

## Carbon stock assessment for a forest-to-coffee conversion landscape in Sumber-Jaya (Lampung, Indonesia): from allometric equations to land use change analysis

Meine van Noordwijk<sup>1</sup>, Subekti Rahayu<sup>1</sup>, Kurniatun Hairiah<sup>2</sup>, Y. C. Wulan<sup>1,3</sup>,  
A. Farida<sup>1</sup> & Bruno Verbist<sup>1</sup>

1. International Centre for Research in Agroforestry (ICRAF) SE Asia, P.O.Box 161, Bogor 16001, Indonesia;

2. Brawijaya University, Malang, Indonesia;

3. Bogor Agricultural University, Bogor, Indonesia

Correspondence should be addressed to Meine van Noordwijk (email: m.van-noordwijk@cgiar.org)

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**Abstract** The change in stored carbon (C) stocks was assessed for a 700 km<sup>2</sup> area where forest cover decreased from 60% to 10% in the last 30 years. At the same time, the area under coffee increased from 7% to 70% with a gradual evolution from open “sun coffee” systems to multi-strata “shade coffee” systems that provide a partial compensation for C loss. The use of a generic tropical forest rather than tree-specific allometric equation can lead to substantial (up to 100%) overestimates of aboveground biomass depending on wood density and tree shape. The shoot:root ratio (biomass) of coffee shifted with age, from the 4:1 value often assumed for tropical trees to 2:1. Annual aboveground C stock accumulation rates during the establishment stage after slash-and-burn land clearing were 1, close to 2 or 3.5 Mg C ha<sup>-1</sup>a<sup>-1</sup> for sun coffee, shade coffee and fallow regrowth, respectively. Forest remnants, shade coffee and sun coffee had soil C stocks in the upper 30 cm of the soil that were 79%, 60% or 45%, respectively, of the values expected for primary forest in Sumatra. Total C stock (time averaged, above – 0.3 m in the soil) for forest, shade and sun coffee was 262, 82 and 52 Mg C ha<sup>-1</sup>, respectively. In the 1970–1984 period, while forest cover was reduced from 59.5% to 19.7%, the landscape lost on average 6.8 Mg C ha<sup>-1</sup> a<sup>-1</sup>. In the 1984–2000 period forest cover was further reduced to 12.6%, but the landscape lost only 0.39 Mg C ha<sup>-1</sup> a<sup>-1</sup>, as forest loss was partially compensated by an increase in shade coffee systems. Conversion of all current sun coffee to shade coffee systems while protecting the remaining forest, could increase average landscape level C stocks by 10 Mg ha<sup>-1</sup> over a time frame of say 20 years, or 0.5 Mg C ha<sup>-1</sup> a<sup>-1</sup>.

**Keywords:** allometrics, carbon stock, coffee, soil carbon, wood density.

Changes in carbon (C) storage in terrestrial ecosystems as a consequence of human land use have been simplified in the Kyoto protocol to a forest-nonforest dichotomy<sup>[1]</sup>, and its derivatives (deforestation, reforestation, afforestation). As most definitions of “forest” depend on a threshold land cover fraction by woody perennials, the derived systems such as coffee plantations with or without shade trees may fall under the definition. The variation in C stocks within the forest category, whatever operational definition one chooses, is considerable and most of the changes due to a gradual degradation or aggradation of C stocks can remain unnoticed if one uses only two land