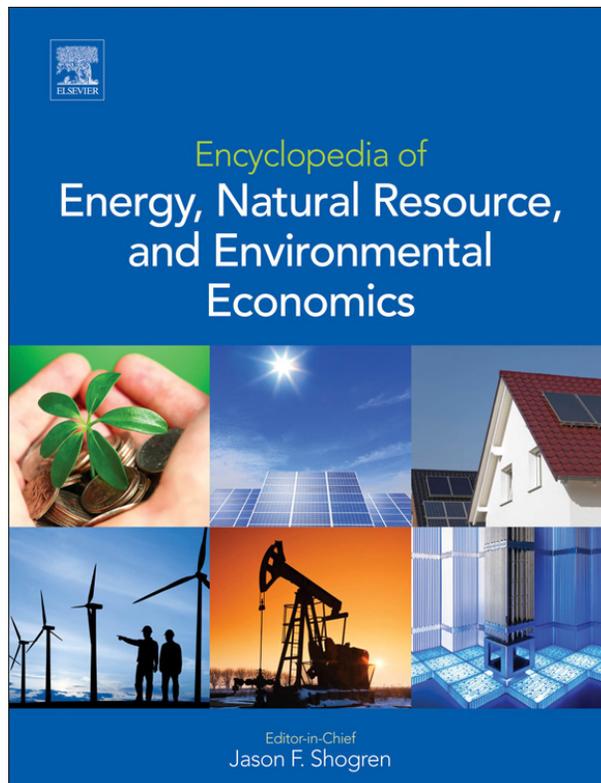


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Deforestation and Forest Degradation: Concerns, Causes, Policies, and Their Impacts

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Why Worry?

Concern about deforestation has been focused primarily upon the tropics. In the past, this was motivated largely by concern about the potential for loss of the enormous biodiversity possessed by tropical forests. More recently, the concern about forest loss has been reinforced by the recognition that deforestation and forest degradation account for roughly one-sixth of total anthropogenic emissions of greenhouse gases.

In addition, both biodiversity and carbon storage are global public goods that will require public initiative to secure their ongoing provision, as the local private agents who make the relevant production decisions capture more of deforestation's local benefits than they incur of the global costs of lower forest services. In addition to reductions in these global public goods (biodiversity and carbon storage), the total costs of deforestation include losses of regional hydrological and climatic ecosystem services, negative impacts on forest-dependent peoples – including indigenous groups – and other socioeconomic costs, such as diseases associated with forest frontiers as well as violence and the waste of high-value timber when people fight to control land. In sum, permanent conversion of tropical forest to other land uses is widely considered to have been excessive because, on net, all these costs are judged to be greater than the total societal benefit.

Deforestation clearly does have private benefit, though in particular for the agents who drive the process. Benefits have included the creation of agricultural land and resulting supply of many agricultural outputs. Particular actors in the deforestation process may also profit from the sale of timber as well as from sales of cleared land itself, given that land may rise in price or at least hold its value in inflationary economies. Keeping in mind spatial variation in costs and benefits, the operative question is not how to stop all of the deforestation, but rather what incentives produce the optimal level and spatial distribution of deforestation.

Degradation of a standing forest, like deforestation, reduces carbon storage, the quality of species habitat, and the provision of local ecosystem services, such as water quality. For instance, in parts of the dry tropics (e.g., in Africa, Central America, and South Asia), fuelwood and fodder collection lowers forests' quality. While degradation is more difficult to track because it is not as visible in remotely sensed images, recent estimates suggest that degradation due to logging may account for 10% of total emissions in the tropics.

Forest Stocks and Flows

Five countries possess more than half of the world's forests. To first order, in Russia, the USA, and Canada the forest area has

been stable in recent decades, although forest fires significantly have changed the forested landscape within Russia. Within China, forested area has increased through plantations. However within Brazil, as in most tropical countries, the native forests are being lost through conversion to agriculture.

The Food and Agriculture Organization (FAO) of the United Nations estimates that, globally, 36% of the current forested area is native forest relatively untouched by humans, which is sometimes called "primary forest." However, the majority of current forested area (57%) has naturally regenerated after some human disturbance. Also, 7% of forest area is in plantations, which are growing both in size and in importance as a source of industrial wood products. China, the USA, and Russia possess roughly half the global forested plantation area, although in tropical forested countries, such as Brazil, Indonesia, and Mexico, plantations are being rapidly expanded, partly because of higher forest growth rates than in the northern hemisphere.

Considering just the gross loss of standing forest, that is, including deforestation and loss from natural causes while excluding any gains in forest area from regeneration and plantations, the FAO estimates that the global rate of gross loss of standing forest was 16 million hectares per year during the 1990s and that this fell to 13 million hectares per year during 2000 through 2010. South America lost the largest absolute area of forest, while the highest percentage rates of deforestation have occurred within places with relatively little forest. In recent years, Brazil and Indonesia have accounted for a large portion of the global deforestation totals. While statistics about land change in Africa are generally less reliable, the Congo basin clearly also merits policy attention because it has the second largest area of contiguous tropical rainforest after the Amazon.

Ongoing Forest Loss

Globally, efforts to slow forest loss have had some impact, yet they have failed to substantially lower the rates of loss in the tropics, which have caused the most concern. In many cases, the lesson for policy is that the lack of impact is due to a failure to address incentives within the two sectors that most cause forest loss.

Agriculture is the first causal sector. Its expansion, with all associated infrastructure, is the primary driver of tropical deforestation. When forest is cleared, the land is almost always converted to crops or pasture. Thus, the rapid clearing of forest is driven by the expected benefit of producing staple foods for local and national markets, as well as internationally valued

commodities including biofuels, timber, and fiber. Deforestation pressures can be exacerbated by government support, from investments in new roads to the provision of cheap credit and easier access to titles for land cleared of forest. Some of these drivers can be shifted by government policies, whereas others are a function of global market demands, for example, for soybeans.

Forest is the second causal sector, including logging and fuelwood collection. Forest loss can be driven by the often low net benefits of sustainable forest management that result from low timber prices, due in part to supply from illegal or unsustainable operations; a lack of credit for forestry, which makes it difficult to finance upfront investments required for sustainable management; and the lack of secure tenure, which necessitates costly private protection of forest. These constraints can drive critical management choices: forest tends to be degraded rather than sustainably managed; companies build roads to access timber but then abandon the degraded forest to be cleared for agriculture; and a profit-maximizing landowner may rationally choose to clear land for agriculture rather than managing for forest products. Further, because the ecosystem services that are provided by forests usually do not generate revenue, they are not considered in decision making about the use of private land. This all leads to forest degradation, and without management also can lead to deforestation because degraded forest often is more vulnerable to clearing and disturbances, such as fire.

Domestic Development Causes

Development – often summarized as increasing income per capita – may itself affect rates of deforestation. For instance, the concept of “the forest transition” captures an empirical regularity within many countries: forest loss at first rises with economic development and then falls with further development, even to the point of reversal, that is, rising forest cover. However, it is acknowledged that this resulted in part from trade, that is, it depended at least in part upon imports from other regions incurring more forest loss than otherwise.

Whatever effect development itself may have, for forest it is also important how this development occurs. At any point along the time path of increasing income, the mix of policies can affect how forests will fare. Here, we consider policies that have caused prior deforestation but could be shifted to lower rates of loss.

Infrastructure Policies

Transport costs matter for agriculture, as well as logging and fuelwood collection. New road investments raise access to forested areas and more generally lower commodity transport costs, raising the profitability of clearing for commodities and leading to greater forest loss. This is empirically supported by studies that have linked remotely sensed deforestation data with surveys of local agents or, on a broader scale, with secondary biogeophysical and socioeconomic data, showing profit's impact. In the Amazon, for instance, one key role for logging is the building of unofficial roads that open up new areas.

Where exactly new roads go also affects the rate of forest loss because the impacts of new roads vary over space. New roads in already developed areas raise deforestation less than do new roads at a development-forest frontier. That is probably also the case for other infrastructure, such as energy pipelines. Sequencing of roads with other policies, such as tenure clarification and creation of protected areas, also affects impact.

Agricultural Policies

Deforestation rates are affected by any changes in relative profits from agriculture (versus from forest), including changes completely unrelated to forest policy, such as recessions, currency revaluations, and violent conflict. Government policies that could be shifted to reduce forest loss include subsidies through output prices (e.g., import tariffs upon competing products, subsidized processing) and input prices (interest rates, fertilizer costs), taxes, land titling requirements, and programs to reduce risks from agricultural pests and disease, or raise yields through research and development. These policies have generally increased the loss of forest given a lack of any off-setting public support for forest management.

Biofuels merit special mention given their increasing importance and the likely role of policy in their fate. If they are cultivated on croplands, then forest clearing may rise as the supply of the displaced agricultural commodity (e.g., soy) falls, and thus its price should increase. Biofuel subsidies targeting lands that are not in agricultural production, and not forested, might lower emissions from fuel use without more forest loss.

Reconsidering all of the above, while tropical forest regions are increasingly well-integrated into markets, still it is worth noting that some standard predictions are reversed in the context of ‘incomplete’ markets. For instance, high off-farm wages could lower forest clearing by increasing the opportunity costs of labor, yet when credit markets are incomplete that element of development could, instead, relax cash constraints and thus increase clearing of forest. Another well-known example, whose relevance is debated, is that any policy that increases yields could lower clearing when production is for subsistence instead of markets.

Land Tenure

Regimes where clearing of the forest yields squatter's rights, and eventually perhaps title, long have promoted deforestation. Even clearing that is not followed by profitable land use may lead to profits by allowing acquisition of title, which facilitates credit as well as future resale. Insecurity in such land rights is believed to affect the advancement, and even the location, of agricultural forested frontiers. For instance, to obtain their own plots people may go to where access is established but tenure is not yet.

Even with official permanent title, the risk of expropriation of one's forested land reduces one's incentive for long-term sustainable management. Such possibilities also increase the chances that smallholders and communities will be exploited by illegal loggers and trespassers, as is widespread in tropical forested regions. In the Brazilian Amazon, it has been asserted that only land clearing for at least 5 years protects against such risks. The costs of protecting forest land tend to be high particularly where government enforcement is limited because

of budgets, remoteness, and corruption. This lowers investments in sustainable management of native forest and intensive production forestry (e.g., plantations). Such costs influence land-use choice.

Corruption

Government corruption is present in many developing countries possessing large forest areas. It can take the form of large firms influencing government policy, land allocation, and concession choices, or of smaller firms or landowners bribing state officials to overlook rules regarding land use, harvesting, processing, or exporting. Corruption and forest pressure from resulting illegal activities have been documented in Africa, Asia, and Latin America. It is accepted that the rule of law affects deforestation, and bribes, for example, to allow illegal timber trade, have been singled out as confounding efforts to promulgate better forest policy.

Corruption is more likely when discretionary power is held by government officials in positions featuring access to bribes, as well as when there are high rents to government-owned resources and the probability of detection or punishment is low. This suggests corruption can be limited by well-financed enforcement systems, for example, by high wages for public officials combined with a relatively high probability of detection. For the forestry sector, researchers find more corruption with underpaid government forest inspectors, as well as with: complex regulations involving property rights; many bureaucratic steps to obtain permits to use or to establish productive forests; lower penalties for illegal logging; and open access to native forest.

Domestic Conservation Policies

Protected Areas

Protected areas (PAs) are the most common policy that explicitly targets conservation of forests, and their area has increased substantially over the past 2 decades. PAs have been established with quite a wide range of institutional arrangements, from strictly protected areas, such as national parks managed by central government agencies, to state reserves that are managed for multiple uses by the local community. Strict PAs do reduce deforestation, but less than often assumed as they tend to be located in sites facing relatively low threat of forest loss. Selecting sites for many reasons, including specific ecosystem services, created PA networks on land with higher slope and lower soil quality, relatively far from roads and cities. For sites not profitable for clearing – not facing an imminent threat – protection has little short-run impact.

This suggests that spatial planning should consider threats as part of assessing the benefits of protection. Such planning or spatial targeting, or more generally siting, can be affected by institutional arrangements. For instance, recent research suggests that various forms of multiple-use areas permitting some extraction, including indigenous reserves, avoid more deforestation and fires on net despite allowing deforestation. The reason is their higher threat locations. One possibility is that permitting some local needs to be met allows for PAs in such locations, although political-economic dynamics that

influence siting vary widely. Factors affecting siting affect PA impacts (while correcting for siting biases improves impact evaluation).

Ecopayments

Payments for ecosystem services (PES), such as water quality, habitat, or carbon storage, can reward owners for conserving forests that generate those services instead of clearing for agriculture. It is clear why this might be assumed to reduce forest loss but, just as governments may put PAs in more remote areas with less threat, landowners may seek PES for lands that they are not planning to convert. PES programs typically are voluntary, with landowners choosing whether to volunteer and which lands. Land that can produce high profits is more likely to be cleared and less likely to be offered for the PES.

Within the early stages of Costa Rica's early and famous PES program, for instance, participants differed significantly from non-participants in characteristics that are relevant for land use. Thus, it is no surprise that research on Costa Rica's and Mexico's programs finds that deforestation would have been lower on the paid parcels regardless of payments. The small effects PES did have are varied across space and time, for example, in Costa Rica, in part because of NGOs within particular regions as well as shifts in the national policy.

Concessions

Logging within government forests often is carried out under private concession contracts. Typically, large foreign firms bid for contracts stating a volume or area to harvest within a given period. Environmentally sensitive harvesting methods (for instance techniques for "reduced impact logging") increasingly are required. Harvesters pay royalties for the right to harvest, yet inappropriate royalty rates or inadequate enforcement can increase forest degradation, for example, triggering illegal logging despite reformed concession laws. Challenges include revenue capture, exclusion of illegal loggers, and enforcement.

Illegal logging in tropical forests typically means harvesting outside of agreed areas and failing to declare actual harvested volumes or to use agreed methods. A common recommendation is to raise royalty rates in order to increase rent collection as well as to reduce excess harvest. Others call for more enforcement, but this is costly and its impacts depend on logging firms' risk preferences as well as the type of penalties. Another policy alongside concessions has been export bans for logs. Their effects on deforestation are not clear; they are not all well enforced and have led to adjustments, such as further processing prior to export.

Decentralization

Most tropical forests are state-owned, so millions who live in them have "use" rights but – at least in a legal sense – no rights to own, manage, or block others' exploitation of local resources. However, now many governments have devolved some forest ownership and management to local institutions. As of 2001, at least 60 countries had reported some decentralization reforms within natural resources.

Increasingly, this includes local community property rights to forests. While individual or state ownerships were long the only options considered, interest has grown in regimes in which groups of forest users hold management responsibility. Common property regimes with local control can be efficient relative to individual ownership if productivity is greater for larger units, or relative to state ownership given gains from local knowledge and monitoring. However, for decentralization to achieve its potential, devolved powers must go to institutions accountable to all locals and complementary to other parts of governance, including higher levels of government, which can help enforce rights of exclusion and mediate conflicts.

Forests under community management in India have been sustainably managed for decades, and there is some evidence that such local community councils conserve forests more effectively than state agencies. Yet in general decentralization cannot be considered a panacea for all situations, and, without question, it could lead to increases in deforestation. Traditional communities are not inherently focused upon conservation *per se*, although they may depend on forests. Especially if forest rights are not secure, for instance if residents feel that rights will be revoked, people may accrue forest profits while they can.

International Policies

Few international policy initiatives have influenced the underlying drivers of deforestation, if they have even focused upon them, or sustainably improved rural economic conditions and development practices. Nonetheless, there are cases where targeted, well-managed international efforts have catalyzed domestic pressures for reforms, or realigned political and economic interests to achieve tropical forest conservation.

Loan Conditionality

Before 1990 most long-term aid carried little or no effective forest conditionality. Partly in response to unsustainable forestry practices, starting during the 1990s increasingly specific reforms were attached to international lending, such as improving law enforcement or expanding PAs. Often conditionality failed to bring about the envisioned (at times sweeping) changes in policy, yet there have been successes when the interests of lenders and key local stakeholders aligned, such that the conditions imposed on loans reinforced local reform agendas. In some cases in Africa and Southeast Asia, loan conditionality backed domestic interests that had lacked political capacity to enact change given opposition from industry. In the Philippines, World Bank loans allowed the government to raise logging taxes, resist special interests, and enforce forestry laws despite a powerful opposing lobby. A similar case unfolded within Papua New Guinea, where conditional adjustment lending allowed reform advocates already within the government to consolidate and implement policies to curb illegal logging.

Donor Coordination

Donor coordination aims to increase the effectiveness and efficiency of development assistance by reducing duplication and administrative burden while increasing strategic targeting of aid. Yet fragmentation of efforts, an overly technical focus, and poor policy selection all persist as challenges. Even coordinated donor efforts can be expected to fail in efficiently lowering forest loss if governments do not share donors' goals, if contracts cannot be used effectively, and if corruption captures core funds.

A Tropical Forestry Action Program (TFAP), founded in 1985, increased aid, coordinated spending, and developed national plans for sustainable practices, fuelwood and energy activities, and forest conservation. Under this initiative, over 40 agencies and NGOs contributed to 70 recipient countries that possess 60% of the tropical forest area. In the same time-frame (1980–90), tropical deforestation rose by 40% to nearly 17 million ha/year. We cannot know what forest loss would have been without TFAP, but clearly it did not reduce loss as much as hoped, and many consider it to have been a failure. Some faulted the TFAP for not including forest-dependent communities and not addressing all root causes of deforestation, such as those originating outside of the forest sector *per se*, for instance within the highly relevant agricultural sector.

Another multidonor effort was the Pilot Program to Conserve the Brazilian Rain Forest (or PPG7). This initiative appears to have built Brazilian capacity, for example, by modernizing scientific research centers and fire training, though with unknown impacts. One widely lauded accomplishment is the involvement of forest-dependent communities in setting up boundaries for forest reserves and indigenous land, which have been found to result in additional forest conservation at a relatively low cost, at least in terms of external funds. A key lesson is the importance of local 'buy-in,' including from the many forest-dependent communities.

Debt Relief

Government debt may raise forest loss if it encourages governments to raise more revenues, from timber royalties or agricultural taxes, by expanding the forested area used for harvest or for clearing. Devaluation to raise revenue may increase forest clearing too, because of rising agricultural or timber exports. Finally, debt also can restrict a government's spending on the enforcement of its forest conservation laws.

Debt relief structured specifically to generate funding for forest conservation, for example, 'debt-for-nature swaps,' has generated US\$140 million in locally denominated relief across the tropics. Conservation NGOs have purchased debt at a discount and then traded it back to debtor countries in exchange for establishment of conservation trust funds, although with uncertain impacts upon deforestation. Under the Tropical Forest Conservation Act of 2009, the US government reduced debts of 13 countries (most in Latin America).

Demand Management

Decreased global demands for pulp, paper, food, biofuel, and other outputs of both deforestation and degradation in principle could lower forest loss. While most industrial roundwood

from developing countries is consumed in those countries, for example, trade in logs and in processed outputs (particularly via China) is worth hundreds of billions of dollars. Also, for instance, Brazil exports a large portion of its beef and soy production, while most palm oil is exported from Southeast Asian producers. Slowing forest loss without addressing demand faces serious challenges. Supply-side actions like wood processing fees or log export bans may not be effective if returns to harvesting logs are sufficiently high.

In practice, growing 'soft policy' (driven by non-governmental actors) designed to influence trade flows through such channels appears to have real but limited impact. Campaigns against "rainforest beef" or in favor of 'forest-friendly' commodities, such as certified timber and nontimber forest products, have rarely shifted global prices significantly, though they have created some market niches. Forest certification may shift relevant demand, but few developing countries have certified large areas of native forest (FSC 2009).

Government regulation of trade can also mitigate the impact upon forests of global commodity demands. The EU's FLEGT program aims to reduce illegal imports of timber by financing improved governance, although critics assert that voluntary bilateral agreements are less effective than legally binding controls. The Lacey Act in the United States is an example of such legally binding controls. This longstanding act regulates trade in endangered species, and it was amended in 2008 to be applicable also to illegally sourced wood.

REDD+

Under the UN Framework Convention on Climate Change, negotiations are ongoing to create an international incentive system for developing countries to reduce emissions from deforestation and forest degradation, and promote conservation and sustainable management of forests and enhancement of forest carbon stocks (often referred to as REDD+). Compared to the past, this could provide more funding and require greater accountability for slowing forest losses. Reducing deforestation could substantially reduce emissions, and developed countries could finance this in order to meet their targets for reduced emissions.

Several reviews of policy alternatives to reduce greenhouse-gas emissions have concluded that REDD+ is one of the least expensive options, primarily because the land under tropical forest is widely considered to have low potential in alternative uses, such as agriculture. Yet in some parts of the tropics, deforestation is now driven primarily by market forces, with production of international commodities, such as beef and oil palm, being profitable on previously forested lands. Also, most tropical forest is now occupied or used by traditional peoples who depend on forests and make historical access claims, sometimes with legal rights. They could bear significant costs if REDD+ blocks their access, and a related point is that effective forest conservation can have large transactions costs, for example, to clarify land tenure to identify who is held accountable for deforestation. Adding these to opportunity costs, REDD+ no longer appears to be low cost.

Despite these significant challenges and also in part because they are not always so widely acknowledged, there remains strong international interest in REDD+, with many pilot

projects implemented by NGOs and supported by bilateral donors. This is partly because carbon is just one benefit from avoided deforestation, and many supporters of REDD+ also value co-benefits, such as biodiversity and regional ecosystem services, which are not going to be provided by most or any of the alternative, non-forest-based emissions policies.

Lessons for Future Policy Initiatives?

Two opposite schools of thought are emerging regarding the role of policies that could reduce forest loss. One asserts that the cost of stopping deforestation is the opportunity cost of foregone alternative land uses (e.g., profits generated by agriculture). Many who hold this view focus on regions where the profits from deforestation and degradation are perceived to be low, and conclude that conservation is relatively cheap.

The second view implies considerably higher cost, although often the costs are not quantified. Underlying this view is pessimism about the possibilities for reducing forest loss, given the high transactions costs and the poor track record of many previous policy efforts. For instance, many countries currently are thought to lack the governance capacity to effectively implement new and appropriate policy programs.

We believe, looking ahead, that the reality will lie between these extremes. In particular, under a global REDD+ mechanism there are indeed opportunities to avoid tropical deforestation at a relatively low cost compared to other options for reducing greenhouse-gas emissions. Yet related claims about the forest conservation opportunities immediately available have likely been overstated, since the actual costs of reducing deforestation include costs to reform land tenure, to distribute payments, and to establish, manage, and monitor protected areas, for instance. Continued demand for wood and for agricultural products, along with population pressures, weak governance, and other institutional factors constrain the reduction of deforestation and degradation. Thus, opportunity costs do not always indicate the full costs of conservation, but instead a minimum for or a lower bound on the costs of implementing a forest policy.

Our review of past efforts to halt tropical deforestation is sobering. However, as discussed above, many features of past policies could be drastically improved in the future. Future policies, including REDD, could be designed and implemented to change defaults, and thus lead local actors to value providing forest services, making it locally profitable to manage for the local and global goods that intact forests provide.

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