Introduction to the use of carbon accounting models and how they could be used to determine a Reference Emissions Level

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BioCarbon Fund Initiative for Sustainable Forest Landscapes
Workshop to discuss landscape-level carbon accounting approaches
Washington DC, USA, January 26-27, 2016

Natural Resources Canada   Ressources naturelles Canada

Canada

Motivation:

Globally the land sector is a large contributor to GHG emissions and removals and can therefore also contribute significantly to GHG emission reduction targets – relative to a baseline.

Tools are required to integrate data from many sources and to estimate past, current and projected future emissions and the GHG mitigation benefits of changes in human activities.

Ideally, such tools should be easily adapted and customised to meet the requirements and national circumstances of different countries.

Outline

- Background
- Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)
- Activity Data
- Reference levels
- Next Generation Tools – moja global
- Conclusions

Terminology 101:
Estimation, Reporting, Accounting, Review

Estimate

- Calculate carbon (C) stock change and GHG emission and removal estimates using methodological guidance of the IPCC

Report

- Provide estimates and other information in national reports, using internationally agreed upon formats and guidelines
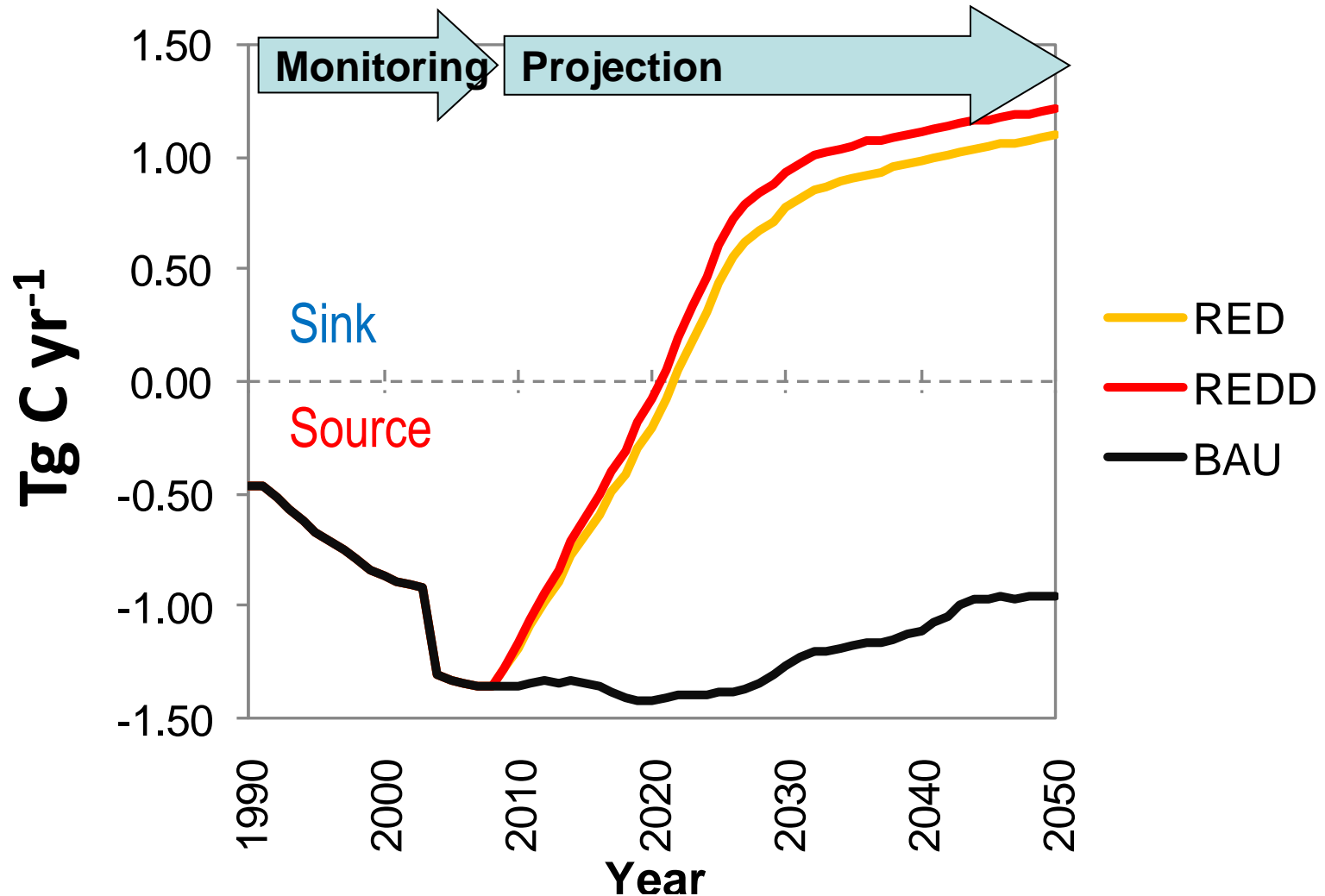
Account

- Use reported estimates and other information to show progress toward, or compliance with, a target

Review

- Process of examination (by others) of reported information in relation to an objective

Policy makers require estimates of impacts of human activities on current and future GHG balance
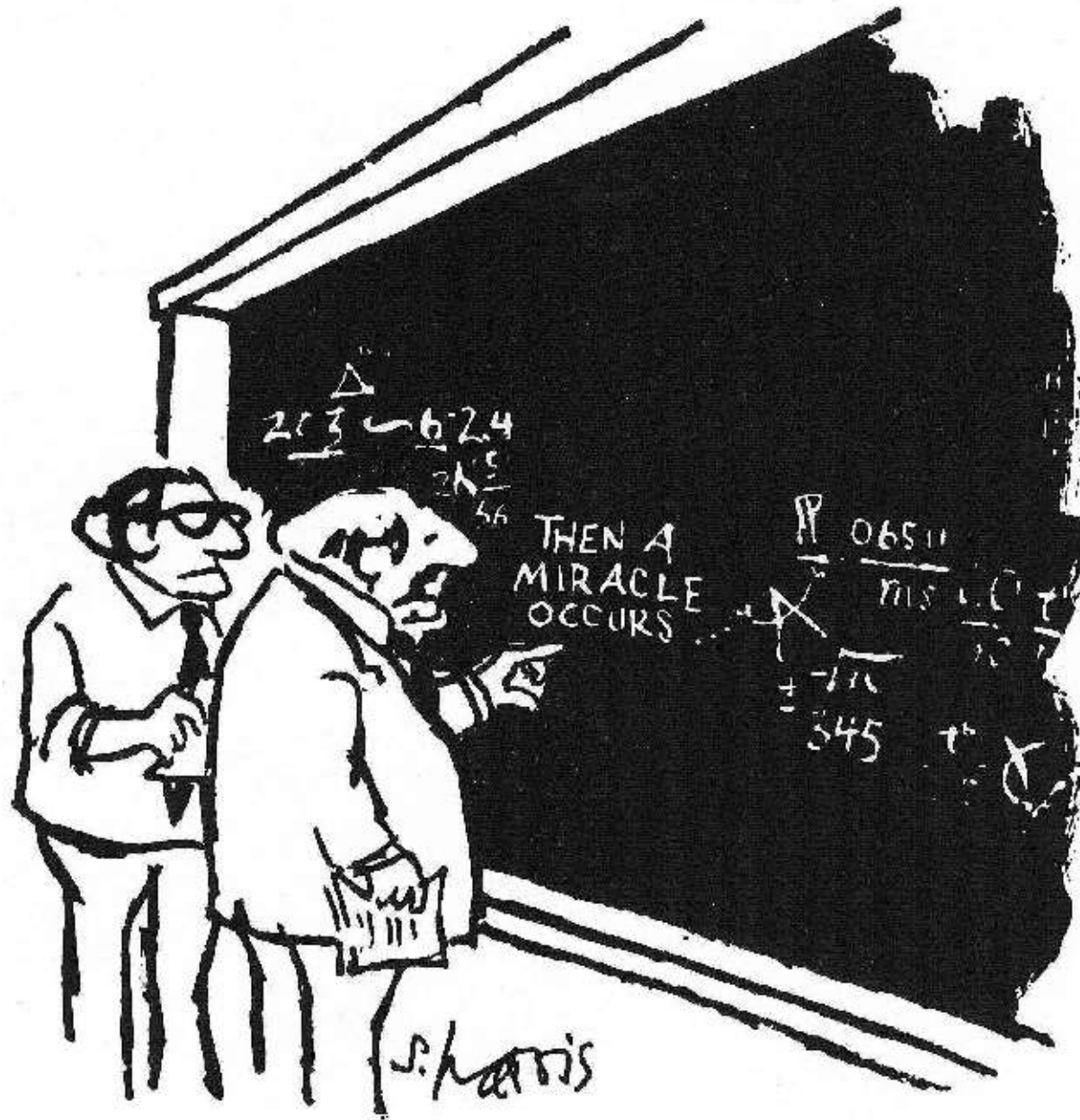

Source: Olguin et al., 2012, Example of Chiapas pilot project

Problem

MRV and remote sensing products are developed to aid GHG emissions and removals reporting and REDD+
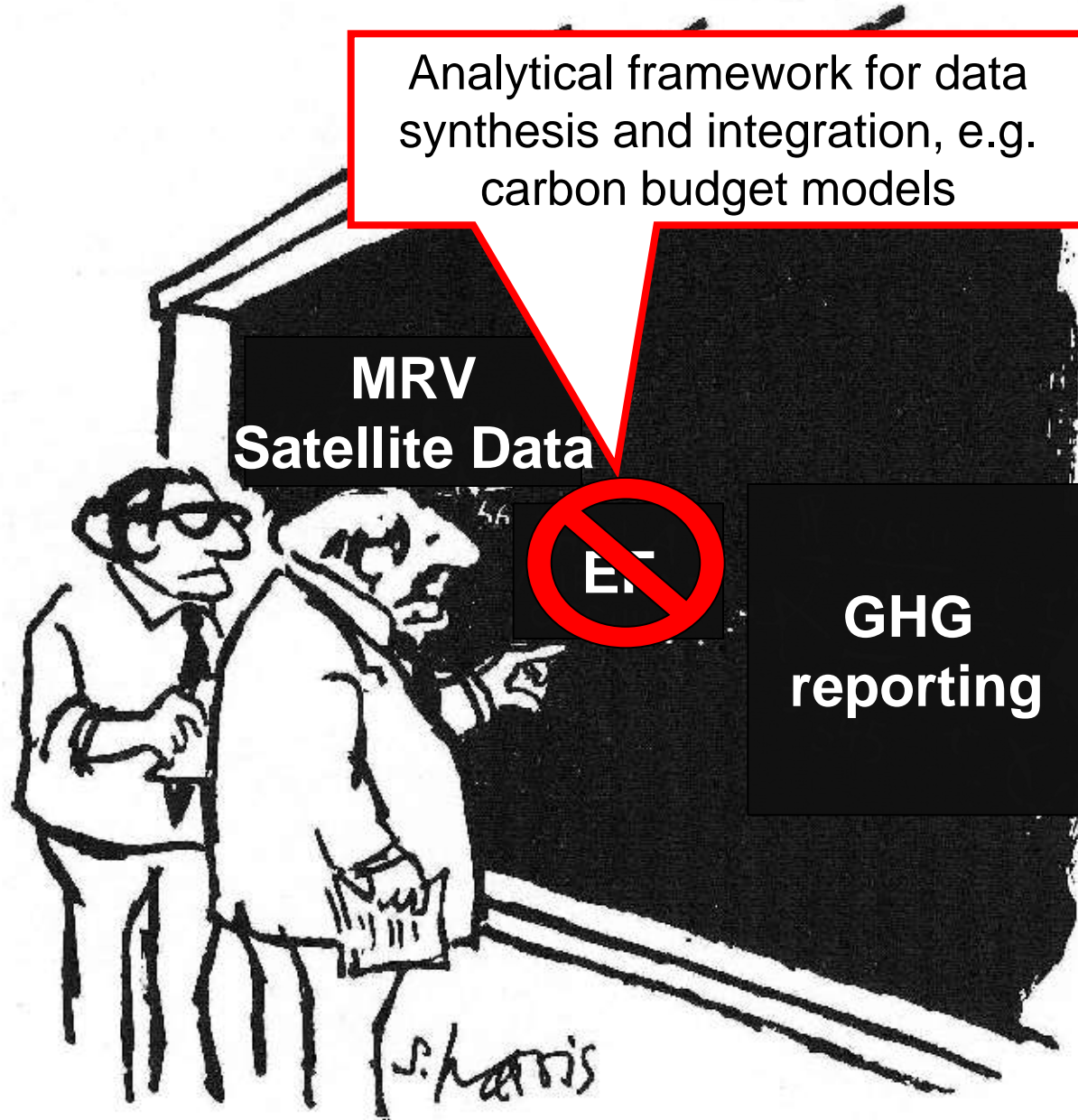
but …

"I think you should be more specific here in step 2"

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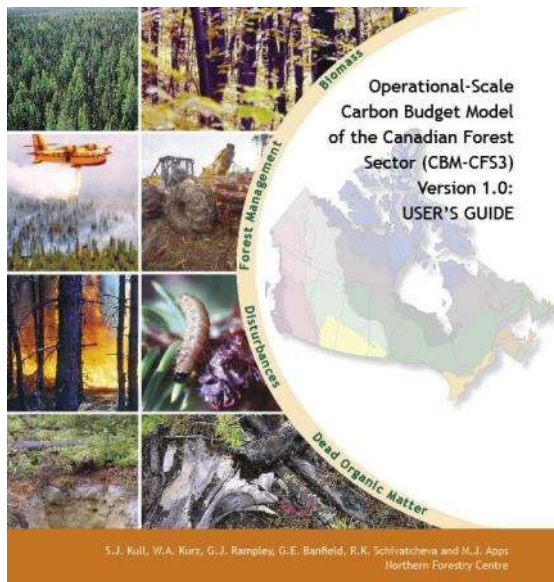
but …

"I think you should be more specific here in step 2"

# Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

- An operational-scale model of forest C dynamics.
- Allows forest managers to assess carbon implications of forest management: increase sinks, reduce sources

Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

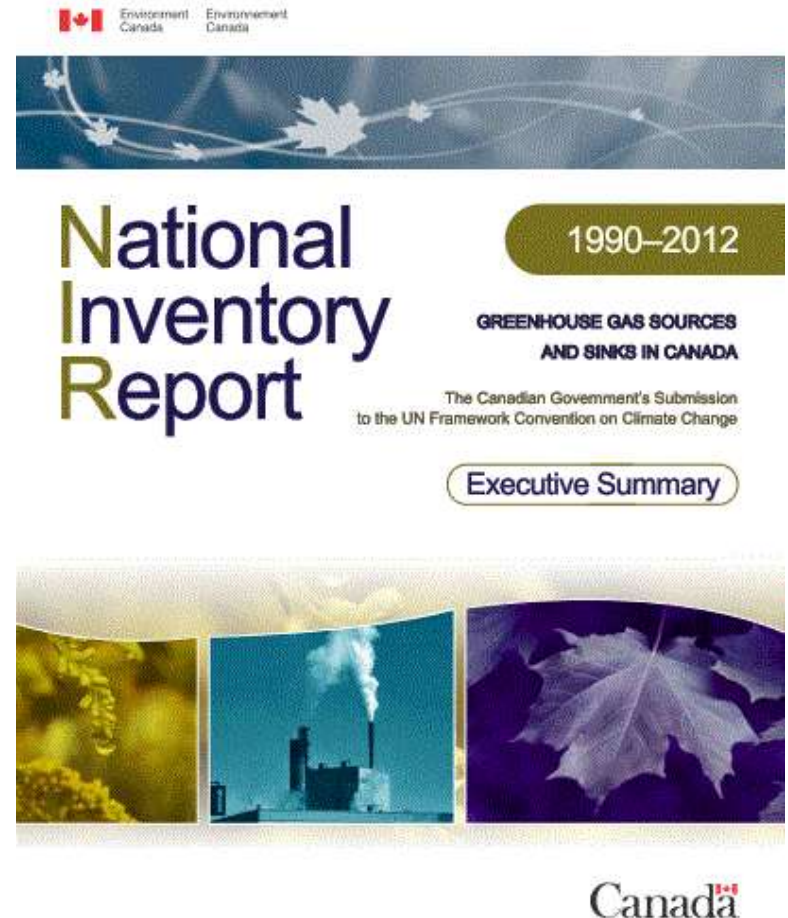- CBM-CFS3 Toolbox includes
    - Software and databases
    - User's Guide and Tutorials
- Freely available
- 1360 downloads in 55 countries,
- 550 trained (18 domestic workshops, 4 international),
- model in 5 languages (English, French, Spanish, GUIs for Russian and Polish).
- User community includes government, industry, academia, agencies, ENGOs

- Extension Forester for support: Stephen.Kull@canada.ca
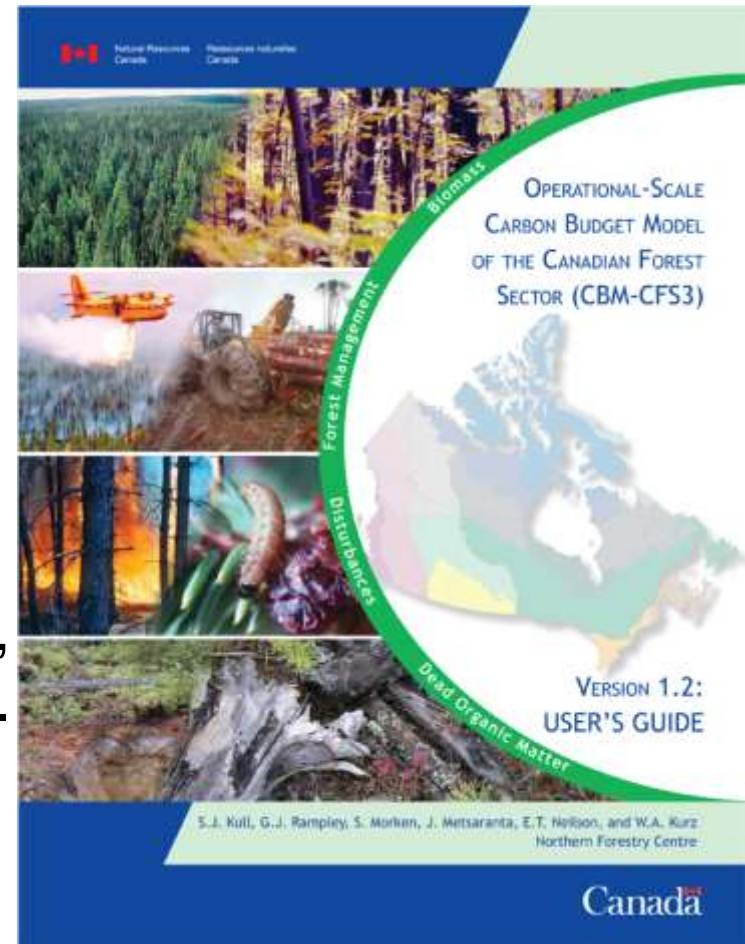
Canada's National Forest Carbon Monitoring, Accounting &Reporting System uses CBM-CFS3

One national system, many uses:

- Reporting past C dynamics
  - National GHG Inventory
  - State of Canada's Forests

- Projecting future C dynamics
  - Scientific research
  - Policy development
  - International negotiations

- Develop climate mitigation and adaptation strategies

National Inventory Report 1990–2012

GREENHOUSE GAS SOURCES AND SINKS IN CANADA

The Canadian Government's Submission to the UN Framework Convention on Climate Change

Executive Summary

http://www.ec.gc.ca/ges-ghg/

Modelling Framework for Integration of Data from Multiple Sources

The CBM-CFS3 integrating framework:

- is "scale-independent" – i.e. it works at the scale of pixels or stands to small regions to the nation using the same principles and general approaches – nested so that the sum of regions is equal to the national estimate.

- can use "spatially-explicit" or "spatially-referenced" data

- accommodates data from multiple sources and of varying quality within a consistent stratification (geographically and forest types).

- is expandable to increased complexity as new scientific data become available – e.g. increase the number of yield curves (forest strata) as inventory data become available

- Includes all five IPCC pools

- links dynamics of dead organic matter and soil C to dynamics of biomass C pools.

Approach

CBM-CFS3 uses IPCC "Gain-Loss" method and requires:

- Characterization of initial forest (land) conditions (strata)

- Growth rates of forests in different strata

- Activity data (disturbances, management, land-use change)

- Ecological data (decay rates, litterfall and turnover, etc.)
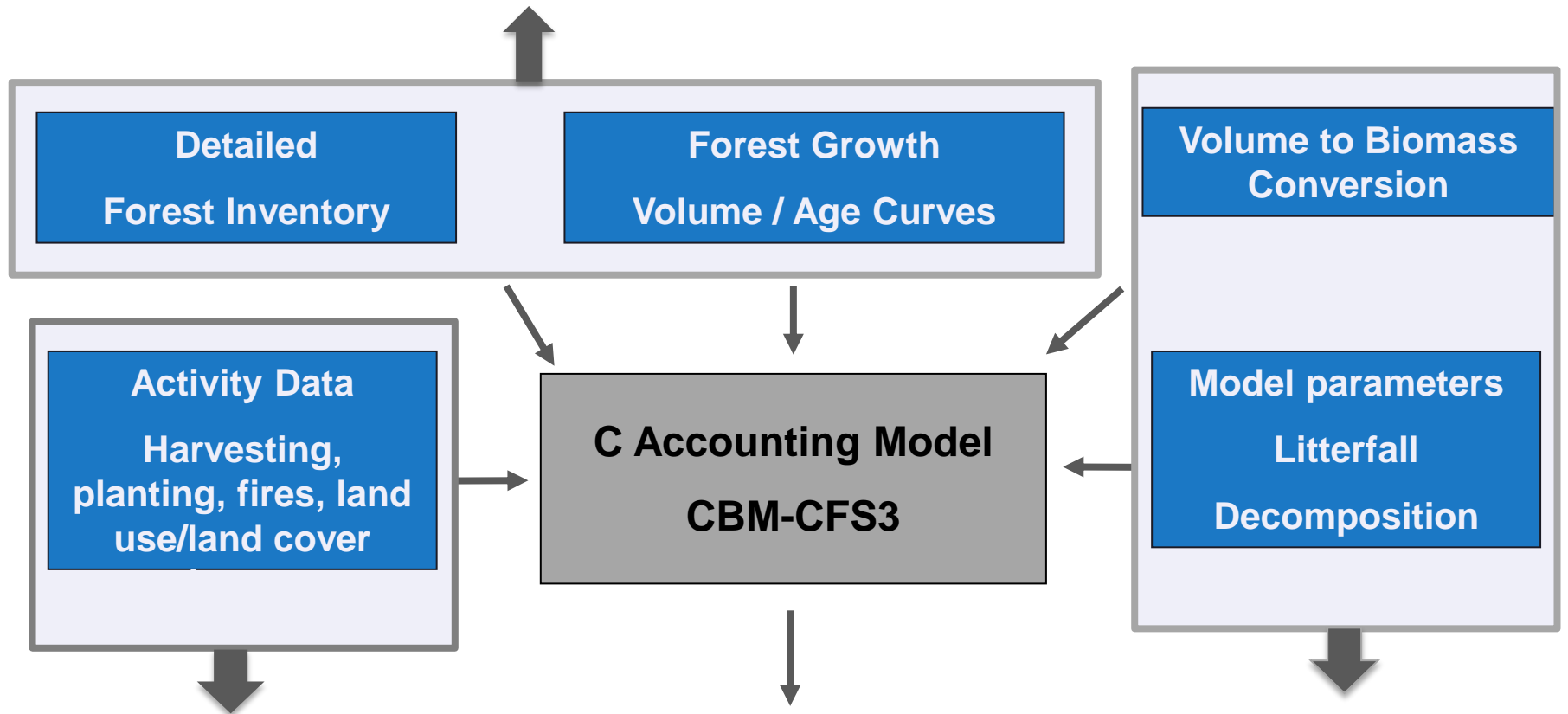
- Climate data

Data

- Input data vary depending on national, regional or local circumstances

- Always start with "best available" data

- Improve data over time following the IPCC Guidance to "identify, quantify, and reduce uncertainties as far as is practicable".

- Once integrating tools are in place, conduct sensitivity analyses to guide investments into future data collection and improvements.

- Note that the reporting requirement is for emissions and removals, i.e. stock changes not on estimates of stocks.

- Thus, we can accept greater uncertainties for those stocks with anticipated small changes (soils) and focus on those areas and pools with anticipated large changes.

Model components and data sources (Mexico)

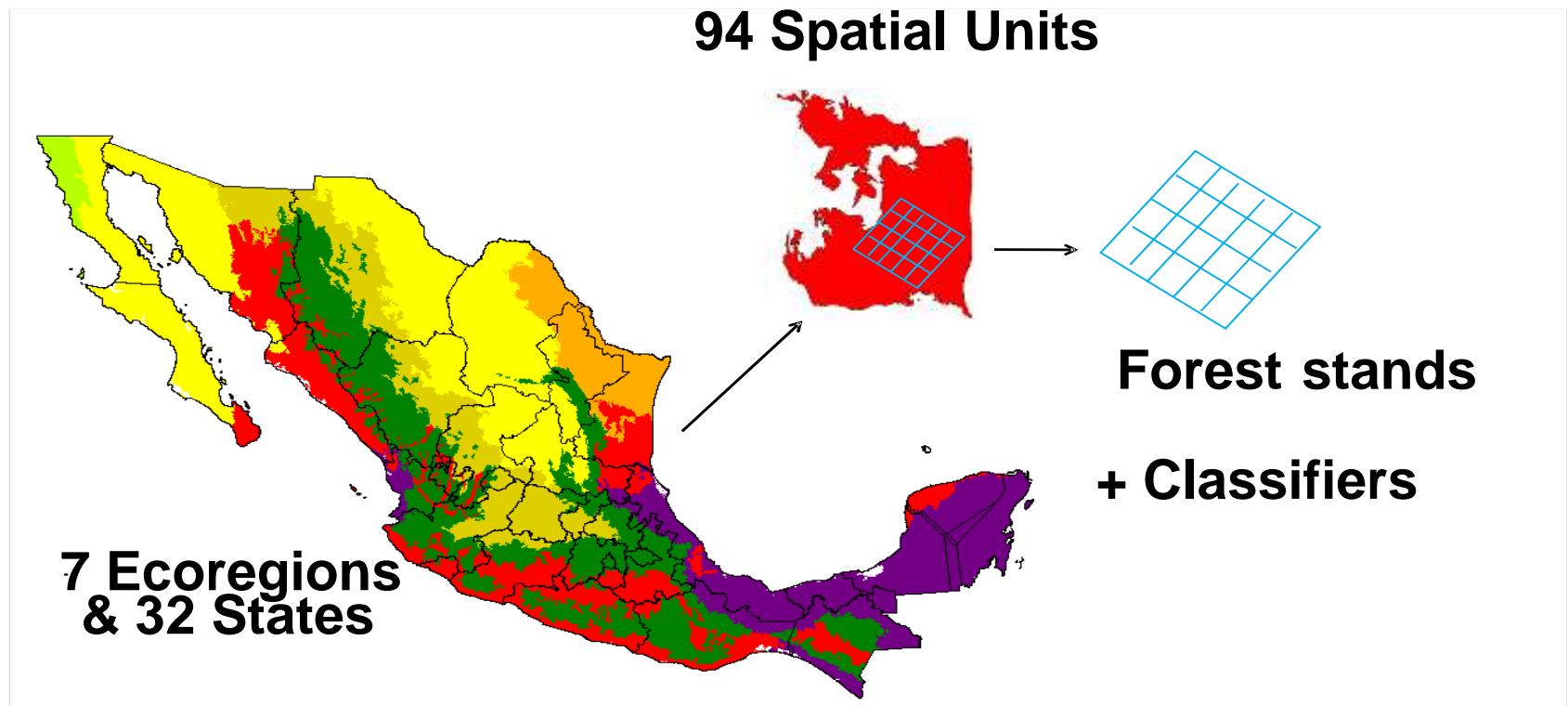**a) National Forest Inventory** (~26,000 plots) + MAD-Mex monitoring system

Detailed Forest Inventory	**Forest Growth Volume / Age Curves**	**Volume to Biomass Conversion**
Activity Data **Harvesting, planting, fires, land use/land cover**	**C Accounting Model CBM-CFS3**	**Model parameters Litterfall Decomposition**
	Results database	

b) MAD-Mex (Landsat, 1993-2011; Rapid eye, 2011-2012) **+ National statistics**

c) Intensive C Monitoring Sites (Mex-SMIC Network)

# Spatial concepts easily applied in other countries

- E.g. in Mexico intersection of boundaries of 32 states with 7 ecozone (level 1) yields 94 spatial units.

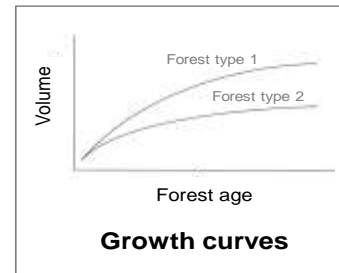- Implementation with spatially-explicit or spatially-referenced activity data

94 Spatial Units

Forest stands

+ Classifiers

7 Ecoregions & 32 States

Spatially-explicit use of activity data

Single Landsat scene:

Yucatan Peninsula, Mexico

Forest type map

Forest age map

+
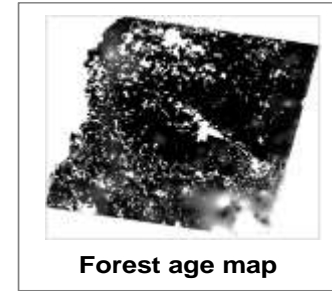
Library of growth curves derived from Inventory plots

Volume

Forest type 1

Forest type 2

Forest age

Growth curves

+

Stack of annual disturbance data (30 m resolution)

Disturbance map

16
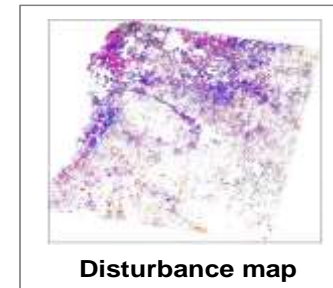
Spatially-explicit CBM simulation

Source: Greenberg et al. 2015

Spatially-explicit use of activity data

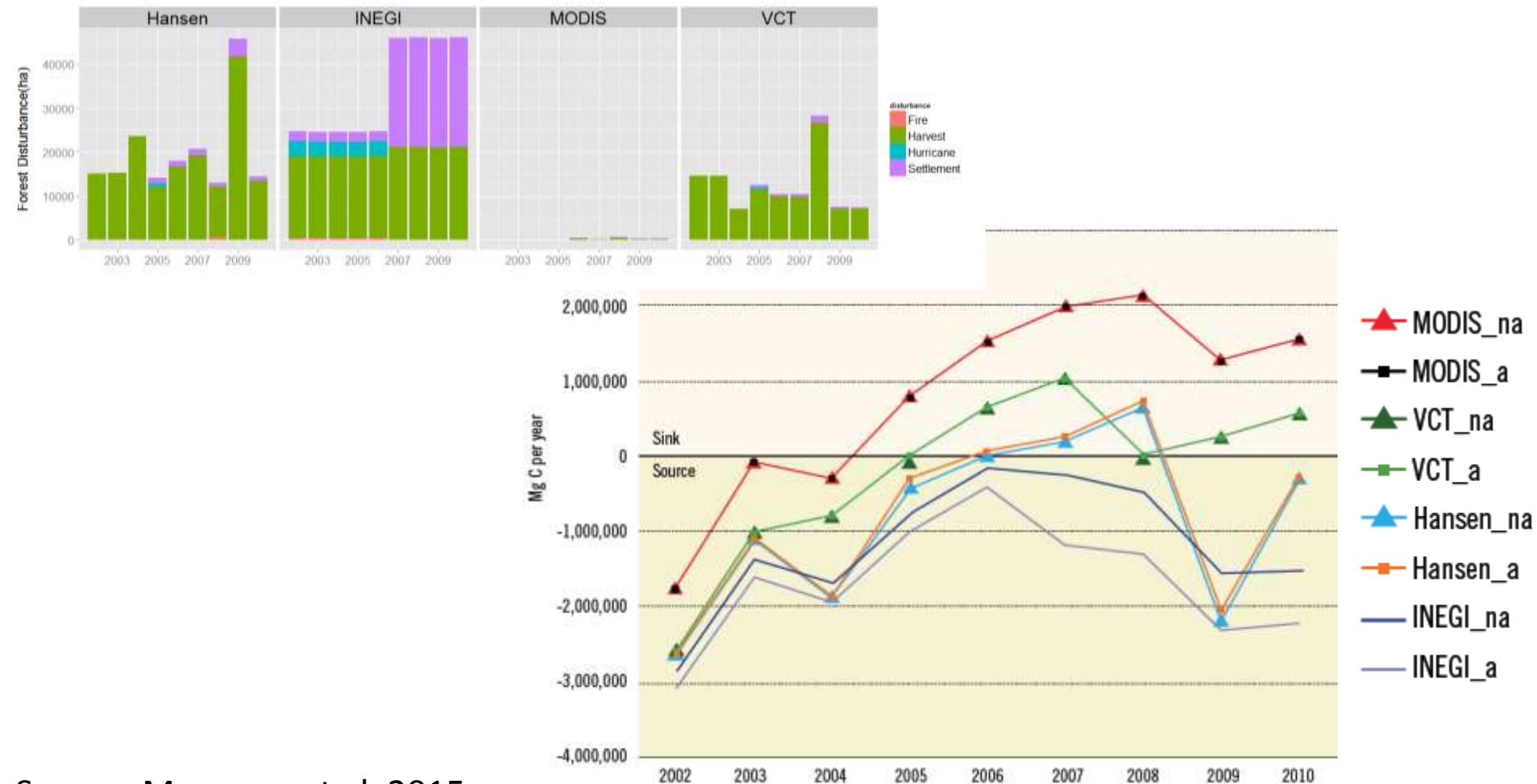Single Landsat scene: Yucatan Peninsula, Mexico

4 RS products, with and without attribution of disturbance types

Source: Mascorro et al. 2015

Spatially-referenced use of activity data

Activity data

Land cover change matrices
*Available LC INEGI maps, reclassified according to MAD-Mex

Area (ha)	To year 2007						
From year 2002	Oak forest	Mixed forest	Humid forest	Dry forest	Non-Forests	Others	Total
Oak forest	7,852		172		561		8,586
Mixed forest		2,953	607		338		3,898
Humid forest		1,061	6,268,561	16,022	107,772	8,739	6,402,155
Dry forest		111	63,409	3,300,862	148,221	626	3,513,230
Non-Forests	585	4,746	131,878	91,554	1,915,202	4,198	2,148,163
Others			2,668	194	2,922	432,921	438,705
Total	8,437	8,871	6,467,295	3,408,633	2,175,015	446,484	**12,514,736**

Activity Data
*annualized LC changes to account for deforestation and forest regeneration

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Source: Olguin et al. 2015
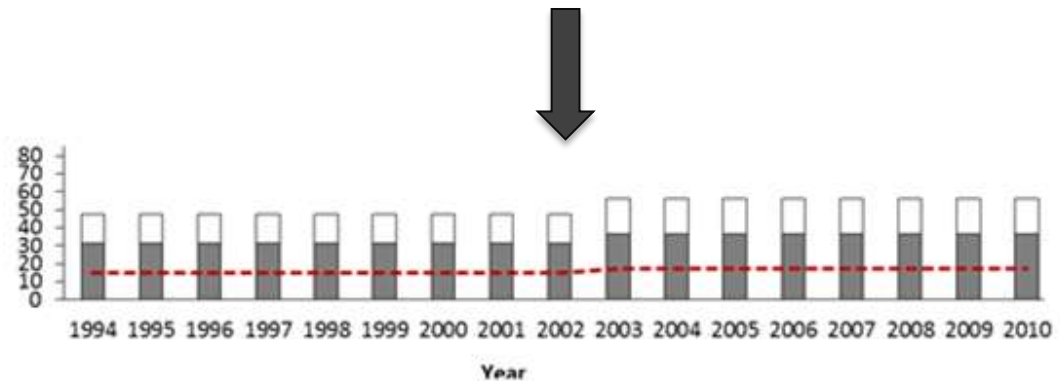
Spatially-referenced use of activity data

Preliminary Results:
**State-level historic net balance of GHG emissions**
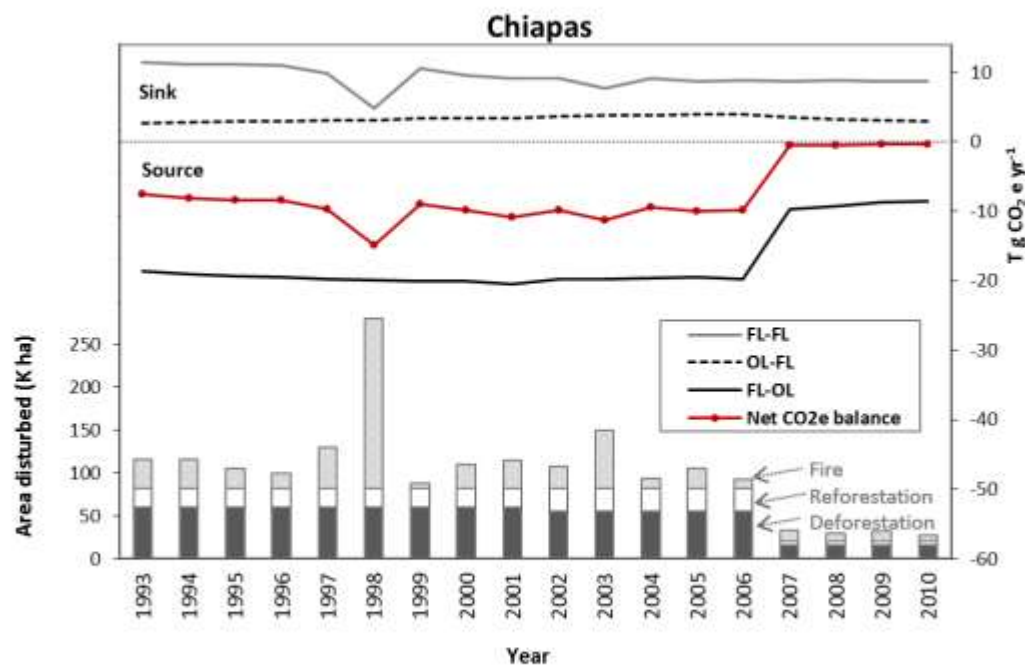
Example of the contribution of each land class category to the net CO_2e ecosystem balance:

FL→FL: Forest Land remaining Forest Land
FL→OL: Forest Land converted to Other Lands
OL→FL: Other Lands converted to Forest Land
OL→OL: Other Lands remaining Other Lands

* Key drivers: FL→FL (forest management)
                      FL→ OL (deforestation)

Source: Olguin et al. 2015

Choice of Reference levels

Examples of reference levels based on average emissions or average activity data (Yucatan Peninsula, Mexico)

Source: Olguin et al. 2015, Kurz et al. 2016

Choice of Reference levels

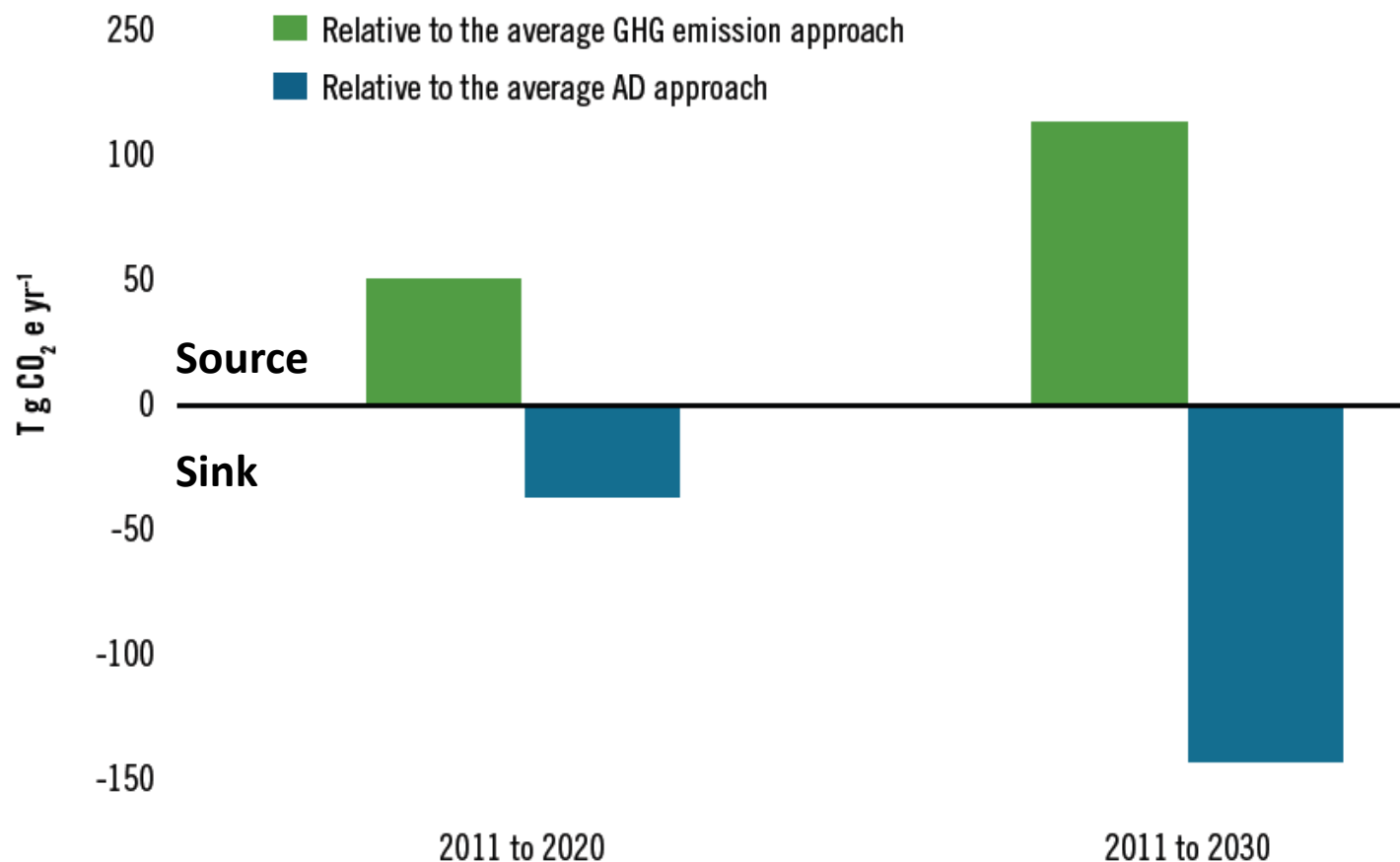**Examples of reference levels based on average emissions or average activity data (Yucatan Peninsula, Mexico)**

Source: Olguin et al. 2015, Kurz et al. 2016
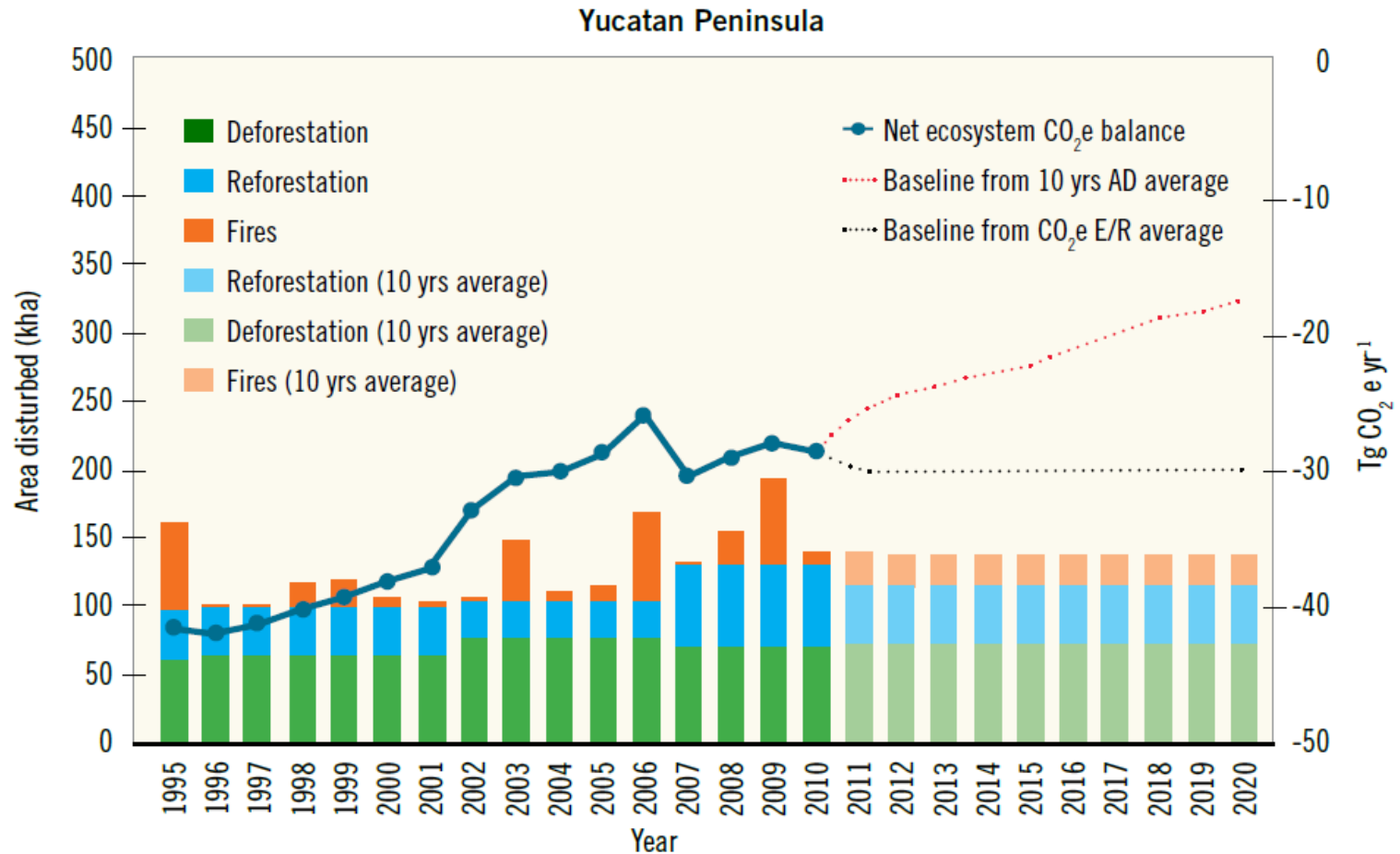
Outline

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- Activity Data
- Reference levels
- **Next Generation Tools – moja global**
- Conclusions

DEVELOPMENT OF SECOND GENERATION CARBON ESTIMATING AND REPORTING TOOLS

AN INTERNATIONAL TEAM EFFORT!

Rob Waterworth, Jim Leitch, Malcom Francis, (Australia)

D. James Baker, Molly Bartlett (CCI, US)

Jackson Kimani, Peter Ndunda, Moses Kihumba (CCI, Kenya)

Werner Kurz, M. Fellows, S. Morken, G. Zhang, (CFS, Canada)

Guy Janssen, Dean Rizzetti, (CCI)

And many others!

Background

- Increasing need for information about the role of the land sector in GHG emissions and removals.

- Reporting and policy needs

- High demand for support of analyses that identify and quantify forest sector climate change mitigation options.

- Two countries with the most advanced tools are Australia and Canada (others are evolving).

- Ongoing collaborative work with teams from Australia, Canada and Kenya, with financial support from Clinton Climate Initiative and Gov. of Australia to Kenyan and Australian teams.

Why would we want/need another tool?

- While existing tools are very powerful, more is needed
- There is no one tool that can do everything needed
  - Combined CBM and FullCAM cover 90%, but individually far less
- Both tools are based on dated computing science and cannot cope well with the huge influx of new data from remote sensing
- Countries are starting to demand more
  - Not just emissions, but other needs (co-benefits)
- Countries want more ownership and control
  - In particular in choosing methods and models
- It is no longer efficient to modify existing tools – we need to move to new computing science / technology

SLEEK requirements drove initial needs

- SLEEK is the first attempt to account for all lands in a single system and simulation (Tier 3, Approach 3)
  - Highly integrated and automated, making use of remote sensing, climate, soils mapping, management information and ground data
  - Accounting for changes in land use, management and natural disturbances
- Identified need for multiple co-benefits
  - Supporting land use planning, food security etc
  - Needed to operate at multiple scales and support project level tools and accounting needs
- Expensive and time consuming to build, so decided to develop as a generic framework other countries can use
  - Formed a collaboration with key experts involved in development of first generation tools to design and build
  - This will greatly reduce costs for others

High-level concept
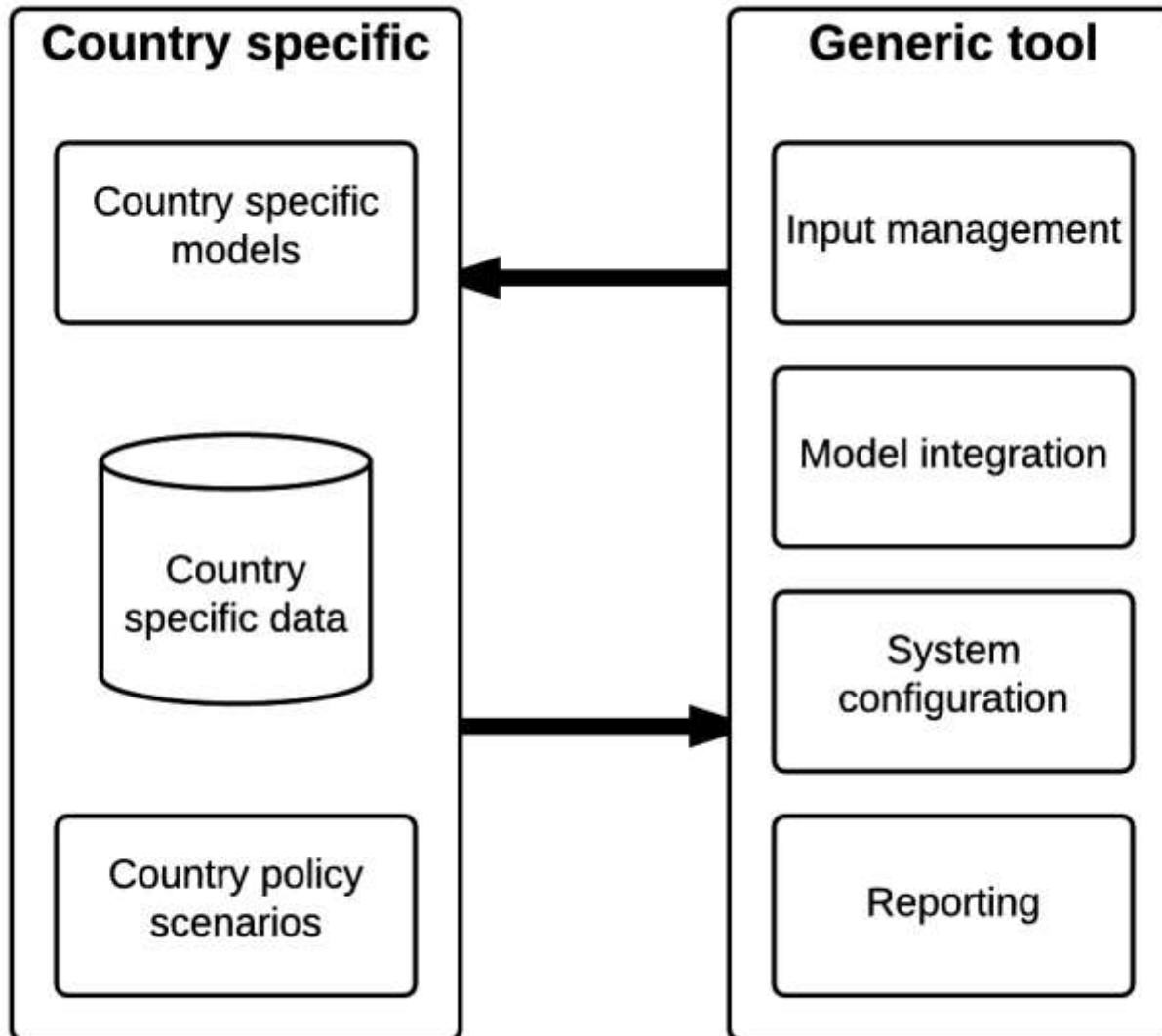
Current Status (Technical)

- Working prototype in place – current testing in:
    - Kenya using FullCAM-derived and other modules
    - Canada using CBM-derived modules
- Integrating platform
    - Spatially-explicit activity data (at variable resolutions)
    - Proven reduction in code requirements for individual modules
    - Multithreading working
    - Reporting module working

BUT: a lot remains to get done to complete the tools

- Next 12 months of development critical for success

Current Status (Institutional)

- Clinton Climate Initiative leading institutional arrangements

- Implementation in Kenya supported by CCI with funds from Australian Government.

- Implementation in Canada uses internal funds.

- Ongoing exploration of future funding options and discussion with several interested parties.

- Ongoing exploration of future delivery and governance mechanisms (e.g. a dedicated foundation: moja global)

Moja global organisation

- A proposed new organization to manage generic tools
    - Provide confidence to governments that the tools will be managed and sustained
    - Several tools considered, the new integrating tool being the core
- Managed through an international board
    - Not 'owned' by any one country or organization
    - Enhancements driven by the user community
    - Based on the concepts of the Global Earthquake Model
- Focus on professional software management
    - Applying established principles: unit testing, continuous integration, documentation are all in place
- Can provide support to countries looking to use the tools
    - But will not implement: this remains the role of national governments

Conclusions (1/2)

- Globally the land sector is a large contributor to GHG emissions and removals.

- Changes in land management can contribute significantly to climate change mitigation, reducing GHG emissions and delivering co-benefits.

- Tools are required that allow countries to compile and apply best available data to estimate and report GHG E/R and to assess policy options including REDD+ and sustainable forest management.

- Such tools must be able to draw on global, national and local data sources, where these are available.

Conclusions (2/2)

- Canada's CBM-CFS3 and Australia's NCAS are two national-scale tools that have been applied in other countries.

- A new second-generation integrating framework is under development that can greatly reduce duplication of future efforts by providing a generic platform that works with existing or new modules developed to address national circumstances.

- This new platform can assist developing countries access and process global remote sensing products to support the development of MRV systems.

- An MRV system that uses the compiled data to also support other land management objectives will be of greater use to developing countries.

Thank-you

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Publications at:

http://cfs.nrcan.gc.ca/publications/search?query=Kurz

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