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Estimating CO₂ Sequestration Potential in Northwest Vietnam: Combination of Field Measurements and Remote Sensing Analysis

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Abstract

Increasing population density and economic development have forced people to expand agricultural production into upland areas in Vietnam. This resulted in decreasing natural forest cover with a conjoint increase of tree-based plantations and a replacement of traditional swidden farming systems with commercial cropping systems. Our study aimed at reconstructing past land cover based on remote sensing imagery, and combined this information with primary quantitative biomass and C stocks data of perennial vegetation to quantify and evaluate communal CO₂ sequestration potential.

To generate land cover maps of Chieng Khoi commune, Northwest Vietnam, LANDSAT 1993, 1999 and IRS LISS III 1C 2007 were used. 262 Ground Truthing Points (GTP) were collected, and farmer interviews and group discussions were conducted to gather information per GTP in past times. Hybrid classification methods were applied to classify land cover maps. Land suitability information, cropping season calendar, participatory soil maps and local stakeholder interviews were used to classify crop cover. To quantify C stocks, 10 perennial land-use systems were surveyed using a nested sampling plot design. Aboveground biomass parameters of overstorey trees were measured non-destructively, parameters of mid-, understorey vegetation and coarse litter were sampled destructively. Allometric equations for early succession species were developed.

Land cover maps for 1993, 1999 and 2007 were generated, overall accuracies were 81.1%, 98.5% and 82.5%, respectively. Even though forest areas decreased by ‘only’ 36%, based on the map of 2007, our results showed a reduction of 61% in total communal carbon stocks during the last 50 years. This shows the different carbon storing capacities of natural forest vegetation and tree based plantation systems and limited usefulness of C stock estimates based on rough land cover categories without site-specific ground measurements.

The study combined methods to quantify biomass and carbon stocks over time at landscape scale. It also provided input data for a spatially explicit and dynamic Land use Change Impact Assessment tool, which can be applied to assist land use planners to mitigate climate change and improve the management of natural resources.

Keywords: Allometric equation, carbon stocks, land cover maps, remote sensing, vietnam