International Expert Meeting on **Addressing Climate Change Through Sustainable Management of Tropical Forests** 30 April – 2 May 2008, Yokohama, Japan Methodologies for monitoring GHGs from deforestation and forest degradation



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Guidance on Methods and Procedures for Monitoring, Measuring and Reporting on REDD

Current draft available online:

www.gofc-gold.uni-jena.de/redd (Registration required)



Reducing Greenhouse Gat Emissions from Defonistation and Degradation in Developing Countries: A Sourcebeck of Methods and Procedures for Monitoring, Messuring and Reporting

The (current) list of contributors to this sourcebook is:

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Overview of Sourcebook

Focuses on using existing data with limited guidance on collecting new data



Overview of Chapter 4 on Carbon Stocks

Which Tier Should be Used? Stratification by Carbon Steps to estimate Carbon Stocks of Forests Undergoing Change How to assess Uncertainty resulting from the forest carbon stock estimations

Which Tier Should be Used?

IPCC Tier	Data needs/examples of appropriate biomass data	•The IPCC
Tier 1 (little guidance needed)	Default mean annual increment (MAI for degradation) and/or forest biomass stock (for deforestation) for broad continental forest types—includes 6 classes for each continental area; default values given for all vegetation-based pools	recommends that it is good practice to use higher Tiers for the measurement of significant
Tier 2	MAI and/or forest biomass values from existing forest inventories and/or ecological studies. Default values provided for all non-tree pools Newly-collected forest biomass data.	sources/sinks of GHGs •For deforestation and significant timber baryesting
Tier 3	Repeated measurements of trees from permanent plots and/or calibrated process models. Can use default data for other pools stratified by in-country regions and forest type, or estimates from process models	activities this would imply a <u>Tier 2</u> or higher

General approaches to improving estimates of carbon stocks

- 1 STEP 1: Identify strata where assessment of carbon stocks is needed
 - Not all forest strata are likely to undergo change
 - Can identify by stratifying forests by factors that affect biomass:
 - Biophysical factors such as climate (wet to dry) and elevation
 - Human disturbance factors such as closeness to roads, human settlements, etc.



Example of how to stratify country's forests for carbon estimation

Accessibility category

Less than 10 km distance from major roads More than 10 km distance from major roads

Kilometers

Stratified Forest Ecological zone/Elevation catagory/Accessibility category (thousands ha)

Tropical dry/<1,000 m/<10 km (155 ha) Tropical dry/<1,000 m/> 10 km (15 ha) Tropical moist deciduous/<1,000 m/> 10 km (1,365 ha) Tropical moist deciduous/<1,000 m/> 10 km (1,323 ha) Tropical moist deciduous/>1,000 m/> 10 km (2,446 ha) Tropical moist deciduous/>1,000 m/> 10 km (3,864 ha) Tropical mountain system/<1,000 m/> 10 km (3,864 ha) Tropical mountain system/<1,000 m/> 10 km (466 ha) Tropical mountain system/>1,000 m/> 10 km (1,885 ha) Tropical mountain system/>1,000 m/> 10 km (3,003 ha) Tropical ra inforest/<1,000 m/> 10 km (77,332 ha) Tropical ra inforest/>1,000 m/> 10 km (845 ha) Tropical ra inforest/>1,000 m/> 10 km (1,647 ha)

Elevation category Less than 1,000 m Greater than 1,000 m



General approaches to improving estimates of carbon stocks

- <u>2 STEP 2: Assess existing data quality</u>
 - e.g.—less than 10 years old, derived from multiple plots, sampled from good coverage of the strata, all species and minimum diameter at least 20-25 cm included if using forest inventory data
 - Provides detailed guidance on how to convert forest inventory data to carbon stock estimates
 - STEP 3: Collect missing data
 - Based on decisions about which strata at risk of deforestation or degradation in the future but do not have estimates of carbon stock
 - Specific guidance on designing and implementing field measurement of carbon stocks can be found in Chapter 4.3 of IPCC GPG LULUCF and also in the World Bank's BioCarbon Fund Sourcebook for Land Use, Land-Use Change and Forestry (available at http://www.winrock.org/Ecosystems/files/Winrock-BioCarbon Fund Sourcebook-compressed.pdf

How to monitor degradation?

Need to know cause so can design a system for monitoring and accounting logging, fire, fuelwood, removing biomass > ability to regrow, etc..

Different systems needed for different causes

General procedures for estimating degradation impacts on C stocks exist in IPCC for many causes
Changes in C stocks in "forests remaining as forests"

IPCC methodology for accounting for emissions from "forests remaining as forests"

- Use "gain and loss" approach
 - ΔC stock = Gain in C-Loss in C
 - Loss from harvest of logs, fuelwood, or disturbance
 - Gain from regrowth of degraded forest over multiple years
- Can use "stock-difference" method but requires repeated inventories through time
- Can include all 5 pools—aboveground biomass, belowground biomass, dead wood, litter and soil
- Wood into products assumed to oxidize in year harvested—overestimates emissions if goes into long term wood products
- Does not include losses from collateral damage to stand, construction of skid trails, roads and landing decks

Data needs to estimate impact of logging on changes in forest carbon stocks

- 1. Area logged in a given year
- 2. Amount of timber extracted per unit area per year, and area of infrastructure (roads etc.)
- 3. Amount of dead wood produced per unit area per year (from tops and stump of the harvested tree, mortality of the surrounding trees caused by the logging)
- Tree mortality from the skid trails, roads, and logging decks
- 5. Decomposition rate of dead wood
- 6. Amount going into long term storage as wood products
- 7. Regrowth rate of stand after logging per unit area per year for multiple years

1. Area logged per year

Reliable national statistics
Independently by remote sensing

Obtain area logged in a given year
Monitor and record logged area over time
Can give area under logging in current year and if archived, area logged through time

Carnegie Landsat Analysis System (Asner et al.)[©]



Brazil Amazon: deforestation (R) and selective logging (L) differences



PRODES Classes (Brazil data) Forest Deforestation 2001-2002





CLAS

- Recent Logging
 Forest Cover
- Woody Debris
 - Soil



However monitoring degradation needs to be frequent



Rate of forest recovery after logging and fires is fast and needs frequent monitoring



From Carlos Souza, IMAZON, Brazil,

2. Amount of timber extracted per unit area per year

Reliable national statistics-IPCC Illegal logging? Extract more than allowable cut Independent method: Aerial imagery using a sampling approach—produces estimates of area of gaps (timber extracted), and other impacts

Fly aerial transects over concession to monitor logging gaps, roads, etc







Strips of aerial imagery showing logging damage

- Left with gaps delineated automatically
 - Right-without

- Use imagery to estimate area of gaps, roads and length of skid trails

- Estimate proportion of total sample area covered by gaps to get total gap area

3. Change in live and dead C stocks of forest



Logging has the effect of decreasing the stocks in live biomass and increasing the stocks in dead wood and wood products



Quantify change in live and dead C stocks

•Collect measurements on felled trees to estimate the Δ live C and the Δ dead C

Use biomass regression equations to estimate biomass of felled trees
Dead biomass (top) = total minus biomass in logs

Extracted volumes

Estimate carbon in log based on volume and density

Tree fall damage Measure diameter of collateral damage trees and estimate biomass from regression equations



4. Road and skid trail damage

Estimated skid trail damage by measuring fallen trees on ground and road damage from area and C density





Summary of field results from Congo (100 plots)

	Factor	95% CI
m ³ extracted / m ² of gap area	0.0444	±0.0057
Kg C extracted / m ² of gap	12.10	±1.58
area Kg C damaged / m ² of gap area	18.52	±2.29
Kg C damaged / m of skid trail	6.83	±2.44
Kg C damaged / m ² of road area	27.67	±10.39

Combining field data with imagerysummary of results

Extracted 9.6 m³/ha and about 0.5 trees/ha

	Total carbon impact		Impact per concessior	ha of
	t C	95% CI	t C/ha	95% CI
Extracted biomass carbon	3,824	± 248	2.60	± 0.17
Damaged biomass carbon in logging gap	5,698	± 343	4.01	± 0.23
Damaged biomass carbon in skid trails	126	± 10	0.09	± 0.007
Biomass carbon impact of logging roads	3,194	± 598	2.17	± 0.41
TOTAL	13,042	± 1,199	8.86	± 0.81
Emissions per m ³ extracted			3.6 t CO2	

Other impacts

- 5. Loss: Decomposition rate of dead wood from literature (varies ~3-12%/yr)
- 6. Amount going into long term storage as wood products (IPCC assumes zero, varies 30-60% depending on milling efficiency and final product)
- 7. Regrowth rate of stand after logging per unit area per year for multiple years poorly known, default values given in IPCC but not for logged areas specifically Regrowth generally affects gap areas only created by logging not whole area of concession

Putting it all together to estimate change in C stocks of logged forests

	A	В	С	D	E	F	G	Н	I	
1	Model to es	timate net	emissions	of carbon i	from forest	harvesting				
2										
3							Only change	data in blue hi	ghlighted cells	;
4										
5	Assumptions:	Density of harvested wood				0.6 t/m^3				
6		Amount of wood extracted, m^3/yr				insert into col B				
7		Total biomass damageddamage factor				2.0	t damaged			
8	Amount into wood products = volume x density x 0.5 x conversion efficiency					conversion efficiency				
9		Conversion efficiency		ficiency			0.3		<u> </u>	
10		Decompositio	on rate of wood	l (% per year)			0.07			
11										
12		Area damaged per m3 of removed timber			(from field data)		600	m2/m3		
13		Regrowth in I	ogged gaps				2	t C/ha/yr		
14		_								
	Live biomass removals									
15	Live biomass re	movals			Change in dea	d wood pool				
15 16	Live biomass re Year	movals Volume	Total C	Damaged	Change in dea Dead wood	d wood pool Change in dead	Annual	Regrowth in	Annual emissio	ns
15 16 17	Live biomass re Year	movals Volume removed	Total C removed	Damaged	Change in dea Dead wood pool	d wood pool Change in dead wood C pool	Annual wood products	Regrowth in logged areas	Annual emission from logging	ns
15 16 17 18	Live biomass re Year	movals Volume removed 10^3 m^3/yr	Total C removed 1000 t C/yr	Damaged 1000 t C/yr	Change in dea Dead wood pool 1000 t C	d wood pool Change in dead wood C pool 1000 t C/yr	Annual wood products 1000 t C/yr	Regrowth in logged areas 1000 t C	Annual emissio from logging using 0.07	ns
15 16 17 18 19	Live biomass re Year	movals Volume removed 10^3 m^3/yr	Total C removed 1000 t C/yr	Damaged 1000 t C/yr	Change in dea Dead wood pool 1000 t C Decomposition	d wood pool Change in dead wood C pool 1000 t C/yr nrate = 0.07	Annual wood product: 1000 t C/yr	Regrowth in logged areas 1000 t C	Annual emission from logging using 0.07 1000 t C/yr	ns
15 16 17 18 19 20	Live biomass re Year 1997	movals Volume removed 10^3 m^3/yr 45.0	Total C removed 1000 t C/yr 40.5	Damaged 1000 t C/yr 27.0	Change in dea Dead wood pool 1000 t C Decomposition 27	d wood pool Change in dead wood C pool 1000 t C/yr nate = 0.07 27	Annual wood products 1000 t C/yr 4	Regrowth in logged areas 1000 t C 5	Annual emissio from logging using 0.07 1000 t C/yr 14.9	ns
15 16 17 18 19 20 21	Live biomass re Year 1997 1998	emovals Volume removed 10^3 m^3/yr 45.0 45.5	Total C removed 1000 t C/yr 40.5 40.9	Damaged 1000 t C/yr 27.0 27.3	Change in dea Dead wood pool 1000 t C Decomposition 27 52	d wood pool Change in dead wood C pool 1000 t C/yr nate = 0.07 27 25	Annual wood products 1000 t C/yr 4	Regrowth in logged areas 1000 t C 5	Annual emission from logging using 0.07 1000 t C/yr 14.9 16.8	ns
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Changes in C stocks from logging

Net Change = Δ live – Δ dead – Δ wood products + Regrowth



Conclusions

- When deforestation or degradation is a key category need to use at least a Tier 2 or Tier 3 method—implies collection of new data
 - Most tropical countries need to measure and estimate C stocks in key pools to participate in reducing emissions from deforestation
 - Need to collect country specific data on direct logging impacts (field data), area logged per year, actual extraction rates, losses caused by decomposition of wood, and regrowth of logged areas through time
 - Methods for collecting required data available
- IPCC methodology of gain and loss useful for forest degradation
 - However it needs to be modified to account for all emissions from changes in C stocks from logging—collateral damage, roads, etc.

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 - <u>http://www.winrock.org/Ecosystems/</u>
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