As primary forests become increasingly rare and expensive to protect, many ecologists are looking to better management of Human Modified Landscapes (HMLs) to shepherd and shield biodiversity in the tropics. Secondary forests, selectively logged forests and lands devoted to sustainable agriculture already play an important role in conservation efforts. However, the idea that HMLs will serve as a "Noah's Ark" for biodiversity, is controversial.

In the 2013 paper, "On the hope for biodiversity friendly tropical landscapes" published in Trends in Ecology and Evolution, scientists venture into the complex topic of HMLs, setting up a framework that connects disturbance, land use, ecosystem services and biodiversity. The paper also offers a model showing potential outcomes for forests in response to different styles of forest management.

"The most important controversy is that the HML is sometimes assumed by default as viable conservation landscapes, mostly based on the number of species they can harbor at the present," lead author Felipe Melo of Universidade Federal de Pernambuco, Brazil, told mongabay.com. "However, we argue that biodiversity persistence in HML is completely context-dependent."

Context does seem to be key. Along with human use and disturbance, forest size, type, and the surrounding landscape matrix all affect the biodiversity friendliness of an HML.

The landscape matrix is the background cover type in a landscape, the stuff between and around the HMLs. An HML is limited in biodiversity conservation potential by this very matrix. For instance, a forest fragment embedded in a harsh matrix, such as a large clear-cut area, does not fare well. Yet even small patches of tropical forest can support long-term biodiversity if they are embedded in a large-scale forested landscape.
Land management practices vary, and researchers are at odds as to which best support biodiversity. Beyond this management-style disagreement, a debate exists known as "land sparing versus land sharing." Land sparing argues that setting aside intact ecosystems, for example in large parks, while dedicating remaining lands to intensive agriculture is the best approach to species conservation. Land sharing, however, argues against industrial agriculture urging mixed land use, for examples supporting farming practices such as agroforestry, which combines forest components or tree planting with the growth of products for people.

Research supports both schools of thought. In several instances, "land sharing" agroforestry practices have proven effective in retaining biodiversity. In the Western Ghats of India, areca nut plantations still retain 90 percent of the bird diversity of native forests in the region, after two thousand years of cultivation in the area. Due to costs, scientists often measure bird and tree diversity as biodiversity indicators, and many data sets support the idea that shade-grown crops support bird diversity. This has left many questioning the effects on other species. In the Brazilian Atlantic forests where less than 6 percent of primary forest remains, one study found that in addition to birds and trees, 70 percent of bat, butterfly, fern, frog, and mammal species (to name a few) flourished in shade grown cacao crops.

A 2011 study conducted in Ghana and published in Science came out in favor of "land sparing" when researchers concluded that setting aside land for protection and using other land for intensive agriculture was the best way to both feed people and conserve species. In later comments about the study on mongabay.com, the lead researcher made it clear that they were not making a case against agroforestry, but that they encourage both "land sparing" and a move away from harmful industrial agricultural practices such as monocultures.

When asked for some successful cases of HMLs as havens for biodiversity, Melo replied, "There are no safe havens for biodiversity, at all. Even protected areas are suffering from local extinctions of forest dependent species. Amongst the HML, however, we believe that low-intensity agriculture practices such as agroforestry and some shaded cultures such as cacao and coffee should be friendlier to biodiversity. Thus, the main challenge is making such wildlife-friendly farming more profitable and competitive."

The study by Melo and his team provides a conceptual model showing the results of different styles of forest management for forests. Given the overall complexity of the topic, this model represents a major contribution to the field.

"The model aims to show that some key landscape attributes such as the amount of old-growth forest habitat and connectivity among forest patches will determine the potential for natural regeneration and the probability of long-term persistence in the HML," Melo says. "The take-home message being that lack of management and forest protection will drive HML to degraded state that is likely to be irreversible without human intervention such as forest restoration."

Many questions remain unanswered in this emerging field, which Melo calls "the ecology of disturbance," especially in regards to how ecosystems will perform in a human matrix. Given this, the study ends with a call for more research: "Classical ecological theory was developed to explain the world under 'normal' circumstances and to understand the ecology of the disturbance should be a good chance to refine our understanding of the real world."

Conservation policies that boost farm yields may ultimately undermine forest protection, argues study
mongabay.com
April 17, 2013

Rising agricultural profitability due to higher prices, improved crop productivity, and forest conservation itself could make it increasingly difficult for conservation programs tied to payments for ecosystem services to succeed, warns a study published this week in the journal *Proceedings of the National Academy of Sciences*.

The prediction is based on a model that forecasts the potential impact of agricultural intensification on small farmers' behavior in the Democratic Republic of Congo (DRC). Whereas subsistence farmers may now accept a pittance for abandoning low-yielding agriculture, in the future, higher-yields from improved genetic stock (including genetically modified crops), increased fertilizer use, and better farming practices would necessitate far higher payments to persuade farmers to keep forests standing. In other words, a program that compensated farmers based on the carbon stored in forests — like the nascent Reducing Emissions from Deforestation and Degradation (REDD+) mechanism — would have difficulty competing against increasingly industrialized agriculture.

"Our research suggests that as agriculture becomes more intensive, the small payments successful at incentivizing forest conservation today could increase to well beyond what is considered economically efficient, or even feasible," said study lead author Jacob Phelps of the National University of Singapore. "We anticipate that similar patterns are likely across the tropics, including in places like Indonesia."

---

**Relationship between REDD+ policies, agricultural intensification, and deforestation.** New REDD+ policies drive agricultural intensification, which increases future agricultural rents and incentivizes forest clearing for agricultural expansion. A number of feedbacks (e.g., reinvestment, in-migration) create further incentives for expansion. Whether these result in deforestation or land sparing for conservation depends on two mediating factors (1): robust forest sector governance and (2) whether REDD+ payments match future agricultural rents.
The results add weight to arguments made elsewhere. For example, Greenpeace and the Rainforest Foundation UK both cited the issue in their criticism of McKinsey’s cost curve for mitigating greenhouse gas emissions from deforestation. The activist groups said that REDD+ wouldn’t compete be able to financially with industrial activities, including large-scale commercial agriculture and mining, and thereby fail to address major drivers of deforestation. Several studies also suggested that financial returns from REDD+ would not be sufficiently high to compete with palm oil production, which is one of the most profitable forms of land use in the tropics. One paper even argued that REDD+ could undermine less yield-oriented forms of agriculture like organic farming.

In the PNAS study, Phelps and colleagues found that financial break-even points for REDD+ versus cassava and maize cultivation in DRC would require higher and higher carbon prices as crop productivity increased.

"Increasing agricultural rents are likely to incentivize future agricultural expansion, including through forest encroachment."

Subistence agriculture like this in Suriname may be cheap to stop now, but as farming becomes more industrialized like the oil palm plantation in Borneo below, it will be increasingly costly to discourage.
The study seems to highlight the risk that while a program like REDD+ could work in the short-term while crop prices and yields are moderate, it may fail to protect forests in the long-run when prices and yields are higher. The authors add that forest conservation initiatives could even have a perverse impact if they focus on intensifying agricultural production.

"Our conceptual framework, supported by the illustrative model of the DRC, highlights how conservation policies that promote intensification anticipating automatic long-term forest conservation and emissions reductions may face unintended outcomes," they write. "Curiously, conservation policies that promote or impose an intensification agenda on extensive farmers may actually spur future agricultural expansion."

While illustrative, the study does come with some important caveats when evaluated on a scale beyond DRC. For one, it doesn't directly account for the likelihood that higher profitability could encourage expansion into non-forest areas like degraded lands. Brazil and Indonesia both boast tens of millions of hectares of such lands. It also excludes the value of forest products — timber, food, and other non-wood forest products — that might continue to be available to local communities under REDD+ programs. Nor does it factor in potential payments for other ecosystem services (PES) like water and biodiversity. Nonetheless the research does raise significant points of consideration for the design of REDD+ and other PES schemes.

"Conservation policies that overlook future agricultural rents may fail to promote long-term conservation," the authors write. "While our model was illustrative, rather than predictive ... it highlights the possible impacts of agricultural intensification to long-term tenability of conservation incentives such as REDD+, and highlights under-investigated issues such as the importance of recurring conservation incentives and viability of financial versus nonfinancial incentives."

Could forest conservation payments undermine organic agriculture?
Rhett A. Butler, mongabay.com
September 07, 2010

Forest carbon payment programs like the proposed reducing emissions from deforestation and degradation (REDD) mechanism could put pressure on "wildlife-friendly" farming techniques by increasing the need to intensify agricultural production, warns a paper published this June in Conservation Biology.

The paper, written by Jaboury Ghazoul and Lian Pin Koh of ETH Zurich and myself in September 2009, posits that by increasing the opportunity cost of conversion of forest land for agriculture, REDD will potentially constrain the amount of land available to meet growing demand for food. Because organic agriculture and other biodiversity-friendly farming practices generally have lower yields than industrial agriculture, REDD will therefore encourage a shift toward from more productive forms of food production.

"Land sparing, that is intensive farming on a smaller area of land, may offer more hope for meeting agricultural demands at lower costs to biological diversity than wildlife-friendly farming," we write. "Because land productivity under intensive agriculture is high, the opportunity costs of REDD will rise, particularly as demand for commodities rises."

We cite the expected demand for rubber as an example.

By 2050 growth in car ownership may necessitate production of 164 million metric tons of natural rubber for the tires alone, which would require 54 million ha of land under intensive rubber production or 161 million ha under lower-yield agroforestry production. In other words, the acreage requirements for low-yield, "jungle rubber" holdings are three times greater than industrial plantations.

Of course REDD may improve the viability of agricultural production on degraded lands, potentially relieving some of the pressure to intensify agriculture. Nevertheless the amount of land needed to meet forecast demand for food, fuel, and fiber is immense: 400-500 million hectares of new plantations and croplands may well be needed by 2050, assuming a 2-3 percent annual improvement in yields, a rosy scenario given the marginal productivity of...
So what is the future of wildlife-friendly farming techniques in a land-constrained world where forests are increasing pit against human consumption? We don’t pretend to know the answer.

While wildlife-friendly farming offers greater opportunities for carbon sequestration (potentially combining biodiversity and climate change mitigation goals), it suffers from lower yields than industrial approaches to food production, making meeting future demand from a hungrier and more populous humanity all the more challenging.


Comments (0)


Mongabay.com seeks to raise interest in and appreciation of wild lands and wildlife, while examining the impact of emerging trends in climate, technology, economics, and finance on conservation and development.

Copyright mongabay 2009
Controversial study finds intensive farming partnered with strict protected areas is best for biodiversity

Jeremy Hance
mongabay.com
September 01, 2011

Tropical forest in Ghana, an irreplaceable habitat for many species. Photo courtesy of Ben Phalan.

Given that we have very likely entered an age of mass extinction—and human population continues to rise (not unrelated)—researchers are scrambling to determine the best methods to save the world's suffering species. In the midst of this debate, a new study in *Science*, which is bound to have detractors, has found that setting aside land for strict protection coupled with intensive farming is the best way to both preserve species and feed a growing human world. However, other researchers say the study is missing the point, both on global hunger and biodiversity.

While many factors are behind the decline in global species, the biggest is habitat loss, with natural ecosystems usually losing out to agricultural expansion. This situation has led to a debate among researchers known as "land sparing versus land sharing". Land sparing argues the best way to conserve species is to set aside as much intact ecosystems as possible, while intensively growing crops on remaining land. Land sharing, however, argues that agriculture should forgo industrialization and become more biodiversity-friendly, allowing species to survive in a mix of forests and less-impact agriculture. According to the new study, land sparing achieves a better result for biodiversity than seeing land as both a reservoir for agriculture and species.

"It would be nice to think that we could conserve species and produce lots of food, all on the same land," said study author, Malvika Onial from the University of Cambridge, in a press release. "But our data from Ghana and India show that's not the best option for most species. To produce a given amount of food, it would be better for biodiversity to farm as productively as possible, if that allows more natural habitat to be protected or restored."
The study measured populations of 341 bird species and 260 trees in Ghana and India across "remnants of forest within a matrix of farmland ranging from diverse low-yielding mosaic agriculture to large-scale high-yielding monocultures."

The results, they say, were unambiguous: species would have the largest populations—and therefore be the furthest from extinction—if farming was kept to a minimal amount of land growing high yields, while natural habitat was set aside. The results worked both for rare and common species.

"Farmland with some retained natural vegetation had more species of birds and trees than high-yielding monocultures of oil palm, rice or wheat but produced far less food energy and profit per hectare," explains lead author Dr Ben Phalan from the University of Cambridge. "As well as requiring more land to produce the same amount of food, the 'wildlife-friendly' farmlands were not as wildlife-friendly as they first appeared. Compared with forest, they failed to provide good habitat for the majority of bird and tree species in either region."

However, the authors caution that their study should not be taken as one-size-fits-all, since it only looked at two regions—southwest Ghana and northern India—and two types of species, birds and trees.

Still with these findings in hand, the researchers conclude that India and Ghana "could produce more food with minimal further negative impacts on forest species if they were to implement ambitious programs of forest protection and restoration alongside sustainable increases in agricultural yield, but they could not if they adopted land sharing."

William Laurance, a tropical forest scientist with James Cook University, told mongabay.com that the study makes a good point, although there are caveats.

"Broadly speaking, I'm inclined to agree with the authors' conclusions," Laurance says. "However, there's a lot of local variation in land-use practices across the tropics that could influence whether land-sharing or land-sparing is the best alternative. Land-sparing can be difficult to achieve in some regions—for instance, many protected areas in the tropics, which are supposed to be spared from development, are suffering from various forms of encroachment. So, the decision of whether to favor land-sparing or land-sharing may well depend on the local context, though when it's feasible I do believe a land-sparing approach will generally be superior for biodiversity."

The authors of the study agree with Laurance that their results are "not enough to argue that land sparing is the optimal strategy for reconciling food production and biodiversity conservation everywhere and for all taxa," according to their paper. But they argue that similar studies should be conducted elsewhere to strike the right balance between land sharing and land sparing.

However, not every researcher believes that this debate is the right one for biodiversity or for...
feeding the world. Ivette Perfecto, who has spent her career studying how farmers can work with nature instead of against it, says that focusing on land sharing versus land sparing entirely misses the point on global hunger.

"The problem of hunger and starvation in the world is largely a consequence of access to food that is already available, and increasing per hectare productivity especially in large-scale monocultures is not likely to change this problem, which is fundamentally a socioeconomic and political one," Perfecto told mongabay.com, adding that, "the need to feed the world should not be used as an excuse to continue with an agricultural model that degrades the environment and has failed to eliminate hunger in the world."

As of 2009 a billion people in the world—the most in history—suffered from hunger, despite the fact that there is more than enough food to go around, according to Perfecto.

She says that when it comes to hunger and biodiversity, small-scale farms that practice agroecology—applying ecological principles to growing crops—have in fact been shown as incredibly effective, both in tackling food problems and preserving species and ecosystem services.

"Food production in smallholder farms is the key to food security and to the conservation of biodiversity. Increasing food production locally, where the poor live, can be accomplished using agroecological methods that can promote biodiversity both within farming systems and at the landscape level," says Perfecto, who adds that industrial agriculture does not necessarily mean other land will be spared, instead her research has shown that industrial agriculture "frequently leads to more deforestation and loss of biodiversity." In other words large-scale commercial agriculture simply begets more large-scale commercial agriculture, devastating ecosystems and species in the process.

Study author, Rhys Green from the Royal Society for the Protection of Birds (RSPB) and the University of Cambridge, says that their *Science* study is not meant to grant carte blanche to industrialized agriculture.

"High-yielding organic farming and other systems such as agroforestry can be a useful component of a land sparing strategy and may offer the additional advantage of fewer adverse effects of farming from fertilizers and pesticides," he admits. "But whatever the farming system, protection of natural habitats will continue to be essential for the conservation of many species."

But Perfecto argues that the land sparing argument tacitly accepts the need for large-scale industrialized agriculture.

"The land sparing/land sharing debate is a false debate proposed by those who wish to justify the continuation of industrial agriculture," she told mongabay.com "Those of us that 'argue for 'land sharing' or wildlife-friendly farming recognize the importance of maintaining natural habitat and argue that there is no need to destroy more natural habitat in order to produce enough food to feed the world."

---

Comments from Ben Phalan, lead author of the study after the article was published: I'd like to respond to some of the criticisms here. We agree that solving hunger is about far more than increasing food production. But it is food production which affects biodiversity. Our conclusion that land sparing would be a better option than land sharing holds even if total production could be frozen or substantially reduced (see figure 2 of our paper). Therefore, arguing against our conclusion on the grounds that total production could be frozen or cut does not stack up.

We have no wish to "justify the continuation of industrial agriculture." Look at our past publications: what we are concerned about is how biodiversity conservation can be more effective. Our results persuade us that – at least in southwest Ghana and northern India – the conservation potential of land sharing is more limited than often recognised. Land sparing is not about business-as-usual, but needs to be radical and innovative, and might often involve smallholder farmers.
In seeking a "solution" to deforestation of tropical rainforests—whether it be through debt-for-nature-swaps, extractive reserves, selective logging, ecotourism, or another strategy—the ultimate fate of forests rests in the hands of local people. While some would argue that rainforests can be "saved" by restricting economic growth, it is necessary to realize that parks and reserves will not persist unless local communities are persuaded that it is in their material interest to conserve.

Agriculture

For thousands of years tropical rainforests have been managed to sustain productive agriculture and at times to support dense human populations. It is estimated that more land was under cultivation in the Amazon on the eve of the arrival of Columbus than is today. Studies suggest that perhaps 12 percent of Amazonian terra firme (upland) forests are "anthropogenic in nature, resulting from prolonged management by prehistoric populations." The fact that certain forms of agriculture are possible is a vital consideration for the sustainable, economic development of tropical rainforests.

Rainforests have a long history of disturbance by humans who promoted areas of concentrated diversity of useful species within a diverse landscape. Without undermining the ecological basis of production, indigenous communities promoted the abundance of certain valuable species by creating conditions favoring their growth and development. They fostered palm forests, groves of Brazil nuts and fruit trees, and vine forests near ancient Amazonian settlements (past settlements are marked by the presence of pottery and anthropogenic "black soils"). These vegetation types have species useful for everyday life.

Actions

Today we can incorporate the techniques of indigenous peoples into agricultural projects in the rainforest to increase the productivity of degraded forest lands and promote sustainable use of forest resources. Through agroforestry and floodplain orchards, outright destruction of rainforests can be avoided, while improving economic efficiency and providing a source of income for rural poor.

Roughly a third to two-fifths of rainforest deforestation is caused by the shifted cultivator, who is usually pushed to marginal lands by lack of other suitable land. In some areas these farmers may be forced into the forests as a result of population growth and by landowners who hold large tracts of farmland. In many countries, wealthy landholders—who have the most political clout—control the most productive lands, leaving the small farmers little choice but to clear a homestead from the forest. For example, in Brazil, 10 percent of the population owns almost 90 percent of the fertile land. In many countries, the politically expedient way of dealing with this skewed land distribution has been to open up "unused" wildlands for poor farmers, rather than confront large landowners.

Some argue that some form of agrarian land reform is the best way to attack forest loss caused by "swidden agriculture." Land reform may turn some productive land over to poor farmers and be accomplished by reducing subsidies granted to large landowners for leaving tracts of their land uncultivated.
An additional, potentially complementary, approach to addressing the needs of the shifted cultivator and agriculturist alike is improving and intensifying currently existing agricultural projects and promoting alternative cultivation techniques—notably agroforestry—based on those used by indigenous forest dwellers. Many cleared forest areas used for agriculture and now in decline can be salvaged by cultivation techniques that loosely mimic the diversity of the surrounding rainforest. In other words, polycultural fields—patchworks of perennial crops, annual crops, pasture land, secondary growth, and forest—could be the key to increasing agricultural productivity and reducing destruction in many rainforests.

Historically, agriculture in the Amazon rainforest has had a highly dynamic nature whether it be on a grand scale or at a subsistence level. Today a good deal of rainforest agriculture consists of monocultures (single crop fields) of annual crops, which must be replanted on a regular basis to sustain yields. Poor tropical soils quickly wear out under a regime of annuals, and fertilizers must be added or additional forest cleared if growth is to continue.

Many forest dwellers instead focus on perennials—crops which continue to produce for a number of years like citrus, manioc, vanilla, banana, mango, pepper, cacao, coffee, and rubber—as the basis of their agricultural techniques. Instead of continually clearing new sections of forest, these cultivators plant perennials or a mixture of perennials and annuals on their patch of land. Perennials can help restore nutrients to degraded soils, and they remain productive for decades, bringing a steady stream of cash to needy farmers.

A mixture of perennials and annuals often works best for small agricultural plots because such polycultural fields provide a diversified income (prices of many cash crops are notoriously volatile), as well as insurance if one crop fails. The home gardens of many forest dwellers are one form of agriculture well-suited to the rainforest environment. These diverse agroforestry systems provide a wealth of plant species—both local and foreign, since tropical plants like mango, pineapple, manioc, papaya, and orange have almost cosmopolitan distribution today. These species are also useful in everyday life. Home gardens can serve as a living pharmacy and a local hardware store, while providing shade for humans and livestock, foods for the kitchen, and ornamentals. Many home gardens contain remnants from old-growth forest in that useful forest trees (like Brazil nuts) are often left standing when clearing a homestead.

An added bonus of such agroforestry systems is that they maintain forest systems, soils, and biological diversity at a far higher level than do industrial agricultural techniques. As long as such fields are adjacent to secondary and old-growth forest, many species will continue to thrive. Growing crops like coffee, cocoa, bananas, and vanilla in the shade of canopy trees preserves more biodiversity than standard cultivation techniques. In recent years, "rainforest-friendly" coffee has gained popularity and is now heavily promoted in some parts of the United States. Polycultural fields also recover considerably faster than conventional fields when they are abandoned, because forest systems are maintained, including hydrological cycles, nutrient recycling, and seed dispersal.

Additionally, seed banks in the soil persist and crop trees provide shade necessary for canopy tree-seed generation, allowing a relatively smooth transition to secondary forest once the farmer moves on to a new area.
Despite all these positives, sustainable agriculture faces several hurdles in reaching widespread acceptance. Agroforestry and other forms of reduced-impact agriculture are more attuned to the ecological realities than most forms of agriculture in the rainforest, but they must also be attuned to economic realities. For example, many migrants to the rainforest are ignorant of such cultivation methods. Instead—assuming they even know anything of agricultural techniques—they often rely on what works in different climates and soil conditions—methods that typically fail on cleared rainforest lands. Thus, one major challenge in promoting agroforestry is overcoming the ignorance of people who may have migrated to forest areas from cities about farming techniques that are effective in tropical areas. A second obstacle is the lack of access for many rural poor. Without means to transport their goods to market or even a market for their goods, locals have little chance of turning a profit for their labor. Another issue is a general lack of credit facilities from which poor farmers can borrow in times of need. Overcoming these obstacles—whether through improvement of existing roads, education systems, microfinance, or other means—will bring us much closer to resolving the shifted-cultivator problem.

Agroforestry techniques can be applied on a larger scale using corridors of forest and a mixture of perennials and annuals. While management and harvesting costs generally increase, these negatives could be outweighed by the value of income diversification, soil protection, maintenance of forest functions, and preservation of biodiversity. Sustainable agriculture is one of many means that can offer economic survival to landless poor and industry. Sustainable development through harvesting of the forests' renewable resources has potential for saving rainforests by providing tangible returns in the short run.