Integrated Modelling and Assessment of North American Forest Carbon Dynamics and Climate Change Mitigation Options

Project goals are to:

① Develop science-based decision support models, data and tools.

② Improve the capacity to inform estimates of forest greenhouse gas (GHG) balances using newly available time series of land-cover change and disturbance information.

③ Pilot models and tools for use at local, regional and national scale to refine forest carbon budgets in selected landscapes across North America.

④ Contribute data and information to support Mexico's development of a monitoring, reporting and verification (MRV) system.

⑤ Support the generation of North American land cover data by the North American Land Change Monitoring System (NALCMS) experts group at a spatial resolution of 250 m and 30 m.

⑥ Cultivate a network of government experts, academics and policy makers to work on forest carbon dynamics.

A longer-term goal is to help identify the most effective approaches in each country to achieve climate change mitigation and adaptation objectives in the forestry sector.

Key Results

- Development and dissemination of continental and site-specific land cover and land cover change products for 2005-2010.
- Refinement and application of empirical models (CBM-CFS3) in selected forest areas in each country and the comparison and application of process models (Forest-DNDC and Biome-BGC) in these same areas.
- Evaluation of the impacts on GHG emission estimates from different time series of activity data (fires, hurricanes and land-use conversion)

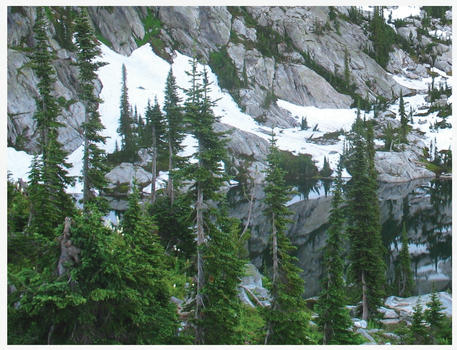

Photo: Mike Hayes

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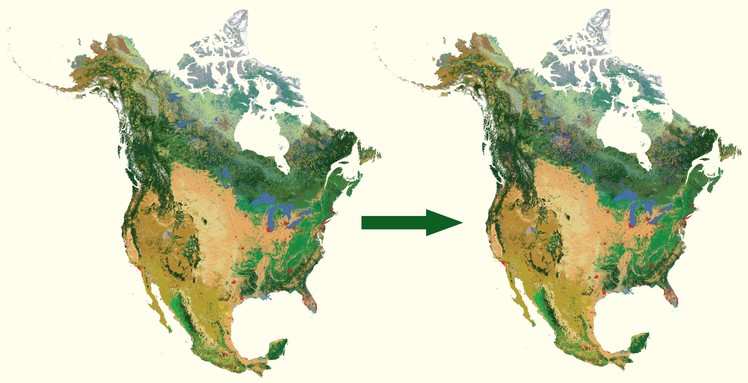
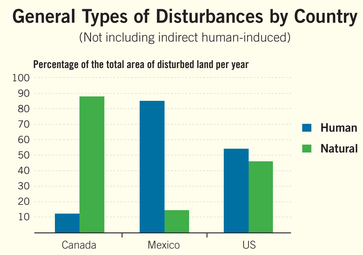
Since 2011, experts from **Canada**, **Mexico** and the **United States** have been working together to develop and pilot tools for estimating forest carbon dynamics to inform climate change policy in North America. This is being done with support from the Commission for Environmental Cooperation (CEC), and in collaboration with the Canadian Forest Service, US Forest Service, USAID, CONAFOR, CONABIO, Mexico-Norway Project Reinforcing REDD+ and South-South Collaboration, Colegio de Postgraduados and SilvaCarbon.

Lessons Learned



Land Cover Change

- **There is a need for consistent continental land cover information that transcends national boundaries, and this should be pre-processed and classified using the same algorithm and classification scheme**. However, each country or region can then use different land cover change methods to suit local conditions while retaining the product consistency at the continental level. This is important because a single continental algorithm is unlikely to capture the details discerned on a national or regional scale.
- **The spatial resolution of input remote sensing data influences the amount of changes discernible (e.g. MODIS 250 m resolution vs. Landsat 30 m).** But, this must be traded-off with the frequency of data (i.e., daily image acquisition) and the probability for cloud-free observations at various stages of ecosystem changes.
- **Comprehensive land cover change data and the ability to attribute land cover changes improve estimates of GHG emissions for forests.** Land cover change data at finer spatial and temporal resolution reduce uncertainty of emission estimates.

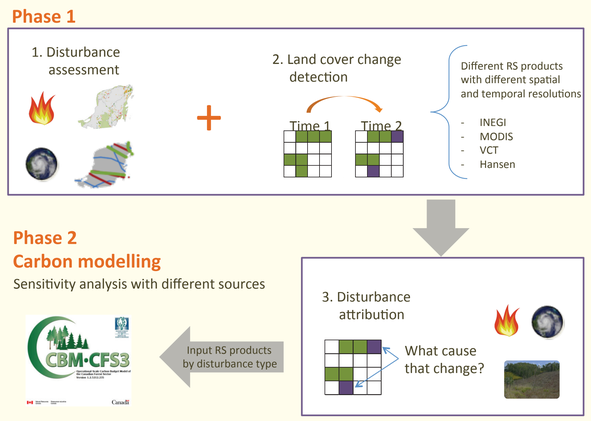


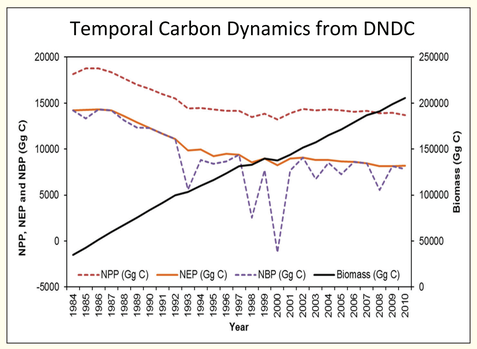
Empirical models

- **Sophisticated disturbance datasets reduce model uncertainty.** Using highly-specific data on the characteristics of stands affected by each disturbance type and year – ideally, identifying the individual stands that were affected – reduces uncertainty in estimates of forest carbon budgets.
- **Improving the efficiency of data processing allows for the use of large raster datasets at high spatial resolutions (e.g., 30 m).** As high-resolution spatially-explicit data become available, using them effectively requires "bridging the gap" between the remote sensing science and carbon modeling by developing flexible computational tools that can use a wide range of remote sensing disturbance products.

Process Models

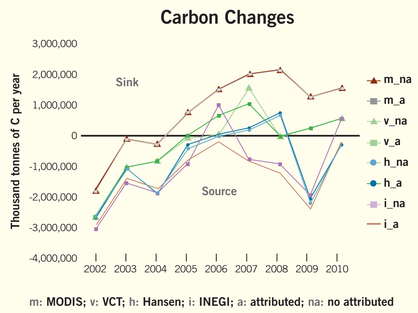
- **Different process models produce similar results for estimating carbon stocks in different forests**. However, models such as Forest-DNDC require good input data that have been vetted by a multidisciplinary team with a good understanding of hydrology, climate, geology, and forestry and running the models requires a significant amount of time.
- **Modelling carbon loss due to different disturbances (e.g., hurricanes, fires, thinning) versus land conversion requires associated data about impacts on different carbon pools.** For example, land conversion may have a much larger impact on soil carbon than other disturbance types.
- **Modelling the impacts of climate variability and change on carbon sequestration shows that carbon stocks are sensitive to warming.** However, good results require accurate precipitation, temperature, and phenology data coupled with understanding of vegetation responses to climate.





Activity Data

- **Finer spatial resolution of remote sensing products (e.g., Landsat-based products) resulted in more accurate detection of forest disturbances compared with coarser resolution products (e.g., MODIS-derived products).** Results suggest that increased spatial resolution should be a high priority when deriving activity data for carbon modeling.
- **Activity data acquired on an annual basis were necessary for the accurate simulation of carbon dynamics and quantification of subsequent carbon emissions and removals following disturbance.** Results showed that even missing a single year in the land-cover observations can lead to substantial errors; especially in ecosystems with rapid-regrowth forests.
- **Identifying the disturbance type causing land-cover change is essential to accurately quantify its impact on forest-carbon dynamics.** Field data and other auxiliary information (e.g. path of hurricanes) can assist in assigning disturbance type to remotely sensed data on land cover change.



Both Types of Models

- **Empirical and process-based carbon dynamics models can yield different estimates of forest carbon budgets for the same site when the same core datasets are used.** Without independent validation data (e.g., measurements of carbon stocks and fluxes from intensive monitoring in the field) there are no clear ways to assess their relative accuracies, however more work on this is underway.

Next Steps

- **Application of tools in support of regional assessment of forest sector climate change mitigation potential.** Analyses are planned that will identify and evaluate options to reduce carbon emissions and increase sinks.
- **Collaboration with the CEC's "Blue Carbon" projects to evaluate contribution of terrestrial carbon to aquatic carbon dynamics.**

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