HOW WELL DO WE NEED TO KNOW BIOMASS?

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ABSTRACT

The long-term net flux of carbon between terrestrial ecosystems and the atmosphere has been dominated by two factors: changes in the area of forests and per hectare changes in forest biomass resulting from management and regrowth. While these factors are reasonably well documented in countries of the northern mid-latitudes as a result of systematic forest inventories, they are uncertain in the tropics. Recent estimates of carbon emissions from tropical deforestation have focused on the uncertainty in rates of deforestation [*Achard et al*., 2002, 2004; *DeFries et al*., 2002; *Houghton*, 2003]. By using the nearly the same data for biomass, however, these studies have underestimated the total uncertainty of tropical emissions and may have biased the estimates. In particular, regional and country-specific estimates of forest biomass reported by three successive assessments of tropical forest resources by the *FAO* [*FAO/UNEP*, 1981; *FAO*, 1995; *FAO*, 2001] indicate systematic changes in biomass that have not been taken into account in recent estimates of tropical carbon emissions. The 'changes' more likely represent improved information than real on-the-ground changes in carbon storage. In either case, however, the data have a significant effect on current estimates of carbon emissions from the tropics and, hence, on understanding the global carbon balance.

Values of average forest biomass as reported by successive assessments of the FAO are shown in Fig. 1 along with estimates computed from analyses of land-use change (*Houghton*, 2003). The FAO averages are lower than Houghton's in every region. Because Houghton's values are similar to those used by *Achard et al*. [2002, 2004] and *DeFries et al.* [2002] in calculating emissions from land-use change, these estimated carbon emissions may be overestimated, if the FAO averages are correct, and if the forests actually deforested are an unbiased sample of each region's forests.

The trends in biomass reported by the FAO over the 20-year period reflect the accuracy of the values. The decline in average biomass reported by FAO for tropical Asia, for example, are surprisingly similar to the decline obtained by *Houghton* [2003] (Fig. 1), a result of heavy logging in a relatively small area of forest. In contrast, FAO's reported increase in Latin American forest biomass is steep compared to that found by Houghton. The reported increase cannot be explained by growth or preferential clearing of low biomass forests. Rather, it signifies a revision of FAO estimates. In Africa, both the reported and the calculated changes in biomass are small.

To compare the effects of uncertain biomass with the effects of uncertain deforestation rates, we designed a simple sensitivity analysis. The analysis included three scenarios with different rates of deforestation [*Achard et al.*, 2004; *DeFries et al.*, 2002; *FAO*, 2001] and three scenarios with different estimates of average biomass [*Houghton*, 2003; *FAO*, 1995; FAO, 2001]. The 'reference' scenario included *Houghton*'s [2003] estimates of biomass and the *FAO* [2001] estimate of deforestation. The results show that the range of flux values for different estimates of biomass (1.0 PgC/yr) is almost as wide as the range of values for different estimates of deforestation (1.3 PgC/yr) (Fig. 2). Because we cannot be sure that the average values of biomass represent the biomass of forests actually deforested, the uncertainty in flux estimates as a result of uncertain biomass is larger than given by these scenarios. Thus, biomass and rates of deforestation contribute equally to uncertainties in estimated carbon flux.

It is tempting to speculate that the release of carbon from land-use change in the tropics is lower than Houghton's estimate of 2.2 PgC/yr for the 1990s because all of the other scenarios give a lower estimate of flux. None of the scenarios is unrealistic, however, given the current uncertainty of data used in the analyses.

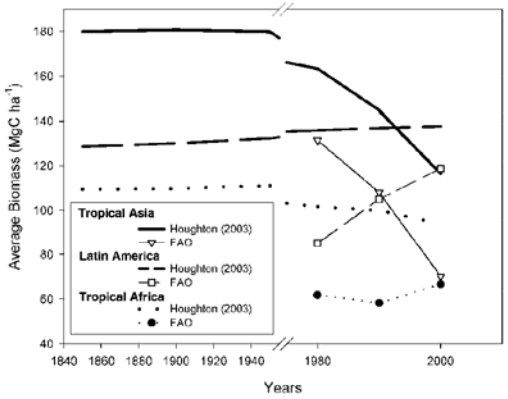

Fig. 1 Estimates of the average biomass of tropical forests, reported by the FAO (1980, 1990, and 2000 assessments) (light lines) and as modeled from changes in land use (1850-2000) (Houghton, 2003) (heavy lines).

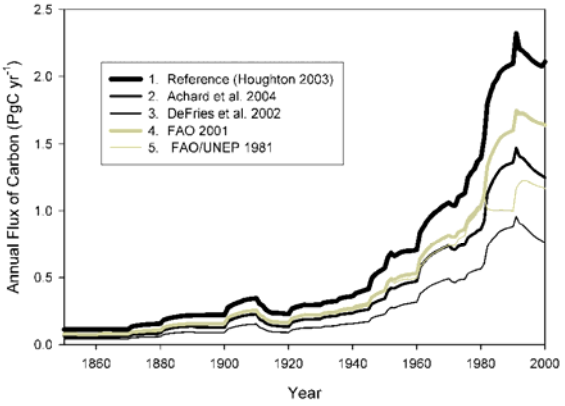

Fig. 2 Annual emissions of carbon from land-use change in the tropics according to alternative rates of tropical deforestation and alternative estimates of average forest biomass.

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