LANDIS-II---A Forest Ecosystem Computer Model for Simulating Growth, Succession, and Disturbance Effects

"Institute for Applied Ecosystem Studies: Theory and Application of Scaling Science in Forestry "

A research work unit of the USDA Forest Service Northern Research Station

5985 Hwy K Rhinelander, WI 54501

For more information, contact Eric J. Gustafson

Principal Partners:
Portland State University; University of Wisconsin—Madison;
US Forest Service Northern Research Station; Smithsonian; Green Code LLC

LANDIS-II is a landscape-scale forest ecosystem model for simulating fundamental ecological processes such as forest growth, forest type succession, and various natural and human disturbances (fire, insect outbreaks, drought, and logging). It projects changes in forest composition (proportions of various tree species and their ages), landscape pattern (how the species are located across the landscape), tree biomass (amount of wood), and habitat for wildlife. These projections are made for areas as large as 30 million acres and for time periods from 50 to hundreds of years.

Using LANDIS-II can reduce uncertainty about future forest ecosystem changes under various management and global change scenarios. This helps forest managers and policy-makers evaluate likely outcomes of alternative potential management strategies. LANDIS-II is also an important research tool for testing hypotheses about the relationships between fundamental causal factors (climate, atmospheric chemistry, soil nutrients, and disturbances) and long-term landscape-level forest conditions.

Forest damaged by a severe thunderstorm in July 2012, Chippewa National Forest, Minnesota.

LANDIS-II is open-source---the computer code is freely available on the internet, meaning that other scientists can examine, modify, and enhance LANDIS-II components to make them applicable in other parts of the world or to improve their predictive ability. Thus, the LANDIS model has been tested and used throughout the world, and has produced an ever-increasing collection of process components from which model users can choose.

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How LANDIS-II Works

LANDIS-II represents a landscape as a grid of cells, or pixels. For each cell, the model keeps track of the tree species growing there and the amount of wood (biomass) in each age class for each species. The model is process-based, meaning that each fundamental ecological process is programmed as a separate component that operates independently (addition or subtraction) on the biomass found on cells. Some processes are related to forest growth and development, such as seed dispersal by wind or animals (such as squirrels or birds), seed germination, tree growth and death by old age. Other processes are related to forest destruction caused by wildfire, wind storms, insect outbreaks, drought, logging, deer browsing, etc.

The interactions among all these processes are usually so complex that it is impossible for even experts to predict how they will play out in the distant future on a particular landscape. Because these processes act independently on the biomass in age classes within LANDIS-II, the effects of the interacting processes emerge in the form of the final amount of biomass in the various species across the landscape after all the processes have produced their individual effects. LANDIS-II produces maps of various forest characteristics through time and these can be analyzed to compare the effects of alternative management or global change (air pollution, climate, land use) scenarios on the condition and sustainability of future forests. A large number of future characteristics can be evaluated, such as abundance of each species and age class, amount and type of timber, amount and quality of habitat for various species of wildlife, amount of forest lost to disturbance, and many other characteristics.

Examples of LANDIS-II Applications

LANDIS-II was applied to identify the best of four potential strategies to minimize the landscape-wide risk of wildfire in a fire-prone part of the Chequamegon-Nicolet National Forest that also has many private homes within it.

A prior version of LANDIS was used to predict the effect of nine proposed alternative management strategies for the Chequamegon-Nicolet National Forest on habitat for the American marten, a threatened furbearing species.

LANDIS-II is currently being used on all six Lakes States National Forests to project future forest conditions under alternative climate futures ranging from no change to dramatic change.

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LANDIS-II was used to scale up to landscape scale the results of a site-level field experiment (Aspen-FACE) on the effect of elevated CO_2 and ozone on trees common in the northern forests of the eastern United States.

LANDIS-II was used to study how logging practices and spruce budworm outbreaks interact to determine fire risk in the Boundary Waters region of northern Minnesota and western Ontario. Forest management strategies to reduce forest destruction by spruce budworm in Minnesota were identified.

A new LANDIS-II component was recently developed to simulate the death of trees caused by drought. Studies showed that forest composition in the future can indeed be changed because of droughts occurring now.

Contact Information

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Technical Information on the Internet

LANDIS-II website: http://www.landis-ii.org/

Northern Research Station LANDIS webpage (includes some publications): http://www.nrs.fs.fed.us/tools/landis/