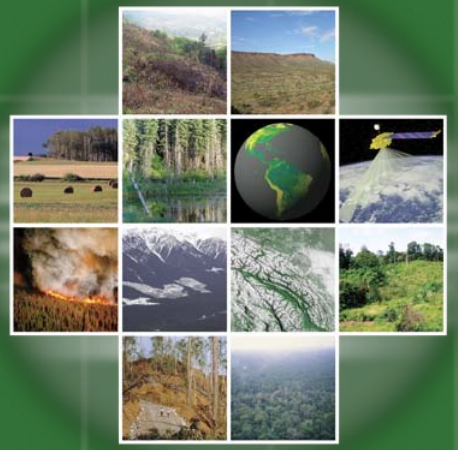
GOFC-GOLD

Global Observation of Forest and Land Cover Dynamics

Building nation forest carbon monitoring capabilities using the GOFC REDD sourcebook

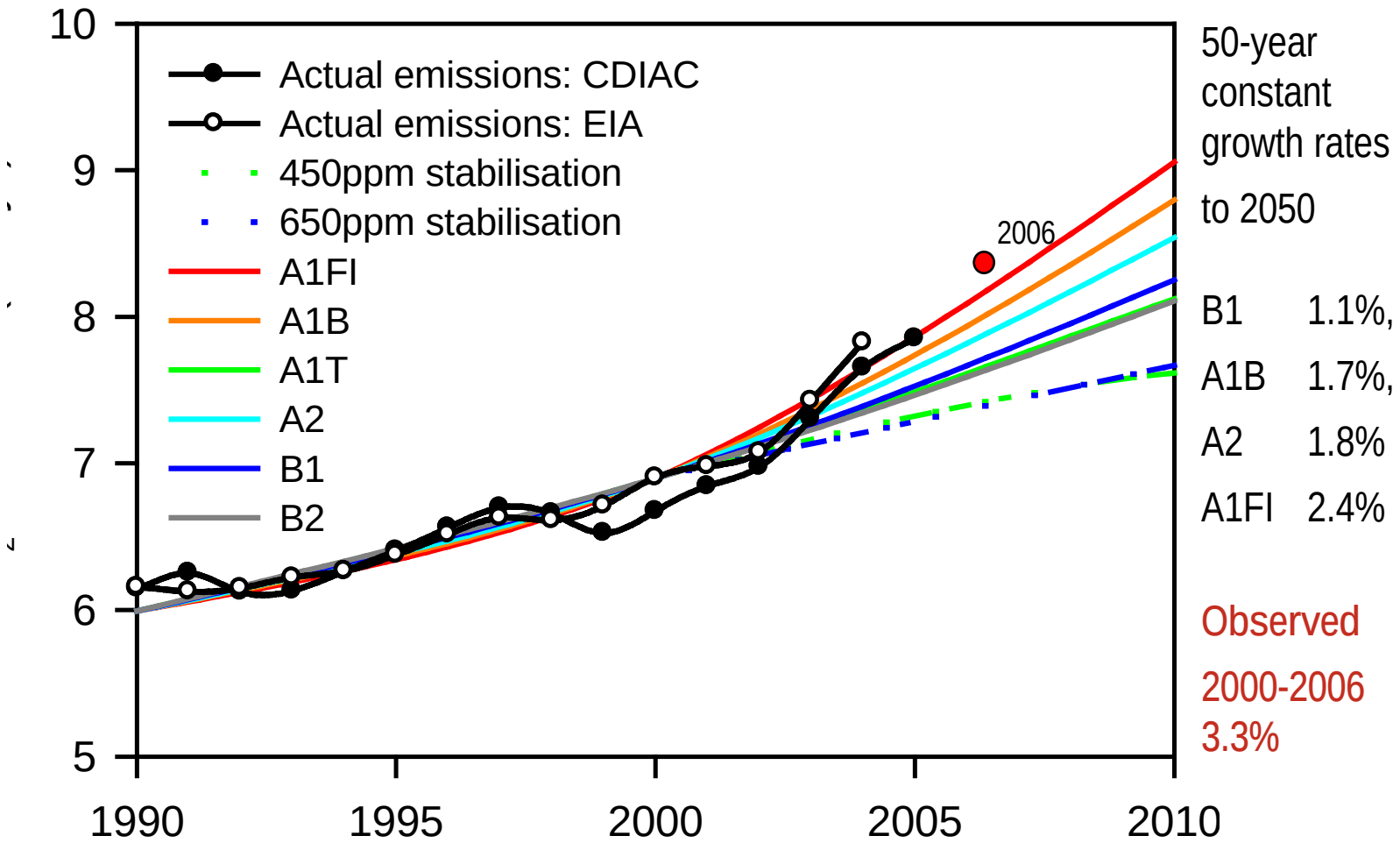


GOFC-GOLD Land Cover Office, FSU Jena, Germany
www.gofc-gold.uni-jena.de

GLOBAL TERRESTRIAL OBSERVING SYSTEM

GTOS

Trajectory of Global Fossil Fuel Emissions



Raupach et al. 2007, PNAS; Canadell et al 2007, PNAS

REDD and implementation

- Starting REDD implementation:
  - *National carbon accounting capacities*
  - *National REDD implementation strategy and activities*
- Tools for estimating, accounting, reporting on REDD:
  - *IPCC Good Practice Guidelines and Guidance*
  - *Stronger role for satellite remote sensing*
  - *Dedicated research and case studies*
- 2005: Establishment of GOFC-GOLD REDD working group
  - *Promote satellite monitoring as objective and efficient approach in developing countries*
  - *Forest changes can be monitored with confidence for assessing and comparing historical and future rates of deforestation*
  - *Consensus technical guidance are in development (REDD sourcebook)*

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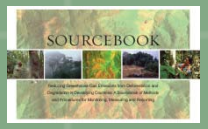
Earth observation contribution to UNFCCC-REDD

GOFC-GOLD working group est.

GTOS/GOFC report

1.+ 2. REDD Sourcebook draft



1st GOFC-GOLD workshop

2nd GOFC-GOLD workshop

3rd GOFC-GOLD workshop

ED/GOFC SBSTA side event

ESA/GOFC Side event + booth

ESA/GOFC-GOLD side event

WINROCK/ GOFC-GOLD side event

GTOS/GOFC -GOLD side event

PNG / GOFC-GOLD side event

GTOS submission I

GTOS submission II

GTOS submission III

COP11 Montreal

SBSTA 24

COP12 Nairobi

SBSTA 26

COP13 Bali

SBSTA 28

COP14 Poznan

SBSTA 30

1st SBSTA workshop

2nd SBSTA workshop

3rd SBSTA workshop

Informal REDD workshop

Subm. of view by parties I

Subm. of view by parties II

Subm. of view by parties III + IV

2005

2006

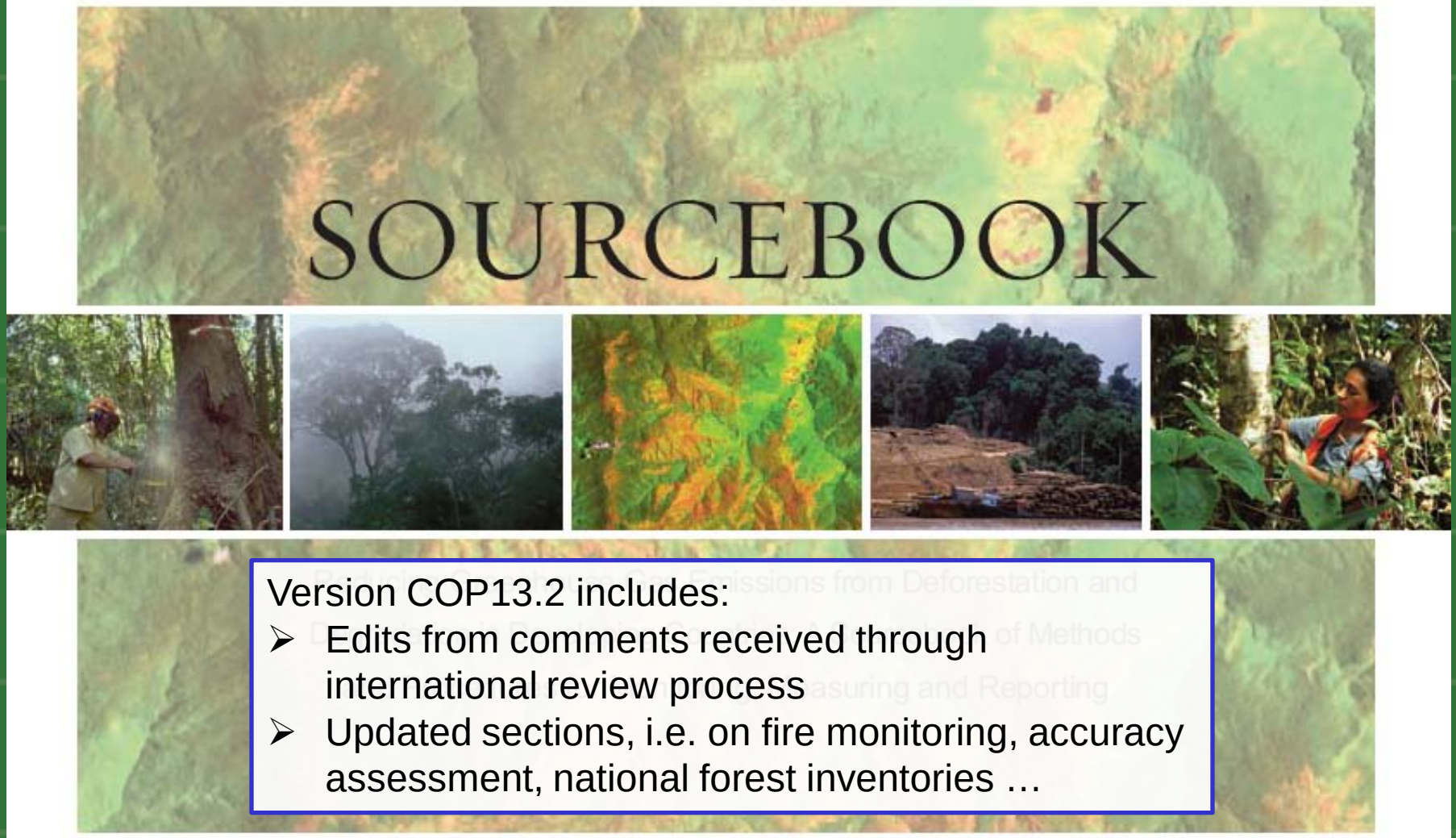
2007

2008

2009

GOFC-GOLD

Sourcebook version COP13.2



Version COP13.2 includes:

- Edits from comments received through international review process
- Updated sections, i.e. on fire monitoring, accuracy assessment, national forest inventories …

Acknowledgement

Sponsors of the Global Terrestrial Observing System:

FAO FIAT PANIS · ICSU · UNEP · UNESCO · WMO

Sourcebook authors:

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Support for GOFC-GOLD REDD working group and Sourcebook preparation:

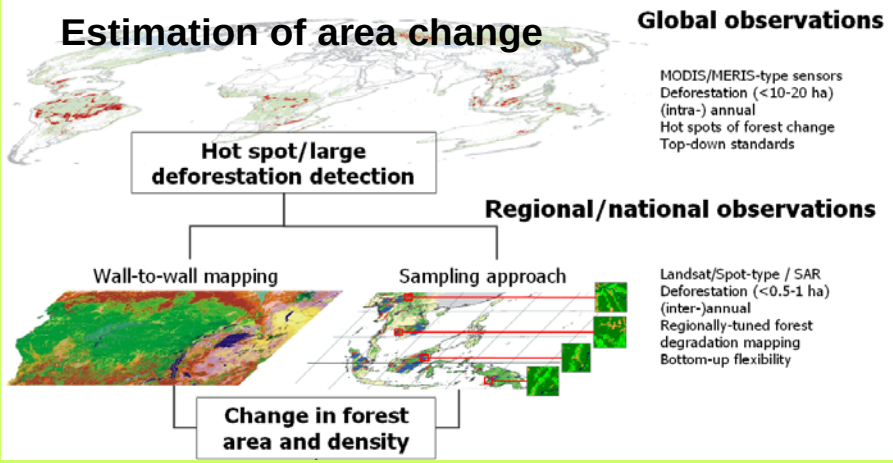
esa · START IHDP • IGBP • WCRP · NASA · Canada · The Nature Conservancy · CSA ASC

Sourcebook objectives

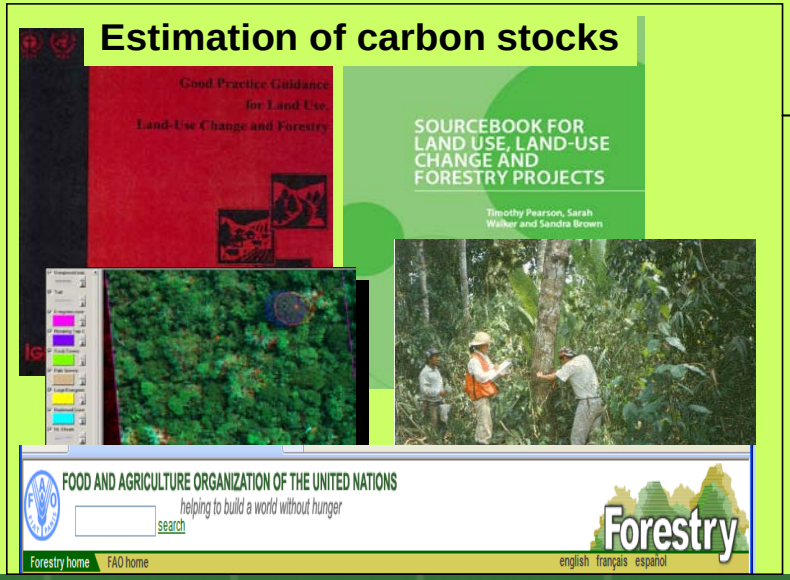
1. to provide transparent methods that are designed to produce estimates of changes in forest area and carbon stocks from deforestation and degradation
   - in a format that is user-friendly
2. to complement the IPCC GPG-LULUCF (2003) and IPCC Guidelines-AFOLU (2006) by providing additional explanation,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

Sourcebook initial format

Chapter 1 and 2: Introduction and definitions



Chapter 3



Chapter 4

Chapter 5

Estimation of CO_2 emissions

Chapter 6

Guidance on reporting of CO_2 emissions

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

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

BREAK OUT GROUPS

At 3rd GOFC-GOLD symposium 13.10.08:

- Degradation/regrowth – Achard/DeFries
- Biomass burning – Justice
- Evolving technologies – Held
- Data collection at local/national level– Van Laake/Mayaux

Degradation More Difficult

1. More severe degradation (area/intensity) results in more distinct indicators for efficient monitoring
2. Monitoring degradation requires understanding and emission significance of human processes
   - Define on efficient, long term observation approach given relevant processes
3. Assessment of degraded forest area and the carbon stocks changes per unit area:
   - More reliance on ground data/pilot studies
   - Remote sensing data to assess the area affected
   - Ground measurements required for carbon stock change
   - Current data/knowledge uncertain on area/emission factors

Change in forest areas remaining as forest (degradation)

1. Inventory based approaches, field surveys, and forest statistics (i.e. logging concessions and harvest estimates)
2. Remote sensing to detect degraded area:
   - Direct detection of degradation processes (canopy damage):
     - Landsat-type data with annual observations
     - Very high-resolution datasets (IKONOS type)
     - Hot spot sampling approach maybe effective
   - Indirect approaches:
     - Detecting required infrastructure and its changes (roads, log landings)
     - Concept of intact versus non-intact forests
     - Suitable also for historical periods
3. Operational fire monitoring systems

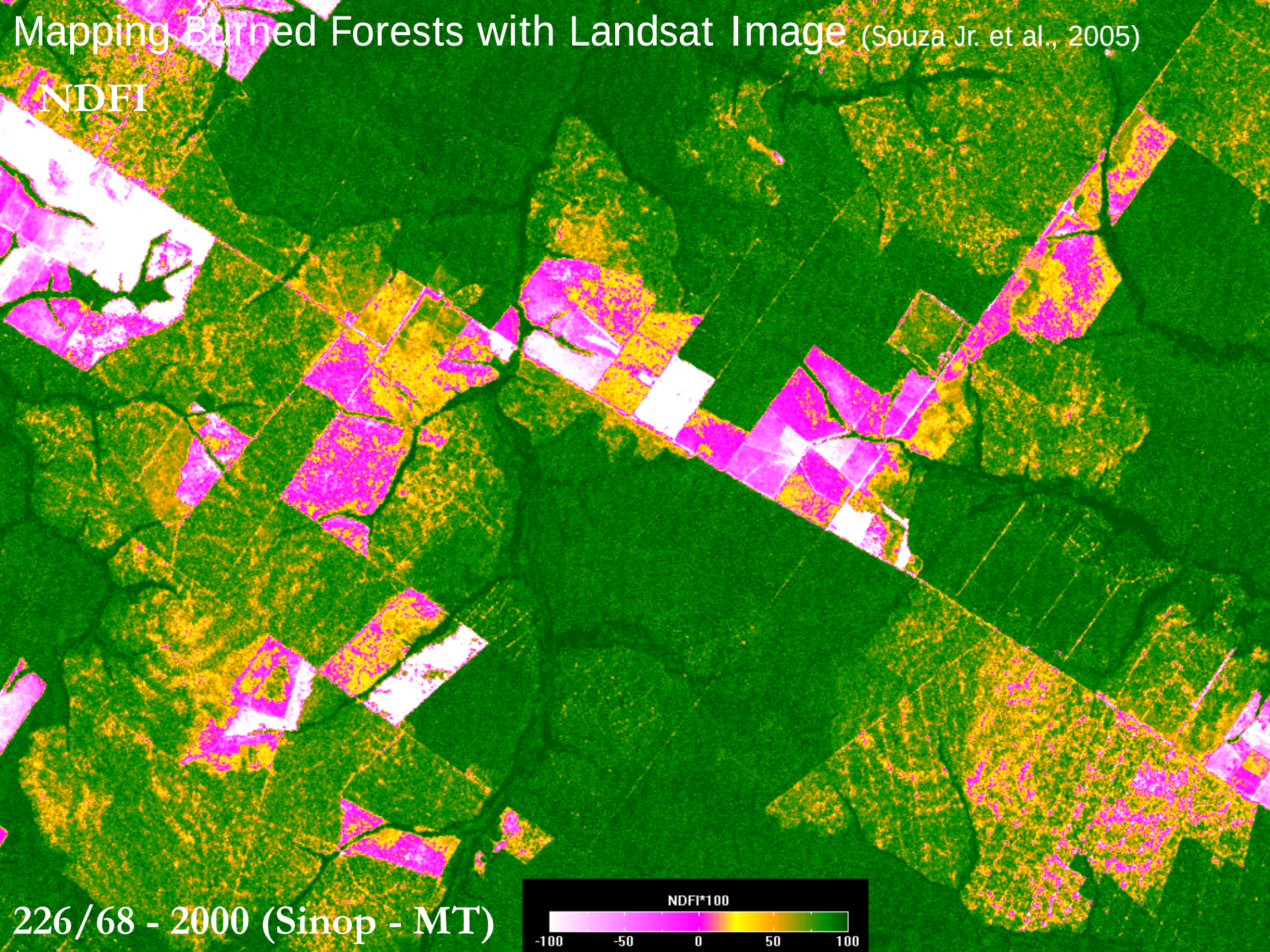
Direct approaches to detect forest degradation

Highly Detectable	Detection limited & increasing data/effort	Detection very limited
• Deforestation • Forest fragmentation • Recent slash-and-burn agriculture • Major canopy fires • Major roads • Conversion to tree monocultures • Hydroelectric dams and other forms of flood disturbances • Large-scale mining	• Selective logging • Forest surface fires • A range of edge-effects • Old-slash-and-burn agriculture • Small scale mining • Unpaved secondary roads (6-20-m wide) • Selective thinning of canopy trees	• Harvesting of most non-timber plants products • Old-mechanized selective logging • Narrow sub-canopy roads (<6-m wide) • Understory thinning and clear cutting • Invasion of exotic species

(using Landsat-type observations)

Peres et al., (2006) TREE

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



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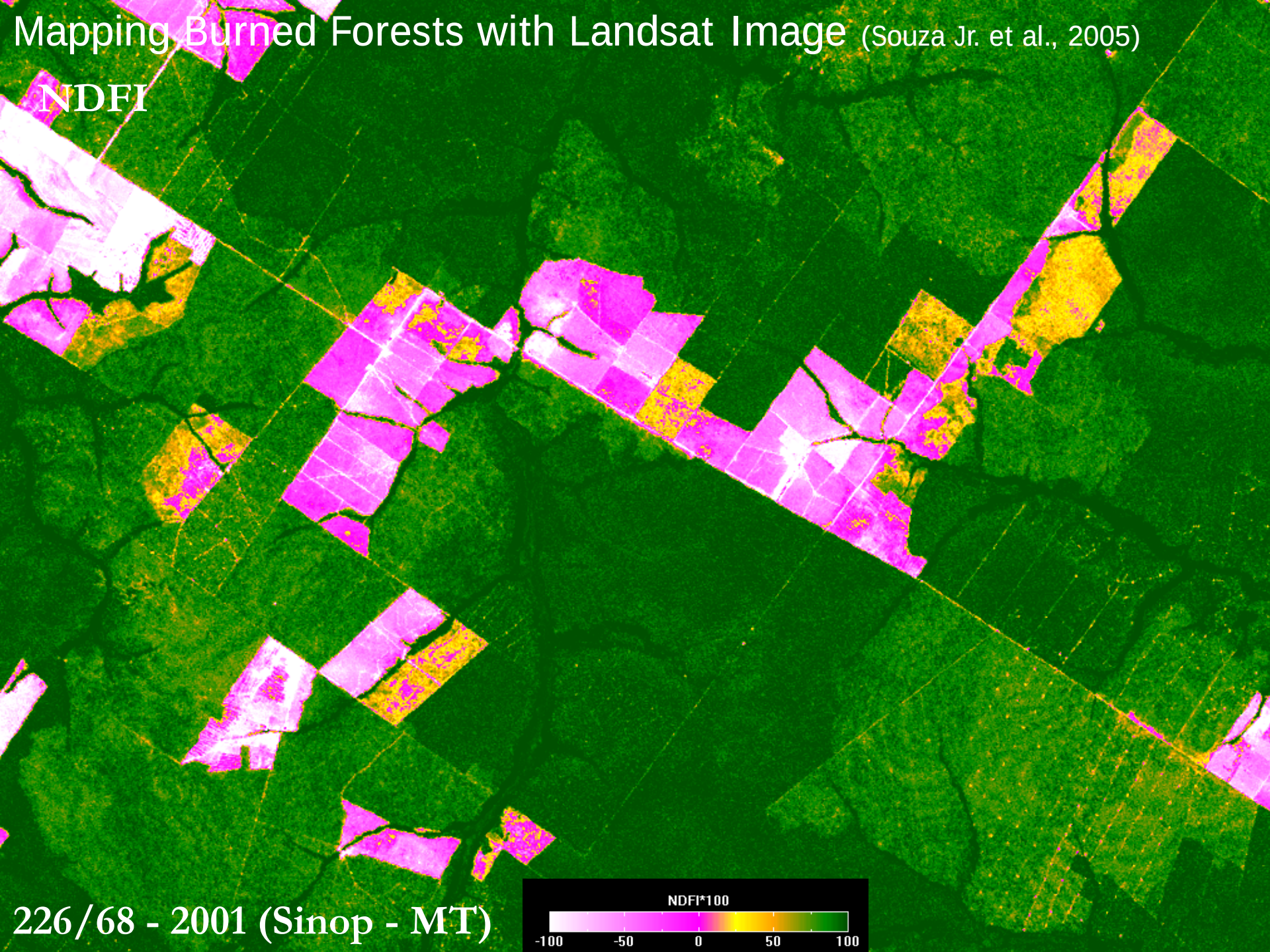

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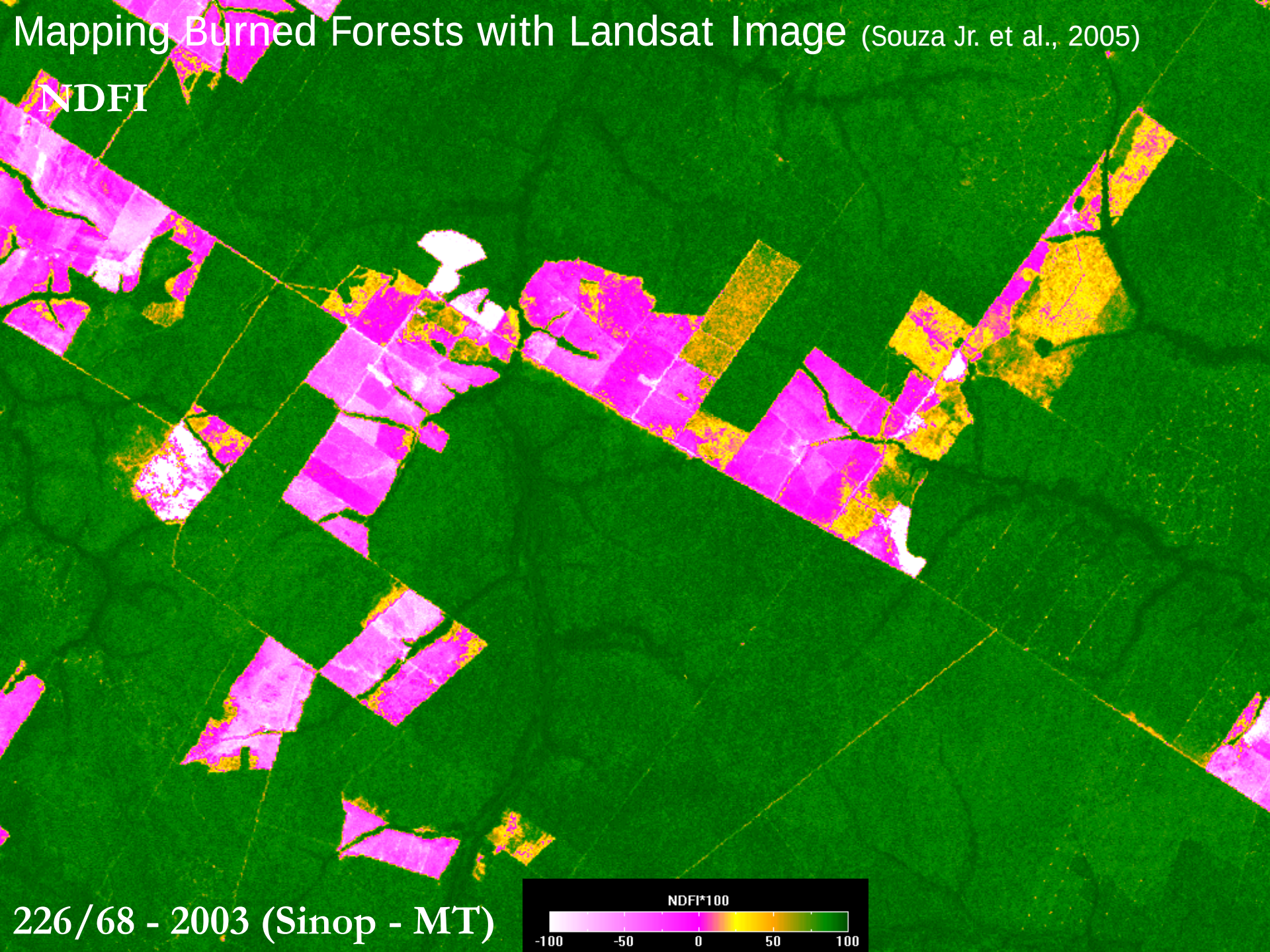

Proposed Table of Content (for COP-14 in Poznan)

1. INTRODUCTION

2. METHODOLOGICAL SECTION

3. PRACTICAL EXAMPLES FOR DATA COLLECTION

4. GUIDANCE ON REPORTING

New sections shown in RED

Proposed Table of Content (for COP-14 in Poznan)

1. *INTRODUCTION*
   - *1.1 Purpose and Scope of the Sourcebook*
   - *1.2 Issues and Challenges*
2. *METHODOLOGICAL SECTION*
   - *2.1 Guidance on Monitoring of Changes in Forest Area*
     - Monitoring of Deforestation
     - Monitoring of Forest Degradation
     - Monitoring of Forest regrowth
   - *2.2 Estimation of Carbon Stocks*
   - *2.3 Methods for estimating CO_2 Emissions from Deforestation & Degrad.*
   - *2.4 Methods for estimating GHG's emissions from biomass burning*
   - *2.5 Estimation of uncertainties*
   - *2.6 Status of evolving technologies*

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Proposed Table of Content (for COP-14 in Poznan)

3. PRACTICAL EXAMPLES FOR DATA COLLECTION

3.1 Overview of annex-I GHG's national inventories on LULUCF

3.2 Overview of the existing forest area changes monitoring systems

3.3 National forest inventories

3.4 National carbon assessment through carbon budget model

3.5 Forest inventories at community level

3.6 Forest carbon assessment at project level

4. GUIDANCE ON REPORTING

Forest fire observations

- Forest fires occur annually in all vegetation zones causing direct release of GHG to atmosphere
- Under UNFCCC reporting provision, countries have to report on GHG's emissions from biomass burning
  - Observation and assessment in research phase
- Coarse resolution sensors provide near-real time, operational information
- Moderate resolution (30m) sensors provide more detailed information over limited areas
- Satellite fire observation objectives:
  - *extent and intensity of ongoing fires*
  - *area, severity and impact of burns*
  - *support for fire early warning systems*

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

Consideration of evolving technologies

- Sourcebook describe readily available following IPCC good practice guidance for:
  - Derive activity/area change data
  - Data on carbon stocks and carbon stock changes
- New technologies and approaches for monitoring changes in forest area, forest degradation and carbon stocks that:
  - are potentially useful for REDD implementation
  - have not been operationally for national level assessments
  - may provide additional data and certainty
  - may not be available for all developing countries
  - implementation usually requires an additional resources
  - further pilot cases and international coordination needed
  - their utility may be enhanced in coming years depending on data acquisition, access and scientific developments

Current availability of fine-scale satellite data sources and capacities for global land cover change observations

	Satellite observation system/program	Technical observation challenges solved	Access to information on quality of archived data worldwide	Continuous observation program for global coverage	Pre-processed global image datasets generated & accessible	Image data available in mapping agencies for land change analysis	Capacities to sustainably produce/use map products in developing countries
OPTICAL	LANDSAT TM/ETM						
	ASTER				On demand		
	SPOT HRV (1-5)				Commercially		
	CBERS 1-3				Regionally		
	IRS / Indian program				Regionally		
	DMC program			Probably	Commercially		
SAR	ALOS/PALSAR + JERS				Regionally		
	ENVISAT ASAR, ERS 1/2				Regionally		
	TERRARSAR-X				Commercially		
	IKONOS, GEOEye			Probably	Commercially		
	ICESAT/GLAS (LIDAR)						

(Note: dark gray=common or fully applicable, light gray=partially applicable/several examples, white=rare or no applications or examples)

Evolving technologies remarks

- New sections on evolving technology to be added to the GOFC-GOLD sourcebook:
  - Evolving technologies and data sources – potential of methods not considered operational today
  - Usefulness for monitoring historical changes versus future capabilities
  - Suitable approaches for communication status, progress, and requirements to achieve progress for data collection procedures and interpretation methods
- Importance of synergy among different data sources
- Evolving approaches for collecting in-situ data

New Sections on evolving technologies

- SAR – Draft Section from Joseph Kellendorfer, Dirk Hoeckman, Ake Rosenqvist
- LIDAR – Draft Section Mike Wulder - (concentrate on airborne technologies at this point, carbon stocks, useful for sampling and site-based verification)
- Fine resolution (purpose, eg for use in validation and accuracy assessment) (Caccetta & ?)
- Hyperspectral (include short section on technology and potential future applications (Asner, Held?)
- Thermal Imagery (forest fire radiative power estimation) (draft by Justice & Chuvieco)
- Data integration tasks - Draft from Mike Wulder
- Recommendation section
- Table on outputs (measurements) vs technology options

Need for accuracy assessment

- Simple area estimation for land category:
  - use as indicated in map
  - common but (often) biased
- Accuracy assessment using a sample of higher quality data as integral part of national monitoring/accounting
- IPCC GPG: uncertainties should be quantified and reduced as far as practicable
- 2 different objectives:
  - Assess accuracy of land/use (change) map
  - Adjust area estimates (if validation shows bias)
- For REDD - accuracy assessment as process
  - using best efforts and continuous improvement while working towards a robust assessment in the future
  - for future commitment periods: robust accuracy assessment in place

Accuracy assessment procedures

Consensus methods exist for assessing the accuracy of remote sensing-derived (singe-date) land cover maps:

http://nofc.cfs.nrcan.gc.ca/gofc-gold/Report%20Series/GOLD_25.pdf

- Implementation steps for robust approach:
  - **Sample design:** a probability sampling design is the preferred approach for selecting reference locations
  - **Response design:** protocols to determine the reference or ground condition label and comparison to map labels
  - **Analysis design:** includes estimation formulas and analysis procedures for accuracy reporting, i.e. error matrix, accuracies and errors of omission and commission
- Often errors of omission and commission are not equal
- Use accuracy information on bias in the map to adjust area estimates and also to provide the confidence intervals

Practical considerations

- Robust approach may not be achievable or practicable i.e. monitoring historical land changes in developing countries
- Verification should build confidence, improve knowledge of potential errors and is used for continuous improvements
- If no thorough accuracy assessment is possible or practicable, recommendation to:
  - apply the best suitable mapping method in a transparent manner
  - consistency assessment allow some estimation of the quality
  - work backwards from most recent time (more reference data)
- Information without a proper statistical sample can be useful in understanding the basic error structure:
  - Confidence values provided by interpretation or classification
  - Qualitative examinations/comparison with other maps
  - Systematic review and judgments by local and regional experts
  - Comparisons with non-spatial and statistical data

Recent GOFC-GOLD REDD group Activities

1. 20/21. Oct. 08: attended informal REDD method. Meeting at UNFCCC Secretariat
   - *Focus on monitoring forest degradation*
   - *http://unfccc.int/methods_science/redd/items/4579.php*
2. 17-19. Nov. 08: Capacity development organized by Coalition for Rainforest Nations
   - *GOFC-GOLD co-organizer, focus on area change*
   - *More than 30 countries present*
3. 26-28. Nov. 08: Expert consultation on national forest monitoring and assessment at UN FAO
   - *New requirements from REDD*
4. 3. Dec.08: Sourcebook side event at UNFCCC COP 14 hosted by PNG

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Web resources

- **GOFC-GOLD REDD sourcebook:**
  - http://www.gofc-gold.uni-jena.de/redd
- **Global Terrestrial Observing System (GTOS):**
  - http://www.fao.org/gtos/
- **GOFC-GOLD:**
  - http://www.fao.org/gtos/gofc-gold/
- **GOFC-GOLD land cover project office:**
  - http://www.gofc-gold.uni-jena.de/