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Global Observation of Forest and Land Cover Dynamics

Methodological aspects for forest area change assessment through remote sensing

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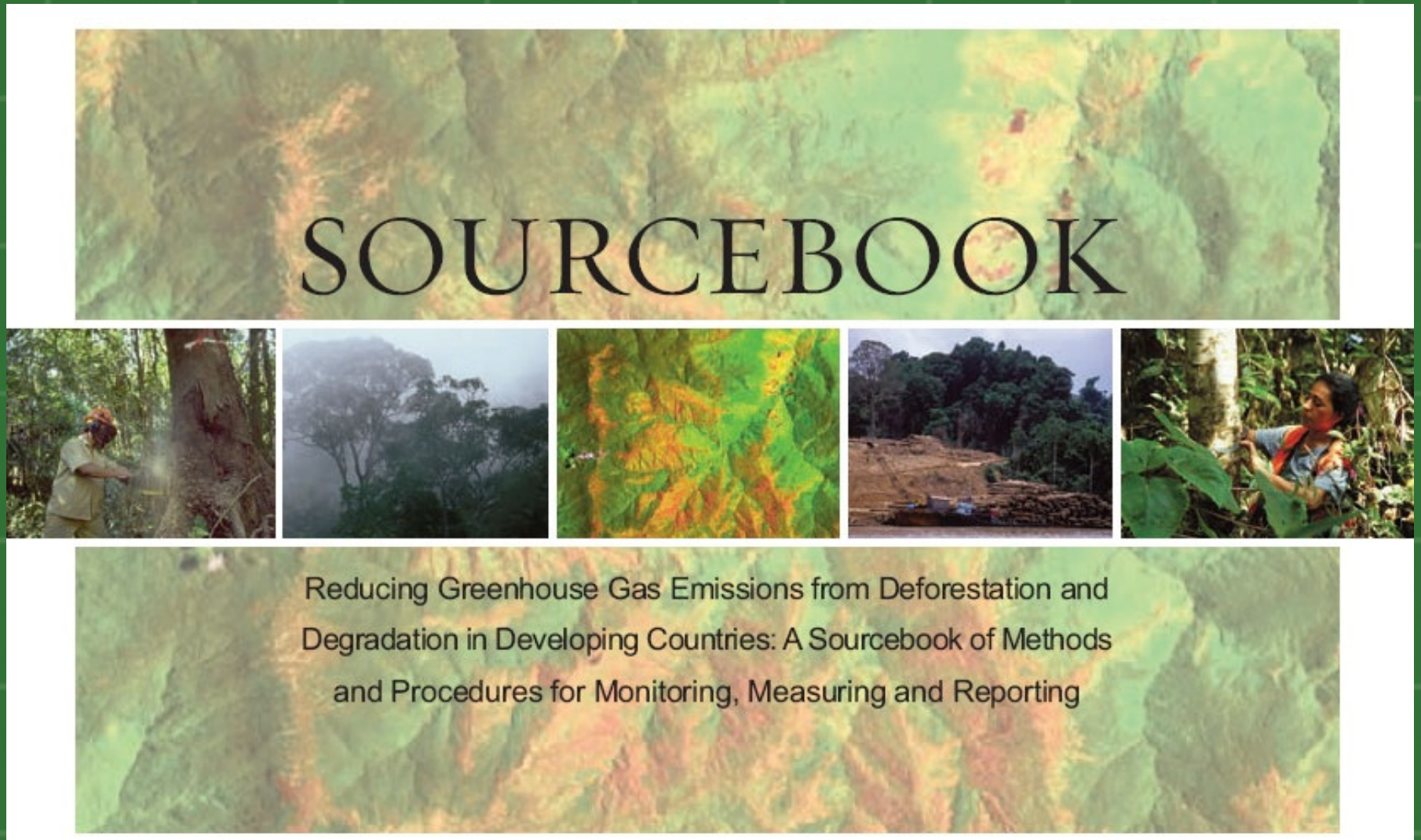
Sourcebook version COP15



http://www.gofc-gold.uni-jena.de/redd

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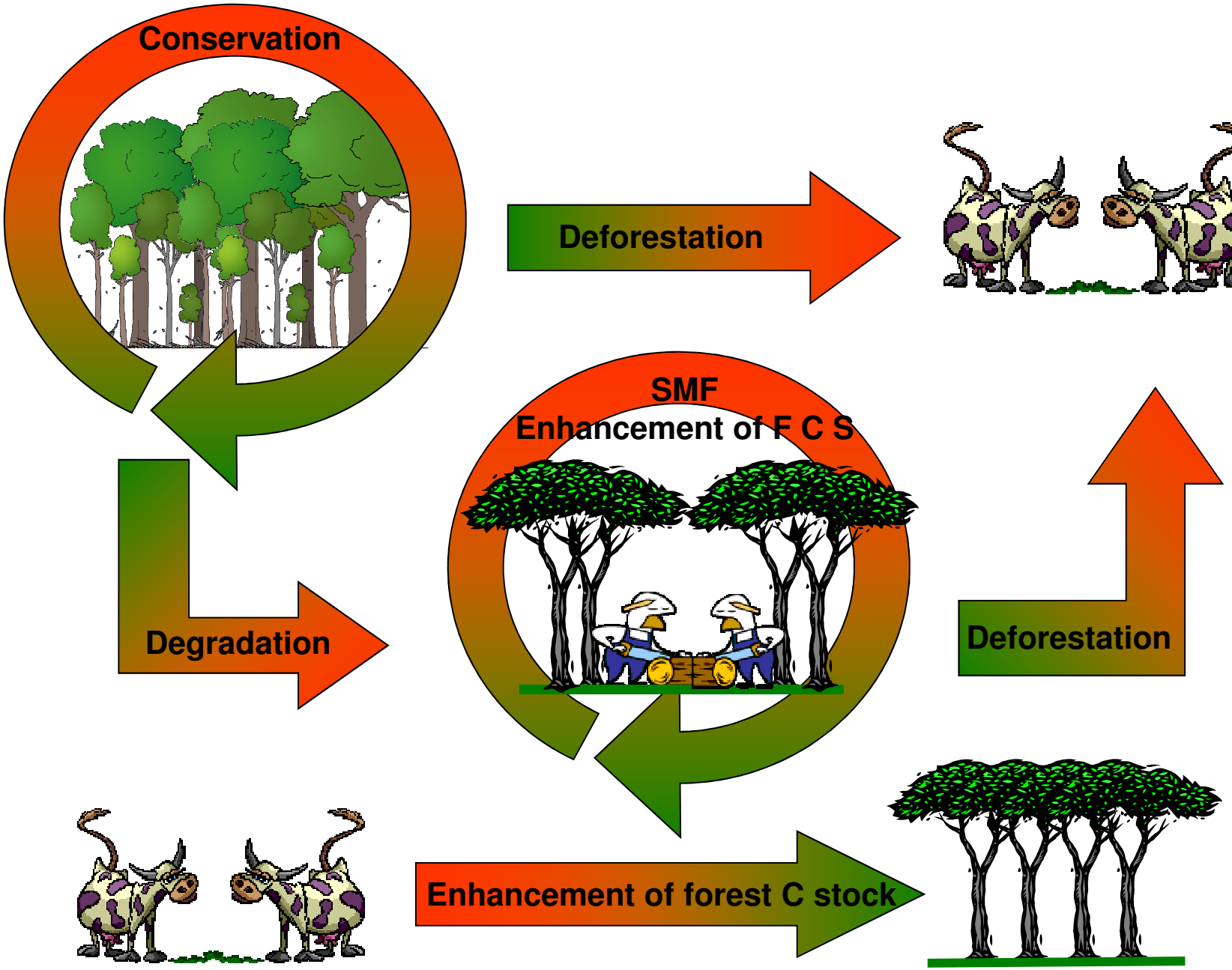

Implementation remarks

1. Building a national forest carbon monitoring system is a process (that can start now):
   - *Assessment of existing national capacities and available data*
   - *Methods and guidance exist*
2. Capacity building as key factor for “readiness phase”:
   - *Technical monitoring capabilities*
   - *IPCC compliant estimation, accounting and reporting*
3. Start conservative with motivation to improve monitoring system over time

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Sourcebook objectives

1. to provide transparent methods that are designed to produce estimates of changes in forest area and carbon stocks from deforestation and degradation
   - in a format that is user-friendly
2. to complement the IPCC GPG-LULUCF (2003) and IPCC Guidelines-AFOLU (2006) by providing additional explanation, clarification and enhanced methodologies for obtaining and analyzing key data
3. to support REDD early actions, capacity development and readiness mechanisms on national level

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Gross carbon emissions (concept)

Gross carbon emissions | Gross deforestation | Gross degradation

$$C_{gr\_em} = \left(\sum_{i=1}^{m} A_{loss(i)} \cdot C_{loss(i)} \right) + \left(\sum_{i,j=1}^{n,m} A_{dgr(ij)} \cdot C_{dgr(ij)} \right)$$

A_{loss} = Area of deforestation (ha)
C_{loss} = Carbon emission from deforestation (t/ha)
} for forest types i … m

A_{dgr} = Area affected by degradation (ha)
C_{dgr} = Carbon emission from degradation (t/ha)
} for degrad. types j … n
for forest types i … m

Area change is most dynamic: needs to be observed from satellite !

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Overview

1. *Monitoring deforestation*
2. *Monitoring forest degradation*
3. *Accuracy assessment*
4. *Final remarks*

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Building national capabilities

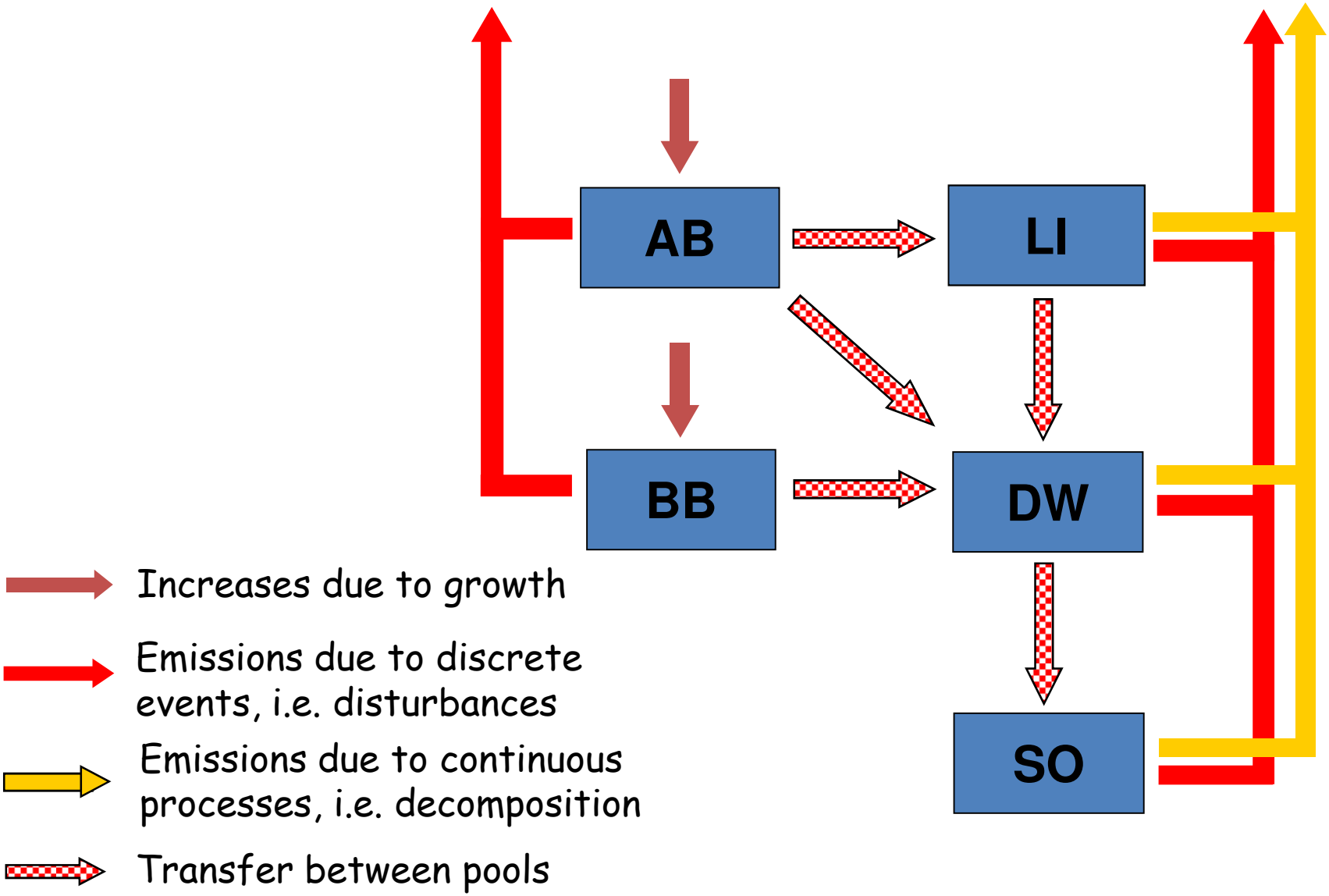
Important components	*Practical considerations*
FOREST AREA CHANGE	Primary source: Landsat-type satellite data
Deforestation	Starting point for historical assessment 1990-2005 (3 time steps minimum) Build basic satellite data proc. capabilities
Monitoring of forest degradation Forest fire and burned area	Relevance and characteristics for human-induced carbon emissions Definition of suitable monitoring system
Accuracy assessment	Using best/transparent methods and efforts for continuous improvement Prepare for statistically robust approach
CHANGE in CARBON STOCKS	Primary source: ground/inventory data
Existing stratifications and forest carbon estimates	Inventory of available data Decide on carbon pool/TIER level to report
Towards improved carbon stock change estimations	New inventory including other carbon pools Stratification in relevant areas/forest types
ACCOUNTING & REPORTING	Provide conservative estimates

IPCC indication: *Countries should characterize and account for all relevant land areas in a country consistently and as transparently as possible. Data should reflect the historical trends in land-use area.*

Approach for activity data: Area change
1. Country statistics (e.g. FAO-FRA)—generally gives net change in forest area
2. Based on maps, surveys, and other national statistical data (nonspatially-explicit land-use conversion matrix)
3. Spatially explicit land use data from interpretation of remote sensing data (spatially-explicit land-use conversion matrix)

In almost all the developing countries the only way to represent land in a consistently and transparently approach with a time frame of 20 years backward is the use of satellite remote sensing data which allows to follow the Approach 3

Carbon Stock Changes = Gains – Losses (by pool)



Monitoring deforestation at national scale

- Satellite monitoring: National examples from Brazil, India and several national REDD case studies
- Starting point to develop more detailed monitoring system:
  - Motivation to use more detailed data than 1990-00-05
  - Identify hot spots of forest loss
  - Stratified approach to estimate area change in future or for monitoring degradation
  - Establish or enhance national capacities
  - Develop understanding of historical (spatial) processes
  - Remote sensing data output to guide further field work related to carbon accounting (i.e. stratification)

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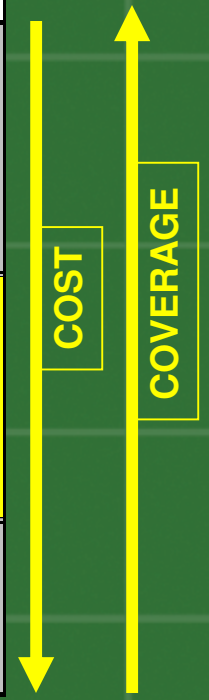
What analysis approach should be used to assess change at repeated intervals?:
2) DATA SOURCES

Table 3.1. Utility of optical sensors* at multiple resolutions for deforestation monitoring

Sensor & resolution	Examples of current sensors	Minimum mapping unit (change)	Cost	Utility for monitoring
Coarse (250-1000m)	SPOT-VGT (1998-) Terra-MODIS (2000-) Envisat-MERIS (2004 -)	~ 100 ha ~ 10-20 ha	Low or free	Consistent pan-tropical annual monitoring to identify large clearings and locate "hotspots" for further analysis with mid resolution
Medium (10-60m)	Landsat TM or ETM+, SPOT HRV IRS AWiFs or LISS III CBERS HRCCD	0.5 - 5 ha	<$0.001/km^2 for historical data $0.02/km^2 to $0.5/km^2 for recent data	Primary tool to map deforestation and estimate area change
Fine (<5m)	IKONOS QuickBird Aerial photos	< 0.1 ha	High to very high $2 -30 /km^2	Validation of results from coarser resolution analysis, and training of algorithms



*non-optical sensors appear promising for future but not yet operational

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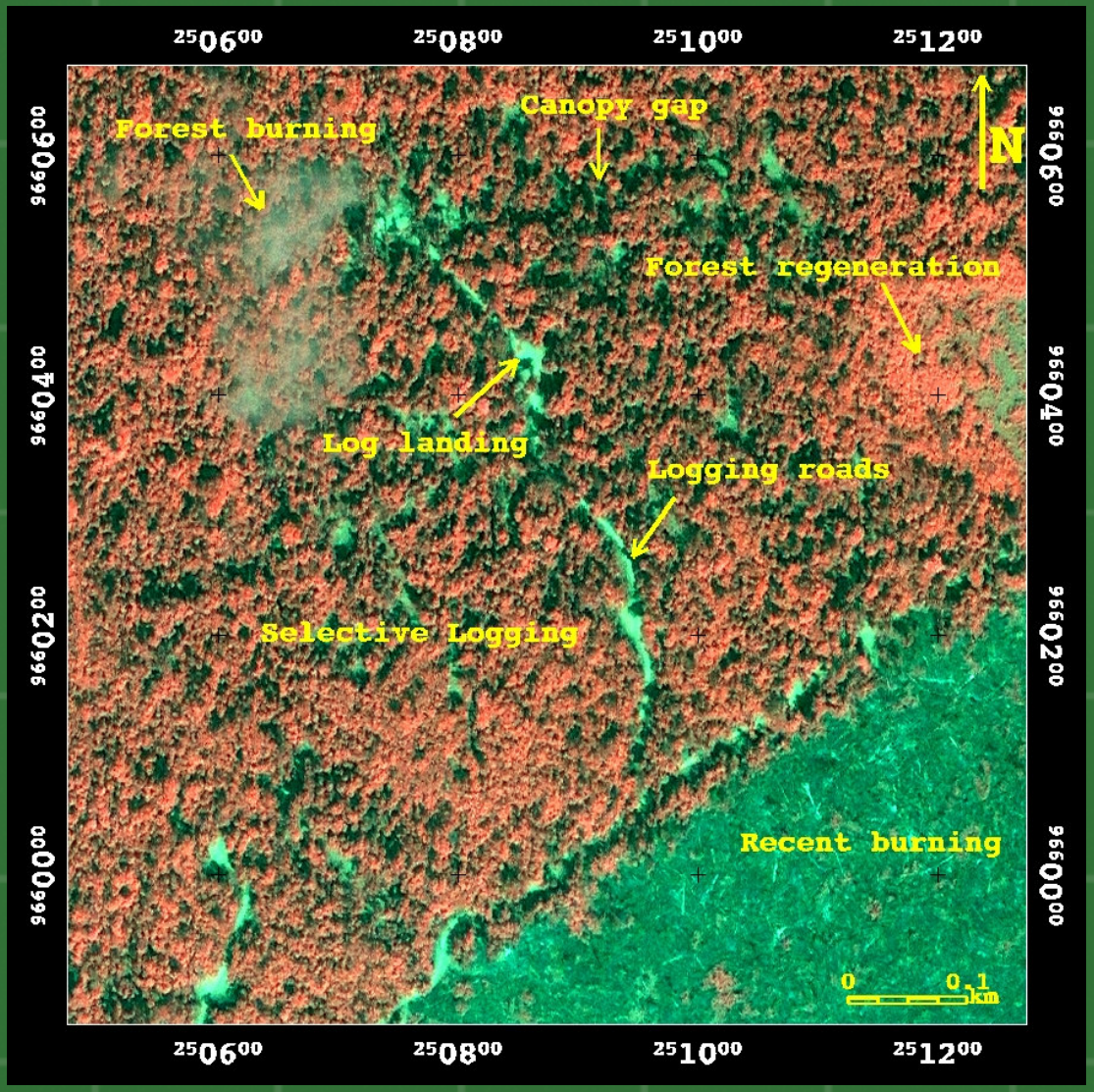
Degradation: introduction

- Forest degradation leads to loss of carbon stocks
- Some monitoring assumptions:
  - IPCC good practice guideline/methods to account for changes areas of forests remaining as forests
  - Monitoring degradation requires understanding and emission significance of human processes
  - Assessment of degraded forest area and the carbon stocks changes per unit area
  - Less efficient than for deforestation: lower C-emissions per ha versus higher costs & lower accuracies
- Monitoring forest degradation important to avoid displacement of emissions from reduced deforestation

Change in forest areas remaining as forest (degradation)



Ikonos Image – Paragominas, PA

Souza Jr. and Roberts (2005) - IJRS

- Caused by:
  - Selective logging
  - Forest fires
  - Forest use (wood, agricuture)
  - ….
- Creates a complex environment:
  - Undisturbed forests
  - Canopy gaps
  - Exposed soils
  - Dead vegetation
- Can be precursor to:
  - Deforestation
  - Further disturbances

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Change in forest areas remaining as forest (degradation)

1. Inventory based approaches and long-term field observations:
   - Establish emission factors: national stratification by carbon density, degradation process & its temporal dynamics
   - Continuous monitoring to assess net emissions from land use practices, regeneration, further disturbances etc.
2. Remote sensing to detect degraded area:
   - Direct detection of degradation (i.e. canopy damage):
     - Landsat-type data with annual observations or very high-resolution datasets (IKONOS type)
     - Hot spot sampling approach maybe effective
   - Indirect approaches:
     - Detecting required infrastructure (roads, log landings)
     - Suitable also for historical periods
3. Operational fire monitoring systems

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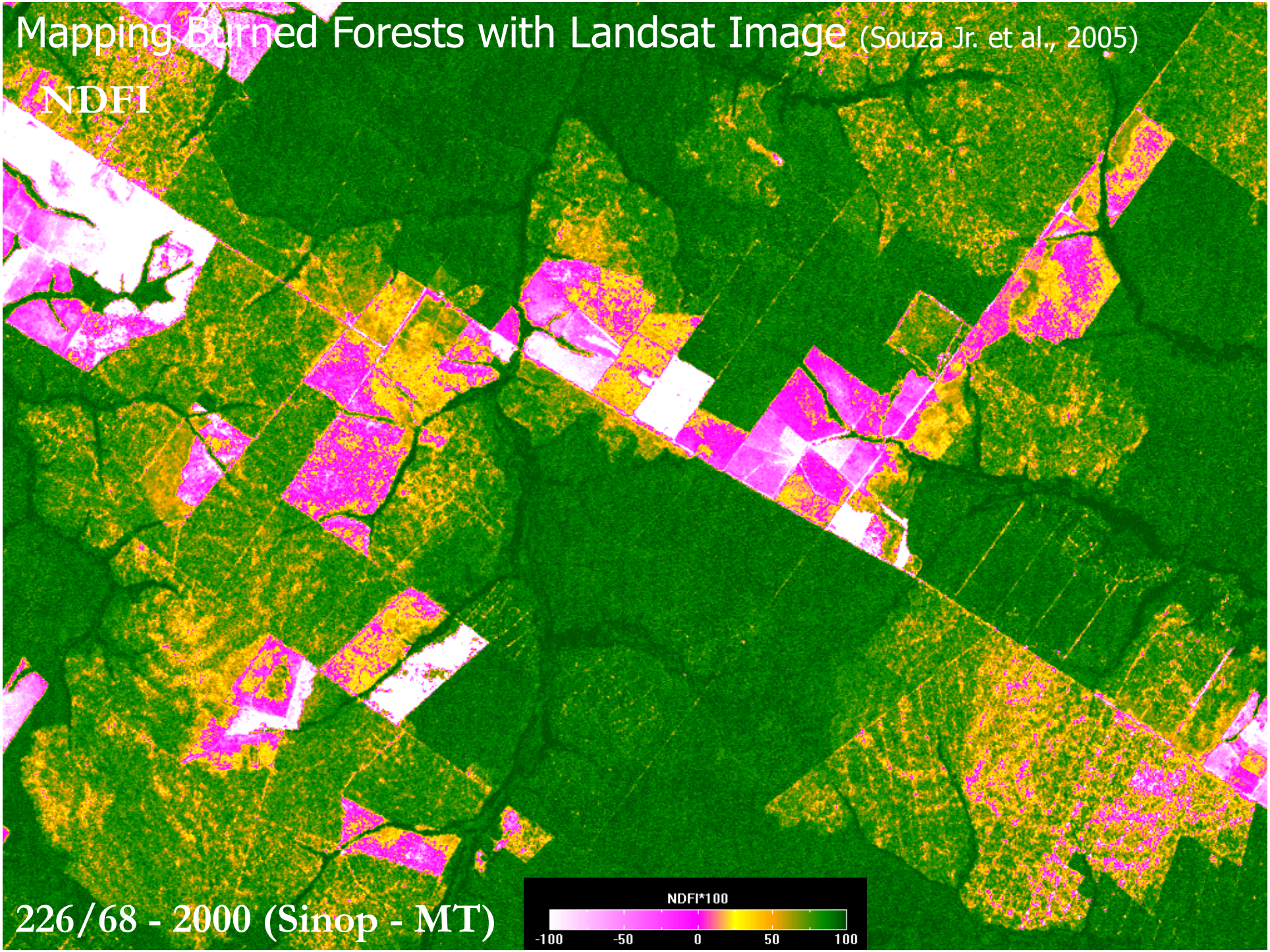
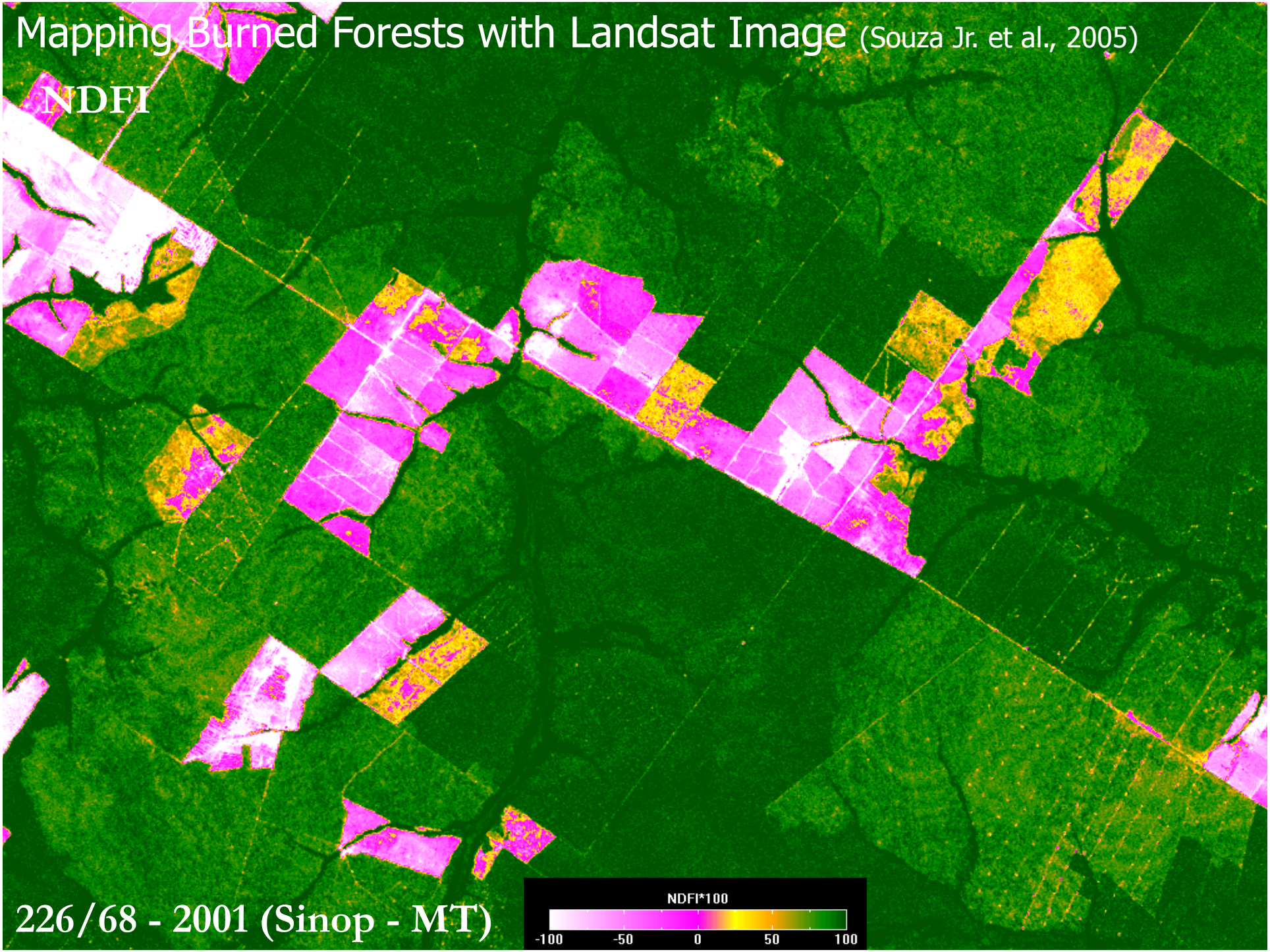

Mapping Burned Forests with Landsat Image (Souza Jr. et al., 2005)
NDFI
226/68 - 2000 (Sinop - MT)
NDFI*100
-100
-50
0
50
100


Mapping Burned Forests with Landsat Image (Souza Jr. et al., 2005)
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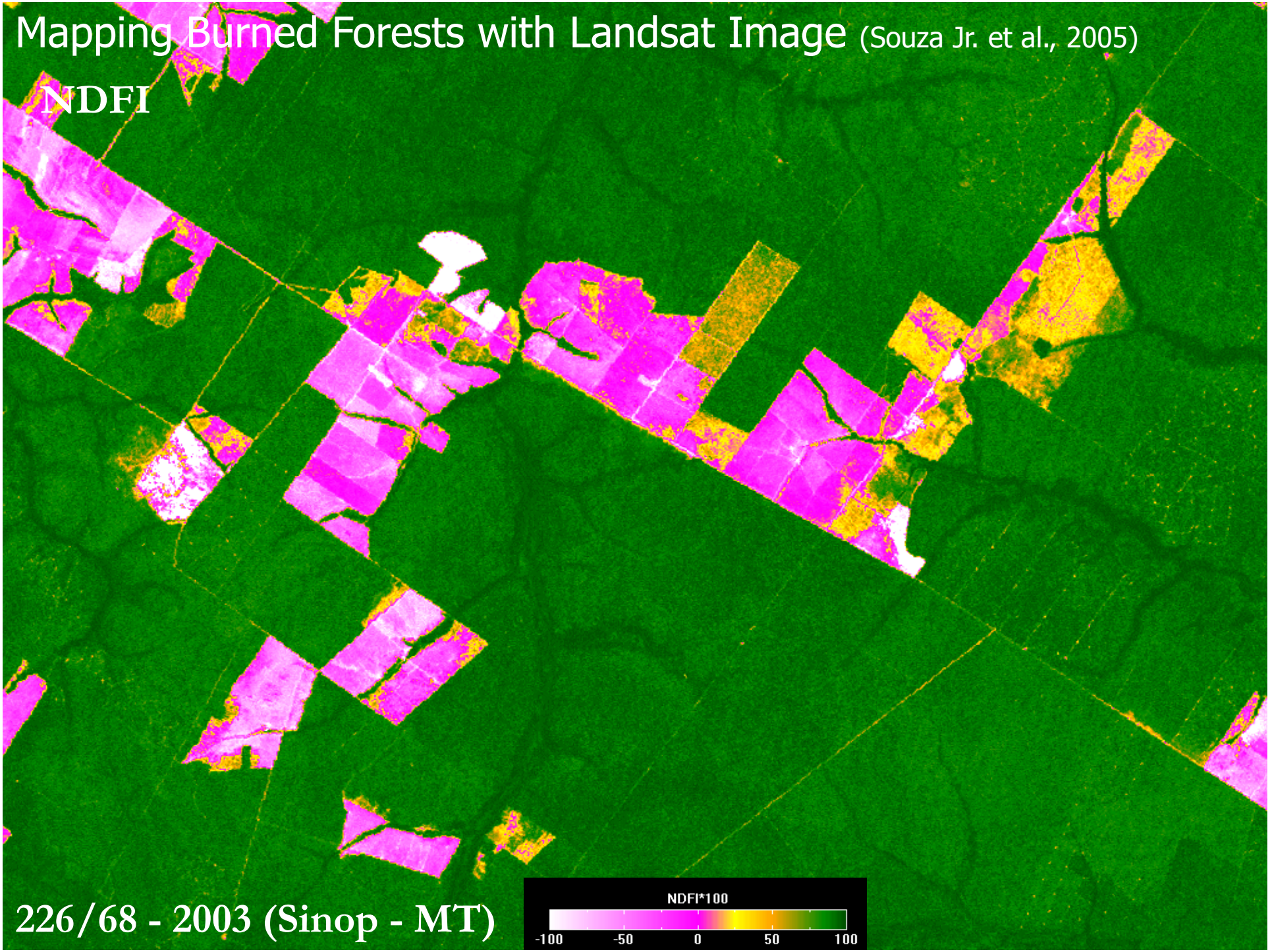
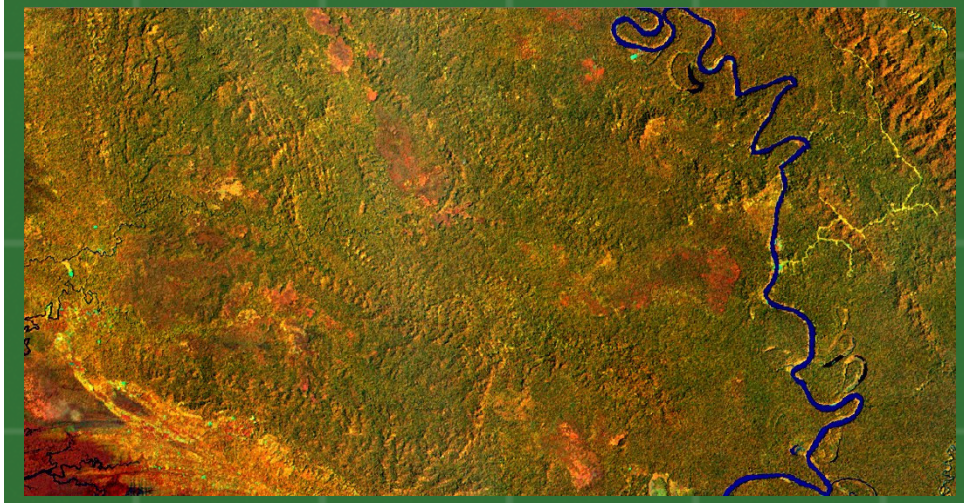
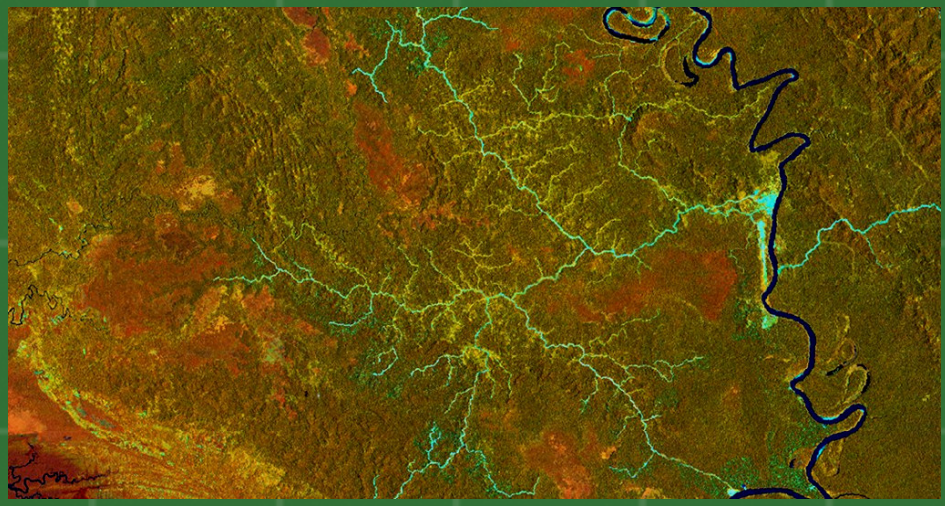

Mapping Burned Forests with Landsat Image (Souza Jr. et al., 2005)
NDFI
226/68 - 2003 (Sinop - MT)
NDFI*100
-100
-50
0
50
100

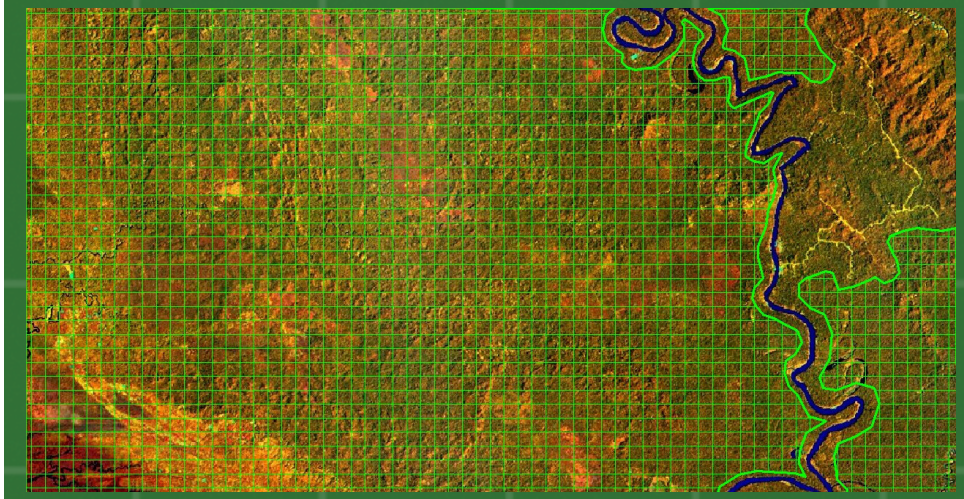
Example for indirect approach

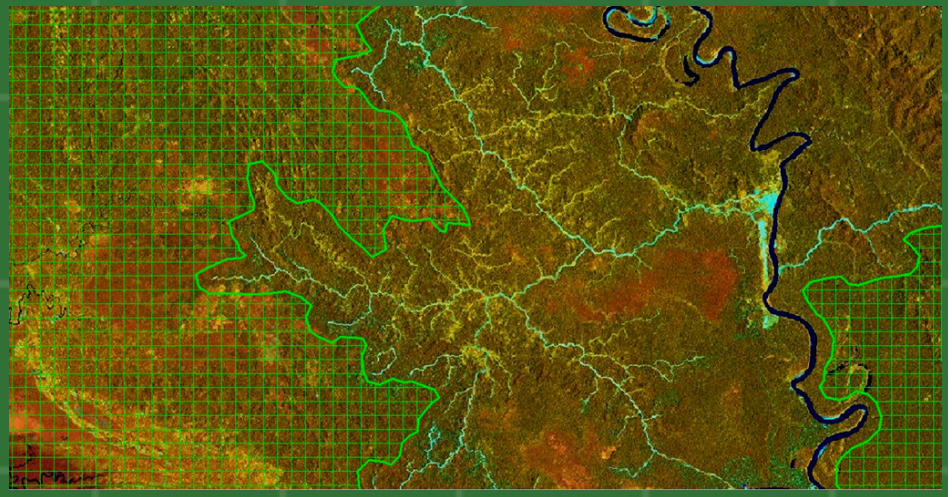
Landsat 1990



Landsat 2000







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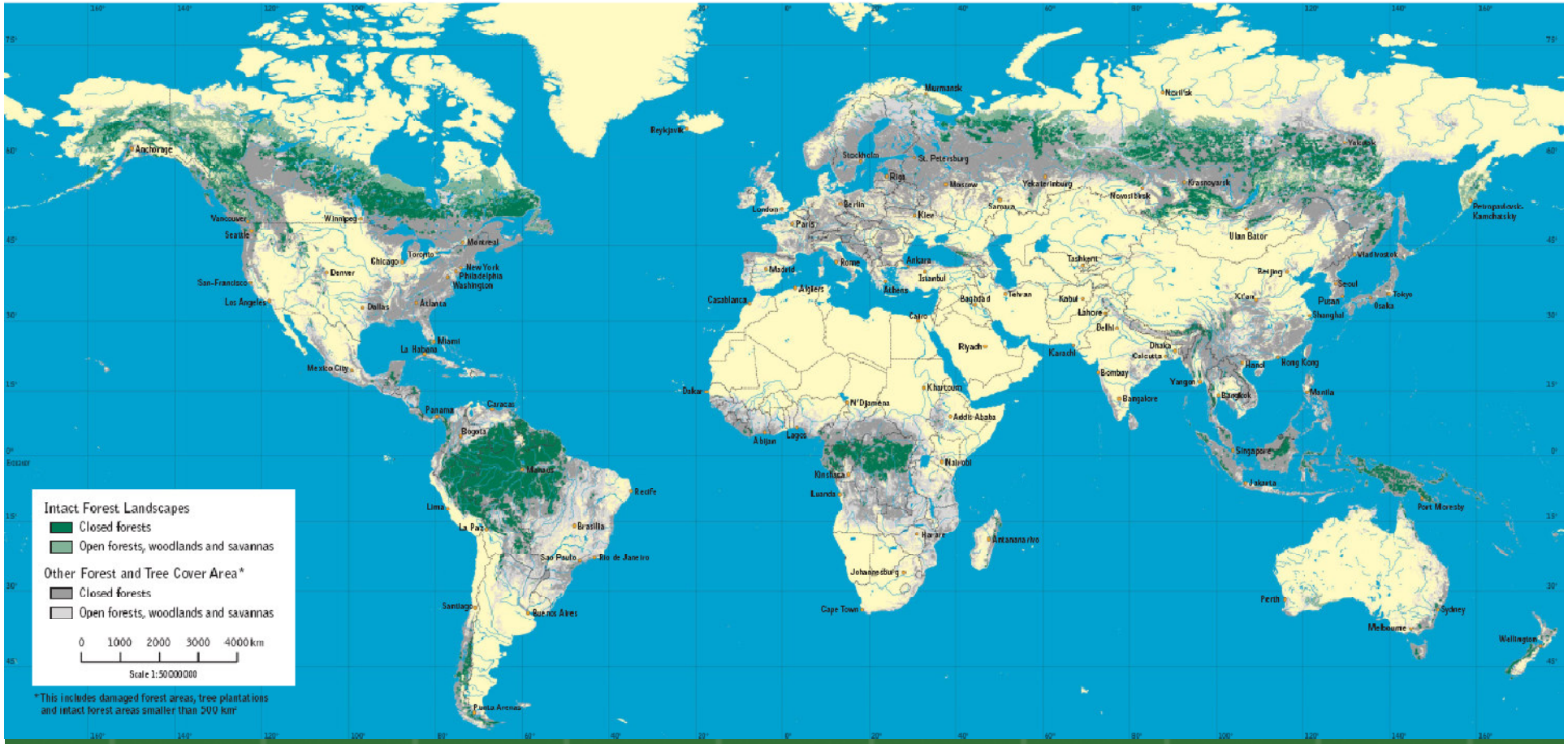
Indirect approach: the origin

The world's last intact forest landscapes

GREENPEACE



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Fire observations and their usefulness for national REDD implementation

Approach	Information	REDD objective	Suitability
Pre-fire	Early warning system	Protect forest areas at risk and address leakage and permanence	Most suitable for countries with significant amount of wildland fires and known fire regimes
Active fire	Hot spot satellite data	Fire relief and active emissions reduction Support of in-situ actions	Most suitable for countries with large number of small-scale deforestation fires
Post-fire	Burned area estimates	Support estimation of areas of deforestation and degradation	All countries with forest loss due to fire

Final remarks

- Building a national forest carbon monitoring system is a process (that can start now):
  - Assess and use existing national capacities and data
  - Start conservative with motivation to improve monitoring system over time
  - Some limitations in historical period for challenging issues
- Updated GOFC-GOLD sourcebook guidance on:
  - Monitoring forest degradation, sustainable management of forest land, conservation, enhancement of forest carbon stocks
  - Observations of biomass burning
  - Accuracy assessments
  - Evolving technologies and data sources
  - Support capacity building

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