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Chapter 48: Tropical Forests in Mitigating Climate Change

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I.) INTRODUCTION

Deforestation contributes significantly to global warming, which means that actions to reduce deforestation have a valid role as part of strategies to mitigate climate change, especially since avoided deforestation is a relatively cost effective mitigation strategy.

This chapter discusses policy debates over the use of avoided deforestation as an option for mitigating global warming. The value of forests as a carbon sink is reduced (but not eliminated) by the lack of permanence of holding carbon out of the atmosphere in the case of individual forest tracts and by the greater uncertainty associated with forests as compared to fossil carbon. However, these effects can be offset by avoiding substantially larger amounts of carbon emission than the amount of any carbon credit that is granted. Permanence of rainforest carbon can also be addressed by a sequence of temporary credits (as is currently done for silvicultural plantations under the Kyoto Protocol). In addition to avoiding greenhouse-gas emissions, avoided deforestation generates climatic benefits by maintaining evapotranspiration and water cycling, in addition to its fundamental role in maintaining biodiversity.

Brazilian Amazonia is the focus of the present chapter. High rates of deforestation in the region are a major source of emissions: the net committed emission for 1990 from deforestation in Brazilian Amazonia was 218.1-227.8 $\times 10^6$ Mg of CO_2-equivalent C/year for biomass emissions only, and 230.0-239.7 $\times 10^6$ Mg of CO_2-equivalent C/year including soils and other sources (1), updated based on revised wood density estimates in (2). Deforestation in 1990 (the standard base year for national inventories under the United Nations Framework Convention on Climate Change) was 13.8 $\times 10^3$ km^2 (in primary forest only, not counting clearing of savannas or re-clearing of secondary forests). The deforestation rate in 2004 was 27.4 $\times 10^3$ km^2 per year, which corresponds to a net committed emission of 456.7-475.9 $\times 10^6$ Mg of CO_2-equivalent C/year. This is almost six times Brazil's approximately 80 $\times 10^6$ Mg of CO_2-equivalent C annual emission from fossil fuels and cement. Thus, the case of Amazonia is both illustrative and substantive.

II.) AVOIDED DEFORESTATION AS A MITIGATION OPTION

Proposals to avoid tropical deforestation as a means of mitigating global warming have been the source of considerable controversy. As a matter of disclosure, my role as the originator of such proposals in the early days of this discussion (*e.g.*, 3, 4), and my participation as a combatant in the debates over the succeeding decades, makes me clearly partial to using this option to the fullest extent possible. The threat to tropical forests posed by climate change has been a key part of this debate. Opponents of granting credit for avoided deforestation claim that the eventual demise of the forests will release stored carbon

in any case; credit should not be given for temporary carbon storage. Some background on the controversy surrounding carbon credit for avoided deforestation is needed.

Prior to the December 1997 Kyoto Protocol, slowing tropical deforestation to avoid greenhouse gas emissions was regarded as a top priority by European governments (*e.g.*, 6) and environmental non-governmental organizations (NGOs) headquartered in Europe (7, 8). With the advent of the Protocol, these governments and NGOs suddenly reversed their positions due to the concern that avoided deforestation would be a temporary and uncertain a mitigation strategy (*e.g.*, 5, 9). In addition, ruling out avoided deforestation as a mitigation strategy would level the playing field between Europe and North America by forcing the US to raise fuel prices to reduce emissions instead of relying on the substantial credit that would come from avoiding deforestation. Environmental NGOs headquartered in other parts of the world outside Europe virtually all continued to support credit for avoided deforestation (see 10). Grassroots organizations in Brazilian Amazonia overwhelmingly supported credit for avoided deforestation.

On the other hand, the Brazilian foreign ministry opposed credit from avoided deforestation based on the belief that Brazil's sovereignty over Amazonia is under permanent threat and that the major economic interests represented by carbon credit could lead to international pressures that might jeopardize the country's control over the region. Although belief in a threat of "internationalization" of Amazonia is widespread in Brazil, the view that carbon credit for avoided deforestation poses a danger in this regard is not shared by most sectors of Brazilian society outside of the foreign ministry. Brazil's Ministry of the Environment has long favored carbon credit for avoided deforestation (see 11). The nine state governments in Brazil's Amazon region have all favored carbon credit for avoided deforestation and one has even attempted to sell it on international commodity exchanges.

At the Conference of Parties (COP) in Bonn, July 2001, the countries that remained in the Kyoto Protocol (after US president George W. Bush withdrew the United States) agreed to exclude avoided deforestation from crediting in the 2008-2012 first commitment period. While the Bonn agreement excluded tropical deforestation, it allowed credit for plantations of trees such as *Eucalyptus*. The only country that wanted credit for plantations but not for avoided deforestation was Brazil, which has one of the world's largest plantation industries (13).

Following the Bonn agreement, the European governments and NGOs have since reverted to their original positions of support for including avoided deforestation in the measures for credit in the second commitment period (2013-2017). The geopolitical situation surrounding the current negotiations for the second commitment period is very different from the one that applied to the first commitment period during the 3½ year-long battle over this issue between the signing of the Kyoto Protocol and the Bonn agreement. For the second commitment period the emissions quotas (assigned amounts) and the rules for crediting (for example, for avoided deforestation) will be negotiated simultaneously, thereby eliminating parallel advantages that countries can get for themselves by excluding avoided deforestation; this negates any argument for a climatic advantage to be achieved by allowing only the minimum possible amount of mitigation in the forest sector. If tropical forests are excluded

from credit, then the industrialized countries that would have purchased the credit will simply agree to more modest cuts in their national emissions.

In the current negotiation for including tropical forests in the second commitment period, it is important that countries (or other actors) must take both the benefit and the onus of commitments to reduce deforestation. It is not enough to take credit when deforestation goes down and incur no penalty when deforestation goes up. Proposals advanced in this regard essentially treat avoided deforestation as speculating on the stock market, where the objective is to "buy low and sell high." In other words, the natural oscillations in annual deforestation rates would generate credit even without any change in the behavior of deforesters. Several proposals are under consideration. One is that of the 15-country "Coalition for Rainforest Nations" led by Papua New Guinea and Costa Rica, which presented a proposal in Montreal in December 2005 to grant carbon credit that could be sold and used to meet emissions reduction commitments made under Kyoto Protocol (15, 16). Brazil submitted a competing proposal in Nairobi in December 2006 for a voluntary fund for financing deforestation reduction that would not produce credit towards achieving targets for reducing use of fossil fuels (17). Whatever solution is adopted, the important role that tropical forests play in global warming means that sooner or later measures to reduce deforestation are likely to be funded as mitigation measures.

III.) UNDERLYING ISSUES IN COUNTING MITIGATION BENEFITS

A.) THE VALUE OF TIME

In order to reflect a preference to receive benefits as soon as possible and delay incurring costs as long as possible, economists and entrepreneurs apply a discount rate to all future income and expenses (see chapter XX). An annual discount rate is a percentage by which future quantities are devalued for each year between the present and the expected credit or debit (after adjustment for any inflation). Financial decisions are often based on annual discount rates on the order of 10 or 12%, and are essentially based on the rate at which money can be made from alternative investments in the economy. Policy decisions intended to address different social concerns use other (generally lower) discount rates.

The Kyoto Protocol has adopted a formulation for calculating the equivalence between greenhouse gases with widely differing atmospheric lifetimes based on "Global Warming Potentials," or GWPs, that are based on a 100-year time horizon with no discounting over the course of the time horizon (*e.g.*, 23, p. 121). This formulation gives a value to time that is equivalent to an annual discount rate of approximately 1% (24).

By giving any value to time greater than zero the value of delaying global warming is recognized. If warming by a given amount is delayed by, for example, 50 years, all of the impacts that otherwise would have occurred over those 50 years represent a permanent benefit with real value. Temporary storage of carbon, for example in trees, delays global warming and therefore has a value. While the value of temporary storage is less than that of permanent storage, it is not zero. Even if Amazonian forest is in fact destroyed by climate change in 80 years (as the Hadley Center model indicates under a business-as-usual scenario; see Chapter ___), those 80 years have value that must be compensated if deforestation is avoided.

Various formulations have been proposed to account for time based on the "ton-years" that the carbon remains out of the atmosphere (see 26). The weak point of such formulations is that they require a negotiated agreement on a discount rate or other alternative time-preference weighting. A means of avoiding an explicit negotiation was found by relying on market mechanisms as embodied in the "Colombian Proposal," which creates temporary carbon credits that have to be renewed at defined intervals, either by purchasing another temporary credit or by making a permanent reduction through avoided fossil-fuel emission (27).

The question of time preference has come to the fore with the recent discovery that living terrestrial vegetation, including tropical forest, may be emitting methane to the atmosphere (28, but see recent questioning of this conclusion: 29). How should the small amount of methane a forest emits per hectare per year be weighed against the large immediate impact of cutting down a hectare of tropical forest? Each hectare of deforestation in Brazilian Amazonia releases net committed emissions totaling 170 Mg CO_2-equivalent carbon (updated from 31, 32 with altered adjustments for hollow trees and form factor based on 30 and wood density based on 2, 34, 35). Therefore, with no discounting, it would take 665 years for the methane emission from a hectare of standing Amazonian forest to offset the impact of deforesting that hectare, with the range of uncertainty extending from 423 to 1566 years. Even the low end of this range should make clear the tenuous nature of arguments that would sacrifice the benefits of forests over the next several centuries in the interests of climatic gains that will only begin to accrue several hundred years in the future. If any discounting or other form of adjustment is made for the value of time, keeping the forest becomes the best choice regardless of the time horizon. Any discount rate above a mere 0.15% annually would negate forever the benefit of sacrificing tropical forest to avoid its natural emissions of methane.

B) THE ROLE OF UNCERTAINTY

The global-warming impacts of tropical deforestation, and the benefits of any measures taken to reduce it, are inherently more uncertain than are comparable emissions and reductions in fossil-fuel combustion. At each stage of the process, from the planning of a mitigation measure or activity to the execution of the plan to the later evaluation and monitoring, a forest-sector measure will invariably be more uncertain than an energy-sector one.

Uncertainty (the variation in outcomes due to lack of knowledge) and risk (the variation due to known causes) are everyday considerations in financial decisions of all sorts (see chapter XX). These concerns are incorporated into the sum of costs and benefits by means of the "expected monetary value" (EMV), with appropriate adjustments for factors such as risk aversion. EMV represents the sum of the products of the value of each possible outcome times its respective probability of occurrence. For example, if one is betting in the lottery, one may get a million dollars if one wins, but the probability of winning will be, say, one in ten million, making the EMV of a one-dollar lottery ticket only 10 cents. In the case of carbon from avoided deforestation, the reward may only have a modest probability of being achieved, but its EMV is still considerable because of the large "jackpot" if avoided deforestation is indeed successful (see 36).

The best way to ensure that the climate is not stuck with the losses from overly optimistic expectations of mitigation benefits is to insist on a "pay-as-you-go" policy. This also avoids sovereignty issues that are sometimes raised as objections to avoided deforestation, especially in Amazonia. Any advances of funds on the basis of future expected carbon benefits would have to come from normal financial markets, not from governments or international guarantees.

Unfortunately, uncertainty has often been raised as an objection to using avoided deforestation as a global-warming mitigation option. Representatives of the Association of Small-Island States (AOSIS) insisted that avoided deforestation is too uncertain and that fossil fuels should be the exclusive focus of mitigation efforts. I argue that restricting mitigation to fossil fuels is not in the best interests of those who, like small island residents, are most at risk from global warming because the expected benefit is substantially higher from avoiding deforestation than it is from the same investment in reducing fossil fuel emissions. The carbon benefits are similar to the "expected monetary value" (EMV) of financial decision making. The device of insisting on complete or nearly complete certainty has the result of ruling out forests as mitigation options (see 10).

IV.) ADDITIONAL BENEFITS OF AVOIDED DEFORESTATION

A.) BIODIVERSITY

Climate change and biodiversity conservation are intimately linked in various ways. These are explained in more detail in Chapter ___. Both the climatic and biodiversity functions of tropical forests are vulnerable in the face of catastrophic impacts that have been predicted for Amazonia. The recent finding of multiple extinctions of Costa Rican frog species due to pathogens whose spread was aggravated by climate change underlines the widespread and poorly understood nature of these effects (37). An analysis of the Hadley Center results under a business-as-usual emissions scenario indicates that 43% of a representative sample of 69 angiosperm plant species would become unviable by 2095 due to shifts in climatic zones (38). Both climate and biodiversity concerns are also linked by the benefit of avoiding deforestation: saving a hectare of forest from deforestation both mitigates climate change and preserves biodiversity. In addition, Amazonian forests recycle a tremendous amount of water, supplying water vapor to the atmosphere that sustains rainfall in the Amazon Basin, which is necessary to maintain the forest itself (39, 40). This water also maintains rainfall in heavily populated parts of Brazil such as São Paulo (41).

There is a natural alliance of interests between those who want to conserve Amazonian forest for its biodiversity benefits and those who want to conserve it for its climatic benefits. However, this general alignment can break down when it comes to identifying which pieces of forest should receive top priority (42). Often, biodiversity conservation focuses on the very long-term future, or what "will be left" after deforestation has presumably run its course for many years and left a landscape of remnants, mostly in protected areas (therefore favoring investments in large reserves far from the present deforestation frontier). Global warming mitigation benefits, on the other hand, are generally judged in terms of "additionality" over the span of a five-year Kyoto commitment period, and would favor reserves near the deforestation frontier if credit were granted (43).

Biodiversity and climate considerations lead to sharp differences in priorities for the tropical forest locations that are most important to protect. Biodiversity is often discussed in terms of "hotspots" where many endemic and endangered species occur (*e.g*., 44). These include the Yungas region along the eastern foothills of the Andes, the Atlantic Forest on the southeastern coast of Brazil, Central America and Madagascar. With the partial exception of the Yungas, all of these areas represent the last remaining fragments of forests that have suffered centuries of degradation. From the point of view of climate, these forests have lower priority than the vast expanses of remaining forest in Amazonia because any change that might be achieved in public policy to reduce future deforestation in these last remaining forest remnants would affect a minimal area of forest and stock of carbon, whereas even a slight change in deforestation rates in Amazonia affects an incomparably larger stock of carbon (45).

Reducing emissions globally will require using every existing mitigation option, among which reducing tropical deforestation is one of the most cost effective (11, 45-50). The IPCC has identified deforestation as the dominant form of potential mitigation in the tropics (51). In other words, keeping forests standing for their biodiversity value also helps avert the climate change that threatens biodiversity and, through its feedback to emissions, provokes still more climate change.

B.) EQUITY

Equity issues are intimately linked to climate change impacts, mitigation and the future of tropical forests. These issues are covered in more detail in Chapter ___. The tropical forest areas of the world are economically poor as compared to the industrialized areas that are responsible for most of the world's release of greenhouse gases. The misconception is common that avoiding tropical deforestation means preventing poor farmers from feeding themselves with slash-and-burn agriculture in order to let rich Americans drive luxury cars. However, in Brazilian Amazonia (in contrast to some other parts of the tropics) deforestation is mostly done by the rich (52, 53). This presents an opportunity through what this author refers to as the "Robin Hood strategy," or taking from the rich to give to the poor by halting the deforestation by wealthy ranchers and land speculators and using the value of the environmental services from this as a means of sustaining Amazonia's poor rural population (54).

A recurrent question is how to compensate for the environmental services of standing forest without rewarding *grileiros* (land thieves) and those who have been victorious in the often-bloody struggle for land. Compensation for carbon makes it even more profitable to enter into Amazonian land grabs as an economic activity. Social impacts represent grounds for concern in a wide variety of potential mitigation projects in tropical forests (55). While many policy and legal safeguards (and social struggles) will be needed to ensure that disadvantaged segments of the region's population benefit from mitigation activities; the first step in any plan to tap the value of the forest's environmental services must be creation of that value in the first place. The existence of equity concerns indicates the need for social changes, not that the carbon value of tropical forests should be denied.

The place of indigenous people in maintaining Amazonian forest is a crucial part of the debate on the role of avoided deforestation in mitigating global warming. Indigenous

areas are a primary bulwark against deforestation and account for much more forest than do conservation units (56). The notion that those concerned with global warming can just pocket the environmental contributions of indigenous peoples for free is gravely mistaken and is likely to lead to erosion and loss of the protection these forest guardians now provide (57).

V.) CONCLUSIONS

Because tropical forsts contain large stocks of carbon that are released as greenhouse gases when the forests are cleared, substantial benefit for climate is achieved if deforestation is avoided. Advances in creating international mechanisms that grant carbon credit for avoided deforestation are needed. Other environmental services, such as maintenance of biodiversity and of water cycling, also have value that could be tapped to help slow deforestation.

Incorporating tropical forests into efforts to mitigate global warming has proved to be a complex and controversial task. Establishing an equivalence between permanent avoidance of fossil-fuel emissions and non-permanent storage of carbon in forests requires assigning a value to time, either explicitly or by indirect market mechanisms. It also requires acknowledging the greater uncertainty of forest carbon. However, the greatest impediments have been political rather than technical, and the current prospects of reaching agreement are much better than at any time since the 1997 Kyoto Protocol. Keeping tropical forests standing not only avoids emissions but also benefits biodiversity, traditional peoples and social equity for the region's population as a whole.

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