Progress Report 1999

Land Cover-Land Use Change Program (LCLUC-0018)

Modeling carbon dynamics and their economic implications in two forest regions: Pacific Northwestern USA and Northwestern Russia.

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General Progress

Our general progress has remained excellent over the last year. The overall strategy outlined in our proposal is still working, although whenever we can improve a method or make it more efficient we take the opportunity. We foresee no major problems ahead and anticipate making more excellent progress as we bring the project to completion in the upcoming year. Below we outline the progress in the last year by specific areas.

Remote Sensing

Western Oregon Land Cover Mapping. We have finished the TM-based mapping of land cover in western Oregon. This database is now available via the WWW at http://www.fsl.orst.edu/larse/wov/88wov.html. A combination of unsupervised classification and GIS mapping was used to develop a first level classification of the study area. Pixels within the forest class were then modeled in a continuous fashion to produce estimates of the following vegetation attributes: 1) percent green vegetation cover, 2) percent conifer cover, 3) visible crown diameter of conifers (in areas with 70-100% conifer cover), and 4) conifer age (also in areas with 70-100% conifer cover). The predictive equations were developed using regression techniques with air photo or ground survey data serving as a reference. The problem of differing radiometric properties between scenes was ameliorated by using an applied normalization process. For any given vegetation attribute, the predicted values from a source scene were used to "train" the spectra of an adjacent destination scene. This resulted in a new predictive model with slope and intercept parameters adjusted to calibrate the destination scene predictions. A manuscript entitled “Modeling forest cover attributes as continuous variables in a regional context with Thematic Mapper data” that documents the approach and results has been submitted by Cohen, Maiersperger, and Oetter to the International Journal of Remote Sensing.

Western Oregon Disturbance Mapping. Earlier work produced a stand replacement disturbance map for the periods 1972-77, 1977-84, 1984-88, and 1988-91 for western Oregon. Using the same techniques (Cohen et al., 1998), we have completed adding the 1991-1995 period to the disturbance map. This database is also now available

via the WWW at http://www.fsl.orst.edu/larse/wov/88wov.html. The map indicates the different locations of disturbances (fires are in the south) as well as the pattern of land ownership (clustered harvest on private and State lands versus diffuse cutting on Federal lands). Additionally, a new accuracy assessment for the map and a manuscript have been completed.

Western Washington. We have started work on the western Washington portion of the remote sensing. We will accelerate this work once we complete the analysis of the Russian data.

Northwestern Russia Forest inventory polygons acquired for Russia were used as ground reference for a land cover classification similar to that used in western Oregon. We are nearing completion of this task for the Russian portion of our project. Once this is completed we will begin work on the disturbance mapping.

Rates of Succession. Drs. Cohen and Harmon are co-major advisors to a Ph.D. student (Yang Zhiqiang) who is examining the extent and causes of variations in the rates of succession in the Pacific Northwest. This subproject is concentrating on the Willamette basin and the Oregon Coast Range. Photointerpretation is being used to estimate the cover of major cover types (e.g., shrubs, hardwoods, and conifers) and the rate of change over the last 50 years. Sites were selected by using a DEM to find candidate sites that represented all combinations of slope steepness and aspect. Mr. Yang is also developing a method to determine the extent of several succession types using the 1988 TM land cover datasets and the year the forests were harvested. This should allow him to correlate the occurrence of sites with slow conifer rates of regeneration with physical features and site treatment.

Carbon Modeling.

Stand Level Modeling. We are nearing the first revision of the STANDCARB model. This includes a number of new silvicultural treatments (selective cutting of species, herbiciding, timber salvage). We plan to post the documentation for this model on the WWW. As a prototyping exercise we placed the documentation for the first version of the model on the WWW in the last year (http://www.fsl.orst.edu/lter/pubs/modelsfr.htm). In cooperation with a graduate student, Michele Pruyn, we will be performing sensitivity analysis on the second version of the STANDCARB model. Results from the model will be presented at the upcoming symposium on Carbon Sequestration in Boreal Forests to be held in Edmonton, Alberta.

Forest Products Modeling. We are in the midst of revising the forest products model (FORPROD) as well. The original version was tied to a specific modeling software (Time0). We are now reprogramming the model into C++ so that it can be ported more easily. We plan to put the documentation of the model on the WWW as

well as making the model available at this website. In addition to the reprogramming we will be adding in engineered wood products (e.g., laminated beams) and an ability to track several manufacturing streams representing different regions. Thus we will be able to track the fate of harvested logs that are exported to a region that has a manufacturing process that differs from the source region.

Potential Maximum Carbon Stores. Warren Cohen and Mark Harmon are co-major professors for a PhD student (Erica Hoffa) who is examining how to predict the maximum carbon stores as a function of climate, soils, producer species, and disturbance regime. At this point we have started programming model in C++ and have completed the effects of climate, soils, and producer species. In addition we have developed a method to include the effects of disturbances at the landscape level. Preliminary results are being presented at the 1999 AGU meeting in San Francisco. The latter result is quite exciting because it suggests a way that carbon dynamics at the regional level could be simplified. We summarized existing data on maximum carbon stores in the Pacific Northwest and presented the preliminary findings at the 1999 Ecological Society of America meeting. These data will be used to corroborate the predictions of the maximum carbon stores model.

Soil Stores of Carbon. The use of soil spatial databases in this project to provide information about soil carbon and soil water holding capacity is contingent upon the validity of the data bases. We compared the State Soil Geographic Data Base (Statsgo) for western Oregon with soil pit data. Soil C was consistent between individual Statsgo map units and NRCS soil pits within those map units, but there was less agreement with soil pits data from other sources. Lack of perfect agreement indicates uncertainty in the distribution of soil properties across the region, but the general consistency among approaches suggests that Statsgo is an adequate source of soil spatial information for this project. We are continuing to test the validity of Statsgo by assessing western Washington. More than 200 soil pits have been identified within western Washington to extend the comparison. Washington and Oregon Statsgo layers have been merged to allow unified representation of entire Pacific Northwest study area.

The relation of soil C and N to site variables has been extended beyond the western Oregon analysis presented by Homann et al. (1995). Previous research demonstrates that relations of soil C and N to climate and soil texture differ among regions. However, these studies have been carried out by different groups of researchers, using varied methods and data sources. Therefore, it remains unclear whether the differences observed among regions are due to actual differences in environmental processes or differences in researcher methodology. Data for 3093 soil pits within the continental United States were extracted from the Natural Resources Conservation Service's Soil Survey Laboratory Characterization Data on CD-ROM (September 1997 version). These soil pits met the following criteria: (i) a

location specified in latitude and longitude or public land survey system (PLSS) coordinates, (ii) organic C percentages and rock content specified for the top mineral horizon, and (iii) data measurements encompassing at least 80% of the top 20 cm, for all variables. We calculated soil organic C and N, and sand, silt, and clay contents to a 20 cm depth, which facilitates comparison to similar studies. We obtained climate variables and ecoregion assignments from GIS layers, and grouped soil pits into seven geographic regions. Using multiple regression we analyzed the relations of soil organic C and N to annual precipitation, annual temperature, evapotranspiration, and contents of sand, silt, and clay. We quantified relationships for the entire continent and for each of the seven regions. The relations of soil C and N to site variables differ both qualitatively and quantitatively among the regions, indicating generalizations about soil response to climatic and land use changes are not valid.

Economic Analysis

Joe Kerkvliet is major professor for a Masters student, Olga Zyrina, who is examining the economic implications of various carbon sequestration methods. The STANDCARB model is being used to generate carbon stores for a wide range of silvicultural treatments. This data will be used in combination with the monetary value of certain types of wood and the cost of various silvicultural treatments to identify the treatments that are most cost effective. Simulation experiments are about to start now that the model has been calibrated to the Oregon forest conditions. Similar economic data has been gathered for forests of northwest Russia by Dr. Sergi Gresnov. This will allow us to perform a similar analysis for Russia once the Oregon analysis has been completed.

Russian Collaboration

In June of 1998 Mark Harmon and Olga Krankina met with the Russian collaborators in St. Petersburg. Our interactions with the rest of our Russian colleagues mostly involved the continued development of book chapters describing the climate, forests, soils, peatlands, and forest products of the St. Petersburg region.

Symposium/Workshop Plans

We feel we have made very important progress over the course of this project in the Pacific Northwest and in Russia. Parallel analyses are nearing completion at both locations. We feel there is sufficient material to synthesize into a book that compares the carbon dynamics of both regions. We are hoping to secure funding from NASA and/or NSF-International Programs to host a workshop in Corvallis. This workshop will be crucial to concluding the first phase of this collaborative effort.

References

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Papers

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Cohen, W.B. M. Fiorella, D.R. Oetter, and T.K. Maiersperger. 1999. Characterizing stand replacement disturbance in western Oregon forests using historic Landsat data, presented at the *ASPRS Annual Conference*, 17-21 May, Oregon Convention Center, Portland, OR.

Cohen, W.B. 1999. Spatial modeling of carbon flux in the Pacific Northwest, USA, presented at the *95th Association of American Geographers Annual Meeting*, 23-27 March, Honolulu, HI. (Abstract published)

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Yang, Z., W.B. Cohen, and M. E. Harmon. 1999. Spatial modeling of early secondary forest succession in western Oregon, poster presented at the *Second Annual H.J. Andrews LTER Symposium*, 18 February, LaSells Stewart Center, Corvallis, OR.