TerrSet

Geospatial Monitoring and Modeling System

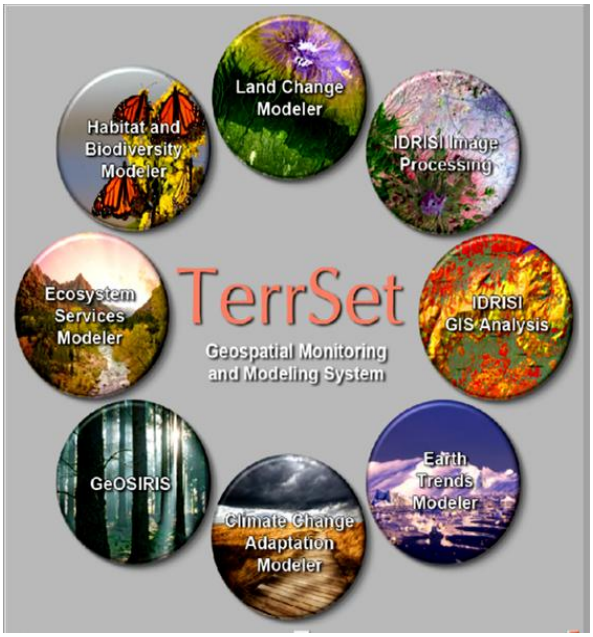
A NEW NAME, A NEW CONCEPT, AND A WEALTH OF ADVANCES

For close to 30 years, Clark Labs has been a pioneer in the development of geospatial software. The IDRISI GIS and Image Processing system set new standards for decision support in geographic analysis and remote sensing applications. Then we added the Land Change Modeler (LCM) for the empirical modeling and future prediction of land cover change— a vertical application built on top of a GIS. Next came the Earth Trends Modeler (ETM)—a radically new system for time series analysis of earth observation imagery for understanding climate and global environmental change.

TerrSet builds on this trajectory, adding new vertical applications and a range of important new features to the existing base.

The New TerrSet Interface

The IDRISI GIS Analysis and IDRISI Image Processing components provide access to the full IDRISI system along with new enhancements. The Land Change Modeler has now been split into two to allow for greater expansion. One part is still called the Land Change Modeler (LCM) and focuses on that task with the additional capability of estimating greenhouse gas emissions for the support of REDD (Reducing Emissions from Deforestation and forest Degradation) projects. The Habitat and Biodiversity Modeler (HBM) takes all of the habitat/landscape/ biodiversity components from the previous LCM and puts them into a new system with room for growth.



The Completely New Elements of TerrSet include:

- **The Ecosystem Services Modeler (ESM)** for assessing the value of various ecosystem services such as water purification, crop pollination, wind and wave energy, and so on. ESM is based closely on the InVEST toolset developed by the Natural Capital Project.
- **The Climate Change Adaptation Modeler (CCAM, pronounced "see cam")** – a tool for modeling future climate and assessing its impacts on sea level rise, crop suitability and species distributions.
- **GeOSIRIS** – a unique tool for national level REDD (Reducing Emissions from Deforestation and forest Degradation) planning, developed in close cooperation with Conservation International. With GeOSIRIS one can model the impact of various economic strategies on deforestation and carbon emissions reductions.

The interface for TerrSet has been completely reorganized around the eight components of the TerrSet constellation:

- IDRISI GIS Analysis
- IDRISI Image Processing
- Land Change Modeler
- Habitat and Biodiversity Modeler
- Ecosystem Services Modeler
- GeOSIRIS
- Earth Trends Modeler
- Climate Change Adaptation Modeler

TerrSet provides:

- A complete GIS analysis package for basic and advanced spatial analysis, including tools for surface and statistical analysis, decision support, and change and time series analysis
- A complete Image Processing system with the most extensive hard and soft classifers in the industry, including machine learning classifiers such as neural networks and classification tree analysis, as well as image segmentation for classification
- Integrated modeling environments including the Earth Trends Modeler for image time series of environmental trends and Land Change Modeler for land change analysis and prediction, a critical component for REDD projects
- Complete utilities for import and export along with a comprehensive set of documentation and tutorials.

KEY FEATURES

The IDRISI GIS and Image Processing software provides a host of utilities and procedures to optimize, analyze and visualize your raster data and imagery. Extensive conversion tools allow for easy import and export with many of the most popular software and government formats.

➢ GIS Analysis

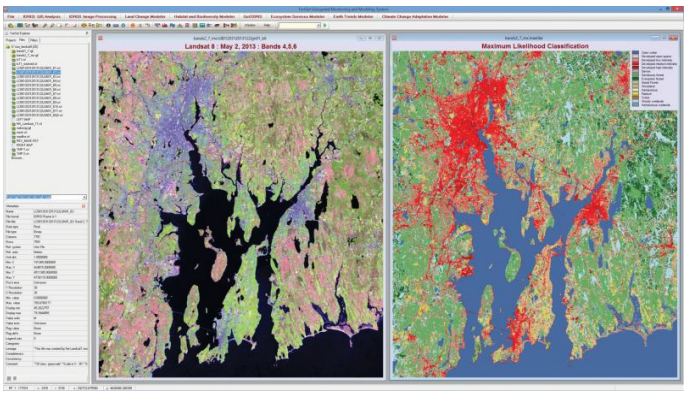
TerrSet includes a range of tools for the analysis and manipulation of spatial data. With TerrSet, you can query and explore your raster data, derive new data layers, evaluate and measure spatial relationships, and identify patterns and trends.

- Database query and overlay analysis.
- Derivative mapping with mathematical and relational modeling.
- Distance and context operations to analyze interactions over space.
- Standard and advanced spatial statistics.
- Surface analysis tools including interpolation and hydrological modeling routines.
- Change and time series procedures to measure change at local and global scales.
- Exclusive tools for multi-criteria and multi-objective decision support and land suitability analysis.

➢ Image Processing

TerrSet provides a complete suite of image processing tools, including the widest range of classification techniques in the industry, for both multispectral and hyperspectral remotely sensed imagery. All major imagery formats are accommodated.

- Pre processing tools for noise and distortion removal, data transformation and full georeferencing.
- Visual and data enhancement tools, including digital filters, color compositing, pansharpening and others.
- Unsupervised and supervised classification techniques including innovative "soft" classifier support.

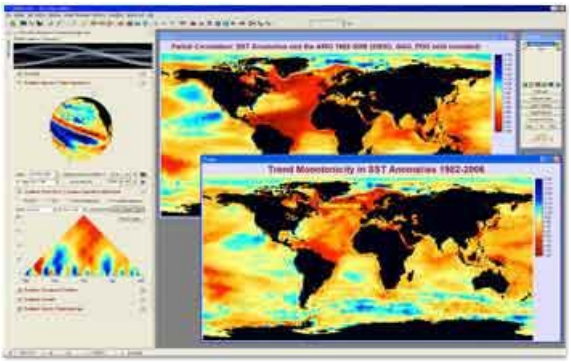


- Transformation tools including Principal Components Analysis and Canonical Components Analysis.
- Segment-based classification whereby pixels are grouped into segments based on homogenous spectral similarity.
- Machine learning classifiers including a host of neural networks and a classification tree procedure.

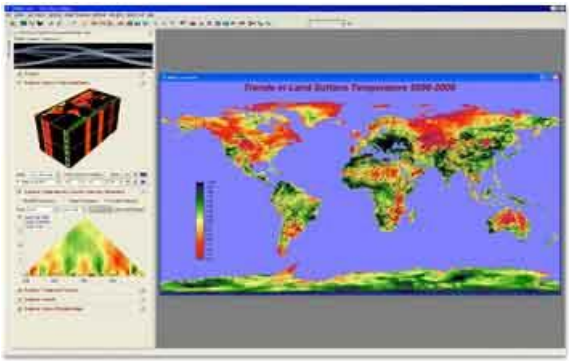
➢ Modeling

TerrSet provides several environments for users to develop their own models. The software also includes specific modeling applications for land change analysis and image time series analysis.

- Earth Trends Modeler, a modeling application for analyzing trends and anomalies in image time series with particular relevance for climate change and ecosystem dynamics.
- Land Change Modeler, a modeling application with tools to quickly assess land change, predicts future scenarios and assesses the impacts of these predictions on biodiversity. Land Change Modeler is widely used for REDD projects.
- Macro Modeler, a graphical modeling environment for building and executing multi-step models.
- Integration for user-created scripts and procedures via a COM object model interface.
- An Image Calculator for the construction of algebraic and logical formulas on map layers.



Earth Trends Modeler provides an integrated environment for the analysis of time series data. Here an analysis of trends in sea surface temperature from 1982 to 2006 shows a strong increasing trend of temperature in the Atlantic and its relation to the Atlantic Multidecadal Oscillation (AMO). The triangular wavelet analysis diagram shows the nature and scale of these trends in the Labrador Sea. The animated globe shows variations in ocean height which are closely related with temperature variations.



In Earth Trends Modeler, an analysis of trends in MODIS land surface temperature in degrees Celsius from 2000-2006. The map shows warming zones in North America, Eurasia, and Australia. Large cooling zones are depicted in Southern Europe and throughout Asia.

This version includes a variety of enhancements to the display subsystem of the IDRISI suite, including image pyramids and support for large images. Significant additions and enhancements have been made to both Land Change Modeler and to Earth Trends Modeler.

➢ Land Change Modeler Enhancements

The Land Change Modeler has become a major tool for many of our users and with this release we have expanded and enhanced its capabilities. These include:

- A new REDD tab to support projects aimed at Reducing Emissions from Deforestation and Forest Degradation. The new REDD tab is intended to support the various methodologies being reviewed and approved by the Verified Carbon Standard (VCS) for the voluntary market. The REDD tab facilitates the estimation of baseline emissions from various carbon pools and allows the calculation of deferred emissions and carbon credits.
- A pioneering new land cover change modeling procedure, SimWeight, a machine learning procedure that has proven to yield results that rival that of the Multi-Layer Perceptron with minimal (and easily understood) parameters.
- A new land cover preprocessing procedure called Harmonize that coordinates the land cover layers in terms of their spatial characteristics, background masks and categorizations.
- An integrated link to the popular MAXENT procedure for species distribution modeling.

➢ Earth Trends Modeler Enhancements

With the release we have incorporated a major expansion of our spectral decomposition capabilities in Earth Trends Modeler, continuing TERRSET's ground breaking leadership in Earth System Information Science for climate change and ecosystem dynamics.

- Principal Components Analysis (PCA) and Empirical Orthogonal Teleconnection (EOT) analysis now offer extended modes where multiple data series can be analyzed simultaneously.
- Multichannel Singular Spectrum Analysis (MSSA) and Multichannel Empirical Teleconnection analysis are now included analyzing patterns that evolve in space and time.

- All Principal Components Analysis procedures now offer both T-mode and S-mode orientations for analysis – the first GIS/Image Processing software system to offer both.
- Both Principal Components Analysis (PCA) and Empirical Orthogonal Teleconnection (EOT) analysis now have the option to uncenter the analysis, i.e., the option to remove the mean from a data set.
- A new procedure for Canonical Correlation Analysis (CCA).
- A change to the Fourier-PCA routine to perform the analysis in S-mode rather than in T-mode.
- A Contextual Mann-Kendall (CMK) trend significance measure has been added to the Seasonal Trend Analysis procedure.
- When viewing one-dimensional time series graphs, such as from PCA, you can now interactively slide the second series forwards or backwards in time and display the lagged correlation between the two series.
- For missing data interpolation we have extended the linear interpolation option to allow bridging over gaps of any specified duration (as opposed to just one-time-slice gaps).
- The Inverse PCA denoising option now also offers a choice between S-mode and T-mode.
- The Generate/Edit series options now also include a spatial subsetting tool.

➢ Display Enhancements

Probably the most immediately noticeable features of are the new display elements. These include:

- An auto-arrange feature whereby IDRISI automatically arranges map elements such as titles, legends, scale bar, insets, etcetera.
- The Composer window has changed; besides a new a new interface design, it is sizeable in order to better handle long file names and compositions with many layers.
- Map windows can now be very simply resized by pulling out or pushing in the lower-right corner.
- With the edition, IDRISI breaks through the Windows 32-bit display architecture, with the ability to now display images much greater that 32,000 rows and columns, depending on your hardware.
- To support the rapid display of large images, IDRISI has also introduced support for an image pyramid – a multiple resolution image that allows the rapid display of large images regardless of the level of zoom.
- Another new display feature is the ability to display vector fields. The inputs can be of two types – a magnitude and direction force pair (such as slope and aspect) or as the X and Y (U and V) components of the force.

➢ New Analytical Modules

Changes have also been made to the extensive set of independent analytical modules IDRISI provides. These and other additions include:

- A Radial Basis Function (RBF) neural network classifier has been added to complement the existing suite of neural network classifiers.
- A Chain Clustering procedure has been added to the basic clustering tools available in TerrSet.

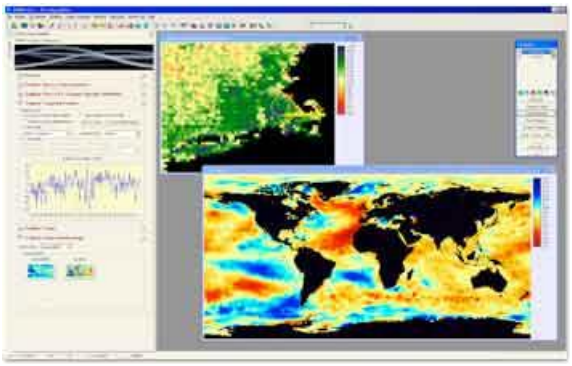
- A Durbin-Watson module has been added independently of ETM to map locations where serial correlation is present.
- A new high-precision rank-and-slice technique has been added to help support decision making procedures. It pulls out the top ranked pixels according to a specified threshold and is incorporated in to Land Change Modeler for land allocation and as a stand-alone module.
- A revised PCA module offering distinctions between S-mode and T-mode even for multivariate cases not involving time series. The options for standardized/unstandardized, centered/ uncentered and forward/inverse transformation are also included.
- A general purpose Canonical Correlation Analysis procedure has been added for the analysis of pairs of data sets.

➢ New or Revised Import/Export Modules

- Support for KML files (Keyhole Markup language, used by Google) has now been extended to include the import and export of point, line and polygon files as well as raster images.
- An import routine to convert MODIS tiled imagery to IDRISI raster format. The files are imported and then the tiles are mosaicked, with options to mosaic tiles of different geographic extent.
- The import utility for MODIS Quality Control data has been extended. Quality control maps can now be generated for vegetation indices using MODIS collection 5, land surface temperature collections 4 and 5, and Albedo collection 5.

➢ Improved Modules

- Every so often we take the opportunity to substantially revise modules that we think could benefit from a different approach. With the release, we have focused on the core of the distance-based routines – DISTANCE, COST, VARCOST, DISPERSE and BUFFER. The optimization is substantial, with most routines running considerably faster.



An example of temporal profiling (of NDVI anomalies in southeast Massachusetts) followed by subsequent analysis of its relationship with global sea surface temperatures using the linear modeling tool

The SEGMENTATION module creates an image of segments that have spectral similarity across many input bands. The image on the left uses a larger similarity threshold than the one on the right, resulting in more generalized, less homogeneous segments. Using this threshold, the image allows for segments that wholly contain building objects.

Validation allows you to assess the quality of your prediction model. In this example, a model was developed to predict forest cover loss to 2004 based on historical patterns. We predicted from a known state in 2001 to 2004 and validated the prediction map to a known state in 2004. The

validation map shows the hits (green), misses (red), and false alarms (yellow) of our model.