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# DEVELOPMENT AND USE OF AN EXTENSIVE REGIONAL DATABASE FOR ECOLOGICAL RESEARCH, INVENTORY, AND MONITORING

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## A New Research Project

A new PNW research project entitled "MODELING THE EFFECT OF LAND USE AND CLIMATE CHANGE ON CARBON STORAGE IN THE FORESTS OF THE PACIFIC NORTHWEST" has been funded by NASA. The purpose of the study is to quantify the direction and magnitude of carbon flux in the Pacific Northwest region (Figure 1) associated with conversion of old-growth forests to young forests during the last two decades, and to predict changes in flux over the next two hundred years in response to different climate scenarios. This project is important because it has significant implications for management of the region's forests, which are a major terrestrial carbon pool; more specifically, the trade-offs between land use change and climate change. The project has a duration of three year, a budget of $400,000, and will involve the development of a GIS to link LANDSAT satellite data, a stand-level forest carbon model, a climate simulation model, and digital elevation model (DEM) data. Primary personnel working on the project include the PI, Warren Cohen (PNW), and co-PIs, Mark Harmon, David Wallin, Phil Sollins, and Bill Ferrell (Oregon State University). The information provided in this short paper is to inform interested parties about this new research project and to stimulate related research ideas that could use the extensive regional database that will be developed.

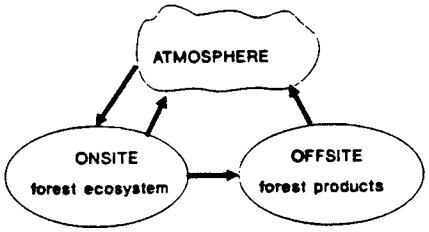
## Models for Carbon Flux Determination

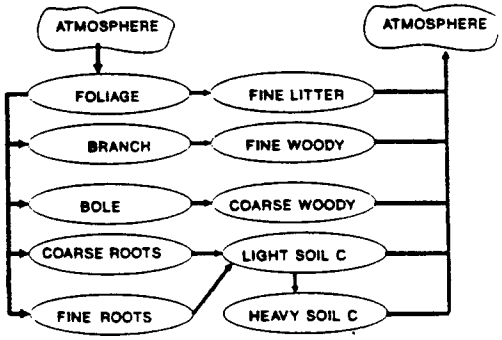
Our stand-level forest carbon model, Disturbed Forest Carbon (DFC), has two basic modules: ONSITE and OFFSITE (Figure 2). ONSITE tracks carbon stored by a forest stand in separate carbon pools, as a function of time since major disturbance, or stand age. Major inputs required to run ONSITE are mean temperature and precipitation. OFFSITE deals with disposition of trees after harvest, taking into account breakage, the various products made from tree boles, and their rates of decay and destruction.

Extrapolation of DFC to a regional scale involves four separate steps (Figure 3). First, ONSITE will be run for a variety of temperature and precipitation scenarios to create carbon storage look-up tables (LUT). Second, a stand age map will be created for a given year from the satellite imagery. Next, a climate simulation model will be used to develop regional temperature and precipitation maps from the DEM data. Finally, the first three steps will be combined to create carbon storage maps for the given year. To accomplish the latter step, temperature and precipitation for each stand (from the respective temperature and precipitation maps) will dictate which carbon storage LUT to use, and stand age (from the appropriate age map) will dictate where in the LUT to find the amount of carbon storage for each living

☐ Proposed Study Area

Figure 1. Study area for the proposed research. This study will focus on the forested portions of western Oregon and Washington. Forests to the east of the Cascades will not be included.



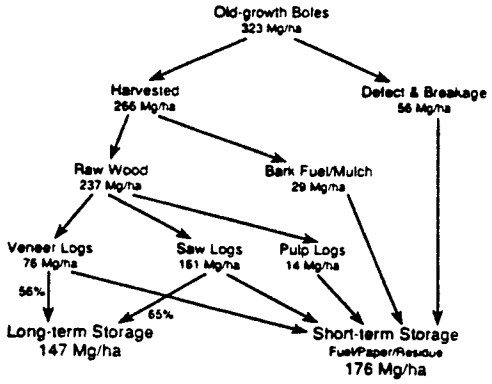




Figure 2. Top left) Overall structure of the Disturbed Forest Carbon Model (DFC). Top right) Structure of the ONSITE module. Bottom) Structure of the OFFSITE module with hypothetical quantities of carbon shown.

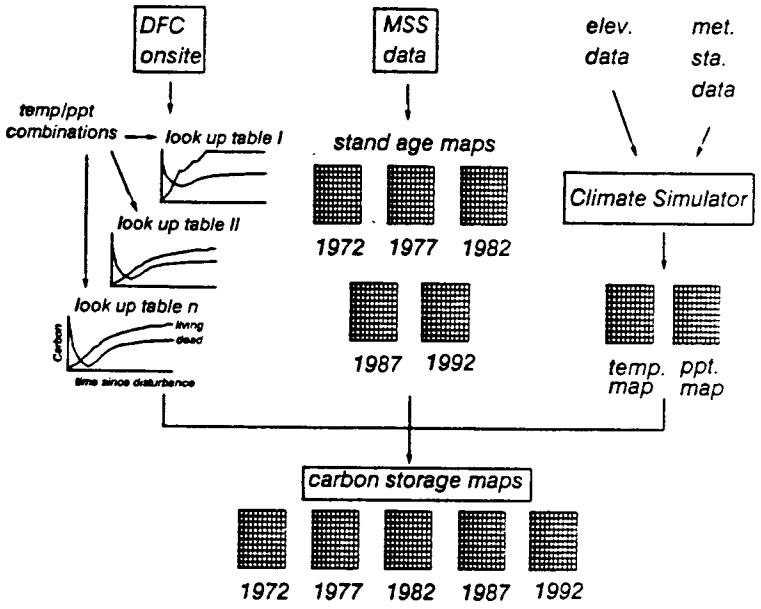



Figure 3. Conceptual framework for generating regional carbon storage maps.

and detrital pool of each stand. One carbon storage map will be constructed for each pool, and a total carbon storage map will be created by summing the individual pool maps. Use of the LANDSAT Multispectral Scanner (MSS) data archive will permit creation of carbon storage maps from 1972 to present. The plan is to create these maps at five year intervals up to 1992.

To derive the total carbon storage onsite in the region for a given year we will sum the carbon storage in all cells of the appropriate carbon storage map (Figure 4). Subsequently, a temporal carbon storage profile for the entire region will be created. When a given stand age map detects that a stand has been harvested, the merchantable portion of the above ground carbon is exported from the landscape to the OFFSITE module. Merchantable carbon harvested (MCH) then is partitioned into various long-term and short-term storage pools within OFFSITE. Carbon in each of these pools decomposes at different rates. OFFSITE can then be used to create the temporal profile of carbon stores offsite by combining decomposition offsite and inputs of MCH. The temporal profile of regional carbon exchange between the forest and the atmosphere can then be computed by combining the carbon stores on the landscape with the carbon stores offsite.

## The Regional Database

This study will provide for the development of a very extensive database for much of the forested area of Washington and Oregon. The database will include LANDSAT MSS images, topographic data (DEM), and temperature and precipitation "drapes" for at least two-thirds of the western portions of

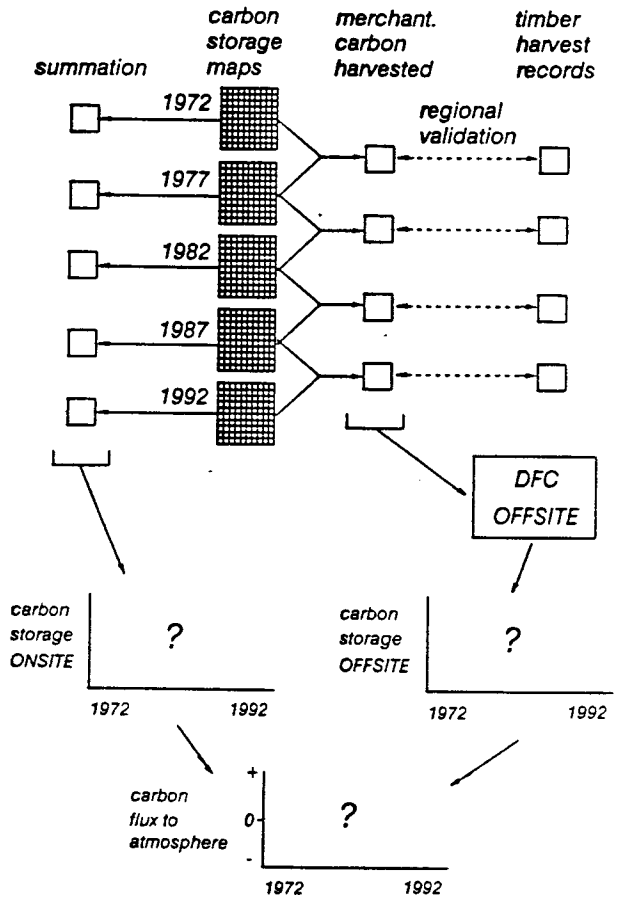



Figure 4. Conceptual framework for generating carbon flux profiles and regional validation of merchantable carbon harvested.

Washington and Oregon, all in a digital format. The satellite images will exist for the whole study area for each of five different time periods from 1972 to 1992.

To validate the various models used in this study, a variety of ground data sets will be incorporated. Much of this will be plot- and stand-level data for forest stands that can be located on aerial photographs, and then subsequently in the satellite images. Data from nearly 300 meteorological stations around the region are available and will be incorporated in the database. To verify the estimates of MCH we will compare the actual volume of logs harvested to that predicted by DFC (Figure 4). These data are available by land ownership (i.e., federal, private, state) for counties in which harvest statistics are reported. We also will gather timber volume statistics to test if our estimates of living carbon stores are correct.

## Opportunities for Collaboration

Existence of the extensive database permits numerous landscape to regional scale research opportunities. Since most of the cost of database development is covered through the NASA grant, costs of using the database for purposes outside the context of the carbon study are essentially limited to data processing, enhancements to the database, and any related travel and supplies. For selected areas in the region other types of satellite images also will be a part of the database, including LANDSAT Thematic Mapper (TM), AVHRR, and SPOT High Resolution Visible (HRV). Addition of satellite images for specific areas outside the core area of study can be added to the database simply by purchasing the images. MSS data two years or older cost only $200 per 34,000 $km^2$ of ground coverage. This means MSS coverage of areas in eastern Washington and Oregon not already in the database could be purchased for about $3,000 per year of coverage, if the data are at least two years old. For data less than two years the cost is approximately $15,000.

Possible research projects that could make use of the database are numerous. A few of these are listed below.

* Monitoring; e.g., evaluate remote sensing as a monitoring tool for change detection.

* Forest health monitoring; e.g., wildfire fire hazard monitoring and patterns and dynamics of pest outbreaks.

* Biodiversity; e.g.,effects of forestry practices on amounts and patterns of various habitats.

* Inventory; e.g., develop a unified private and Federal database.

* Climate change; e.g., detailed analysis of carbon flux from specific landscapes.

* Spotted owls and conservation areas; e.g., quantify pattern and dynamics of conservation areas.

* Riparian zones; e.g., monitor changes in buffer strips.