Comment on "The Incidence of Fire in Amazonian Forests with Implications for REDD"

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Aragão and Shimabukuro (Reports, 4 June 2010, p. 1275) reported that fires increase in agricultural frontiers even as deforestation decreases and concluded that these fires lead to unaccounted carbon emissions under the United Nations climate treaty's tropical deforestation and forest degradation component. Emissions from post-deforestation management activities are, in fact, included in these estimates—but burning of standing forests is not.

Satellite-based observations of Earth's surface allow us to map active fires and smoke under a range of conditions, but do not reliably detect fires that burn beneath the canopies of standing moist tropical forests (*1*). Until we can quantify the types of human-caused fires across Amazonia (*2*), not just the occurrence of fire, the carbon consequences of fire-facilitated clearing and land use and associated accidental fires will be uncertain.

Our inability to fully differentiate among different types of vegetation fires detected by satellites can lead to potentially erroneous conclusions. Aragão and Shimabukuro (*3*) presented evidence that fire frequency can increase even as deforestation (forest felling and immediate burning events) decreases in Amazon frontier zones—an important finding. However, they go on to conclude that the observed increase in post-deforestation fire reverses the emissions reductions that might be achieved through the United Nations initiative for reducing emissions from deforestation and degradation (REDD). However, this conclusion is not justified by their data because they cannot say what proportion of the observed fires took place as part of the multiyear process to burn off unwanted forest biomass or what proportion, if any, occurred in otherwise intact, standing forests. Moreover, once an area is deforested, there is a high likelihood that management fires will follow, particularly in pastures.

Aragão and Shimabukuro (*3*) measured fire occurrence using temperature threshold data from the National Oceanic and Atmospheric Administration's Advanced Very High Resolution Radiometer (AVHRR) and Moderate Resolution Imaging Spectroradiometer (MODIS). These data principally provide information on clearing and management fires ignited by farmers and ranchers to remove brush and organic debris from their land and on unintentional fires that burn across cleared land (*4*). The carbon emissions from these repeated fires, including "slash-and-burn" fires, take place over a several-year period after forest felling (*5*) and, contrary to Aragão and Shimabukuro's statement, are already included in carbon emissions estimates from deforestation (*6*, *7*). Because the authors do not characterize the different types of fires, they could not quantify the proportion of fires that are part of the normal post-felling process and those that escaped into surrounding forest.

Fires that burn standing forests, referred to here as understory fires, are not included in most estimates of carbon emissions from deforestation, even though they can affect more than twice the area deforested annually (*8*). These fires kill many trees, from 8 to 64% of mature individuals across Amazon forest sites (*9*), and burn biomass (*10*)—thereby reducing forest carbon stocks. Understory fires represent a threat to the "permanence" of carbon that could eventually be compensated through a REDD program.

REDD+, as currently negotiated, will provide benefits to nations that decrease carbon emissions from deforestation and forest degradation and that enhance forest carbon (*11*). Prevention of forest degradation from fire will not be rewarded under REDD+, in part because robust methods for quantifying emissions from degradation have only recently become available (*12*). Nations that do not succeed in implementing wildfire control programs to protect forest carbon will therefore likely be penalized (*11*). Fire represents an important threat to the permanence of forest carbon stocks, and in this sense the Aragão and Shimabukuro study (*3*) is a welcome contribution.

In 2010, the pattern documented by Aragão and Shimabukuro (*3*) may have appeared on the scale of the Brazilian Amazon. By 3 October 2010, more than 104,000 active fires had already been detected in Brazil, which is 14% higher than the average between 2005 and 2009 for this same 9-month period (*13*). Total deforestation detected within Brazil's legal Amazon was only 925 km^2 between January and August 2010 (*14*). If this rate continues, total forest loss for 2010 will be even lower than the record low of 7464 km^2 detected for the period from August 2008 to August 2009 (*15*).

Future research will need to find ways of differentiating between those fires that are the result of intentional clearing, continued land management, or unintentional, escaped wildfires. Further, we need to better understand how fire management decisions and drought can lead to extensive and sustained wildfires. New remote-sensing technologies such as burned-area mapping and quantification of fire radiative power will enable better understanding of the diversity of intentional and unintentional anthropogenic fires across this region. But in the meantime, as 2010 demonstrates, Brazil needs a strong national firefighting plan for Amazonia and a new model of rural development that encourages more sustainable and fire-sensitive investments—especially if it is to defend its remarkable progress in slowing deforestation (*16*).

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