



A soybean plantation has replaced a swath of Amazon rainforest near Santarém, Brazil.

REMOTE SENSING

Satellites document rapid expansion of cropland

Farms added 100 million hectares globally over 2 decades, threatening biodiversity and accelerating climate change

By Gabriel Popkin

Farmland is overtaking much of the planet. A new global map assembled from satellite imagery shows that over the past 2 decades, fields of corn, wheat, rice, and other crops have eaten up more than 1 million additional square kilometers of land—roughly twice the area of Spain.

“The inexorable march of the human footprint is just brutal,” says study co-author Matt Hansen, a geographer at the University of Maryland (UMD), College Park. The food needs of a fast-growing population in Africa are driving some of the expansion. But the study also highlights how Earth’s land is becoming, in essence, a unified global farm, with wealthier countries increasingly outsourcing crop production to poorer regions. Half of the new fields have replaced forests and other natural ecosystems that stored large amounts of carbon, threatening efforts to conserve biodiversity and avert catastrophic climate change.

To construct their map, the researchers used data from the U.S. Geological Survey’s and NASA’s Landsat program, which has launched a series of satellites that periodically image every spot on Earth with pixels covering roughly 30 square meters, or about the size of a baseball diamond. The team visited farms around the world

and used high-resolution commercial satellite photos available from Google to train algorithms to distinguish croplands from natural grasslands and other types of land cover. The maps yield both wide-angle and close-up views. “You can get a global story; you can also tell the story of [a single nation such as] Cambodia,” Hansen says.

At the global scale, the cropland footprint increased 9% over the study period, which covered 2000 to 2019, the team reported on 23 December 2021 in *Nature Food*. The increase is several times higher than the 2.6% growth in “arable land” over the same period calculated by the Food and Agriculture Organization of the United Nations.

South America led the world in relative cropland expansion, with the continent’s farms growing by nearly 50% during the study period. That’s thanks largely to a booming soybean industry supplying livestock farmers in China and elsewhere. Africa saw the largest absolute growth in the total area of new fields as it struggled to feed a fast-growing population. Forty percent of Africa’s cropland was created in the past 2 decades, and the rate is accelerating. Farmland also swelled in several nations in South Asia and in North America’s Great Plains.

Crops didn’t gain ground everywhere. In the former Soviet Union, for example, farmers abandoned unproductive areas.

But overall, the analysis underscores that people are creating far more cropland than they are abandoning or restoring to forest or grasslands, says Tim Searchinger, a senior fellow at the World Resources Institute who was not involved with the work. He notes that farming likely gobbled up even more land than the analysis found, because it didn’t tally areas converted to new livestock pastures and tree plantations.

The map is sharper and more up to date than many currently in use, says geographer Amy Molotoks of the Stockholm Environment Institute. She and her colleagues “are highly likely to use it in the future” to determine where farms have replaced forests or other natural ecosystems, she says.

Those shifts have worrisome implications for efforts to preserve biodiversity. The conversion of rainforests like the Amazon to agriculture often gets the headlines, but the study found new crop fields took a bigger bite out of less heralded biodiversity hot spots, such as dry forests and savannas. In South America, important dry ecosystems known as the Chaco and Cerrado took major hits, says study lead author Peter Potapov, also at UMD. “They will disappear completely very soon,” he fears.

Such losses accelerate climate change, because carbon stored in trees and soil escapes to the atmosphere when land is cultivated. Land clearing currently causes roughly one-eighth of humans’ total carbon emissions, researchers estimate.

The study did reveal some hopeful trends. Over the study period, the growth rate of plant biomass in croplands increased by 25%, and per capita crop area decreased by 10%, suggesting humanity is continuing to find ways to squeeze more food out of a given hectare.

Molotoks says that, by showing how consumer food choices drive environmental change, such analyses could help conservation advocates make the case for greener practices. In the United Kingdom, she notes, some consumers have shifted to plant-based diets after learning that farmers in South America are clearing large tracts of forest to grow soybeans for animal feed.

The study also highlights the need to boost cropland productivity in Africa, which has the world’s lowest crop yields, meaning more land is needed to grow a given amount of food. “If the world wants to solve climate change,” Searchinger says, “from a purely self-interested standpoint, it needs to support Africa in solving its land use challenge, and that includes much higher yield growth and food security.” ■