

Development Research Group

Knowledge in Development Note 9

Tropical Deforestation, Biodiversity, and Development¹

June 2007

Tropical deforestation is an important but seemingly intractable global problem. Each decade, a forest area the size of Portugal is destroyed. The clearing and burning of these forests releases CO₂ to the atmosphere, accounting for about one-fifth of the annual human effect on global warming, about twice the amount contributed by the world's cars and trucks. The loss of these forests and other natural habitats places a substantial proportion of the world's plant and animal species in jeopardy of extinction. And these land-use changes can result in local environmental damages, such as flooding and soil erosion.

Forests play a crucial role in the lives of many poor people. Almost 70 million people—many indigenous—live in remote areas of closed tropical forests. Another 735 million rural people live in or near tropical forests and savannas, relying on them for much of their fuel, food, and income—or chopping them down for crops and pasture.

The dilemma for the Bank, and its clients, is that forest clearing is often related to agricultural expansion and rural development. How can society balance the benefits, including enhanced rural production and employment, against the costs of local and global environmental damage?

To resolve this, we need to understand the relationship between deforestation, poverty, and environmental damage; assess who benefits and who loses from deforestation; and devise institutions that balance the interests of these groups and bring about more equitable, efficient, and sustainable land uses.

Causes and consequences of deforestation and of forest poverty

Deforestation is mostly related to agricultural conversion and is not necessarily a symptom of poverty

The generalization that “poverty causes deforestation” is only partly accurate and is a poor guide to policy. Deforestation is undertaken by rich and poor, for gains large and small, sustainable and unsustainable. The per-hectare value of newly-deforested land ranges from a few dollars (for extensive pasture or subsistence crops) to thousands of dollars (for some tree crops and for soybeans).

Deforestation is often undertaken by large commercial interests rather than small subsistence farmers, especially in Latin America and Indonesia. In Brazil, for instance, less than a fifth of deforestation is attributable to smallholders, while two fifths occurs in individual clearings greater than 200 hectares, indicating the work of well-capitalized actors.

Forest poverty stems from remoteness and lack of rights

There are two distinctive features of forest poverty. First, since the best lands have long been farmed in many parts of the world, forests tend to be relegated to remote and unfavorable areas. These areas have low access to market and face high costs of infrastructure and service provision. So they tend to have low population densities but high poverty rates.

Second, forest dwellers may be unable to tap forest resources. Much of the tropical world's forest estate is under nominal government ownership. Governments or wealthy interests sometimes limit local people's use of trees and land. In other cases, forests effectively belong to no one, and become degraded through overuse.

Road accessibility, especially in agriculturally favorable areas, stimulates both deforestation and rural development. Trade and macroeconomic reforms favoring agriculture will have the same tendency.

Road placement in forested areas raises the farmgate price of crops and of standing timber, increasing the incentive to deforest. For instance, in the Brazilian Amazon, the deforestation rate is just 0.5%/year where the price of beef is at the breakeven point of R\$400/ton, but skyrockets to 8%/year when the price is above R\$600 (holding constant agroclimatic conditions and land tenure.) This raises important issues for rural development policy, because the extension of rural roads is also a potentially powerful instrument for improving farm incomes. Similar trade-offs might occur when trade reforms or currency movements boost the local price of export crops.

Deforestation imposes geographically varied environmental damages

While deforestation benefits some people, it imposes environmental damages on others.

The most widespread impact, and arguably the one with the most costly damages, is the effect of forest loss on climate change via CO₂ emissions. These greenhouse effects are associated with all permanent forest loss, regardless of location.

Deforestation is also a leading cause of global biodiversity loss. Because biodiversity is unevenly distributed, it is possible to identify 'hotspot' locations where deforestation poses a particularly severe threat to biodiversity. These locations are disproportionately located in the fragmented, depleted forests near urban areas.

Forests are often thought to prevent floods, aid dry season flows, and prevent erosion and sedimentation, and these suppositions have been used to justify significant policy decisions (such as China's decision to ban logging following the Yangtze floods). Modern hydrological science has, however, cast significant doubt on the strength and generality of these relationships. In particular, there has been skepticism about whether there is a link between upland deforestation and flooding in downstream cities (important, because urban willingness to pay for flood mitigation might be large).

Emerging research points to specific geographical situations where forest conservation might result in significant downstream benefits. In Guatemala for instance, small, hydrologically sensitive watersheds cover only one-third the country's area, but contain one-third of the country's poor people and 42 percent of its montane forest. At a global scale, new studies suggest that large-scale deforestation might indeed increase the exposure of downstream populations to flooding, though not to the most catastrophic floods. One study estimated that loss of all critically endangered biodiverse forest areas in the tropics would expose about 100 million floodplain dwellers to increased water flows, likely meaning a greater incidence of flooding. In general, however, deforestation will tend to have the greatest impacts on water flow and sedimentation within small watersheds rather than large ones.

But deforestation tends to *increase* rather than decrease dry-season water flows. And there are alternatives to forest conservation—including agroforestry—which produce many of the same hydrological benefits with higher incomes to landholders though lower biodiversity benefits.

Policy and institutional responses to deforestation and forest poverty ***The central role of governance***

Combating deforestation and alleviating forest poverty are fundamentally problems of governance. Nations need to sort out who has the rights to manage forests and how stringently to regulate those rights in the public interest.

Three types of forests with different challenges

The governance challenges play out differently in three different types of forests: In *mosaiclands*, patchworks of farms and forest near cities, land tenure is typically fairly well defined. Here environmental services markets can help to reconcile environmental protection with agricultural production.

At *forest frontiers* and in *areas of disputed tenure*, the challenge is to fairly resolve and reliably enforce conflicting claims to resources. This includes enforcement of regulations against illegal deforestation by large interests. *Beyond the agricultural frontier*, the challenge is to recognize and defend long-standing indigenous rights claims, and to avoid disorderly races for property rights when the frontier arrives.

Parks and protected areas are often surprisingly effective in deterring deforestation. But the scope for park expansion is limited

Parks have been criticized as being exclusionary of local populations, and as being unenforced and ineffective—"paper parks." But research is finding that deforestation rates within parks and indigenous areas are significantly lower than in comparable unprotected areas. Protected area establishment is a potentially appropriate

instrument for areas beyond the agricultural frontier. Indeed, parks have mostly been established in remoter areas, where pressures for conversion are relatively low. But the effect of protected area establishment on local people's welfare is poorly studied.

Economic instruments can, in theory, minimize the trade-offs between agriculture and biodiversity conservation in the mosaiclands

The biodiversity crisis is most grave, and the potential tradeoffs most severe, in the hotspots. Reduced to mere fragments by agricultural and population pressure, these patches of vegetation cover 1.4 percent of the earth's surface but contain about a third of its biodiversity. That biodiversity is at severe risk of near-term extinction unless these fragments are expanded, reconnected, and buffered by more biodiversity-friendly agriculture. But how, in these often densely populated areas, can landholders be induced to make the necessary changes in land management?

The traditional approach has been command-and-control conservation planning. This has achieved some success through the establishment of parks and protected areas. But it is now widely understood that biodiversity conservation requires not only additional parks, but also changes in land use management by private landholders, over wide areas. Here the command-and-control approach has broken down. Although sophisticated technical tools exist to plan biodiversity corridors (ensuring enough contiguous habitat to maintain viable animal and plant populations), attempts at enforcing these plans through zoning have failed to secure compliance. The World Bank, for instance, has loaned hundreds of millions of dollars to Brazil for land use planning and zoning, but concluded that these plans were ineffective.

An alternative attracting interest is the use of economic instruments to induce voluntary cooperation with conservation plans while minimizing the total cost of the plans. A common feature is a payment conditional on some landholder action. Simulations for Brazil (where the conservation-development relationship is of intense policy interest) have shown that the use of economic instruments can in principle drastically reduce the social cost and increase the environmental benefits associated with achieving conservation goals. The reason is that there is substantial spatial cross-variation in the economic and ecological value of land. A surprising finding is that economic instruments appear, in some circumstances, to achieve specific ecological goals (such as conserving contiguous areas) that were thought to require top-down, command-and-control planning.

The carbon market could potentially finance forest conservation on a large scale—but there are political barriers to be overcome

Under the Kyoto Protocol, developed countries accept limits on their emissions of greenhouse gases. But they have the option to offset their emissions by purchasing emissions reductions from the developing and transition economies. Emissions reductions are produced when the supplying countries switch to more efficient energy technologies and (to a limited extent) when they sponsor reforestation. This arrangement reduces the

global cost of mitigating climate change, while transferring resources and technology to the developing world. The World Bank's Carbon Finance Business has been playing an important role in prototyping and funding carbon projects in the developing and transition economies.

The Kyoto Protocol does not, however, currently allow developing countries to sell emissions reductions based on prevented deforestation—a lost opportunity in economic and environmental terms. In some places at the forest frontier, a hectare of forest is converted to a pasture worth a few hundred dollars, while emitting 500 tons of CO₂ or more. Forest conservation could therefore reduce emissions at costs as low as less than a dollar a ton, while maintaining irreplaceable biodiversity. In contrast, the going price for emissions reductions in the European carbon market is currently about \$20 per ton CO₂. However, that market also does not recognize credits from reduced deforestation.

Active discussions are however now underway under UN Framework Convention on Climate Change auspices to expand the global climate change regime to include the provision of positive incentives, at the national level, for reduced emissions from deforestation and forest degradation (REDD). The G8 has called on the World Bank to pilot approaches to implementing such incentives. Such pilots will face a wide range of technical issues. These revolve around guaranteeing the integrity of the claimed emissions reductions, reflecting both economic concerns (does protection of one forest merely divert pressure to a neighboring one) and institutional ones (how can long-term permanence of carbon sequestration be guaranteed?). Solutions have been proposed for most of these problems. A key factor both for environmental integrity and for political acceptability will be to bundle forest protection with activities to promote sustainable agricultural intensification and employment generation on already-deforested lands. This will address the root causes of deforestation.

Designing and implementing effective REDD policies will require significant investments in monitoring, evaluation, and analysis of pilot efforts. Better systems for monitoring forest cover and forest dwellers' welfare are urgently needed.

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Endnote

Most Bank documents cited in this summary are available through the documents and reports portal of the World Bank <http://www-wds.worldbank.org/>. The word “processed” describes informally reproduced works that may not be commonly available through library systems.

¹ This note is based on *At Loggerheads? Agricultural Expansion, Poverty Reduction, and Environment in the Tropical Forests*, Policy Research Report by K. Chomitz with P. Buys, G. De Luca, T. Thomas, and S. Wertz-Kanounnikoff, 2007.