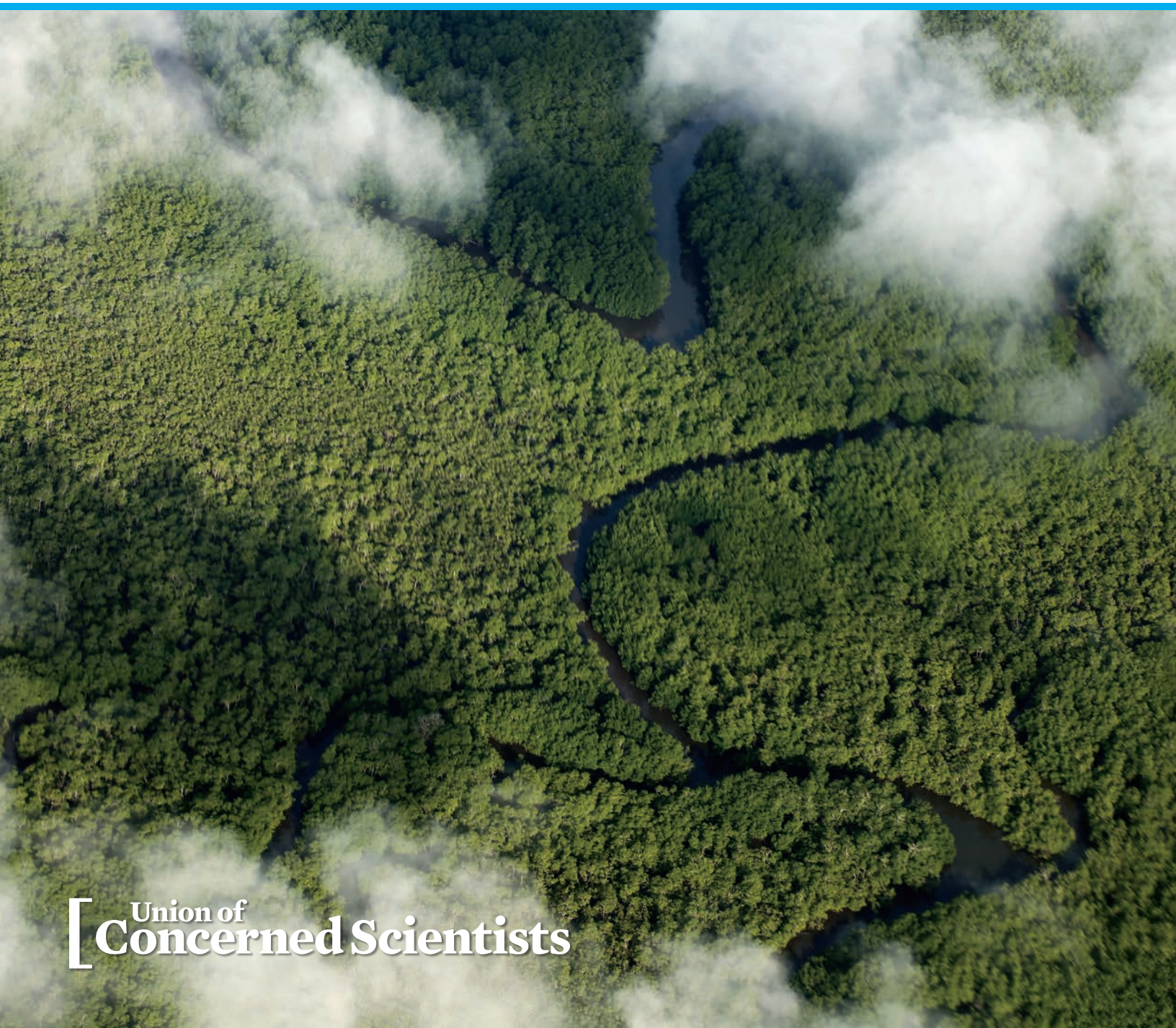
Deforestation Success Stories

Tropical Nations Where Forest Protection and Reforestation Policies Have Worked



Union of Concerned Scientists

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Tropical Nations Where Forest Protection and Reforestation Policies Have Worked

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This report was produced by the Tropical Forest and Climate Initiative (TFCI) of the Union of Concerned Scientists (UCS). **Doug Boucher**, **Jordan Faires**, and **Sharon Smith** are UCS staff members specializing in tropical forests, agriculture, and climate. **Pipa Elias** is a consultant to the TFCI.

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The TFCI, a project of the UCS Climate and Energy Program, analyzes and promotes ways to cut global warming pollution by reducing tropical deforestation. To learn more about this work, visit *www.ucsusa.org/forests*.

This report is available online (in PDF format) at *www.ucsusa.org/forestsuccess*.

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[EXECUTIVE SUMMARY]

This report shows how a substantial number of developing countries, home to most of the world's tropical forests, have reduced deforestation and thus their emissions of the global warming pollution that threatens the world with dangerous climate change.

Based on peer-reviewed quantitative data, the report demonstrates success at a variety of scales, ranging from whole countries and regions—which just by themselves contain large areas of tropical forest (e.g., Brazil, central Africa)—down to relatively small projects in parts of other countries (Madagascar, Kenya, and Mozambique). The funding for these successes has come from a variety of sources, including bilateral REDD+ (reducing emissions from deforestation and forest degradation) programs, carbon credits, and even emigrants (El Salvador), and much of the financial support has come from the countries' own citizens. Beyond money, these examples also demonstrate how the power of political will—manifested in a range of actors across the public, private, and community spectrum—can have positive impacts on forest conservation, socioeconomic development, and forest/land use changes.

An important concept for trends in land use is the "forest transition," a well-established pattern of how deforestation in a region generally increases, then decreases, and finally transitions to *re*forestation over the course of time. We examine countries across the spectrum of the forest transition curve—ranging from high-forest/low-deforestation nations and regions (Guyana and central Africa) to those with substantial deforestation rates (Brazil, Mexico, Mozambique, Tanzania, Kenya, and Madagascar) and those that are reforesting (Vietnam, India, El Salvador, and Costa Rica).

Overall, we can distinguish three kinds of success stories:

- The implementation of a set of policies and programs has been responsible for substantial success in reducing emissions from deforestation or in promoting reforestation. This category is covered in the first grouping (Part 2) of this report, and includes examples from Brazil, Guyana, Madagascar, Kenya, and India.
- Other policies and programs—e.g., payment for ecosystem services in Mexico, Vietnam, and Costa Rica—have been beneficial for the forests despite not having worked out in the way that economists and policy makers designed them. And the programs' contributions to social and economic development have often been less than advocates had hoped. This category is covered in Part 3.
- Finally, in a few cases (central Africa, El Salvador) there has been considerable success, but due to changes in the socioeconomic context as well as policy reforms and their implementation (Part 4).

Nearly all the successes are partial ones, with the drop in deforestation or extent of reforestation limited by factors such as "leakage" (transfer of emissions elsewhere) due to globalized commodity production. But despite the varying outcomes, the overall result is that deforestation has been reduced and reforestation increased.

Primary among the successful approaches are REDD+ programs, which provide both financial and political support from the international community for tropical countries' efforts. These programs may include:

- Payments for ecosystem services, whereby landowners who protect forest carbon, water quality, biodiversity, and sources of environmental value are compensated

- Strong efforts to enforce existing laws, often combined with increases in transparency from the targeted use of technology
- Governance reforms of many kinds, including the combating of corruption, strengthening of existing laws' enforcement, recognition of land tenure, and reinforcement of private commitments with legal steps to require their implementation
- Moratoria by public and private authorities on deforestation, on permits to deforest, or on purchases of commodities that come from deforested lands
- Combining environmental actions with social and economic development efforts

We explore these efforts and how they have paid off in Chapters 1 through 12, and we offer broader conclusions and provide specific recommendations for policy makers in Chapter 13.

These are inspirational stories, with important lessons for the entire global community. They show how people are changing the landscapes of their countries and the future of the planet through innovative policies, strong leadership, and hard work. If nothing else, these stories should encourage the global community to increase its support for these kinds of efforts, which are providing important benefits—not only in the areas in which they are happening but also across the world.

Introduction

In the 1990s, deforestation was consuming 16 million hectares a year and was responsible for about 17 percent of total global warming pollution. Two tropical forest countries, Brazil and Indonesia, were respectively the fourth and fifth largest emitters on the planet at the start of the twenty-first century (World Resources Institute 2014). Many decried the situation, as there seemed to be virtually no way to turn the tide. But today the overall picture looks considerably brighter. The pace of deforestation is down by 19 percent—to 13 million hectares annually in the first decade of the 2000s (FAO 2010)—as a variety of efforts have proven successful at protecting forests while boosting local economies and livelihoods.

> ***The pace of deforestation is down by 19 percent—to 13 million hectares annually in the first decade of the 2000s.***

This report is about early successes from programs designed to protect or restore individual countries' forests and thus help to stave off global warming. Backed by scientific evidence, the report showcases a wide variety of examples from developing countries in which people are confronting climate change with concrete, on-the-ground efforts to halt deforestation and restore forests. These efforts, often helped by support from developed countries, are making a real difference.

The successes have been quite varied. Some of them—in Brazil, Costa Rica, and Kenya, for example—have been part of the approach known as reducing emissions from deforestation and forest degradation (REDD+). Based on standards and rules agreed on in the international climate negotiations from 2007 to 2013 and in related forums, REDD+ programs provide tropical countries that reduce their emissions from forest loss with compensation in the form of payments from developed countries. The funding may come either from public or private sources, and the efforts can be nationwide programs, local projects, or at scales in between. As the importance of tropical forests for the global climate has been increasingly recognized, REDD+ has come to provide a framework for climate change amelioration efforts, even when the effort was originally begun for other reasons, such as to protect biodiversity, defend indigenous rights, or provide for community control of local natural resources.

How We Defined Success

The cases collected here are stories of success—but because they are also stories based on science, it is important to explain our three criteria for inclusion. First, we chose to address tropical countries exclusively, as they are where the vast majority of deforestation takes place. Second, we considered only cases with quantitative evidence—whether through direct estimates of emissions reductions or measurements of proxy variables, such as decreased deforestation—that global warming emissions have been reduced. So, for example, measurements of decreases in the area of tropical forest converted to pasture qualified a project for inclusion, but

measures of *effort* to reduce emissions—such as numbers of farmers participating, funds paid out, or protected areas established by legislation—did not. The latter phenomena are, of course, critical to success, but they do not show that it has been achieved.

Third, we looked for some independent review of the evidence beyond the statements and presentations of data by those carrying out the program. Such independent verification included peer-reviewed studies in academic journals, validation of emissions-reduction amounts by a third-party verifier, and assessment by entities such as the Organization for Economic Cooperation and Development (OECD) or the REDD Desk program. The key point is that someone besides those actually making the effort to reduce global warming pollution had looked at the evidence and considered it valid.

Success can be achieved—and can teach valuable lessons—at all scales.

The reader may notice that our success stories involve forests rather than agriculture. Of course, direct agricultural emissions—such as methane from cattle and other livestock, nitrous oxide from fertilizer and manure, and carbon dioxide from the soil—constitute a fraction of the world's global warming emissions comparable to those from forests (IPCC 2013) and show great promise for potential reductions. But efforts on the agriculture side are generally more recent than those involving forests, and these programs have not yet generated the kind of peer-reviewed quantitative evidence that we required for inclusion. Luckily, because two excellent recent publications from the Program on Climate Change, Agriculture, and Food Security (CCAFS) do analyze examples of such "climate-smart agriculture" in depth (Cooper et al. 2013; Neate 2013), we can refer the interested reader to those reports.

Having explained the criteria we required for a case study to be included, we should also mention some elements that, though important, were *not* required. They included (1) evidence of additionality, (2) estimates of leakage, and (3) assurance that social and economic benefits were widely and fairly shared.

- "Additionality" refers to the "might have been," or counterfactual, case—namely, would emissions have dropped even if a given program had not been carried out? For example, would changing economic circumstances, such as falling commodity prices or simply a slowdown in economic growth, have reduced emissions anyway? (Nepstad et al. 2009). If so, then the success of the effort cannot be ascribed to it and there is little or no additionality.
- "Leakage" refers to an increase in emissions outside the area where reductions occurred—e.g., in neighboring villages, provinces, or countries (Boucher and Elias 2013). Such increases can happen simply because some of the drivers of deforestation (loggers or cattle ranchers, for example) move to that neighboring area. Leakage can also be the result of the way commodity markets operate. For example, Meyfroidt and Lambin (2009) have estimated that about 40 percent of the reforestation in Vietnam has come from "exporting deforestation"—importing wood from other countries to be processed into furniture rather than getting it from Vietnam's own forests (see Chapter 8). Leakage frequently occurs, and it does not mean that the local effort was unsuccessful; it simply shows that, in net terms, the amount of success was less than estimated.
- Equitable social and economic criteria—the sharing of benefits as well as recognition of land rights, democratic management, and the absence of exploitative actions—are key to achieving true and lasting success in any kind of environmental effort. We established at the outset that if the reductions in emissions appeared to result fundamentally from oppressive actions, we would not include that case. On the other hand, all climate efforts take place in societies with divisions of class, gender, and power, so it is not surprising that they often have elements of injustice and inequality in how they work out.

For all three of these questions—additionality, leakage, and social justice—we chose to discuss them in telling the individual success stories rather than try to use them as criteria for inclusion or exclusion. This was because information on all three can be difficult and costly to gather and is often lacking or uncertain. When we did find evidence of them in the cases we reviewed, we discussed it in the appropriate chapter.

The forest-related success stories we recount here cover a wide range of scales. Some are projects in relatively small areas; others cover subnational jurisdictions such as provinces or large regions (e.g., the "Legal Amazon" in Brazil); still others are whole countries or even multi-country regions (the Congo Basin of central Africa). While successes involving larger areas and more people will generally contribute more than smaller projects to solving the climate crisis, we wanted to show how success can be achieved—and can teach valuable lessons—at all scales (Boucher and Elias 2013).

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As detailed in Chapter 2, Brazil is a global leader in its efforts to reduce deforestation and emissions. Eighty percent of the original Amazon forest remains standing, and deforestation rates in Brazil are down 70 percent in 2013 compared with the 1996–2005 average.

The Forest Transition

Our chapters also cover a range of points along the "forest transition curve," an important concept in understanding how deforestation and reforestation rates tend to change within a country over time (Rudel, Schneider, and Uriarte 2010). A forest transition curve (Figure 1, p. 6) shows that, starting from initially high levels of forest cover, the deforestation rate in a region tends to increase before forest cover reaches a low point—when the rate drops to zero in net terms—and the level of forest cover begins to recover. Thus the curve of forest cover versus time starts from a high level, heads more and more steeply downward, but then slows, bottoms out, and begins to climb back.

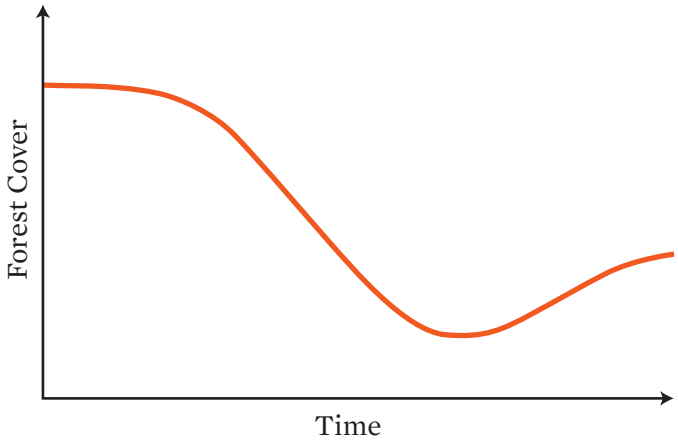
An interesting thing about the forest transition concept is that there is broad agreement among scholars that it happens, but continuing argument as to why. New ideas about the underlying forces driving the transition continue to emerge and are energetically debated (Rudel, Schneider, and Uriarte 2010). We don't delve into this interesting literature in this report, but we do find the forest transition curve very useful in placing the different chapters in context, and will return to it in Chapter 13 (Conclusions).

Thus some countries and regions, including Guyana and central Africa (to use examples from this report), are today in the early stages of the forest transition and still have high levels of forest cover. Others, such as Tanzania and Madagascar, have moved into the steepest part of the curve (highest deforestation rate). Further along the curve and approaching the low point—due in part to the successes described in this report—are Mexico and Brazil. Finally, Vietnam, El Salvador, Costa Rica, and India have passed the bottom of the curve and are on the upswing, with net increases in their forest cover.

A vital point about the forest transition curve, however, is that the changes it describes are not inevitable. The stories in this report show that they happen because of the dedicated efforts of many people, whose hard work bends the curve, slowing and eventually stopping deforestation and moving onto the upward path toward forest recovery. Support from the international community, too, has been important in helping countries make their forest transitions.

In the chapters that follow, our aim is to examine the evidence with the rigor and skepticism that is fundamental to science but also with understanding of the difficulty and complexity of the task. This is not a meta-analysis or a comprehensive review paper—we did not look for failures, and

FIGURE 1. The Forest Transition Curve



As countries and regions go through the forest transition, they initially lose forest cover to deforestation, then reach a low point, and finally begin to recover as the rate of reforestation comes to exceed that of deforestation.

NOTE: Forest cover is generally measured in terms of area. The exact shape of the curve will vary, and indeed one of the main goals of policy is to try to make it bend upward.

> ***There are enough examples of success, some very rapid and far-reaching, to encourage continuing the global effort—and indeed, stepping it up.***

certainly there are successes we have left out—though we do try to draw some generalizations in the final chapter by identifying common threads of the different stories.

The report omits many tropical forest countries' experiences—some of which have good evidence for success in reducing deforestation—for reasons of space. One omission in particular is worth mentioning, however. Indonesia is one of the largest tropical forest countries and, given the drop in deforestation in Brazil, probably the one with the largest emissions of global warming pollution from land use change. Indonesian government entities have taken important policy actions in recent years, such as the moratorium on permits to deforest that was declared by President Susilo Bambang Yudhoyono in 2011. Furthermore, both the official data on deforestation (Erviani 2013; Purnomo et al. 2013) and some independent data analyses (Mietennen, Shi, and Lieuw 2011; Wheeler, Kraft, and Hammer 2010) show decreases in Indonesia's deforestation. However, other recent data (Hansen et al. 2013 and forthcoming publications) show the opposite trend. Because of this conflicting information, we felt that at present we could not confidently consider Indonesia a success story in accordance with our criteria, and thus we left it out of the report.

The Structure of the Report

A key question for policy makers is: What kinds of programs and actions have shown themselves to be successful in reducing deforestation or increasing reforestation? We have grouped the chapters in three clusters, corresponding to the three-part answer to this question. The cases in Part 2 of the report—Brazil, Guyana, Madagascar, Kenya, and India—are ones in which the policy efforts have largely worked out as expected, leading to success. Part 3 presents four examples—Mexico, Vietnam, Costa Rica, and Tanzania/Mozambique—in which the policy did not work exactly as expected but nevertheless had successful outcomes. Notably, this section includes three examples of payment for ecosystem services (PES) programs, in which the payments are supposed to make the critical difference as to whether landowners choose to deforest or not. Finally, in the two cases of Part 4—central Africa and El Salvador—changing social and economic context seems to have been more important than policy efforts in producing success.

We return to evaluate the importance of policy, with recommendations for policy makers both in tropical-forest and industrialized countries, in the final chapter. Here we simply point out a general theme that runs through the entire report: the efforts that have been made so far to reduce emissions from deforestation have great value, even when their results were different than expected. By their very nature, broad policy efforts to transform land use toward preserving and restoring forests will seldom work exactly as planned. Implementation will almost always turn out to be different from design, and changing external circumstances can have large effects—both positive and negative—on the outcome. Yet there are enough examples of success, some very rapid and far-reaching, to encourage continuing the global effort—and indeed, stepping it up.

The stories in this report are inspiring because, among other things, they show that individuals in many different roles—government policy makers, legislators, prosecutors, business leaders, farmers, and those who are active (including indigenous peoples and local communities) in nongovernmental organizations (NGOs)—can make important contributions to confronting the climate problem.

Brazil: The World's Biggest Reductions in Deforestation and Emissions

The Nation That Has Achieved the Greatest Reductions

In the first decade of the twenty-first century, many countries have begun to take the threat of climate change seriously and thus have moved to reduce their global warming emissions. In some of these countries, including the United States and members of the European Union, these emissions have stopped increasing and have even begun to fall. But it is clear that the nation that has done the most is Brazil (Wolosin and Springer 2014).

The breakdown of global warming emissions from various sectors of Brazil's economy is shown in Figure 2, originally created by Wolosin and Springer (2014) using data compiled by the Brazilian *Observatorio do Clima* (Climate Observatory).

While most sectors have steady or increasing emissions from 2001 to 2011, there was an overall decreasing trend in Brazil's emissions. This net decrease was more than 750 million tons of CO_2eq annually—a cut of almost one-third. And it was all due to success in the "land use change" sector, where emissions fell by a billion tons—a 64 percent drop—while in other sectors they increased (Figure 2, p. 8).

Essentially all of the reduction in land use change emissions came from the decrease in deforestation in the Amazon, the world's largest tropical forest. About 60 percent of the Amazon forest is in Brazil, and about 80 percent of the original forest still remains (Nepstad et al. 2009). But only a decade ago it was disappearing at a rapid rate, making Brazil the leader in deforestation worldwide at the time and the world's third-largest source of global warming emissions, after the United States and China.

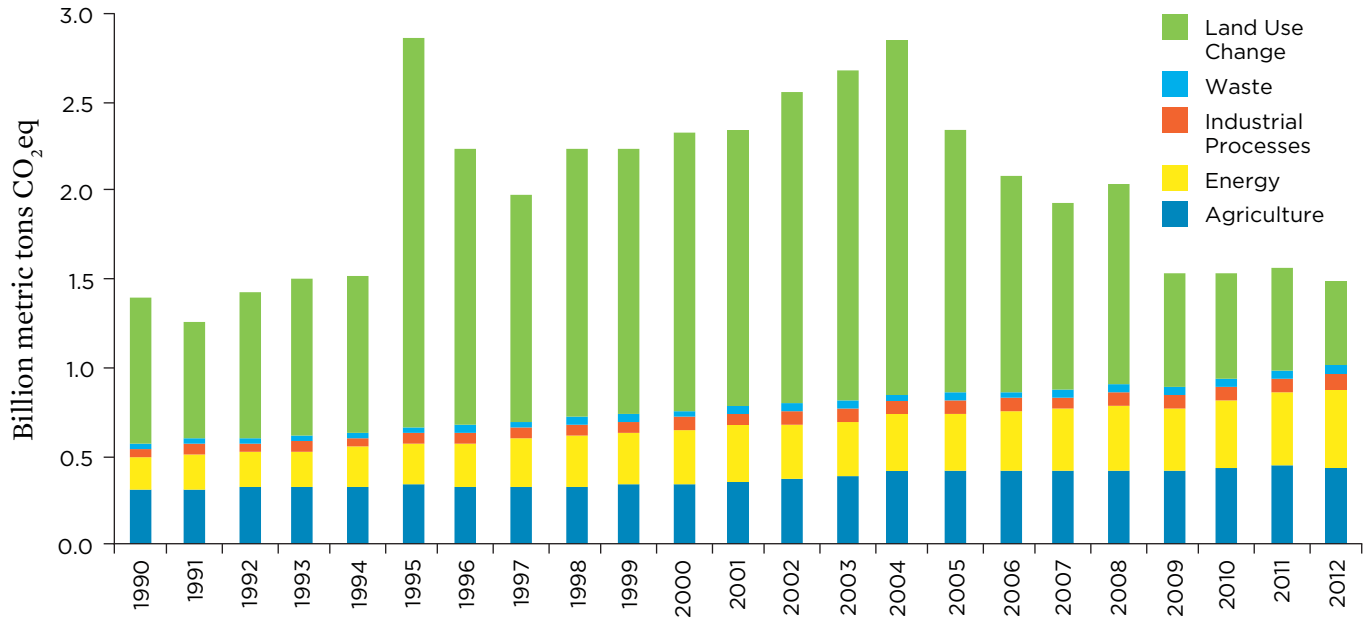
The changes in the Brazilian Amazon in the past decade, and the contribution that they have made to slow global warming, are unprecedented. Although they fit into the general pattern of the forest transition (Chapter 1), the speed of the change in only a decade—indeed, just from 2004 to 2009—is breathtaking. Who deserves the credit, and what did they do to achieve this dramatic success?

The changes in the Brazilian Amazon in the past decade, and the contribution that they have made to slow global warming, are unprecedented.

A Changing Political Dynamic

The beginnings of Brazil's reduction in deforestation go back to the administration of President Fernando Henrique Cardoso (1995–2002) with the establishment of new protected areas in the Amazon, including indigenous reserves and sustainable use areas. This effort was expanded and became part of a broad plan to combat Amazon deforestation—the PPCDAm (Plan for the Prevention and Combating of Deforestation in the Amazon)—after the election of President Luis Inácio Lula da Silva ("Lula") in 2002. Lula's Workers Party (PT) had its social base in the trade unions, landless peasants'

FIGURE 2. Brazil's Global Warming Emissions from 1990 to 2012, by Economic Sector



The majority of Brazil's global warming pollution was due to deforestation until the middle of the 2000s decade. However, deforestation emissions have decreased by more than two-thirds since then, outweighing increases in other sectors.

NOTE: Nearly all of the emissions from "Land Use Change" are due to deforestation.

SOURCE: DATA ARE FROM THE OBSERVATORIO DO CLIMA'S *SISTEMA DE ESTIMATIVA DE EMISSÕES DE GASES DE EFEITO ESTUFA* (SEEG; SYSTEM FOR THE ESTIMATION OF GREENHOUSE GASES), ANALYZED BY CLIMATE EXPERT TASSO AZEVEDO (AZEVEDO 2012).

organizations, and forest peoples' movements such as the rubber tappers' union. It had been organizing for change over many years before Lula's election, and part of its agenda was action against deforestation.

An important figure in Lula's government was Marina Silva, his first Minister of the Environment. She came from the Amazon state of Acre, where she had worked with Chico Mendes to organize the rubber tappers' union and the state branch of the PT. Her responsibility as minister included the implementation of the PPCDAm, which initially followed the lines established in the previous administration, emphasizing the creation of protected areas and recognition of indigenous lands as well as enforcement actions against illegal logging and other violations of laws relating to conservation (Boucher, Roquemore, and Fitzhugh 2013; Ricketts et al. 2010).

During the first three years of the Lula administration, there was little success. Indeed, deforestation rose to a high point in 2004–2005, driven by the expansion of soy and beef production in response to increasing international prices (Macedo et al. 2012; Nepstad et al. 2006). But then deforestation began to fall, and it continued to do so even when commodity prices rebounded to record high levels in the latter part of the decade.

Initially, the policies of Lula's government had been aimed at achieving broad-based social and economic development, particularly for urban workers and the peasants and

> ***Deforestation, seen in the twentieth century as necessary to development and a reflection of Brazil's right to control its territory, came to be viewed as the wasteful and exploitative destruction of resources that were the patrimony of all Brazilians.***

landless laborers in the rural sector. The government implemented new social programs to reduce poverty and hunger, such as *Fome Zero* (Zero Hunger) and *Bolsa Familia* (Family Allowances). These programs were major successes, as they reduced the country's poverty rate from more than 34 percent to less than 23 percent in the six years after Lula's 2002 election. Hunger and malnutrition rates dropped substantially, and there was substantial progress in reducing economic inequality (Chappell and LaValle 2010; Rocha 2009), which increased political support for the Lula government—including for its actions to counter deforestation.

Just as important, and enabled in part by the political capital gained through social and economic development, Lula's government also brought about a change in the political dynamic around the Amazon. Deforestation, seen in the twentieth century as necessary to development and a reflection of Brazil's right to control its territory, came to be viewed as the wasteful and exploitative destruction of resources that were the patrimony of all Brazilians, and especially of the forest peoples such as indigenous groups and rubber tappers. In 2008 the broad movement led by social and environmental organizations, rural and urban alike, came together in the Zero Deforestation campaign, which became an important force in countering both the large ranches that had traditionally dominated the Amazon and the new drivers of deforestation such as the rapidly growing soybean industry (Walker, Patel, and Kalif 2013; Morton et al. 2006; Nepstad, Stickler, and Almeida 2006; Fearnside 2001).

The social and environmental movement—supported by international NGOs with a strong base in Brazilian society, such as Greenpeace International, Friends of the Earth, and the World Wildlife Fund—not only supported government efforts but also pressured politicians to go further. They exerted direct pressure on deforesting industries as well, leading to those industries' voluntary adoption of moratoria to end their deforestation.

The Soy Moratorium

The first dramatic change came in the soy industry, which had expanded into the Amazon during the previous decade

An aerial view of the Amazon rain forest near the city of Manaus (the capital of the state of Amazonas). Amazonas was one of the Brazilian states to act decisively to curb deforestation, significantly contributing to Brazil's overall reduction of emissions by one-third between 2001 and 2011.

(Morton et al. 2006). Brazilian soy exports were growing rapidly, increasing more than ten-fold from 2.5 million tons in 1990 to 31.4 million tons by 2010. The industry was thus quite sensitive to the potential loss of its export markets, which were put in danger with the 2006 release of Greenpeace's report *Eating Up the Amazon* (Greenpeace International 2006). It showed the connections between the soybean industry and deforestation, global warming, water pollution, and slave labor, with a particular focus on two multinational companies: Cargill, an enormous soy and grain trader, and McDonald's, the largest fast food chain in the world.

> ***The slaughterhouses agreed to only buy cattle from ranchers registered with the rural environmental land registry.***

Within weeks, the soy industry responded through its two main trade associations, the Brazilian Association of Vegetable Oil Industries and the National Association of Cereal Exporters. They declared a moratorium on deforestation, pledging not to buy any soybeans produced on Amazon lands that were deforested after June 24, 2006.

By the time the soy moratorium had been in place for six years, studies based on satellite imagery were able to show its success. Rudorff et al. (2011) found that by the 2009–2010 crop year, only 0.25 percent of land with soybean crops had been planted in areas deforested since the moratorium began. These fields created by Amazon deforestation represented only 0.04 percent of the total soybean area in Brazil.

Extending these studies, Macedo et al. (2012) looked at soybean production and deforestation in the state of Mato Grosso and found that the link between the two variables had been broken. Although soy prices had risen to record highs since 2007, tropical forest clearing for soybeans had declined to very low levels in Mato Grosso. What's more, the feared leakage of deforestation into the adjacent *cerrado* biome (a high-diversity landscape of forest and savanna) had not taken place; deforestation there had also been substantially reduced.

The transparency enabled by the use of remote sensing data, combined with land tenure information, not only provided the evidence of the moratorium's success but was in fact crucial to making that success possible. Overlaying deforestation maps (e.g., from the Brazilian Space Agency, or INPE) with ownership maps showed which farms were deforesting and which were not, thus supplying a key piece of evidence needed to take effective enforcement actions.

Over the past several years, the soybean industry has actually done very well—without deforesting the Amazon—by increasing yields and through multiple cropping (more harvests per year). The harvest for 2013–2014 is estimated at 95 million tons, up from 88 million the previous year, allowing Brazil to surpass the United States and become the world's largest soybean producer (Lima 2014). The industry has alleged that the moratorium is no longer needed, but growers nevertheless have recently agreed to extend it, partly in response to pressure from international companies such as McDonald's, Carrefour, Nestlé, Tesco, Ahold, Marks & Spencer, Waitrose, Sainsbury's, and Asda (Rowling 2014).

The Cattle Moratorium

After soy, the next driver of Amazonian deforestation—the beef and leather industry—came into focus in 2009 (Walker, Patel, and Kalif 2013). Two NGO reports, Amigos da Terra—Amazônia Brasileira's *Time to Pay the Bill* and Greenpeace's *Slaughtering the Amazon,* made the connection between expansion of cattle pasture and destruction of the Amazon forest. The reports showed that responsibility was shared by ranchers, banks that financed forest clearing for pastures, slaughterhouses that bought the meat, exporters that shipped it abroad, and government policies that provided subsidies to the whole supply chain. As they had with the soybean industry three years before, NGOs demanded a moratorium on deforestation for cattle pasture.

Ranchers mostly resisted, but other actors in the supply chain quickly saw the need to deal with the controversy. For example, when the International Finance Corporation (part of the World Bank Group) responded by canceling a loan for expansion in the Amazon to Bertin, S.A.—then the country's second-largest beef exporter—Brazilian supermarket chains quickly announced that they were suspending purchases of beef from Bertin. Soon, the four largest slaughterhouses in Brazil's beef industry announced their agreement with Greenpeace to establish a moratorium on deforestation within the Amazon biome. This was just one example of actors in the global supply chain responding to publicity about deforestation by cutting their ties to those responsible.

While both the soy and beef moratoria were voluntary, actions by federal public prosecutors, particularly in the state of Pará (and later Mato Grosso), reinforced them with complementary actions having the force of law. The slaughterhouses agreed to only buy cattle from ranchers registered

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Marina Silva, President Luiz Inácio Lula da Silva's first Minister of the Environment, played a critical role in curbing Brazil's once-rapid deforestation. An Amazonian and the first rubber tapper to be elected to Brazil's Federal Senate, Silva promoted a policy agenda that prioritized forest protection, social justice, and sustainable development for the Amazon region.

> ***The indigenous peoples' reserves play an especially critical role in conservation of the Amazon rain forest.***

with the rural environmental land registry. As a precursor to registration, the ranchers needed to provide the GPS coordinates of their property boundaries, thereby allowing comparison of a map of ranch locations with a map of deforestation. The moratorium thus was strengthened with legally enforceable commitments, and public prosecutors (see below) warned supermarkets that if they sold beef in violation of them, as well as other environmental laws, they too would be held responsible.

The cattle moratorium has forced change, but it has come more slowly than with soy. Further, the moratorium does not apply to all producers, and companies vary substantially in their commitments to enforcing it (Walker, Patel, and Kalif 2013). However, because pasture expansion has been responsible for the vast majority of Amazon deforestation in recent years (McAlpine et al. 2009; Kaimowitz et al. 2004), it's clear that the drop in overall deforestation is also an indication that deforestation due to beef has gone down as well.

Expanding Indigenous Reserves and Other Protected Areas

Another important contributor to reducing emissions from deforestation has been the continuing expansion of Brazil's network of indigenous lands and protected areas across the Amazon since 2002 (Ricketts et al. 2010; Soares-Filho et al. 2010). More than 50 percent of the Brazilian Amazon forest is now under some form of legally recognized protection, and nearly half of this land is reserved for indigenous peoples. The kinds of protected areas vary a great deal. Some follow the traditional model of national parks and wilderness areas, but

many others are used for sustainable extraction of natural resources by rubber tappers and other forest peoples.

The indigenous peoples' reserves play an especially critical role in conservation of the Amazon rain forest (Schwartzman et al. 2013). Legally, these lands are held in collective tenure and their owners have the right to use them for sustainable forest management and the utilization of timber and non-timber forest resources. As a result, these areas' rate of emissions from deforestation is only about a tenth of those of neighboring areas (Ricketts et al. 2010). The indigenous reserves are thus not only a recognition of the rights of long-repressed minorities but also an important contributor to reducing Brazil's output of global warming pollution, as local communities now have the authority to ensure that these forests are protected from farmers, ranchers, and others.

State and Local Actions

Brazil has a system under which the states, as well as the federal government, have responsibility for land use law and its enforcement. Several of the Amazon states—e.g., Acre, Mato Grosso, Pará, and Amazonas—have moved strongly to reduce deforestation and thus can take a substantial part of the credit for the national success. They also have pushed the federal government for stronger anti-deforestation policies.

Pará, for example, established as a target the reduction of deforestation to zero by 2020 (compared with the federal goal of an 80 percent cut from the 1996–2005 average by the same date). Amazonas reduced its deforestation rate by 70 percent from 2002 to 2008 while increasing its state GDP by 65 percent. Acre has been developing a detailed system for monitoring its reductions in emissions and exploring sales of REDD+ credits to the emerging California cap-and-trade market.

Additionally, various municipalities in the Amazon—some of them as large as Central American countries—are demonstrating local leadership in reducing deforestation and establishing themselves as places from which businesses wanting to guarantee the sustainability of their raw-materials sourcing can buy with confidence. This is the objective of the Pará state government's "green municipalities" program, for example, which is now being financed through the Amazon Fund. The fund in turn has been receiving money through the pay-for-performance compensation provided by Norway through its bilateral REDD+ agreement with Brazil's federal government.

The Brazil-Norway agreement is the largest REDD+ program anywhere in the world.

International Support

The Brazil-Norway agreement is the largest REDD+ program anywhere in the world, and it has already provided $670 million in compensation for the reductions made in the first few years after its signing. Rather than requiring detailed measurements for verification of how much emissions have been reduced, it uses the data on deforested area already being collected by the INPE, which takes the average 1996–2005 deforestation rate as its baseline and makes some simple, conservative assumptions: Amazon forest is assumed to contain 100 tons of carbon per hectare (although it is doubtless higher over most of the region), and the estimated reduction in emissions is paid for at a fixed rate of five dollars per ton of CO_2. Taken together, these two assumptions effectively mean that Brazil is receiving considerably less for its emissions reductions than if they were sold for credits on an international carbon market, and that the country is absorbing the majority of the opportunity cost itself (Boucher, Roquemore, and Fitzhugh 2013).

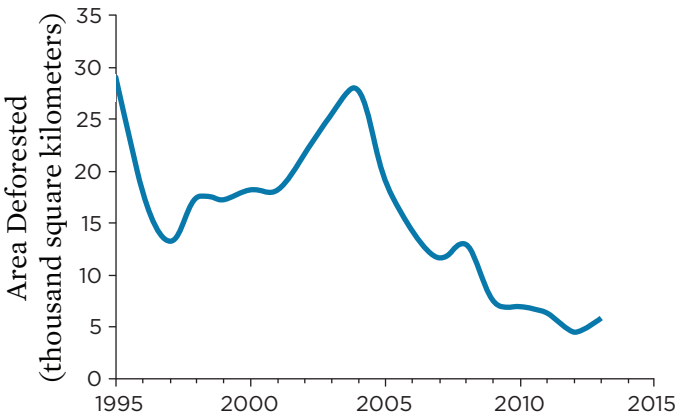
However, the importance of the REDD+ agreement with Norway is political and symbolic, not just financial. The same is true of Germany's support for early action in Acre and the United Kingdom's contribution of $70 million, as well as of programs in other countries (e.g.; Norway-Guyana; see Chapter 3). These agreements demonstrate the commitment of the international community to support tropical countries' efforts. In so doing, they help reinforce the political changes that led to increased action against deforestation in the first place.

The Public Prosecutors

A distinctive and very important role has been played in Brazil by the federal Public Prosectors' Office (an independent arm of government separate from the executive and legislative branches), which has the power to prosecute violations of the law. The lawsuits it has brought, often against politically powerful constituencies such as large rural landowners, have led—with the aid of advanced mapping and monitoring systems—to greatly strengthened enforcement of

> ***Brazil has inscribed its plan to reduce deforestation 80 percent by 2020 into national law. In the Amazon, reducing deforestation has already made a very large contribution to combating climate change—more than that of any other nation on Earth.***

FIGURE 3. Annual Deforestation Rate in the Amazon Region of Brazil



Deforestation in the Brazilian Amazon has dropped dramatically over the past decade, and remains low despite the small upticks in 2008 and 2013.

NOTE: Deforestation rate is measured in square kilometers of forest loss per year. Time frame corresponds to the "Amazon year" that runs from August through July, and results are based on the analysis of the PRODES program.

SOURCE: BRAZILIAN NATIONAL INSTITUTE FOR SPACE RESEARCH (INPE), ONLINE AT *WWW.OBT.INPE.BR/PRODES/INDEX.PHP.*

existing laws (Assunçao, Gandour, and Rocha 2013; Walker, Patel and Kalif 2013; Aguiar et al. 2012).

These actors have also reached settlements with other entities in the supply chains driving deforestation, such as the slaughterhouses and exporters (to whom most beef is sold), that require them to know the boundaries of the ranches from which they are buying beef. This information, overlaid with the deforestation data from the INPE, makes it possible to ascertain which ranches are deforesting and exclude them from the supply chain.

The prosecutors also play a role in mediating disputes over forest and land between different claimants, including indigenous peoples. Actions by the public prosecutors have thus created mutually reinforcing pressures both on business and government entities, strengthening the cattle and soy moratoria and leading to important changes in business behavior (Assunçao, Gandour, and Rocha 2013).

The Future

We have told of just a few of the elements that contributed to Brazil's dramatic reductions in deforestation and global warming emissions. Others included increases in productivity among the industries driving deforestation (Walker, Patel, and Kalif 2013; Macedo et al. 2012), development of new kinds of protected and sustainable use areas both at the federal and state levels (Ricketts et al. 2010), and many other efforts large and small. However, two changes in 2013 cast doubt about the future of Brazil's success: amendments to the Forest Code that provide amnesty for previous deforestations (Tollefson 2013), and data showing a 28 percent increase in the 2012–2013 deforestation rate compared with 2011–2012 (Figure 3).

Does this upswing indicate that Brazil's progress in reducing deforestation has ended? Or is it a temporary reversal, similar to the one seen in 2008, after which the downward trend resumed?

At this point it is simply too soon to tell. However, Figure 3 helps put the data in perspective. Although the increase in 2013 was 28 percent compared with the previous year, that percentage change was high because deforestation had already been reduced to a low level. Even with this rise, the 2013 figure was 9 percent below that of 2011 and 70 percent below the 1996–2005 average.

Brazil has inscribed its plan to reduce deforestation 80 percent by 2020 into national law (Government of Brazil 2009), but for continued progress to occur it will need to redouble its efforts at reducing emissions. Meanwhile, its reduction in Amazon deforestation has already made a very large contribution to combating climate change—more than that of any other nation on Earth. For this accomplishment, Brazil can rightfully be very proud.

Keeping Deforestation Low in Guyana to Help Prevent Global Leakage

When there is international leakage—that is, when deforestation decreases in one country but increases similarly in another—then there has not been any net reduction in global warming emissions (Boucher and Elias 2013). A particular way this can happen is through trade, which often exports deforestation (Meyfroidt, Rudel, and Lambin 2010; Minang et al. 2010).

The concern about international leakage is the underlying reason for paying attention to what is happening in countries such as Guyana, where deforestation rates are close to zero and large amounts of forest remain. Such "High Forest, Low Deforestation" (HFLD) countries, which have not yet begun the forest transition, are potential destinations of leakage. They are places to which deforestation might move in the future, as the agents of deforestation shift away from countries and regions where it is no longer so profitable.

Guyana, in the northeastern part of South America, is a small nation in population, with about 750,000 people living along its Atlantic coast. But inland, Guyana has large expanses of forest that extend southward to the Brazilian border and cover about 87 percent of its territory. The deforestation rate in recent years has been very low, estimated to have been around 0.03 percent annually from 2000 to 2009, driven mostly by the mining sector (CEED Knowledge 2013).

To prevent leakage and demonstrate the role of HFLD countries in a global REDD program, Guyana and Norway created a partnership in 2009 whose goal is to promote development in Guyana without an increase in deforestation (Government of Guyana 2013; Donovan, Moore, and Stern 2012). Here success is not defined as a reduction in emissions—already close to zero—but rather as keeping emissions low while the nation develops. If the deforestation rate rises significantly above the historical average, the Norwegian funding will drop drastically.

The partnership, with funding of up to $250 million over five years, compensates Guyana in proportion to its success in

Former President of Guyana Bharrat Jagdeo briefs press at the United Nations on the high-level event "Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD)" in September 2009. Guyana sets an important example in a global REDD framework as a High Forest, Low Deforestation country.

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Guyana's tropical forests cover 87 percent of its territory, and its main success has been keeping its deforestation rate very low, rather than reducing deforestation. Pictured: Kaieteur National Park in central Guyana.

keeping its deforestation rate low. These performance-based payments—made only after success is verified—are used for low-carbon development projects and for programs that involve the legal recognition of, and the awarding of official land titles to, Amerindian communities in the interior of the country. Although they are only a small proportion of Guyana's total population and not agents of deforestation, Amerindian groups are a key element to the partnership's success because they are the traditional inhabitants of the country's forests. In line with the principle of free, prior, and informed consent (FPIC), the 100-some Amerindian communities of Guyana will have the right to accept or reject participation in the national REDD+ program (CEED Knowledge 2013; Fook 2013; Donovan, Moore, and Stern 2012).

One of the problems in implementing the Guyana-Norway agreement arose from the financial payments having been set up with the World Bank as a trustee. Due to bank concerns about accountability, the flow of money from Norway to Guyana was initially delayed for many months, even after the verification of continued low deforestation rates during the first two years of the agreement (0.06 percent in 2009–2010, 0.05 percent in 2010–2011) (CEED Knowledge 2013). However, payments have now begun to flow, and Guyana has been earning money for its success in keeping deforestation low (e.g., $74 million, almost 3 percent of GDP, for the October 2010–December 2011 period) (Government of Norway 2012).

> ***In Guyana success is not defined as a reduction in emissions—already close to zero—but rather as keeping emissions low while the nation develops.***

Some aspects of Guyana's planned actions, such as FPIC with Amerindian communities, seem to have been well implemented (CEED Knowledge 2013), while others have been criticized both internally and externally—e.g., continued forest degradation (although Guyana is laying out a road map of actions to control illegal logging) and lack of democratic management and transparency (Fook 2013; Donovan, Moore, and Stern 2012). But in terms of its fundamental objectives—to keep Guyana's deforestation low, with its forests continuing to sequester carbon, while resources are provided for low-carbon development—the partnership clearly seems to be working.

Working with Local Communities to Protect a Forest Corridor in Madagascar

Madagascar is known throughout the world as the home of unique animal species—lemurs, indris, sifakas, tenrecs, aye-ayes, and many more (Mittermier et al. 2010)—with appearances and behavioral patterns as exotic and varied as their names. Madagascar's flora is equally unusual, with hundreds of varieties of rare orchids, and three times as many palm species as can be found on the entire African continent. But many of Madagascar's unique species have declined drastically since people first settled the island nation some 2,000 years ago. This is due primarily to widespread deforestation in the country's three regions: the rain forests of the east, the dry spiny forests of the west, and the central highlands. By the twenty-first century, only about 16 percent of Madagascar's land remained in forest cover.

In 2003, President Marc Ravalomanana made a commitment to triple Madagascar's land area under protection, covering about a tenth of the country—or more than 60,000 square kilometers, an expanse larger than Switzerland. At that time, the government gave provisional protected status to a large swath of land called the Ambositra-Vondrozo Corridor (COFAV) in southeastern Madagascar, where the main economic activities are cattle grazing, timber cutting, and the cultivation of rice, coffee, and bananas. This corridor was selected because its forests are rich in biodiversity and also because it serves as a connection between existing lowland and highland protected areas. The corridor also has an important role in watershed protection, because it includes the headwaters of some 25 different rivers.

> ***Instead of declaring this protected area off-limits to any production, the effort aimed to create sustainable economies within the corridor that included nearby local communities as project managers.***

Starting in 2007, the corridor program undertook a new approach to conservation, as part of a cooperative effort between the government of Madagascar and Conservation International (an NGO), with funding from the United States government and private sector. Instead of declaring this protected area off-limits to any production, the effort aimed to create sustainable economies within the corridor that included nearby local communities as project managers (VCS 2013a). That is, the corridor was planned to include not only strict protected areas but also sustainable-use forests and settlement enclaves. Also novel was the idea of getting voluntary REDD+ funding for communities from the international sale of carbon credits, once reductions in emissions from deforestation were documented.

Although the formal establishment of the COFAV as a 285,000-hectare protected area was critical for its success in reducing deforestation, actions at the community level have been just as important. These included:

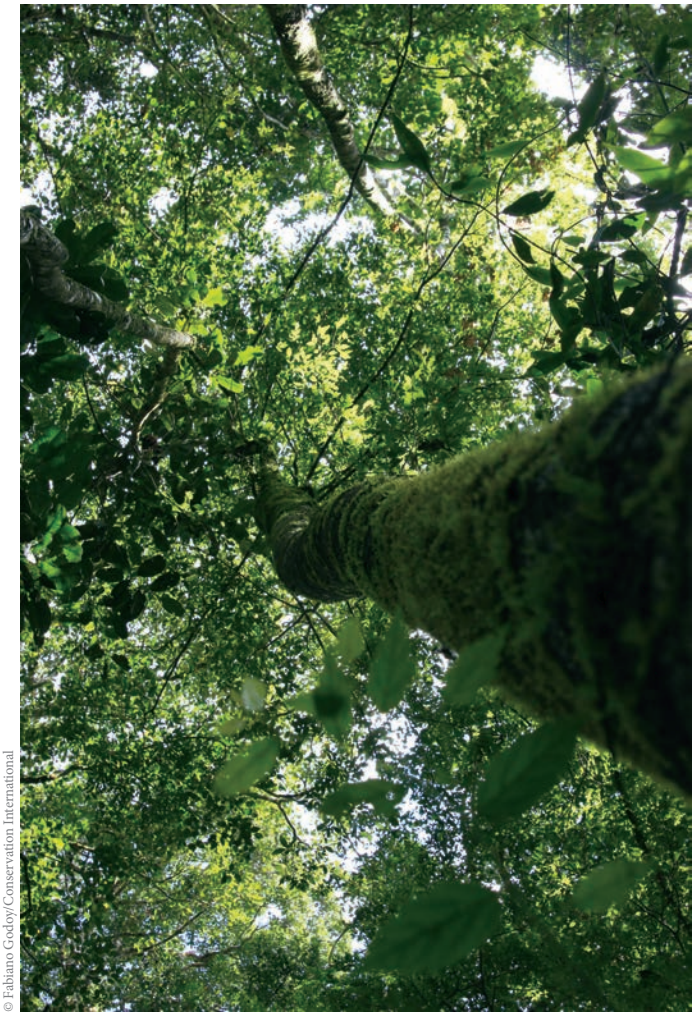
- Establishment of a multi-stakeholder co-management approach, in which communities created structures to incrementally take on operation of the project. Conservation agreements tied environmental performance to incentives and provided the indicators needed to adjust management policies, if needed.
- Legal management rights, which were delegated to communities based in the various zones of the reserve.
- Technical and financial assistance for community activities, including peer-to-peer extension, so that farmers could share sustainable agricultural practices. Grants were provided for sustainable economic projects such as agroforestry, tree nurseries, and ecotourism.
- An integrated health, population, and environment program, which provided local communities with access to health services, including nutrition, hygiene, water, sanitation, and family planning.

Taken together, these activities were successful in reducing deforestation and its resulting global warming emissions. In October 2013, third-party analyses determined that the COFAV reserve had reduced carbon dioxide emissions by some 2.2 million tons between 2007 and 2012. Baseline carbon dioxide emissions were calculated to be about

In October 2013, third-party analyses determined that the COFAV reserve had reduced carbon dioxide emissions by some 2.2 million tons between 2007 and 2012.

Community activities—such as peer-to-peer farmer extension and grants for agroforestry and tree nurseries—have been an important aspect of Madagascar's reductions in deforestation. The Tolonguina Commune, pictured above, is in the heart of the Ambositra-Vondrozo Corridor.

Community forest management has also been recognized as a key building block for reducing emissions throughout the rest of Madagascar.



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The COFAV reserve connects existing lowland and highland protected areas and includes the headwaters of 25 different rivers. Between 2007 and 2012, the reserve has managed to reduce carbon dioxide emissions by approximately 2.2 million tons.

812,000 tons of CO_2 per year, while measured emissions over the 2007–2012 period averaged just 367,000. Estimates of leakage to surrounding areas showed that it had actually dropped compared with baseline levels (VCS 2013b).

The current arrangement for the COFAV corridor is designed to remain in effect for 90 years (VCS 2013a). In addition to continued documentation of emissions reductions, verification is expected to include measured benefits to the local communities and forest biodiversity, using the international Carbon, Community, and Biodiversity Standards.

What explains the success of COFAV? One key factor was certainly the national government's political will to designate new protected areas and serve as sponsor of a project using the Verified Carbon Standard, an internationally recognized system for evaluating the credibility of carbon credits. Madagascar's government also stepped in with enforcement actions to address the threats from illegal miners and loggers (USAID 2009); actions by the Ministry of Waters and Forests and the Ministry of Mines were swift in response to these threats. Enforcement actions included field visits to areas where illegal activity was occurring, communication efforts that explained the rules governing different parts of the corridor and called for an end to illegal activities, and fining perpetrators. Further, the federal government undertook additional rural development efforts in conjunction with much of the conservation work, which helped create sustainable economies. For example, the government helped improve telecommunications in the area. Identification of the drivers of deforestation, and creation of viable alternative incomes to those activities, also were significant.

Importantly, community commitments were vital to the corridor's success as well. The program emphasized the importance of identifying the multiplicity of local players and creating inclusive management plans. This meant giving rights to forest-dwelling peoples and developing community associations that could implement sustainable management plans. Such community forest management has also been recognized as a key building block for reducing emissions throughout the rest of Madagascar (Ferguson 2009).

The use of a combined approach—neither wholly top-down nor bottom-up, but some of both—also proved important to the project's longevity. The corridor continued to evolve even with the overthrow of the elected federal government; following a series of demonstrations, a coup d'état removed President Ravalomanana from office in March 2009. A new constitution was adopted by referendum in 2010, followed by presidential elections at the end of 2013. Despite these conflicts and disruptions, COFAV carried on its work in slowing deforestation, reducing global warming emissions, and bringing economic development to the region.

Using Carbon and Wildlife Credits to Protect the Kasigau Corridor in Kenya

Foreigners commonly associate East Africa with spectacular wildlife, human origins, and the (diminishing) snows of Kilimanjaro, but the region's hills and mountains—specifically, the Eastern Arc that extends from southwestern Kenya across Tanzania—are also one of the global centers of biodiversity (Platts et al. 2011). This diversity includes not only charismatic nocturnal primates such as galagos but also more than 20 species of endemic African violets (*Saintpaulia*)—i.e., the wild ancestors of some of our most common houseplants.

> ***Kasigau is also the location of one of the longest-running private efforts at large-scale conservation in Africa.***

Named after Mount Kasigau, which emerges from the East African plains between Kenya's Tsavo East and Tsavo West National Parks and rises to 1,641 meters, the Kasigau region is mostly what is called bushland. In ecological terms, 86 percent of the area is *Acacia-Commiphora* dryland forest (Code REDD 2013). This refers to its dominance by relatively small trees and shrubs, without a closed canopy. The *Acacia*s are thorn trees of several species, while *Commiphora africana* is the African myrrh, related to the medicinal plant traditionally believed to have been the source of the gift brought to the baby Jesus by the wise man Balthasar.

© LisaKristine.com/Courtesy of Wildlife Works Carbon

Revenue from the sale of voluntary carbon credits in the Kasigau Corridor go back to local landowners or support side projects in the area, such as a clothing factory and school classrooms.

Kasigau is also the location of one of the longest-running private efforts at large-scale conservation in Africa. Originally established in the late 1990s to provide a corridor for elephant migrations between the two Tsavo National Parks, it has been expanded in the past decade into a REDD+ program as well, designed to protect the carbon stock of about 200,000 hectares of woodland and dry forest (Dinerstein et al. 2013).

> ***By late 2012, revenues from the sale of voluntary carbon credits had already reached $1.2 million.***

In the first phase of the conservation project, emissions were reduced by providing alternatives to slash-and-burn farming. This included not only changes in agricultural practices but also jobs outside of agriculture (Wildlife Works 2011a). In the second phase, the main focus has been on the land that was previously leased out to cattle ranchers, who were instead paid to lease the carbon rights to their land to Wildlife Works—the organization managing the project (Wildlife Works 2011b). The landowners receive about a third of the proceeds from carbon credit sales.

Wildlife Works Carbon, the firm managing this project, is a for-profit company. It works to obtain carbon credits as a tool to protect biodiversity and promote rural development in a variety of countries. Startup funding for its work came from the large multinational bank BNP-Paribas and, beginning in 2011, it has earned revenue from the sale of carbon credits, which are based on emissions reductions certified under the Verified Carbon Standard (VCS). This was the first REDD+ project to receive such certification (Dinerstein et al. 2013). By late 2012, revenues from the sale of voluntary carbon credits had already reached $1.2 million.

Wildlife Works Carbon has used these funds for the direct carbon payments to local landowners and to support side projects that it designs and operates in the area, such as a clothing factory that employs local men and women and the construction of 20 school classrooms. The revenue also goes toward employing staff whose work directly supports the conservation and carbon-credit aspects of the conservation project, including a Kenyan biologist who oversees the social and environmental monitoring work and the rangers who patrol to prevent wildlife poaching and illegal grazing and tree cutting (Dinerstein et al. 2013).

Economically, an important aspect of the project is that the carbon credits reflect not only the carbon value of the forest but also conservation values verified under the Climate, Community, and Biodiversity Standard —a "wildlife premium"—which increases the attractiveness of the carbon credits. In the future, Wildlife Works Carbon may even increase the cost of its carbon credits because of the wildlife benefit they provide, which could be helpful in this relatively low-carbon region—being an ecosystem with sparser tree cover, the *Acacia-Commiphora* woodland has less carbon in its trees than the dense rain forests of other parts of Africa.

A study of the Kasigau corridor project's governance found that there is currently widespread support for the project among local community members (Atela 2013) and that although the project developers are from outside the community, the key players in Wildlife Works Carbon had been working in the region for almost a decade before the project started. This presence in the area helped them gain significant community support for the array of activities associated with reducing deforestation. Further, the work of monitoring and enforcement has been done by community members, which not only strengthens support for the project but also provides additional economic benefits.

The Kasigau corridor seems to have been a success both in economic and environmental terms. While many of the techniques used in this case may offer promise elsewhere, it is also true that some of the conditions that made it possible may not be readily duplicated in other areas. These conditions included the many years of investment before emissions reductions became a basis for financing, the critical need to create a corridor between preexisting national parks, and the possible additional interest from investors due to the presence of charismatic wildlife species such as elephants, lions, and cheetahs.

Community Management for Reforestation in India

India is one of only a few countries in the world to reverse their once-high rates of deforestation, stabilize forest cover, and reduce emissions from land use change (Sharma and Chaudry 2013). Passing through the bottom of the forest transition curve and moving into a period of net reforestation, however, was no accident. Innovative policies, beginning in the late 1980s, drove action at all levels of Indian society from the national government to rural communities. When afforestation (conversion of previously unforested land to forest) and reforestation were set as a national priority, thousands of communities nationwide were enrolled in decentralized forest management programs, setting the stage for a remarkable turnaround in deforestation.

The world's second-largest country in terms of population, India has incredibly diverse forest ecosystems, ranging from tropical mangrove swamps along its coast to alpine forests in the Himalayan Mountains. For more than 150 years these forests were under assault. Policies first developed in the colonial era promoted the commercial use of forests over conservation or the preservation of biodiversity, resulting in severe deforestation and degradation.

Reliable overall data on India's forests prior to 1980 are scarce. However, the first report from the Forest Survey of India in 1987 estimated that India had lost approximately 4.34 million hectares (or 12 percent of its total forested area) between 1951 and 1980 and that in 1983 the country's forests covered 64.2 million hectares (Government of India 1987). India began to reverse its deforestation trend in the 1990s. Forests now cover 68 million hectares (FAO 2010), with the rate of forest change currently at 0.21 percent annually (the positive number indicating net forest growth). Between 2005 and 2010, India added 145,000 hectares of forest area per year (FAO 2010). The country's land use, land use change, and forestry (LULUCF) sector is a net carbon sink, sequestering 177 million tons CO_2eq as of 2007. This is a marked improvement from 1994, when the LULUCF sector contributed 14.3 million tons CO_2eq to India's global warming emissions annually (Kishwan, Pandey, and Dadhwal 2009).

> ***Innovative policies, beginning in the late 1980s, drove action at all levels of Indian society from the national government to rural communities.***

India's forests are still under tremendous pressure, however. A large proportion of the nation's land is devoted to agriculture (43 percent, or about 142 million hectares), it has a very high density of livestock, and India is one of the most densely populated countries in the world (with only 0.06 hectare of forest area per capita) (Pande and Pandey 2004). How then has India been able to curb its deforestation and actually *re*forest?

A key element in India's success has been legislation (especially the National Forest Policy Act of 1988) that made the preservation of forests a national priority. India was slow in recognizing the value of preserving forests, focusing heavily

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Farmers from Madyapur, India, plant poplar saplings in the margins of their field. Due to joint forest management programs and aggressive reforestation efforts, India's forest cover has been steadily increasing since the 1990s. India plans to further increase forest cover by 5 million hectares between 2012 and 2022.

> ***India's land use, land use change, and forestry (LULUCF) sector is a net carbon sink, sequestering 177 million tons CO_2eq as of 2007.***

on timber as a commercial commodity while restricting village access to forest resources. But driven in part by the growing Chipko environmental movement of the late 1970s (a program of organized resistance in which, for example, villagers literally hugged trees to prevent their felling), the government began enacting new legislation to stem severe deforestation.

India's landmark National Forest Policy of 1988 reversed the country's traditional prioritization of commercial plantations by emphasizing the importance of conservation and local engagement with forest management. The policy went so far as to state that, "The derivation of direct economic benefit must be subordinated to this principal aim [of environmental stability and ecological balance]" (Government of India 1988). Most important, this policy paved the way for decentralized forest governance (through joint forest management [JFM] programs) and brought an end to the "commerce era" of Indian forestry.

Currently more than 22 million hectares of forest are managed cooperatively by community groups and state governments under the country's JFM program (Nayak and Berkes 2008). Now one of the world's largest community forest initiatives, with more than 106,000 participating villages, this program was first introduced in 1990 on the heels of 1988's National Forest Policy Act. India had been enacting small social forestry programs since the 1970s—for example, by distributing seeds for planting in vacant areas—but these projects were generally seen as a way to protect plantation forests *from* local villagers rather than as an empowerment

or joint management effort (Pande and Pandey 2004). Joint forest management took a different direction. It built on these initial programs under the assumption that the participation of local village communities, in partnership with the state Forest Department, was necessary for the preservation and regeneration of forests.

JFM programs are implemented at the state level, thus resulting in a diversity of institutional mechanisms. But they have some common elements. Village committees generally create, together with an officer from the state's Forest Department, a localized micro-plan for forest management (Ravindranath and Sudha 2004), and they cooperate on program implementation and monitoring. Villages receive a share of the income from timber and non-timber forest products (NTFPs) that are harvested from the area, with a portion of the proceeds going to the state government as well. These economic benefits accruing to the community are crucial for incentivizing effective collective management. "Social fencing" is the main mechanism through which forests are protected. Members of village forestry groups prevent forest access by outsiders to prevent illegal logging, fires, or poaching of NTFPs.

The implementation of JFM has been critiqued in many areas, however, for being a seemingly top-down approach in which the Forest Department, rather than the local community, holds most of the decision-making power (Sarker 2009; Kashwan 2006).

Important for the climate impacts of these programs, India's reforestation hasn't translated into the displacement (otherwise known as leakage) of deforestation to neighboring countries, which could undermine the programs on a global scale. Meyfroidt, Rudel, and Lambin (2010) conclude that while India's population, consumption, and forest cover have increased together, it has also been able to produce more grain and dairy to meet domestic and international demand (from other Asian countries). India was an early adopter of "green revolution" seeds, which resulted in a significant increase in crop productivity.

There are legitimate concerns that India's successes in reforestation and community management are only superficial. Recent analysis suggests that the country's native forests are continuing to decline, with the visible growth in forest cover deriving from the establishment of tree plantations rather than growth of natural forests (Puyravaud, Davidar, and Laurence 2010). Degradation is also a serious problem that still needs to be addressed, with approximately 40 percent of India's forests already degraded (Aggarwal, Paul, and Das 2006). Much of this degradation stems from the felling and thinning of forests for fuelwood, which a majority of rural Indians use for energy (Pandey 2002).

The Mission for a Green India (otherwise known as GIM)—the federal government's latest forest policy initiative under the National Plan on Climate Change—is a promising step toward forest preservation and emissions reductions. With afforestation and reforestation as a dominant climate mitigation priority (Vijge and Gupta 2013), the initiative continues India's aggressive forestry efforts with plans to add 5 million hectares of forest between 2012 and 2022. Importantly, the mission will shift focus to the *density and quality* of existing forests, with plans to restore an additional 5 million hectares of degraded forests.

The Mission for a Green India is a promising step toward forest preservation and emissions reductions.

The government estimates that the Mission for a Green India will increase the share of global warming emissions offsets from forests by 1.5 percent (from 4.5 percent of India's emissions in the absence of the mission to 6 percent of emissions with it). Many see the GIM as a critical component for India's long-term REDD+ strategy—especially given the country's plan to devote nearly $8.5 billion (US) to GIM and the fact that a large number of afforestation and reforestation measures under GIM may be REDD/REDD+ eligible (Vijge and Gupta 2013).

India's forest transition is especially remarkable in light of the intense pressures on its natural resources, given that it is a rapidly developing country. While much of its success stems from a strong national climate change policy, India's story also shows how the engagement of local communities in sustainable resource management can prove to be an effective way to protect forests and mitigate emissions. Most notably, India's divestment of forest management to local communities has allowed for positive changes across the country's diverse landscape, with empowered localities able to make the best management decisions for their own particular forests.

Paying for Ecosystem Services in Mexico

Mexico is renowned internationally as a leader in the global effort on climate change. This was dramatically highlighted in December 2010, in the tumultuous conclusion of the U.N. climate negotiations in Cancún. After tense days of stalemate, Mexico's Minister of Foreign Affaris Patricia Espinosa, presiding over the final middle-of-the-night session, pushed through the decisions that became the Cancún Agreements to loud cheers and a prolonged standing ovation.

This and other actions by Mexico, both international and domestic, have been recognized as showing "great leadership and a strong commitment to addressing climate change" (OECD 2012). For example, the country has committed to cutting its global warming emissions in 2050 to half the level of 2000 (Figure 4). It has also set an interim target of a 30 percent cut by 2020 and included this pledge both in the Cancún Agreements and in its own 2012 General Law on Climate Change (OECD 2012). Yet we are left with questions. Have these diplomatic and legislative actions been matched by actions on the ground? What has happened to land use in Mexico, and to the global warming emissions generated by deforestation? The evidence shows that with respect to forests, Mexico's accomplishments have been just as notable as its commitments.

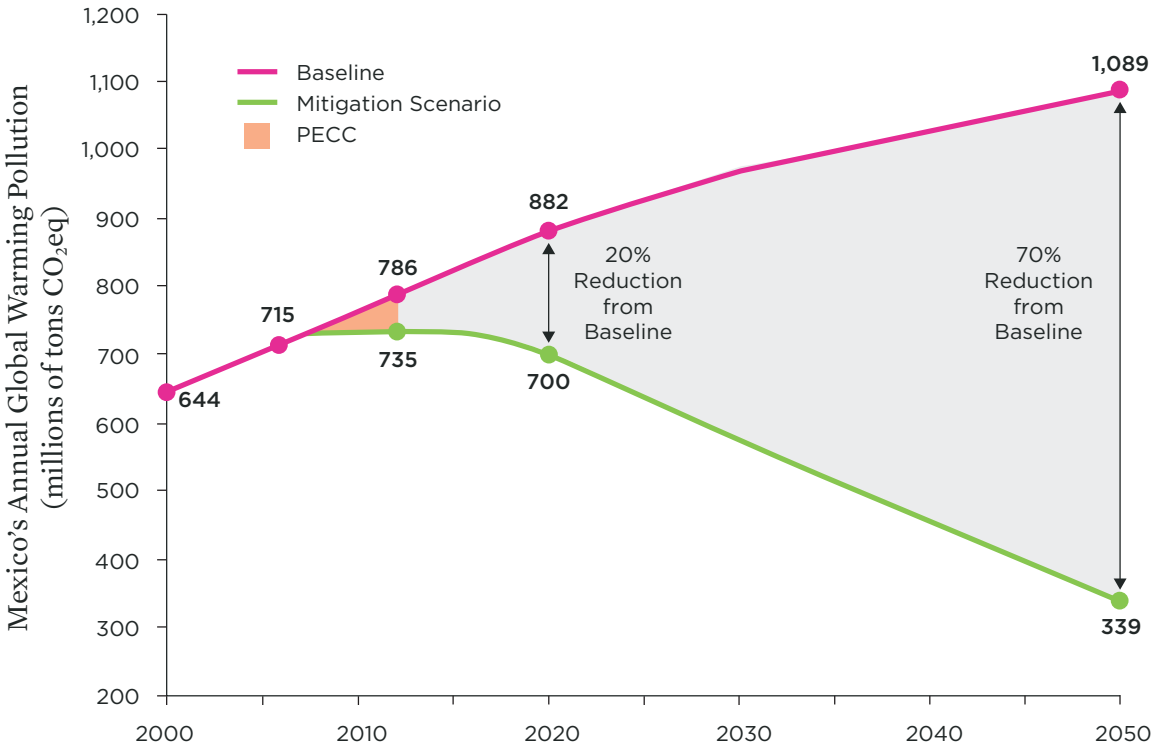
Since Mexico joined the OECD—the traditional "rich countries club" of industrialized nations—it has been subject to periodic environmental performance reviews by its fellow member countries. Mexico's most recent review, 178 pages long, provides abundant data on many aspects of its progress toward achieving environmental goals. Its data show that Mexico has reduced its rate of loss of primary forests dramatically—from more than 2 percent annually in the 1990s to just 0.13 percent in the 2005–2010 period (Figure 5, p. 26).

Patricia Espinosa (at right), then Mexico's Minister of Foreign Affairs and President of the UN's Climate Change Conference (COP 16), greets U.N. Secretary-General Ban Ki-moon at the opening of COP 16 in Cancún, Mexico, in 2010.

As one would expect, this reduction in deforestation has led to a substantial decrease in the emissions of CO_2 from Mexican forests. The rate of loss of total forest carbon stock has been cut in half, from 5.1 percent per decade in the 1990s to 2.6 percent per decade in the 2000s (FAO Forestry Department 2010).

Some of the strategies that Mexico used to achieve this reduction are decades old and have been applied in many countries. For example, federally protected areas were expanded considerably over the last decade. By 2010 they totaled 12.9 percent of Mexico's land area (OECD 2012). There has also been increased enforcement of laws against illegal hunting of wildlife, support for reforestation projects, and in 2012 the adoption of a National Ecological Land Use

FIGURE 4. Mexico's Commitment to Emissions Reductions through 2050, from Its Special Program on Climate Change (PECC)



Mexico has pledged to reduce its emissions of global warming pollution dramatically through 2050, not only in comparison to the business-as-usual baseline but also in absolute terms.

SOURCE: COMISIÓN INTERSECRETARIAL DE CAMBIO CLIMÁTICO 2009.

Plan. But the most far-reaching and novel effort is the Payment for Environmental Services program (PSA), which covers 3.4 million hectares—more than 5 percent of Mexico's total forest cover (Shapiro-Garza 2013).

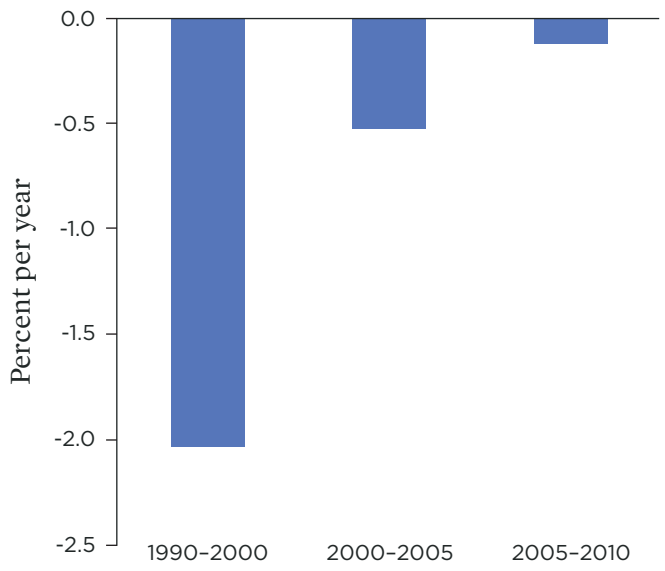
The changes in the PSA over the years show that while policies don't always get implemented in the way their designers intended, they might nonetheless work well. Initially, the PSA was supposed to transition into a market in ecosystem services, which would channel payments from the users to the providers of environmental goods such as clean water, biodiversity protection, and the mitigation of climate change. It also was intended to incentivize forest conservation and to produce a change in communities' perception of natural resources.

As noted by the OECD, "Ecosystem service providers in Mexico are predominantly *ejidos* (communal property)." This system of land tenure, established by the Mexican Revolution in the early twentieth century, remains predominant in rural areas despite recent government pushes for privatization, and it is especially important in indigenous areas and other traditionally marginalized parts of the countryside (Shapiro-Garza 2013).

The first two components of the PSA, dealing with water and carbon, were established in 2003 and 2004, respectively, and combined in 2006 into "ProÁrbol," which included not only the PSA but also the Sustainable Community Forestry program and other components. Between 2003 and 2011 nearly half a billion dollars was paid to 6,000 participating entities. Almost all of the money came from the federal government, supported by substantial loans from the World Bank. But the government as the source of money was seen as a temporary expedient until private consumers of ecosystem services—e.g., downstream water users, buyers of carbon market credits—could take over (Shapiro-Garza 2013).

Given a limited budget (less than could cover all the land that would be eligible for payments), a priority system was needed. Moreover, in line with the goal of moving toward markets for ecosystem services, even the initial government

FIGURE 5. Annual Rate of Change in the Area of Primary Forest in Mexico from 1990 to 2010



Mexico has reduced the rate at which its primary forests are being lost more than ten-fold since the decade of the 1990s.

SOURCE: OECD 2012, FIGURE 5.2.

payments were intended for those who could deliver the services most efficiently, not to those who needed the money the most. This was quite consistent with the underlying economic approach and considerations such as additionality (see Chapter 1), and the OECD, the World Bank, and other financial institutions have continued to recommend targeting "areas with high biodiversity benefits, high risk of loss (to ensure additionality), and low opportunity costs" (OECD 2012).

However, this market-based point of view conflicted with the traditions of the Mexican Revolution, which developed programs of government support for rural communities on the basis of need. Poor and marginalized groups, especially indigenous peoples, had often received direct and indirect subsidies to *ejidos*. By this concept, poverty alleviation—rather than the development of efficient markets—should be the basic goal of government payments to the rural sector (Shapiro-Garza 2012).

The outcome, so far, is that the economists' vision has lost out. This is due partly to the political strength and effective mobilization of rural movements and their urban allies. But it also reflects the fact that the markets that were supposed to take over from the government as the source of ecosystem services payments simply have not materialized (Boucher and Elias 2013; Shapiro-Garza 2013). There is no international carbon market of businesses buying forest credits to comply with emissions restrictions (those that exist, such as the VCS defined in Chapter 5 and illustrated in Chapters 4 and 10, are small and mostly voluntary), and few downstream cities have wanted or needed to pay communities in their watersheds for what they used to get for free. For biodiversity, it is not clear how the service is going to be measured, let alone how it can be packaged for sale to private businesses.

Thus the Mexican federal government has continued to be the source of ecosystem services payments targeted on the basis of social criteria—not of additionality and low opportunity costs. Most of the lands receiving PSA payments were not considered to be at high risk of deforestation, so by a strict economic interpretation the payments cannot be credited with protecting them. Indeed, the OECD has argued that between 2003 and 2007, of the 1.8 million hectares enrolled in the water part of the PSA program, only 18,000 were prevented from being deforested (OECD 2012). In this narrow view, then, the program has been an inefficient use of money.

Yet as Shapiro-Garza (2013) has pointed out, in 94 percent of PSA sites the recipients of payments chose to invest a significant part of the money in forest management actions, even if not obligated to do so by their PSA contracts. These have included firebreaks, firefighting equipment, measures to control pests and diseases, fencing to keep livestock out, and patrols to guard against illegal logging and poaching. Thus a broader view of the PSA program suggests that it has encouraged actions that have reduced the rate of deforestation—just not for contractual, market-compensated reasons. So although one of the principal market-based tools designed to reduce global warming pollution has worked differently from its original conception (Shapiro-Garza 2013), the results have nonetheless been quite impressive.

> ***Mexico is a world leader on climate change—not only in the political arena but on the land as well.***

Mexico now seems to be rapidly passing the low point of the forest transition (see Introduction), taking actions that protect and restore forests and thus reduce emissions of global warming pollution. The country is a world leader on climate change—not only in the political arena but on the land as well.

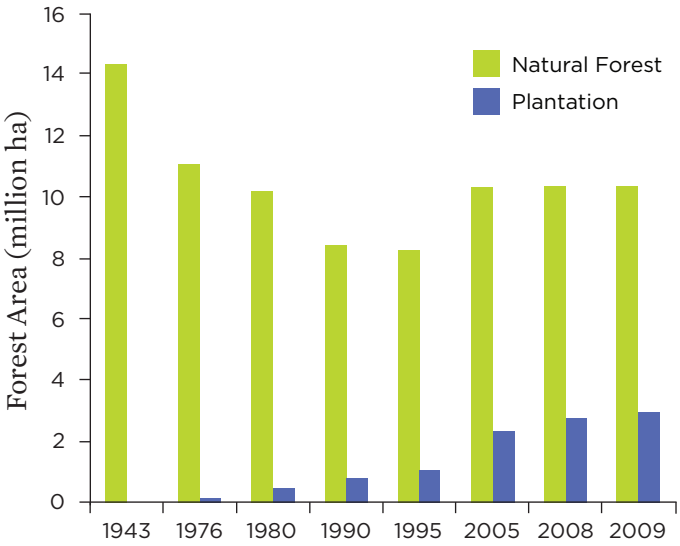
Reforesting While Agriculture Grows in Vietnam

During the 1990s and 2000s, after decades of decline, Vietnam's forests began to increase in area (Figure 6). This growth came from both an ambitious program of afforestation and some recovery of natural forests (Pham et al. 2012). Thus the country has passed the low point of the forest transition curve in the past few decades and begun the climb upward (Meyfroidt and Lambin 2009).

One of the interesting characteristics of Vietnam's turnaround in forest cover is that it has come during a period of strong growth in agricultural output and exports (Pham et al. 2012). Between 1995 and 2009, coffee exports grew from 248,100 tons to 1,184,000 tons and rubber exports from 138,100 tons to 731,400 tons. The export value of timber and timber products rose from $344 million in 2001 to $2.55 billion in 2009—a rate of growth of 28 percent annually. Vietnam has become one of the world's leading exporters of rice, coffee, rubber, and black pepper (Pham et al. 2012). All in all, the statistics indicate that growth has been directed in ways that render agriculture and forests compatible.

Vietnam's forest transition is often ascribed to three policies: the end of collective farming, the start of decentralization of control over forests in the early 1990s, and the Payment for Forest Environmental Services (PFES) program established in 2004. While these shifts have played important roles, in-depth studies of changes in rural areas show that the story is a lot more complicated. Moreover, detailed examination of trade trends have shown that some—but not most—of Vietnam's success has come from leakage (that is, "exporting deforestation" by importing needed timber from neighboring countries rather than growing the wood itself) (Meyfroidt, Rudel, and Lambin 2010; Meyfroidt and Lambin 2009; Meyfroidt and Lambin 2008). And while the overall forest trend is certainly a positive one, the numbers also conceal the fact that deforestation continues. Just 1 percent of Vietnam's primary forests remain, yet they continue to undergo some clearance, often illegally (Pham et al. 2012).

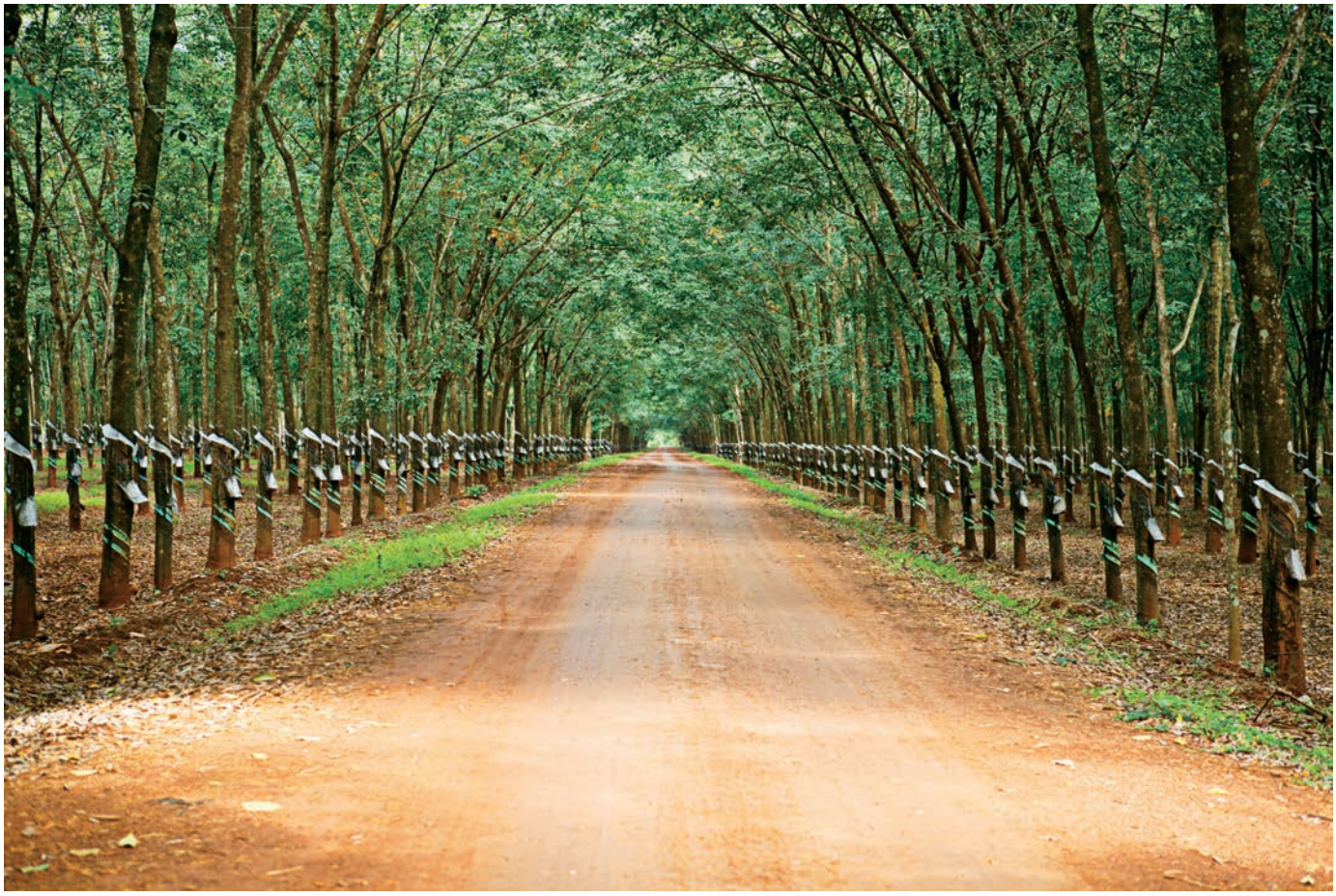
FIGURE 6. Changes in Vietnam's Forest Area from 1943 to 2009



The area of forest in Vietnam reached a low point in the mid-1990s, but has recovered since then. This is due to gains in both plantations and natural forests.

NOTE: Dates correspond to censuses and are not evenly spaced in time.

SOURCE: PHAM ET AL. 2012.



© iStockphoto/Ska_Zka

Vietnam has become one of the world's leading exporters of commodities such as rubber while simultaneously increasing its forest cover since the 1990s. This success can be attributed to smallholder agricultural intensification, aggressive afforestation efforts, and the Payment for Forest Environmental Services (PFES) program established in 2004.

However, there is little doubt that forest area has expanded and that the trend is reversing (Figure 6). While leakage explains about 40 percent of the increase (Meyfroidt and Lambin 2009), this still leaves 60 percent that is real growth—a glass that is more than half full. Agricultural land distribution and decentralization of control over forests since the 1990s seem to have combined to produce a "smallholder agricultural intensification" type of forest transition, in which farmers decrease their cultivation of hillsides and other marginal lands, many of which are subsequently reforested. Labor is concentrated on the more fertile soils, sometimes with new crops, and their agricultural productivity increases substantially. The result is that both agriculture and forests can expand simultaneously (Meyfroidt and Lambin 2008).

The PFES program has been widely adopted, and many rural families have received payments, but the amounts have generally been small (Sunderlin et al. 2013; Kolinjivadi and Sunderland 2012). Further, the program differs from the basic theory of PFES payments in some fundamental ways: much of the land enrolled in the program belongs to the state, so there is little real choice on whether to join the program, and the payments are seldom conditional on providing the environmental services or even protecting the forest effectively (Wunder, The, and Ibarra 2005).

Nonetheless, despite the departure from PFES theory (as in Mexico and Costa Rica; see Chapters 7 and 9), the program does seem to have encouraged reforestation and promoted rural development. It has also laid the groundwork for a REDD+ system with wide if not necessarily equitable distribution of benefits (Hoang et al. 2013).

Vietnam's recent history shows that rapid economic growth with an expanding agricultural sector is quite compatible with recovery of the nation's forests. Further, the changing pattern of land use is in broad terms a more ecologically sensible one, with agriculture concentrating on the best lands while the erodible hillsides are reforested. The causes of success do not always conform to economic theories or the expectations of policy makers, but the beginning of restoration of Vietnam's forests—during a period of rapid agricultural growth—is undeniable.

Making Costa Rica a Carbon-Neutral Country

Over the past quarter-century, the small Central American country of Costa Rica has reversed its trend of deforestation, moving from high rates of forest loss up until the 1990s to substantial recovery since then (Figure 7, p. 30).

Costa Rica is now well known around the world for its environmental leadership, giving it a role in international climate and biodiversity policy-making far greater than its small size (51,000 square kilometers, populated by just under 5 million people) would suggest. This renown as a "green nation" is the source of important economic benefits, bringing in millions of ecotourists per year who are the basis of a sizeable fraction of the country's income.

In recent years, Costa Rica has set itself a new and ambitious goal: to become a carbon-neutral country, with at least 100 percent of its global warming emissions balanced by carbon sequestration, by the year 2021. Part of Costa Rica's success thus far in moving toward this goal has come from favorable social and economic circumstances, but specific policies have also made important contributions. They include the promotion of ecotourism, large-scale expansion of protected areas and publicly owned forests, and an early program of payment for ecosystem services (PES) that has formed the basis for the country's current leadership on REDD+ (Kuper and Fernández Vega 2014; Corbera et al. 2011). These policies have not always worked out as planned, and by some criteria—e.g., the cost of preventing additional deforestation—they have been poor investments (Robalino and Pfaff 2013). But taken together, they have transformed the country's attitudes toward its land and natural resources in just a few decades, making the goal of carbon neutrality not only feasible but also a further source of national pride.

In some ways, Costa Rica confirms the generalization that social and economic development can be important in diminishing deforestation. It has the highest per capita income in Central America—about double that of most of its neighbors—and has shown the most substantial gains in forest cover in the region in the past decade. Notably, it is the only Central American country in which deforestation of its rain forests on the Caribbean coast was reversed in the 2000s, following an earlier transition to reforestation in the dry forests of the Pacific slope (Figure 7) (Redo et al. 2012). In other words, Costa Rica bears out the prediction of substantial net reforestation based on a high level of the Human Development Index, a measure that includes not only economics but also social measures of well-being such as education, health, and democratic governance (Redo et al. 2012). The country

Costa Rica has set itself a new and ambitious goal: to become a carbon-neutral country, with at least 100 percent of its global warming emissions balanced by carbon sequestration, by the year 2021.

FIGURE 7. Forest Cover in Costa Rica from 1940 to 2005

Costa Rica lost forest at a rapid rate through the 1980s, but reached a low point and began to recover in the 1990s.

NOTE: The original cartography was done by Costa Rica's National Forest Financing Fund, FONAFIFO.

SOURCE: U.N. ENVIRONMENT PROGRAMME 2009.

Costa Rica's forests, such as those on the Osa Peninsula (pictured), are an important source of economic benefits for the country. Forests also play an important role in the government's plan to be a completely carbon-neutral country by the year 2021.

now has more than 50 percent of its land in forest, up from just over 20 percent in the late 1980s (Kuper and Fernández Vega 2014).

In the earlier years of its recent ecological upswing, changes in international markets—often for the worse for the economy—led to some of Costa Rica's gains in forested land. The collapse of beef exports in the 1980s, for example, provided the opportunity and impetus for large-scale reforestation and expansion of protected areas in the northwest of the country—a region that had been dominated by cattle ranching since colonial times—as well as for reduction of deforestation pressures along the Caribbean coast (Meyfroidt, Rudel, and Lambin 2010). But in other social contexts these international market changes could have led to increased poverty in Costa Rica rather than ecological transformation. The democratic traditions and social progress of earlier decades—e.g., abolition of the army after the 1948 revolution and social spending close to 20 percent of GDP—provided the basis for support of environmental goals even as income from traditional agricultural exports such as coffee and beef declined (Redo et al. 2012).

> ***Costa Rica bears out the prediction of substantial net reforestation based on a high level of the Human Development Index.***

An early policy contributing to reduced deforestation was the expansion, beginning in the early 1970s, of conservation programs such as national parks. This has led to 21 percent of the country's forest now being in national parks and biological reserves, another 19 percent in forest reserves and wildlife refuges (many on private land), and an additional 10 percent in indigenous reserves (Corbera et al. 2011). Some of the protected areas extend all the way from the Pacific

coast through the mountain cloud forests and down to the Caribbean lowlands, encapsulating much of the range of biological diversity found in tropical habitats.

The expansion of protected areas attracted ecotourism and helped to reduce deforestation rates, but the country moved beyond traditional forms of conservation with the Forest Law of 1996, which included the national Payment for Ecosystem Services Program (PPSA) (Kuper and Fernández Vega 2014). The Forest Law substantially limits forest clearance, with the PPSA providing compensation to landowners who voluntarily enroll their forestlands in conservation programs or who regenerate already-cleared areas. It is funded by an energy tax, principally on fossil fuels, based on the "polluter pays" principle (Redo et al. 2012).

> ***The PPSA has contributed by reinforcing the political dynamic that made the Forest Law's restrictions on deforestation socially acceptable, and indeed politically popular.***

Although the PPSA is well known and has inspired ecosystem services payment programs in other countries, detailed studies have shown that in microeconomic terms, the payments did little to diminish deforestation. This is because most of the forests enrolled were in little danger of being deforested anyway. By the time of the enactment of the PPSA the country's deforestation rate was already quite low, so that on average only two of every 1,000 hectares of forest were going to be lost, regardless of whether their owners were paid or not. In policy terms, the program had very little additionality (Robalino and Pfaff 2013; see also Chapter 1).

Yet in a broader sense, the PPSA has contributed by reinforcing the political dynamic that made the Forest Law's restrictions on deforestation socially acceptable, and indeed politically popular. The same can be said of the commitment to carbon neutrality, which brings with it an economic cost in terms of foregone income in the short term. As one of the early leaders in selling carbon credits—the first sale took place in 1996, to a consortium of Norwegian energy companies (Kuper and Fernández Vega 2014)—and one of the two countries that proposed REDD+ at the international climate negotiations in 2005, Costa Rica is very well placed to make money by selling REDD+ credits.

There are a number of ways in which REDD+ could be funded. To date, most of the efforts have been funded through agreements that pay for emissions reductions, without giving the funders any carbon credits for the emissions reduced (e.g., Norway's agreements with Brazil and Guyana, Chapters 2 and 3). However, in the future REDD+ could be financed through offsets, which would allow the buyers to increase their emissions by an amount equal to Costa Rica's emissions reduction. Thus, in terms of carbon losses to the atmosphere, there would be no net change.

If REDD+ offsets were used to pay Costa Rica, its carbon neutrality would be a sham, as it would not have reduced global warming pollution but merely moved it to other countries. Thus to achieve real carbon neutrality in 2021, Costa Rica will have to avoid any offset payments for REDD+. The idea that Costa Rica may need to cancel some of its REDD+ credits is recognized in the country's national plans and legislation, by which it will effectively reduce its income in order to make carbon neutrality a reality (Kuper and Fernández Vega 2014).

Finally, a personal note. The lead author of this report, Doug Boucher, has witnessed Costa Rica's environmental progress since 1971, first working for its newly established National Park Service, then doing PhD research in Santa Rosa National Park during the late 1970s, teaching agroecology courses in the 1980s, and finally as a simple ecotourist in the 1990s and 2000s. The changes he has witnessed have been dramatic, but it is especially notable because in the early years there were real reasons to doubt whether Costa Rica's efforts would succeed. Having seen the importance of the determined leadership, often against great pressure, of conservationists such as Mario Boza and Alvaro Ugalde (the first two directors of the National Park System), Boucher well understands that forest transitions such as Costa Rica's are not the inevitable results of abstract socioeconomic trends. They happen because people make them happen, and those people deserve the world's thanks for what they have achieved.

Participatory Management in the Miombo Woodlands of Tanzania and Mozambique

The Miombo woodlands of eastern and southern Africa are characterized by a widespread type of seasonally dry deciduous vegetation that covers about 2.7 million square kilometers (Williams et al. 2008). They are called woodlands because the trees are not as tall or densely packed as in a forest; the canopy is not closed, so lots of light gets to the ground even in the wet season, when the trees have leaves.

Because the trees are small and sparse they have little commercial value for timber, and the ecosystem contains much less carbon than, say, the rain forests of the Congo Basin (Dewees et al. 2011). However, 100 million people rely on the Miombo woodlands for their livelihoods (Campbell et al. 2007), using them as a source of fuel, wood for construction, tools, household utensils, food, medicine, and grazing. The woodlands also are ecologically significant for providing biodiversity, carbon sequestration, soil fertility, erosion control, shade, and water (Republic of Tanzania 2011).

The governments of Tanzania and Mozambique, two countries with substantial Miombo area, have run innovative programs since the 1990s to conserve and maintain this ecosystem and its services to their citizens. During that time, the Tanzanian initiative has been transformed from a collection of local projects into a national program, based on decentralization of control to the local level and the concept of participatory forest management (PFM) (Blomley and Ramadhani 2006). In Mozambique, the N'hambita community in Sofala province undertook a project that has been intensively studied (Rainforest Alliance 2010; University of Edinburgh 2008; Williams et al. 2008) and found to have reduced global warming emissions substantially. Both examples show how Miombo deforestation and the associated global warming pollution can be combated by efforts and management at the village level.

Tanzania's sustainable forest management policy is integrated with the country's poverty reduction efforts. The overall policy objective is "to achieve sound sustainable development by reconciling economic growth and conservation of resources while spearheading social development" (Republic of Tanzania 2011). In pursuit of this goal, Tanzania has enacted policies since the late 1980s that have decentralized resource management. By 2006, about 3 million hectares were under local management, with local democratically elected bodies having substantial rights and authority over forest resources (Lund and Treue 2008; Blomley and Ramadhani 2006).

> ***The woodlands are ecologically significant for providing biodiversity, carbon sequestration, soil fertility, erosion control, shade, and water.***

This project's initial success led to its expansion into a full-fledged participatory forest managment program, initially targeting 37 districts across the country (Blomley and Ramadhani 2006). One such district, Mfyome in the southern highlands, was studied by researchers from the University of Copenhagen,

who found that annual harvesting rates for logs, charcoal, firewood, and poles and sticks for construction were lower than current forest growth rates (Lund and Treue 2008). Thus the woodland is being restored and sustainably managed.

In Mozambique, the N'hambita community is remote, with almost no infrastructure, and still recovering from decades of war. Its members farm just outside Gorongosa National Park, a well-known protected area at the southern end of the Rift Valley with an abundance of spectacular wildlife (Haslam 2012; Williams et al. 2008).

Begun in 2003, the N'hambita project, now called the Sofala Community Carbon Project, emphasizes both reforestation and avoidance of deforestation (University of Edinburgh 2008). For example, trees are grown in nurseries and then used in agroforestry systems or to reforest a buffer zone around the park, and locally based fire-protection teams endeavor to prevent forest fires. The project includes local control of resources under a policy of the Mozambique government begun in the early 1990s to regularize traditional communities and resolve land use titles (University of Edinburgh 2008). The initial objectives—to develop and research sustainable land use practices in participation with the community and to build local capacity to apply the results of the research across the province (University of Edinburgh 2008)—were expanded in the 2000s to include REDD+ goals, including the generation of income from carbon credits.

> ***By 2008, the N'hambita project had generated 1.1 million tons of carbon dioxide emissions reductions.***

Miombo woodlands (pictured here in southern Zambia) are sparser than other tropical forests, but hold important benefits in terms of carbon sequestration, biodiversity, and resources for rural populations. More than 100 million people rely on the Miombo woodlands for fuel, wood, food, and livestock grazing.

Mozambique's carbon credits program proved successful due to the involvement of many actors. The local farmers and other villagers held the carbon rights and "produced" the carbon; Envirotrade, a carbon-offset business, developed the market of buyers; the international organization Plan Vivo provided certification; the Rainforest Alliance verified the results according to international standards; the University of Edinburgh Centre for Carbon Management gave technical support; and the Mozambique Carbon Livelihoods Trust was launched in 2007 as an entity to manage the proceeds from carbon sales (University of Edinburgh 2008).

By 2008, the N'hambita project had generated 1.1 million tons of carbon dioxide emissions reductions (Rainforest Alliance 2010). A separate study of the project's reforestation components found that the replanting efforts in areas that had previously been agricultural ("slash-and-burn" systems) recovered woody carbon stocks to the same level as the woodlands (even though soil carbon was not fully recovered to previous levels) (Williams et al. 2008).

Thus in both countries the efforts seem to have been successful, if one judges by criteria such as deforestation and carbon sequestration. On the other hand, the results do not seem to have been enough to make the woodlands sustainable in economic and social terms. For example, in Mozambique's N'hambita community the economic impact of this work was smaller than expected and did not seem to make a significant change to local livelihoods (University of Edinburgh 2008). The in-depth study of Mfyome in Tanzania found that, "Forest revenues cover the costs of management and finance local public services, but the underlying taxes and regulations have made the poorest worse off. Governance outcomes are also ambiguous. Revenues are administered transparently, but village leaders are coercive toward forest-dependent minorities" (Lund and Treue 2008).

Based on these kinds of results, Campbell et al. (2007) argued that sustainable Miombo woodland management and use can help mitigate poverty but not eliminate it. They concluded: "The crucial role of Miombo for poverty mitigation is in spite of the fact that Miombo is of low productivity and is not well endowed with high-value timber resources. This makes them less interesting to commercial concerns, but what matters is their high local value to tens of millions of poor households." The Miombo management programs have protected ecosystems, reduced global warming emissions, and guarded a resource that is important to millions. These are important contributions, even if they do not by themselves lead to sustainable economic and social development.

The Miombo management programs have protected ecosystems, reduced global warming emissions, and guarded a resource that is important to millions.

Bringing Low Deforestation Rates Even Lower in Central Africa

The rain forests of the Congo Basin, fittingly called "the great green heart of Africa" (Malhi et al. 2013) and second only to Amazonia in size, contain more than 90 percent of the carbon stored in the continent's ecosystems (Mayaux et al. 2013). One of the surprising discoveries of recent years is that even though tropical forests in Africa and elsewhere are old, they are still absorbing carbon from the atmosphere (Fisher et al. 2013). This means that central Africa's natural forests are contributing to reduction of global warming pollution by pulling carbon dioxide out of the air. They store this carbon mostly in the trunks of their enormous trees, which are large even compared with those of Amazonia and Southeast Asia (Malhi et al. 2013).

Six countries in central Africa—the Democratic Republic of the Congo (DRC), the Congo Republic, Gabon, Cameroon, the Central African Republic, and Equatorial Guinea—contain substantial amounts of rain forest (Figure 8). These forest areas vary greatly in size, with the DRC alone containing more than half of the total (Malhi et al. 2013). The Congo Basin has traditionally been a "High Forest, Low Deforestation" (HFLD) region, with large proportions of the land remaining forested and low rates of loss. In other words, it has been in the initial stage of the forest transition, like Guyana (Chapter 3), so that central Africa's principal goal in terms of deforestation is to keep the rate low and prevent leakage into the region from other parts of the world (Figure 1).

Surprisingly, a recent analysis indicates that the deforestation rates of these forests were cut in half between the decades of the 1990s and the 2000s (Mayaux et al. 2013). This is striking, as the rates were already low—0.28 percent per year in the 1990s, compared with a global average of about 0.5 percent during that period. But rather than moving into a phase of increasing deforestation, the region has stayed in the initial HFLD category.

How has this happened? The reasons seem to be a combination of deliberate policies and the effect of socioeconomic changes. These changes include economic and sociological trends such as urbanization, increasing extraction of oil and minerals, and growing importation of foodstuffs (Rudel 2013). But the success in reducing deforestation and forest degradation is also linked to new forest management policies, begun in the 1990s, that now seem to be paying off (Sabogal et al. 2013).

The socioeconomic trends started from a late-twentieth-century situation in which large agro-industry, a major driver of deforestation in Latin America and Asia, was practically nonexistent in central Africa. For example, the biggest agro-industrial installation in the DRC, a sugar complex in a

The Congo Basin has traditionally been a "High Forest, Low Deforestation" (HFLD) region, with large proportions of the land remaining forested and low rates of loss.

non-forest zone, covered less than 150 square kilometers (Mpoyi et al. 2013). This was because much of the rain forest region was essentially inaccessible, with sparse human populations. In addition, there was a relative abundance of non-forested lands such as savannas that were far easier to convert to agricultural production or use as a source of fuelwood (Mpoyi et al. 2013).

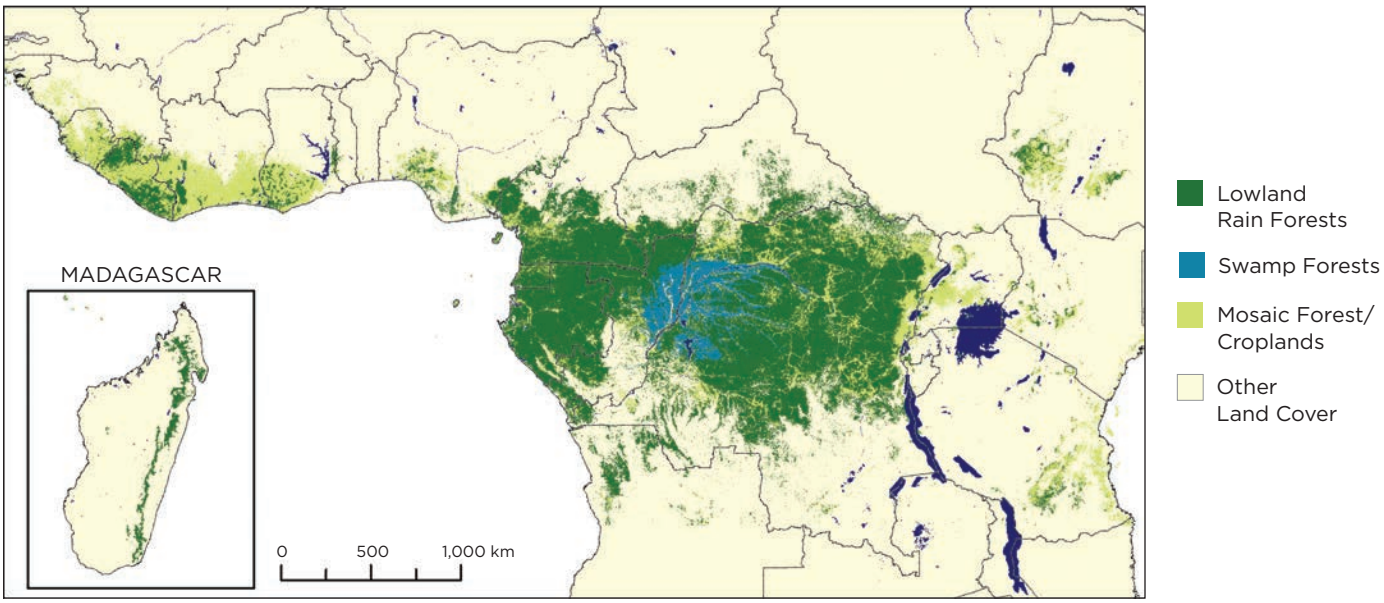
As the oil and mineral resources of the region were tapped in the last few decades, this brought in new and higher incomes as well as associated changes in socioeconomic patterns. This led to rapid urbanization associated with the growth of trade as industry and government drew people out of rural areas and into large cities—Kinshasa, the capital of the DRC, now has more than 7 million inhabitants. Further, these changes stimulated more imports, including foodstuffs that competed with what was produced from local agriculture.

The net result of this pattern of oil- and mineral-based development has been that agriculture has declined. The overall demand for charcoal and fuelwood has grown, but mostly in areas close to the cities. Thus pressure on the forests, though intense in some near-urban areas, has dropped in the more distant regions where most of the rain forest area is found (Rudel 2013).

These trends are not the only reasons for the apparent decline in deforestation, however. There have also been strong efforts to improve forest management across the Congo Basin, reflected in programs such as the Congo Basin Forest Partnership (CBFP), begun in 2002; the Central Africa Regional Program for the Environment, launched with U.S. Agency for International Development (USAID) funding the following year; and the Congo Basin Forest Fund, established in 2008 with funding from Norway and the United Kingdom (Sabogal et al. 2013; Endamana et al. 2011; Duveiller et al. 2008). The largest of these programs, the CBFP, brings together governments, NGOs, the private sector, and international organizations in dialogue to create bridges between funding and implementing entities. Further, the CBFP has identified 13 priority conservation landscapes (covering 700,000 km^2) that cover key ecological zones and biodiversity "hot spots "(Duveiller et al. 2008). Currently, the CBFP is made up of 21 governments, 12 international organizations, 20 nonprofit organizations, and eight private-sector members.

Even before these regional programs started, all of the region's countries had adopted new forest codes during the 1990s, and little by little, forest management plans were implemented and extended to cover more and more forest (Sabogal et al. 2013). In some of the countries, the extension

FIGURE 8. The Rain Forests of Africa



Most of Africa's rain forests are in the Congo Basin, in six countries in the center of the continent.

SOURCE: MAYAUX ET AL. 2013; EC JOINT RESEARCH CENTRE.

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Recent oil and mineral wealth in central Africa has drawn rural populations to major urban areas, such as Kinshasa. This trend is concurrent with a decline in rural agriculture, reducing pressure on tropical forests (and deforestation) in much of the region.

of forest management was very rapid. In Cameroon, for example, the area covered by forest management plans increased from 1.8 million hectares in 2005 to 5.3 million hectares in 2011, with 1 million hectares already certified by the Forest Stewardship Council (FSC). In Gabon in 2010, 3.5 million hectares of forest had fully developed forest management plans, with additional plans in development for another 6 million hectares. A total of 1.87 million hectares of Gabonese forest were FSC-certified as sustainable—the largest area of any country in Africa (Sabogal et al. 2013).

Although the effectiveness of these governance reforms has varied from place to place and country to country, overall they have made a big difference. As a recent United Nations Food and Agriculture Organization (FAO) review of forest management across the globe put it: "The gradual establishment of sustainable production-forest management has been one of the major developments in the forest sector in the Congo basin in the last 15 years; little by little, SFM [sustainable forest management] approaches have replaced extractive approaches involving intensive logging and inadequate planning" (Sabogal et al. 2013).

The low rate of deforestation in central Africa from the 1990s to the 2000s has made an important contribution to slowing global warming pollution. Several caveats should be noted, however. The DRC, where war and civil conflict have characterized recent decades, has not been able to implement reforms to the degree that its neighbors have, so the future of the Congo Basin's rain forests is heavily dependent on what happens in this, the region's largest country. Other analyses suggest that in the DRC, the rate of deforestation in the 2000s was considerably higher than the estimate of Mayaux et al. (2013), although it was still relatively low (Tyukavina et al. 2013). However, because the DRC has by far the most forest in the basin, if its deforestation rate did not remain low the overall success of the region would disappear.

Even in the other countries, reforms in forest management have been impressive but are still quite incomplete. It is possible that present logging efforts have merely caused "lagged" deforestation, in which the roads used for the currently sustainable logging concessions are later used by others who do not follow management plans and leave the forest heavily degraded and damaged (Mayaux et al. 2013). And if the drop in deforestation is indeed related to the increase in oil and mineral wealth and its impact on imports, it could well reverse itself as markets change.

Nonetheless, despite all these caveats, something impressive has taken place in central Africa in recent years, largely unnoticed by the rest of the world. While not all the credit can go to the region's governments and their new forest policies, they have still made an important contribution by keeping their already-low deforestation rates down and protecting some of the most carbon-rich forests on Earth.

Emigrant Support and the Reforestation of El Salvador

Only a few decades ago, El Salvador was one of the most fractured countries in the world. It was being torn apart by a bloody civil war, with leftist guerillas struggling against a repressive right-wing government, and fully one-sixth of its citizens fled to neighboring countries and the United States. Much of El Salvador's cropland was too dangerous to farm because of the violence, and even those farmers who stayed in the country had little chance of working enough land to make a living (Davis and Lopez-Carr 2014). The possibility of peace—let alone economic and social development—seemed very far away.

El Salvador's environment was faring no better. Most of the country's land, from the slopes of its spectacular volcanoes down to the Pacific coastal plain, had been stripped of its forest cover (Hecht and Saatchi 2007). No one could gather reliable data under the violent conditions, but recent analyses indicate that forest cover had fallen to less than 20 percent of the country (Meyfroidt and Lambin 2011; Hecht et al. 2006), and only 6 percent of the natural forests remained undisturbed (Hecht and Saatchi 2007).

The dire environmental situation was ascribed not to the war, however, but to El Salvador's high population density. A well-known ecologist, examining the country's environment and its population density at the end of the twentieth century, stated flatly that, "Nature had already been extinguished in El Salvador" (Terborgh 1999), which averaged more than 200 people per square kilometer—the highest in Latin America—and was seen as a classic example of Malthus's thesis that population growth will inevitably lead to destruction of natural resources and repression of the general population (Hecht et al. 2006).

Yet in the last few decades, El Salvador has seen a remarkable turnaround. Peace has been restored, a democratic system has been established, and the economy has grown at a rapid pace. And the forests have begun to come back as well.

From the early 1990s to the 2000s, there were signs of forest recovery. The area of less-dense forest (with 30 to 60 percent canopy cover) grew by 22 percent, and that of denser forest (with more than 60 percent cover) grew by 6 percent. Initially, some interpreted this phenomenon as confirming the Malthusian story: because the rural areas had been depopulated by war and repression, driving hundreds of thousands of El Salvador's citizens out of their own country, the forests were left alone to recover. If this were the case, then over time peace would have been bad for the forests, allowing refugees to return and reestablishing the imbalance between land and people.

> ***Peace has been restored, a democratic system has been established, and the economy has grown at a rapid pace.***

Yet the ecological progress continued into the twenty-first century, even as emigrants returned home and the population grew. Agrarian reforms such as the Land Transfer Program, established in 1992 by the Peace Accords, had

distributed land to one-fifth of rural households. This was achieved by expropriating many of the large agro-industrial holdings, thereby weakening the dominance of the rural elite (Hecht et al. 2006) and decreasing the inequity in control of the country's land (Davis and Lopez-Carr 2014).

Data from 2001 to 2010 continued to show an increase in El Salvador's woody vegetation, which grew by 16 percent (Redo et al. 2012). The country appears to have passed the low point of the forest transition (Meyfroidt and Lambin 2011), with forests in all three major biomes (dry forest, highland conifers, and moist forest) showing net recovery. Forest cover is still the lowest in Central America, but clearly on the upswing (Redo et al. 2012).

What explains El Salvador's successful passage through the low point of the forest transition and onto a course of recovery? Examining data from all the Central American countries over the twenty-first century's first decade, Redo et al. (2012) found that social and economic development appeared to be the most important factor. The variable with the strongest correlation to the gain in forest cover was the Human Development Index—a measure that includes not just economic growth indicators such as GDP but also health and educational variables that relate to the welfare of the whole population. Similarly, net reforestation is highest in those parts of the country with the lowest infant mortality rates.

A number of factors accounted for El Salvador's social, economic, and ecological progress. They included policies not only on agrarian reform and but also on encouragement of broad-based development. The contributions of the country's emigrants were another important and distinctive feature.

Many emigrants returned home after peace was established, bringing with them the savings they had accumulated in their years abroad. Others stayed in the United States and other countries but regularly sent money back to their families. These "remittances" were a very large contribution to the economic security and welfare of the country's families—in 2010 some 45 percent of El Salvadoran households were receiving them. The remittances, adding up to the highest in Central America and among the highest in the world (Davis and Lopez-Carr 2014), constituted nearly 16 percent of the country's GDP.

Returning emigrants also brought large amounts of capital to rural areas, as 60 to 90 percent of them came back to their native communities. Although there was a danger that the infusions of funds—both from repatriation and remittances—would lead to the expansion of agriculture and greater pressure on forests, the data indicate that this was not the case (Davis and Lopez-Carr 2014). Rather, the areas with the most remittances were the ones that had the highest rates of forest recovery (Hecht and Saatchi 2007; Hecht et al. 2006).

An infusion of funds from repatriation and remittances to El Salvador has helped contribute to its growing forest cover and environmental recovery. Indeed, areas with the highest remittances were found to have the highest rates of forest recovery.

While they are not native forests, shade-grown coffee plantations in El Salvador still substantially contribute to biodiversity, carbon sequestration, and economic livelihoods for local farmers.

> ***The areas with the most remittances were the ones that had the highest rates of forest recovery.***

Most of the recovering forest is still young, with incomplete canopies. Indeed, a significant fraction of the "forest" is made up of coffee plantations shaded by tall native trees. These expanses are hardly natural, but they nevertheless contribute substantially to biodiversity habitat and carbon sequestration (Perfecto et al. 1996). In western El Salvador, certified shade ("bird-friendly") coffee has not only had ecological benefits but has also become an important component of regional land use, covering one-third of the landscape and bringing significantly higher incomes to hundreds of farms.

So while El Salvador's forest transition is partly due to peace and agrarian reform, with inspired political leadership deserving a share of the credit, the money contributed by El Salvadorans abroad—those who came home once peace was established as well as those who did not return but who send remittances back to their families—is also an important part of the story (Hecht 2010; Hecht and Saatchi 2007; Hecht et al. 2006). These expatriates, whether former or continuing, deserve recognition as contributors to a historic change in their native country's environment.

Conclusions

Many Ways to Reach the Goal

A clear message of this report is that numerous paths are possible for successfully reducing deforestation and the global warming pollution it causes. Some efforts have come from the bottom up, others from the top down, and many have combined the two. Some work at the community level, others at the scale of large nations or even of multinational regions such as the Congo Basin. Some focus on carbon, some on countering the main drivers of deforestation, and others on securing the rights and livelihoods of forest peoples.

> ***Technological advances have made it feasible to assess how much tropical forest remains and where it is diminishing or increasing over time.***

The financial resources to pay the costs have likewise come from a variety of sources. In some countries, such as Brazil, Guyana, and Vietnam, there has been REDD+ funding from developed nations. Even in these cases, however, the tropical forest country has often absorbed much or most of the cost itself. In particular cases, such as that of El Salvador, the resources sent or brought home by emigrants have been an important contribution to reforestation. Voluntary market funding at the project scale has been used in some cases, such as Kenya's Kasigau and Madagascar's COFAV. But contrary to the expectations of a decade ago, carbon markets have not yet generated the large amounts of financing for REDD+ required to abate global deforestation rates (Boucher and Elias 2013).

Using New Technologies for Transparency and Enforcement

Legal registries, combined with on-the-ground verification of who owns what land with data from new remote sensing technologies, can be key to making deforestation transparent and prompting effective actions to stop it. Thus an important development of the past few decades is that technological advances have made it feasible to assess how much tropical forest remains, where it is diminishing or increasing, how these trends have been changing over time, and most importantly where—on whose land—the deforestation is taking place.

There is now satellite image data from across Latin America, for example, that make it possible to map in detail, at the level of municipalities, where there has been deforestation and where there has been reforestation (e.g., Aide et al. 2013, Figure S1). Such maps, some derived from images available in near-real time through systems such as Global Forest Watch 2.0 and Google Earth, were not possible to create until the end of the twentieth century. Using this kind of technology, Brazil's National Institute for Space Research has been able to provide accurate assessments of where and when forest change is taking place, with monthly updates serving as the basis for rapid enforcement actions when new hot spots

Reducing deforestation is most likely to be successful in the long run if linked with efforts to improve livelihoods and human rights and empower marginalized communities. Pictured here are rice farmers in southeastern Madagascar.

of deforestation are detected. As other countries develop similar systems, such as Indonesia with its One Map program, not just the technology but also the commitment to transparency will be important factors.

And within the technology sphere, it is not just the capabilities of satellite imagery that have advanced. Aerial and on-the-ground assessments of forest change and carbon density are critical complements to what the satellites see. Here too, sophisticated systems—such as airplane-borne LiDAR and also the broad availability of smartphones, which can be used to collect data, take photographs, and share them globally—are transforming our ability to know what is happening in the tropical forests.

The importance of these technological advances goes far beyond their capacity to produce impressive animated multicolored maps. As shown most notably in Brazil, they are a key element of transparency, making it possible to ascribe deforestation to specific actors and take measures to drop them from global supply chains. Such actions can be based on steps to enforce existing laws or on commitments by businesses, such as soy processors and slaughterhouses, that buy the products of deforesters. And, as the innovative and energetic work of the Public Prosecutors' Office in Brazil has shown, these actions can be combined and made mutually reinforcing.

The Global Economy

Another clear message of this report is that the broader macroeconomic situation within which a country finds itself can be very influential in its degree of success with reforestation and reducing deforestation. The pressure to deforest from the major drivers, such as soy and beef in the Amazon and palm oil in Southeast Asia, varies with international demand for these commodities and their global prices (Nepstad, Stickler, and Almeida 2006). Because such products are exported in large quantities, much of the emissions associated with their growth, processing, and distribution are "embodied in trade" (Minang et al. 2010). To some extent, then, success

in reducing emissions from deforestation is hostage to changes in prices, exchange rates, trade patterns, and the displacement of production and processing to different parts of the globe (Meyfroidt, Rudel, and Lambin 2010).

But there is clear evidence that agriculture can continue to grow rapidly while deforestation is reduced or while substantial reforestation takes place. Although the examples from some countries (e.g., central Africa, Mexico, Costa Rica) show shifts of the economy away from agriculture toward other sectors, others (such as Brazil and Vietnam) demonstrate that a strong and modern agricultural sector can grow at the same time that the landscape becomes more forested. Agriculture and forests need not be mutually exclusive. Rather, as shown by successful programs based on community development (e.g., Madagascar, Kenya), they can be mutually reinforcing.

There is clear evidence that agriculture can continue to grow rapidly while deforestation is reduced or while substantial reforestation takes place.

Leakage and Displacement

Another clear message is that flows between countries—of emissions, commodities, capital, or people—can be critical for efforts to reduce deforestation. Sometimes such transfers provide important financial support for developing-country efforts, as shown by our examples from Guyana, Madagascar, Kenya, central Africa, and El Salvador. In other cases the trade flows help reduce the pressure for deforestation in one country but at the cost of increasing deforestation in others, as with Vietnam's forest transition (Meyfroidt, Rudel, and Lambin 2010). This leakage can be difficult to calculate, but there is no doubt that it occurs, and it may neutralize significant fractions of the apparent reductions in emissions. In one country there may appear to be great success, but "what the atmosphere sees"—the global net effect of all the changes—can be a considerable attenuation of that success.

On the other hand, an equally important message is that while leakage may reduce the degree of success, it does not negate that achievement entirely. For example, in Vietnam (one of the best-studied cases), leakage was estimated to have reduced the net change in emissions by 40 percent, but that still left a substantial amount of progress. Particularly for efforts involving big countries (e.g., Brazil, Indonesia) or multicountry regions (such as central Africa), leakage can be reduced by simultaneous large-scale efforts over broad regions (Boucher and Elias 2013). Action over wider areas of the globe tends to reduce the risks of national efforts being counteracted by trade flows, and it leads to greater overall success in reducing total emissions worldwide.

Approaches That Have Led to Success

What, then, has worked? Our stories show that several different kinds of efforts have been successful in reducing emissions from deforestation. They include:

- **REDD+** (Guyana, Brazil, Kenya, Madagascar, Costa Rica). Many current examples of REDD+ programs and projects developed from earlier efforts that focused on deforestation for non-climate reasons, such as biodiversity, wildlife, ecotourism, and poverty alleviation. With REDD+, these efforts have taken on an explicit climate focus—with emphasis on reducing emissions and compensation linked to verified reductions—as global concern about climate change has grown in recent years. This has clearly brought about large increases in potential funding for forests, even if in actuality the total still remains well below what is needed. And the results have been rapid and impressive in countries across the spectrum—e.g., Brazil's dramatic reductions but also the success in keeping deforestation low in Guyana and continued progress despite political change in Madagascar. REDD+ financing, with all its problems, has proved to be money well spent in these countries.
- **Payments for ecosystem services** (Costa Rica, Mexico, Vietnam). These cases have had somewhat ironic outcomes, as PES programs often do not appear to have worked as designed. They have real difficulties in targeting payments to those people and places where they would seem to be most effective, and thus may appear to show little additionality. They also have come to be considered as anti-poverty and social-development programs rather than as directed at specific environmental objectives. And yet they have become well established in the countries that adopted them and have been successful in reducing deforestation and promoting reforestation, even if the reality of these PES programs deviated greatly from the theory. In a broader sense, one could say they have worked in combination with other factors, such as protected areas,

Reforestation of a mangrove forest in Bac Lieu province, Vietnam.

community development efforts, and reorientation of agricultural growth in more forest-friendly directions.

- **Governance and enforcement** (central Africa, Brazil). Often, changing the situation in the forest seems daunting in the face of weak governance, corruption, complex political structures, and long-prevalent dominance of rural areas by entrenched elites. Yet even where it has appeared most challenging, there have been important advances in establishing effective management, transparency, and the rule of law. Simply enforcing existing laws effectively has paid off in the long term in changes that reduce deforestation and transform expectations of "how things are done."
- **Moratoria** (Brazil). Even temporary halts to the activities that drive deforestation can have important effects. They need not be moratoria on deforestation itself, but rather on the permits or purchases that drive it. Enforcement is never easy or totally effective, and often the coverage is incomplete and leaves out important areas or parts of the supply chain. Yet moratoria can still have important effects, not only through their direct impacts but also from the signal they send that "things have changed." Even if initially implemented for only a year or two, they can be renewed repeatedly and in effect become part of the landscape's new reality.
- **Combining environmental action with social and economic development** (nearly every country). If there is one theme that seems to cut across differences of approach, scale, and history, it is the value of integrating efforts to reduce emissions from deforestation with broader efforts in development, human rights, and social progress. Environmental progress is most likely to happen when it is linked to real steps forward in areas such as recognizing indigenous rights, developing alternative sources of income or energy, or empowering marginalized sectors of society. Combining environmental, social, and economic progress is more complicated than focusing on a single goal, but ultimately it may lead to successes in all of these areas.

Recommendations for Policy Makers

The selected countries' success stories in this report are diverse examples of how to approach reductions in emissions from the land sector; looking at them as a whole can identify some lessons learned and thereby help to replicate results elsewhere. Based on this research, we recommend the following steps to policy makers (those in governments, international organizations, businesses, and NGOs):

- **Implement REDD+ programs.** The implementation of policies to reduce emissions from deforestation and forest degradation has had a major impact, despite occurring across several countries in different phases of the forest transition. Important elements of these policies include multiple scales of action, ranging from projects at the local level up to the regional and international levels, and the taking of such action through partnerships that bridge governments, the private sector, and NGOs.

> ***Almost every story in this report illustrates the benefits of empowering local communities and decentralizing forest management decisions.***

- **Provide payments for ecosystem services.** Many of the stories in this report point to the importance of national commitments to conservation by protecting a range of ecosystem services, including climate, water, biodiversity, and forest-based resources. Providing payments for ecosystem services, as well as for carbon, can be an effective way to implement these commitments, which may succeed even when they do not function as expected from economic theory.
- **Practice strong governance and enforcement.** The positive impact of establishing strong forest-protection laws and enforcing them is clear in the chapters of this report. They can entail both direct government actions and indirect enforcement steps, such as certification of the sustainable production of commodities, which almost always includes legality requirements. Empowerment of enforcement officials to fully implement the laws already on the books is often as important as pursuing new and nominally more comprehensive statutes.
- **Combine environmental action with social and economic development.** Almost every story in this report illustrates the benefits of empowering local communities and decentralizing forest management decisions. Examples include legal recognition of indigenous land tenure, creating sustainable-use areas, establishing and supporting community forestry management systems, and funding social development efforts as well as conservation in integrated development programs. Some of these efforts have linked ecosystem services and social objectives such as poverty reduction, resulting both in emissions reductions and economic benefits.
- **Establish moratoria.** Voluntary or legislated moratoria on deforestation per se, on permits to clear forestland, or on the purchase of goods produced in deforested areas can help address the drivers of deforestation. Moratoria, even if temporary, can become parts of corporate responsibility policy that transform whole sectors and move provisional moratoria toward permanence.
- **Obtain financing for action.** Although the success stories in this report cannot provide a clear cause-and-effect relationship between international financing and successful results, it is notable that all the cases depended to some extent on international support. There is the potential in many other countries to reduce land-based carbon emissions substantially if financing were provided to do so. The stories in this report should bolster the political will, country by country, to obtain or provide such funding and thus contribute to the global effort to curb global warming.

We have often pointed out the differences among countries in terms of the forest transition concept—with its curve of increasing deforestation, then decreasing deforestation, and finally reforestation (Figure 1). Effectively combating global warming will require changes along each part of this curve: avoiding the commencement of deforestation (in countries such as Guyana and the central African nations), reducing deforestation in the curve's steep slope (Brazil, Indonesia, Madagascar, Tanzania, Mozambique, Kenya, and Mexico), and finally moving to net reforestation (Costa Rica, India, El Salvador, and Vietnam). In effect, the international community has to actively bend the curve rather than assume it will progress by itself. This is what will turn individual success stories such as those of this report into a *global* success story.

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Deforestation Success Stories

Tropical Nations Where Forest Protection and Reforestation Policies Have Worked

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