the issues and by providing decision makers with timely and trustworthy policy-relevant analysis based on academic research. The Institute, working in conjunction with the Nicholas School of the Environment and Earth Sciences, leverages the broad expertise of Duke University as well as public and private partners nationwide. www.nicholas.duke.edu/institute