Course reading assigned during

WCS Workshop on Land Change Modeling for REDD

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Hosted by

Clark Labs and the Wildlife Conservation Society

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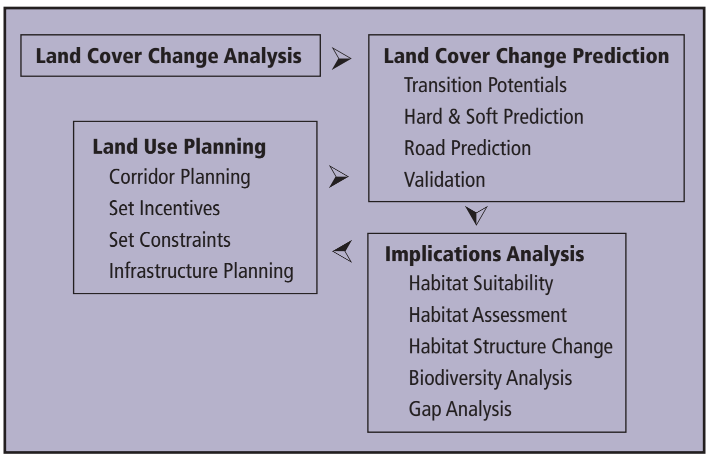
IDRISI Focus Paper

The Land Change Modeler for Ecological Sustainability

The Land Change Modeler (LCM) for Ecological Sustainability is a software solution designed to address the pressing problem of accelerated land conversion and the very specific analytical needs of biodiversity conservation. Integrated within the IDRISI system and also available as an extension to ESRI's ArcGIS, Land Change Modeler provides tools for the assessment and projection of land cover change, and the implications for species habitat and biodiversity.

Clark Labs worked with Conservation International over a period of several years to develop this flexible software environment which can be used for a variety of land change scenarios and contexts.



HOW CHANGE PREDICTION WORKS

In Land Change Modeler, landcover change prediction utilizes two landcover maps from two different dates (time 1 and time 2) to predict what the landcover will be in the future (time 3). Within Land Change Modeler, this is done essentially in two major stages: the transition potential sub-model stage and the change prediction model stage. In the first stage, the user specifies the particular transitions of interest for the sub-model and specifies the variables which drive the type of transition(s) taking place. For example, if we want to determine the potential of new development, we may consider the slope of the terrain, distance to water sources, distance to roads, and distance to previously developed land. In the second stage, the model will predict, for the specified future date, the allocation of landcover change.

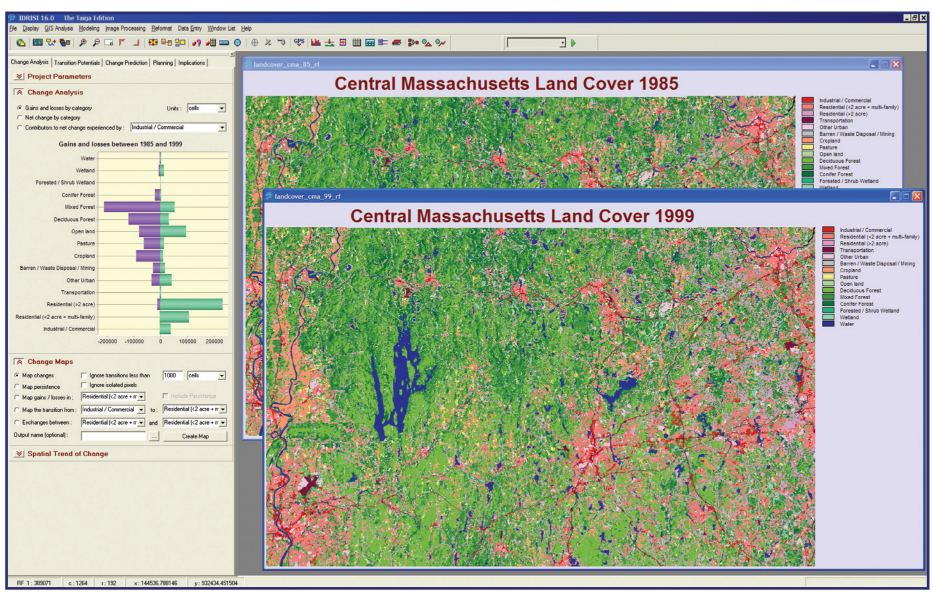
In its simplest form, the model will determine how the variables influence future change, how much change took place between time 1 and time 2, and then calculate a relative amount of transition for time 3.

In order to make the model more robust, Land Change Modeler allows the user to incorporate constraints and incentives, such as zoning maps, and planned changes (dynamic variable calculation) both in infrastructure, such as new roads, and landcover classes, such as new development. Each of these options may be used individually or collectively.

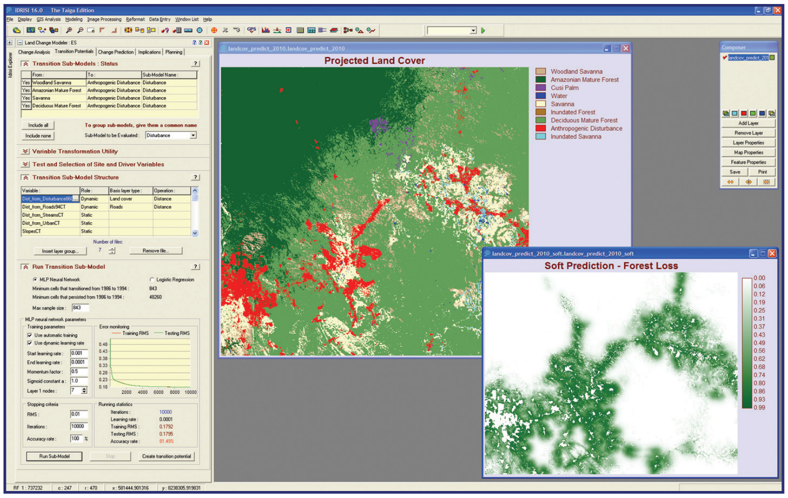
Constraints in development may include protected areas or reserves, where even if there is potential for change, it may be unlikely or prohibited. Conversely, incentives such as tax breaks for development of particular areas, give those areas a greater potential for change. When modeling landcover change, constraints and incentives are not applied until the prediction stage of the modeling process.

ANALYZING CHANGE

A set of tools is included for the rapid assessment of change, allowing for one-click evaluation of gains and losses, net change, persistence and specific transitions both in map and graphical form. In some situations, the amount and nature of change can be very complex. LCM includes a change abstraction tool, based on trend surface analysis, to uncover the underlying trends.



Output from the Change Analysis panel. Using preclassified maps from two dates as input, LCM generates rapid maps of change, persistence, specific transitions and exhanges between categories. Graphs are also produced.



One of the major components of landcover change prediction is modeling transition potential. Once a transition has been selected for modeling, tools are provided for variable transformation and a quick testing of their explanatory potential. Although Logistic Regression is also provided, the primary tool for transition potential modeling is the Multi-Layer Perceptron (MLP) Neural Network (shown here). The MLP has a level of meta-intelligence added that allows it to work in a totally autonomous fashion.

MODELING THE POTENTIAL FOR CHANGE

Change is modeled empirically by using past changes to develop a mathematical model and GIS data layer expression of transition potential. Transitions can be grouped into a set of sub-models and the potential power of explanatory variables can be explored. Variables can be added to the model as either static or dynamic components. Once model variables have been selected, each transition is modeled using either a Multi-Layer Perceptron neural network or Logistic Regression. The result for either model is a potential map for each transition—an expression of time-specific potential for change.

PREDICTING CHANGE

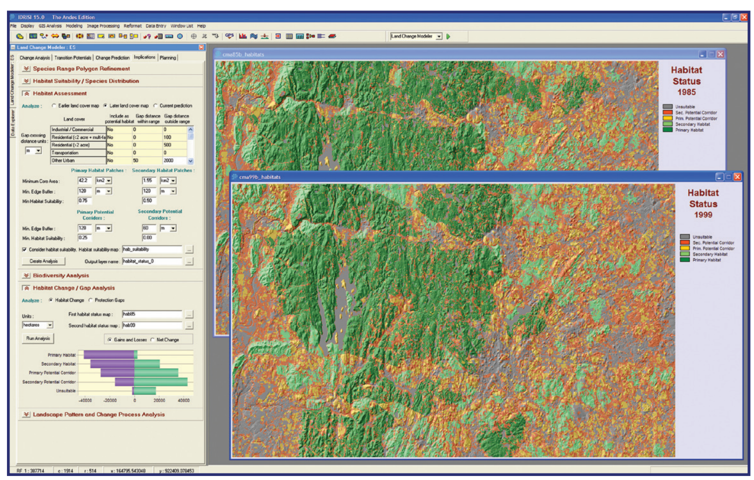
Controls are provided for a dynamic landcover change prediction process. After specifying the end date, the quantity of change in each transition can either be modeled through a Markov Chain analysis or by providing a transition probability matrix from an external (e.g., econometric) model. Two basic models of change are provided. The soft prediction model yields a map of vulnerability to change for the selected set of transitions. The soft prediction model is generally preferred for habitat and biodiversity assessment because it provides a comprehensive assessment of change potential. The hard prediction model is based on a multi-objective land competition model. The hard prediction yields only a single realization out of many possible realizations. Land Change Modeler allows for the input of dynamic variables as well as planning interventions in the change prediction set-up. A validation tool is included to assess the quality of the prediction map in relation to a map of reality (the validation tool is only available in the LCM implementation within IDRISI).

IMPACT ASSESSMENT FOR HABITAT AND BIODIVERSITY

A wide range of tools is provided for assessing the impact of change for ecological sustainability, including species-specific habitat assessment, detection of changes in habitat status and gap analysis by comparison to a map of protection status, landcover pattern and change process analysis, biodiversity assessment, species distribution modeling, and range polygon refinement based on confidence mapping using a cluster analysis of environmental variables.

PLANNING INTERVENTIONS

LCM allows the user to specify planning interventions that may alter the course of development including constraints and incentives, such as proposed reserved areas, infrastructure modifications, such as road developments, and biological corridors. Land Change Modeler also includes an interface to the Marxan reserve system design software, freely available from the University of Queensland (the Marxan interface is only available in the LCM implementation within IDRISI).



LCM's Habitat Assessment panel maps areas into categories of primary and secondary habitat, primary and secondary potential corridor and unsuitable lands based on landcover and habitat suitability along with parameters such as home range size, buffer widths, and gap crossing distances within range and during dispersal.

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