



127th GIS Seminar; 9th July 2015

Introducing TerrSet for Geospatial Analysis

(Actual Demo: Land change modeling)

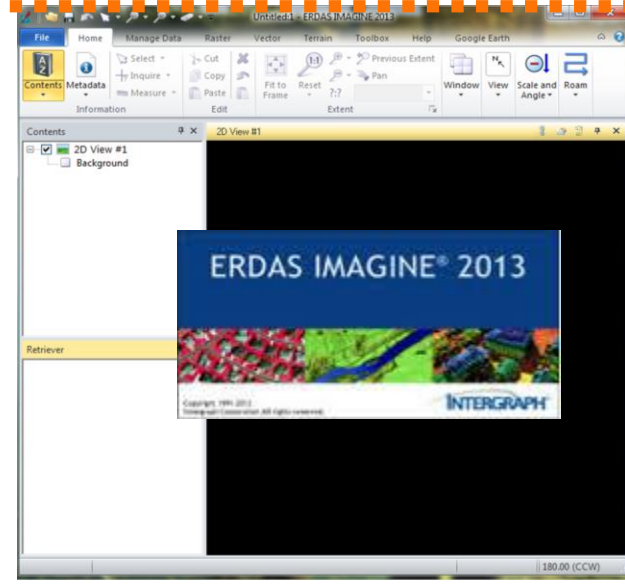
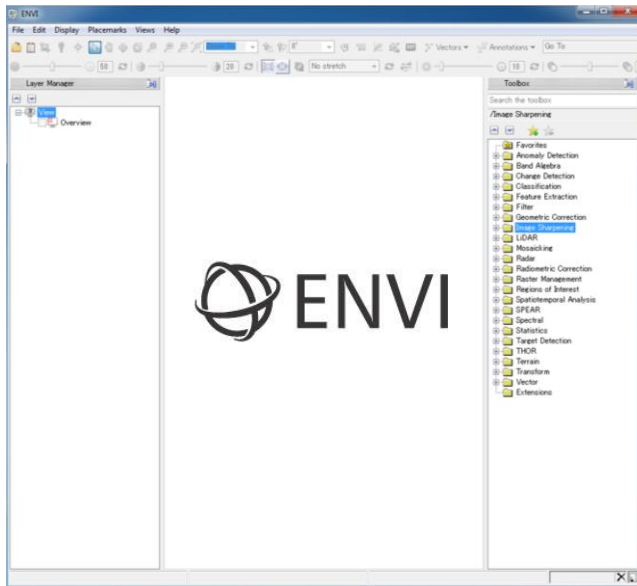
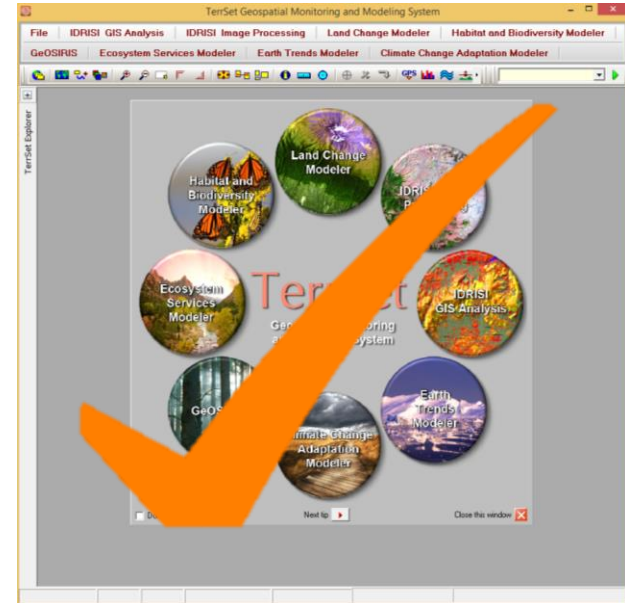
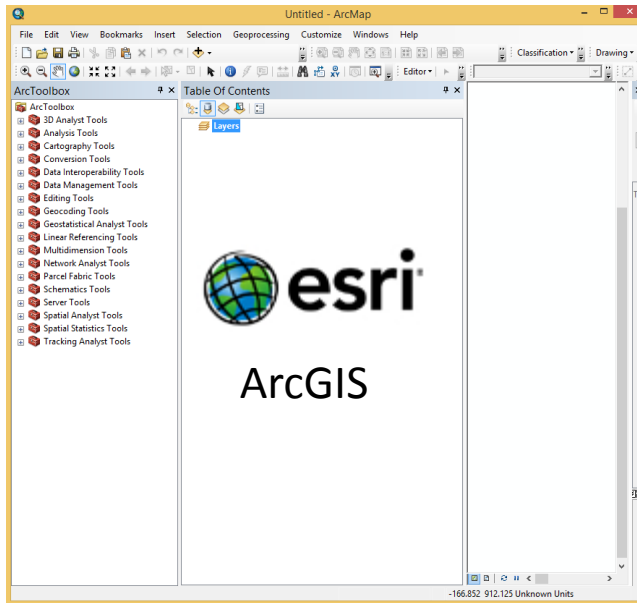
Ronald C. ESTOQUE, PhD

Researcher

University of Tsukuba, JAPAN

Inside the SIS Lab...

We have...



Contents

1. Basic info about TerrSet
 2. Data format (import/export)
 3. Some basic TerrSet modules
 - a. CROSSTAB
 - b. SAMPLE
 - c. ERRMAT
 4. TerrSet Modelers
 - a. Land change modeler
 - Modeling one-way transition
 - Modeling multiple transitions
- Image Processing*
- Accuracy assessment*

Basic info about TerrSet

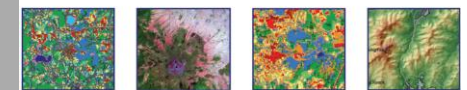
Complete Name: **TerrSet Geospatial Monitoring and Modeling System**

“incorporates the IDRISI GIS and Image Processing tools and offers a constellation of vertical applications focused on monitoring and modeling the earth system for sustainable development.”



Clark University,
MA, USA

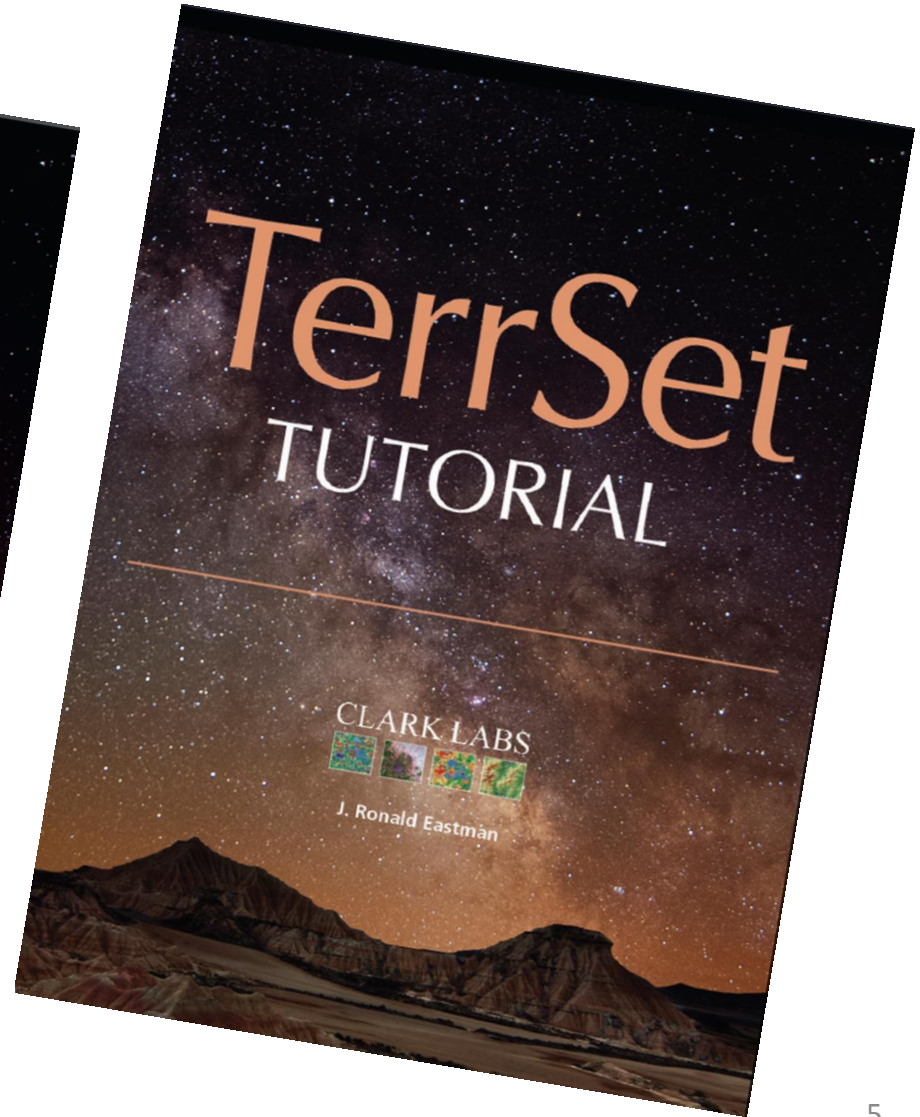
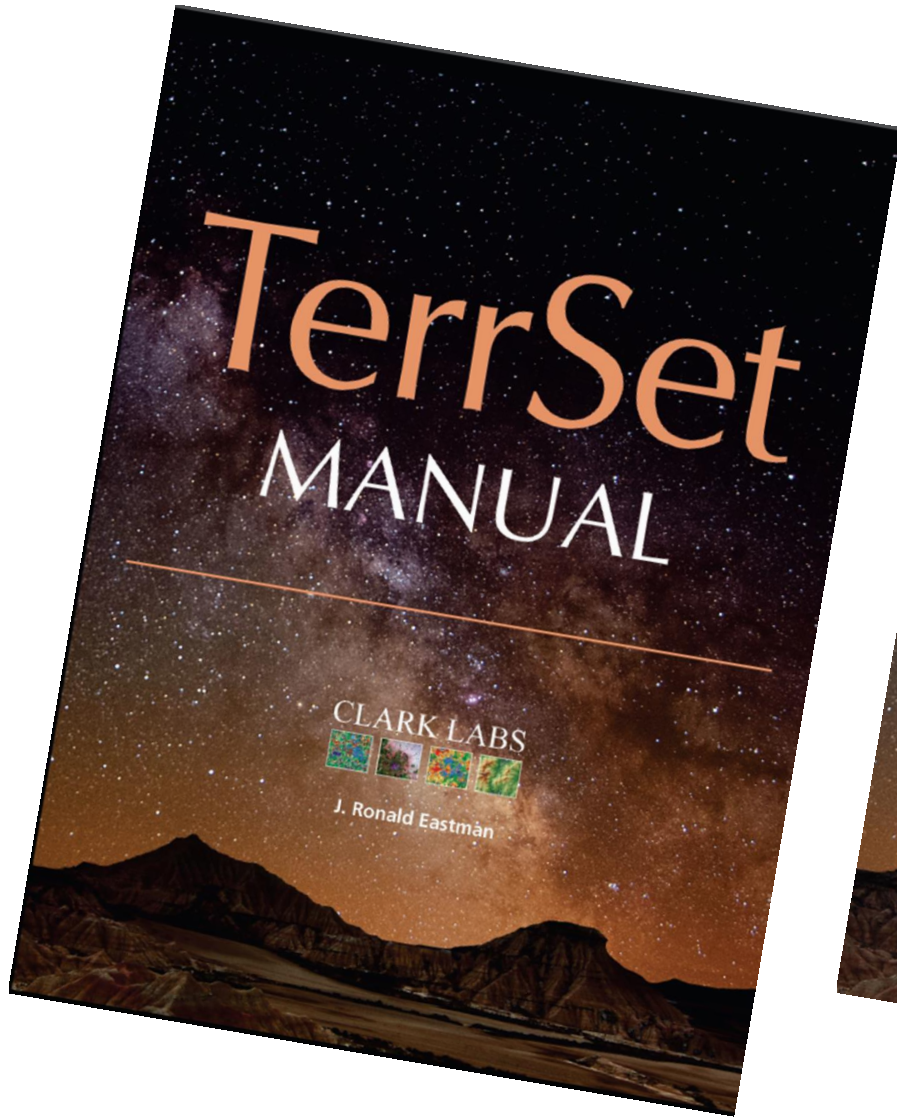
CLARK LABS



Prof. Ronald Eastman

<http://www.clarklabs.org/products/terrset.cfm>

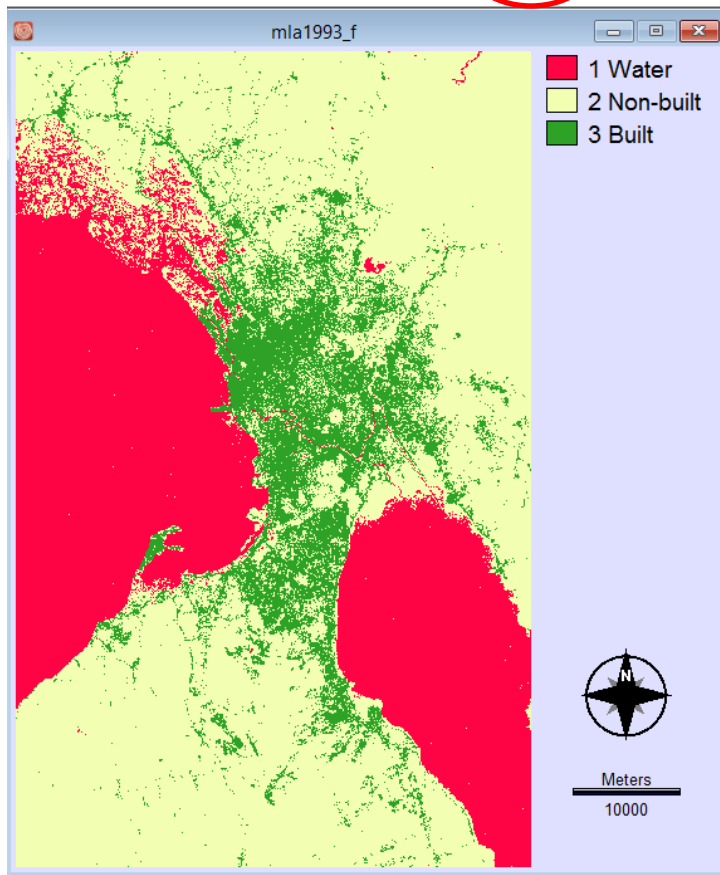
Basic info about TerrSet



1. Data format (import/export)

Raster Data

Filename.rst



RS-based LUC Map

RS – Remote Sensing

Vector Data

Filename.vct



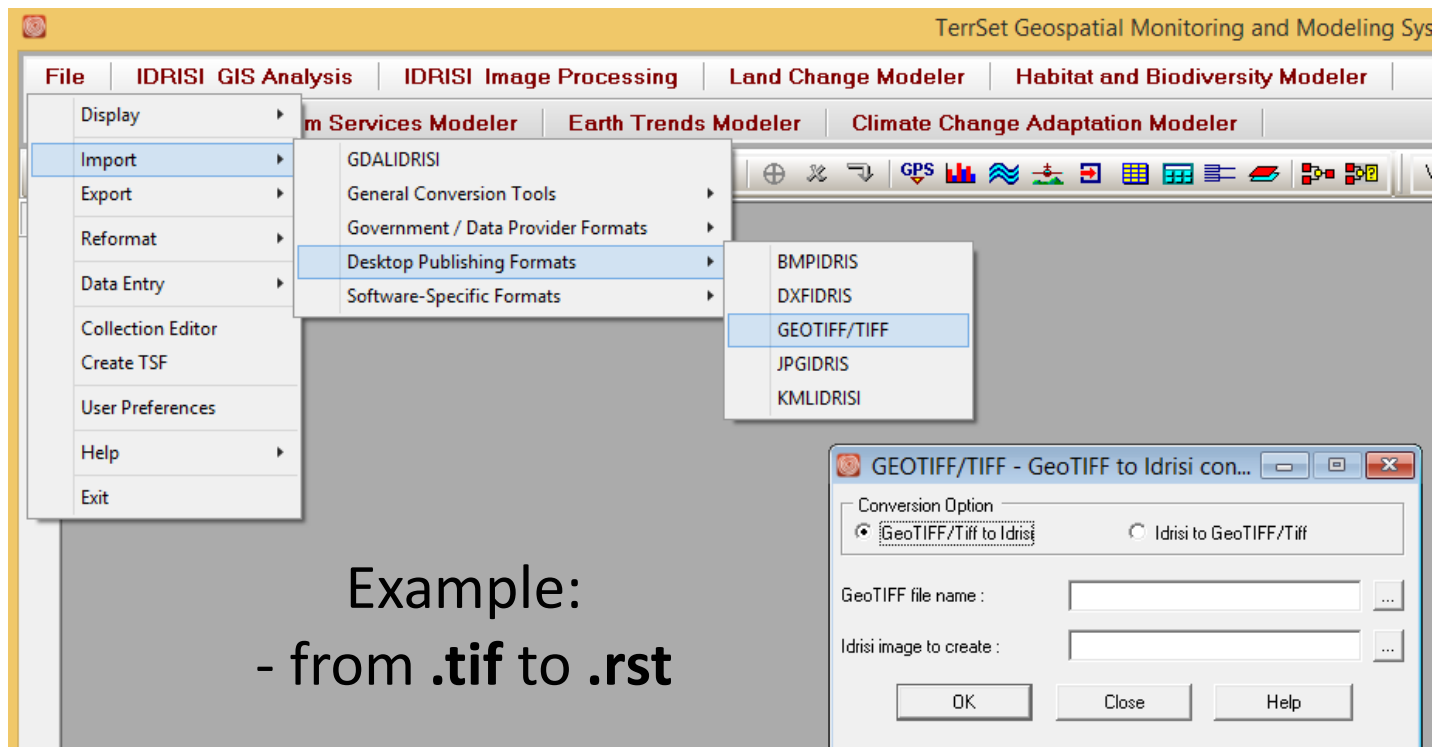
Road Network Map

LUC – Land-Use/Cover

1. Data format (import/export)★

Importing Raster Data into TerrSet format

- ArcGIS grid > (Convert using ArcGIS) > ASCII > (import using TerrSet) > **.rst**
- .tif, .img, etc. > (import using TerrSet) > **.rst**



*From **.rst** to **.tif** – Use the **Export** module to reverse the process.

1. Data format (import/export)★

Importing Vector Data (.shp) into TerrSet format

- ArcGIS .shp > (import using TerrSet) > **.vct**

The screenshot displays the TerrSet Geospatial Monitoring and Modeling System interface. The 'File' menu is open, showing the 'Import' option. A sub-menu for 'Software-Specific Formats' is also open, with 'ESRI Formats' selected. Within 'ESRI Formats', the 'SHAPEIDR' option is highlighted. A dialog box titled 'SHAPEIDR - Shapefile / Idrisi conversion' is open, showing the 'Shapefile to Idrisi' radio button selected. The dialog includes fields for 'Input Shapefile', 'Output Idrisi vector file', 'Reference system' (set to 'plane'), 'Reference units' (set to 'meters'), and 'Unit distance' (set to '1.0').

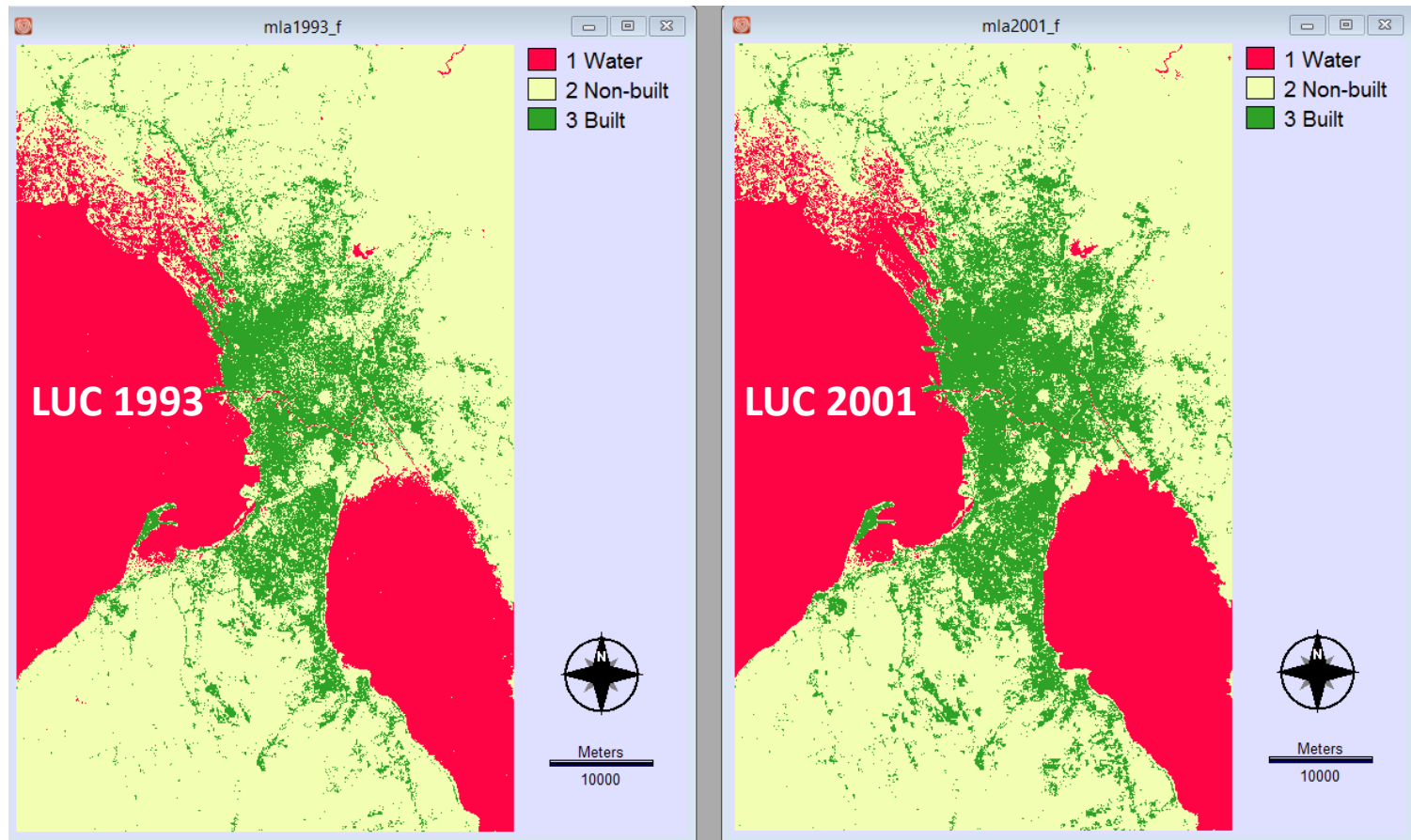
Example:
- from **.shp** to **.vct**

*From **.vct** to **.shp** – Use the **Export** module to reverse the process.

2. Basic TerrSet modules

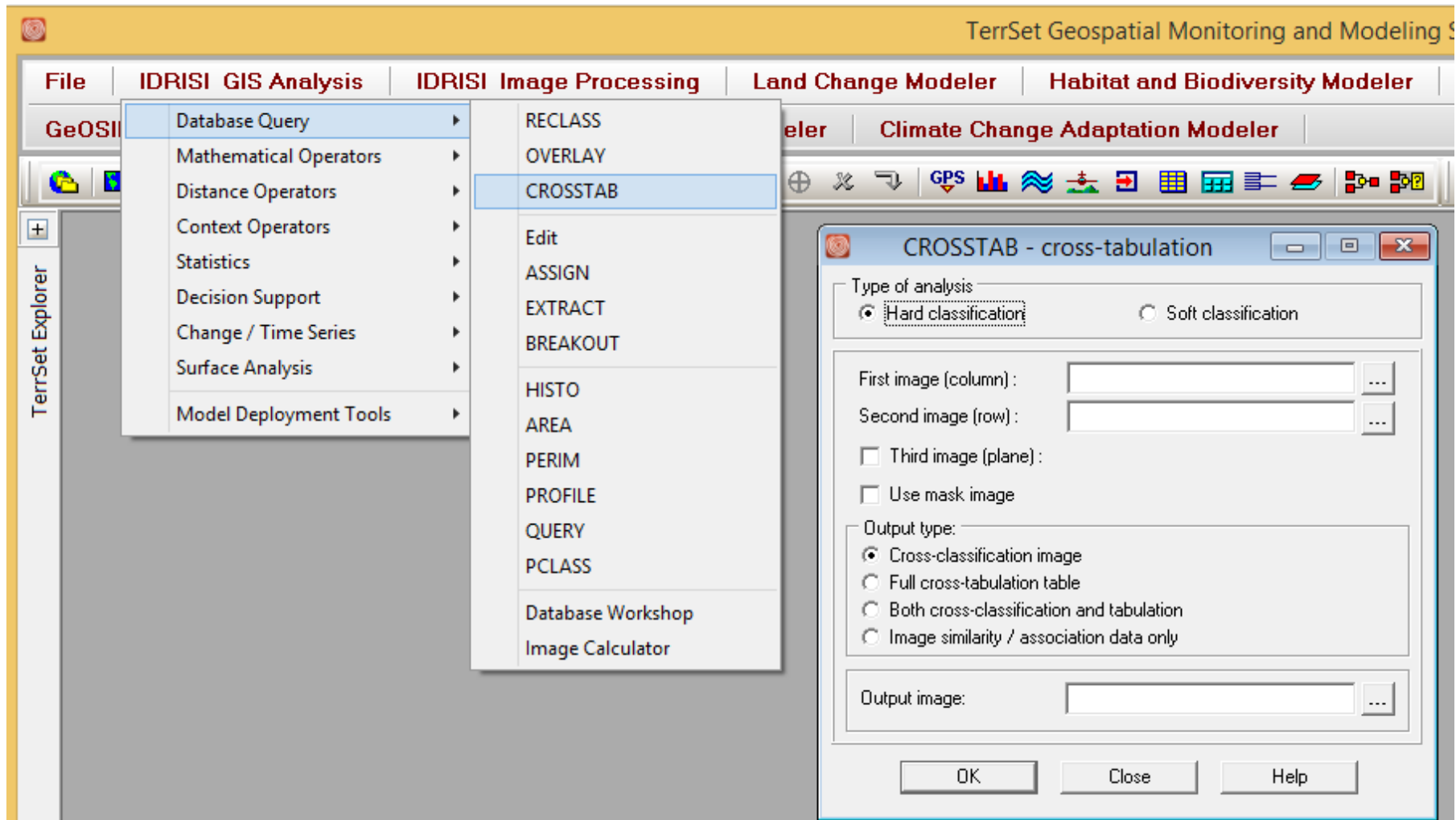
a. CROSSTAB

- **cross tabulates** two or three images or raster files
 - used for change analysis between image pairs



2. Basic TerrSet modules

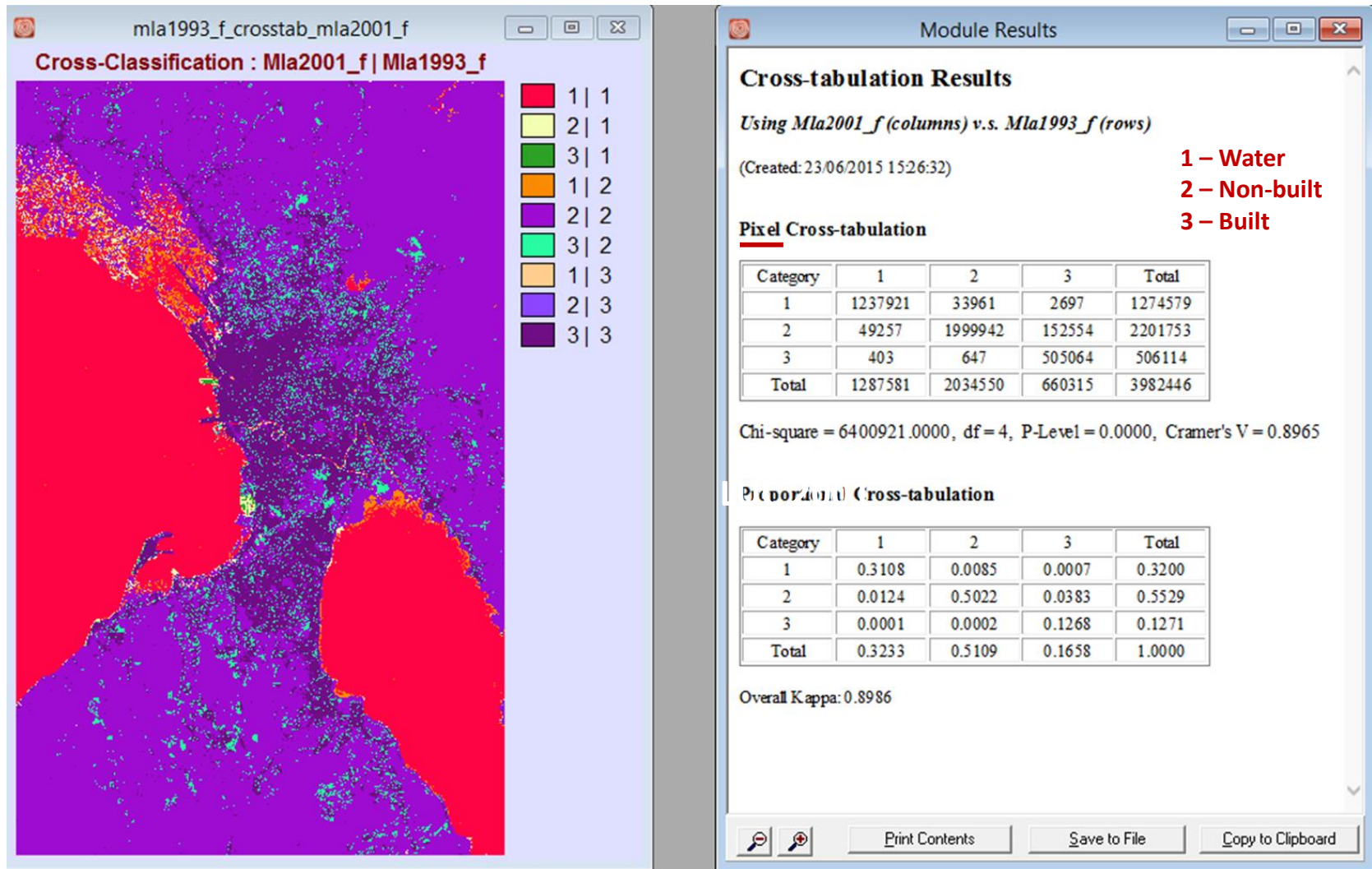
a. CROSSTAB



2. Basic TerrSet modules



a. CROSSTAB – Output



2. Basic TerrSet modules

b. SAMPLE

- used to generate sample points for accuracy assessment
- based on a random, systematic or stratified random scheme

The screenshot shows the TerrSet Geospatial Monitoring and Modeling software interface. The 'IDRISI Image Processing' menu is open, displaying a list of processing options. The 'Accuracy Assessment' option is highlighted, and its sub-menu is visible, showing 'SAMPLE' and 'ERRMAT'. The 'SAMPLE - spatial sampling' dialog box is open, showing the following options:

- Reference image: [Text box]
- Sampling scheme:
 - Random
 - Systematic
 - Stratified random
- Number of points: [Text box]
- Output file: [Text box]
- Output type:
 - Vector file
 - Raster file
 - Vector and raster file

Buttons: OK, Close, Help

Stratified random sampling “is usually preferred since it combines the best qualities of the other two – the unbiased character of the random sampling scheme with the even geographic coverage of the systematic scheme.” Source: TerrSet Manual, p. 100

See also: Stehman, S.V., 2009. Sampling designs for accuracy assessment of land-cover. *International Journal of Remote Sensing*, 30, 5243-5272.

2. Basic TerrSet modules

b. SAMPLE

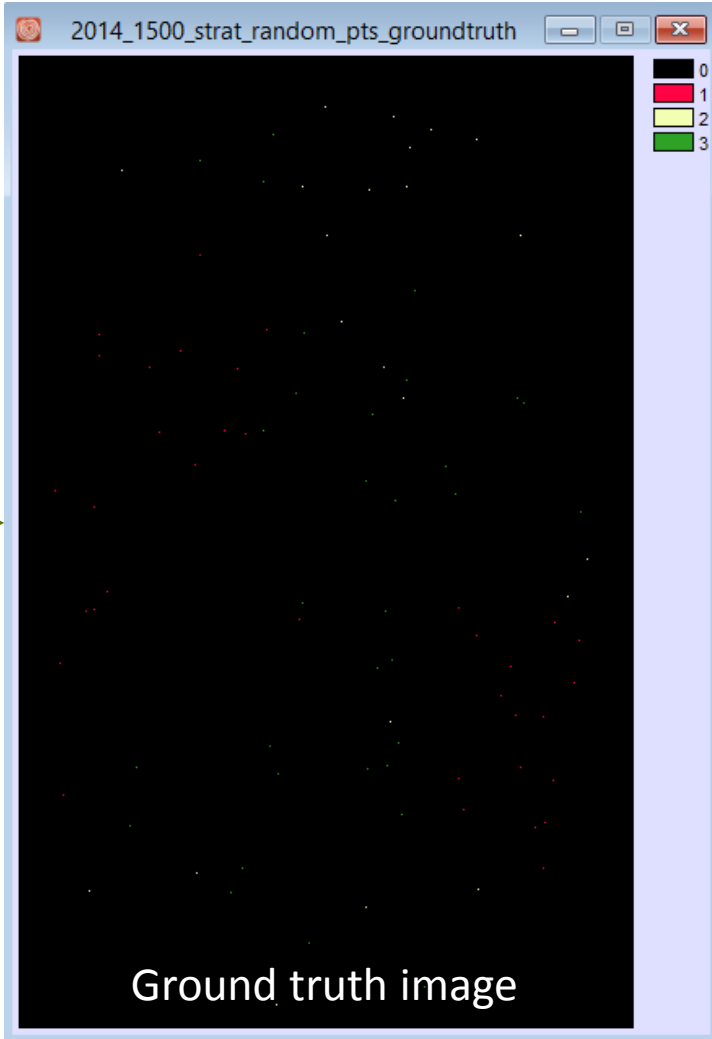
One way to prepare a ground truth image:

Convert to .shp
- and to kml if to be
uploaded to Google Earth

Verify the LUC of the
reference points

Convert to raster
(its properties should be
the same with those of
the 2014 LUC map)

Import into TerrSet
raster format



2. Basic TerrSet modules



c. ERRMAT (Error Matrix)

TerrSet Geospatial Monitoring and Modeling System

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

Restoration
Enhancement
Transformation
Fourier Analysis
Signature Development
Hard Classifiers
Soft Classifiers / Mixture Analysis
Segmentation Classifiers
Hyperspectral Image Analysis
Accuracy Assessment

ERRMAT - error matrix analysis

Ground truth image:
Categorical map image:

OK Close Help

SAMPLE
ERRMAT

mla2014_f

2014_1500_strat_random_pts_groundtruth

Module Results

**Error Matrix Analysis of
2014_1500_STRAT_RANDOM_PTS_REC_REC
(columns : truth) against MLA2014_F (rows : mapped)**

	1	2	3	Total	ErrorC
1	431	3	1	435	0.009195
2	18	501	68	587	0.146508
3	3	76	399	478	0.165272
Total	452	580	468	1500	
ErrorO	0.046460	0.136207	0.147436		0.112667

ErrorO = Errors of Omission (expressed as proportions)
ErrorC = Errors of Commission (expressed as proportions)

90% Confidence Interval = +/- 0.013430 (0.099237 - 0.126096)
95% Confidence Interval = +/- 0.016001 (0.096666 - 0.128668)
99% Confidence Interval = +/- 0.021063 (0.091604 - 0.133729)

KAPPA INDEX OF AGREEMENT (KIA)

Using MLA2014_F as the reference image ...

Category	KIA
1	0.986839
2	0.761129
3	0.759779

2014_1500_STRAT_RANDOM_PTS_REC_REC

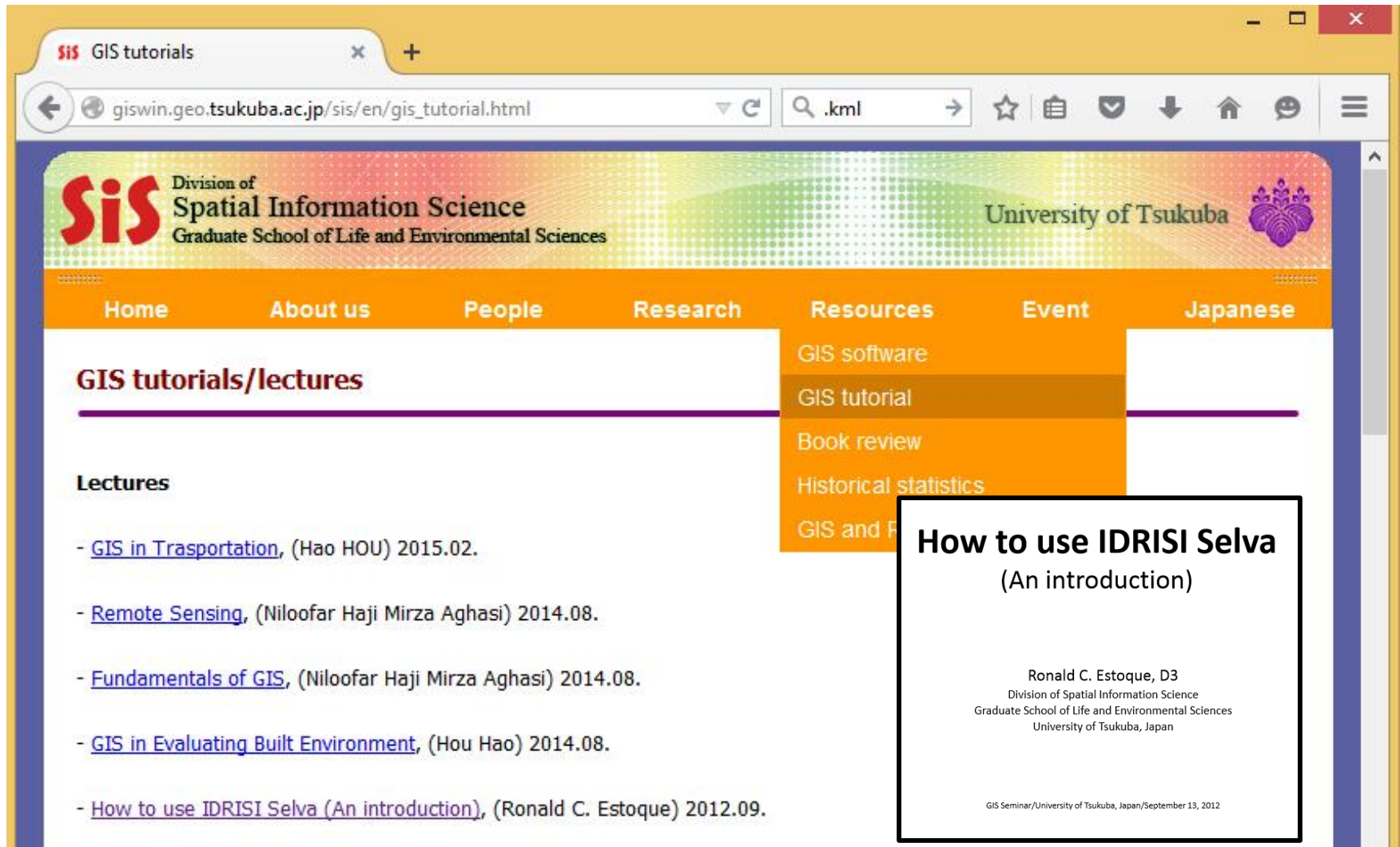
Category	KIA
1	0.934563
2	0.776221
3	0.783607

Overall Kappa = 0.829776

Print Contents Save to File Copy to Clipboard Close

2. Basic TerrSet modules

See also:



The screenshot shows a web browser window with the URL giswin.geo.tsukuba.ac.jp/sis/en/gis_tutorial.html. The page header identifies the Division of Spatial Information Science at the University of Tsukuba. A navigation menu includes Home, About us, People, Research, Resources, Event, and Japanese. The 'Resources' menu is open, showing options like GIS software, GIS tutorial, Book review, Historical statistics, and GIS and F. The main content area is titled 'GIS tutorials/lectures' and lists several lectures:

- [GIS in Trasportation](#), (Hao HOU) 2015.02.
- [Remote Sensing](#), (Niloofar Haji Mirza Aghasi) 2014.08.
- [Fundamentals of GIS](#), (Niloofar Haji Mirza Aghasi) 2014.08.
- [GIS in Evaluating Built Environment](#), (Hou Hao) 2014.08.
- [How to use IDRISI Selva \(An introduction\)](#), (Ronald C. Estoque) 2012.09.

A callout box highlights the lecture 'How to use IDRISI Selva (An introduction)' with the following details:

**How to use IDRISI Selva
(An introduction)**

Ronald C. Estoque, D3
Division of Spatial Information Science
Graduate School of Life and Environmental Sciences
University of Tsukuba, Japan

GIS Seminar/University of Tsukuba, Japan/September 13, 2012

3. TerrSet Modelers

a. Land Change Modeler (LCM)

- for analyzing land-cover change, empirically modeling its relationship to explanatory variables, and projecting future changes
- also includes special tools for the assessment of REDD (Reducing Emissions from Deforestation and forest Degradation) climate change mitigation strategies
 - **Steps**
 - Change analysis
 - Transition potential modeling
 - Change prediction

3. TerrSet Modelers

a. Land Change Modeler (LCM)

Sample Case Study (**One-way transition**)
Urban land-change modeling in Manila

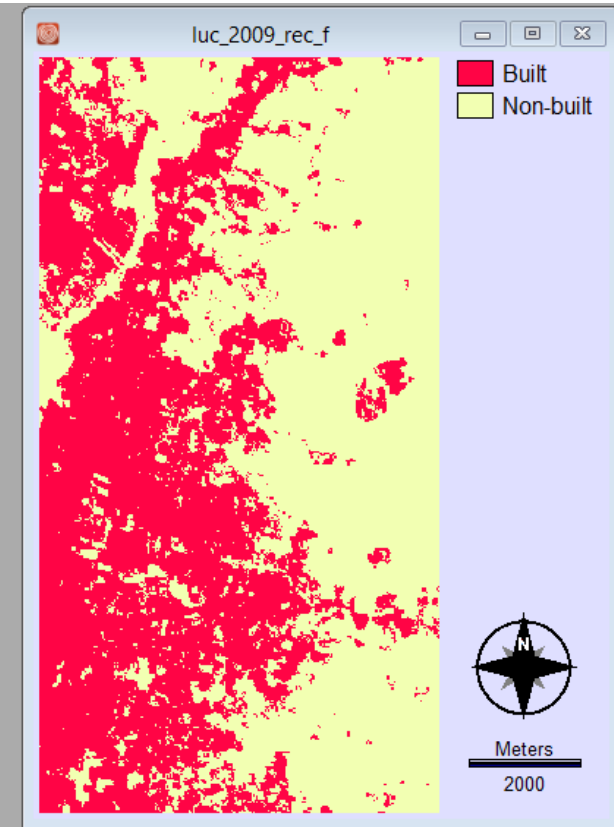
- **Purpose** – to simulate/predict built-up expansion from 2001 to 2009
- **explanatory variables for urban land change**
 - distance to 1993 built, elevation and slope
- **Land-use/cover (LUC) data**
 - 1993, 2001, 2009
 - 1993-2001 – calibration; 2001-2009 - validation

Data: Land-use/cover (LUC) Maps

1993

2001

2009

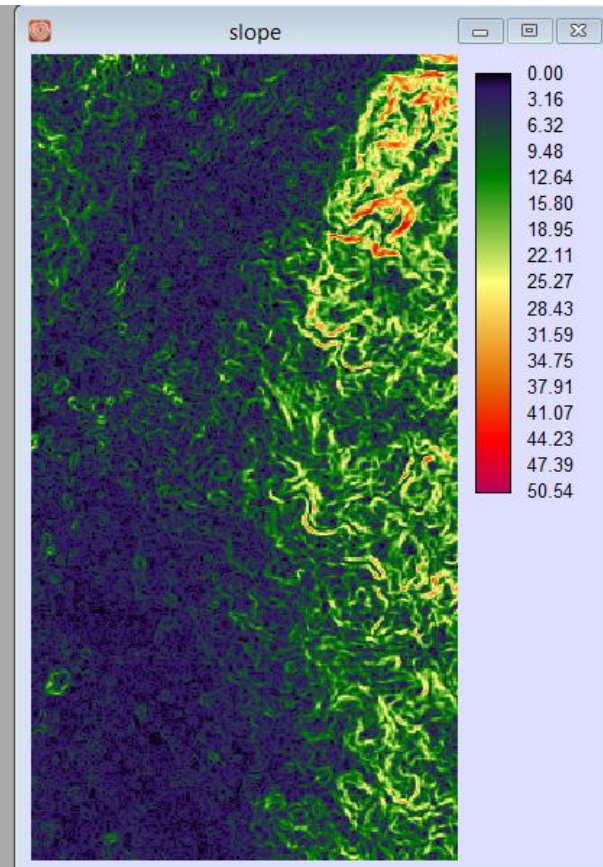
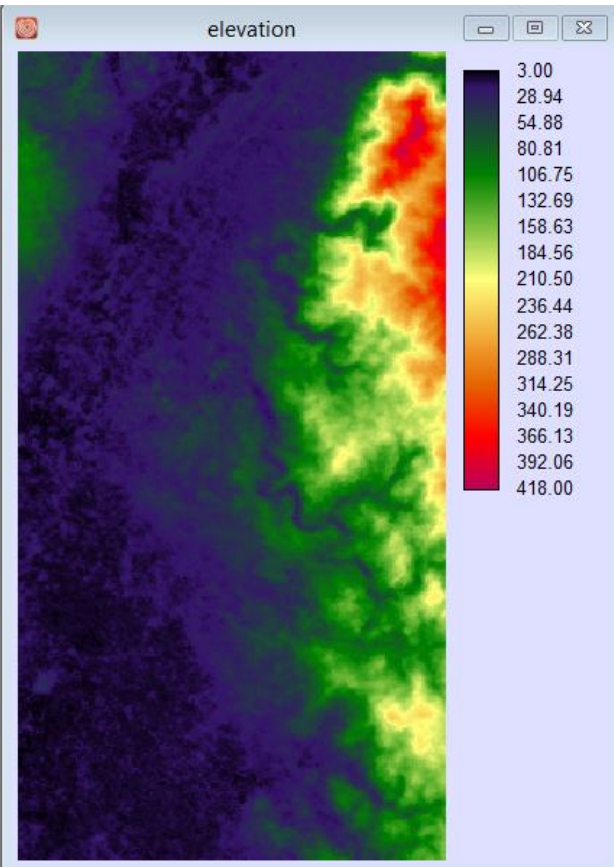
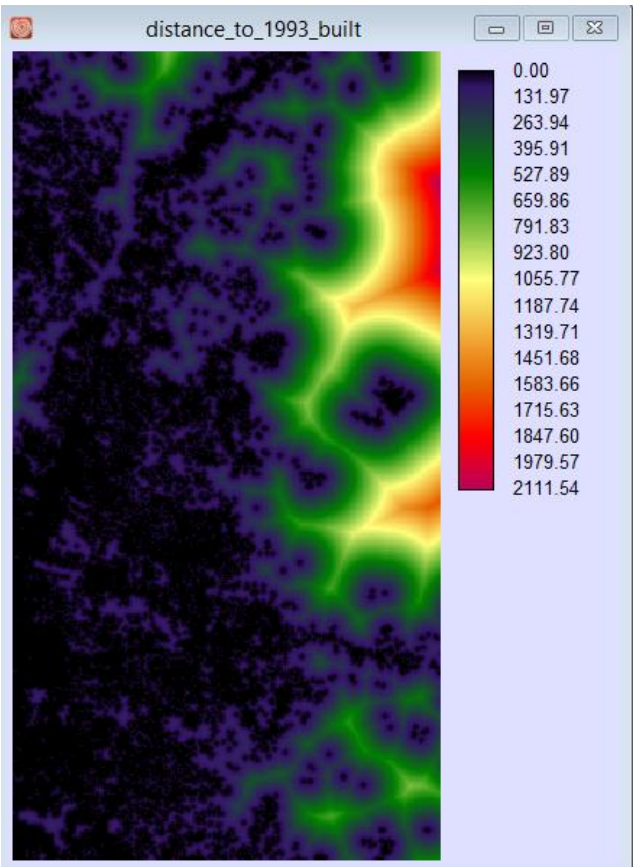


Data: Land change explanatory variables

Distance to
1993 Built (m)

Elevation (m)

Slope (degree)



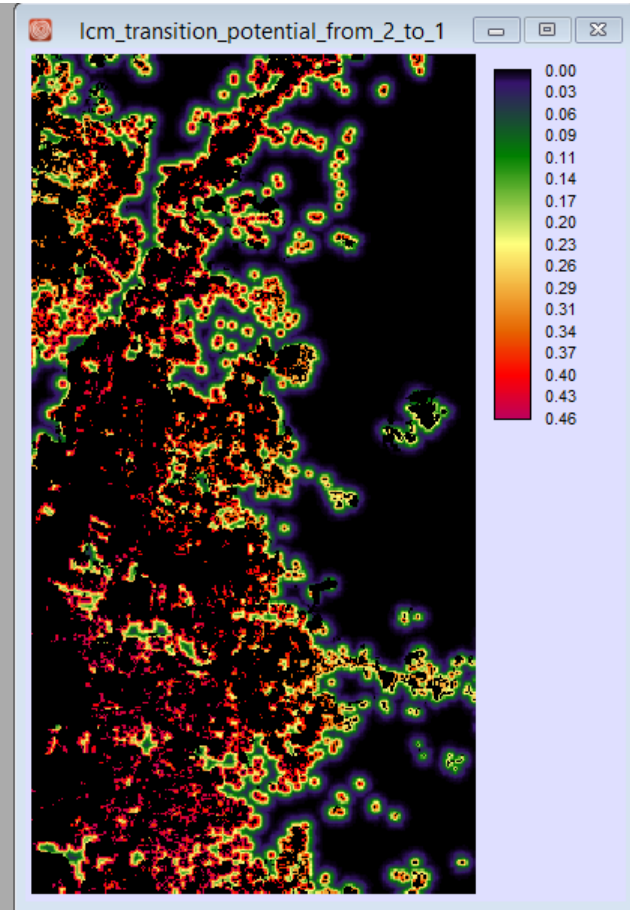
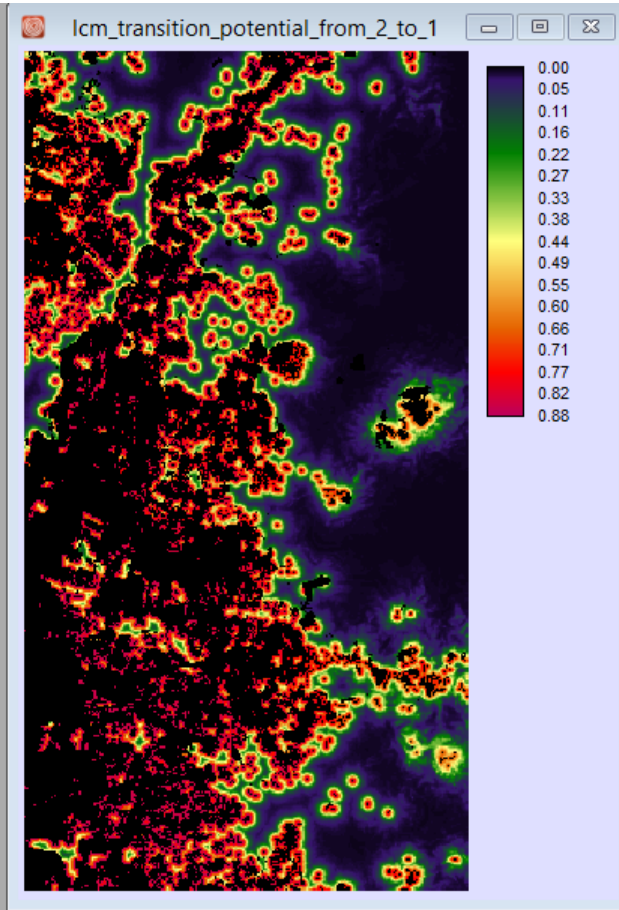
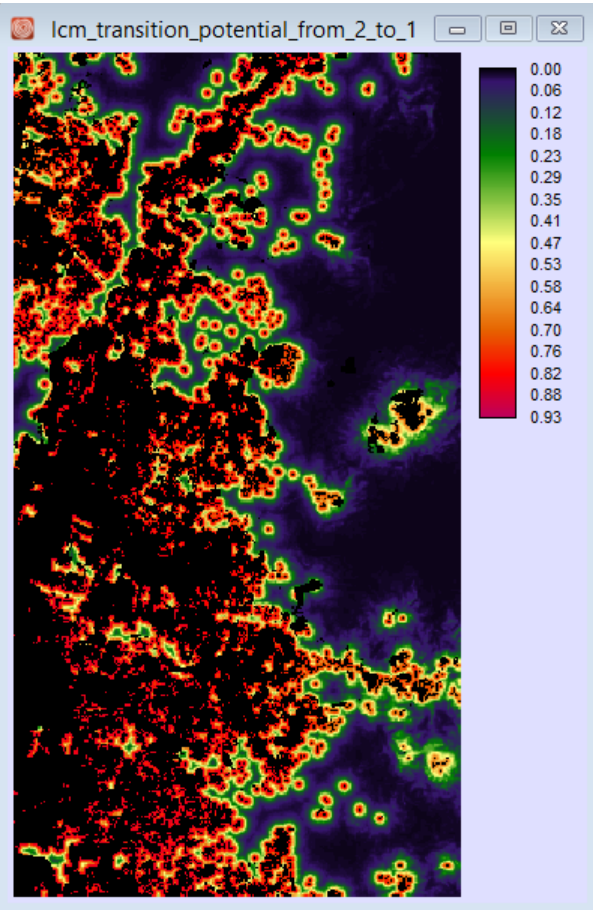
Transition potential maps



MLP Neural Network

SimWeight

Logistic Regression



Results: Predicted 2009 LUC Maps



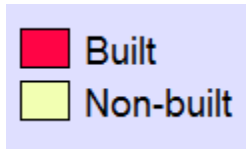
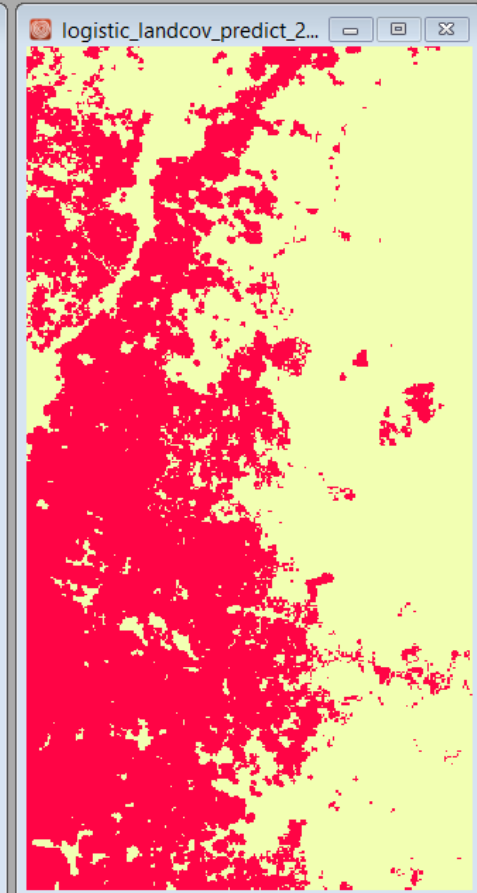
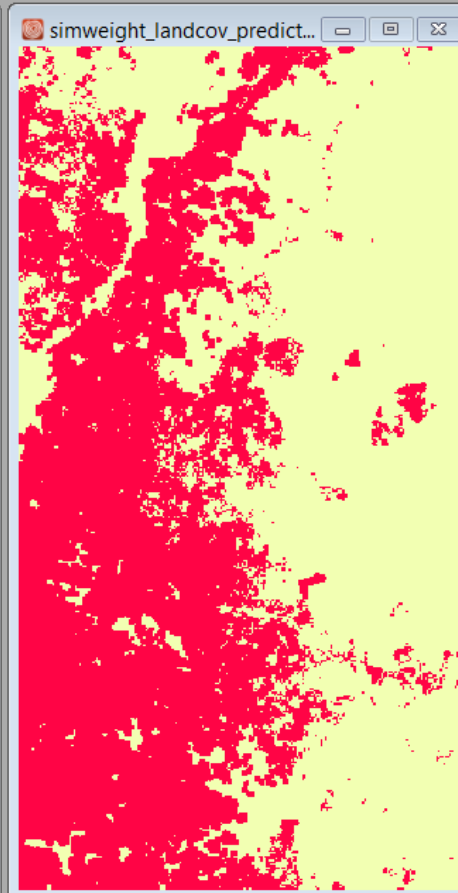
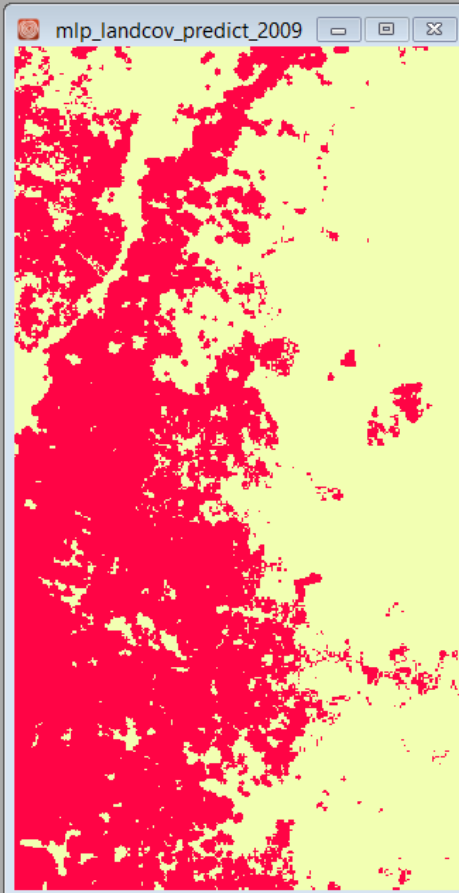
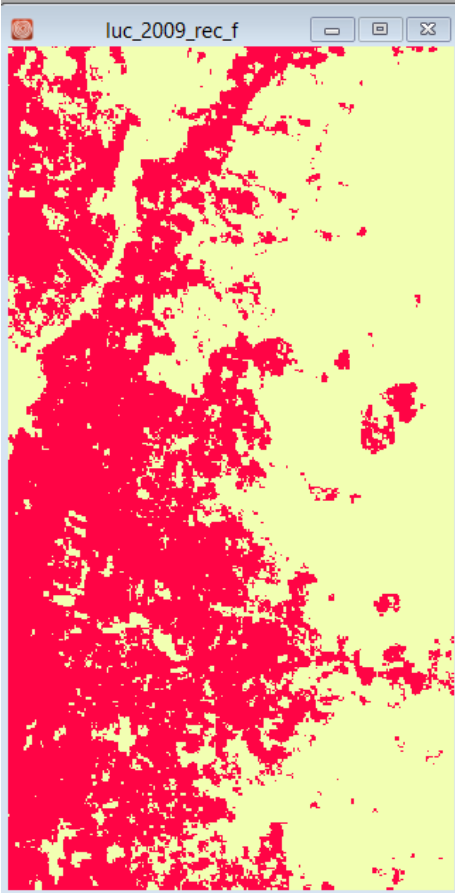
Predicted 2009 LUC Maps

LUC 2009

MLP Neural Network

SimWeight

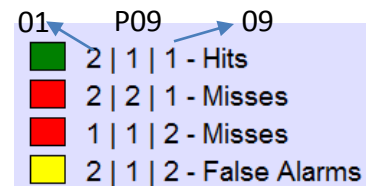
Logistic Regression



LUC 2009 Built = 46,680 pixels
Predicted 2009 Built = 47,263 pixels

Validation Maps

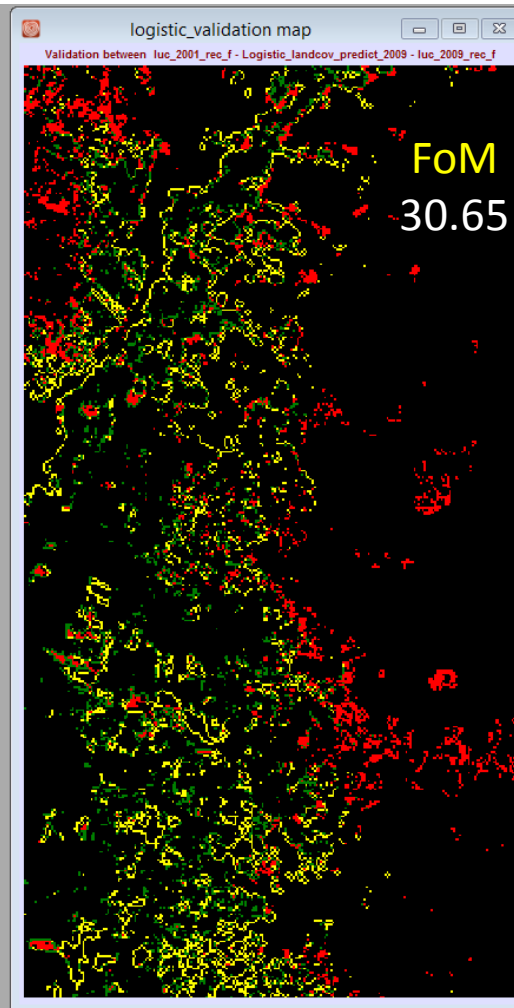
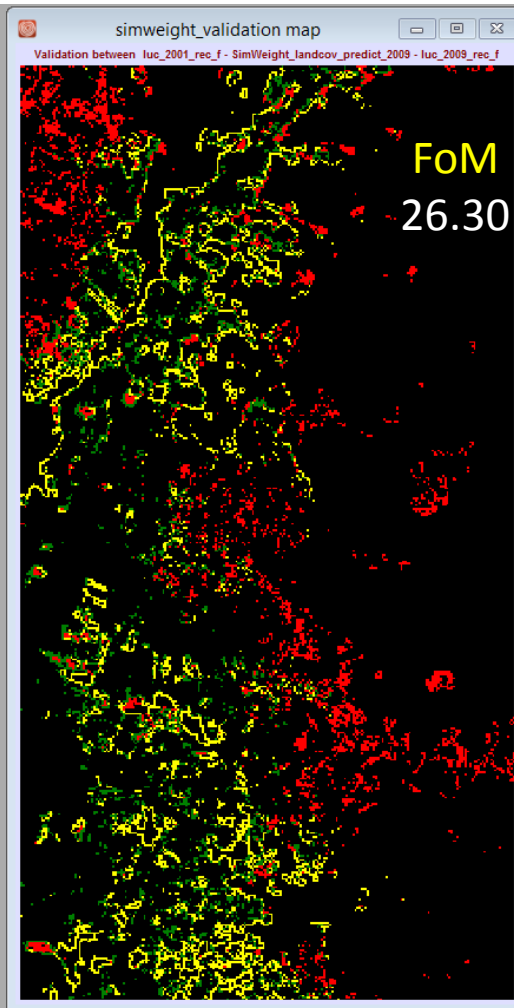
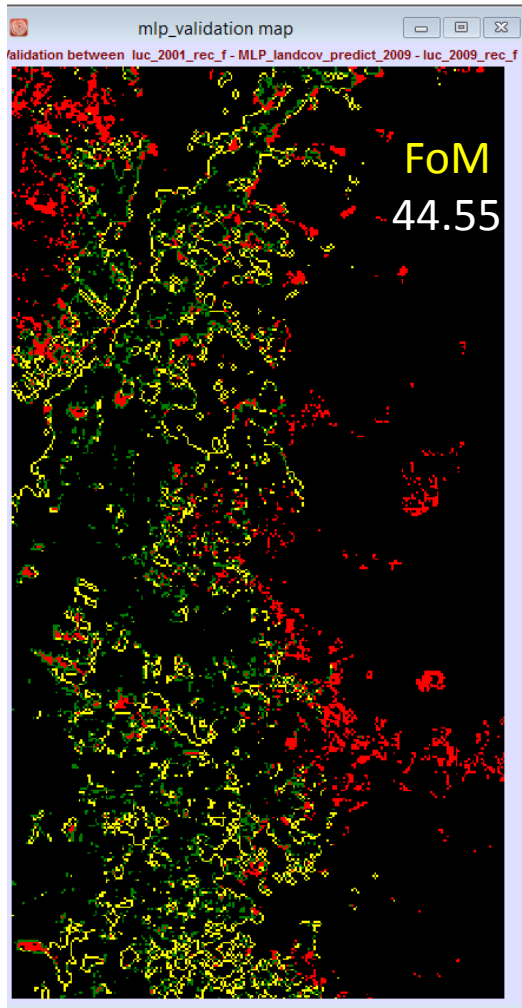
Figure of Merit (FoM)
 $= (H/(H+M+F)) * 100$



MLP Neural Network

SimWeight

Logistic Regression



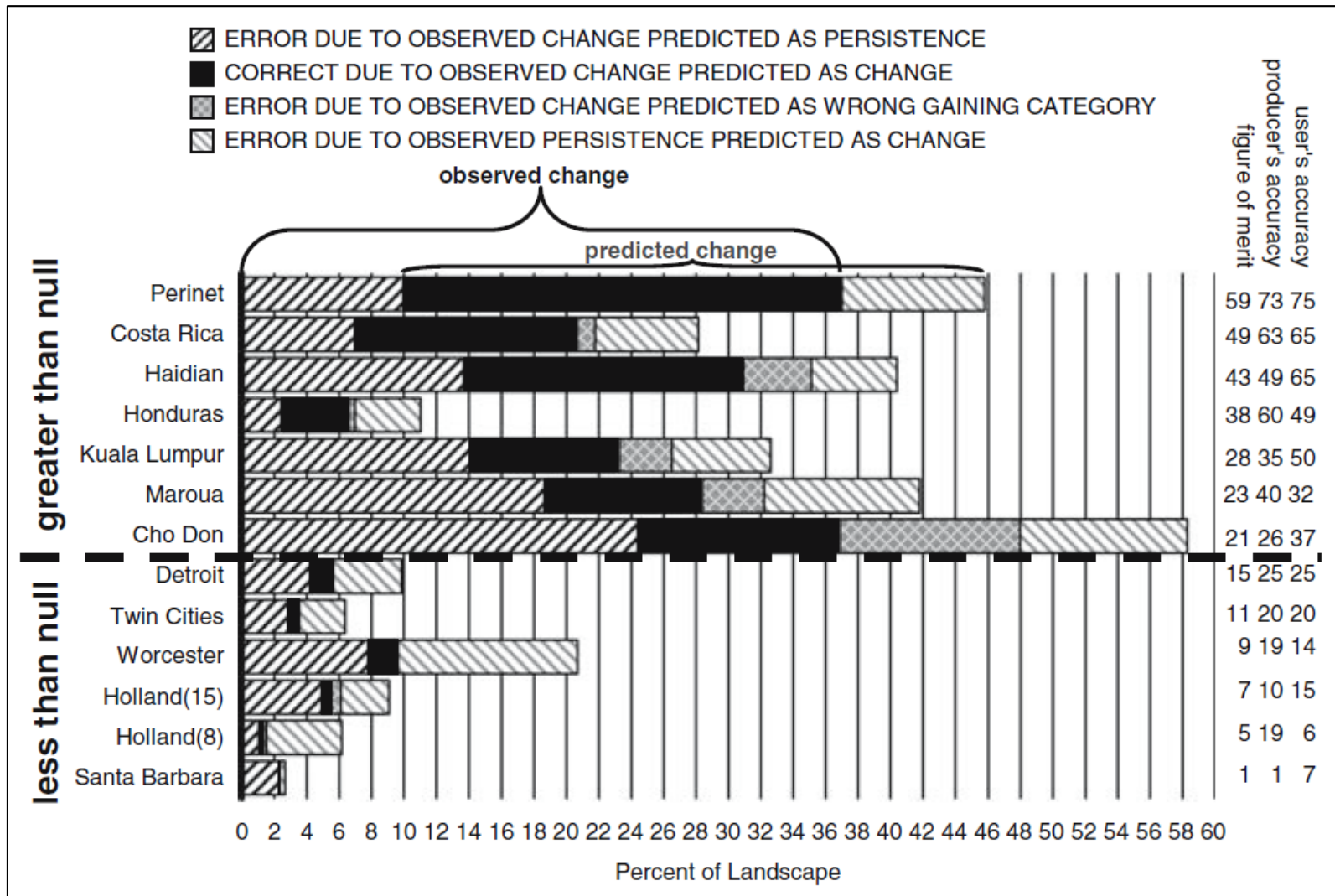
Pixel
Count

H = 4031
M = 4238
F = 4811

H = 3563
M = 4706
F = 5279

H = 4014
M = 4255
F = 4828

Validation: Comparison with other studies



Pontius et al. 2008. Comparing the input, output, and validation maps for several models of land change. *Annals of Regional Science* 42, 11–37.

Validation: Comparison with other studies

Global Environmental Change 22 (2012) 440–453



Contents lists available at SciVerse ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha



FoM = 8.36%

How accurately may we project tropical forest-cover change?
A validation of a forward-looking baseline for REDD

Sean Sloan^{a,b,c,*}, Johanne Pelletier^{d,1}

Computers, Environment and Urban Systems 35 (2011) 25–34



Contents lists available at ScienceDirect

Computers, Environment and Urban Systems

journal homepage: www.elsevier.com/locate/compenvurbsys



FoM = 19-26%

Urban growth modeling of Kathmandu metropolitan region, Nepal

Rajesh Bahadur Thapa^{*}, Yuji Murayama¹

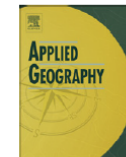
Applied Geography 35 (2012) 316–326



Contents lists available at SciVerse ScienceDirect

Applied Geography

journal homepage: www.elsevier.com/locate/apgeog



FoM = 42.80%

Examining the potential impact of land use/cover changes on the ecosystem services of Baguio city, the Philippines: A scenario-based analysis

Ronald C. Estoque^{a,b,*}, Yuji Murayama^a

3. TerrSet Modelers

a. Land Change Modeler (LCM)

Sample Case Study (**Multiple transitions**)

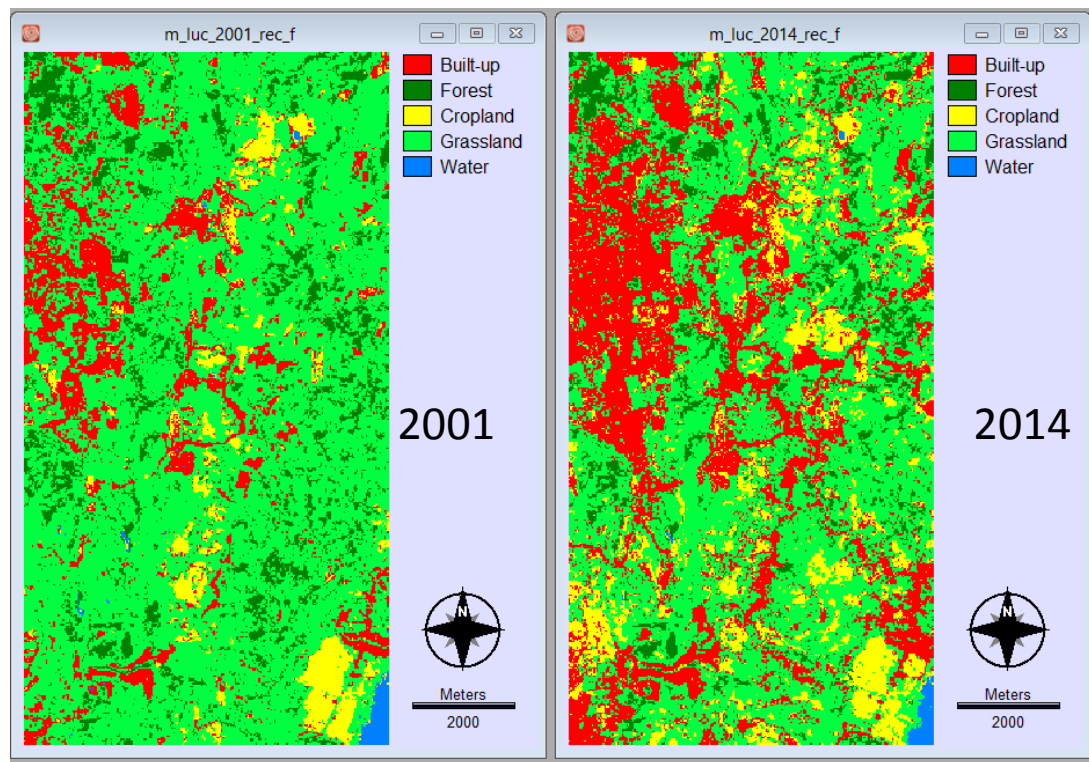
Land-use/cover (LUC) change modeling in Manila

- **Purpose** – to predict LUC change from 2014 to 2027
- **explanatory variables for LUC change**
 - Elevation, slope, and distance maps to 2001 built, forest, cropland, grassland, water, and other land
- **Land-cover data**
 - 2001, 2014



LCM – Multiple Transitions

LUC Maps



Markov transition probability matrix

for 2027 based on 2001-2014 land transitions

- Prepare a transition potential map for each transition (or selected transitions)

Transition Probabilities Grid

Given :	Probability of changing to :				
	Built-up	Forest	Cropland	Grassland	Water
Built-up	0.9999	0.0000	0.0001	0.0000	0.0000
Forest	0.0406	0.5643	0.1366	0.2585	0.0000
Cropland	0.0000	0.0062	0.6588	0.3350	0.0000
Grassland	0.2363	0.0006	0.0961	0.6670	0.0000
Water	0.0000	0.0000	0.1780	0.1243	0.6976

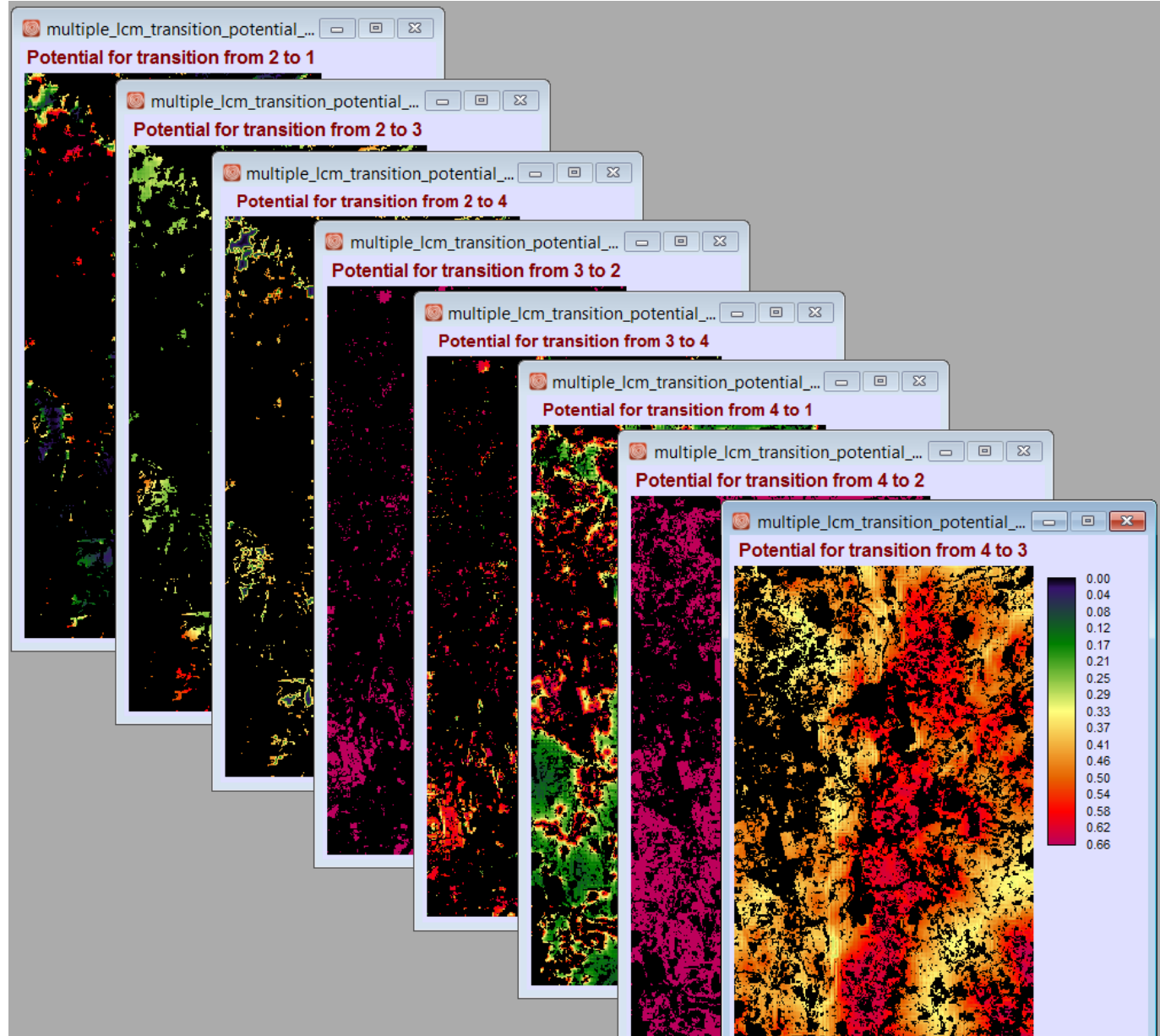
Save Close

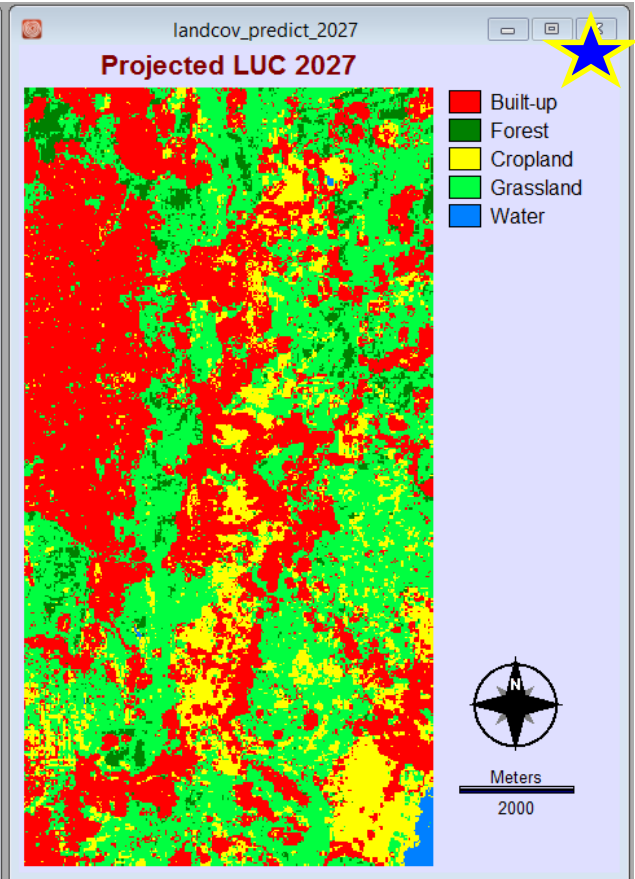
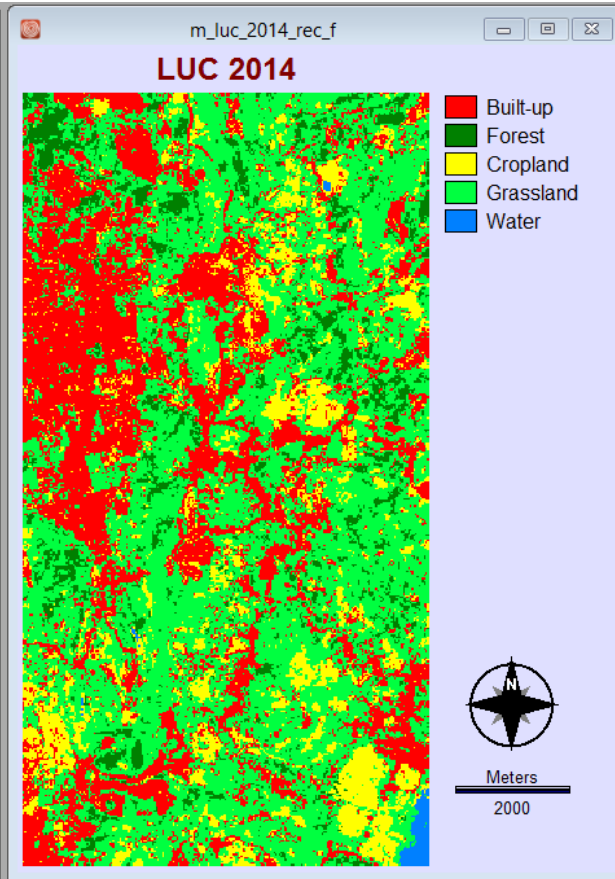
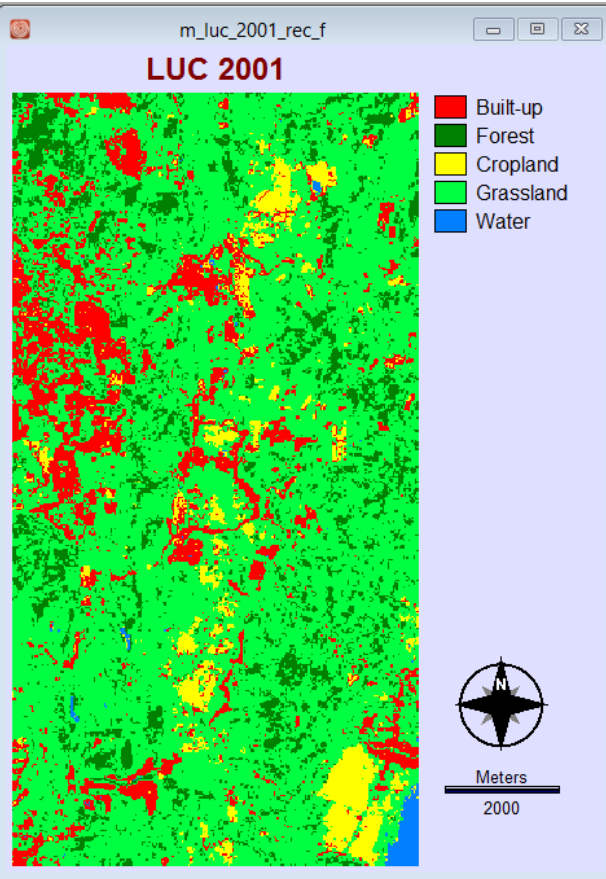


LCM – Multiple Transitions

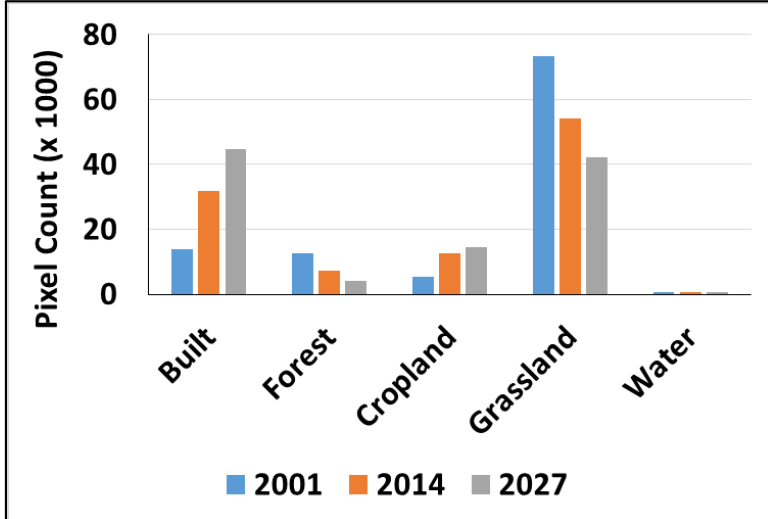
Transition Probability Maps

- a transition potential map was prepared for each transition using MLP NN





Results:
LCM – Multiple transitions

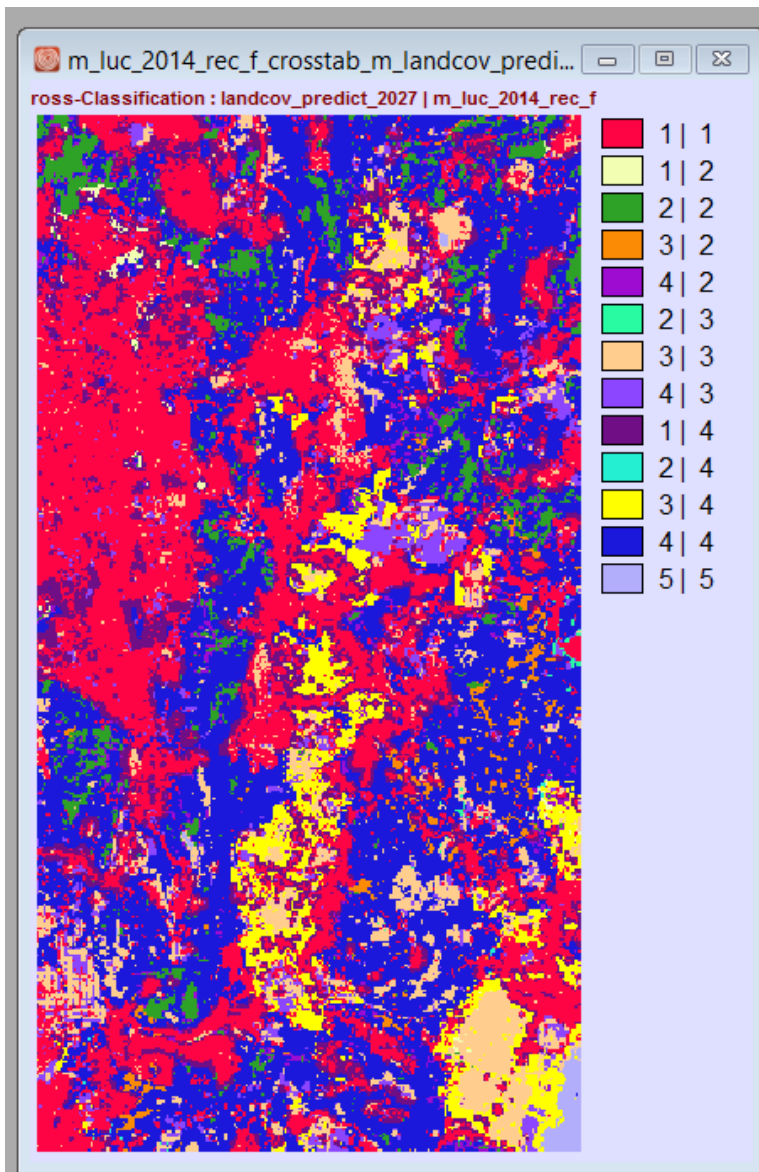


By using the CROSSTAB module



(quantity and location of land changes can be examined)

Predicted changes from 2014-2027



Module Results

Cross-tabulation Results

Using *landcov_predict_2027* (columns) v.s. *m_luc_2014_rec_f* (rows)

(Created: 03/07/2015 11:18:41)

Pixel Cross-tabulation

Category	1	2	3	4	5	Total
1	31675	0	0	0	0	31675
2	289	4023	974	1843	0	7129
3	0	78	8248	4194	0	12520
4	12785	32	5200	36090	0	54107
5	0	0	0	0	533	533
Total	44749	4133	14422	42127	533	105964


Print Contents Save to File Copy to Clipboard

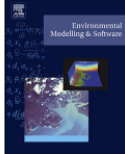
Some references for MLP NN, SimWeight and Logistic Regression Algorithms


2015

Environmental Modelling & Software 69 (2015) 214–221

Contents lists available at [ScienceDirect](#)

 Environmental Modelling & Software
journal homepage: www.elsevier.com/locate/envsoft




Comparison of simulation models in terms of quantity and allocation of land change  CrossMark

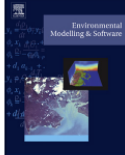
María Teresa Camacho Olmedo ^{a,*}, Robert Gilmore Pontius Jr ^b, Martin Paegelow ^c, Jean-François Mas ^d


2014

Environmental Modelling & Software 51 (2014) 94–111

Contents lists available at [ScienceDirect](#)


 Environmental Modelling & Software
journal homepage: www.elsevier.com/locate/envsoft



Inductive pattern-based land use/cover change models: A comparison of four software packages  CrossMark

Jean-François Mas ^{a,*}, Melanie Kolb ^b, Martin Paegelow ^c, María Teresa Camacho Olmedo ^d, Thomas Houet ^c

2010

 **Transactions in GIS**
Transactions in GIS, 2010, 14(5): 569–580

Research Article

Similarity Weighted Instance-based Learning for the Generation of Transition Potentials in Land Use Change Modeling

Florencia Sangermano
Clark Labs, Clark University

J Ronald Eastman
Clark Labs, Clark University

Honglei Zhu
Clark Labs, Clark University

Summary

- ✓ 1. Basic info about TerrSet
- ✓ 2. Data format (import/export)
3. Some basic TerrSet modules
 - ✓ a. CROSSTAB
 - ✓ b. SAMPLE } *Image Processing*
 - ✓ c. ERRMAT } *– Accuracy assessment*
4. TerrSet Modelers
 - a. Land change modeler
 - ✓ - Modeling one-way transition
 - ✓ - Modeling multiple transitions