LCLUC Abstract

The Role of Land-Cover Change in High Latitude Ecosystems: Implications for the Global Carbon Cycle

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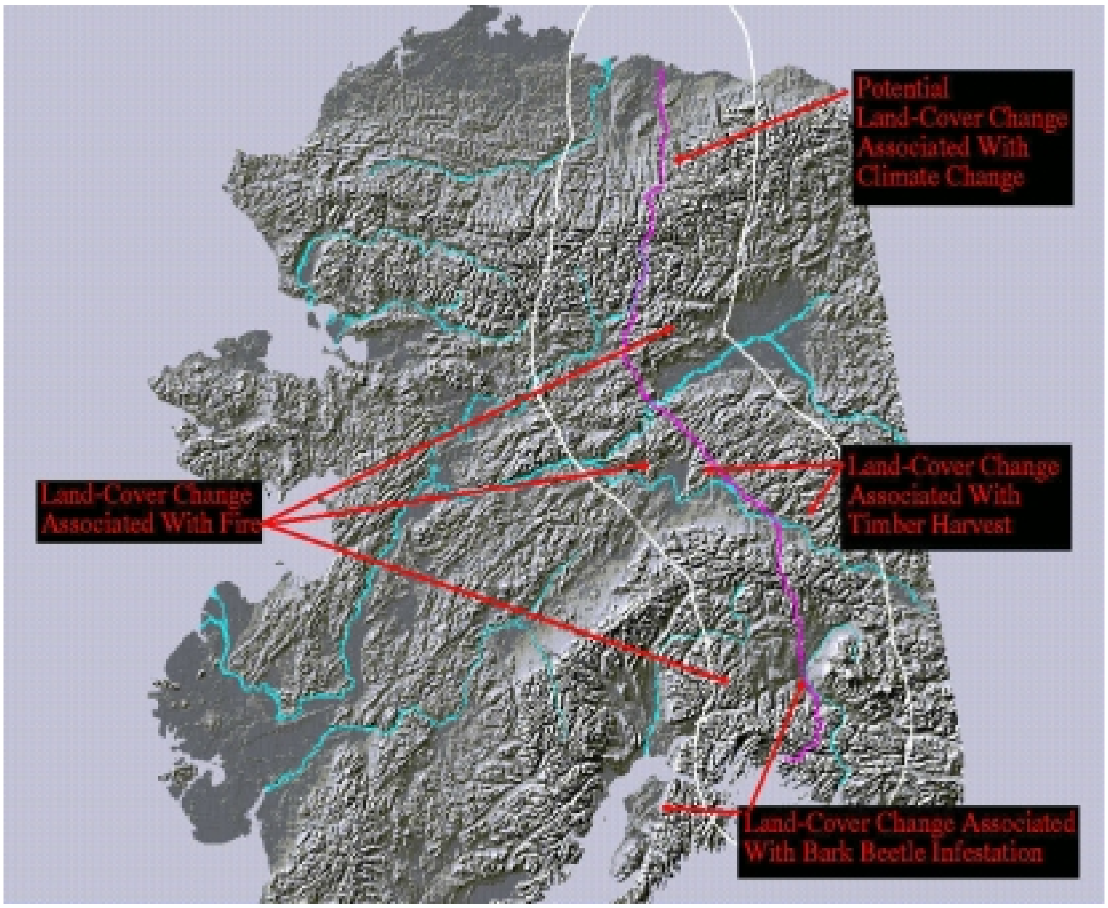

The land cover of northern boreal regions is likely to change substantially during the next century because of disturbances related to climate change, fire, logging, and insects. Changes in land cover of high latitude regions may potentially affect the earth's climate system by influencing the global carbon cycle. We propose a study focused on Alaska to develop a prototype spatially explicit modeling framework capable of using satellite-derived data to estimate how changes in land cover cause changes in ecosystem carbon storage at high latitudes.

Our strategy for this study involves four tasks:

1. development of spatially explicit contemporary land-cover data sets in Alaska
2. development of transient spatially explicit land-cover data sets for the historical satellite record in Alaska
3. development of a successional biogeochemical model
4. application of the modeling framework for estimating the consequences of land-cover change on terrestrial metabolism in retrospective, contemporary, and prognostic analyses.

The development of spatially explicit contemporary land-cover data sets is important for identifying vegetation types relevant to the biogeochemical model and for identifying vegetation that is recovering from specific disturbances. Some of the vegetation types in Alaska that are relevant to the successional biogeochemical model include tussock tundra, shrub tundra, alpine tundra, non-forested boreal wetland, lowland boreal conifer forest (black spruce/Siberian larch), upland boreal conifer forest (white spruce), coastal conifer forest (Sitka spruce/western hemlock), upland deciduous forest (aspen), and grassland/steppe. Additionally, we will to identify vegetation types that are recovering from fire, insect, and logging disturbances. We will focus the development of the contemporary land-cover data set along the Alyeska Pipeline corridor where the timing and spatial extent of disturbances from fire, logging, and insect infestation are well documented. At least three types of remotely-sensed imagery (TM, ERS1, AVHRR) will be used in developing the contemporary land-cover data sets. The development of transient land-cover data sets is important for identifying the timing of disturbances from fire, logging, and insects for the successional biogeochemical model. We will use Landsat MSS scenes along the transect to develop a data set of land- cover from the 1970s. The successional biogeochemical model, which will be based on a transient version of the Terrestrial Ecosystem Model (TEM), will be designed so that it can operate in either a diagnostic or prognostic mode. In the diagnostic mode the model will use the timing of disturbance identified in the transient land-cover data sets to begin modeling ecosystem recovery from disturbance. Retrospective analyses with the diagnostic mode of the model are necessary for testing the dynamics of ecosystem recovery in the model. This testing will be important for establishing confidence in applying the prognostic mode of the model, which will predict simultaneous responses of land-cover and ecosystem function to global change. The prognostic mode of the model will consider land-cover change driven by ecological process and land-cover change driven by human land use. The development of a capability to predict the pattern of ecological land-cover change will build on an ongoing collaboration that is using TEM to develop a dynamic ecosystem/vegetation model. We will work with the agencies and organizations planning future land-use in Arctic and interior Alaska to develop spatially and temporally explicit land-use scenarios for our modeling efforts.

The proposed research will contribute significantly to the NASA ESE Land-Cover and Land-Use Change Program. First, it will develop new and improved regional data sets on land-cover change in high latitude regions. Second, it will use data from process studies of ecosystem responses to land-cover change in the development of a successional biogeochemistry model. Finally, the linkage of land-cover data with a successional biogeochemistry model will provide a framework for how spatially explicit land-cover change influences carbon storage in high latitudes. The development of this framework complements other development projects with TEM funded by NASA EOS. This research also complements the LTER/NASA MODIS Cross-Site Validation. The proposed research will also contribute significantly to assessments of the role of high latitude ecosystems in stabilizing or destabilizing the atmospheric concentration of CO_2, which may have important social and economic consequences for countries that occupy high latitudes. Thus, the prototype spatially explicit modeling framework developed in this study will help provide scientists and decision-makers with a tool to evaluate the consequences of policy decisions that influence land-cover throughout high latitudes in Russia, Canada, Scandinavia, and Alaska.