UC SANTA BARBARA

THE Current

June 5, 2026

Harrison Tasoff

Better land use and management could improve biodiversity, climate and economic development

National governments and multilateral institutions face the difficult challenge of reconciling economic development and environmental goals. Often one appears to come at the expense of the other.

But new research published in Science reveals that optimizing the way we use land can increase the return from both economic uses and ecosystem services, such as carbon sequestration and conserving biodiversity.

A first-of-its-kind analysis covering 146 countries around the world found large potential gains in biodiversity, climate and economic development from improved land use and land management. The team released a short video outlining the analysis in greater detail.

“What I found stunning was seeing how differently countries used their ecosystem resources,” said co-author Rafael Schmitt, an assistant professor in UC Santa Barbara’s Environmental Studies Program. “Some countries, like Japan, have depleted much of their natural capital but generate almost the maximum economic output the land is capable of. While others, like Haiti, use a similar fraction of their natural assets, but see drastically less of the optimal return.”

“This analysis shows that in most countries worldwide there are opportunities to improve both economic output and environmental outcomes at the same time,” added co-author Adrian Vogl, of Stanford University and the Natural Capital Insights (NatCap Insights) consulting firm. On average, countries can almost double their economic or environmental performance by improving on one dimension, without sacrificing the other.

Measuring landscape efficiency

The team, led by researchers at the University of Minnesota, looked at tradeoffs between the economic and environmental objectives for 146 countries. They examined two metrics: a combined measure of carbon storage and biodiversity; and the economic returns from crops, livestock and timber.

The researchers used spatial data on the economic return that any given location on the Earth’s land surface currently generates. They then used models to generate maps of the maximum value each spot could produce in one of five dimensions: two ecosystem values — carbon and biodiversity — and three economic land uses — agriculture, grazing and forestry. They also modeled the potential costs for transitioning a piece of land between these uses.

The result is an “efficiency frontier” for each country in the study, which charts the gap between what the country is currently doing and what’s feasible if they optimize their activities. It also reveals the changes that would move them toward this frontier, including the financial requirements. Namely, it shows the greatest feasible combination of biodiversity conservation; land-based climate mitigation; and net economic value from agricultural crops, livestock and forestry production.

In most countries, land use and land management generates outcomes well inside their landscape efficiency frontier, showing that gains in both environmental and economic development are possible at the same time.

Opportunities for optimization

Summing the results across all 146 countries revealed the potential to increase climate mitigation by the equivalent of more than 200 billion metric tons of CO2, or raise net economic value by over $350 billion. And these improvements wouldn’t

come at the expense of the other objective. The gains occur both from land reallocation — involving selective restoration of areas in highly productive lands — and crop intensification, especially in lower-income countries with current low-yield agriculture.

“We know we're facing both a climate crisis and a biodiversity crisis but, usually, the pushback against doing something about either is that it's going to cost too much,” said lead author Stephen Polasky, a Regents Professor and co-founder of the University of Minnesota’s NatCap TEEMs research center. “One of the main reasons for doing this study was to show, in fact, that there are ways where we can be more efficient and address climate and biodiversity without bankrupting people.”

“Nobody expects that countries will reconfigure their entire landscapes,” said Schmitt. “However, our study shows some bottom-up approaches that lead to win-win situations for people and nature, even after considering the costs.”

These insights are useful for organizations that support and finance development. They provide a guide for better directing resources and support for countries in a way that helps them reach their national goals while also meeting international commitments for biodiversity, conservation, climate change and adaptation.

“We show people what's possible, and that tends to open their minds to thinking about a wider set of alternatives,” said Polasky. “When they can see the gain that could be had by making some of these changes. Then making some of the changes is not so scary.”

“This research proves that the supposed tradeoff between protecting nature and growing economies is false,” said Becky Chaplin-Kramer, global biodiversity lead scientist at World Wildlife Fund-US. “By mapping what's truly possible country by country, we've given policymakers and investors a roadmap to pursue biodiversity gains, climate mitigation and development goals together.”

Expanding the analysis

The team plans to deepen their analysis by considering additional ecosystem services and economic activities. For instance, the current study is exclusively

terrestrial in its focus. Integrating systems like rivers and lakes could provide more nuance to their findings.

“Transitioning from extensive to intensive agriculture could allow us to grow more food while, in some cases, shrinking agriculture’s footprint,” Schmitt said. “But this might require irrigation and greater use of fertilizer, which would impact aquatic ecosystems and other water users.”

The study also didn’t account for discount rates — or the greater perceived value of short-term gains — an important part of economic planning when envisioning how to transition land uses at large scales.

Schmitt is particularly interested in studying other environmental constraints while framing optimality as a legacy of our past. He also hopes to investigate the social aspects and decision processes that led different countries so close or far from their optimal efficiency. “Optimality is strongly linked to the development status of countries, so there is an interesting aspect of equity to be explored,” he said.

“While large-scale land-use transitions may seem unlikely to happen, initiatives such as 30-by-30 — protecting 30% of the world’s land surface by 2030 — are gaining momentum and could greatly benefit from the strategic thinking put forward in this study”, Schmitt said. Schmitt’s colleagues at NatCap TEEMs and NatCap Insights have already started working with other partners to apply this work, including working with the World Bank to answer country-specific specific policy questions.

Funding for the analysis was provided by the Gordon and Betty Moore Foundation, the University of Minnesota Fesler-Lampert Endowment, the University of Minnesota Institute on the Environment, World Resources Institute, and the World Bank.

Media Contact
Harrison Tasoff
Science Writer
(805) 893-7220
harrisontasoff@ucsb.edu

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