

# IDRISI supporting Tools for Ecosystem Services Analysis and Planning

Florencia Sangermano

fsangermano@clarku.edu



CLARK LABS



## Clark labs:

- A non-profit research center at Clark University
- Close links to the Graduate School of Geography, the Department of International Development, Community and Environment and the Marsh Institute
- Purpose of developing Geographic/Earth System Information technology to address the needs of effective decision making for social and environmental security and sustainable development.



Given these goals, our activities have been primarily focused on four areas:

- Software Development
- Analytical Research
- Applications Research
- Technology Transfer

# IDRISI Resource Centers



University-based partners that provide assistance through consulting services, training, user meetings, conferences, workshops, translations, and so on. They are also important partners in providing beta testing and feedback on software development.



# Software Products



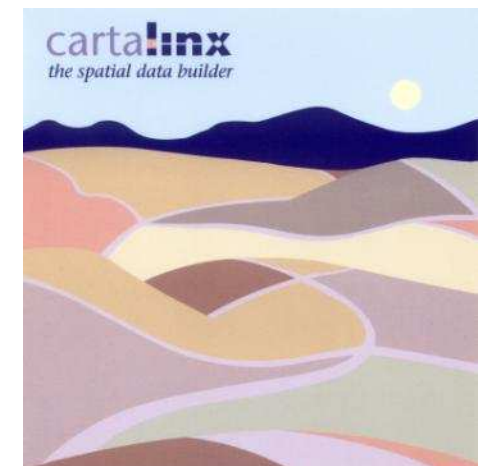
Core Product: IDRISI GIS and Image Processing System

### ArcGIS Extension

- ANALYZING CHANGE
- MODELING THE POTENTIAL FOR CHANGE
- PREDICTING CHANGE
- IMPACT ASSESSMENT FOR HABITAT AND BIODIVERSITY
- REDD MODELING CAPABILITIES
- PLANNING FOR FUTURE SCENARIOS

## Land Change Modeler™

FOR ARCGIS®

The image shows the Land Change Modeler for ArcGIS interface. It features a dark blue header with the title 'ArcGIS Extension' and a list of six bullet points describing the software's capabilities. Below the header is a purple banner with the text 'Land Change Modeler™' and an orange banner with 'FOR ARCGIS®'. The main area displays a colorful map with various shades of green, yellow, and red, representing different land use or change models.



# Supporting GIS for Ecosystem Services

Although there exist multiple tools for mapping and valuation of Ecosystem services, these tools require specific data inputs that need to be developed in advanced.

These input layers to ES tools include for example:

Land Use / Land cover data for current and future dates

Climate

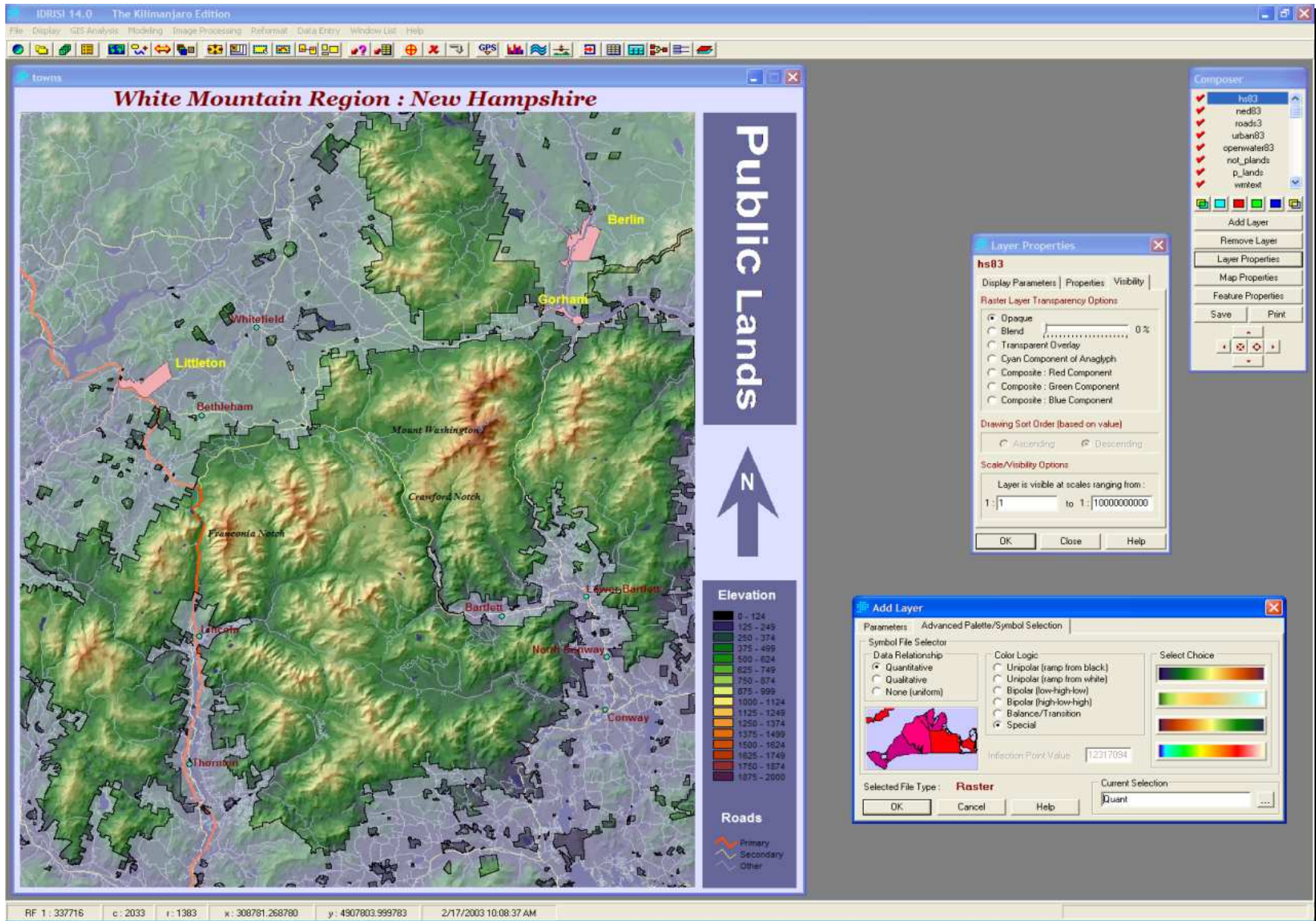
Slope

Watersheds

All these inputs are easily developed with tools within a GIS-IP system



- Broad spectrum GIS and Image Processing System
- Primarily raster
- Can import –export and convert between at types







**RUNOFF - surface runoff accumulation**

Input surface image : sierradem  
 Output runoff image : runoff

Control specifications

Add precipitation image :  
 Add permeability image : permeability  
 Perform pit removal

OK Close Help

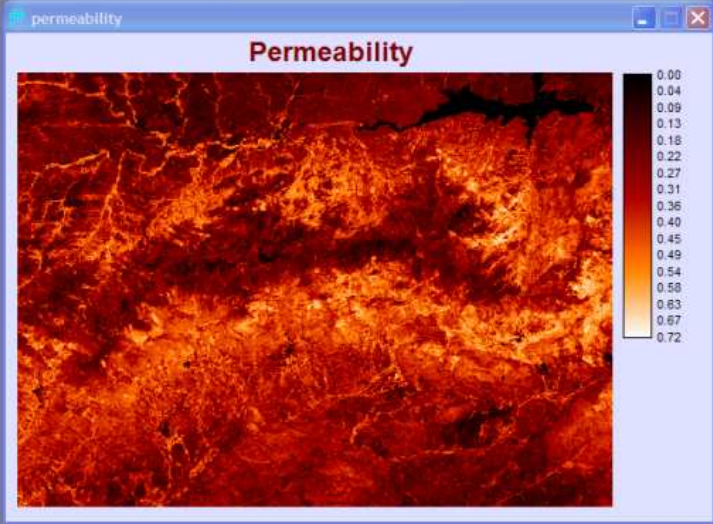
**Image Calculator - Map Algebra and Logic Modeler**

Operation type :  Mathematical expression  Logical expression

Output file name : Expression to process :  
 runoff2 = ln[ runoff ]

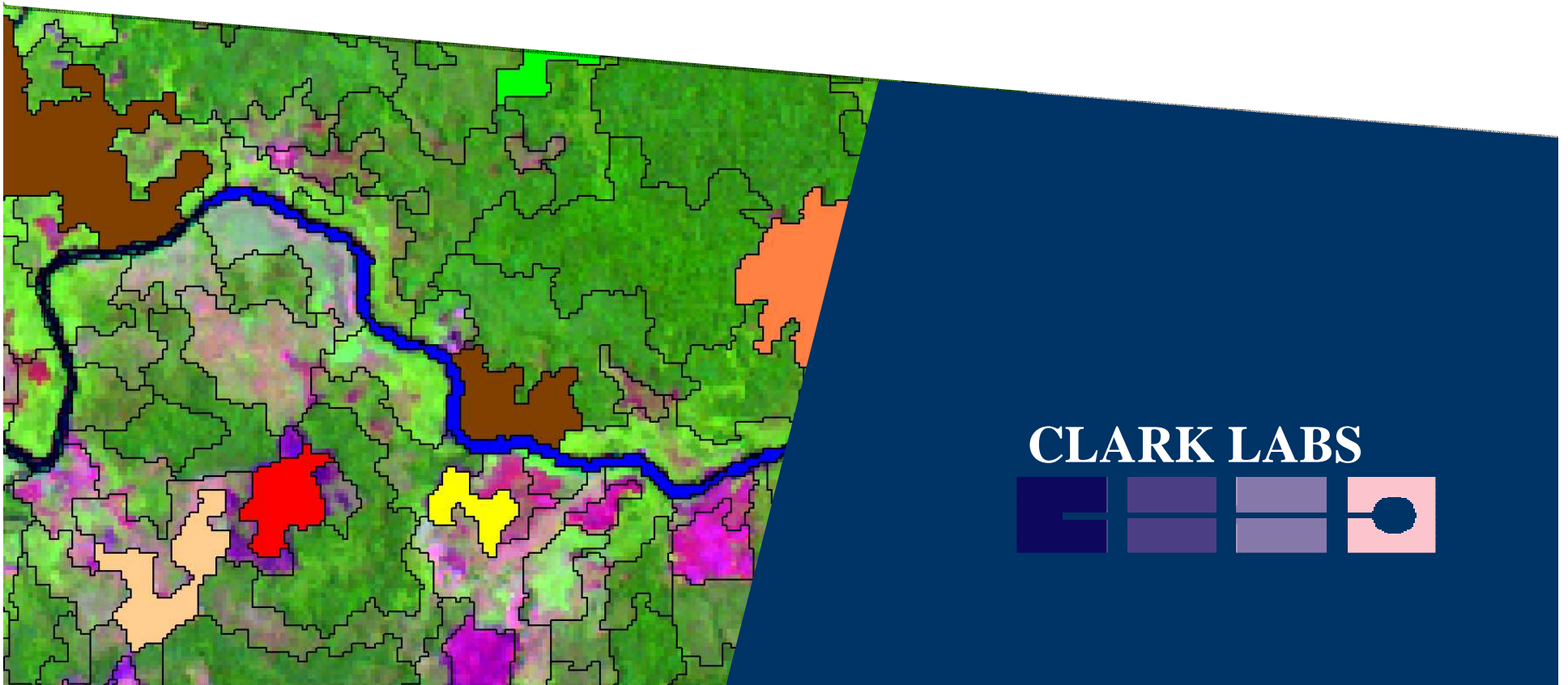
7	8	9	/	^X	COVER	EXP	SIN	ARCCOS
4	5	6	*	NRATIO	NEG	LOGIT	COS	ARCTAN
1	2	3	-	MIN	RECIP	SQRT	TAN	RAD
0	-	-	+	MAX	LN	SQR	ARCSIN	DEG
(	)	[	]	Insert Image		CLEAR	ABS	

Process Expression Save Expression Open Expression Close Help





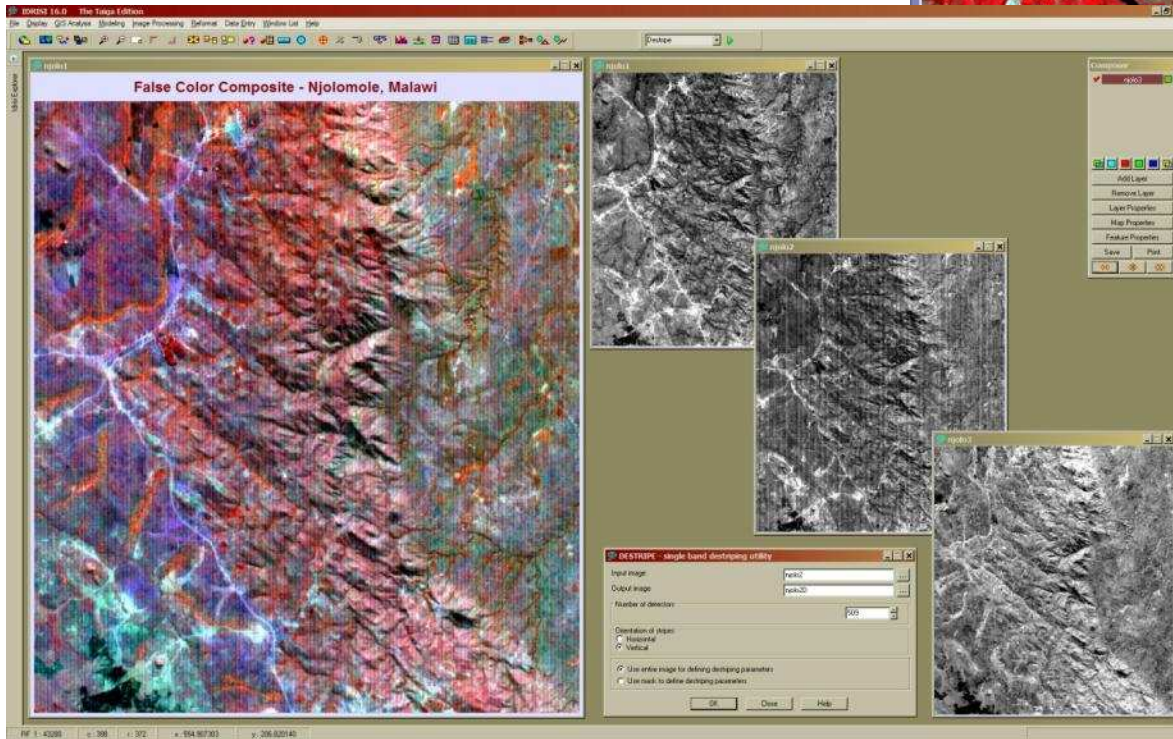
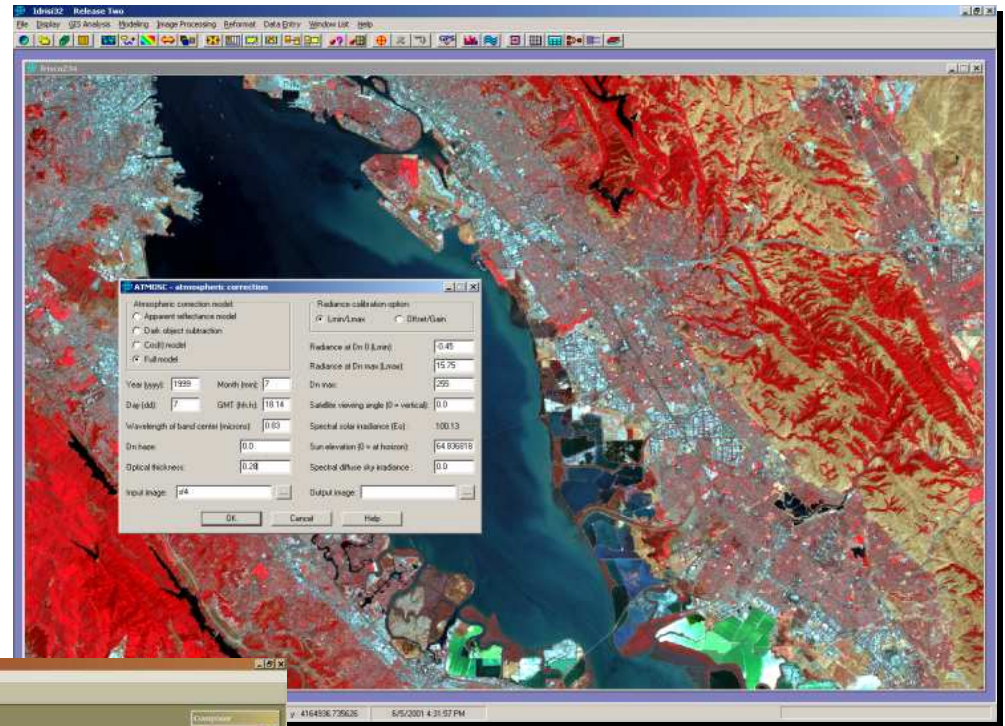
# Support for land cover mapping



# IDRISI Image Processing System

IDRISI includes a full image processing suite for image classification

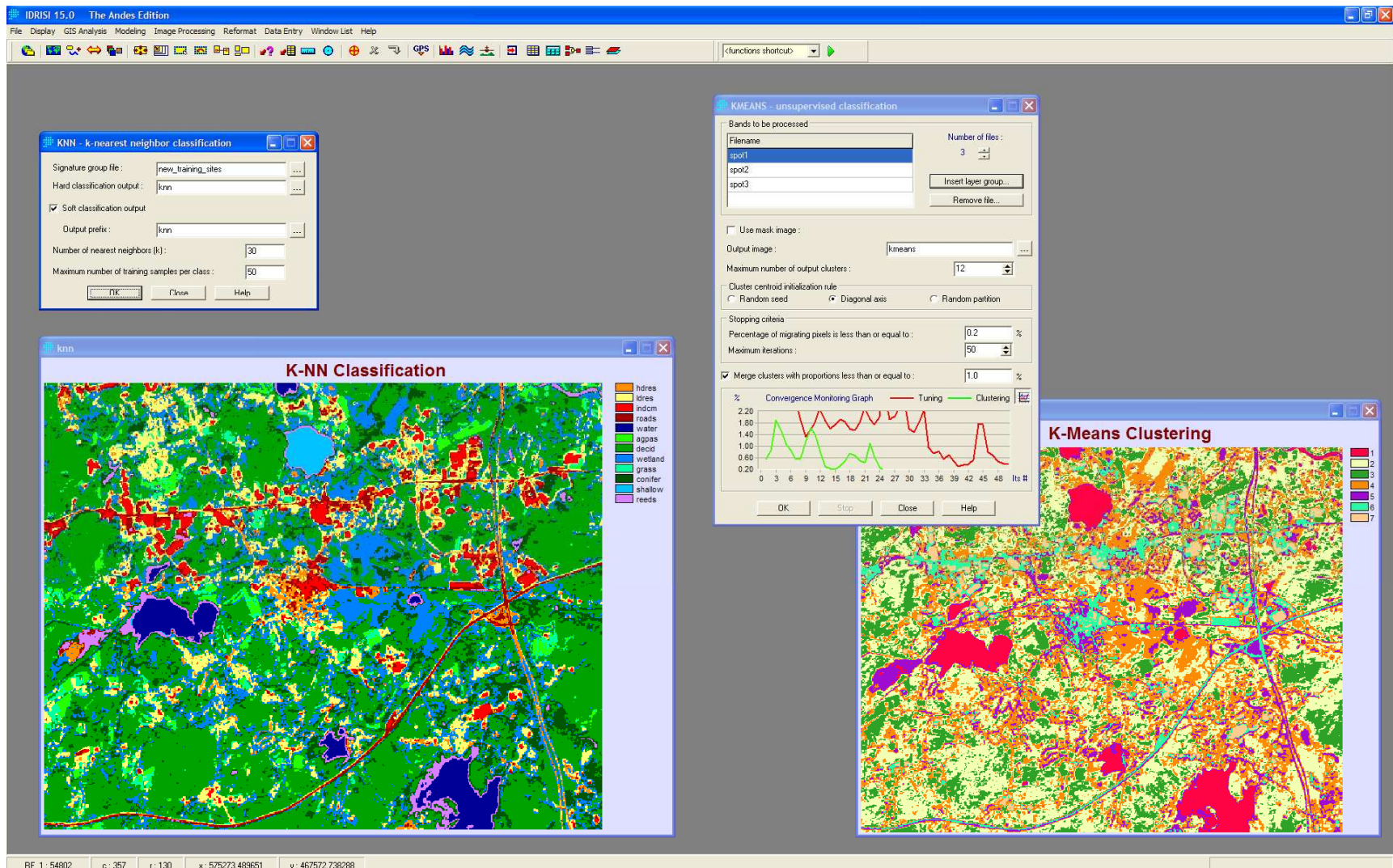
Pre-processing tools





# IDRISI Image Processing System

IDRISI includes the largest suite of **unsupervised** and **supervised** image classifiers in the industry, as well as **soft** and **hard** classifiers.





# IDRISI Image Processing System

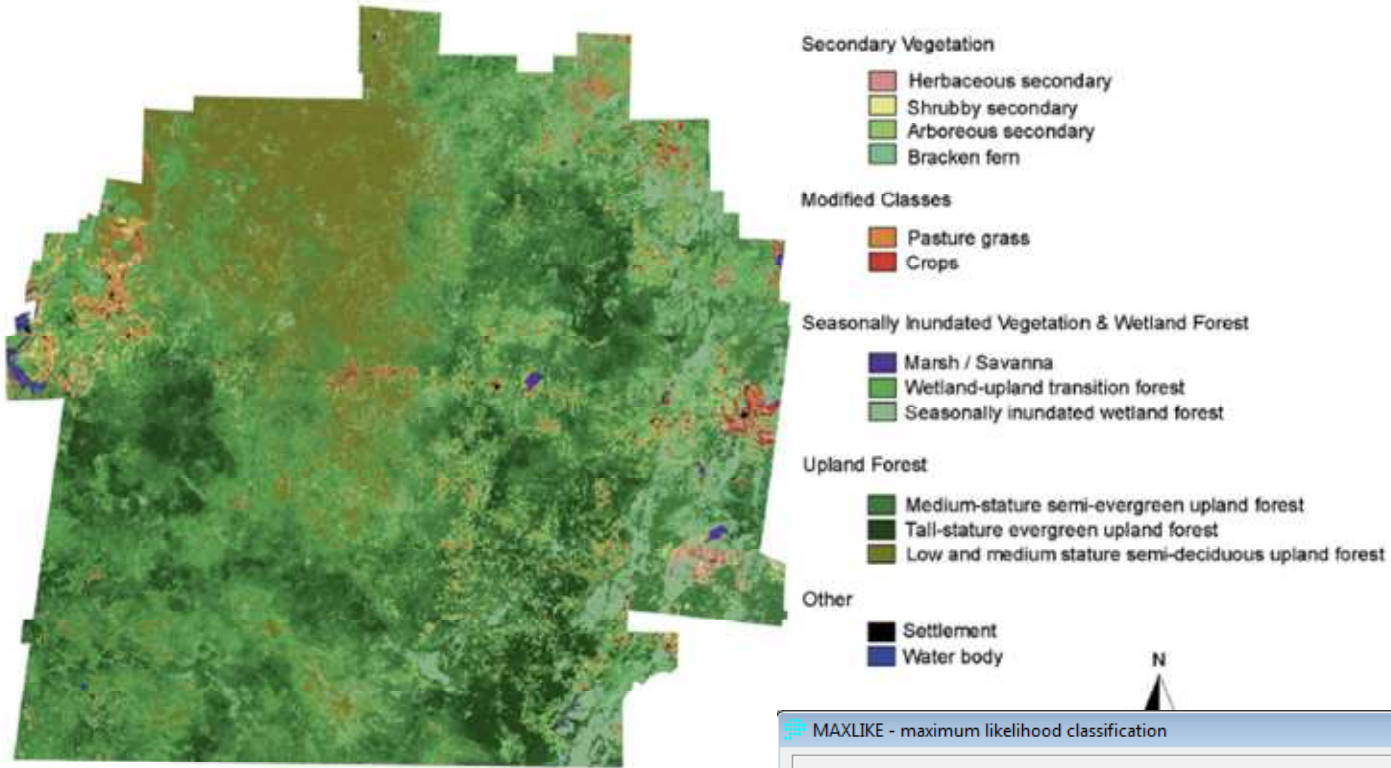
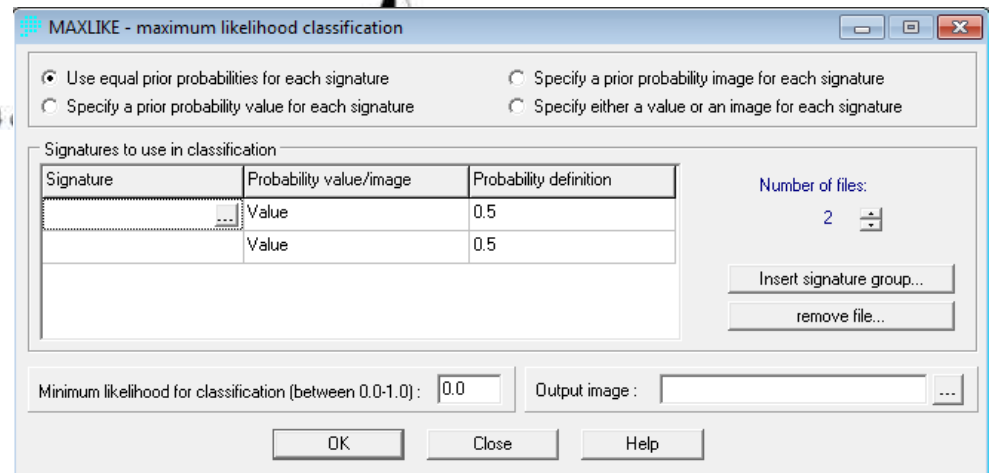


Figure 5. Final classification of the Southern Yucatan Peninsula showing the 14 classes.

## Maximum Likelihood



# IDRISI Image Processing System

**IDRISI 16.0 The Taiga Edition**

File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

MLP

### MLP - Multi-layer perceptron classifier

Application options:  Classification  Regression

Training options:  Train network  Load weights

Independent variable images:

Var ID	Image name	Number of files
Var 1	spwest1	3
Var 2	spwest2	
Var 3	spwest3	

Input specifications:

Training site file:  Image  Vector  Study area mask image:

Avg. training pixels per class: 500

Avg. testing pixels per class: 500

Network topology:

Input layer nodes: 3

Output layer nodes: 11

Hidden layers: 1

Layer 1 nodes: 6

Layer 2 nodes: 1

Training parameters:

Use automatic training

Use dynamic learning rate

Start learning rate: 0.002085

End learning rate: 0.00025

Momentum factor: 0.5

Sigmoid constant a: 1.0

Output options:

Hard classification

Map output activation levels

Map hidden layer activation

Perform confusion matrix analysis

Sigmoidal  Linear

Stopping criteria:

RMS: 0.01

Iterations: 10000

Accuracy rate: 100 %

Running statistics:

Actual training pixels: 4252

Actual testing pixels: 4258

Learning rate: 0.0007

Iterations: 4959 Accuracy: 85.65%

Training RMS: 0.1463 Testing RMS: 0.1464

Output files:

Hard classification image: mlp1

Output layer activation files prefix: mlp\_act\_

Hidden layer 1 activation files prefix:

Hidden layer 2 activation files prefix:

Buttons: Train Stop Save weights Classify Close Help

### Neural Network MLP Classification

- Old residential
- New residential
- Industrial commercial
- Roads
- Water
- Ag-pasture
- Deciduous
- Wetland
- Grass-golf
- Conifer
- Shallow water

### Module Results

Error Matrix Analysis of SPTRAIN (columns : truth) against MLP1 (rows : mapped)

	1	2	3	4	5	
1	230	126	4	116	0	0.5168
2	45	214	4	15	0	0.2595
3	22	1	355	64	0	0.1964
5	0	0	0	0	1386	0.0000
7	0	0	0	0	0	0.0293
8	234	40	0	4	3	0.3092
9	0	1	0	0	0	0.4811
11	0	0	0	0	0	0.0000
Total	531	382	364	199	1389	
Error=O	0.5669	0.4398	0.0220	1.0000	0.0022	

Buttons: Print Contents Save to File Copy to Clipboard Close Help

### Activation Level 1 : Old Residential

Buttons: Print Contents Save to File Copy to Clipboard Close Help

RF: 1: 38193 c: 318 r: 219 x: 318.853846 y: 338.772203 MLP: working..



# IDRISI Image Processing System

The screenshot displays the IDRISI 16.0 software interface, specifically the CTA (Classification Tree Analysis) module. The main window is titled "CTA - classification tree analysis" and contains several panels:

- Input image files:** A table listing three bands:
 

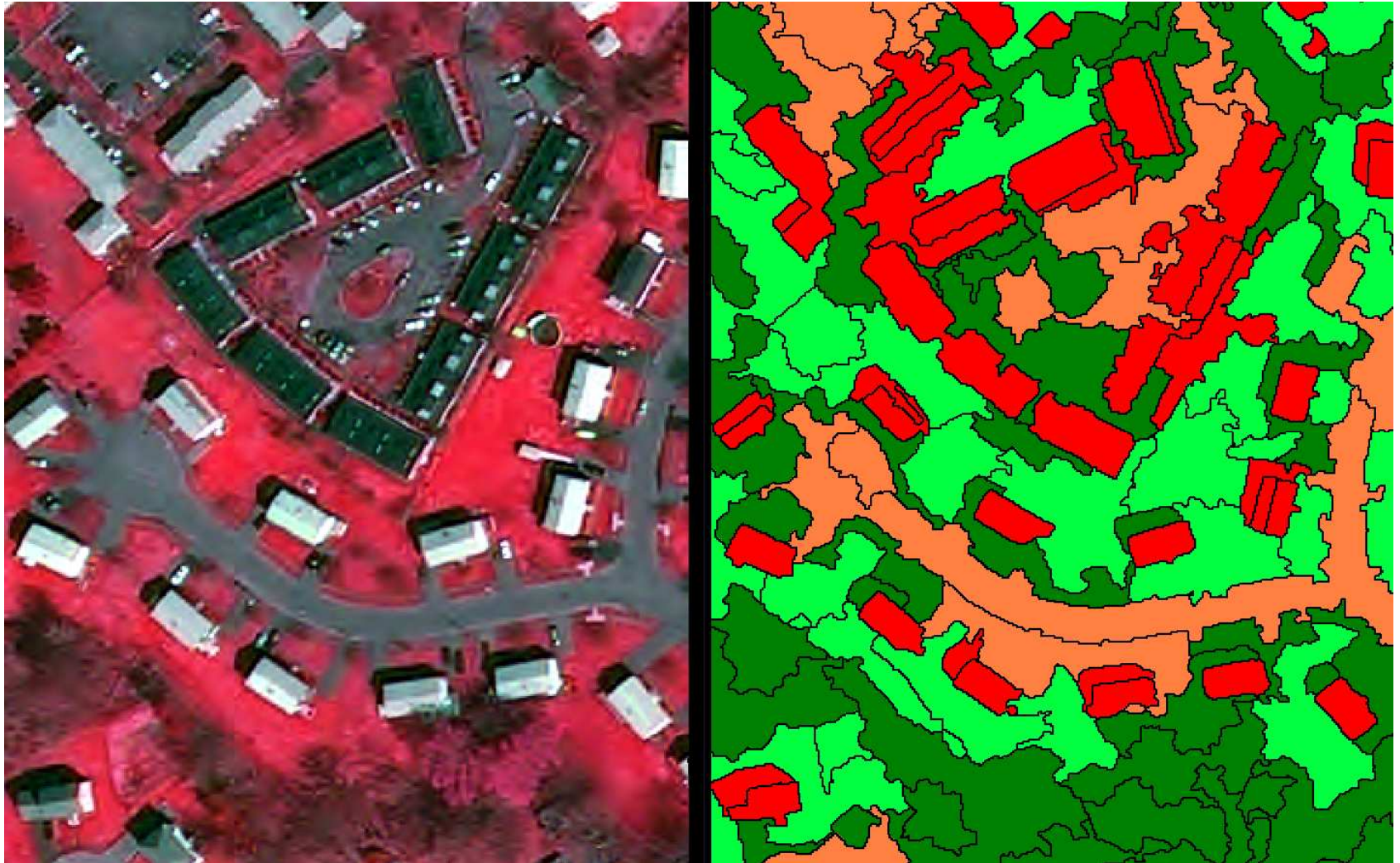
Band ID	Image name	Number of files:
Band 1	spwest1	3
Band 2	spwest2	
Band 3	spwest3	
- Training sites:** Includes options for "Image" or "Vector" and a "File name" field containing "sptrain".
- Split type:** Options include "Ratio", "Entropy", and "Gini".
- Output specifications:** Includes "Leaves with proportion" and "File prefix" set to "tree3".
- Training Pixels Classification Monitoring:** A bar chart showing classification accuracy for 11 classes, ranging from -6.00% to 6.00%.
- Tree Structure:** A hierarchical tree diagram showing splits based on band values and resulting leaf classes with their respective pixel counts and purities. For example, "Band 3 < 90.5 Leaf Class 10 [Pixels 140 : 81.60%] Purity: 95.00%".
- tree31 Residential Membership:** A small map showing membership values for residential areas, with a color scale from 0.00 to 0.14.
- tree2 Classification Tree Landuse Map:** A large map showing the final land use classification, with a legend on the right:
  - Oldres (Orange)
  - Newres (Yellow)
  - Indcom (Red)
  - Roads (Dark Red)
  - Water (Blue)
  - Agpas (Light Green)
  - Decid (Green)
  - Wetland (Dark Blue)
  - Golfgrass (Cyan)
  - Conifer (Dark Green)
  - Shallow (Light Blue)

The bottom of the interface features a control bar with buttons: "Generate Tree", "Classify", "Stop", "Save Tree As...", "Load Tree From...", "Print Tree...", "Tree Printing Setup...", "Close", and "Help".

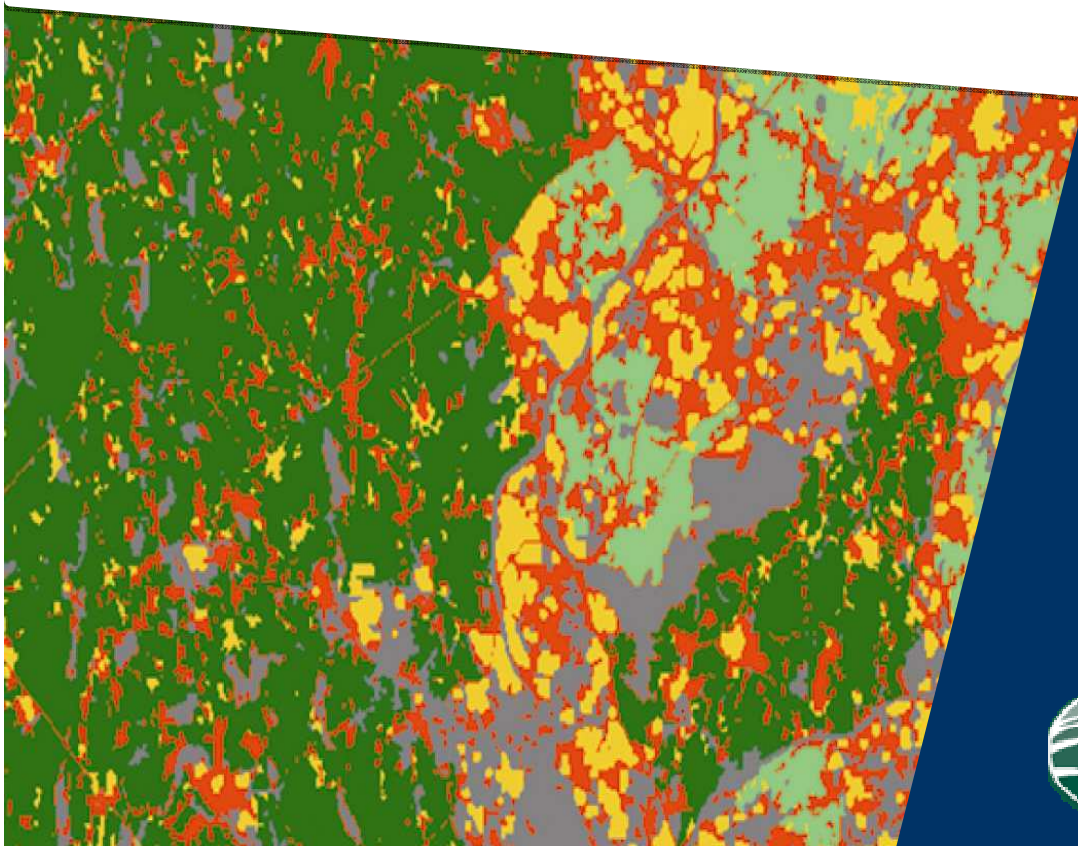


# IDRISI Image Processing System

## Segment-based Classification



# Land Change Modeler



CLARK LABS





# Land Change Modeler

The screenshot displays the IDRISI 15.0 Land Change Modeler interface. The main window shows two land cover maps for Central Massachusetts. The top map is titled "Land Cover : Central Massachusetts 1985" and the bottom map is titled "Land Cover : Central Massachusetts 1999". Both maps use a color-coded legend to represent different land cover types. The legend includes categories such as Industrial / Commercial, Residential (<2 acre + multi-family), Residential (>2 acre), Transportation, Other Urban, Barren / Waste Disposal / Mining, Cropland, Pasture, Open land, Deciduous Forest, Mixed Forest, Conifer Forest, Forested / Shrub Wetland, Wetland, and Water. A scale bar indicates 20000 meters, and a north arrow is present. The interface also includes a menu bar (File, Display, GIS Analysis, Modeling, Image Processing, Reformat, Data Entry, Window List, Help), a toolbar, and a sidebar with a "Study Area Parameters" panel. The sidebar panel shows the following settings:

- Study Area Parameters: Create new study area (checked), Use existing study area (cma)
- Earlier land cover image: landcover\_cma\_85\_rf, Date: 1985
- Later land cover image: landcover\_cma\_99\_rf, Date: 1999
- Use special palette: landcover\_cma\_85\_rf
- Change Analysis, Change Maps, and Spatial Trend of Change options are visible.

RF 1 : 454712 c : 1743 r : 758 x : 159477.454015 y : 913533.875907

**IDRISI 15.0 The Andes Edition**

File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

Land Change Modeler

Land Change Modeler: ES

Change Analysis | Transition Potentials | Change Prediction | Implications | Planning

**Study Area Parameters**

**Change Analysis**

Gains and losses by category Units: hectares  
 Net change by category  
 Contributors to net change experienced by: Residential (>2 acre)

**Contributions to Net Change in Residential (>2 acre)**

Category	Approximate Contribution (hectares)
Water	0
Wetland	0
Forested / Shrub Wetland	0
Conifer Forest	~500
Mixed Forest	~7000
Deciduous Forest	~8000
Open land	~1500
Pasture	~1000
Cropland	~2500
Barren / Waste Disposal / Mining	~500
Other Urban	~500
Transportation	~500
Residential (>2 acre)	~500
Residential (<2 acre + multi-family)	~500
Industrial / Commercial	~500

**Change Maps**

Map changes  Ignore transitions less than 100 hectares  
 Map persistence  
 Map gains / losses in: Residential (<2 acre + n)  Include Persistence  
 Map the transition from: Industrial / Commercial to: Residential (<2 acre + n)  
 Exchanges between: Residential (<2 acre + n) and Residential (<2 acre + n)  
 Output name (optional): Create Map

**Spatial Trend of Change**

Map spatial trend from: All to: Residential (>2 acre)  
 Order of polynomial: 9<sup>th</sup>  
 Output name (optional): trend9 Map Trend

mass\_towns\_spc

### Transitions to Large Residential: 1985-1999

- Industrial / Commercial to Residential (>2 acre)
- Residential (<2 acre + multi-family) to Residential (>2 acre)
- Transportation to Residential (>2 acre)
- Other Urban to Residential (>2 acre)
- Barren / Waste Disposal / Mining to Residential (>2 acre)
- Cropland to Residential (>2 acre)
- Pasture to Residential (>2 acre)
- Open land to Residential (>2 acre)
- Deciduous Forest to Residential (>2 acre)
- Mixed Forest to Residential (>2 acre)
- Conifer Forest to Residential (>2 acre)
- Wetland to Residential (>2 acre)
- Water to Residential (>2 acre)

RF 1: 440305 c: 1901 r: 560 x: 164389.877371 y: 920954.492475



# Land Change Modeler: Change Prediction

IDRISI 15.0 The Andes Edition  
 File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

Land Change Modeler: ES  
 Change Analysis | Transition Potentials | Change Prediction | Implications | Planning

**Change Demand Modeling**  
 Markov Chain Prediction Date: 2010 View / Edit model  
 External Model

**Dynamic Road Development** ?  
 Proactive Growth Earlier Roads Layer:   
 Reactive Growth Basis Roads Layer: roads\_cms  
 Mode of road endpoint generation  
 Random  
 Topography-based Elevation image:   
 Land transition-based

From	To	Include	
Cropland	Residential (>2 acre)	Yes	Include all
Open land	Mixed Forest	Yes	
Deciduous Forest	Residential (>2 acre)	Yes	Include none

Output Roads Layer: new\_roads\_cms

Road type	Road length	Road Distance	Unit
Secondary	5	10	Km
Tertiary	3	7	Km

**Change Allocation** ?  
 Optional Components  
 Dynamic Road Development Prediction Date: 2010  
 Apply Infrastructure Changes Prediction Type:  Hard  Soft  
 Zoning - Incentives/Constraints Dynamic variable recalculation stages: 3  
 Create AVI video Frame Rate (sec): 1

Soft prediction Aggregation Type:  Maximum  Logical OR

From	To	Include	
Cropland	Residential (>2 acre)	Yes	Include all
Open land	Mixed Forest	Yes	
Deciduous Forest	Residential (>2 acre)	Yes	Include none

Output Prefix: vulnerability

cms\_landcover\_prediction\_2010\_final  
**Hard Prediction : Land Cover 2010**

- Industrial / Commercial
- Residential (<2 acre + multi-family)
- Residential (>2 acre)
- Transportation
- Other Urban
- Barren / Waste Disposal / Mining
- Cropland
- Pasture
- Open land
- Deciduous Forest
- Mixed Forest
- Conifer Forest
- Wetland
- Water

vulnerability\_2010  
**Soft Prediction : Vulnerability to Loss of Forest Cover**

0.00  
 0.03  
 0.06  
 0.09  
 0.12  
 0.16  
 0.19  
 0.22  
 0.25  
 0.28  
 0.31  
 0.34  
 0.37  
 0.41  
 0.44  
 0.47  
 0.50  
 0.53  
 0.56  
 0.59  
 0.62  
 0.66  
 0.69  
 0.72  
 0.75  
 0.78  
 0.81  
 0.84  
 0.87  
 0.91  
 0.94  
 0.97  
 1.00

PF 1 : 456178 c : 633 r : 1629 x : 124623.072340 y : 887637.442024

# Land Change Modeler: Validation

The screenshot displays the IDRISI 16.0 software interface, specifically the 'validate' window. The main workspace shows a map titled 'Validation Land Cover 2001 and 2004' with a legend listing various misclassification types such as '3|3|1 - Misses', '4|4|1 - Misses', and '1|10|1 - False Alarms'. Two inset windows, 'lu01' and 'lu04', show the original land cover maps for 2001 and the predicted land cover for 2004, respectively. The 'lu01' and 'lu04' windows have legends listing land cover classes like Forest, Lowland Scrub, Tropical Savannah, Lowland Grasslands, Montane Grasslands, Wetlands, Water, Snow, Other, and Disturbed.

**Validation Legend:**

- 3|3|1 - Misses
- 4|4|1 - Misses
- 1|10|1 - False Alarms
- 10|10|1 - Misses
- 3|3|2 - Misses
- 1|1|3 - Misses
- 2|2|3 - Misses
- 1|10|3 - False Alarms
- 10|10|3 - Misses
- 1|1|4 - Misses
- 7|7|4 - Misses
- 7|7|6 - Misses
- 1|10|7 - False Alarms
- 1|1|10 - Misses
- 2|2|10 - Misses
- 3|3|10 - Misses
- 4|4|10 - Misses
- 1|1|10 - Hits

**Land Cover Legend (lu01 and lu04):**

- Forest
- Lowland Scrub
- Tropical Savannah
- Lowland Grasslands
- Montane Grasslands
- Wetlands
- Water
- Snow
- Other
- Disturbed

**Software Interface Details:**

- Top Bar:** IDRISI 16.0 The Taiga Edition. Menu items: File, Display, GIS Analysis, Modeling, Image Processing, Reformat, Data Entry, Window List, Help.
- Left Panel (Idris Explorer):**
  - Change Demand Modeling:** Markov Chain (selected), Prediction Date: 2004, View / edit matrix.
  - Dynamic Road Development:** (Collapsed)
  - Change Allocation:**
    - Optional Components: Dynamic Road Development, Apply Infrastructure Changes, Zoning - Constraints/Incentives.
    - Prediction Date: 2004, Dynamic variable recalculation stages: 1, Frame Rate (sec): 3.5.
    - Soft prediction: Aggregation type: Maximum (selected), Logical OR.
    - From: Forest, To: Disturbed, Include: Yes.
    - Run Model, Output Name: landcov\_predict\_2004.
  - Validation:**
    - First image: lu01
    - Second image: Current prediction (selected), Second image: landcov\_predict\_2004.
    - Third image: lu04.
    - Validate, Output Name: Validate.
- Right Panel (Composer):** lu04 (selected), Add Layer, Remove Layer, Layer Properties, Map Properties, Feature Properties, Save, Print.
- Bottom Status Bar:** RF 1 : 2189116, c : 914, r : 890, x : -62,562843, y : -17,020507.



# Land Change Modeler: REDD Forest Carbon Accounting with BioCF

IDRISI 16.0 The Tatga Edition

File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

LCM

Land Change Modeler - ES

Change Analysis | Transition Potentials | Change Prediction | Implications | Planning | REDD

CO2 emission within the REDD project

Carbon pools within the REDD project area

Carbon Pool	Include/Exclude	Input type	Value
Above-ground	Included	Constant	Enter 1 ha-1 below
Below-ground	Included	% of AB	Enter % of AB below
Dead wood	Excluded	-NA-	-NA-
Harvested wood products	Excluded	-NA-	-NA-
Litter	Excluded	-NA-	-NA-
Soil organic carbon	Excluded	-NA-	-NA-

Biomass density (t ha-1) within the REDD project area

Names	AB	BB	DW	Hw/P	L	SOC
Forest	125.07	22.62	Excluded	Excluded	Excluded	Excluded
Non-Forest	10.08	2.45	Excluded	Excluded	Excluded	Excluded

Calculate baseline deforestation and carbon stock changes

Non-CO2 emissions within the REDD project

Sources and GHG within the REDD project area

Sources	Gas	Include/Exclude
Biomass Burning	CO2	Included
	CH4	Included
	N2O	Included

Non-CO2 emissions [%] from forest fires

Name	F burnt	Burned AB	Burned DW	Burned L	CE AB	CE DW	CE L
Forest	100	33	33	33	95	95	95
Non-Forest	100	33	33	33	95	95	95

Calculate baseline non-CO2 emission from forest fires

Project Success and Leakage

Reporting Interval	Leakage Rate(%)	Success Rate(%)	Effective(%)
Stage 01: 2006-2010	20	55	35
Stage 02: 2011-2015	20	80	60
Stage 03: 2016-2020	10	90	80

Calculate ex ante net GHG emission reductions

landuse\_05\_4\_classes

Madagascar Landuse 2005

landcov\_predict\_2035\_6\_iterations\_stage...

Madagascar Landuse 2020

landcov\_predict\_2035\_6\_iterations

Madagascar Landuse 2035

landcov\_predict\_2035.xlsx

	A	B	C	D	E	F	K	L	M	N	O	P	Q	R
1	Table 19: Ex ante net anthropogenic GHG emission reduction (C-REDD)													
2														
3														
4	Project Year	Carbon Baseline		Non-CO2		Carbon Leakage		Non-CO2		Carbon REDD		Non-CO2		
5	No	yr	Annual (tCO2e)	Cumulative (tCO2e)	Annual (tCO2e)	Cumulative (tCO2e)	Annual (tCO2e)	Cumulative (tCO2e)	Annual (tCO2e)	Cumulative (tCO2e)	Annual (tCO2e)	Cumulative (tCO2e)	Annual (tCO2e)	Cumulative (tCO2e)
6	1	2006	70,548.95	70,548.95	2,008.75	2,008.75	14,109.79	14,109.79	401.75	401.75	24,692.13	24,692.13	703.06	703.06
10	5	2010	70,548.95	352,744.75	2,008.75	10,043.77	14,109.79	70,548.95	401.75	2,008.75	24,692.13	123,460.66	703.06	3,515.32
15	10	2015	69,484.08	700,165.25	1,978.43	19,935.93	13,896.82	140,033.02	395.69	3,987.19	41,690.45	331,913.03	1,187.06	9,450.62
20	15	2020	69,350.17	1,046,916.06	1,974.62	29,809.04	6,935.02	174,708.09	197.46	4,974.50	55,480.14	609,313.69	1,579.70	17,349.11
25	20	2025	68,451.10	1,389,171.75	1,949.02	39,554.14	6,845.11	208,933.64	194.90	5,949.00	54,760.88	883,118.19	1,559.22	25,145.18
30	25	2030	70,899.66	1,743,670.25	2,018.74	49,647.83	7,089.97	244,383.48	201.87	6,958.38	56,719.73	1,166,717.00	1,614.99	33,220.14
35	30	2035	67,481.88	2,081,079.50	1,921.42	59,254.96	6,748.19	278,124.44	192.14	7,919.09	53,985.51	1,436,644.38	1,537.14	40,905.84
37														
38	C-Baseline: Baseline greenhouse gas emissions within the project area; tCO2e													
39	C-Actual: Actual greenhouse gas emissions within the project area; tCO2e													
40	C-Leakage: Leakage greenhouse gas emissions; tCO2e													
41	C-REDD: Net anthropogenic greenhouse gas emission reduction attributable to the REDD													
42														
43														

# Some Organizations using Land Change Modeler





# OSIRIS



CLARK LABS



# REDD National Planning: OSIRIS impact of policy on REDD

File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

Land Change Modeler: ES

Change Analysis Transition Potentials Change Prediction Implications  
Planning REDD OSIRIS Preprocess

**OSIRIS Project Parameters**

Project information  
 Create new project  Use existing project  
 OSIRIS project name: OSIRIS - Indonesia Continue...

Project saving option  
 Save project  Save project as ...  
 Save OSIRIS project: **OSIRIS - Indonesia** Save

**External factors**

World carbon price (\$/tCO<sub>2</sub>e):   
 Country national reference level as proportion of business-as-usual (BAU) emissions:

**Country decision on national REDD+ rules and incentives**

**Accounting scale**

National accounting  
 L2 sub-national regional jurisdiction level accounting  
 L3 sub-national regional jurisdiction level accounting  
 Site level accounting

**Model parameters**

Proportion of gross agricultural revenue retained after production costs:   
 Soil-carbon percent included in emission factor (non-peat soil):   
 Emission factor for peat soil (tCO<sub>2</sub>e/ha):   
 Sensitivity of frontier agricultural price to change in frontier land area:   
 Endogenous increase in ag price (from decrease in country agricultural area due to REDD+): **1.14**  
 Exogenous increase in ag price (from decrease in global agricultural area e.g. due to global REDD+ mechanism):   
 Proportional change in country ag price:   
**1.5063**

**Input image files**

**Output parameters**

OSIRIS output name: OSIRIS - Indonesia ...  
 Model precision:   
 Maximum number of iterations:   
 Proportional change in country ag price: **1.00** **Equilibrium** **1.5063**  
Run

**p\_deforestation without redd**  
**Deforestation without REDD+ (ha/5 yrs; modeled)**

Legend: <math><0.00</math>, 7.31, 14.63, 21.94, 29.25, 36.56, 43.88, 51.19, 58.50, 65.81, 73.13, 80.44, 87.75, 95.06, 102.38, 109.69, 117.00+

**ad\_deforestation with redd\_wcp\_10**  
**Deforestation with REDD+ (ha/5 yrs; modeled) - WCP \$10.00**

Legend: <math><0.00</math>, 7.31, 14.63, 21.94, 29.25, 36.56, 43.88, 51.19, 58.50, 65.81, 73.13, 80.44, 87.75, 95.06, 102.38, 109.69, 117.00+

RF 1 : 19199553    c : 513    r : 177    x : 12069225.123153    y : 121227.027027



# Habitat and Biodiversity Modeler



CONSERVATION  
INTERNATIONAL



CLARK LABS

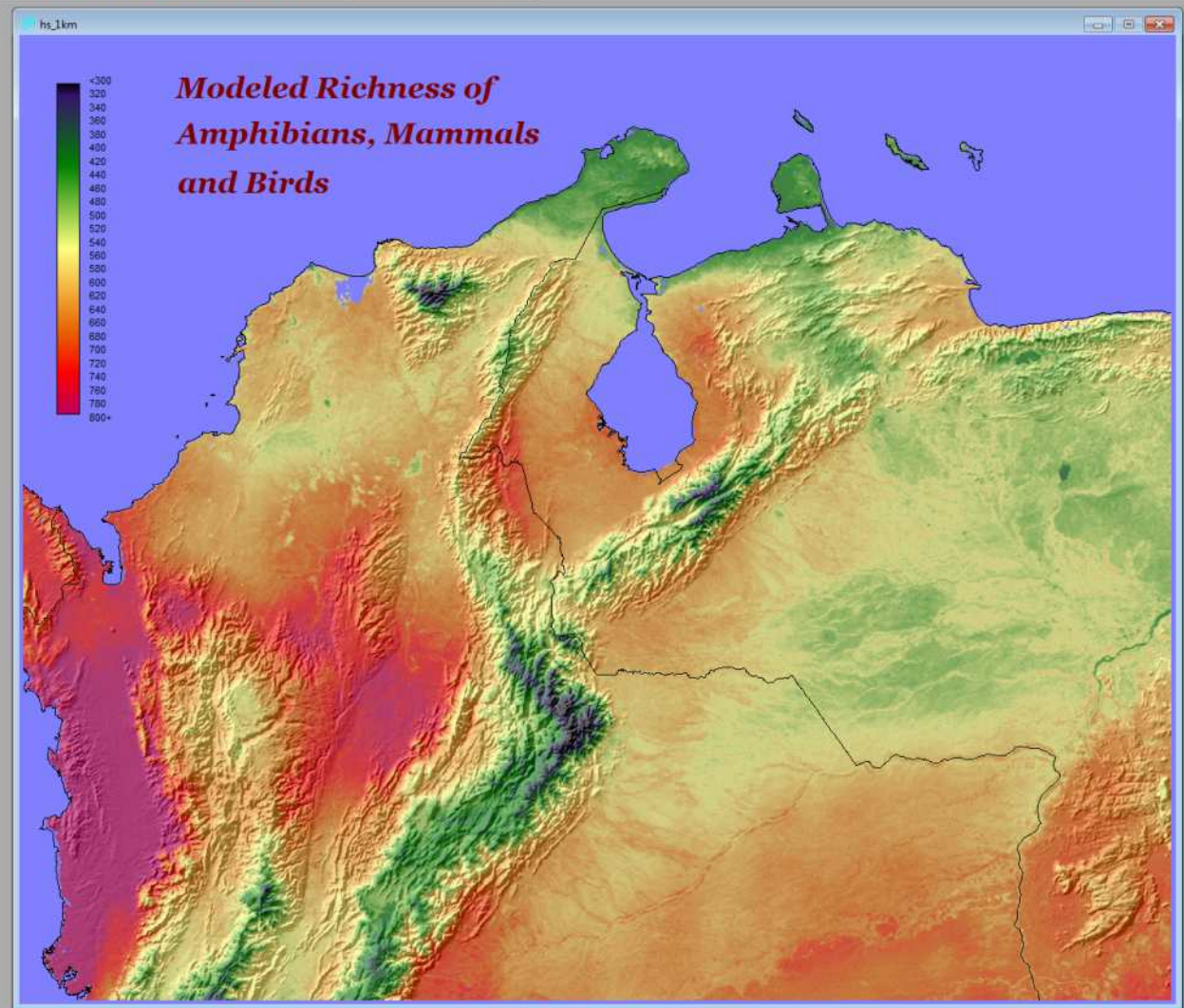


Habitat\_Biodiversity Modeler : HBM

Species | Biodiversity | Landscape Analysis | Planning



- Habitat Assessment
- Habitat Change / Gap Analysis
- Species Range Polygon Refinement
- Habitat Suitability / Species Distribution Modeling





# Habitat and Biodiversity Modeler: Species Distribution Modeling with Maxent

The screenshot displays the Maxent software interface within IDRISI 17.0. The main window shows the 'dromiciops\_gliroides' project with a map of Argentina displaying the 'Probability of occurrence' for the species. The map uses a color scale from yellow (low probability) to red (high probability). A legend on the left indicates the probability scale from 0.00 to 1.00. A small inset image shows a photograph of the species, a rodent.

The left sidebar contains the 'Habitat Suitability / Species Distribution Modeling' section. It includes options for 'Training data character' (None, Presence, Presence / Absence, Abundance), 'Modeling approach' (MCE, MLP, MAXENT, Mahalanobis Typicality, Logistic Regression, Weighted Mahalanobis, Multiple Regression), and 'Training site file type' (Vector, Raster, XYZ-Text, XYZ-CSV, ZXY-CSV). The 'Input training data file' is set to 'monitodelmonte'. Environmental variables are listed as 'W\_CL\_SA\_AMP\_V10\_FLAG', 'W\_CL\_SA\_AMT\_V01\_FLAG', 'W\_CL\_SA\_MDR\_V02\_FLAG', and 'W\_CL\_SA\_MTCM\_V04A\_FLAG'. The 'Species name' is 'Dromiciops\_gliroides'. The 'MAXENT parameters' section includes options for 'Features' (Linear, Quadratic, Product, Auto), 'Output Format' (Logistic), and 'MAXENT memory usage' (512 mb, 768 mb, 1024 mb). The 'Run' button is visible at the bottom of this section.

The right sidebar shows the 'Module Results' window for the 'Maxent model for Dromiciops\_gliroides'. It contains the following text:

**Maxent model for Dromiciops\_gliroides**

This page contains some analysis of the Maxent model for Dromiciops\_gliroides, created Thu Nov 17 14:51:48 EST 2011 using Maxent version 3.3.3e. If you would like to do further analyses, the raw data used here is linked to at the end of this page.

**Analysis of omission/commission**

The following picture shows the omission rate and predicted area as a function of the cumulative threshold. The omission rate is calculated both on the training presence records, and (if test data are used) on the test records. The omission rate should be close to the predicted omission, because of the definition of the cumulative threshold.

**Omission and Predicted Area for Dromiciops\_gliroides**

The graph shows the 'Fractional value' (y-axis, 0.0 to 1.0) versus the 'Cumulative threshold' (x-axis, 0 to 100). Three curves are plotted: a red curve for 'Fraction of background predicted', a blue curve for 'Omission on training samples', and a black curve for 'Predicted omission'. The blue curve is the highest, followed by the black curve, and the red curve is the lowest. All curves start at (0,0) and end at (100,1.0).

The next picture is the receiver operating characteristic (ROC) curve for the same data. Note that the specificity is defined using predicted area, rather than true commission (see the paper by Phillips, Anderson and Schapire cited on the help page for discussion of what this means). This implies that the maximum achievable AUC is less than 1. If test data is drawn from the Maxent distribution itself, then the maximum possible test AUC would be 0.959 rather than 1; in practice the test AUC may exceed this bound.

At the bottom of the interface, the status bar shows coordinates: RF 1:11133846, c:1018, r:1022, x:-68.667274, y:-40.812903.

# Habitat and Biodiversity Modeler: Habitat Assessment

IDRISI 15.0 The Andes Edition  
 File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

**Land Change Modeler: ES**  
 Change Analysis | Transition Potentials | Change Prediction | Implications | Planning

**Species Range Polygon Refinement**  
**Habitat Suitability / Species Distribution**  
**Habitat Assessment**

Analyze:  Earlier land cover map  Later land cover map  Current prediction

Land cover	Include as potential habitat	Gap distance within range	Gap distance outside range
Industrial / Commercial	No	0	0
Residential (<2 acre + multi-la	No	0	100
Residential (>2 acre)	No	0	500
Transportation	No	0	0
Other Urban	No	50	2000

Gap crossing distance units: m

**Primary Habitat Patches:** Minimum Core Area: 42.2 km<sup>2</sup>, Min. Edge Buffer: 120 m, Min Habitat Suitability: 0.75  
**Secondary Habitat Patches:** Minimum Core Area: 1.55 km<sup>2</sup>, Min. Edge Buffer: 120 m, Min Habitat Suitability: 0.50

**Primary Potential Corridors:** Min. Edge Buffer: 120 m, Min Habitat Suitability: 0.25  
**Secondary Potential Corridors:** Min. Edge Buffer: 60 m, Min Habitat Suitability: 0.00

Consider habitat suitability. Habitat suitability map: hab\_suitability  
 Create Analysis Output layer name: habitat\_status\_0

**Biodiversity Analysis**  
**Habitat Change / Gap Analysis**

Analyze:  Habitat Change  Protection Gaps

Units: hectares  
 First habitat status map: hab85  
 Second habitat status map: hab99

Gains and Losses  Net Change

Category	Change (hectares)
Primary Habitat	-20000
Secondary Habitat	20000
Primary Potential Corridor	30000
Secondary Potential Corridor	35000
Unsuitable	15000

**Landscape Pattern and Change Process Analysis**

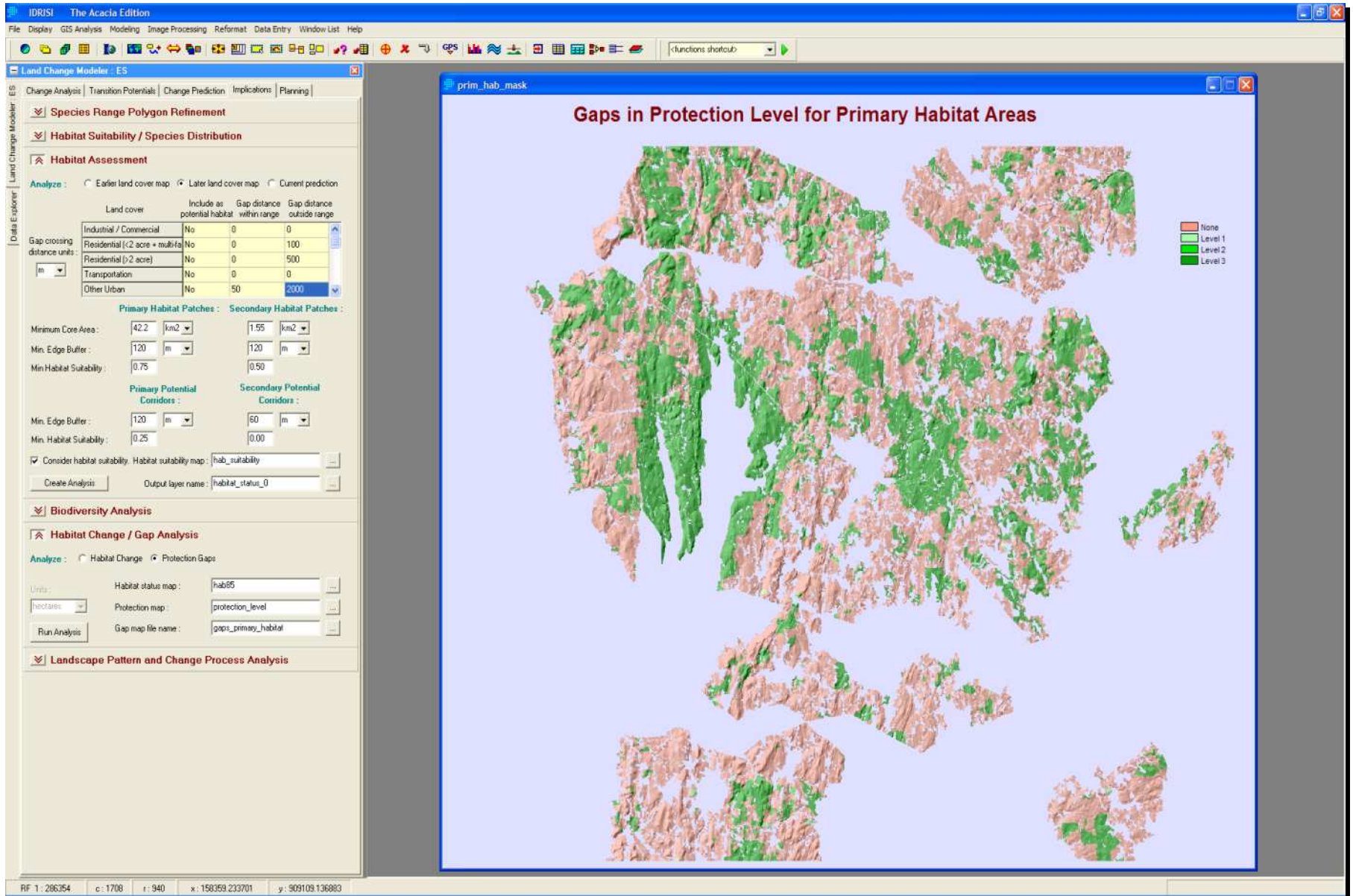
**cmab5b\_habitats**  
**Habitat Status 1985**

**cmab99b\_habitats**  
**Habitat Status 1999**

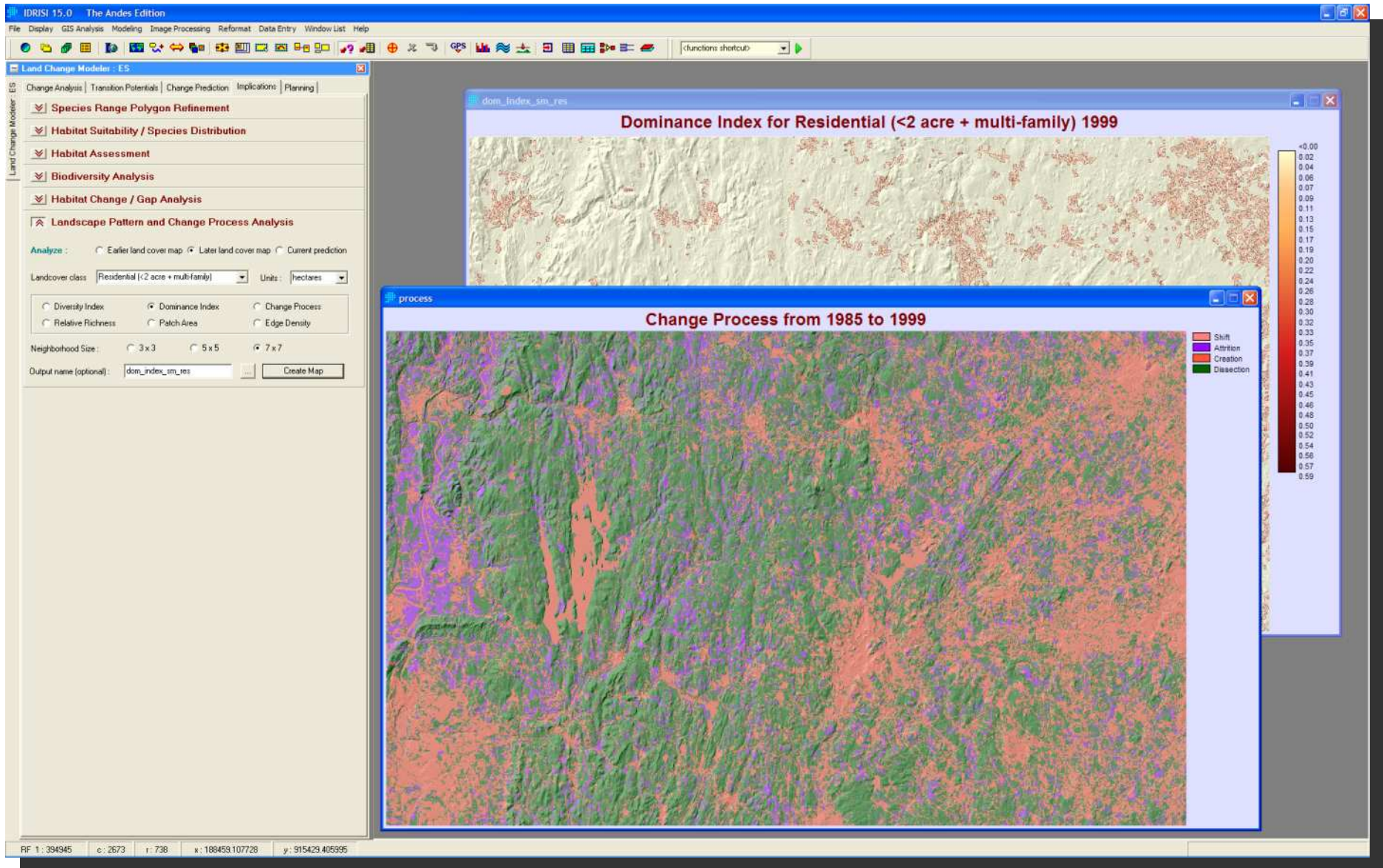
PF 1: 387714 c: 1914 r: 514 x: 164795.543048 y: 922409.078453



# Habitat and Biodiversity Modeler: Gap Analysis



# Landscape Assessment





# IUCN Subset Tool

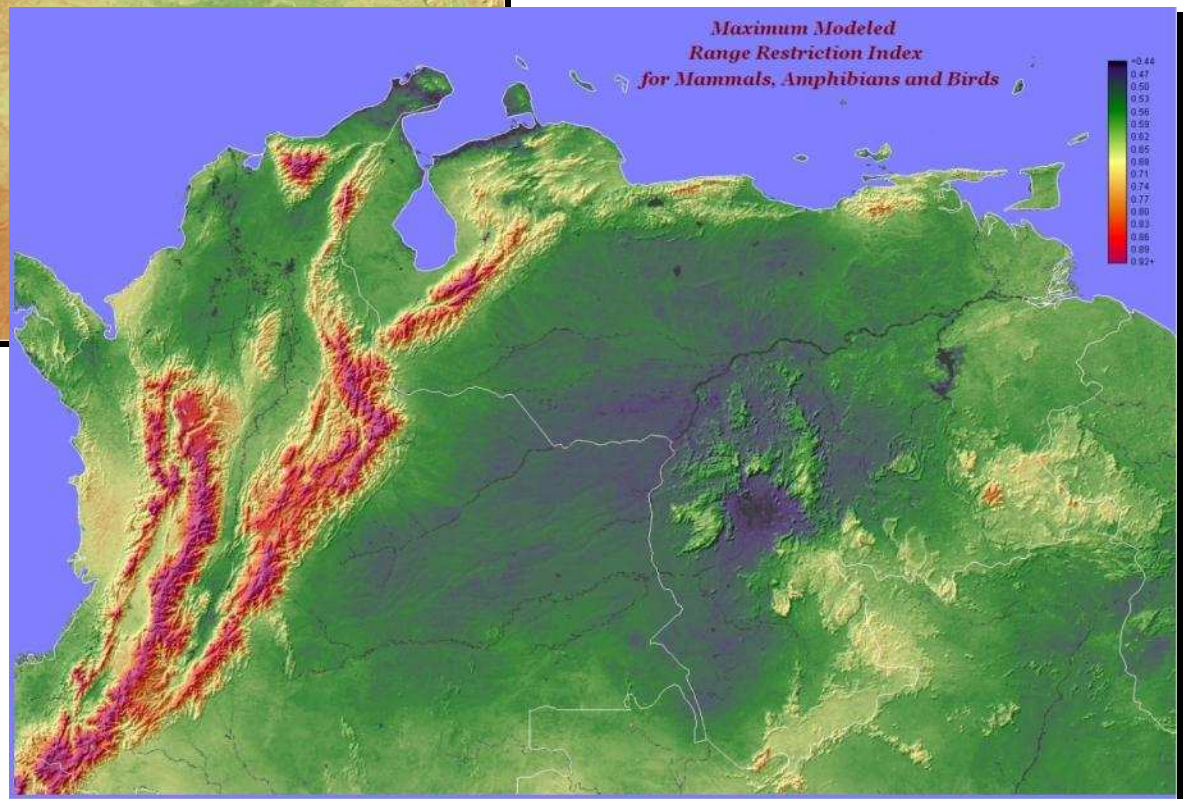
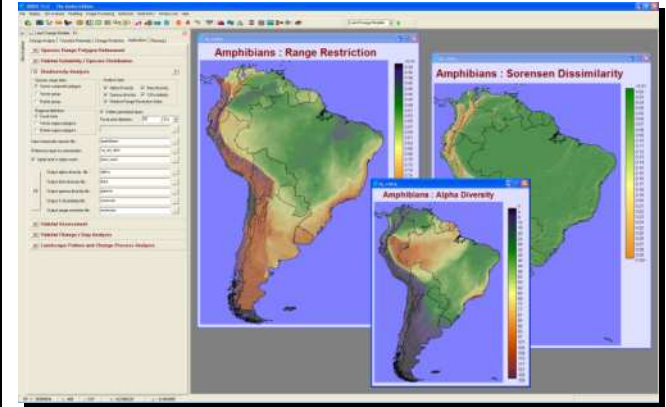
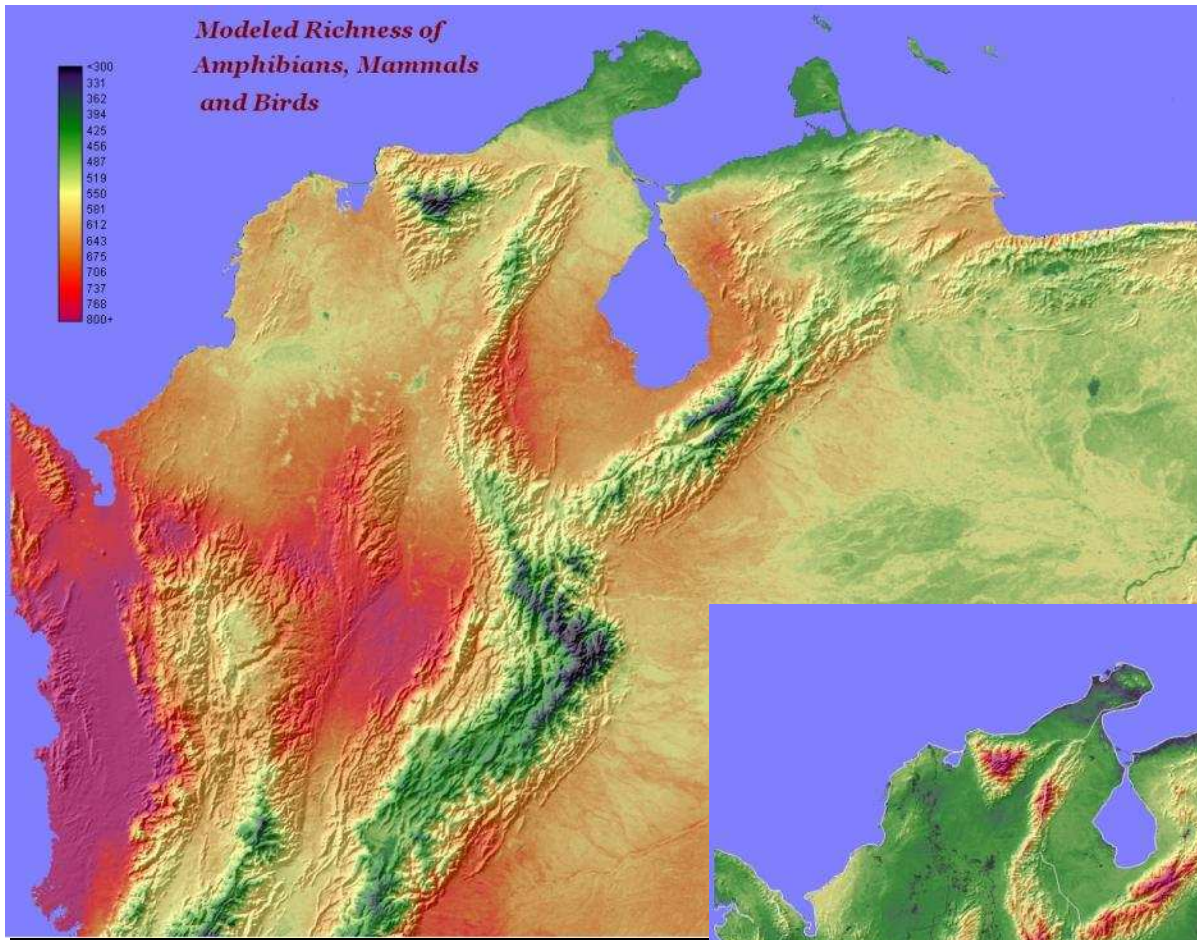
The screenshot displays the IUCN Subset Tool interface within IDRISI 18.0. The main window is titled "Habitat and Biodiversity Modeler: HBM" and contains several panels:

- Species Biodiversity | Landscape Analysis | Planning**: A top navigation bar.
- Subset IUCN Species Ranges**: A control panel with the following settings:
  - IUCN species Red List CSV file: mammals\_higher\_taxonomy.csv
  - IUCN species polygon file: mammals\_i\_1.vct
  - IUCN species database (MDB): mammals.mdb
  - Species identifier field: i\_1
  - Spatial subset option:  Bounding rectangle,  Bounding polygon
  - Red List status subset options:
    - Least Concern (LC)
    - Near Threatened (NT)
    - Vulnerable (VU)
    - Endangered (EN)
    - Critically Endangered (CR)
    - Extinct in the Wild (EW)
    - Extinct (EX)
    - Data Deficient (DD)
  - Bounding rectangle: Min X: -83, Max X: -30, Min Y: -65, Max Y: 14
  - Bounding polygon: Bounding polygon vector file: [empty]
  - Include species if:  Range intersects,  Range is endemic
  - Output prefix: sa\_endemic\_vu+
  - Run button
- Biodiversity Analysis**: A section currently collapsed.

Two map windows are visible:

- sa\_endemic\_vu+\_iucn\_status**: Shows a map of South America with a complex network of black lines representing species ranges.
- alpha\_endemic\_vu+**: Shows a heatmap titled "SA: Frequency of Red List Endemic Mammals (VU/EN/CR/EW/EX)". The map uses a color scale from 0 (dark green) to 13 (dark red) to indicate the frequency of endemic mammals. A legend on the right side of the map shows the color scale.

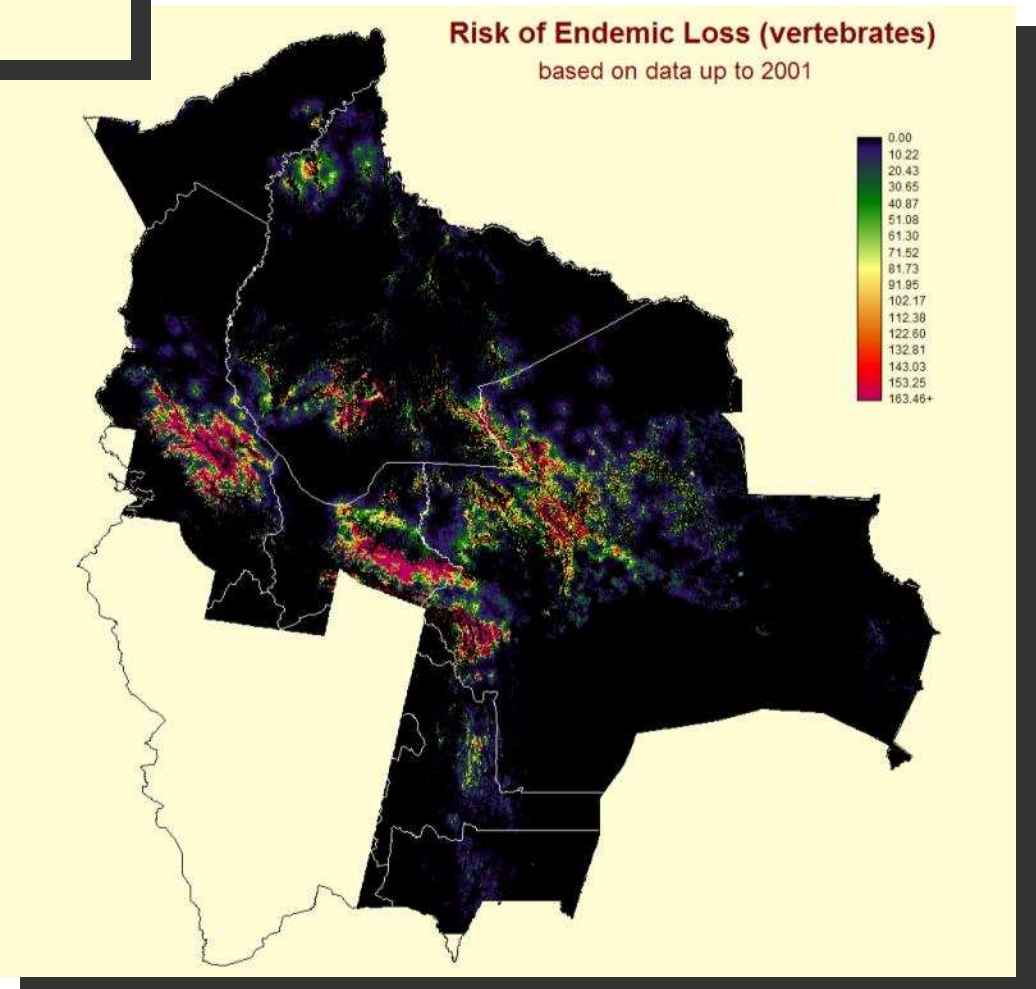
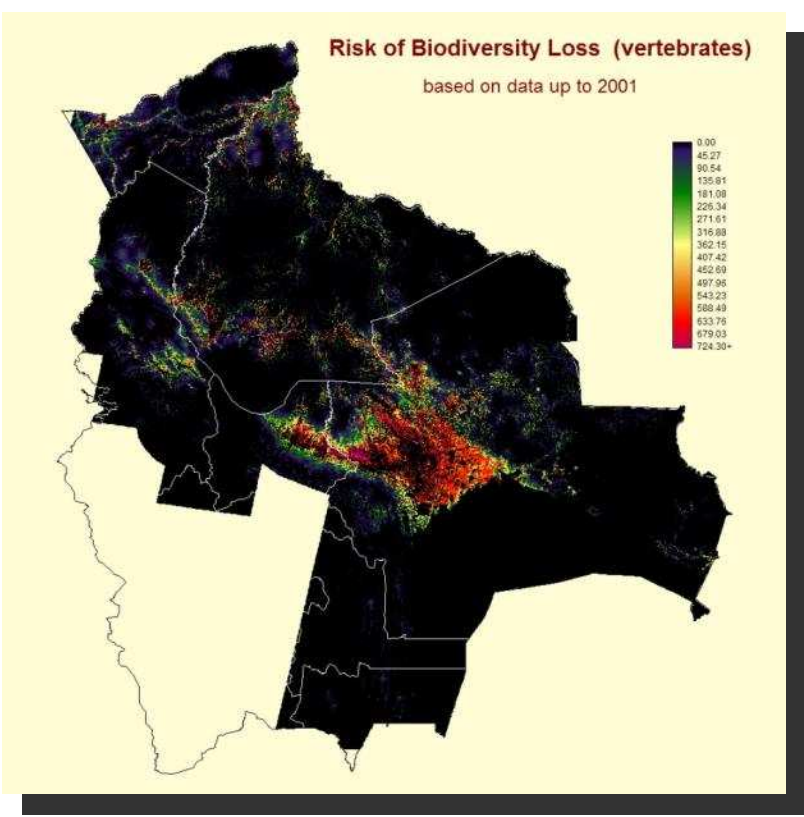
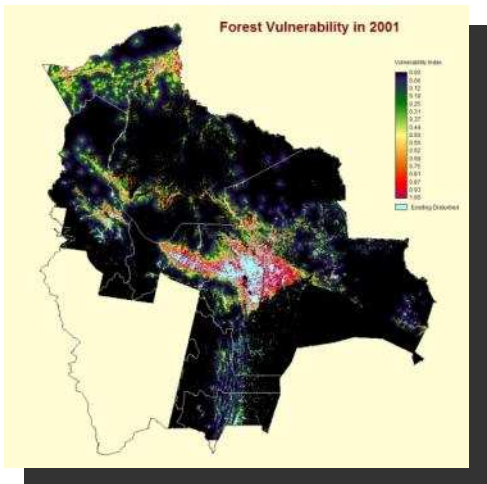
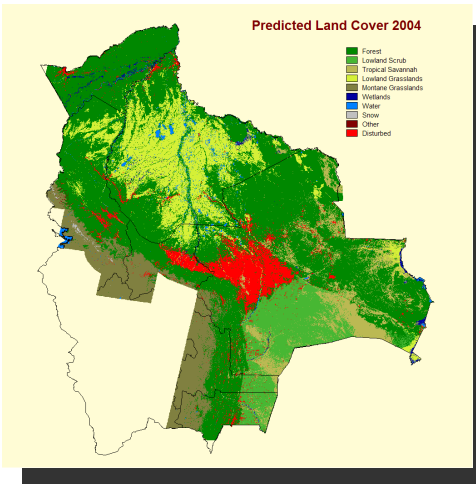
At the bottom of the interface, there are logos for CLARK LABS, CONSERVATION INTERNATIONAL, and GORDON AND BETTY MOORE FOUNDATION. The status bar at the very bottom shows coordinates: RF 1 : 35908133, e : 408, r : 946, x : -62.592444, y : -33.340345.



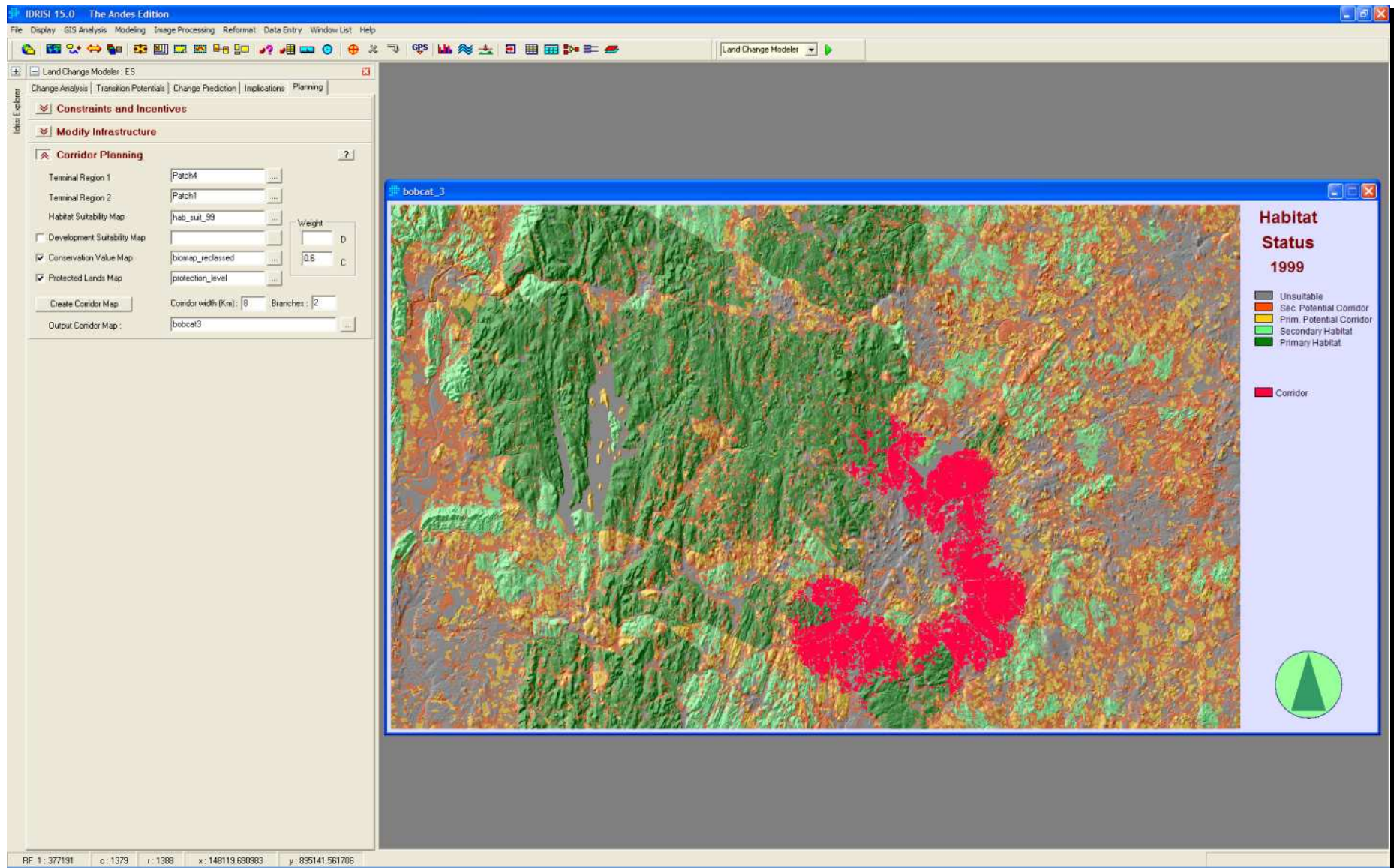
# Biodiversity Analysis



# Biodiversity Analysis



# Habitat and Biodiversity Modeler: Corridor Planning





# Climate Change Adaptation Modeler





Model Global Warming and Sea Level Rise - MAGICC

Model parameters

Emission scenario: A1B-AIM  
 Carbon cycle model: Mid  Carbon cycle climate feedbacks  
 Thermohaline circulation: Variable Aerosol forcing: Mid  
 Vertical diffusion (Kz): 2.3 cm<sup>2</sup>/s Ice melt: Medium  
 Sensitivity (Delta T2x): 4.0 °C Model: User

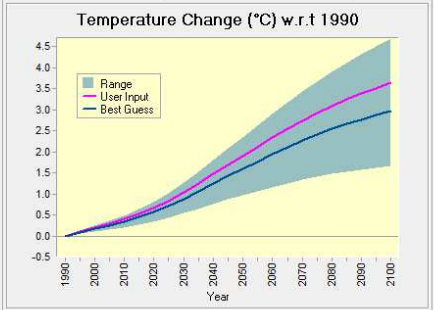
Output parameters

Reference year for climate model output: 1990  
 Last year for climate model run: 2100  
 Interval for climate model: 5

Revert to default setting Run

MAGICC output

Temperature change  Sea level rise View report



Generate Climate Scenarios - SCENGEN

Module Results

Emissions profile: A1BAIM Date: 24 Oct 2013

MID CONCENTRATION PROJECTION FOR CO2  
 (CO2-CLIMATE FEEDBACK INCLUDED)  
 MID CONCENTRATION PROJECTION FOR CH4  
 MID 1990 FORCINGS FOR SO4 AEROSOL  
 STRAT OZONE DEPLETION FEEDBACK INCLUDED  
 FOR HALOCARBONS NOT IN GAS.EMK, EMS CONSTANT AFTER 2100

CLIMATE MODEL SELECTED = MAGICC  
 USER ICE MELT = MID  
 NO EXTRA FORCING ADDED

CO2-DOUBLING FORCING IN W/M\*\*2 = 3.708  
 1990 DIRECT AEROSOL FORCING = -.400W/m\*\*2  
 1990 INDIRECT AEROSOL FORCING = -.700W/m\*\*2  
 1990 BIOMASS AEROSOL FORCING = .025W/m\*\*2  
 1990 FOSSIL ORG C + BLACK C FORCING = .244W/m\*\*2  
 STRAT H2O FROM CH4 : DELQH2O/DELQCH4 = .050

.....

NSIM = 1 : DELT(2XCO2) = 1.800DEGC  
 FULL GLOBAL SO2 EMISSIONS

IVARW SET AT 2  
 PERMANENT THC SHUTDOWN AT W = 2.80M/YR  
 W = ZERO WHEN TEMPERATURE = 8.00degC  
 ACTIVE W SCALED WITH GLOBAL-MEAN TEMPERATURE

XKMS= 1.0 : XKLO= 1.0  
 RM= 60.0M : XK=2.3000CM\*\*2/SEC  
 PI= .2000 : INITIAL W= 4.00M/YR

DIFF/L SENSITIVITY CASE : RLO = 1.300 : XLAML = 1.4261 : XLAMO = 3.0976

1880-1990 CHANGES : GLOBAL DTMP = .233 : DMSL = 4.198  
 DTNHL = .158 : DTNHO = .249 : DTSHL = .209 : DTSHO = .269  
 DTNH = .211 : DTSH = .256 : DTLAND = .175 : DTIOCEAN = .260

\*\* TEMPERATURE AND SEA LEVEL CHANGES FROM 1990 \*\*  
 (FIRST LINE GIVES 1765-1990 CHANGES : ALL VALUES ARE MID-YEAR TO MID-YEAR)

DT2X = 1.50 : VARIABLE W

LOW CLIMATE AND SEA LEVEL MODEL PARAMETERS

YEAR	DELTAQ	TEQU	TEMP	EXPN	GLAC	GREENL	ANTAR 2-XTRA	MSLTOT	TNH	TSH	WNH	
T01990	1.112	.450	.2748	2.71	1.96	.00	.00	.00	4.67	.247	-.302	3.96
1990	.0000	.000	.0000	.00	.00	.00	.00	.00	.000	.000	.000	3.96
1995	-.1566	-.063	-.0526	.38	.08	-.01	-.08	.00	.36	.061	-.044	3.95
2000	-.3813	-.134	-.1079	.79	.16	-.03	-.18	.00	.75	.125	-.091	3.94
2005	-.4809	-.195	-.1544	1.23	.25	-.04	-.29	.00	1.15	.174	-.134	3.93
2010	-.6721	-.272	-.2091	1.71	.35	-.06	-.41	.00	1.60	.234	-.185	3.93
2015	-.8908	-.360	-.2742	2.26	.46	-.08	-.55	.00	2.09	.306	-.243	3.92
2020	1.1153	.451	.3434	2.85	.58	-.11	-.71	.00	2.62	.382	-.304	3.91
2025	1.4189	.574	.4358	3.52	.72	-.13	-.89	.00	3.22	.493	-.379	3.89
2030	1.7389	.703	.5375	4.27	.87	-.16	-1.09	.00	3.88	.614	-.451	3.88
2035	2.0850	.843	.6507	5.11	1.03	-.20	-1.32	.00	4.61	.750	-.551	3.86

Print Contents Save to File Copy to Clipboard Close



IDRISI 18.0 The Coral Edition

File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

Climate Change Adaptation Modeler : CCAM

About CCAM Generate Scenario Impact Analysis Preprocess

Model Global Warming and Sea Level Rise - MAGICC

Generate Climate Scenarios - SCENGEN

Scenario: **A1B-AIM**

Climate scenario generation

Month Season Annual Climatology July

Variable

Mean temperature Precipitation Exponential scaling

Scenario year: 2100

Models

BCCRCM2  CSIRO-3.0  GFDL-CM2.1  IPSL-CM4  MRI-232A

CCCMA-3.1  ECHO-G  GISS-EH  MIROC-HI  NCARPCM1

CCCMA-3.0  FGOALS1G  GISS-ER  MIROC-MED  UKHADCM3

CNRM-3  GFDL-CM2.0  INMCM-3.0  MPECH-5  UKHADGEM

Select default Select all Select none

Options

Overlay vector layer on results: world\_nations

Include spatial effects of aerosols

Drift correction  No correction  Both

Vector overlay line color

Black  Blue  Yellow

White  Cyan  Green

Output prefix: A1B-AIM\_2100\_Temperature\_July Run

CLARK LABS

GORDON AND BETTY MOORE FOUNDATION

RF 1: 190761425 c: 37 r: 33 x: -86.943396 y: 5.653266

a1b-aim\_2100\_temperature\_july\_absdel

**ABSOLUTE CHANGE IN TEMPERATURE : AVERAGE OVER 20 MODELS (degC)**

-2.15  
-1.40  
-0.64  
0.11  
0.86  
1.61  
2.37  
3.12  
3.87  
4.63  
5.38  
6.13  
6.88  
7.64  
8.39  
9.14  
9.89

Composer

a1b-aim\_2100\_tempera

world\_nations

Auto-Arrange

a1b-aim\_2100\_precipitation\_july\_absdel

**ABSOLUTE CHANGE IN PRECIPITATION : AVERAGE OVER 20 MODELS (mm/day)**

<-3.27  
-2.96  
-2.45  
-2.04  
-1.64  
-1.23  
-0.82  
-0.41  
0.00  
0.41  
0.82  
1.23  
1.64  
2.04  
2.45  
2.86  
3.27+

IDRISI 18.0 The Coral Edition

File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

Climate Change Adaptation Modeler - CCAM

About CCAM | Generate Scenario | Impact Analysis | Preprocess

**Sea Level Rise Impact**

Digital elevation model (DEM): EPam\_DEM

Projected sea level rise: 0.36

Uncertainty in the projection (RMSE): 0.18 Note: Sea level rise units must be the same as those used in the DEM

Uncertainty in the DEM (RMSE): 0.30

Overlay original coastline: epam\_arcs

Output probability image: NC\_SLR

Force existing ocean areas to have a probability of 1 Run

Crop Climatic Suitability Modeling

Derive Bioclimatic Variables

**nc\_slr**

**Eastern Pamlico, NC Probability of Inundation 2100**

Legend values:

- 0.00
- 0.06
- 0.13
- 0.19
- 0.25
- 0.31
- 0.38
- 0.44
- 0.50
- 0.56
- 0.63
- 0.69
- 0.75
- 0.81
- 0.88
- 0.94
- 1.00

Composer

- nc\_slr
- nc\_slr
- coastline2

Auto-Arrange

CLARK LABS

GORDON AND BETTY MOORE FOUNDATION

RF: 1: 97503 c: 10509 r: 1409 x: 359017.176574 y: 3897178.794293



IDRISI 18.0 The Coral Edition

File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

Climate Change Adaptation Modeler - CCAM

About CCAM Generate Scenario Impact Analysis Preprocess

Life Exposure

Sea Level Rise Impact ?

Crop Climatic Suitability Modeling ?

Monthly climatology datasets

Precipitation: WIN\_Fut\_precip\_bk ...

Min temperature: WIN\_Fut\_TMIN ...

Mean temperature: WIN\_Future\_Taverage ...

Mask: ...

Crop parameters

Retrieve parameters from database Specify crop parameters directly

Crop database

Search string: blueber

Common name: Lowbush bluebr Scientific name: Vaccinium angustifolius

Growing season (days)		Precipitation (mm)		Temperature (Celsius)	
Min length:	100	Min:	400	Min:	4.00
Max length:	180	Optimum min:	600	Optimum min:	13.00
Mean length:	140.0	Optimum max:	900	Optimum max:	20.00
Used length:	140.0	Max:	1100	Max:	30.00
				Kil:	-40.00

Module parameters

Precipitation and temperature Precipitation only Temperature only

Rain duration considered Interaction of rain and temperature scores

Rain during growing season Multiply temperature and precipitation scores

Rain during year Min of temperature and precipitation scores

Output image: blueberry\_min\_2070 Run

Bioclimatic Variables ?

Species Distribution Impact ?

CLARK LABS

GORDON AND BETTY MOORE FOUNDATION

RF 1: 29402908 c: 2540 r: 3101 x: -72.136909 y: 37.346128

blueberry\_min

Suitability for Low Bush Blueberry: Present

0.00  
0.06  
0.13  
0.19  
0.25  
0.31  
0.38  
0.44  
0.50  
0.56  
0.63  
0.69  
0.75  
0.81  
0.88  
0.94  
1.00

blueberry\_min\_2070

Suitability for Low Bush Blueberry: 2070 HadGemAO RCP8.5

0.00  
0.06  
0.13  
0.19  
0.25  
0.31  
0.38  
0.44  
0.50  
0.56  
0.63  
0.69  
0.75  
0.81  
0.88  
0.94  
1.00

Climate Change Adaptation Modeler: CCAM

About CCAM | Generate Scenario | Impact Analysis | Preprocess

Sea Level Rise Impact ? |  
 Crop Climatic Suitability Modeling ? |  
 Derive Bioclimatic Variables ? |

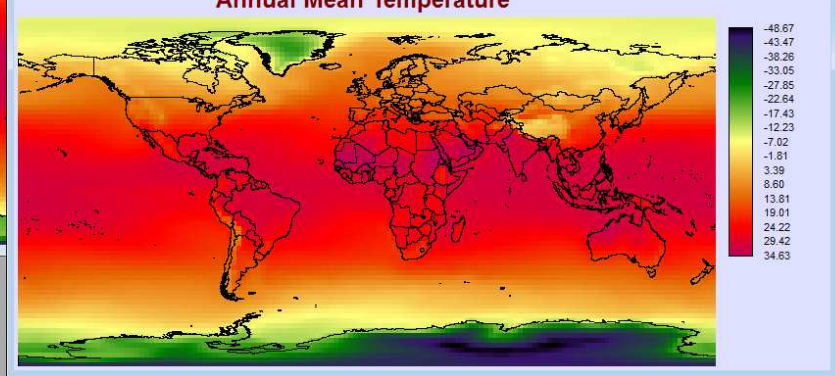
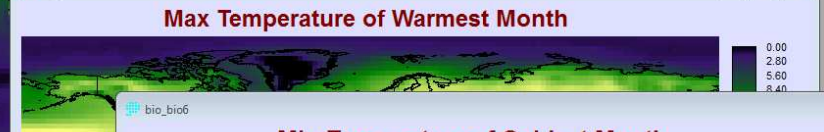
Input options  
 Minimum temperature / maximum temperature / precipitation  
 Average temperature / precipitation

Input RGF files  
 Minimum temperature:   
 Maximum temperature:   
 Average temperature: A1B-AIM\_2100\_Temperature\_Climatology\_Mont ...  
 Precipitation: A1B-AIM\_2100\_Precipitation\_Monthly\_Monthly\_ ...

Output  
 Output prefix: bio

Mask:

Run





# Ecosystem Services Modeler



natural  
capital  
PROJECT

CLARK LABS



- Ecosystem Services Modeler : ESM
- Crop Pollination
  - Habitat Quality and Rarity
  - Habitat Risk Assessment
  - Hydropower
  - Marine Aquaculture
  - Offshore Wind Energy
  - Recreation
  - Sediment Retention
  - Timber Harvest
  - Water Purification
  - Water Yield
  - Wave Energy
  - About ESM
  - Aesthetic Quality
  - Carbon Storage and Sequestration
  - Coastal Vulnerability

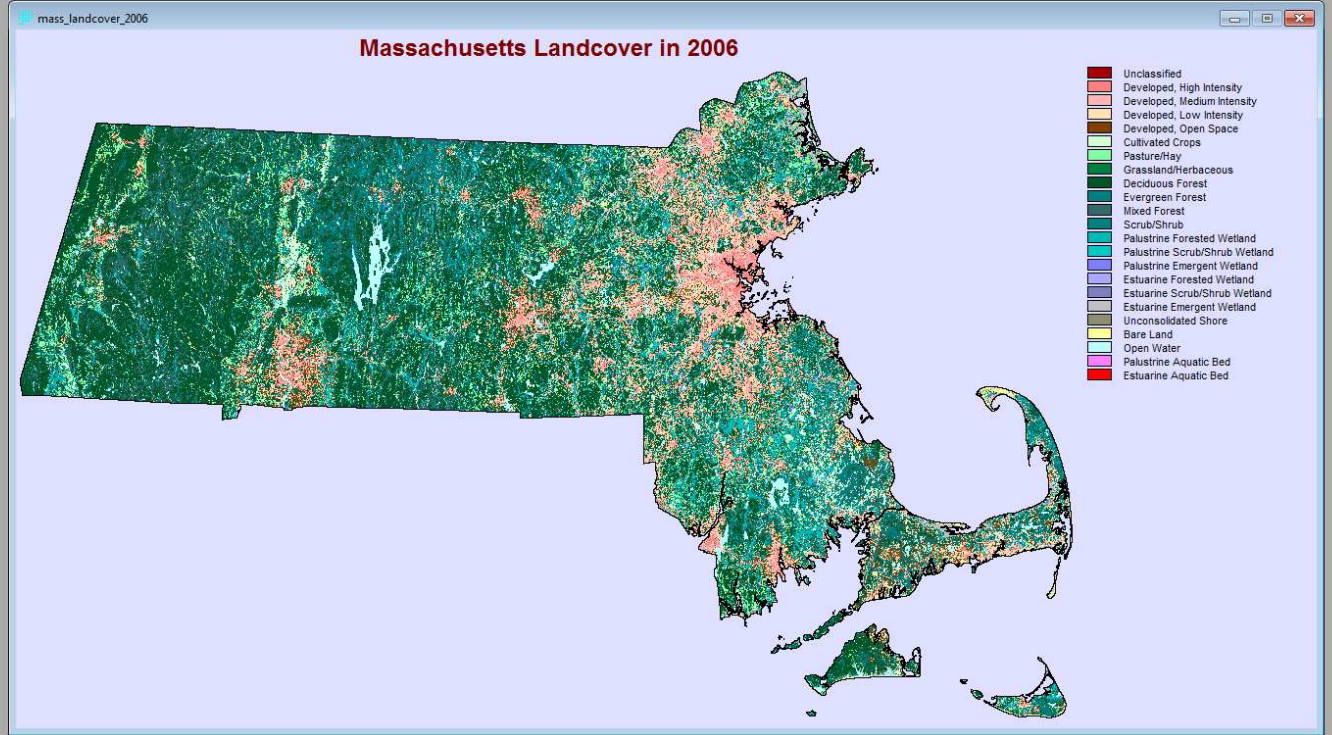


## Ecosystem Services Modeler

### About the Ecosystem Services Modeler

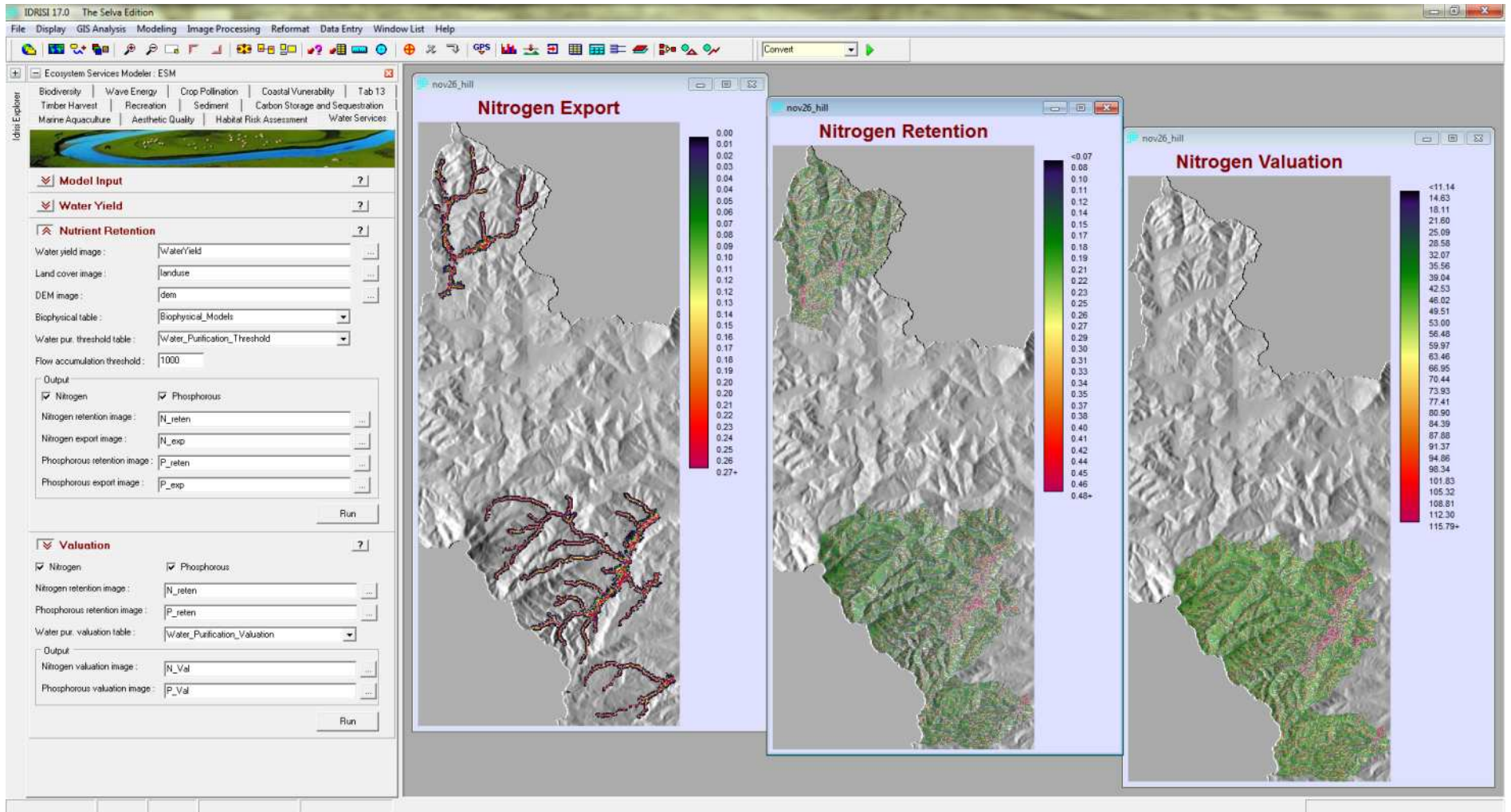
The Ecosystem Service Modeler (ESM) is closely based on the InVEST toolkit developed by the Natural Capital Project - a partnership between the Wood's Institute for the Environment at Stanford University, The Nature Conservancy, the World Wildlife Fund and the Institute on the Environment at the University of Minnesota. In a few instances we have modified the InVEST models when the underlying procedures in the Clark Labs software constellation offer added value. In all cases, however, the fundamental spirit and algorithmic procedures developed by the Natural Capital Project have been maintained. While the InVEST documentation available on-line from the Natural Capital Project is equally relevant to the implementation in ESM, it should be noted that there may be version differences between the two implementations. Reference should primarily be made to the documentation in ESM and all technical inquiries regarding the use of this software should be directed to Clark Labs.

This software implementation has been made possible through the generous support of the Gordon and Betty Moore Foundation and through a memorandum of understanding with the Natural Capital Project. We greatly appreciate the enthusiastic support of both organizations in the development of this project.

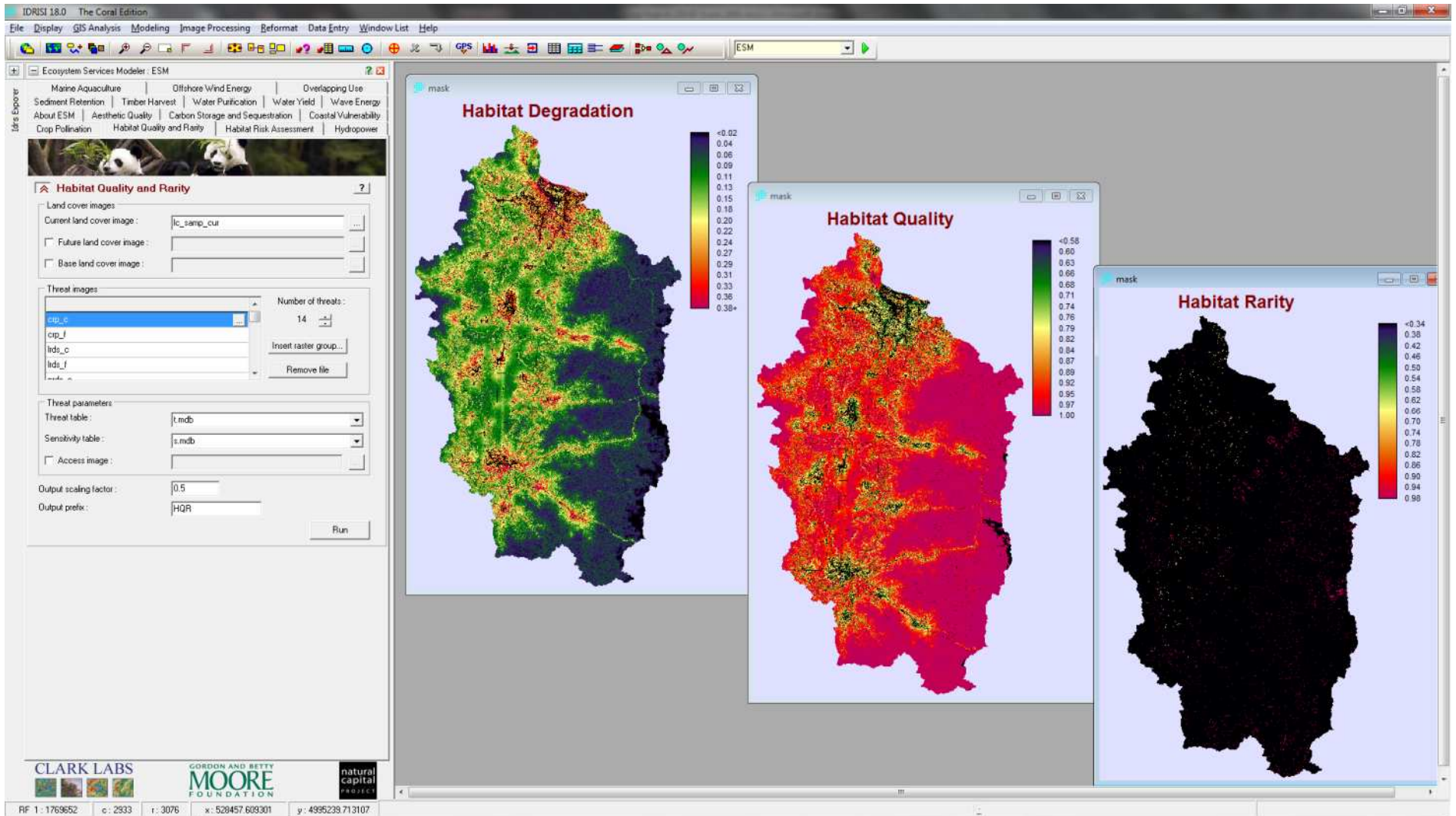




# Nutrient Retention



# Habitat Quality and Rarity





# Aquaculture

**IDRISI 18.0 The Coral Edition**

File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help

Ecosystem Services Modeler: ESM

Tools Explorer: Drop Pollination | Habitat Quality and Risk | Habitat Risk Assessment | Hydropower | Sediment Retention | Timber Harvest | Water Purification | Water Yield | Wave Energy | About ESM | Aesthetic Quality | Carbon Storage and Sequestration | Coastal Vulnerability | Marine Aquaculture | Offshore Wind Energy | Overlapping Use

**Estimation or Site Selection**

Use existing netpen polygons to estimate field  
 Map potential yield using regional sea surface temperature

Vector input:  
Netpen / farm location polygon: netpen  
Daily water temperature table: Aqua\_TempDaily.mdb  
Farm operations table: Aqua\_Operation.mdb

**Output Settings**

Growth and operation:  
Fish growth parameter (grams/day): a: 0.038 b: 0.6667  
Proportion of fish remaining after processing: 85  
Natural mortality rate on the farm (daily): 0.000137  
Duration of simulation (years): 3

Output file prefix (optional): finfish\_netpens  
 Overlay vector layer on results: Vancouver.vct

Valuation:  
 Market price of processed fish (\$/kg): 2.25  
Proportion of market price that accounts for costs: 0.3  
Annual market discount rate: 0.07

**Run**

**Finfish harvest: total harvested cycles (yr)**

**Finfish harvest: total volume harvested (kg)**

**Finfish harvest: total weight harvested (kg)**

**Finfish harvest: total volume harvested (kg)**

**Finfish harvest: net present value (thousands of \$)**

5098  
5607  
6116  
6625  
7133  
7642  
8151  
8660  
9169  
9678  
10187  
10696  
11204  
11713  
12222  
12731  
13240  
13749  
14258  
14766  
15275  
15784  
16293  
16802  
17311  
17820  
18329  
18837  
19346  
19855  
20364

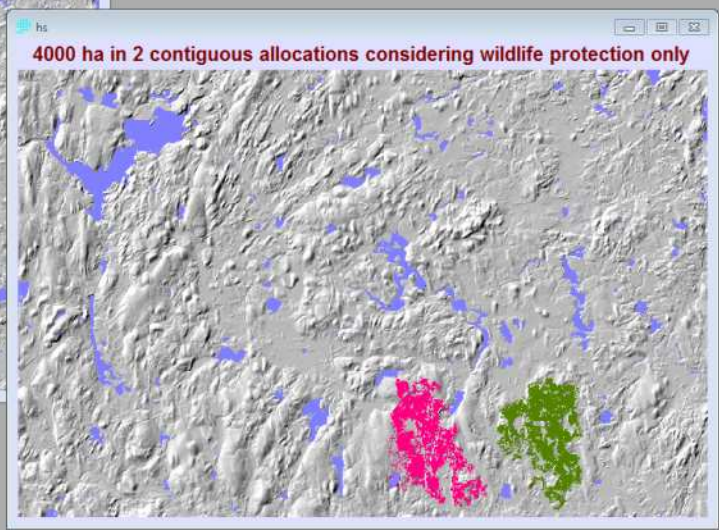
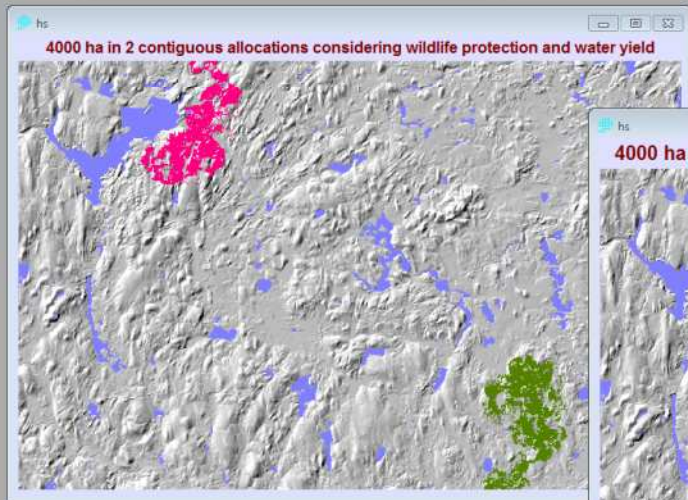
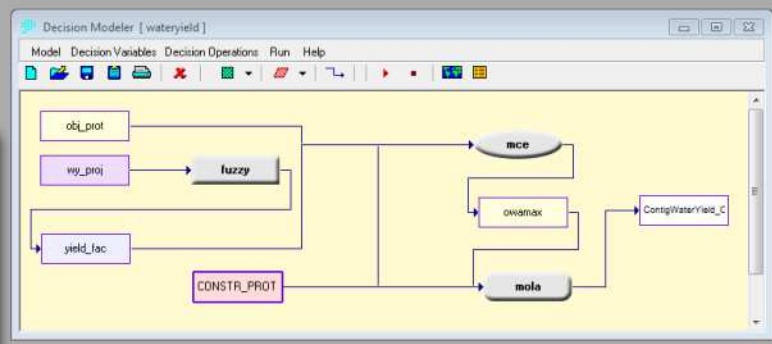
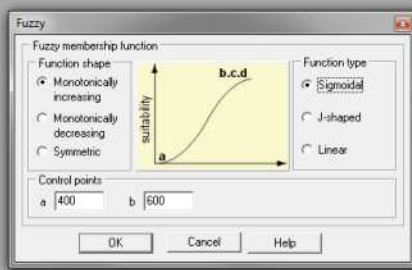
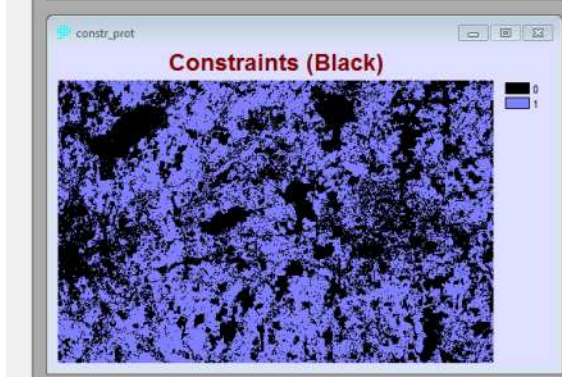
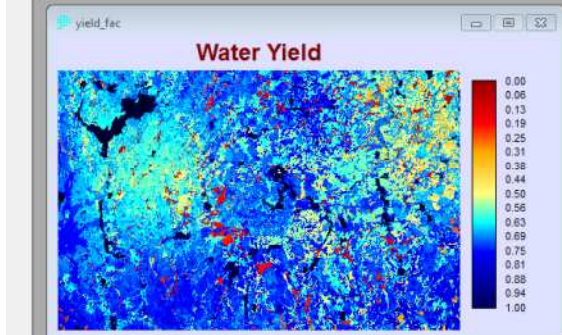
CLARK LABS  
GORDON AND BETTY MOORE FOUNDATION  
natural capital PROJECT

RF 1: 960819 x: 281256.744856 y: 5455458.234478

# Multi-Objective Decision Modeler







Integrated system that simplifies the process of:

Input data generation

Analysis of ecosystem services

Evaluation of impacts

Decision Making

By having everything integrated there is no need of importing- exporting between different software.

All models are documented and referenced. Help, manual, tutorials, customer support

By having the tools within the software allows flexibility in data inputs. Moreover we have a macro modeler interface and an API for development of new tools.

Tools for resampling, upscaling and downscaling, and disaggregation of data.

Lower level and upper level tools allows the use by people with different skills.

Many modules for future scenarios (climate and land cover)

No open source, no free ware- LOW COST (we are non-profit)... BUT there is no need of other supporting software