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Tropical Forests, For Richer and For Poorer

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This chapter provides an economic perspective on the importance of tropical forests to global humankind. It starts by reviewing trends in global forest areas, to provide context for the issues discussed in subsequent sections of the chapter. Important trends include not only the outright loss of forest cover, or deforestation, but also a second trend that has been overshadowed by deforestation, forest degradation. The chapter then discusses the economic importance of tropical forests, both to the citizens of the countries where they are located and to the rest of the world. That discussion emphasizes several points: the industrial forest sector's typically small share of GDP belies the substantial contribution of tropical forests to household incomes in poor rural areas; tropical forests provide global public goods related to climate stabilization and biodiversity conservation; and tropical forests are increasingly concentrated in higher-income developing countries, which is raising the value that domestic populations within tropical countries place on protecting their forests. The chapter closes by reviewing evidence on the effectiveness of the three main types of programs that have been implemented to reduce tropical deforestation and degradation: protected areas, community management rights, and payments for ecosystem services. The main conclusions are that the evidence base is narrow and that research on the effectiveness of forest conservation programs needs to broaden its geographic scope, consider impacts on not only deforestation but also degradation, and become more economic in the sense of evaluating the benefits and costs of programs and not only their impacts measured in physical terms.

Although the chapter focuses on tropical forests, available information often pertains to forests in developing countries, not all of which are in the tropics. The overlap between tropical regions and developing regions is close enough, however, that any errors that result from basing inferences about tropical forests on information about forests in developing countries are likely to be inconsequential, at least for the issues considered in this chapter. And in any event, throughout the chapter I will make clear the types of forests to which I am referring: tropical, developing-country, or otherwise.

Trends in tropical deforestation and degradation

Global forests face two major threats, deforestation and degradation. *Deforestation* refers to the conversion of forests to other land uses, mainly agriculture. During 2000-2010, a net total of 5.3 million hectares of forest was converted to other uses annually, for a deforestation rate of 0.13% per year (Table 1). With one exception (Australia), all of the countries with large losses in forest area during this period were tropical developing countries (FAO 2010b, p. 21). At a pantropical level, large-scale and small-scale agriculture were about equally important drivers of forest conversion 1990-2000 (UNEP, FAO, and UNFF 2009, p. 22). Large-scale agriculture for such crops as oil palm, rubber, and soybeans was relatively more important in Asia and Latin America, while small-scale agriculture for subsistence and cash crops was relatively more important in Africa.

Degradation results mainly from the harvesting of forests for timber and fuelwood. Harvesting, on its own, generally does not result in deforestation in the sense of complete and permanent loss of tree cover (Geist and Lambin 2001). A harvested forest contains fewer trees than the original forest, however, and its ecological processes may take decades or even centuries to recover (Rey Benayas *et al.* 2009). In these senses, it is in a degraded state compared to the original, pre-harvest forest. The best available global measure of forest degradation is the loss in area of primary forests: "forests of native species in which there are no clearly visible signs of past or present human activity" (FAO 2010b, p. 11). Primary forests are also known as virgin or old-growth forests. As of 2010, about a third of the world's forests were primary (FAO 2010b, p. 26), with most of the area being in the tropics (FAO 2010b, p. 55). During 2000-2010, global primary forest area declined by 4.2 million hectares annually, or 0.37% per year (Table 1). As with deforestation, most of the decline occurred in tropical developing countries. Note that the global hectarage degraded according to this measure was not much less than the global hectarage deforested during the same period: degradation ran nearly neck-and-neck with deforestation in absolute terms. But because most of the world's forests are not primary, degradation outraced deforestation in percentage terms.

Degradation shows fewer signs of slowing down than deforestation does. In both absolute and relative terms, deforestation was much lower during 2000-2010 than 1990-2000, when global forest area declined by 8.2 million hectares annually, or 0.20% per year. The chief explanation for the slowing of global deforestation between the two decades is a reversal of the trend in forest area in Asia, from net loss to net gain: mainly in China, but also in India and Vietnam (FAO 2010b, p. 18, 21). In contrast, degradation barely slowed

Table 1. Status and trends in total forest area and primary forest area. Source: FAO (2010b, Tables 2.3, 2.4, 3.1, and 3.3).

a. Total forest area

Region	Area (2010)	Change: 2000–2010		Change: 1990–2000	
	million ha	*million ha/yr*	*%/yr*	*million ha/yr*	*%/yr*
Eastern & Southern Africa	268	-1.84	-0.66	-1.84	-0.62
Western & Central Africa	328	-1.54	-0.46	-1.64	-0.46
East Asia	255	+2.78	+1.16	+1.76	+0.81
South & Southeast Asia	294	-0.68	-0.23	-2.43	-0.77
Central America	19	-0.25	-1.19	-0.37	-1.56
South America	864	-4.00	-0.45	-4.21	-0.45
World	4033	-5.21	-0.13	-8.32	-0.20

b. Primary forest area

Region	Area (2010)	Change: 2000–2010		Change: 1990–2000	
	million ha	*million ha/yr*	*%/yr*	*million ha/yr*	*%/yr*
Eastern & Southern Africa	6	-0.06	-0.88	-0.06	-0.78
Western & Central Africa	28	-0.52	-1.66	-0.50	-1.47
East Asia	25	-0.17	-0.46	-0.11	-0.63
South & Southeast Asia	81	-0.35	-0.29	-0.24	-0.41
Central America	4	-0.05	-1.52	-0.07	-0.98
South America	624	-3.10	-0.46	-2.96	-0.46
World	1102	-4.67	-0.37	-4.19	-0.40

between 1990-2000 and 2000-2010: the decline in global area of primary forests during 1990-2000 was 4.7 million hectares annually, or 0.40% per year.

Economic importance of tropical forests

From an economic standpoint, deforestation and degradation are "problems" only if forests matter to human well-being. Conventional national accounting measures suggest that global forests contribute little to global economic output. According to estimates reported in FAO (2009, p. 70), the sum of value-added in roundwood production (i.e., timber harvesting), wood processing (e.g., lumber, plywood), and pulp and paper processing accounted for just 1% of global GDP in 2006. Moreover, this percentage has declined fairly steadily since 1990, when it was about 1.5%. The forest sector would thus appear to be a small and declining sector of the global economy.

Conventional national accounts do not record all of the economic contributions of forests, however. The amounts just cited refer only to the value-added associated with harvesting and processing wood and wood fiber as industrial raw materials. Forests provide many other goods and services in addition to this (Fig. 1 in Croitoru 2007). For example, fuelwood accounts for about the same global harvest volume as does timber (FAO 2010a, p. 7), but its value is not fully reflected in GDP because it is often a subsistence product collected by local households. Forests are also a source of many other subsistence products, including game, wild fruits, and medicinals. Villagers, pastoralists, and ranchers in countries around the world graze livestock in forests. Forests provide a variety of nonextractive services; for example, they serve as locations for recreation, and they protect water quality. Some forest-related services are global public goods. Two that have attracted particular policy attention are carbon sequestration, which helps mitigate global climate change, and biological diversity, whose sheer existence can be valued by individuals in other parts of the world who never expect to visit the forests that harbor it.

Valuing nontimber goods and services

The development of theoretically sound methods for valuing nonmarket goods and services has been one of the central concerns of environmental and resource economists for the past half-century (Mäler and Vincent 2005, Freeman, Herriges, and Kling 2014). Many studies have applied these methods to tropical forests. A late-2013 search of forest-related keywords ("forest", "rainforest", "woodland", "trees", "endangered species") in the leading global database on valuation studies, the Environmental Valuation Reference Inventory (EVRI; www.evri.ca/Global/Home.aspx), returned 117 studies having been conducted in developing countries. Already two decades ago, Lampietti and Dixon (1995) conducted a global review of the much smaller number of forest valuation studies that had been conducted in developing countries at that time, along with similar studies conducted in developed countries. They found that the sum of nontimber values was about the same as timber value in developing countries and about twice the timber value in developed countries (Table 2). Hence, the total economic value of forests was about two to three times the timber value.

The most rigorous cross-country forest valuation study to date is probably a study of countries in the Mediterranean region by Croitoru (2007). That study is worth considering here despite its nontropical focus, because it attempted to value an even wider range of nontimber goods and services than did the studies available to Lampietti and Dixon, adding carbon values and grazing values to the list. Due to the combination of these additional nontimber values and a smaller estimate of timber values, it reported a

Table 2. Relative importance of timber and nontimber values within total economic value of forestland. Source: author calculations, based on information presented in indicated sources.

Good or service	Lampietti & Dixon (1995):		Croitoru (2007):
	Developing countries	Developed countries	Mediterranean countries
Timber	50%	33%	20%
Fuelwood and minor forest products	31%	0%	25%
Grazing	n.e.	n.e.	10%
Recreation, sport hunting, fishing	7%	56%	17%
Watershed services	5%	5%	11%
Carbon sequestration	n.e.	n.e.	5%
Passive use (option and existence values)	7%	7%	13%

n.e.: not estimated by authors.

higher ratio of total value to timber value than did Lampietti and Dixon: about five (Table 2). The results of these two studies suggest that the annual global economic contribution of the world's forests, inclusive of nontimber values, can be crudely estimated by multiplying the global GDP share cited earlier by a factor of two to five. The resulting estimate remains very small, just 2–5 % of global GDP. Forests still appear to be relatively unimportant in macroeconomic terms, even after accounting for nontimber values.

Tropical forests and rural livelihoods

This crude estimate might well be accurate at a global level, but it is a highly misleading indicator of the economic importance of forests in specific locations. In particular, forests can be very important to human well-being at a local scale in rural areas of tropical countries. The Economics of Ecosystems and Biodiversity (TEEB), which is a global initiative hosted by the United Nations Environment Program (UNEP), has usefully compared conventional GDP shares for the aggregate agriculture, forestry, and fisheries sector to estimates of the "GDP of the poor", which focuses on the contributions by forests and other local ecosystems to the livelihoods of poor rural households in those countries (TEEB 2010, p. 15). TEEB reported estimates for three large developing countries, Brazil, India, and Indonesia. The conventional GDP shares ranged from 6% to 17%, but the shares for the "GDP of the poor" were much larger: 47% in India, 75% in Indonesia, and 89% in Brazil. The numbers of people involved were large too: according to TEEB's estimates, 20 million in Brazil, 99 million in Indonesia, and 362 million in India.

Other evidence confirms that forests are important to local livelihoods in developing countries. The fact that fuelwood accounts for half of global wood harvest hints at forests' major role as a local energy source. Solid biomass, mostly fuelwood, accounts for more than 40% of household energy consumption in most countries in Sub-Saharan Africa and many countries in Central America and Southeast Asia (UNEP, FAO, and UNFF 2009, pp. 30-31). As of 2000, nearly two billion people in Asia and more than half a billion people in Africa relied on biomass for cooking and heating (UNEP, FAO, and UNFF 2009, pp. 31).

The Poverty Action Network of the Center for International Forestry Research (CIFOR) recently completed a comprehensive study on the contribution of forests to total household income (including subsistence) in rural areas of tropical and subtropical developing countries (Angelsen *et al.* 2014). The study surveyed nearly 8,000 households in more than 300 villages in 24 tropical and subtropical countries. All the villages had moderate to good access to forest resources, which characterizes many villages in tropical and subtropical countries. The mean share of forest income was 10-40% in most of the villages. Forest income was split about equally among three product categories – fuelwood (including charcoal), food and medicinals, and building materials (somewhat small than the other two categories) – and it was about five times larger than income from other local environmental sources, such nonforest wildlands (grasslands, bushlands, wetlands), fallows, and wild plants and animals harvested from croplands (Table 3).

Tropical forests and global public goods

The forest sector's small share of conventional global GDP therefore obscures the great importance of tropical forests to rural households. It also obscures the large contributions of these forests to two global environmental public goods: the stability of the earth's climate, and the preservation of biological diversity. According to the latest report of Working Group III of the Intergovernmental Panel on Climate Change (IPCC 2014b, p. 7), forests accounted for about a tenth of global greenhouse gas emissions in 2010. Most of these emissions were from deforestation and forest degradation in tropical countries. In fact, forests in temperate and boreal regions of North America and Eurasia have been net carbon "sinks" for decades, due to expanding forest areas and growth of the trees within them (UNEP, FAO, UNFF 2009, p. 36).

Tropical and subtropical moist forests ("rainforests") are the most biologically rich terrestrial ecosystems in the world, providing habitat for some 20,000 known vertebrate species (UNEP, FAO, UNFF 2009, p. 39) and millions of

Table 3. Sources of total household income in rural areas of tropical and subtropical countries. Source: Angelsen *et al.* (2014, Table 1).

Income category	Global	Africa	Asia	Latin America
Environmental	27.5%	30.1%	22.0%	32.1%
Natural forests	21.1%	20.5%	18.4%	28.5%
Other ecosystems	6.4%	9.6%	3.7%	3.6%
Crops and livestock	41.0%	43.9%	42.3%	30.2%
Wages	15.2%	10.7%	17.6%	22.6%
Other	16.3%	15.3%	18.1%	15.1%

invertebrate and plant species. Other types of tropical and subtropical forests provide habitat for fewer but still large numbers of vertebrate species, about 7,000 for dry broadleaf forests and 4,000 for coniferous forests. Although these numbers are smaller than for tropical and subtropical moist forests, they are larger than for the corresponding forest types in temperate and boreal zones: about 4,000 species for temperate broadleaf and mixed forests, 3,000 species for temperate coniferous forests, and only 1,000 species for boreal forests. The risk of species extinctions is higher in tropical forests than in temperate and boreal forests for the same reasons that carbon emissions are higher in tropical forests, namely higher rates of deforestation and degradation.

Policy debates about greenhouse gas emissions and biodiversity losses in tropical forests have tended to focus more on deforestation than does forest degradation. This is perhaps natural, given that deforestation entails more dramatic ecological changes than degradation does. A degraded forest is still a forest, after all. The global environmental impacts of forest degradation in the tropics are attracting increased attention, however. This is apparent from the evolution of the acronyms for the United Nations' lead initiative to reduce greenhouse gas emissions from tropical forests. This initiative was initially known as RED, for Reduced Emissions from Deforestation. It then took a tentative step beyond deforestation by becoming RED(D), with the parenthetical "D" standing for degradation. It fully embraced degradation in 2008, when it became simply REDD.

Research confirms that the degradation of tropical forests can have a large impact on both greenhouse gas emissions and biodiversity losses. The most careful large-scale comparison of greenhouse gas emissions from tropical deforestation and degradation is probably a study by Asner *et al.* (2010) in the Peruvian Amazon. The study took detailed carbon measurements in a landscape spanning 4 million hectares by integrating data from satellites, airborne sensors, and field plots. It found that degradation was responsible for a third of forest-related greenhouse gas emissions during 1999-2009, with deforestation responsible for the balance.

The best available information on the effects of deforestation and degradation on tropical biodiversity is a meta-analysis by Gibson *et al*. (2011), which analyzed 138 studies conducted at 92 sites in 28 tropical countries. It confirmed that primary tropical forests contain significantly more biodiversity than not only sites that have been deforested (active and abandoned croplands, pastures, and plantations) but also ones that have been degraded (selectively logged forests, secondary forests, agroforestry). According the measure that Gibson *et al*. developed to compare the disparate biodiversity indicators reported in the original studies, the effects of deforestation ranged from 0.5 to 1.1 while the effects of degradation ranged from 0.1 to 0.7, with larger values indicating greater biodiversity losses and the median effect across all types of disturbance being 0.5.

Tropical countries and the value of public goods from forests

Unlike the rural poor who benefit from the contributions of tropical forests to their livelihoods, many of the beneficiaries of global public goods provided by tropical forests live in Europe, North America, and other developed regions, outside the countries where the forests are located. This is the rationale for programs like REDD and the Global Environment Facility, which channel funding from developed countries to developing countries in support of projects that reduce deforestation and degradation. A major concern within the global conservation community is that international flows of funding are below the amounts required to achieve the 2020 biodiversity protection targets set by the UN Convention on Biological Diversity (UNEP 2012), in addition to being below the commitments made by developed countries at the 1992 Earth Summit (Miller, Agrawal, Roberts 2012). UNEP (2012) estimates that a total investment of $74-121 billion is required during 2014-18, while Miller, Agrawal, and Roberts (2012) estimate that the actual flow of biodiversity aid has averaged $1.1 billion since 2002.

The fact that global environmental public goods associated with tropical forests have beneficiaries outside tropical countries does not mean that they do not also have beneficiaries within those countries, however. Information in the latest report of IPCC Working Group II (IPCC 2014a) indicates that tropical countries will benefit greatly if dangerous levels of climate change are avoided. They will avoid losses in agricultural productivity, increased morbidity and mortality from climate-related illnesses, and damage to coastal cities from sea-level rise.

In the case of biodiversity, in a recent paper my coauthors and I draw attention to the increasing concentration of tropical forests in relatively wealthier developing countries and the resulting impact on forest protection values (Vincent *et al.* 2014). As of 2010, countries that the World Bank classifies as upper-middle-income (UMI) – the "richest" developing-country tier – accounted for about half of total forest area across all tropical countries. They accounted for an even larger share of primary forest area in tropical countries, 80%. Only nine tropical countries were in this group in 1990, but the number had grown to 27 by 2010. To be sure, most tropical countries are not in this group, and even UMI tropical countries have large numbers of poor households. Yet, it is more and more misleading to equate "tropical countries" with "poor countries."

My coauthors and I investigated the implications of this trend for forest protection values and conservation finance by compiling and analyzing information from a large number of cross-country datasets and our own large-scale population survey in Malaysia. We found evidence that demand for forest protection by the populations of tropical countries has risen significantly as incomes have grown in these countries. More interesting, we found evidence that the increased public demand has outstripped increases in the creation and funding of protected areas. People in tropical countries, especially UMI tropical countries, want more forest protection than their governments are supplying. This imbalance suggests that domestic funding raised within UMI tropical countries could play a larger role in closing the funding gap for tropical forest conservation.

Results of the Malaysian survey reveal that citizens of that particular UMI country value forest protection to a large extent because they value the preservation of threatened and endangered species found in the forest. They value forest protection even when it does not benefit them more directly, for example by enhancing recreational opportunities or mitigating floods (although they value those uses, too). This "passive use" value is different from the more tangible contribution of tropical forests to household livelihoods, which is also important in poor rural areas of Malaysia. Tropical forests can thus benefit both richer and poorer households in the developing countries where they are found, though not necessarily for the same reasons.

Addressing tropical deforestation and degradation

Programs aimed at reducing tropical deforestation and degradation fall into three major categories: protected areas, community management rights, and payments for ecosystem services. Each of these programs encompasses a larger forest area than it did twenty years ago. *Protected areas* restrict the use of forestland to varying degrees, in some cases prohibiting conversion but allowing timber harvesting (e.g., national forests) and in other cases prohibiting both activities (e.g., national parks). During 1990–2010, the area of forests designated for protection of biodiversity increased by about a tenth in Africa, a third in Asia, and more than a factor of two in South America (FAO 2010a, p. 6). *Community management rights* aim to strengthen incentives for sustainable forest management by giving local communities more authority to determine who is allowed to use the forest and how they can use it (Ostrom 1990, Baland and Platteau 2003). During 1990–2005, the area of public forest managed by local communities nearly quadrupled in developing countries, approaching 200 million hectares (FAO 2010b, p. 126). Nearly all of this increase occurred in South America. *Payments for ecosystem services* (PES) compensate forest owners for refraining from converting or harvesting forests, depending on the specific PES program, with the payments coming from beneficiaries of ecosystem services provided by the forests (Engel, Pagiola, and Wunder 2008). UN-REDD is an example of a global PES program aimed at tropical forests. Most domestic examples within tropical countries pertain to watershed services. As of 2011, there were 113 active watershed payment programs in developing countries, with another 53 in development (Bennett, Carroll, and Hamilton 2013, pp. x–xi).

Evaluating program impacts

Determining the impact of forest conservation programs is important for designing more effective responses to deforestation and degradation, but it is not easy (Ferraro and Pattanayak 2006, Joppa and Pfaff 2010). One cannot simply compare the deforestation rate in a particular location before the introduction of a program to the rate afterwards, because an observed decrease in the deforestation rate could be due to other factors. For example, introduction of a program might happen to coincide with a weakening of demand for agricultural commodities, which made conversion of forests to agriculture less profitable. For similar reasons, one cannot simply compare the deforestation rate in the program location to the rate in a location where the program has not been implemented. The two locations might differ in ways besides the presence or absence of the program, and one or more of those differences could also influence the rate.

Economists have developed a suite of methods that address these challenges for programs in general (not specifically conservation programs) and isolate the impact of a program from other factors that potentially confound it (Ravallion 2008; Imbens and Wooldridge 2009). These impact evaluation methods are being increasingly applied to forest conservation programs. A recent review of such applications by Miteva *et al.* (2012a) turned up several pertinent findings, all of which point toward the evidence base for conservation effectiveness being narrow and somewhat shaky. The total number of applications to forest conservation programs is still small, less than a dozen studies for each of the three program categories. Studies on PES programs cover just three countries, all in Latin America. The situation is little better for protected areas: in-depth studies have been conducted for just four countries, two in Latin America and two in Asia, in addition to a couple of broader-brush cross-country studies. African applications of impact evaluations exist only for community management rights. The literature is also narrow in terms of the conservation outcomes evaluated. No study has evaluated the impact of a given program on both deforestation and degradation. In fact, no study has evaluated the impacts of protected areas or PES programs on degradation;[1] all of the studies on protected areas and PES programs have evaluated impacts only on deforestation.

Given the narrowness of this information base, caution is required when drawing general conclusions about the effectiveness of forest conservation programs. Miteva *et al.* (2012a) conclude that evaluations of protected areas "seem to suggest that PAs [protected areas] are effective at stalling deforestation" (p. 75), at least in terms of achieving "modest reductions" (p. 69). Evidence is "less consistent" (p. 79) for community management rights, where there is "limited evidence" of a "positive impact on forest degradation" (p. 75; i.e., the programs reduced degradation), and PES programs, where studies "tend to find reduced deforestation and increased reforestation" (p. 77) but with the effects on deforestation being smaller than for protected areas (p. 79).

It is therefore currently not possible to state with any confidence the relative contributions of different forest conservation programs on the substantial reduction in tropical deforestation that occurred between 1990-2000 and 2000-2010. This task is made more difficult by the time periods analyzed by many of the studies that have evaluated these programs being restricted to just a few years during the 2000s (see Tables 1 and 2 in Blackman 2013). It is even less possible to say anything definitive about the role of these programs in reducing degradation, which most of the studies have ignored.

Making impact evaluations more economic

Impact evaluation research has the potential to generate insights that can make forest conservation programs more effective, but to achieve this

[1] One study on protected areas examined impacts on forest fires, a proxy for degradation.

potential it must broaden its scope in terms of the countries considered, the time periods analyzed, and the outcomes evaluated (in particular, degradation in addition to deforestation). It also needs to change in another way: it must become more economic (Vincent, in review). It must consider the benefits and costs of the programs evaluated and not just the programs' impacts on physical outcome measures such as area deforested, which is the normal practice. The reason physical measures are inadequate is straightforward: a program that reduces deforestation by only a small amount could still be economically justified if the forest thereby preserved provides goods and services whose value exceeds the program's costs. By the same logic, a program that reduces deforestation less than an alternative program could still be the better program if its benefits exceed its costs by a greater margin.

The potential discrepancy between physical and economic outcome measures is related to the heterogeneity of tropical forests. I have alluded to heterogeneity at several points in this chapter: for example, in the distinction between primary forests and other forests, differences in species numbers across different types of tropical forests, and varying contributions of forests to rural livelihoods. Heterogeneity affects both the benefits that tropical forests provide to humans and the costs of protecting or managing forests to supply those benefits. A study by Pattanayak and Kramer (2001) on a reforestation program in Ruteng National Park in Indonesia provides a dramatic example of the influence of forest heterogeneity. The authors investigated the effect of reforestation on streamflow available for use by farmers downstream from the park. They found that the effect varied greatly across the 37 watersheds in the park: it increased streamflow by large amounts in some watersheds and by small amounts in others, it actually *decreased* streamflow in about half of the cases. Clearly, a meaningful evaluation of the reforestation program would need to account for the fact that reforestation sometimes benefited farmers and sometimes harmed them (and this is what Pattanayak and Kramer did). Information on just the program's impact on area reforested would serve little purpose.

Miteva *et al.* (2012a) report that the focus of impact evaluation research on forest conservation programs is shifting toward the consideration of heterogeneous effects. This shift is in the right direction. Their review also offers evidence that this research has not entirely ignored economic outcomes: several studies have measured the impact of protected areas on poverty in their vicinity. This outcome measure is obviously an important one, given the role of forests in rural livelihoods. Almost entirely missing from the literature, however, is the measurement of outcomes related to any of the forest-related values that motivate the creation of conservation programs in the first place: to pick the three most obvious examples, carbon sequestration, biodiversity protection, and watershed services. A pair of studies on Indonesia by Miteva *et al.* (2012b, c) is a rare exception. The literature also suffers from "a glaring lack of cost data" (Ferraro, Hanauer, Miteva *et al.* 2013, p. 6).

Much work remains to close the gap between the impact evaluation research that has been done on forest conservation programs and the more economically relevant research that is needed to understand the effectiveness and efficiency of these programs and how they can be improved. Closing this gap is vital, given the value of tropical forests to human populations both in the countries where they are found and beyond.

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