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Methodologies for monitoring GHGs from deforestation and forest degradation

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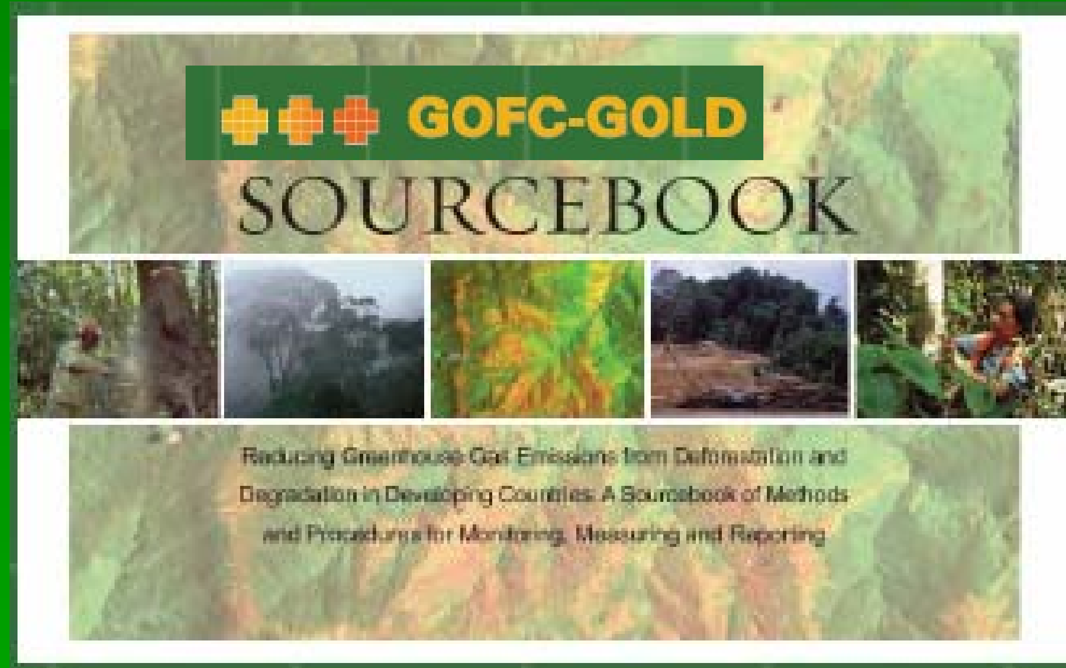
Guidance on Methods and Procedures for Monitoring, Measuring and Reporting on REDD

Current draft available online:

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



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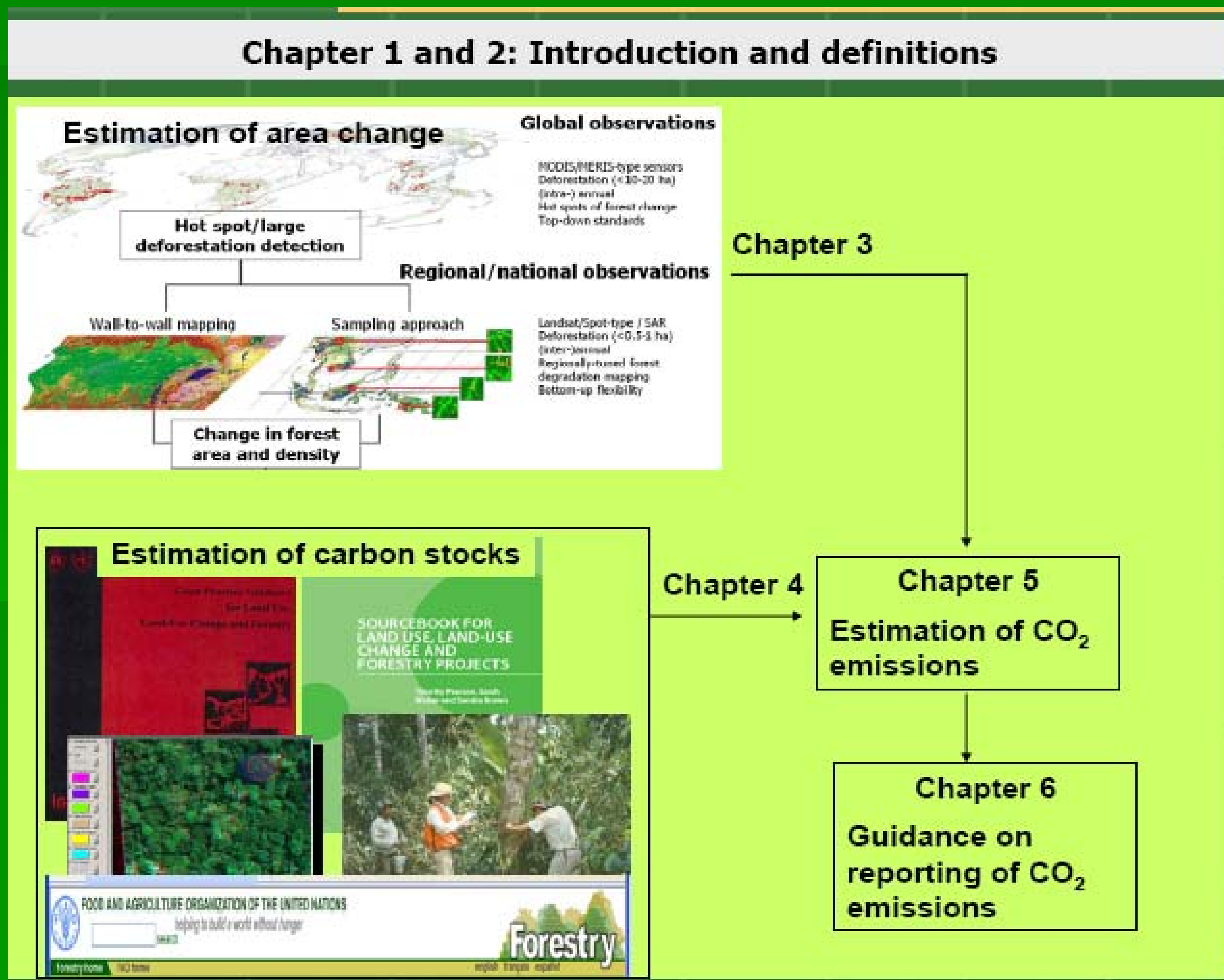
Overview of Sourcebook



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?

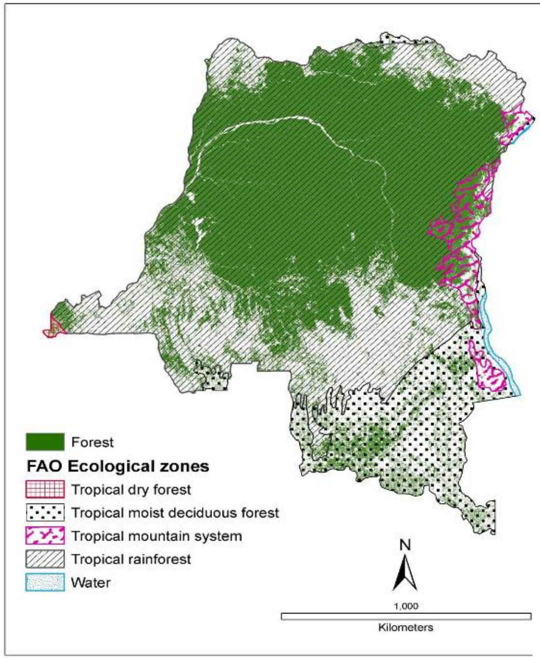
IPCC Tier	Data needs/examples of appropriate biomass data
Tier 1 (little guidance needed)	Default mean annual increment (MAI for degradation) and/or forest biomass stock (for deforestation) for broad continental forest types—includes 6 classes for each continental area; default values given for all vegetation-based pools
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.
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

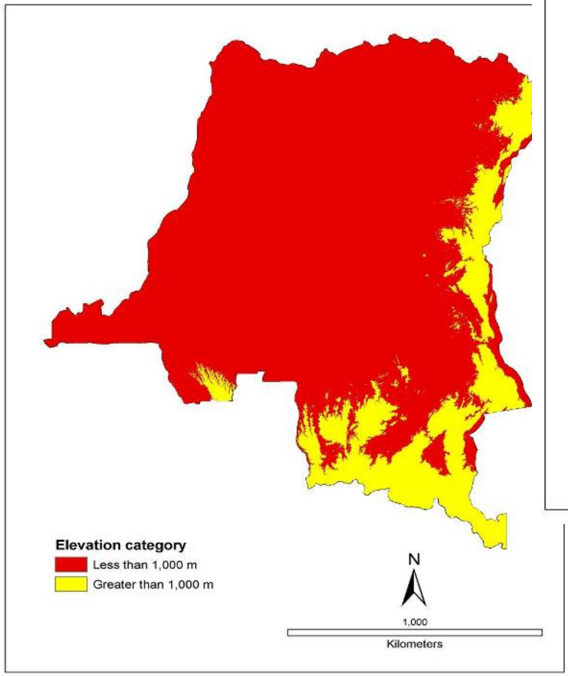
- The IPCC recommends that it is good practice to use higher Tiers for the measurement of significant sources/sinks of GHGs
- For deforestation and significant timber harvesting activities this would imply a Tier 2 or higher

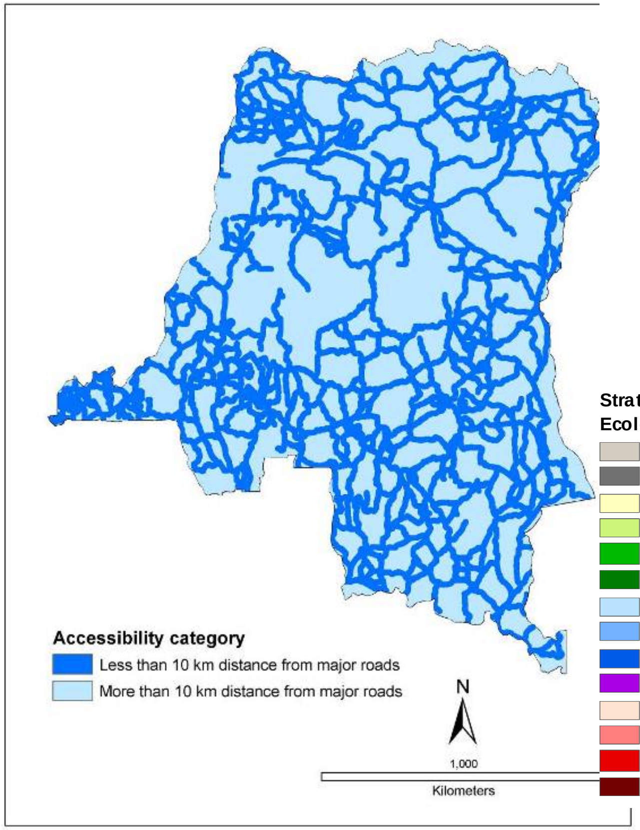
General approaches to improving estimates of carbon stocks

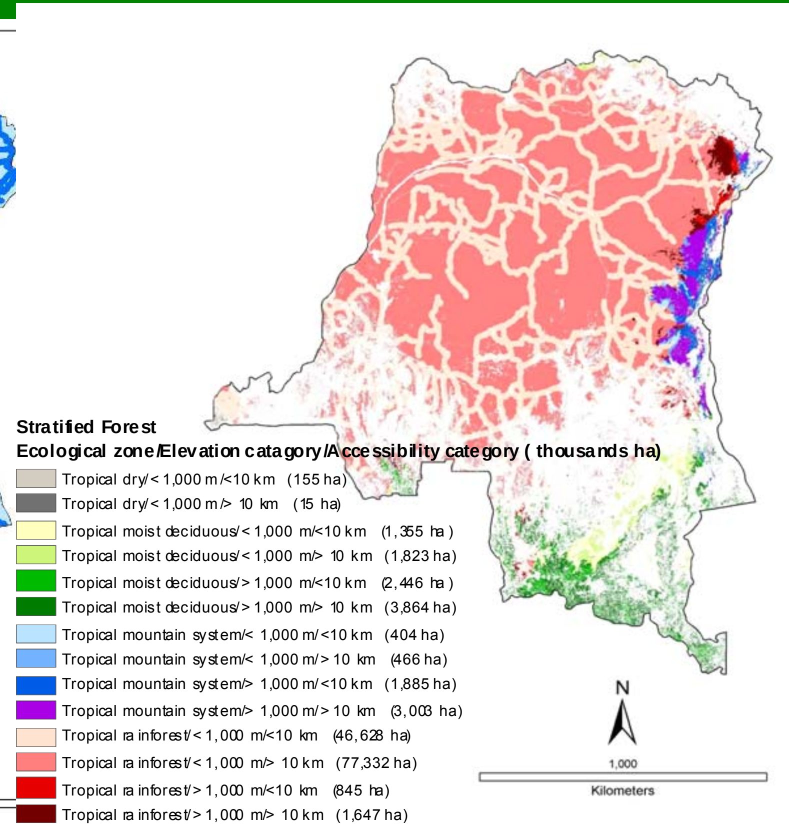
- 1 STEP 1: Identify strata where assessment of carbon stocks is needed
  - Not all forest strata are likely to undergo change
  - Can identify by stratifying forests by factors that affect biomass:
    - Biophysical factors such as climate (wet to dry) and elevation
    - Human disturbance factors such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

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









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
- <u>STEP 3: Collect missing data</u>
  - 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

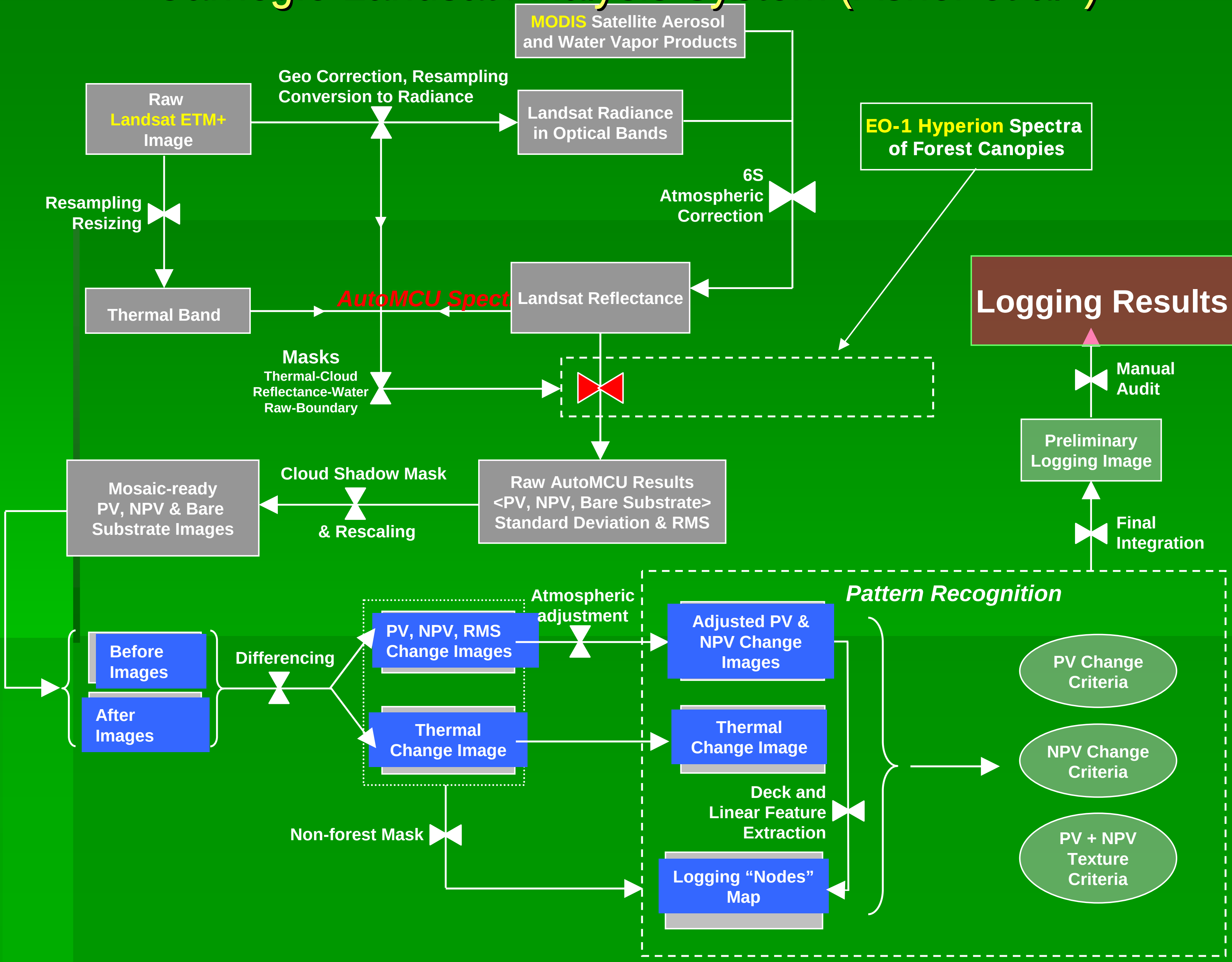
Data needs to estimate impact of logging on changes in forest carbon stocks

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)
4. 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

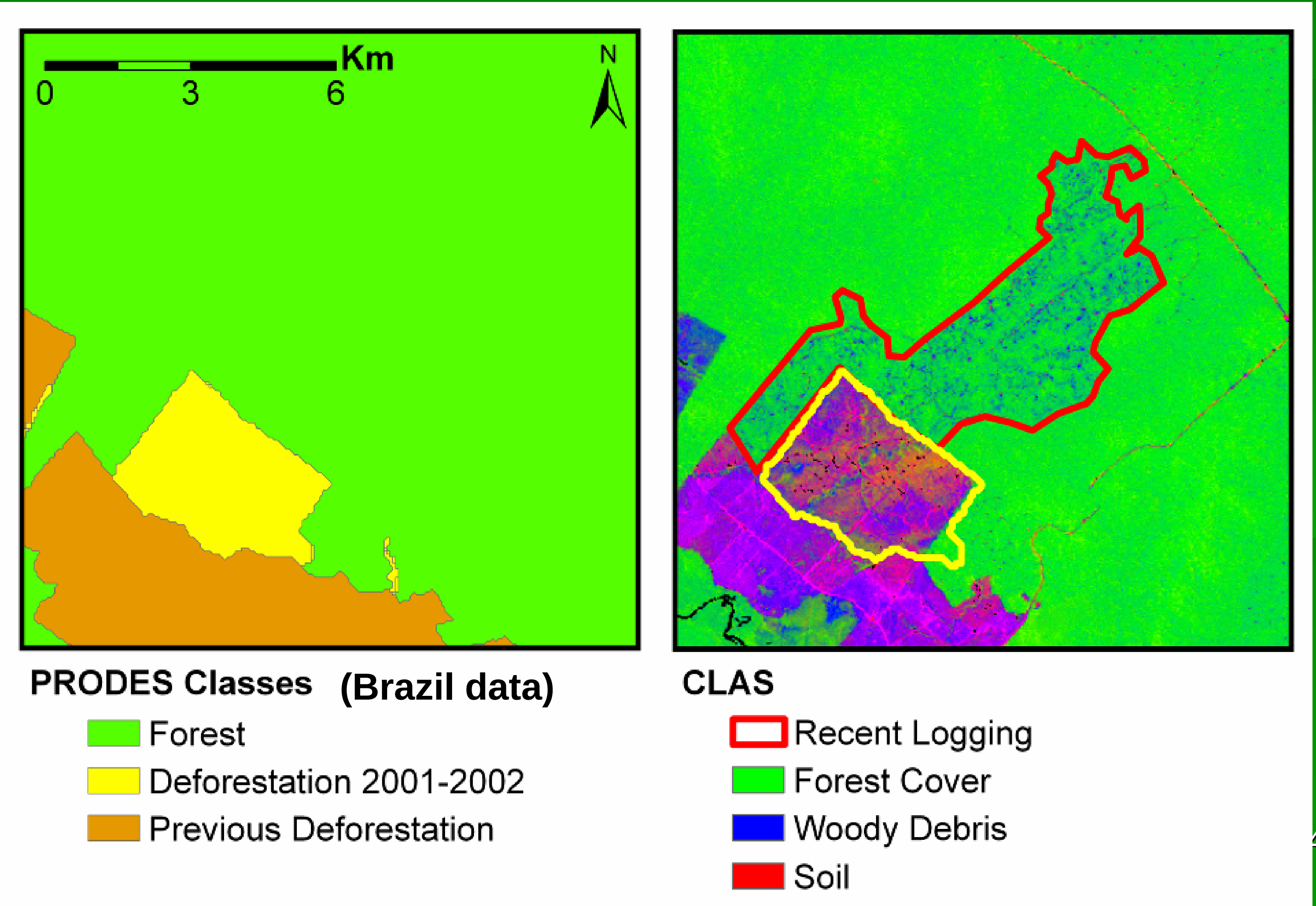
1. Area logged per year

- 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

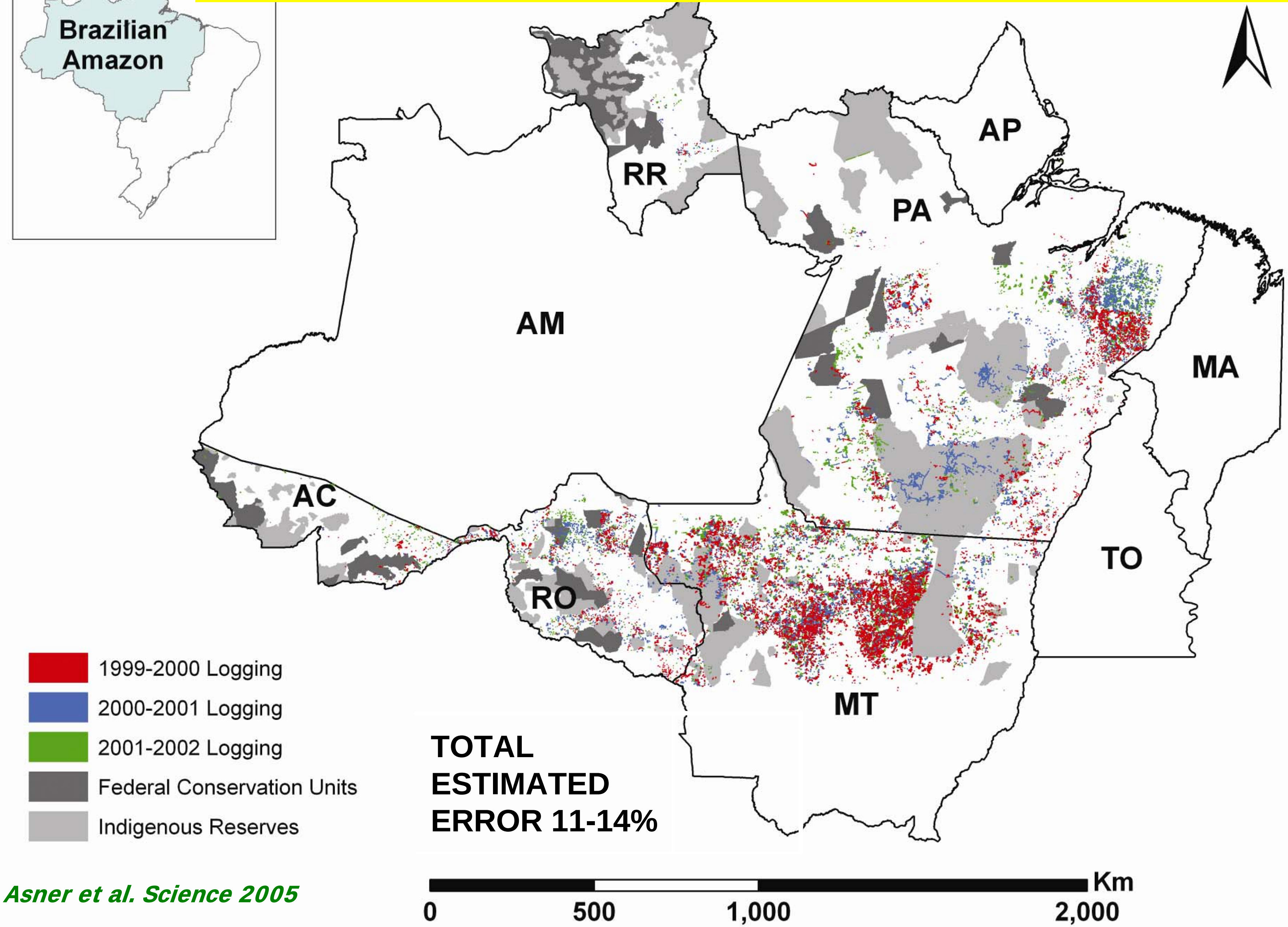
Carnegie Landsat Analysis System (Asner et al.)©



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



Time series of logging activity in Brazilian Amazon

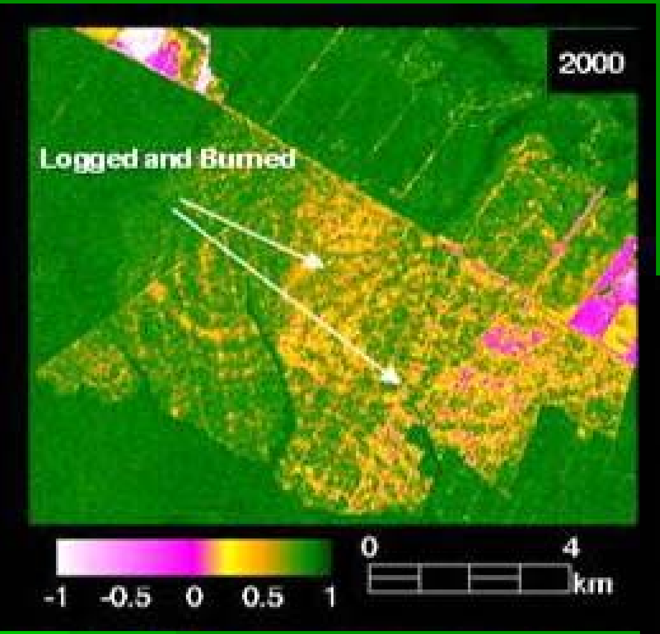


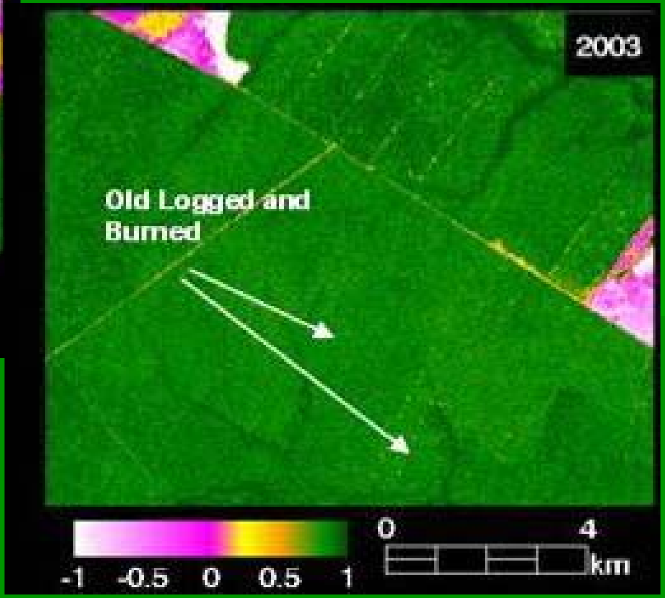
TOTAL ESTIMATED ERROR 11-14%

Asner et al. Science 2005

However monitoring degradation needs to be frequent

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



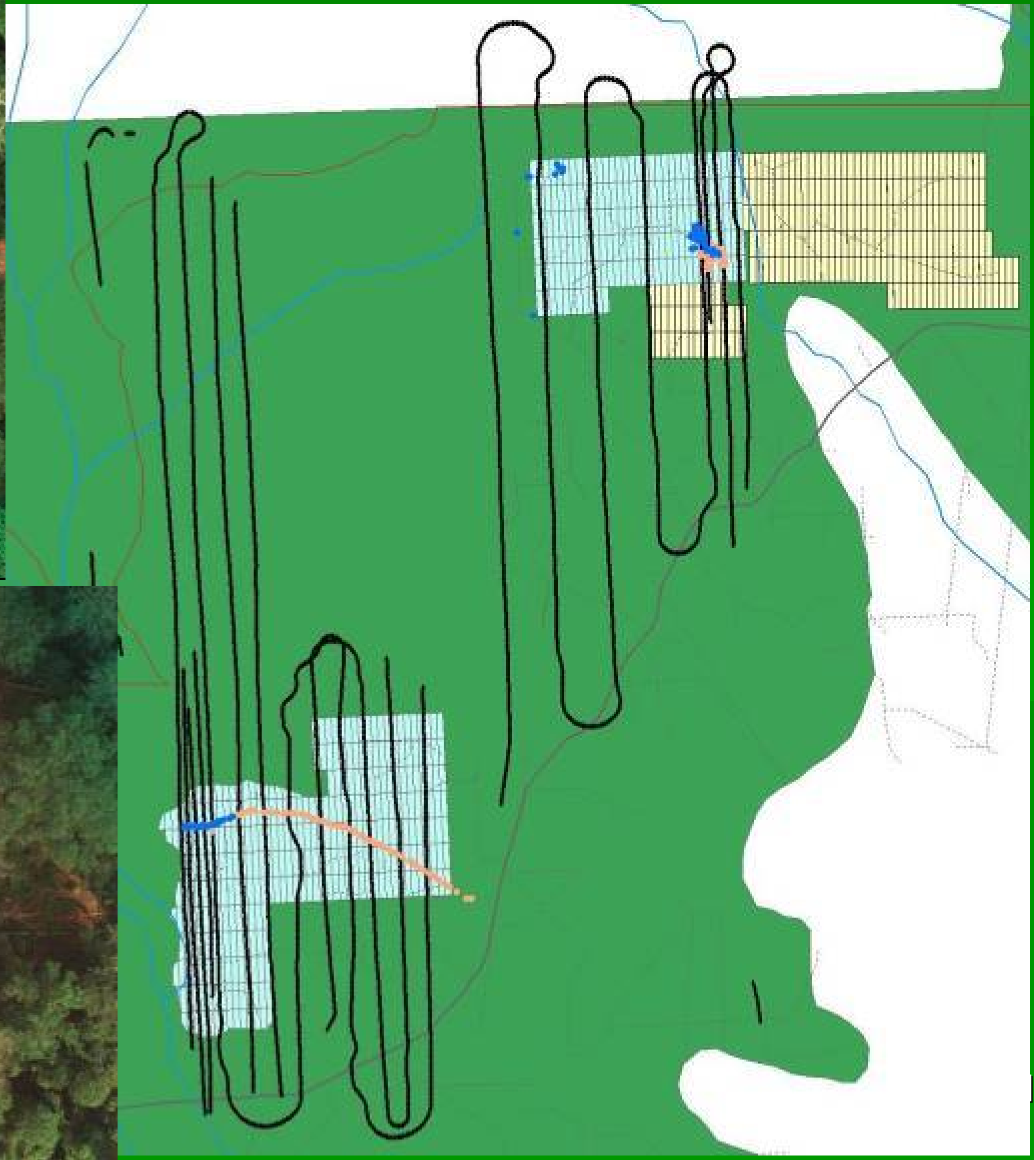


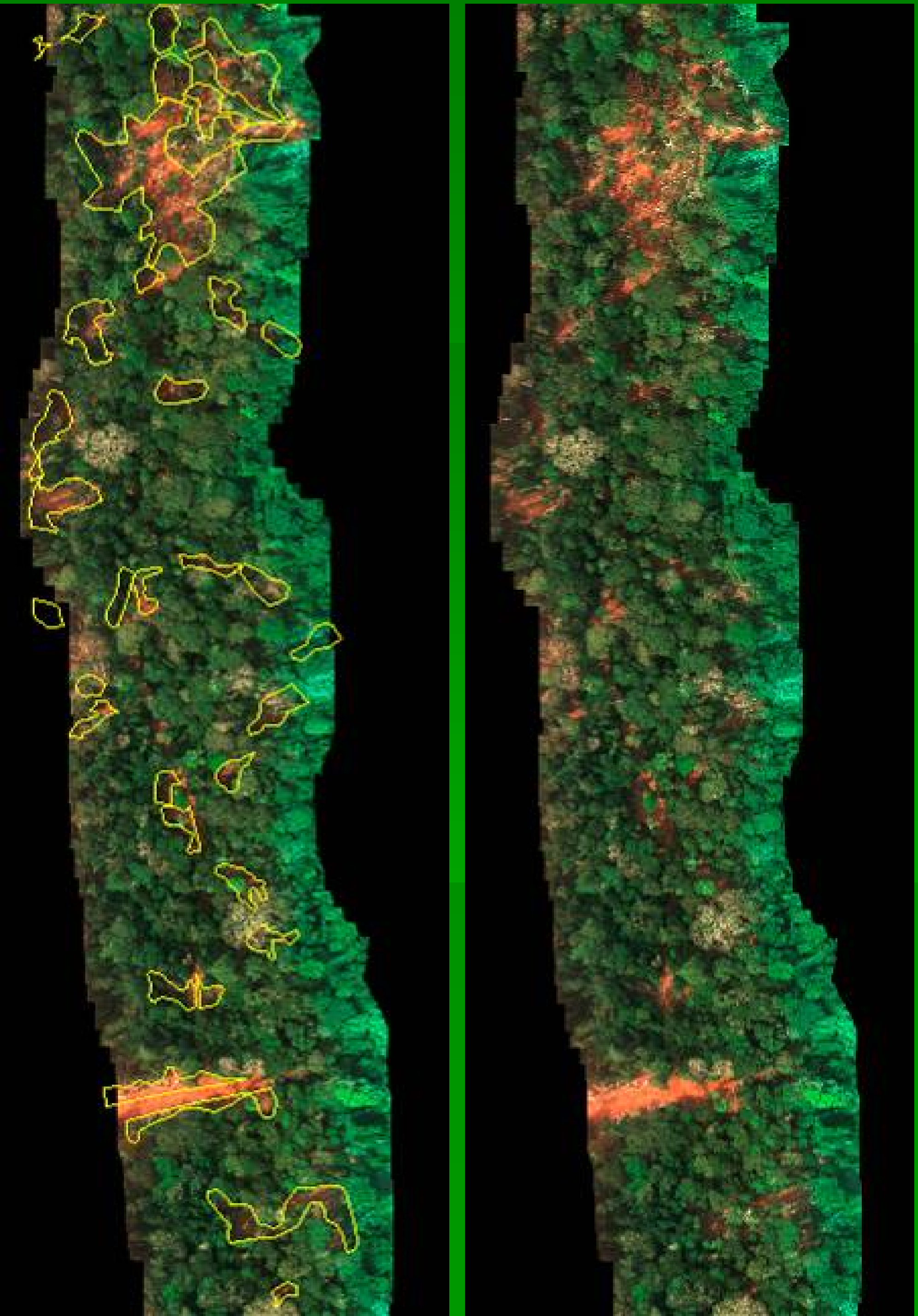
From Carlos Souza, IMAZON, Brazil,

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

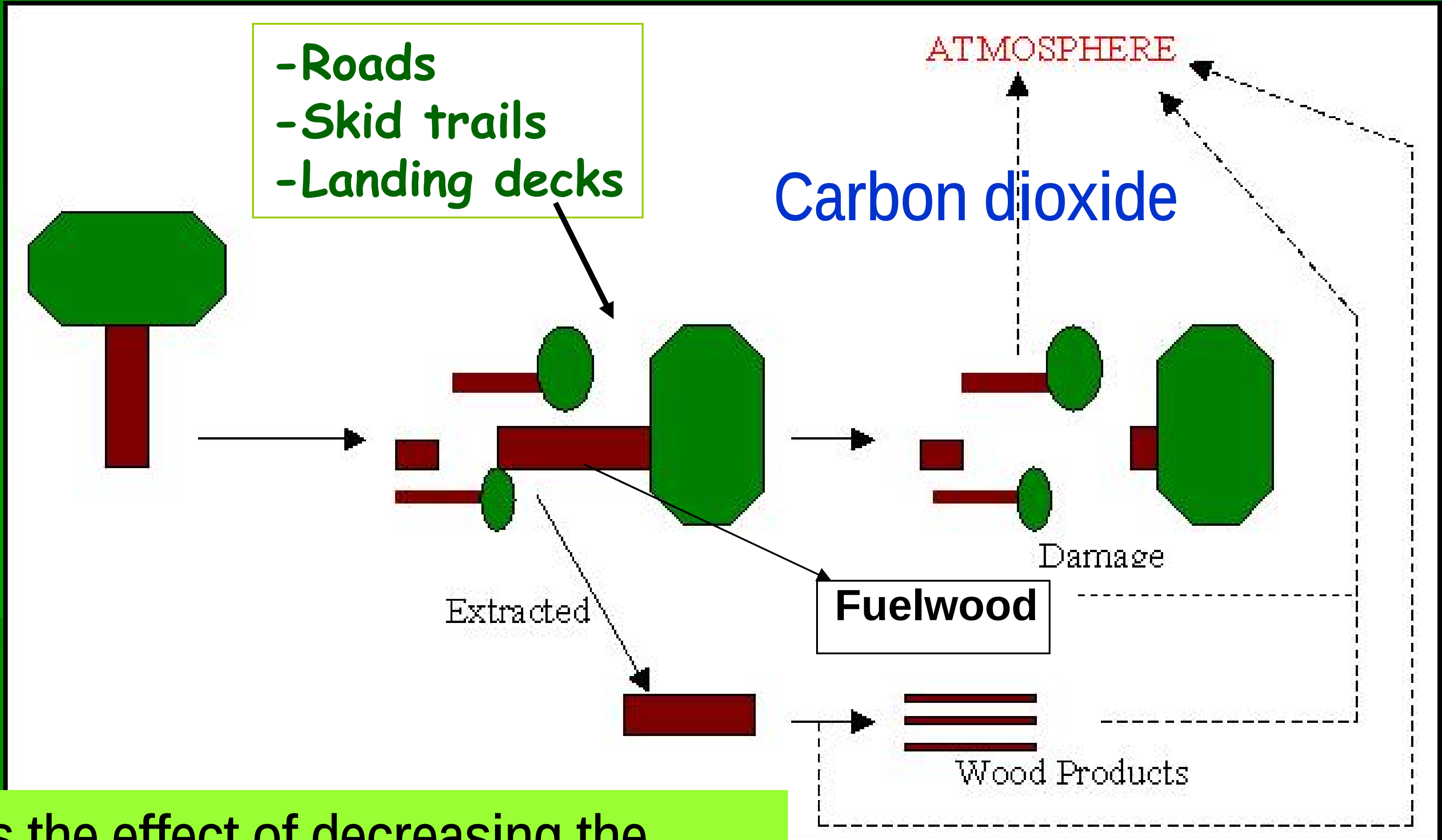
- Left with gaps delineated automatically

 – 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

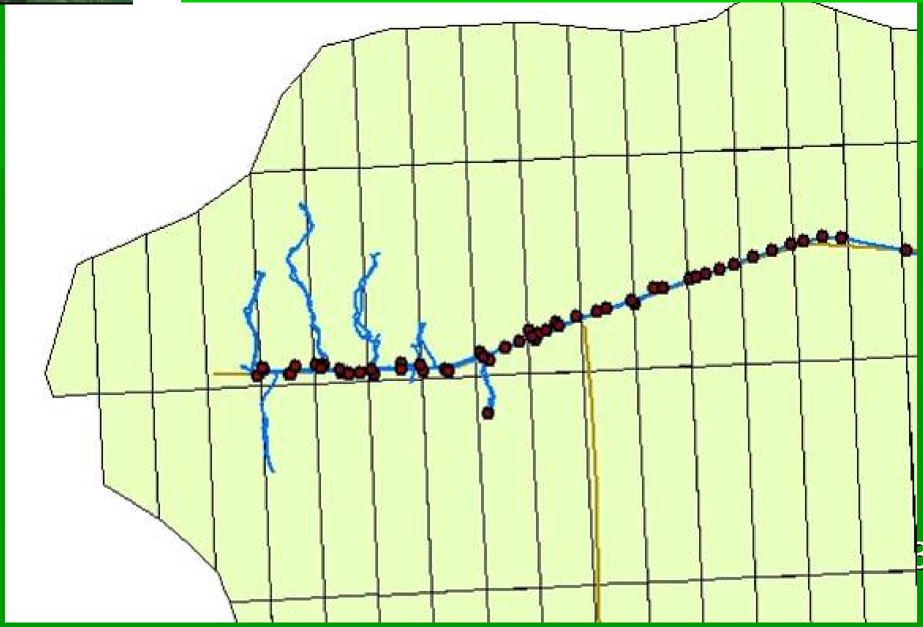
Estimate carbon in log based on volume and density

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 area	12.10	±*1.58*
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 imagery-summary of results

Extracted 9.6 m^3/ha and about 0.5 trees/ha

	Total carbon impact		Impact per ha of concession	
	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

Model to estimate net emissions of carbon from forest harvesting

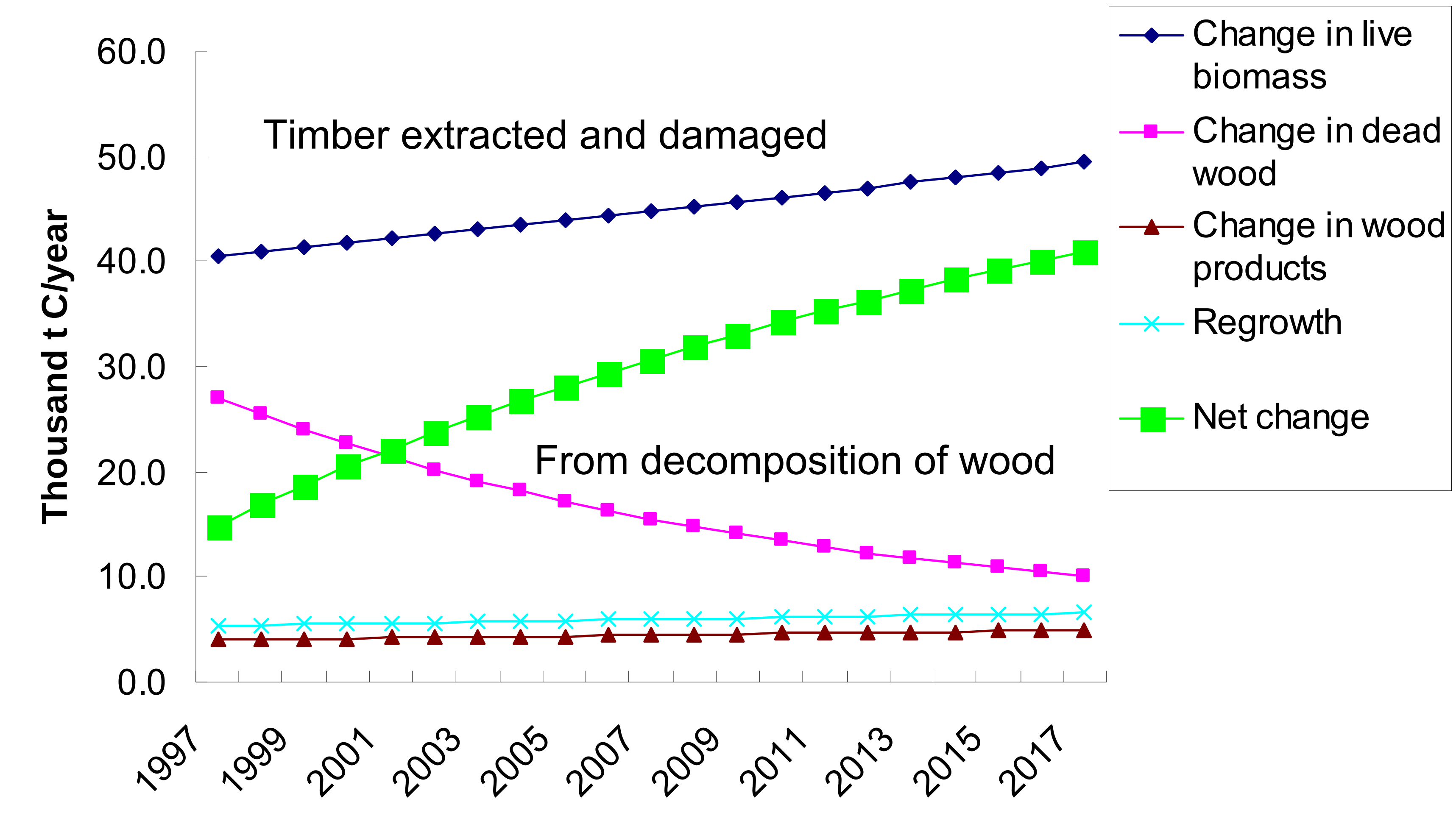
Only change data in blue highlighted cells

Assumptions:	Density of harvested wood	0.6	t/m^3
	Amount of wood extracted, m^3/yr	insert into col	B
	Total biomass damaged --damage factor	2.0	t damaged
	Amount into wood products = volume x density x 0.5 x conversion efficiency		
	Conversion efficiency	0.3	
	Decomposition rate of wood (% per year)	0.07	
	Area damaged per m3 of removed timber (from field data)	600	m2/m3
	Regrowth in logged gaps	2	t C/ha/yr

Live biomass removals				**Change in dead wood pool**				
Year	Volume removed 10^3 m^3/yr	Total C removed 1000 t C/yr	Damaged 1000 t C/yr	Dead wood pool 1000 t C	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 emissions from logging using 0.07 1000 t C/yr
				Decomposition rate = 0.07				
1997	45.0	40.5	27.0	27	27	4	5	14.9
1998	45.5	40.9	27.3	52	25	4	5	16.8
1999	45.9	41.3	27.5	76	24	4	6	18.7
2000	46.4	41.7	27.8	99	23	4	6	20.5
2001	46.8	42.1	28.1	120	21	4	6	22.2
2002	47.3	42.6	28.4	141	20	4	6	23.8
2003	47.8	43.0	28.7	160	19	4	6	25.3
2004	48.2	43.4	28.9	178	18	4	6	26.7
2005	48.7	43.9	29.2	195	17	4	6	28.1
2006	49.2	44.3	29.5	212	16	4	6	29.4
2007	49.7	44.7	29.8	227	16	4	6	30.7

Changes in C stocks from logging

Net Change = Δlive – Δdead – Δwood 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.

Thank You!

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- Support: US AID, US EPA, The Nature Conservancy
- For more information see:
  - http://www.winrock.org/Ecosystems/

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