Workshop on Forest Degradation
AFD, Paris
March 10-11, 2008

Monitoring and Accounting of GHGs from Forest Degradation

Sandra Brown, Winrock International
Greg Asner, Carnegie Institution, Stanford
sbrown@winrock.org

How is forest degradation defined?

Forest Definition: (annex to decision 16/CMP.1 of Kyoto Protocol)

Minimum forest area: **0.05 – 1 ha**

Minimum tree height: **2 – 5 m**

Minimum crown cover: **10 – 30 %**

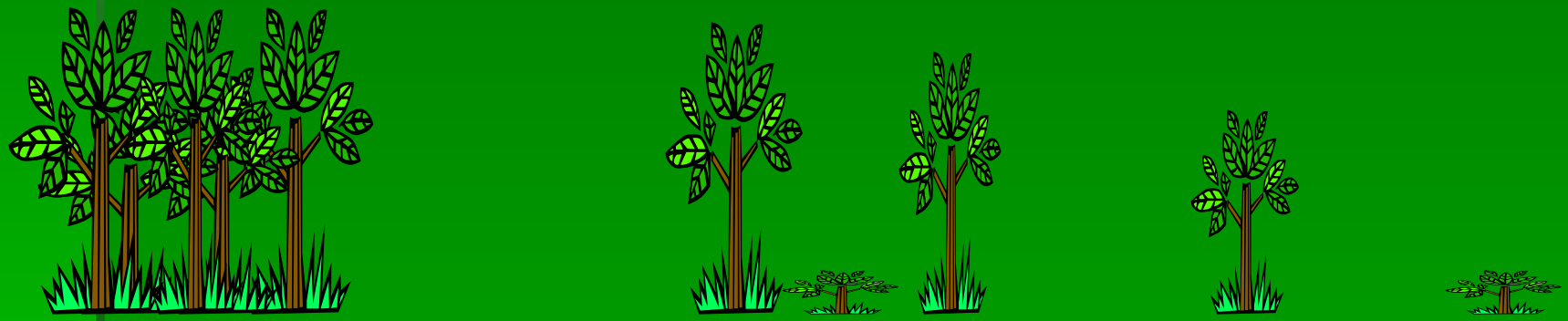
Degradation (from IPCC):

Direct, human-induced, long-term loss [persisting for **X** years or more] or at least **Y%** of forest carbon stocks since time **T** [not qualifying as deforestation]

Application of definitions

Crown cover

80% 30% 10% 0%



Carbon stocks in t C/ha

120 40 12 1

30%

Deforestation ΔC= 80

Degradation: ΔC= >40 and <80 t C/ha

10%

Deforestation ΔC= 108

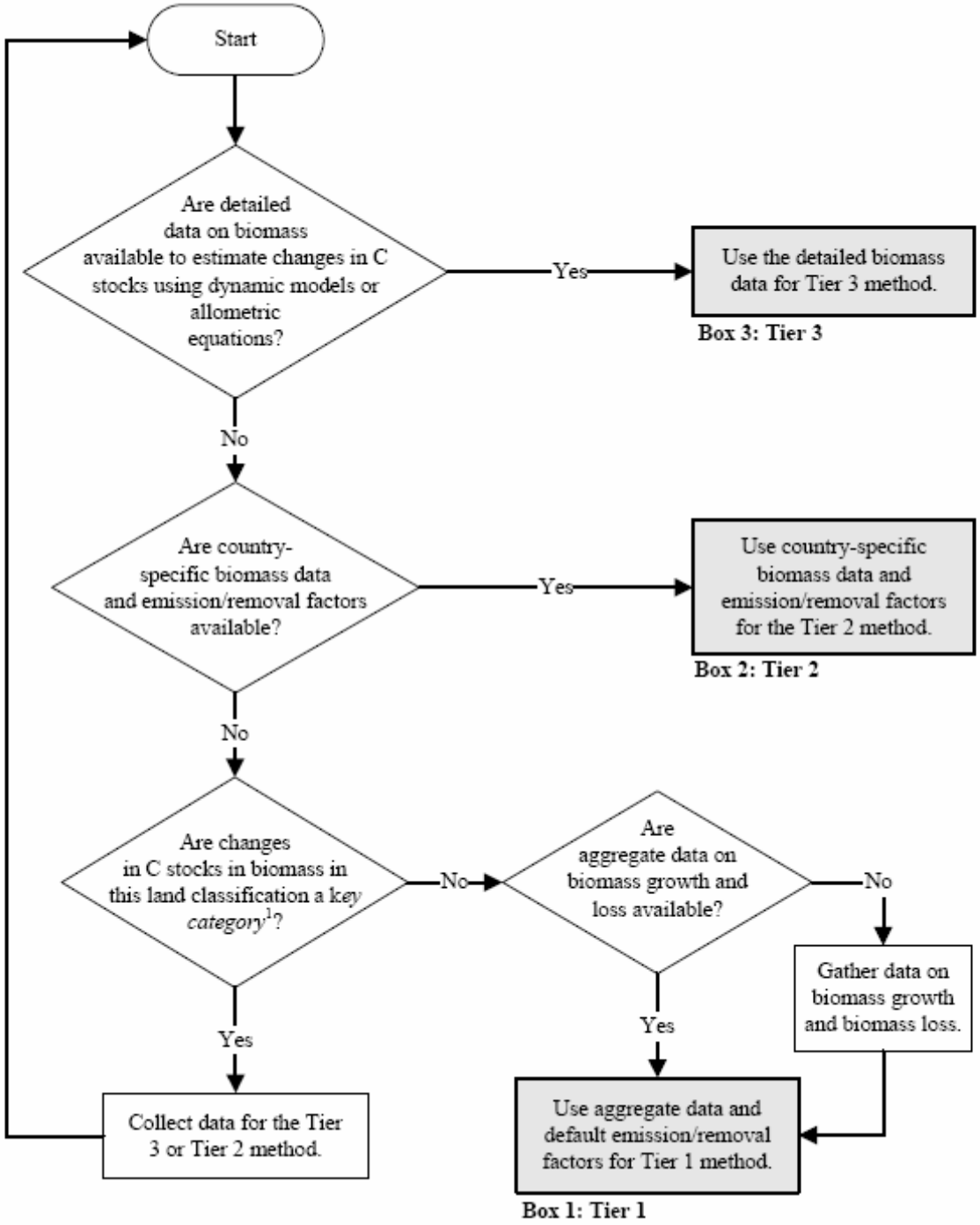
Degradation: ΔC= >12 and <108 t C/ha

What are causes of 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
  - Gain from regrowth of degraded forest over multiple years
  - Loss from harvest of logs, fuelwood, or disturbance
- 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 organic matter
- Wood into products assumed to oxidize in year harvested—overestimates emissions if goes into long term wood products
- Does not directly include losses from collateral damage to stand, nor from construction of skid trails, roads and landing decks



Decision tree to select Tier to use for "Forests Remaining as Forests"

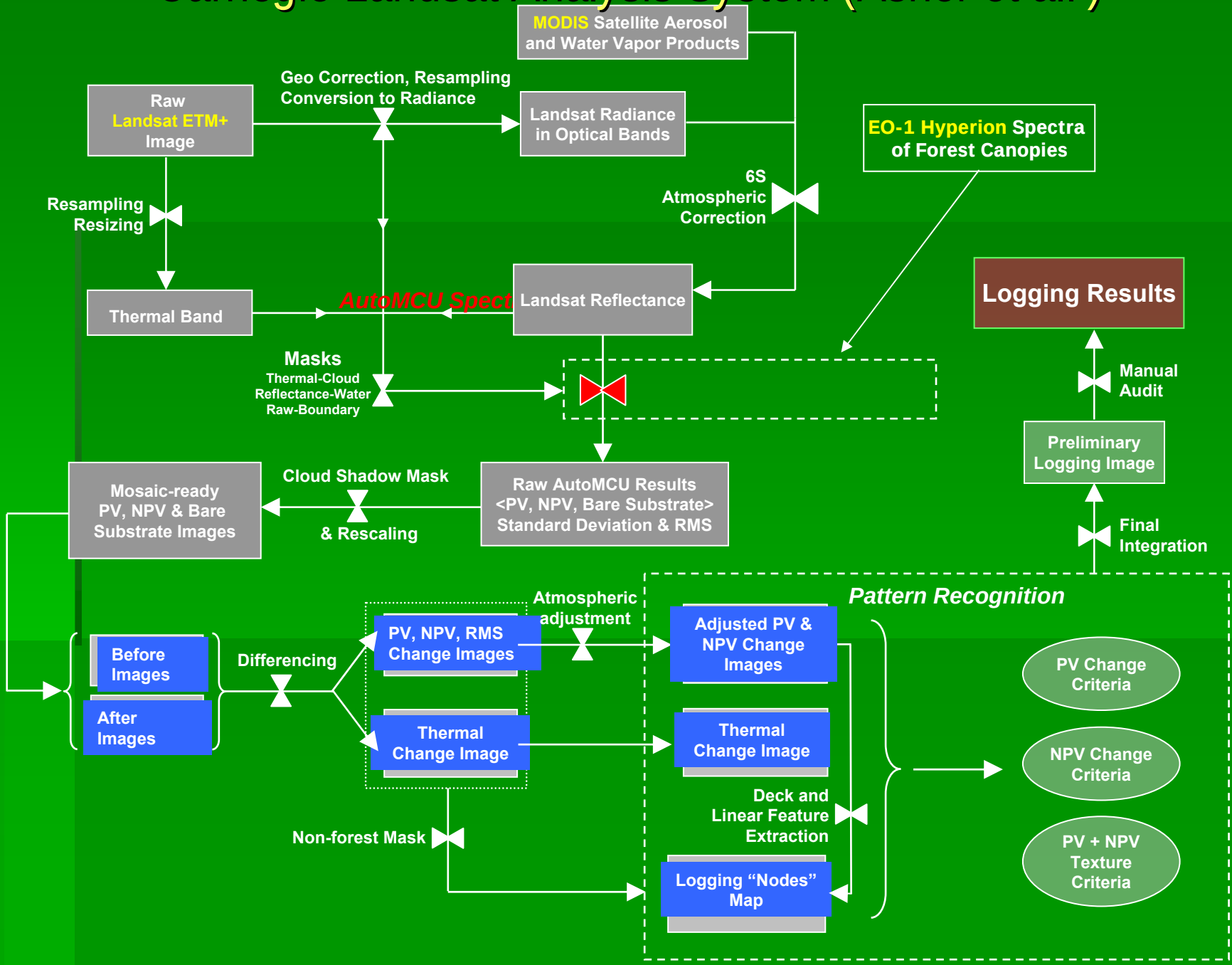
Data needs to estimate impact of logging on changes in forest carbon stocks-a key activity in Central African forests

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

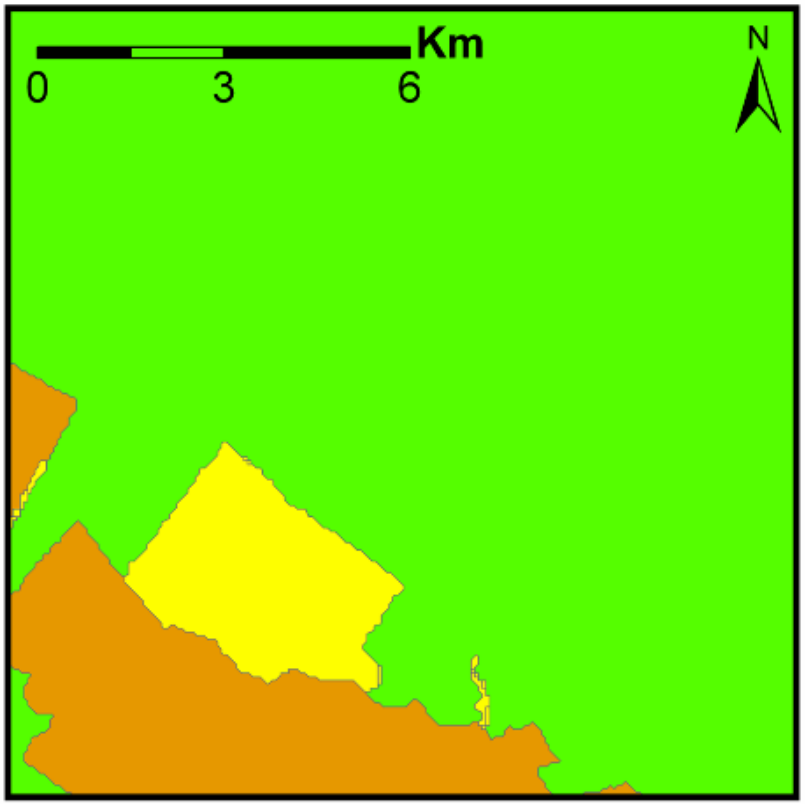
1. Area logged per year

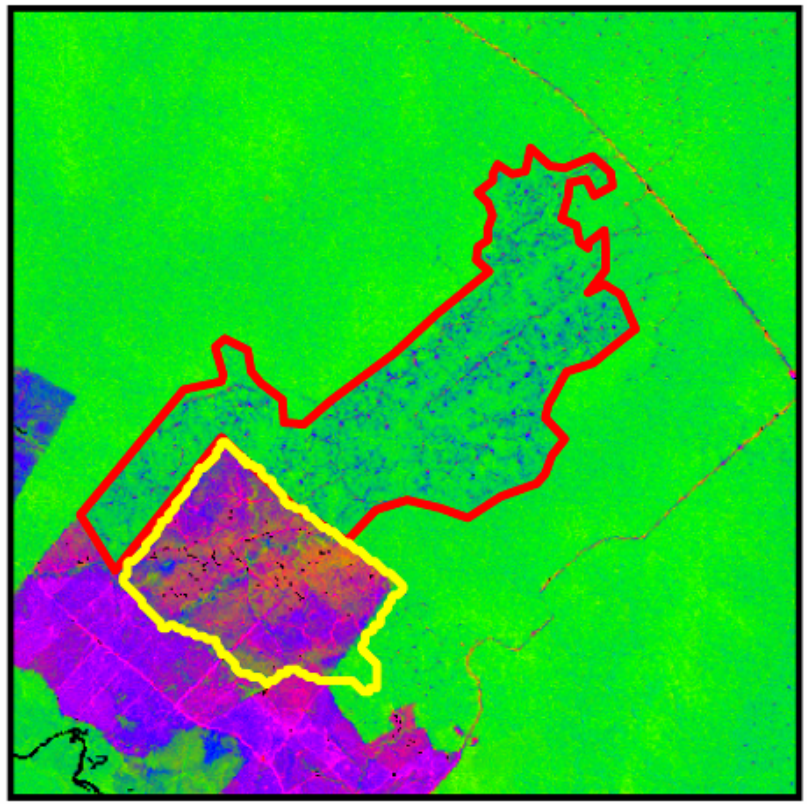
- Reliable national statistics
- Independently by remote sensing
  - Obtain area logged in a given year
  - Monitor and record logged area over time
    - Can give area under logging in current year and if archived, area logged through time

Carnegie Landsat Analysis System (Asner et al.)©



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





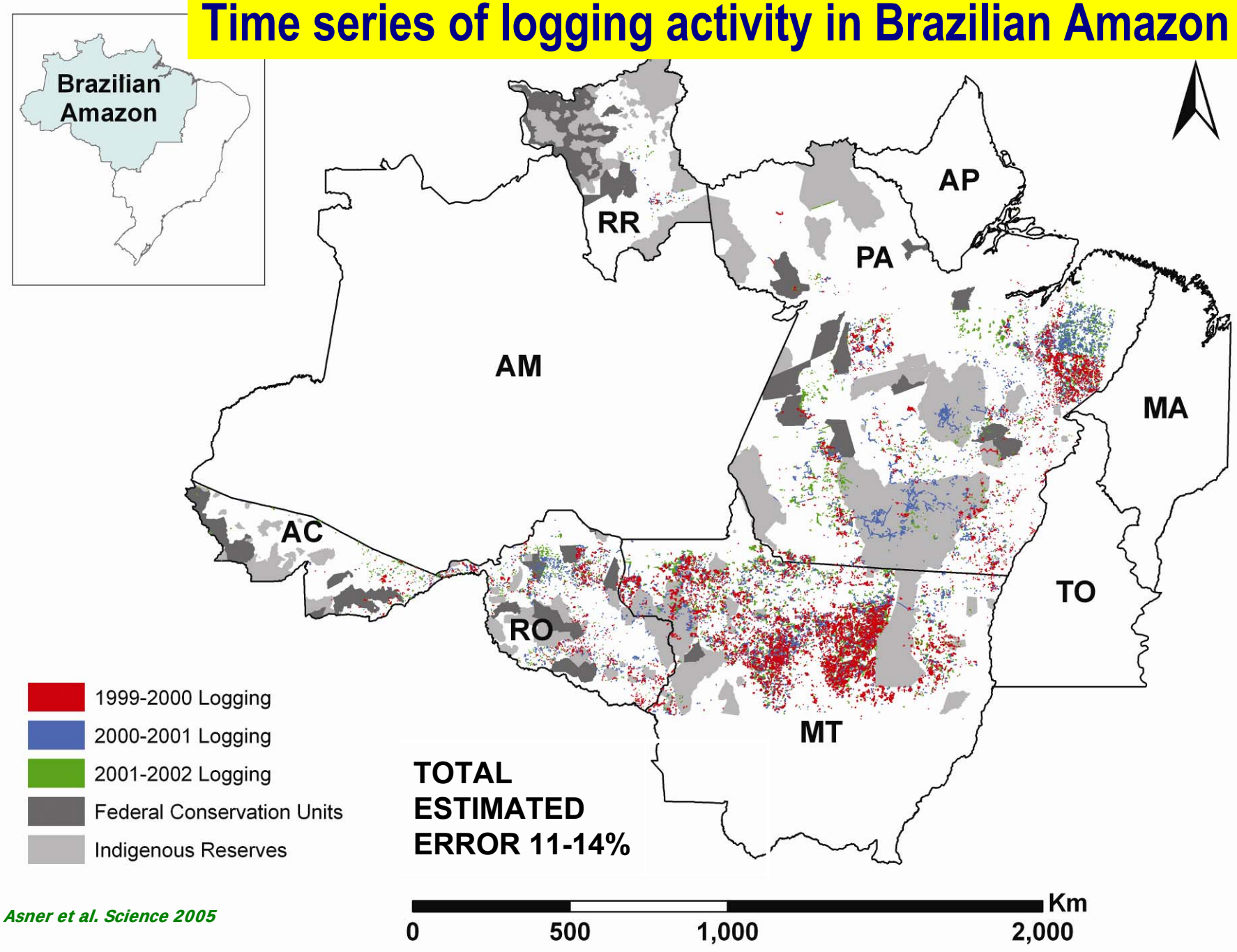
PRODES Classes (Brazil data)

- Forest
- Deforestation 2001-2002
- Previous Deforestation

CLAS

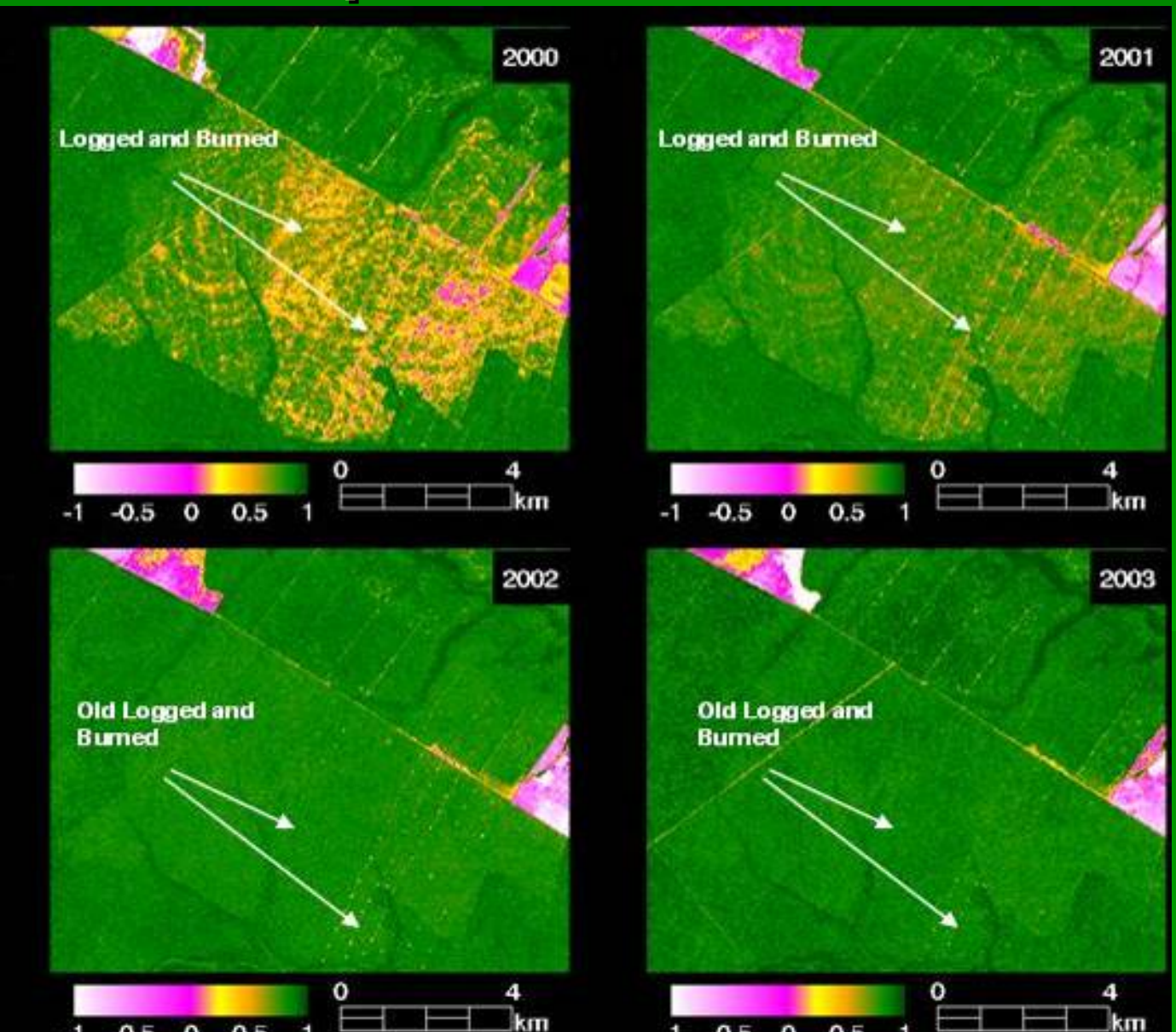
- Recent Logging
- Forest Cover
- Woody Debris
- Soil

Time series of logging activity in Brazilian Amazon



Asner et al. Science 2005

However monitoring degradation needs to be frequent



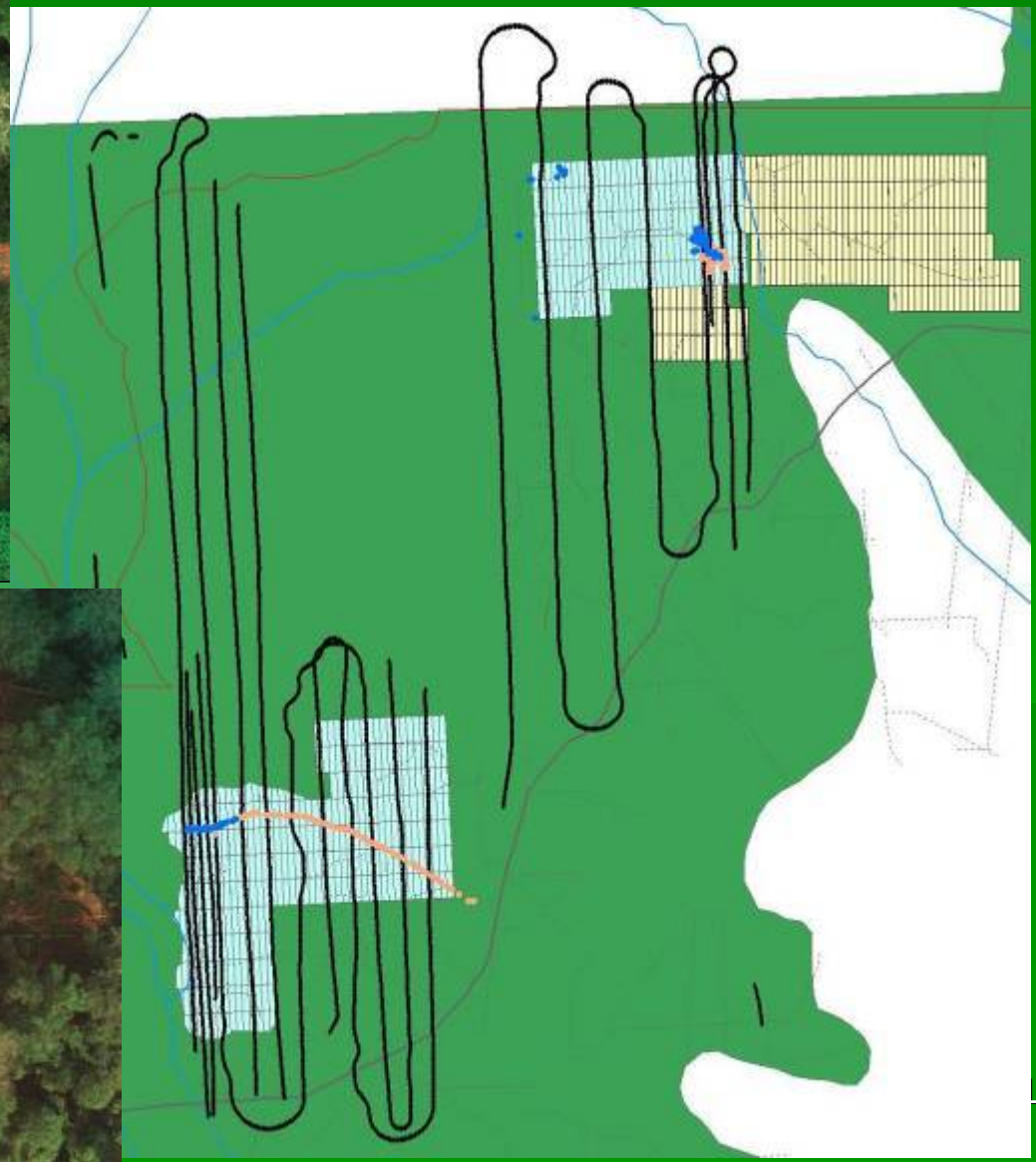
Rate of forest recovery after logging and fires is fast and needs frequent monitoring

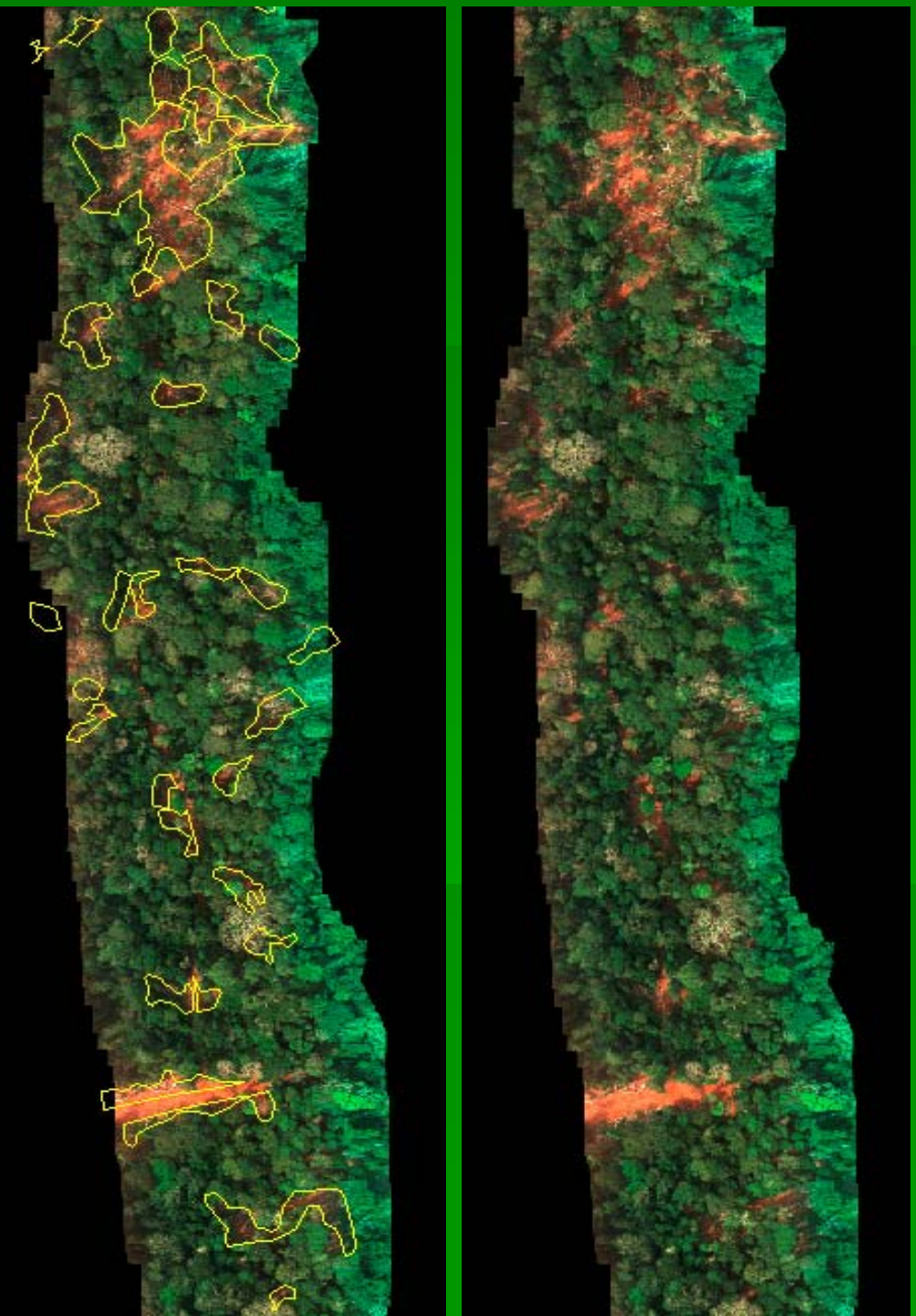
From Carlos Souza, IMAZON, Brazil,

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

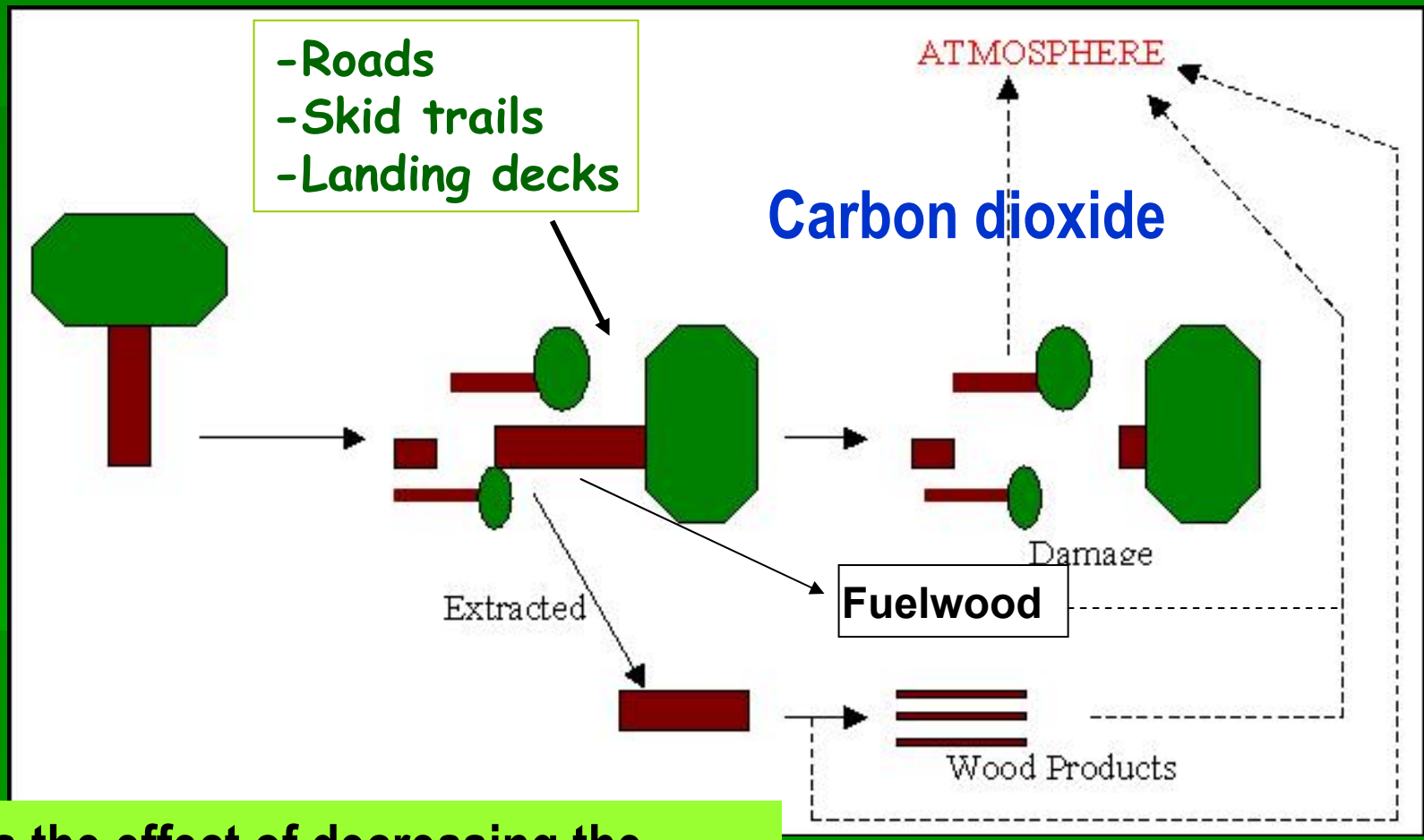




Strips of aerial imagery showing logging damage

- 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

3. Amount of dead wood produced



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

Take 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

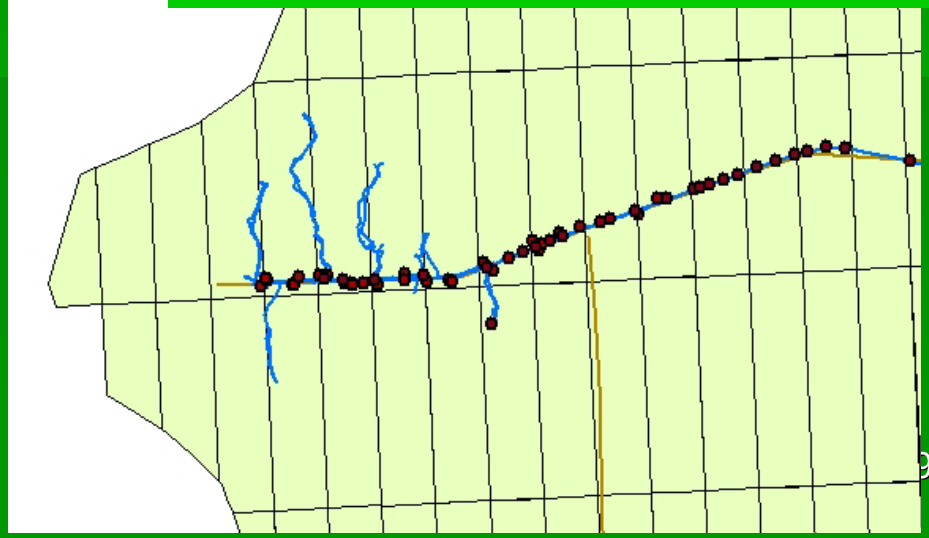
Estimate carbon in log based on volume and density

Tree fall damage

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

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

1. Loss: Decomposition rate of dead wood—from literature (varies ~3-12%/yr)
2. Amount going into long term storage as wood products (IPCC assumes zero, varies 30-60% depending on milling efficiency and final product)
3. 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

Dynamics of gains and losses over time

Year 1 Year 2 Year 3 Year 4…..yr 5….30+ years

Just logged Regrowing

Dead wood decomposing

Dead wood pool increases each year over concession and thus emissions increase

Regrowth in areas directly affected by logging continues until next logging event

Conclusions

- IPCC methodology of gain and loss useful for forest degradation
  - Does not account for all emissions from changes in C stocks from logging
- When logging is a key category need to use at least a Tier 2 or Tier 3 method—
  - 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

Thank You!

- Acknowledge: Tim Pearson and Nathan Moore
- Support: US AID, US EPA
- For more information see:
  - http://www.winrock.org/Ecosystems/
- Or contact me:
  - sbrown@winrock.org