Negotiation-support toolkit for learning landscapes

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Van Noordwijk M, Khasanah N and Dewi S. 2013. Biofuel emission reduction estimator scheme (BERES): land-use history, production systems and technical emission factors. *In:* van Noordwijk M, Lusiana B, Leimona B, Dewi S, Wulandari D (eds). *Negotiation-support toolkit for learning landscapes*. Bogor, Indonesia. World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. P.157-162.

28 Biofuel emission reduction estimator scheme (BERES): land-use history, production systems and technical emission factors

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The Biofuel Emission Reduction Estimator Scheme (BERES) is an integrated assessment method for estimating carbon dioxide and other greenhouse gas emissions related to biofuel production. It includes three different phases of crop production processes within lifecycle analysis and is in line with EU-mandated calculations. The phases are 1) land conversion; 2) crop production; and 3) post-harvest commodity transport and processing.

Introduction

Biofuels appeared to be such a nice way of facing the climate change challenge: they reduced political dependence on fossil fuel supply, could be used with minimal changes to engines and modes of transport, and provided new sources of income for rural economies. However, calculations of the area needed to make a dent in fossil-fuel use quickly showed that biofuels could not make a substantial contribution to 'clean' energy without using large areas of land and interfering with markets for food crops. If biofuel production extends beyond agricultural areas it will often increase emissions of carbon dioxide. The net effect will be a lower estimate of emission reduction than expected but if high carbon stock land is cleared then biofuel use can also increase net emissions. The debate on such emission enhancement has focussed on oil palm in the humid tropics of Southeast Asia, where forest and peatland conversion lead to large emissions, with or without a specific role for oil-palm expansion.

The public debate, however, has linked the two issues. The European Union provided guidance to countries on minimum standards that should be used when biofuels are included in national renewable energy plans. Until 2017, a minimum emission reduction of 35% has to be achieved for any fuel included in the scheme, shifting to 50% by 2017 and 60% beyond. Default estimates are given for major current or potential sources of biofuels. A procedure was established to calculate emission reduction factors, using a lifecycle approach for the supposedly typical production situation. Specific market flows of biofuels can apply for exception from this 'default' for the commodity but the procedures for that are not yet clear. These procedures, and their likely further development, create the need for exporting countries and entities to understand the steps in calculation and to do the research needed to get reliable data. Figure 28.1 shows examples of trees as biofuel sources in the tropics

Figure 28.1. Oil palm, coconut, jatropha and sugarcane: examples of biofuel feedstock sources

Objective

BERES was designed to provide a transparent approach to lifecycle analysis of the emissions associated with production of biofuel feedstocks, as a basis for calculating carbon footprints.

Steps

1. Identify and analyse time-series spatial data of land-cover changes combined with interviews with local witnesses

This includes negotiating the 'attribution' of the changes to various people (for example, legal, government-sanctioned and illegal logging; natural and human-induced fire). See ALUCT for details on the methods for reconstructing land-cover change.

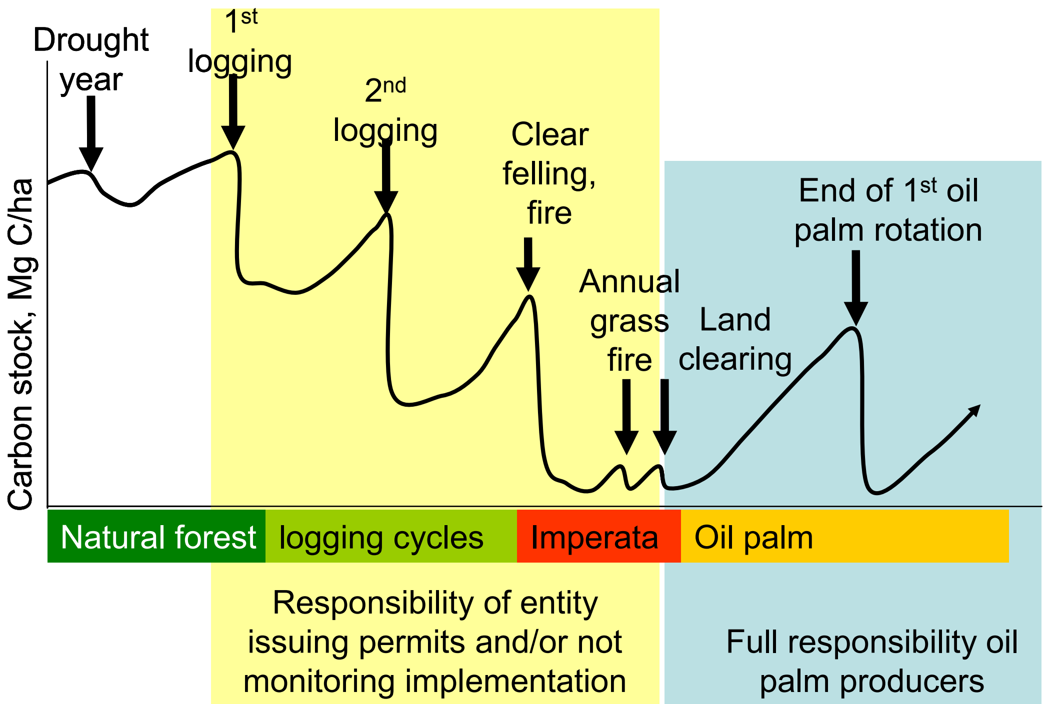


Figure 28.2. Trajectories of land uses and the dynamics of carbon stock

Note: Attribution is often contested more than what actually happened to aboveground vegetation

2. Estimate emissions due to crop production

a. Estimate time-averaged carbon (C) stock of existing land cover, including plantations and surroundings in different production environments (for example, peat and mineral soil types) and management regimes (for example, nucleus/company, plasma and independent).

The 'time-averaged C stock' is the sum of the average of five carbon pools (aboveground biomass, understorey vegetation, surface necromass, soil organic matter and roots) over a production cycle. When the preceding vegetation has a higher time-averaged C stock, the plantation starts with a 'carbon debt' with a 'payment time' or annualized draw on the biofuel carbon accounting. If it is lower, the calculation can reflect a net emission saving for the first production cycle. Methods for measurement of the pools are described in the RaCSA methodology and technical manuals.

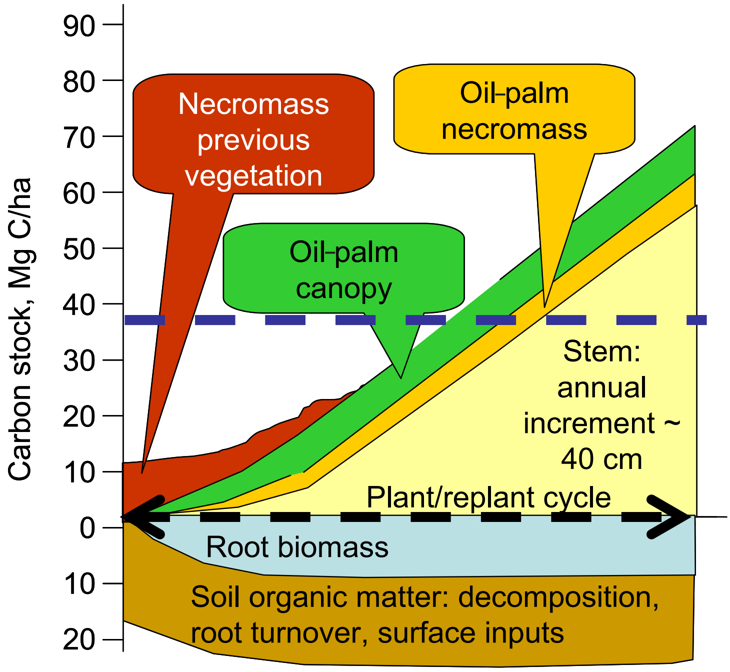


Figure 28.3. Components of C stock in oil-palm plantations, time-averaged over a planting cycle (schematic)

b. Estimate emissions due to use of fertilisers

This includes calculation of greenhouse gas emissions linked to fertiliser use. The Intergovernmental Panel on Climate Change's National Greenhouse Gas Inventory Guidelines suggest that 1% of N fertilizer is lost as N_2O from agricultural systems. Other literature suggests this can be 4%. In the absence of site-specific measurements, both assumptions can be compared for impact on the end result.

3. Estimate emissions due to post-harvest commodity transport and processing

Emission factors for transport and milling are based on fossil-fuel use and technical design of the mill and processing steps before the product reaches the end-user.

4. Conduct sensitivity analysis

The net result is very sensitive to the preceding vegetation. For the oil-palm example, a minimum emission reduction efficiency of 35% can only be reached in a second production cycle or when oil palm replaced vegetation of less than 40 t C/ha. Investment in CH_4 capture at the mill can improve the situation. Where peat soils are used, the effects of drainage on emissions usually means the target efficiency cannot be met. A third factor with considerable influence is the use of N fertiliser in relation to yield. Increase in N use efficiency can lower costs as well as help reach the fossil-fuel substitution efficiency.

Example of application

We applied BERES to 23 plantations in Indonesia that abided by what was considered 'good practice' and estimated whether the net emissions reduction of this 'good practice' was able to meet minimum European Union standards. The estimation of the net emissions included oil-palm lifecycle assessment (Figure 28.4).

Ten of the 23 plantations converted more than 60% of their area from forests to oil palm. In 91% of the plantations assessed, oil palm had replaced vegetation of more than 40 t C/ha thus incurring a carbon debt. The average net emissions rate of all sampled plantations owing to land-use conversion ranged 0–36 tonne of carbon dioxide equivalent per hectare per year (CO_2eq/ ha/yr).

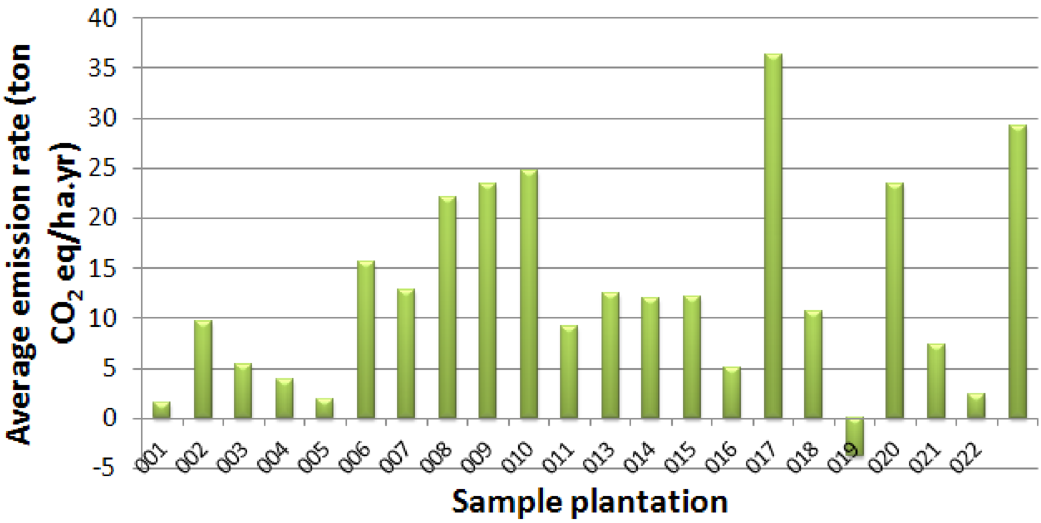
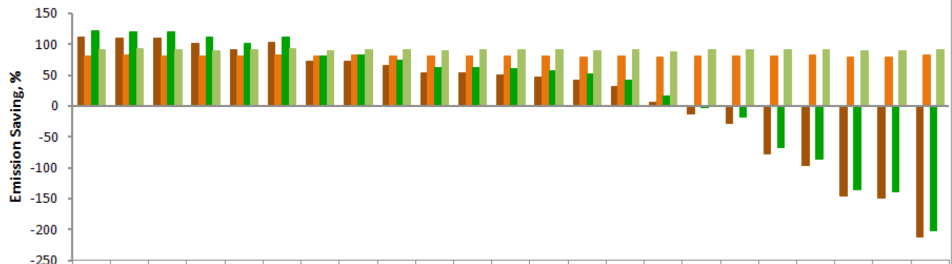


Figure 28.4. Average carbon dioxide emissions caused by land-use conversion

The average fresh fruit bunch production in Indonesia is approximately 18.8 t/ha/yr, which translates into an application rate for nitrogen fertiliser of 141 kg N/ha/yr (Figure 28.5 and Figure 28.6). The higher the yield, the more rapidly carbon debt can be neutralized and net emissions savings earned. However, higher yields depend on more than proportionally higher nitrogen fertiliser use. The additional nitrous oxide (N_2O) emissions need to be accounted for. Net effects depend on the assumed fraction of nitrogen fertilisers lost as N_2O.

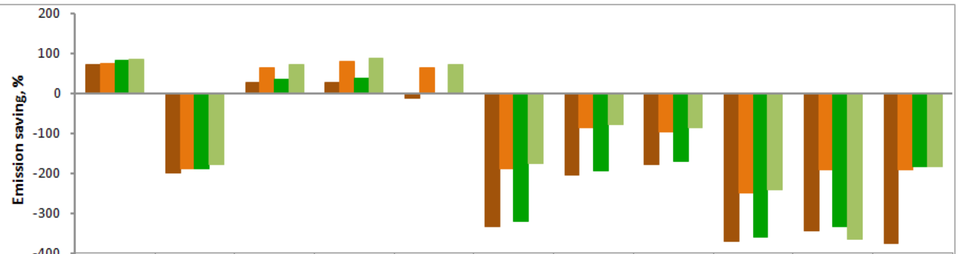
A substantial part of the current production of palm oil can meet the directive for minimum emissions savings. In 39% (first-cycle assessment) and 78% (second-cycle or subsequent assessment) of the plantations, palm oil used for biodiesel can lead to emissions savings (calculated per standard European Union procedure) of at least 35%. Intensification and good management practices will increase emissions savings and decrease the product's carbon footprint.



N fertilizer, Kg N/ha	110	77	110	137	152	77	127	110	154	114	128	114	199	257	140	252	164	164	136	67	104	178	178
Initial C-stock, ton C/ha	10	16	17	21	27	27	50	53	59	62	71	71	77	94	96	132	155	167	196	216	229	274	276
Plantation ID	019b	022b	019a	021b	011b	022a	021a	005	011a	016b	015b	016a	004	018	014	007	020a	020b	009	010	017	023b	023a
1st cycle - w/o CH4 trap	111.9	110.0	109.8	101.4	91.27	102.4	72.09	72.52	65.23	53.02	52.91	50.16	47.71	42.33	32.24	6.61	-12.8	-27.5	-76.7	-95.7	-145.	-149.	-211.
2 nd cycle - w/o CH4 trap	81.80	82.47	81.80	80.24	80.77	82.47	80.41	82.14	80.84	80.46	81.25	81.65	81.25	79.56	81.43	79.03	81.19	81.19	81.11	82.38	80.06	80.06	81.94
1st cycle - w/ CH4 trap	121.5	119.6	119.5	111.1	100.9	112.0	81.73	82.15	74.87	62.65	62.55	59.79	57.34	51.96	41.87	16.25	-3.19	-17.9	-67.1	-86.1	-136.	-139.	-202.
2 nd cycle - w/ CH4 trap	91.43	92.11	91.43	89.88	90.40	92.11	90.05	91.78	90.48	90.10	90.89	91.29	90.89	89.19	91.07	88.66	90.82	90.82	90.74	92.02	89.70	89.70	91.58

Figure 28.5. Attributable emissions savings in relation to former carbon stock and nitrogen fertiliser application

Note: For plantations established on mineral soil and nitrogen loss as N_2O is 1%. (Plantation ID with a = large company as a 'nucleus'; b = 'plasma' (satellite smallholding plantations))



N fertilizer, Kg N/ha	145	136	128	128	128	91	91	122	124	136	136
Initial C-stock, ton C/ha	46	49	67	95	101	119	123	123	137	164	195
Area of peat	0.02	0.78	0.01	0.01	0.04	0.66	0.38	0.58	0.99	0.79	0.73
Plantation ID	001	003	013b	015a	013a	006b	006a	002	008	012a	012b
1st cycle - w/o CH4 trap	71.96	-199.18	26.27	28.77	-10.98	-332.83	-204.42	-178.47	-369.79	-343.07	-375.16
2 nd cycle - w/o CH4 trap	74.57	-188.05	63.60	79.26	63.60	-187.97	-86.73	-95.79	-250.24	-191.50	-191.50
1st cycle - w/ CH4 trap	81.60	-189.54	35.91	38.51	-1.35	-320.49	-194.78	-168.83	-360.16	-333.43	-181.87
2 nd cycle - w/ CH4 trap	84.20	-178.42	73.23	89.00	73.23	-175.64	-77.10	-86.15	-240.60	-365.52	-181.87

Figure 28.6. Attributable emissions savings in relation to former carbon stock and nitrogen fertilser application

Note: For plantations established on mixed peat and mineral soils and nitrogen loss as N_2O is 1%. (Plantation ID with a = large company as a 'nucleus'; b = 'plasma' (satellite smallholding plantations))

Key reference

Khasanah N, van Noordwijk M, Ekadinata A, Dewi S, Rahayu S, Ningsih H, Setiawan A, Dwiyanti E, Octaviani R. 2012. *The carbon footprint of Indonesian palm oil production*. Technical Brief 25: palm oil series. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. http://worldagroforestry.org/regions/southeast_asia/publications?do=view_pub_detail&pub_no=PB0047-12

The landscape scale is a meeting point for bottom–up local initiatives to secure and improve livelihoods from agriculture, agroforestry and forest management, and top–down concerns and incentives related to planetary boundaries to human resource use.

Sustainable development goals require a substantial change of direction from the past when economic growth was usually accompanied by environmental degradation, with the increase of atmospheric greenhouse gasses as a symptom, but also as an issue that needs to be managed as such.

In landscapes around the world, active learning takes place with experiments that involve changes in technology, farming systems, value chains, livelihoods' strategies and institutions. An overarching hypothesis that is being tested is:

> Investment in institutionalising rewards for the environmental services that are provided by multifunctional landscapes with trees is a cost-effective and fair way to reduce vulnerability of rural livelihoods to climate change and to avoid larger costs of specific 'adaptation' while enhancing carbon stocks in the landscape.

Such changes can't come overnight. A complex process of negotiations among stakeholders is usually needed. The divergence of knowledge and claims to knowledge is a major hurdle in the negotiation process.

The collection of tools—methods, approaches and computer models—presented here was shaped by over a decade of involvement in supporting such negotiations in landscapes where a lot is at stake. The tools are meant to support further learning and effectively sharing experience towards smarter landscape management.

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Research Program on Forests, Trees, and Agroforestry