what he had in mind, Varmus said, but he acknowledged that panelists might be "forced politically to move away from the ideal world." The panel is due to deliver its report in September 2003. –JOCELYN KAISER

FOREST ECOLOGY

Satellites Spy More Forest Than Expected

Fifteen years after people began chomping on Rainforest Crunch to help save the Amazon, experts still don't have a good handle on exactly how quickly tropical forests are disappearing. Now on page 999, scientists describe an effort to fill that data void: one of the first studies to assess humid tropical forest with satellite data rather than on-the-ground measurements and guesswork.

The study's conclusion—that deforestation rates were 23% lower between 1990 and 1997 than has been estimated—doesn't change the need for conservation, says remote-sensing expert and study co-author Hugh Eva of the European Commission's Joint Research Centre in Ispra, Italy. Tropical forest cover "is still disappearing at incredible rates."

For climate change experts, however, the study, known as TREES, is making them rethink an important number: how much carbon dioxide land plants are absorbing. "It's a very big deal," because predictions of global warming rely on that number, says ecologist David Schimel of the National Center for Atmospheric Research in Boulder, Colorado.

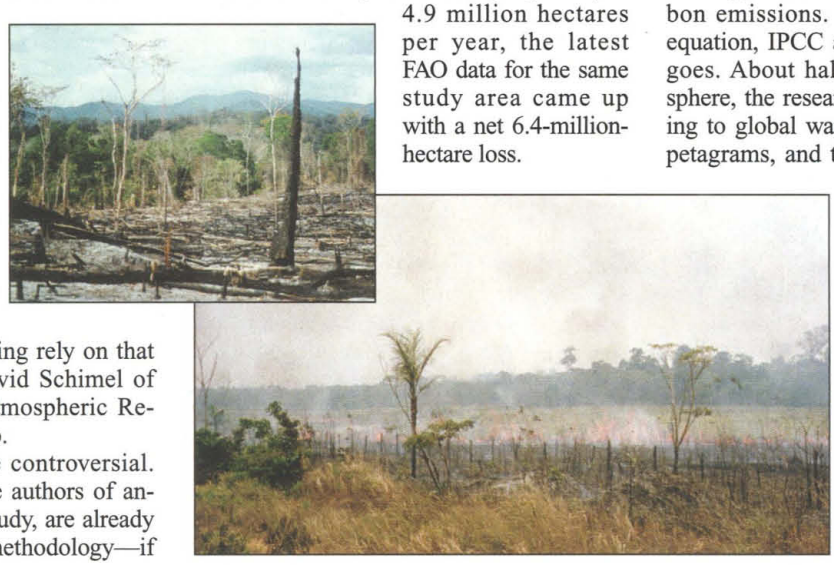
The study is sure to be controversial. Some experts, including the authors of another new remote-sensing study, are already picking apart the TREES methodology—if not its overall conclusions.

The source of most estimates of global forest loss has for years been the United Nations' Food and Agriculture Organization (FAO). Its foresters estimate trends by pooling data from more than 200 countries, but these reports are notoriously inaccurate. Countries don't use comparable techniques, and many lack the expertise or resources to do it rigorously (*Science*, 23 March 2001, p. 2294).

Aiming for more reliable results, TREES, led by Frédéric Achard of the Joint Research Centre, applied a sampling strategy to remote-sensing data for humid tropical forests. (The researchers did not look at dry tropical forests, which cover less area and are being deforested more slowly.) They could have randomly sampled the entire forest. But to improve their accuracy, they sampled mainly where they thought deforestation is happening.

To do this, they first identified deforestation "hot spots" using global maps they assembled from early 1990s low-resolution satellite data and by consulting with local and regional experts. Then they selected 100 sampling sites, statistically weighting them so more fell in hot spots. They compared high-resolution, before-and-after images of these 100 patches—representing 6.5% of the world's humid tropical forests—and calculated how much forest had been lost. Finally, they extrapolated these results to estimate the global deforestation rate for forests of this type.

Between 1990 and 1997, the TREES team found, the world lost an average of 5.8 million hectares of humid tropical forest each year—an area twice the size of Maryland—give or take 1.4 million hectares. The highest percentage deforestation rates were in Southeast Asia, followed by Africa and South America. Whereas TREES found a net annual loss (after counting regrowth) of 4.9 million hectares per year, the latest FAO data for the same study area came up with a net 6.4-million-hectare loss.



Going, going ... A new remote-sensing study gives firmer numbers for humid tropical forest loss from burning and clearing.

CREDITS: HUGH EVA

David Skole, for one, finds the study's approach less than convincing. "I dispute that they got the right hot spots," says Skole, a remote-sensing expert at Michigan State University, East Lansing. By relying on maps from the early 1990s, he says, the study likely missed areas where deforestation began later. Christel Palmberg-Lerche, chief of FAO's Forest Resources Development Service, says her group also sees problems with how TREES found the hot spots.

Skole is a co-author on another new satellite forest study. Led by Ruth DeFries of the University of Maryland, College Park, it is based on a global set of low-resolution images. DeFries uses an algorithm that calculates the amount of forest cover within each coarse pixel from its color and the time of year. The study, which is under review, also finds that the FAO forest loss estimates are too high for the 1990s, but it gets different results for each continent than TREES did. "The regional differences indicate that we still don't have a definitive answer," says another co-author, ecologist Chris Field of the Carnegie Institution of Washington at Stanford University.

Despite such uncertainties, Field and others say the two studies will help resolve a mystery known as the "missing sink." The Intergovernmental Panel on Climate Change (IPCC), the expert group that has concluded that human activities are contributing to global warming, currently draws on studies based on FAO data to calculate how much carbon is released by burning and clearing tropical forests. The group assumed that such deforestation added 1.6 petagrams of carbon (or 1.6×10^{15} grams) to the atmosphere each year in the 1990s. This carbon, plus 6.3 petagrams mainly from fossil-fuel burning, makes up total human-caused carbon emissions. On the other side of the equation, IPCC adds up where this carbon goes. About half of it stays in the atmosphere, the researchers say, likely contributing to global warming. Oceans take up 2.3 petagrams, and the rest—another 2.3 petagrams—has been assumed to be absorbed by temperate forests.

The puzzle is that ground-based inventories of regrowing temperate forests have not found enough vegetation to absorb 2.3 petagrams of carbon. If emissions from deforestation are smaller than estimated, however, then this sink must be smaller, too. Both the TREES team and the DeFries group estimate land-use emissions at about 1 petagram of carbon. This doesn't take care of the entire "missing sink," says ecologist Richard Houghton of the Woods Hole Research Center in Massachusetts, but "you're getting there." The new estimates could change the results of climate models, says Schimel.

These two studies aren't likely to be the last word. Achard and others say that what's needed is for experts in each country to help assemble a wall-to-wall, high-resolution satellite map. Falling costs for images and computers should make this feasible, notes Achard. Until then, scientists still won't be sure just how fast the tropical forest is vanishing. –JOCELYN KAISER