What's New in the Andes Edition

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Overview

The Andes Edition of IDRISI is a major upgrade – one of the most extensive in our 20 year history of cutting edge research and development.

New features for the Andes Edition fall into four primary areas: the Land Change Modeler, Classifiers and Machine Learning, Interface/Display Enhancements and General Analytical Refinements.

The Land Change Modeler for Ecological Sustainability

The Land Change Modeler (LCM) for Ecological Sustainability is an integrated software environment for analyzing land cover change, projecting its course into the future, and assessing its implications for habitat and biodiversity change. Commissioned by the Andes Conservation Biology Center of Conservation International--our inspiration for the *Andes Edition* name--LCM is the first extensive vertical application developed by Clark Labs. (IDRISI is a horizontal application – a software product meant to fulfill many applications. In contrast, a vertical application is directed towards a specific application.) The Land Change Modeler for Ecological Sustainability is oriented to the pressing problem of accelerated land conversion and the very specific analytical needs of biodiversity conservation.

LCM is accessed from the Modeling menu and opens as a special panel attached to the left side of IDRISI's workspace. The panel contains five tabs, each with a set of drop-down panels that are organized around the sequence of tasks involved with:

- Analyzing past land cover change
- Modeling the process of change
- Predicting the course of change into the future
- Assessing the implications of that change for biodiversity and
- Evaluating planning interventions for maintaining ecological sustainability

Analyzing Change

The Change Analysis tab includes a set of tools 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. A change abstraction tool, based on trend surface analysis, evaluates trends up to the 9^{th} order. A filtering tool allows the isolation of significant transitions.

Modeling Change

The Change Modeling tab allows one to group transitions into a set of sub-models and to explore the potential power of explanatory variables. Variables can be added to the model as either static or dynamic components. Static variables are unchanging over time and

express aspects of basic suitability for the transition under consideration. Dynamic variables are time-dependent drivers such as proximity to existing development or infrastructure and are recalculated over time during the course of a prediction.

Once model variables have been selected, each transition is modeled using either Logistic Regression or our Multi-Layer Perceptron (MLP, formerly BPN) neural network, extensively revised to offer an automatic mode requiring no user intervention. After a detailed assessment of empirical modeling tools (such as Weights-of-Evidence, Empirical Probabilities, Empirical Likelihoods, etc.), it was found that these two approaches offer the strongest capabilities, particularly the MLP. The result for either model is a potential map for each transition – an expression of time-specific potential for change.

Predicting Change

The Change Prediction tab provides controls for a dynamic land cover 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 hard prediction model is based on a revised version of the CA_MARKOV module – a cellular automata-like multi-objective land competition model. 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 since it provides a comprehensive assessment of change potential. The hard prediction yields only a single realization.

During set-up of the change prediction analysis, the user can specify the number of dynamic reassessment stages during which dynamic variables are updated. This also includes the optional dynamic growth (intensification) of the road network. At each stage, the system also checks for the presence of planning interventions (see below), including incentives and constraints and major infrastructure improvements.

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. Based on any of the existing or predicted land cover maps and a map of species-specific habitat suitability (see below), the habitat assessment tool develops a map with five categories: primary habitat, secondary habitat, primary potential corridor, secondary potential corridor and unsuitable lands. Important parameters that control this process include the home range size, buffers based on sensitivity to humans and the ability to cross gaps within home ranges and during dispersal. The resulting map can be used to estimate maximum populations (in some instances) and serves as a primary resource when planning for corridors.
- Detection of changes in habitat status and gap analysis by comparison to a map of protection status.
- Land cover pattern and change process analysis. The former assesses the current state of the land covers identified (e.g., fragmentation) while the latter expresses

the character of the process of change. Thus a landscape can be actively fragmenting while it is still largely unfragmented.

- Biodiversity assessment. Using collections of species range polygons (such as those provided by NatureServe), this tool permits the development of maps of alpha diversity (local species richness), gamma diversity (regional richness), beta diversity (local individuality) and species compositional similarity.
- Species distribution modeling. Modeling options are provided for cases with presence data only (Mahalanobis Typicality and Fuzzy Mahalanobis Probabilities), presence/absence data (Logistic Regression, Multi-Layer Perceptron), abundance data (Multiple Regression) and field study data with a specially tailored version of Fuzzy Set Multi-Criteria Evaluation.
- Range polygon refinement based on confidence mapping using a cluster analysis of environmental variables.

Planning

The Planning tab offers an initial set of interventions that will inevitably increase with future versions. The current version offers:

- Incentives and constraints--allows the user to assess the impacts of existing and proposed reserved areas or how tax incentives, for example, might redirect the course of change. These interventions are integrated with the change prediction process.
- Infrastructure modifications—allows the user to specify a set of major infrastructure changes either by indicating the names of existing infrastructure layers and the dates they become effective, or by specifying the end-points and allowing the system to develop the least-cost engineering routes.
- Corridor development--develops biological corridors based on species habitat suitability models, weighted suitability for development, weighted conservation value and protected lands. The underlying procedure is based on a cost distance analysis using frictions developed from a special multi-criteria aggregation of the multiple suitability inputs. Target corridor width and number of branches can also be specified.

The Land Change Modeler introduces a wide range of innovative tools that are new to the fields of GIS and Conservation Biology. Thus we consider it to be experimental and intended as a medium for field evaluation and future enhancement.

Classifiers and Machine Learning

Following on recent releases, Clark Labs continues its major focus on classifier development and we now offer the widest range of classifiers in the industry. Many of these fall into the realm of machine learning and neural networks, making IDRISI the industry leader in cutting-edge classifier approaches. These new additions include:

- Multi-Layer Perceptron. This is a major enhancement of our BPN neural network classifier including an automatic (meta-intelligence) mode, progressive learning

rate modification, two hidden layers and the ability to map all activation layers, including the hidden layers.

- SOM: Kohenon's Self-Organizing Feature Map. This is a neural network classifier that incorporates lateral interaction and the ability to be used in both a supervised and unsupervised mode. Learning Vector Quantization (LVQ) is provided for fine tuning.
- Fuzzy ArtMap. Another neural network that incorporates adaptive resonance. This is a powerful procedure that requires little human interaction and offers both supervised and unsupervised operation.
- Decision Trees -- A true decision tree classifier with a machine learning interface that provides the ability to map any node and to prune either manually or automatically. Both hard and soft classification are provided.
- K-Means. Yes, the familiar K-Means clustering, but now with a true machine learning interface that is unlike anything the industry has ever seen.
- K-Nearest Neighbor – a non-parametric classifier of exceptional simplicity and elegance. Both hard and soft classifications are provided.
- PLUS … all image processing modules now operate on any data type, opening up the possibility of usage for a wide range of applications such as species distribution modeling.

Interface/Display Enhancements

On launching the Andes Edition of IDRISI, major changes are immediately apparent. IDRISI Explorer has been transformed from a file management utility to a major project management tool, and combines the prior facilities of four modules – Explorer, Metadata, Data Paths and Collection Editor. Similar to the Land Change Modeler, Explorer opens as a panel on the left hand side and can be minimized as needed. Along with providing a directory of files, Explorer can be used to create and select projects, perform file maintenance, view and modify layer metadata and create layer collections. Layers can also be displayed by double-clicking them in the list. Further, layers can be dragged and dropped onto the input boxes of IDRISI module dialogs.

Other display and interface enhancements include:

- An enhanced Fly Through module to permit saving and redisplay of flight paths as well as the creation of AVI files.
- A revised Media Viewer to provide total compatibility with AVI. [did I change the meaning here?]
- A new HISTO module with improved graphics and automatic multiple graphing for signature files and raster group files.
- New legend management tools accessed by right clicking any displayed legend. Options include adding or modifying legend entries, calculating the areas of categories and creating Boolean layers for one or all categories.
- Enhanced north arrows allowing use of any EMF format graphic.
- Enhanced grid options including grid ticks.
- The ability to display a map at a specific map scale by changing the RF (representative fraction)

General Analytical Refinements

- All image processing routines have been converted to accept all data types. This permits the processing of higher precision formats and paves the way for the use of classifiers and transformations for a wider range of modeling applications.
- Multinomial Logistic Regression now supports the modeling of multiple category qualitative data as the dependent variable in a regression analysis.
- A new time series analysis tool (TSAFOURIER) performs a Fourier analysis of each pixel over time given a time series file, yielding maps of the amplitude and phase of each harmonic.
- The PCA module has been enhanced to include reverse transformation, a very useful technique for noise removal. Atmospheric noise, image striping and partially transparent clouds tend to show up in the minor components. These can thus be eliminated in the reverse transformation to produce a largely noise-free set of bands.
- A new PANSHARPEN module offers the ability to merge panchromatic and multispectral data using three procedures: color space transformation, principal components transformation and local regression analysis.
- A new image transformation procedure (MNF) based on the minimum noise fraction complements the existing PCA and CCA modules. In this case, the components produced are designed to maximize the signal to noise ratio.
- The RUNOFF module now supports additional control variables including rainfall duration and initial absorption.
- A new SEDIMENTATION module calibrates soil loss and deposition results from the RUSLE module.
- An enhanced SEGMENT now produces an image of homogeneity. The procedure is based on a standard deviation filter to produce categories of similarity.
- BREAKOUT is a new module that creates separate layers of each category in multi-category images and vector files.
- The CROSSTAB module has been extensively revised to include 3-way crosstabulation along with crosstabulation of fuzzy membership maps.
- The ROC and LOGISTICREG modules have both been enhanced to permit faster processing.
- PROJECT now supports reference systems based on the sinusoidal projection.
- THERMAL has been revised to work with any system (not just Landsat TM) and allows for emissivity correction.
- PATHWAY now allows simultaneous pathway determination from multiple targets.
- A revised TREND calculates polynomial surfaces up to a ninth order.
- New import routines support ASD hyperspectral radiometers and images based on the ECW format.