Agroforestry and carbon sequestration

Reference 13

Ziegler, AD; Phelps, J; Yuen, JQ; Webb, EL; Lawrence, D; Fox, JM; Bruun, TB; Leisz, SJ; Ryan, CM; Dressler, W; Mertz, O; Pascual, U; Padoch, C; Koh, LP. 2012 Carbon outcomes of major land-cover transitions in SE Asia: great uncertainties and REDD+ policy implications. Global Change Biology 18: 3087–3099. doi: 10.1111/j.1365-2486.2012.02747.x

Background and objective

Too little is known about differences in carbon cycling within various types of swidden and replacement agricultural systems to provide convincing evidence as to which land-cover/land-use types would provide the most viable basis for emissions mitigation approaches. To analyse available estimates of above-ground carbon, below-ground carbon (in root biomass), and soil in 11 land cover/land use transitions that involve swidden agriculture and are highly relevant to REDD+ and carbon-focused forest management in Southeast Asia. Here we focus on the effects of transitions to agroforestry compared to swidden agriculture and forest.

Search strategy and selection criteria

Not available. They select more than 250 published case studies and relevant reviews for the SE Asia region Selection of case studies reporting on common land-cover/land-use transitions that involve swidden agriculture and are highly relevant to REDD+ and carbon-focused forest management in Southeast Asia, including replacement of swidden by nonsequential agroforestry systems (e.g., home gardens, intercropping strategies).

Data and analysis

For each transition they assign a range of above (AGC)- and belowground carbon (BGC) stock values. When necessary, they estimate carbon biomass as one-half the reported vegetative biomass value. For each prospective transition, they identify a plausible range for total ecosystem carbon (TEC = AGC + BGC + SOC). FOR AGC, they exclude outliers to produce minimums and maximums that define the range of plausible values. For BGC, they rely on biomass partitioning factors (BPF = BGB/AGC) based on reported root:shoot ratios to estimate plausible BGC values. The BPF range assigned to agroforestry is 0.10–0.34, for which the maximum is associated with home gardens in Java. For SOC, they rely on previous syntheses to assign a range of plausible SOC values for each land-cover. From these relationships, they estimate SOC values for different land-cover types using an idealized forest soil profile containing 150 Mg ha-1 SOC as the reference.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
Over 250	11 key land cover/land use transitions in South Eastern Asia that involve swidden agriculture.	The associated land covers for the transitions are the following: forest; logged over forest; orchards and tree-plantations; rubber plantations; agroforest; grassland, pasture, or shrublands; oil palm plantations; and permanent cropland.	NA	Ranges of above-ground carbon biomass, below-ground carbon biomass, soil organic carbon, and total ecosystem carbon.	31%

Results

- The above-ground carbon biomass range is the highest for forests with 40-400 Mg ha-1; for non-swidden agroforestry is 15–100 Mg ha-1; and for short-fallow swidden 2–22 Mg ha- 1; intermediate-fallow systems 4– 50 Mg ha-1; and long-fallow swidden systems 25–110 Mg ha-1.
- Patterns of estimated below-ground carbon values largely follow those for above-ground carbon, with forests having the highest range (4–112 Mg ha-1); various types of nonswidden agroforestry intermediate (2–34 Mg ha-1) and short-fallow swidden the lowest (1–4 Mg ha-1).
- Estimated SOC for the 11 land-cover transitions are not highly variable, in part because of the authors generalized way in making categorical calculations from meta-analysis data. Forests (75-225 Mg ha-1); Agroforestry (61-182 Mg ha-1); and short-fallow swidden (178 Mg ha-1).
- The highest range of total ecosystem carbon stock values is for forests (119–737 Mg ha-1); for agroforestry is 77–316 Mg ha-1; and for short-fallow swidden 62-204 Mg ha-1.
- Positive outcomes of agroforestry transitions: 1)Conversion of permanent croplands and short-fallow swidden systems to other land-uses, including tree-based plantations, orchards, various agroforests; 2) Transition from intermediate-fallow swidden to other agroforestry systems and other tree plantations.

Factors influencing effect sizes

Soil depth: in general, the SOC fraction could be large, particularly for deep soils high in organic material. Age of tree stands: SOC is also likely to increase as tree stands mature, although increases may be curved by understory management approaches that remove vegetation and fine/woody organic debris.

Conclusion

The analysis of plot-level carbon outcomes highlights that in some instances, lengthening fallow periods of an existing swidden system may produce substantial carbon benefits, as would conversion from intensely cultivated lands to high-biomass plantations and some other types of agroforestry.