What Lies Beneath

Studies link deforestation to geology and agricultural demand

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By Janet Raloff, *Science News*

The rocks and soil under a tropical forest have a surprising impact on the amount of climate-warming carbon that logging or clearing will release into the atmosphere—and even how likely the trees are to be cut at all, new research shows. Combined with another recent study highlighting the importance of rainforests as a source of new farmland, the study may help predict future forest losses.

Deforestation releases roughly a billion metric tons of carbon dioxide into the atmosphere each year, making it second only to fossil fuel burning in production of this greenhouse gas. In the current millennium, says Holly Gibbs of Stanford University's Program on Food Security and Environment, global forest clearing has been totaling about 130,000 square kilometers a year. She says that translates into carbon dioxide emissions each year equivalent to the releases from 1.35 billion fossil-fueled cars.

"Rain forests were the primary source for new agricultural land" in the tropics during the 1980s and 1990s, accounting for more than 80 percent of new cropland and ranches, Gibbs and her colleagues report in a paper posted online August 31 in the *Proceedings of the National Academy of Sciences*. The tree cover lost over those two decades: more than 1 million square kilometers, or an area about the size of Alaska.

In a sense, that's not surprising, says Gibbs. "Across the temperate world, we've already largely converted our available landscape to croplands and pasture. So almost all agricultural expansion since 1980 has been occurring in the tropics."

A related study in the same journal, this one posted online September 7, looked more closely at just one region of the tropics—an area about the size of Switzerland in Peru's Amazon. It quantified carbon stored in area trees by overlaying three types of data: forest cover depicted in satellite images; tree-canopy heights as mapped by airborne lidar, a laser technology that measures distances; and detailed measurements on the ground of the biomass in small areas hosting different types of trees and bamboo.

Those on-the-ground measurements serve to calibrate the biomass indicated by lidar data for tree canopies and bamboo, explains coauthor Greg Asner, an ecologist with the Carnegie Institution for Science in Stanford, Calif.

One novel aspect of this study, Asner says, is its observation of geology's link to deforestation. Older rocks and the soils formed from their weathering have "few rock-derived nutrients left in them, like phosphorus and calcium," he explains. "And we in the science community know that this leads to suppressed biomass."

In contrast, younger soils found along river flood plains "are just seething with fertility," Asner says. Upslope just a few tens of meters, there may be rolling, weathered surfaces with low fertility and low carbon stocks.

From tree-by-tree field-plot surveys, "we see that the species found on these different geologies have different nutrient requirements," he says. "So as species change with the geology, the geology becomes linked to carbon stocks." Until now, Asner contends, these associations "were completely invisible to science."

Land-use patterns are also being linked to those geology differences, Gibbs notes. As family farms in the tropics give way to bigger operations—ventures akin to well-financed agribusiness—"we find they're looking for those same flat lands where they can use bulldozers and heavy farm machinery." So in this region, at least, the higher fertility lands are among the first that farmers target for deforestation, she says.

The newfound links between geology, fertility and deforestation "are kind of unexpected," says forest ecologist Douglas Morton of NASA's Goddard Space Flight Center in Greenbelt, Md. But they point to where deforestation may heat up in future years. And that's important, he says, "because the biggest uncertainty term in the global carbon budget remains future land-use changes."

Marc Steininger, who studies forest change at Conservation International in Arlington, Va., notes that to gauge deforestation's impacts on climate, "you have to predict what's going to happen in the future." But predicting land use in areas that now host intact forests remains a weak link.

Tags: deforestation, geology, carbon dioxide, agriculture, environment, global warming