Forestry Projects: Measurement and Monitoring

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Biological Sequestration through Greenhouse Gas Offsets:
Identifying the Challenges and Evaluating Potential Solutions
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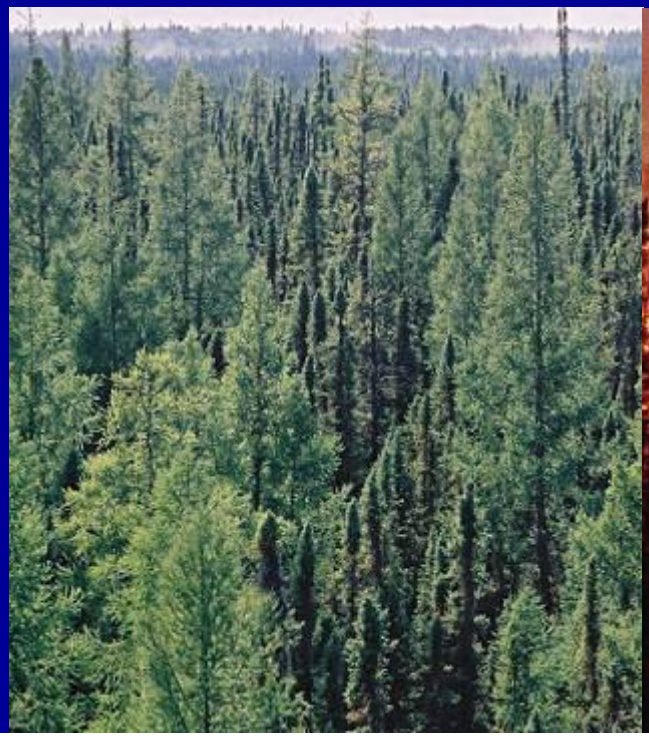
Outline

- Background – climate change and forest mitigation
- Project-level Measurement and Monitoring, Baselines
- Models in project-level accounting
- Conclusions



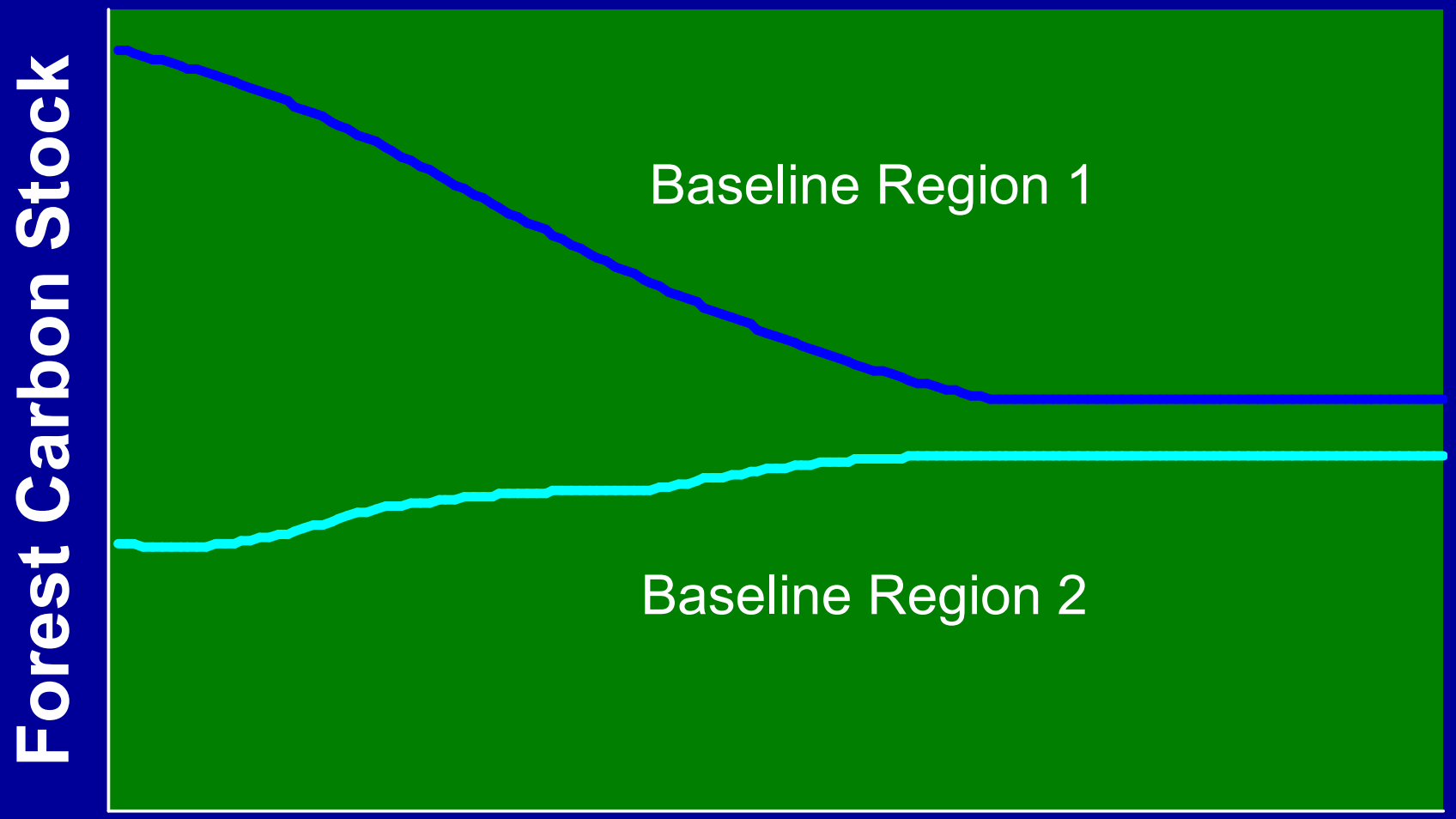
Does the Forest Sector have a Role in a Mitigation Portfolio?

- Climate change will increase the area annually affected by fires, drought, and insects and could have negative impacts on forest carbon stocks.
- Nevertheless, forest management options are available to improve the net GHG balance of the forest sector relative to a forward-looking (business-as-usual) baseline.

Does the Forest Sector have a Role in a Mitigation Portfolio?

- Mitigation objectives are achieved when changes in human activities result in
  - a reduction of emissions or
  - an increase in removals of GHG from the atmosphere relative to a projected (forward-looking) business-as-usual baseline.

Increased Sink or Reduced Source both benefit the Atmosphere



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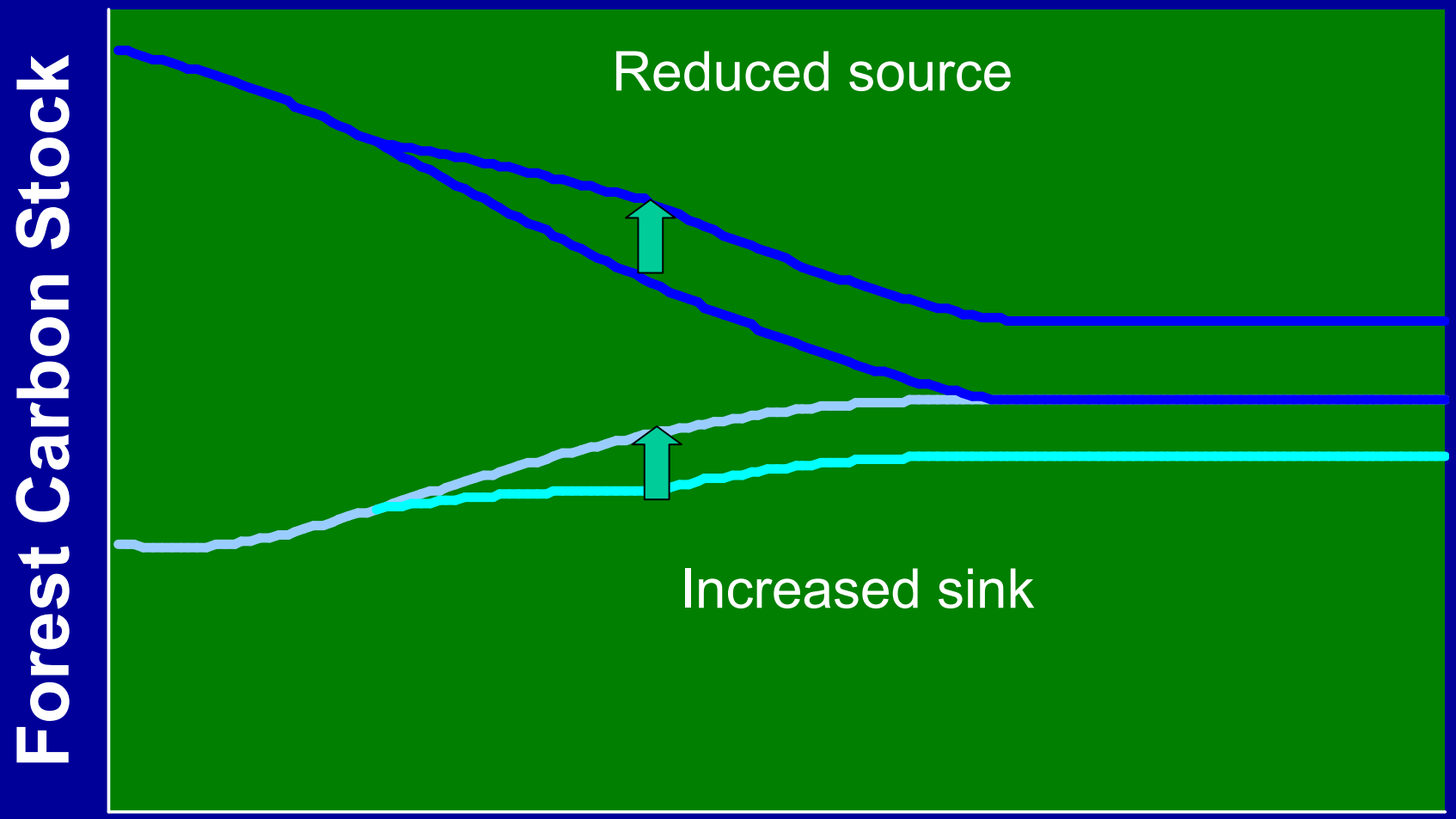
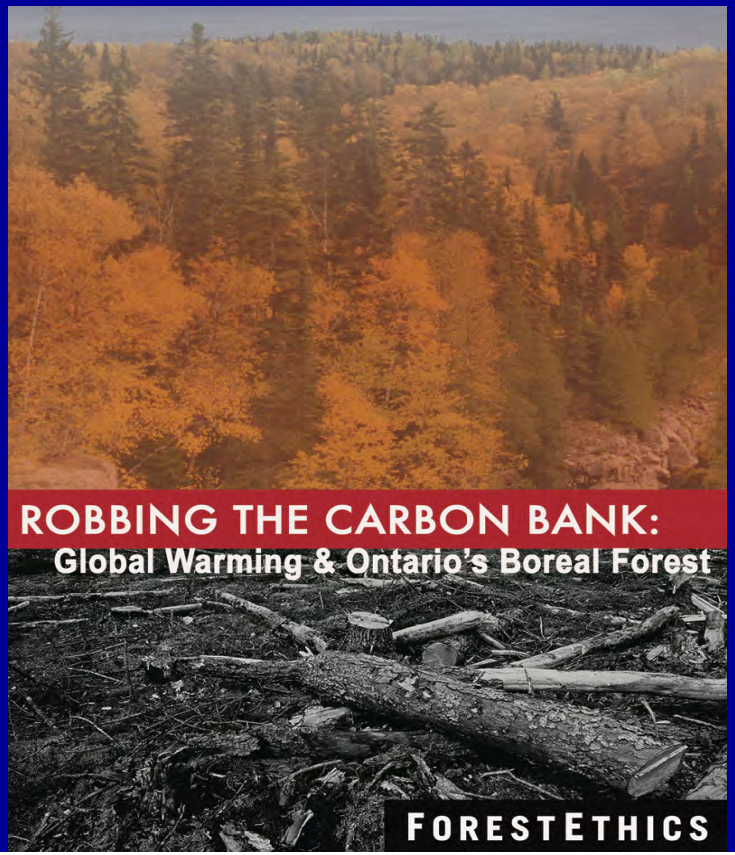


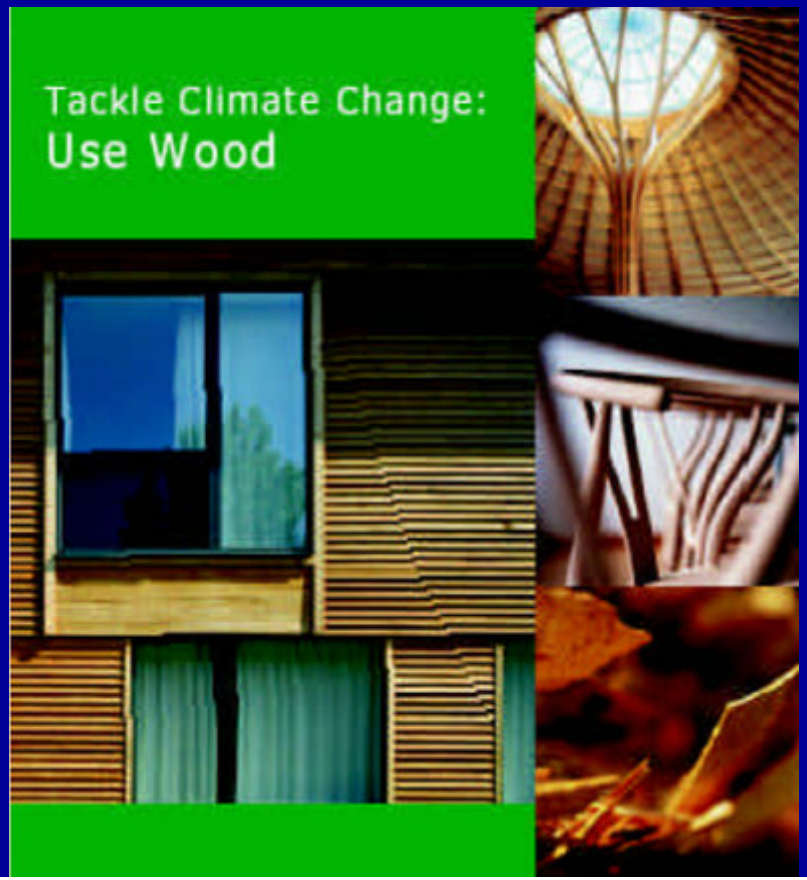
Mitigation Options in the Forest Sector

- Require quantification of trade-offs between ecosystem C storage and use of HWP to store C and to provide substitution of energy-intensive products and fossil fuels.

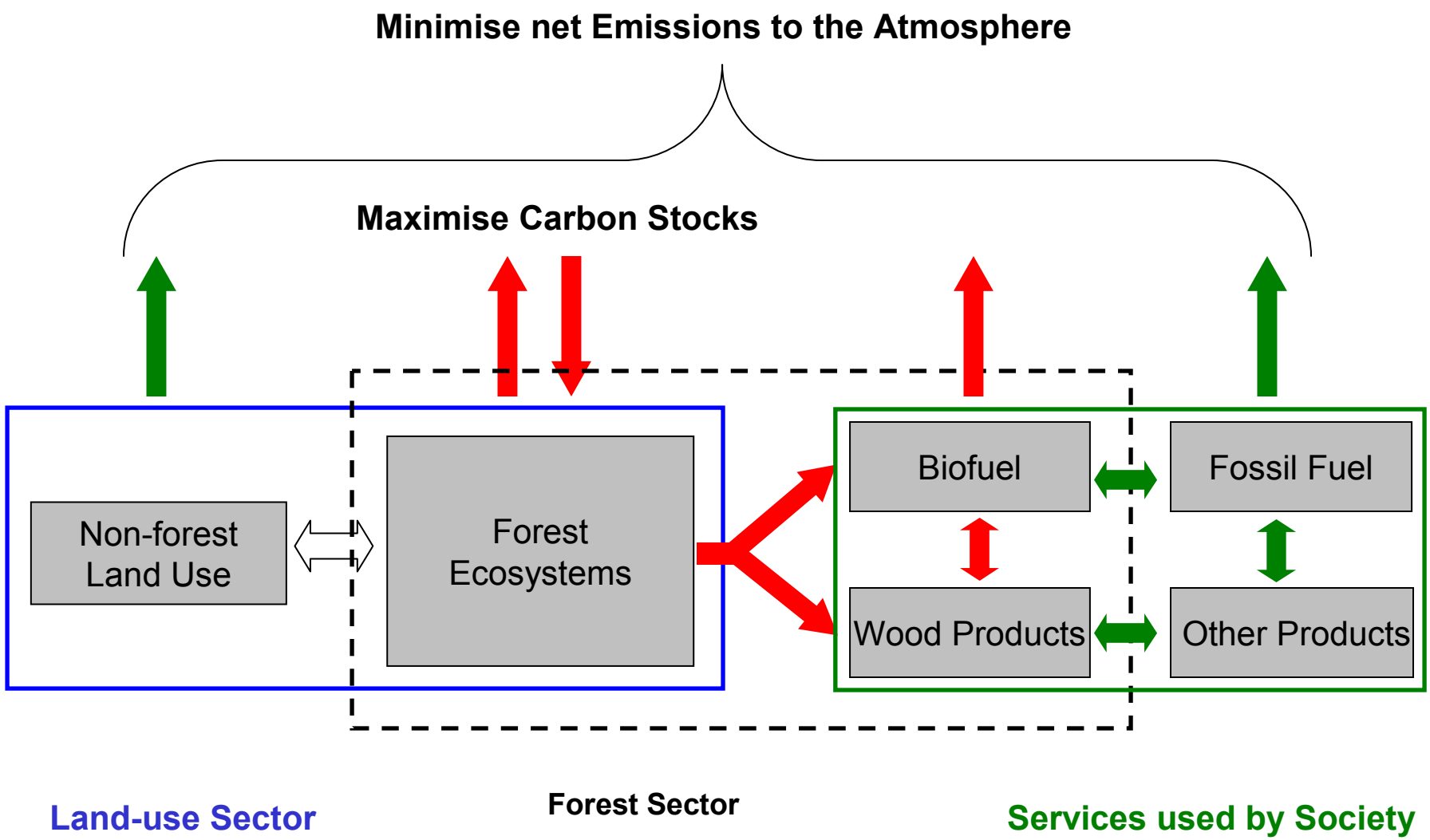
Stop logging …..



… or use wood?



Forest Mitigation Strategies: What to Optimise?



Source: IPCC 2007, AR4 WG III, Forestry

Mitigation Options in the Forest Sector

1. Increase (or maintain) forest area
2. Increase stand-level carbon density
3. Increase landscape-level carbon density
4. Increase C stored in products, reduce fossil emissions through product substitution and through bioenergy use

Measurement and Monitoring: Approaches

Two possible approaches:

1. Measure C Stocks at time t1 and t2 and calculate differences
   - May need to be supplemented with non-CO_2 GHG emission and removal estimates
2. Measure C Stocks at time t1 and add gains and losses
   - Requires measurement or estimation of growth rates, losses from mortality, disturbances, management actions, etc.

Measurement and Monitoring

- High costs – but forest mensuration has developed methods to increase efficiency – can build on experience
- Stratify by land-cover, forest type, treatment history, etc.
- Sampling at plot level
- Remote sensing (air photos, LIDAR, and satellite) to extrapolate land-cover to larger areas
- Use models to combine measurements and synthesize data over space and time.

Measurement and Monitoring: Baseline and Uncertainty

- In projects, uncertainties originate from requirement to compare actual against baseline.
- Baselines can be either a single reference (past year, regional standard, etc.) or a dynamic forward-looking baseline of the carbon dynamics without the project.
- Two sources of uncertainty:
  - Estimates of the actual C and non-CO_2 dynamics
  - Baseline estimates from model projection or other origin
- Additional uncertainties for estimates outside ecosystem such as upstream energy use, leakage, or impacts in forest sector from project (such as changed harvest rates).

Measurement and Monitoring: Land-use Change

- **Afforestation and Reforestation**
  - Standard measurements of area, carbon density, etc.
  - Baseline C stock changes on non-forest land

- **Avoided Deforestation**
  - Constant or small increases in C stocks
  - Baseline of rates of D in the absence of project
  - Main uncertainty not from measurements but from baseline!
  - What would have been deforestation rate?

Measurement and Monitoring: Forest Management

- **Increase <u>stand-level</u> carbon density**
  - Standard measurements of area, carbon density, etc.
  - Challenging but important to obtain non-CO_2 GHG, e.g. avoided slashburning and forest fertilization
  - Baseline C stock changes can be obtained from control plots

Measurement and Monitoring: Forest Management

- **Increase landscape-level carbon density**
  - Standard measurements of area, carbon density, combined with models that allow landscape or regional summaries
  - Baseline challenges where FM is aimed at reducing emissions through fire suppression or insect control (e.g. spraying against defoliators), or reducing future emissions through fuel management.
  - Predicting what would have happened without control efforts is always uncertain. Could estimate from independent models, e.g. area burned from fire weather index.
  - Example of mitigation action that is the “right thing to do” even if it is difficult to derive “credits” or revenue.

Measurement and Monitoring: Forest Products

- **Increase C storage in HWP**
  - More long-lived products
  - Increased land-fill storage (but note CH_4 emissions!)
  - HWP accounting tools to estimate stock changes: difficult for exported products when using “production method” (i.e. accounting of HWP storage for all wood produced in project).

Measurement and Monitoring: Forest Products

- **Carbon Benefits from Substitution Effects**
  - Important for design of mitigation portfolio
  - But should they be “credited”? If real they will be accounted elsewhere through the reduction in emissions.
  - Baselines difficult to establish if substitution effects are included:
    - what was substituted with bioenergy (gas, coal, hydro?)
    - what material would have been used instead of wood?
  - Uncertainties from baseline much greater than uncertainties from estimates of “actual”.

Do we have the tools …?

- **Standard Forest Inventories**
  - Ground Measurements, Aerial photos, LIDAR, satellite.
- **Ecological measurements (DOM, Soil C)**
- **Challenges for non-CO_2 GHG emission**
  - Can use standard emission factors for specific activities (but will have large uncertainties).
- **Models**
  - Should be peer-reviewed – not just the proponent's tool
  - Require regional testing, possibly re-calibration
  - If "bias" exists it will be the same in both the baseline and the estimate of actual

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

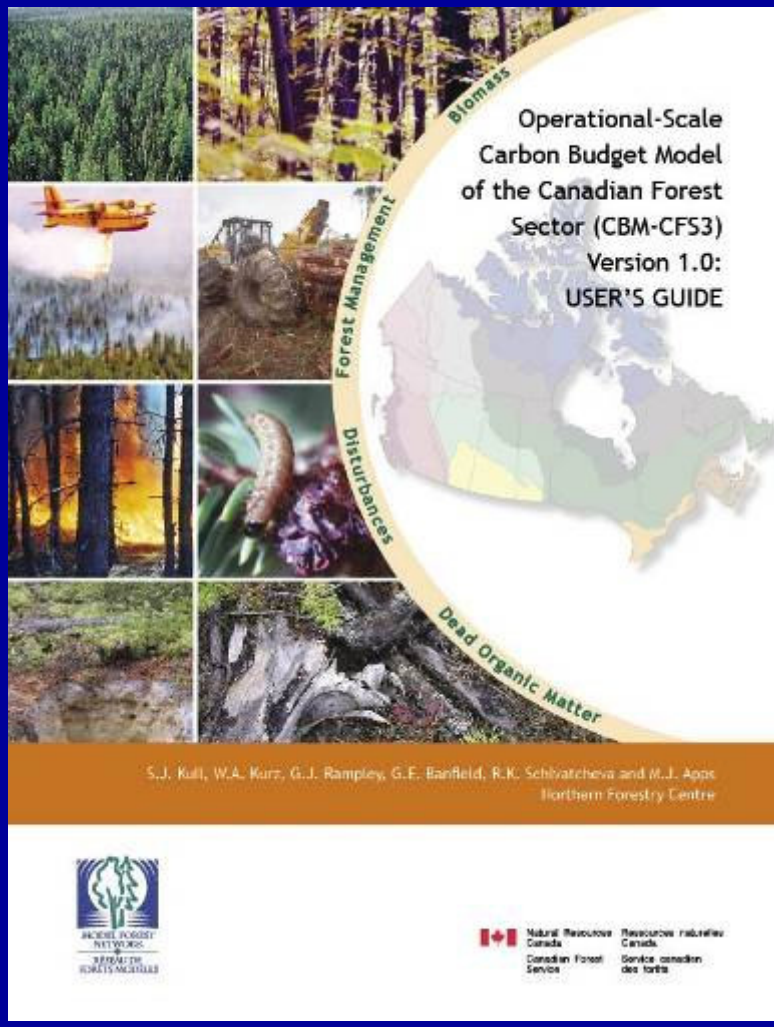
- An operational-scale model of forest C dynamics at stand and landscape scale.
- Allows forest managers to assess carbon implications of forest management: increase sinks, reduce sources

- Builds on ~20 years of CFS Science
- Kurz et al. 2009, Ecological Modelling
- Available at: carbon.cfs.nrcan.gc.ca

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

- CBM-CFS3 Toolbox includes
  - Software and databases
  - User's Guide and Tutorials
- Over 500 downloads / 38 countries
- 8 Training Workshops
  - ~200 Trainees
  - 28 countries

- Liaison Officer for support:
  Stephen.Kull@nrcan.gc.ca



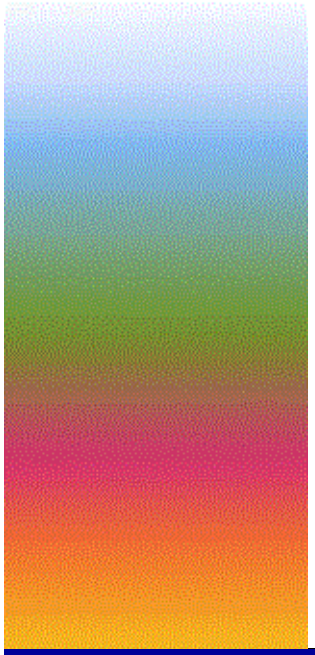
Model is compliant with IPCC GPG

WMO

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

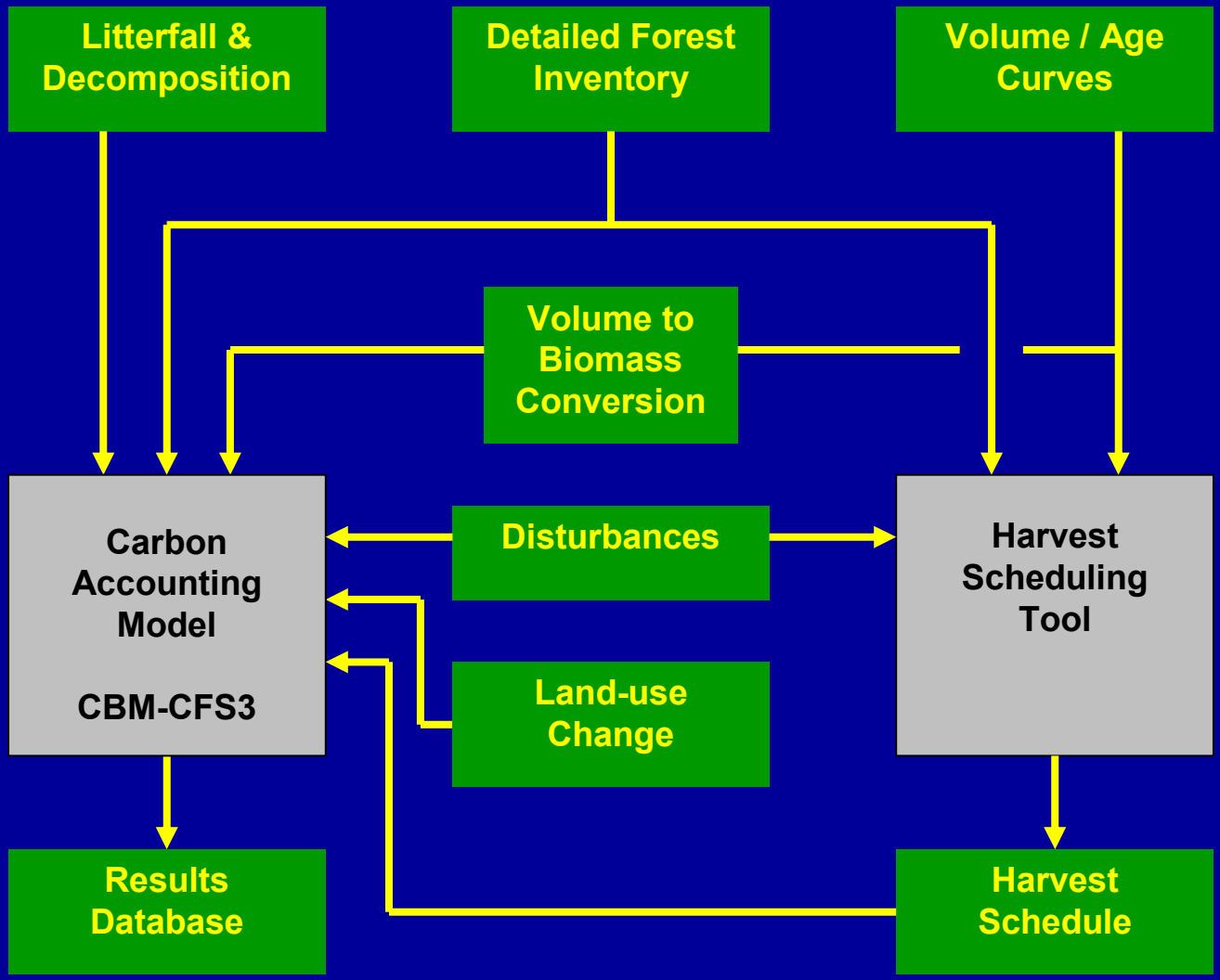
NATIONAL GREENHOUSE GAS INVENTORIES PROGRAMME

UNEP



Good Practice Guidance for Land use, Land-use Change and Forestry

CBM-CFS3 builds on Forest Planning Information



Kurz et al. 2002, Forestry Chronicle

CBM-CFS3 Input Data Requirements

Must Have

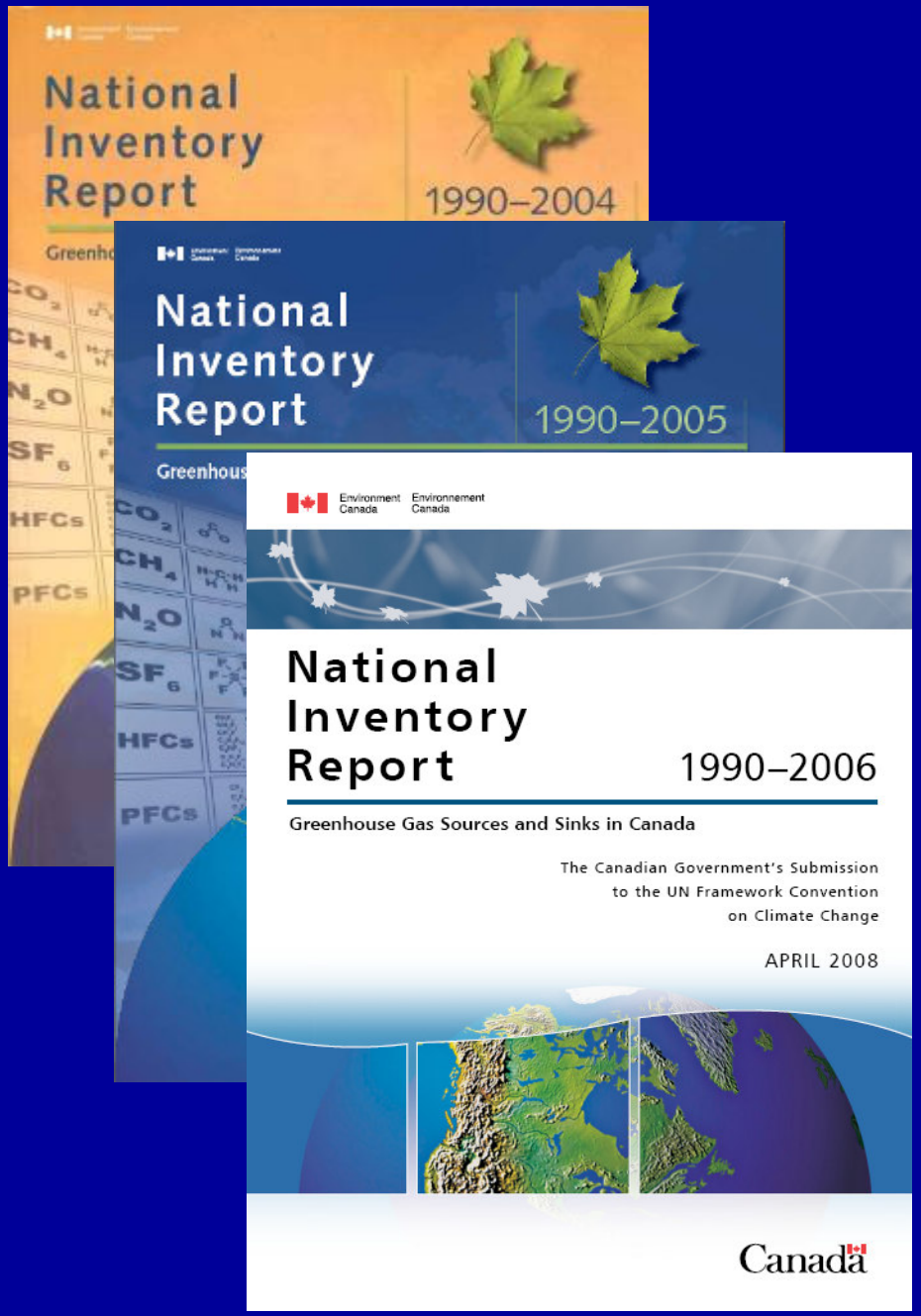
- Forest inventory – area by growth type and age
- Merchantable volume over age curves for all growth types
- Transition rules for growth curves

Optional Input or User-specified Assumptions

- Schedule of harvests and other management activities
- Natural disturbance data
- Land-use change (Afforestation, Deforestation)

Provided with CBM-CFS3 (can be changed by user)

- Volume to biomass conversion parameters
- Ecological parameters



Canada's National Forest Carbon Monitoring, Accounting and Reporting System (NFCMARS)

Estimation of greenhouse gas emissions and removals and reporting to EC for National GHG Inventory Reporting.

Use Model to Estimate Project Benefit

- **Stand- or landscape-level Simulations**
  - Forward-looking business-as-usual projection
  - Actual with project implementation
- Provides estimates of C-stock changes and non-CO_2 GHG emission (in case of fire or slashburning, but not N-fertilization).
- Provides estimates of C-transfer to HWP
- Reduces monitoring costs by providing ecological parameters such as volume to biomass and C conversion.
- Standardizes approach for forest C accounting

Use Model to Estimate Project Benefit

- Constraints - No account of:
  - Non-forest vegetation and carbon dynamics in afforestation baseline (e.g. if cropland or fallow).
  - energy use in Forest Management
  - Upstream energy requirements (e.g. fertilizer)
  - Downstream fate of material removed from site for HWP or bioenergy.
- For application in project-level accounting, additional sources of information for GHG impacts outside the forest will be required.

Conclusions

- Measurement and monitoring in forest projects can build on expertise in forest mensuration and ecological monitoring.
- Techniques exist (not cheap!) to estimate ecosystem or forest sector C stock changes – challenging with non-CO_2
- Project-level accounting requires estimates of actual and estimates of “baseline”.
- Baseline uncertainty often larger than uncertainty of actual.
- Large uncertainties also for leakage.
- Models (e.g.CBM-CFS3) reduce project costs by providing framework for measurement, monitoring and analyses.

Conclusions

- Mitigation opportunities – i.e. reducing sources and increasing sinks relative to a baseline – in both forest management and the forest product sector are available.
- Research is ongoing to assess mitigation options:
  - carbon (and non-CO_2) cost and benefits,
  - costs and barriers to implementation,
  - magnitude of their potential contribution, and
  - risks / probability of success.
- A sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit (IPCC AR4, Nabuurs et al. 2007).

Conclusions

- Forests and forestry cannot solve the problem of fossil C emissions, but they can contribute to the solution.

Thank you very much!

http://carbon.cfs.nrcan.gc.ca
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