127th GIS Seminar; 9th July 2015

Introducing TerrSet for Geospatial Analysis

(Actual Demo: Land change modeling)

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Researcher

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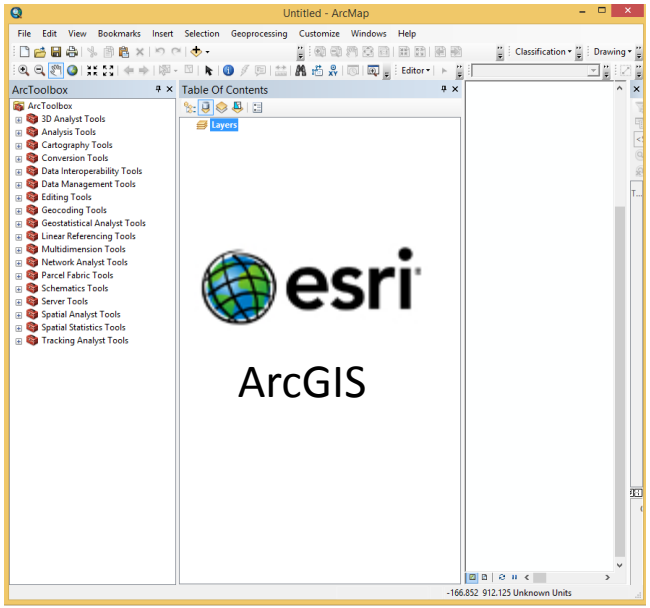
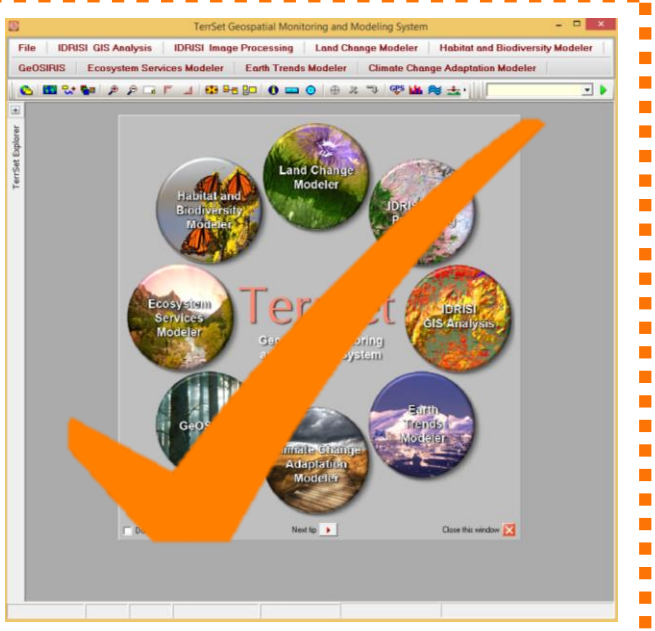
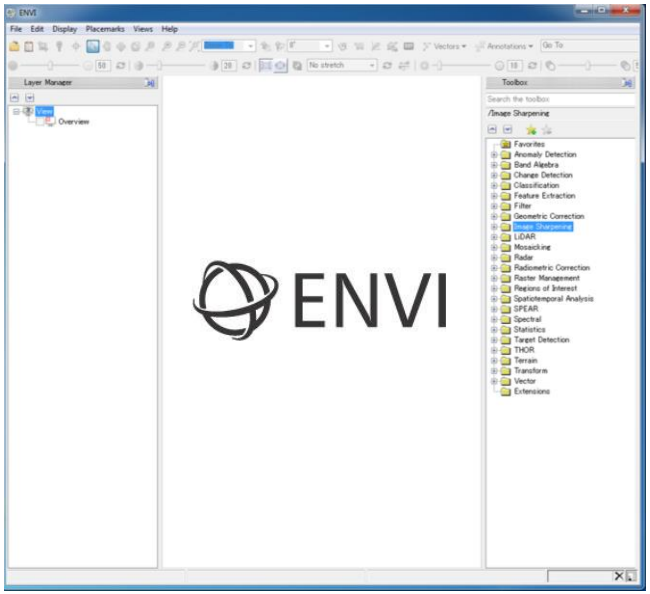
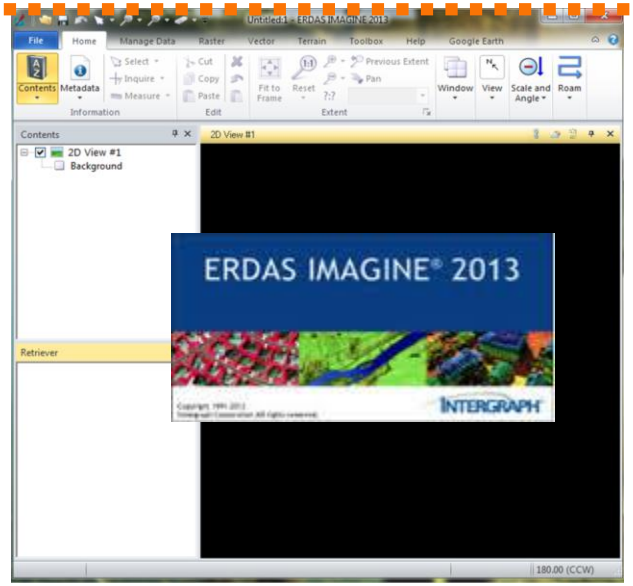
Inside the SIS Lab…

We have…









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      - Modeling one-way transition
      - Modeling multiple transitions

Basic info about TerrSet ★

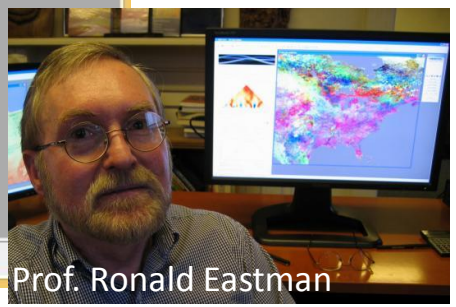
Complete Name: TerrSet Geospatial Monitoring and Modeling System

"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."

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

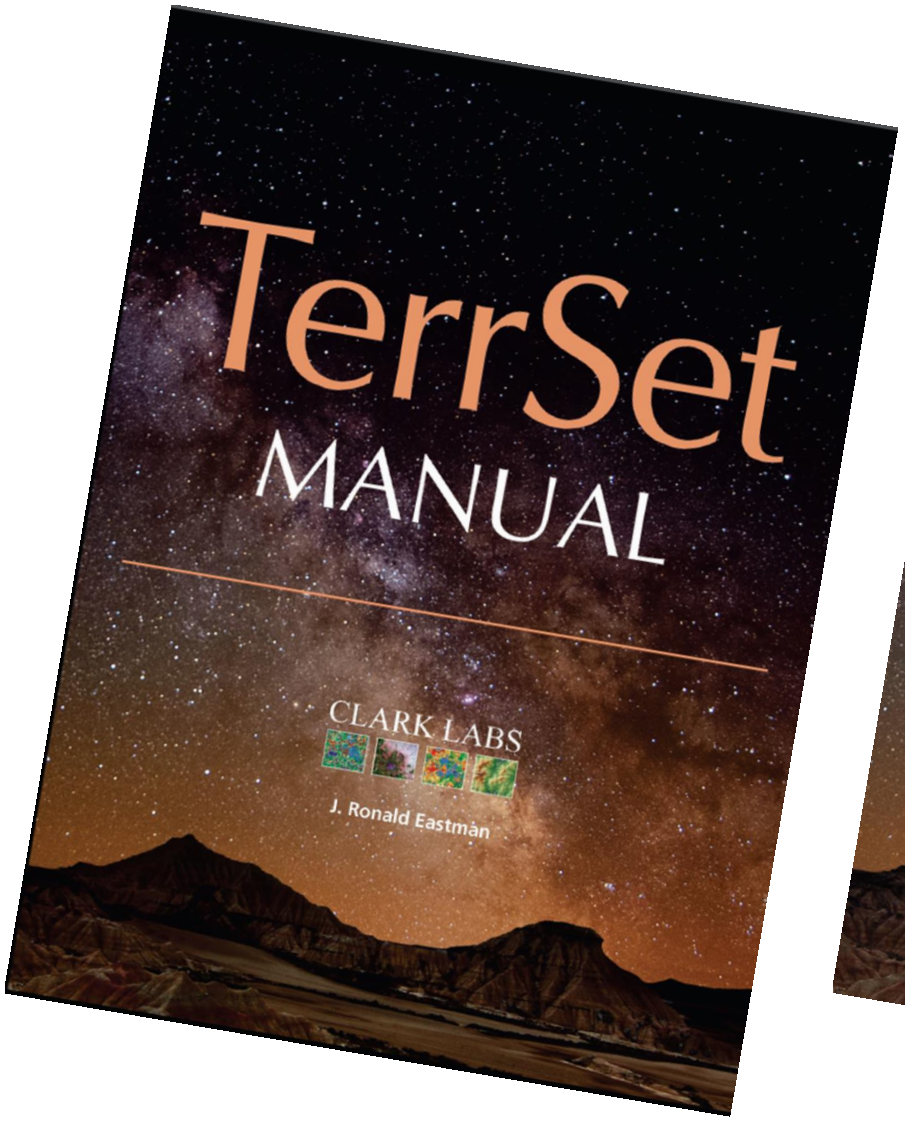
Clark University, MA, USA

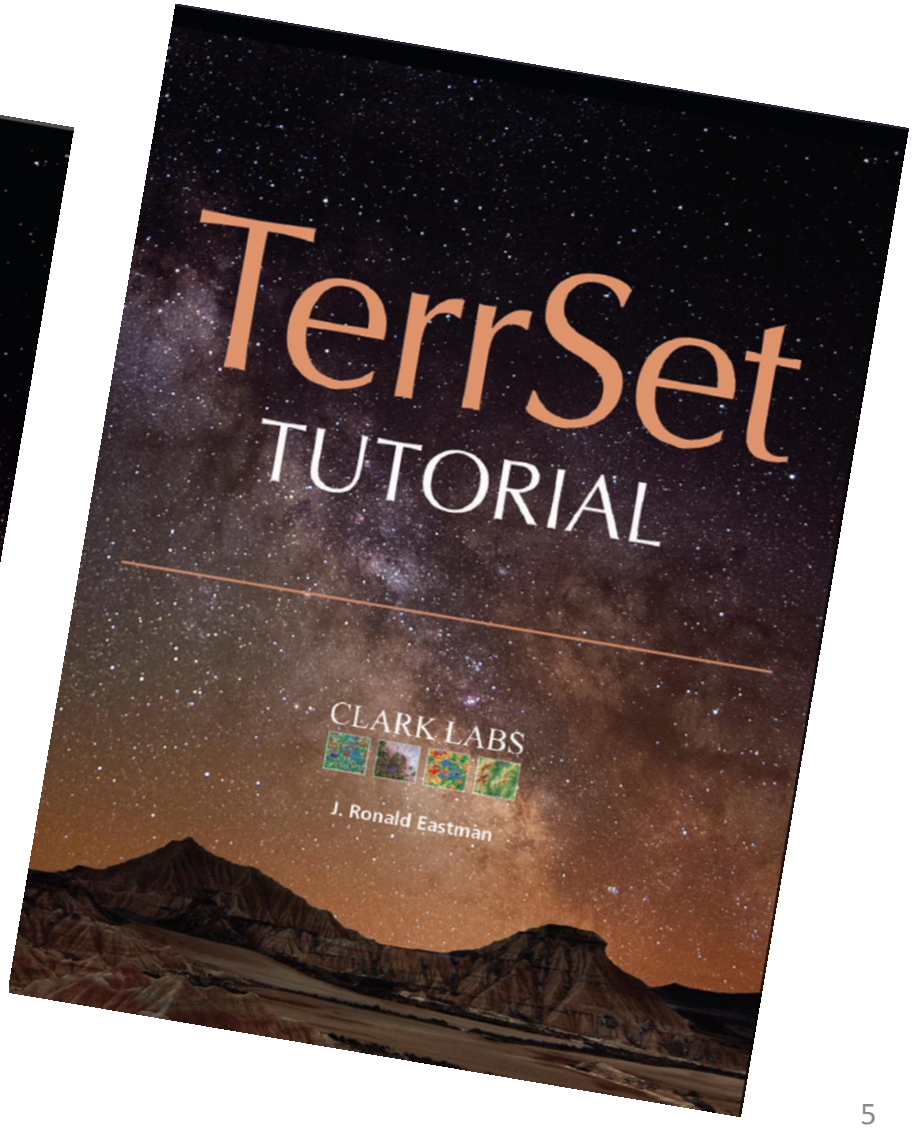
CLARK LABS



Prof. Ronald Eastman

Basic info about TerrSet

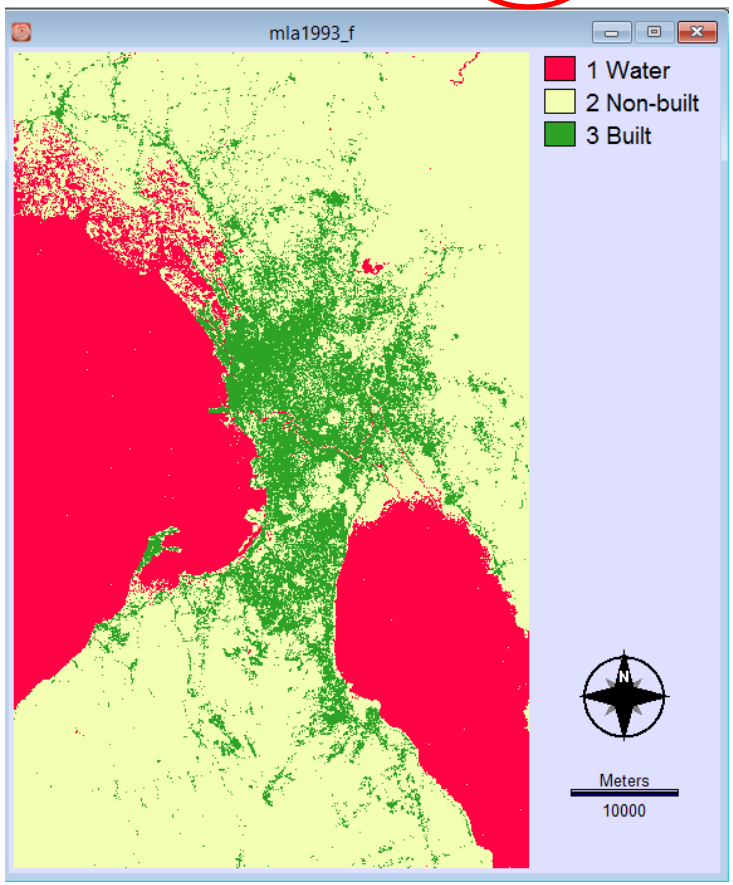




1. Data format (import/export)

Raster Data

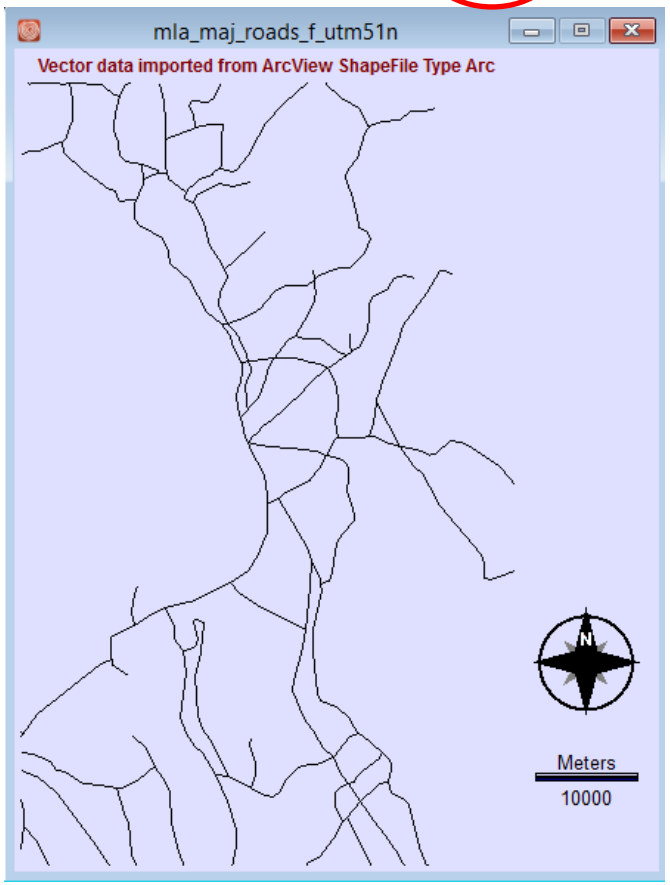
Filename.rst



RS-based LUC Map

Vector Data

Filename.vct



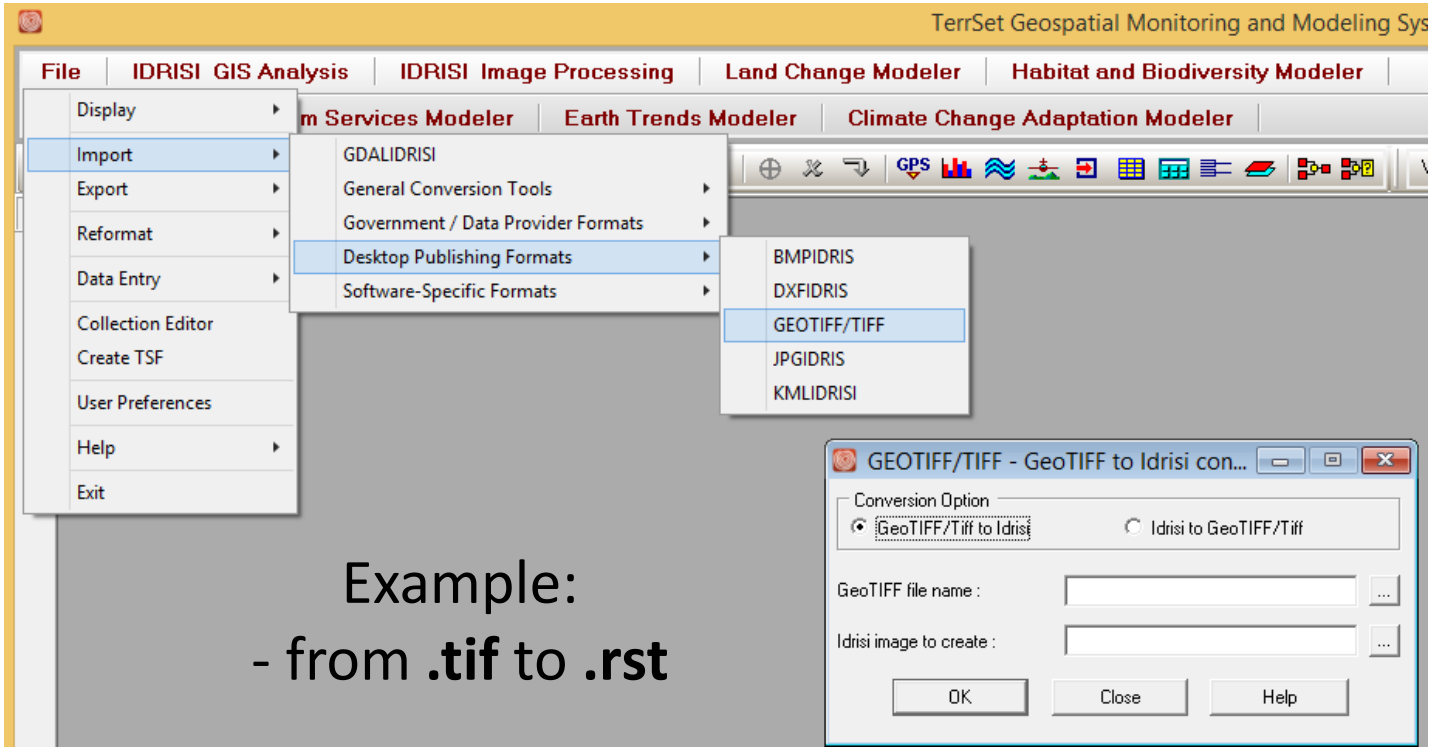
Road Network Map

RS – Remote Sensing 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

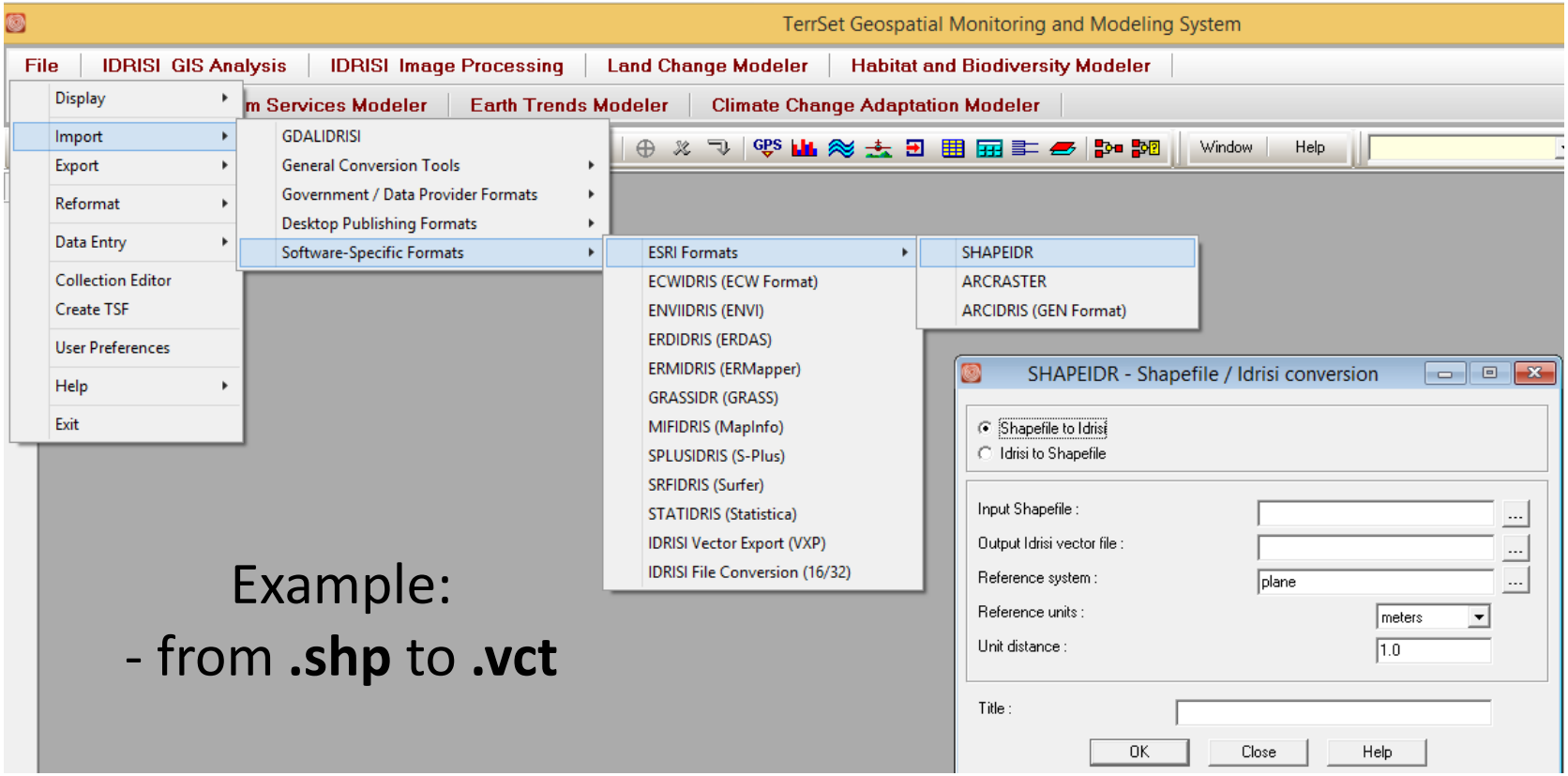


*From **.rst** to **.tif** – Use the **Export** module to reverse the process.

1. Data format (import/export)★

Importing Vector Data (.shp) into TerrSet format

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

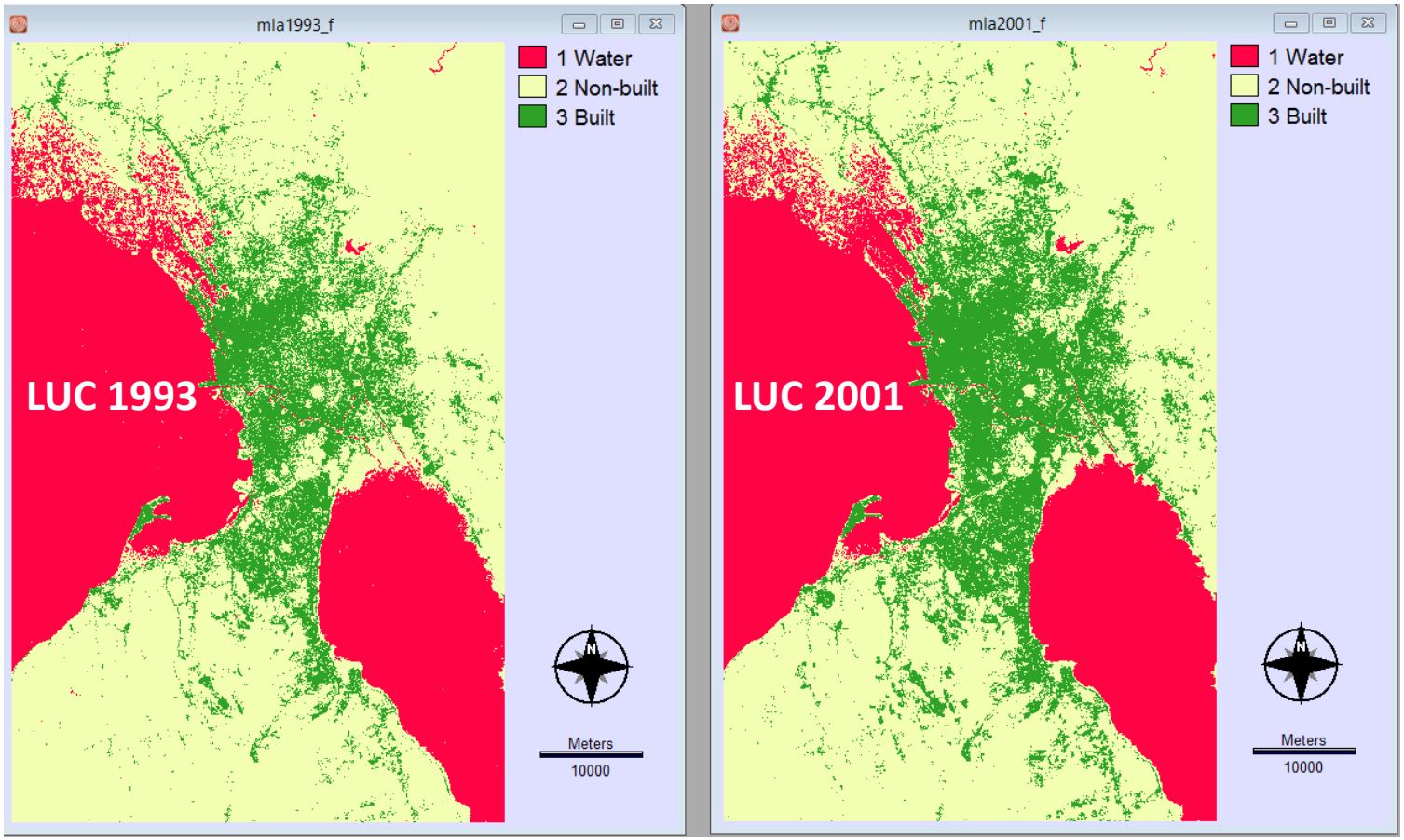


*From **.vct** to **.shp** – Use the **Export** module to reverse the process.

2. Basic TerrSet modules

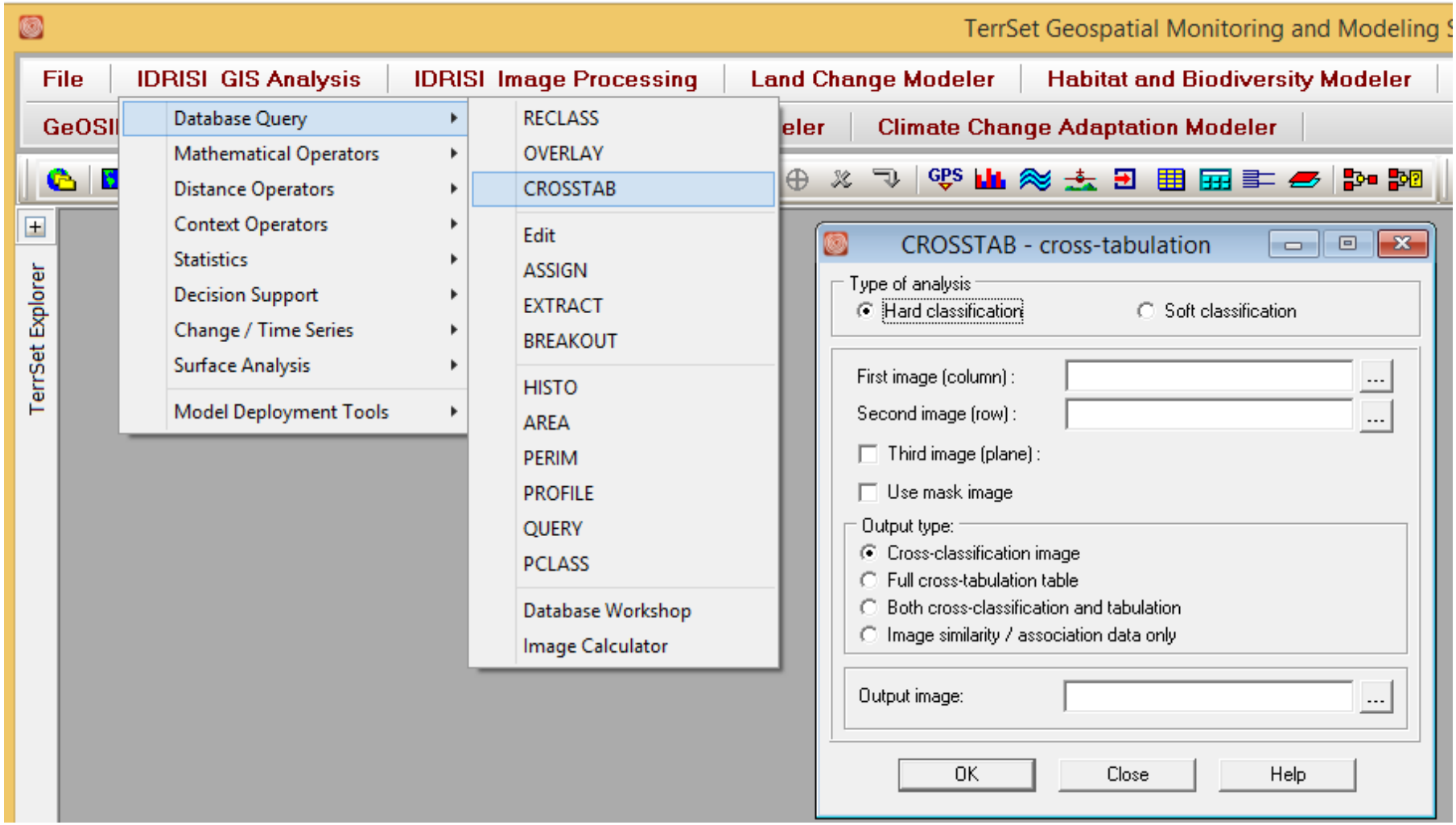
a. CROSSTAB

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



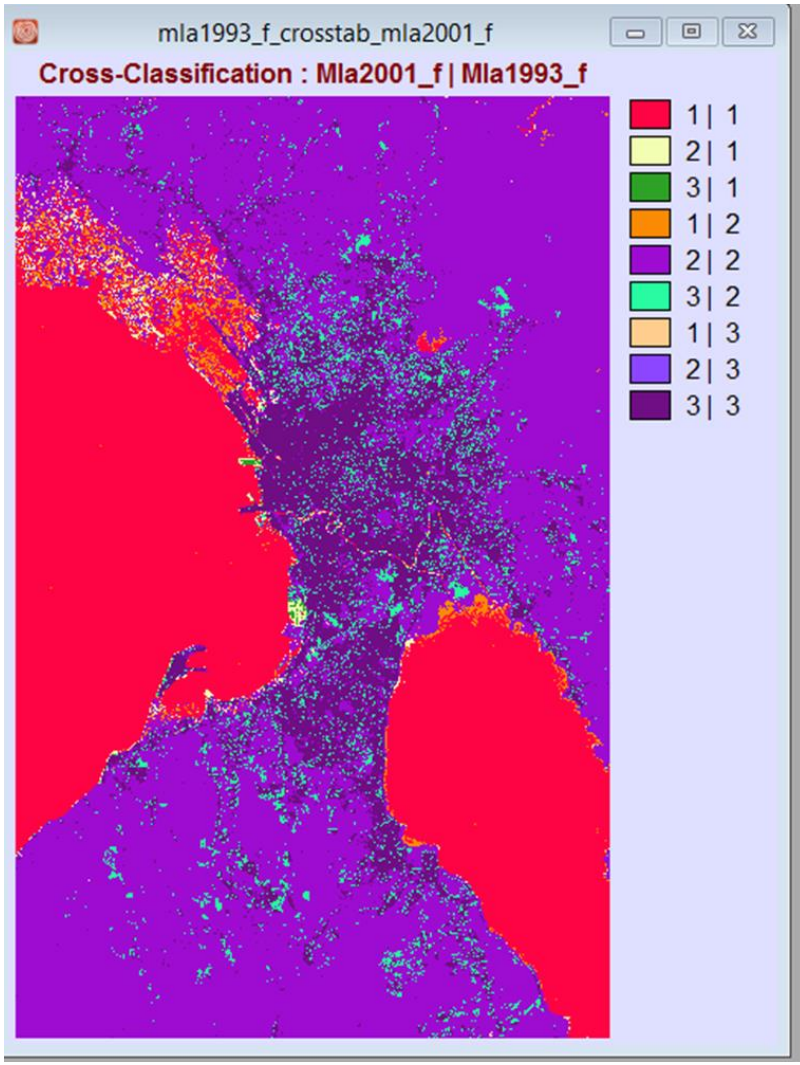
2. Basic TerrSet modules

a. CROSSTAB



2. Basic TerrSet modules ★

a. CROSSTAB – Output



Module Results

Cross-tabulation Results

Using Mla2001_f (columns) v.s. Mla1993_f (rows)

(Created: 23/06/2015 15:26:32)

1 – Water
2 – Non-built
3 – Built

Pixel Cross-tabulation

Category	1	2	3	Total
1	1237921	33961	2697	1274579
2	49257	1999942	152554	2201753
3	403	647	505064	506114
Total	1287581	2034550	660315	3982446

Chi-square = 6400921.0000, df = 4, P-Level = 0.0000, Cramer's V = 0.8965

Proportional Cross-tabulation

Category	1	2	3	Total
1	0.3108	0.0085	0.0007	0.3200
2	0.0124	0.5022	0.0383	0.5529
3	0.0001	0.0002	0.1268	0.1271
Total	0.3233	0.5109	0.1658	1.0000

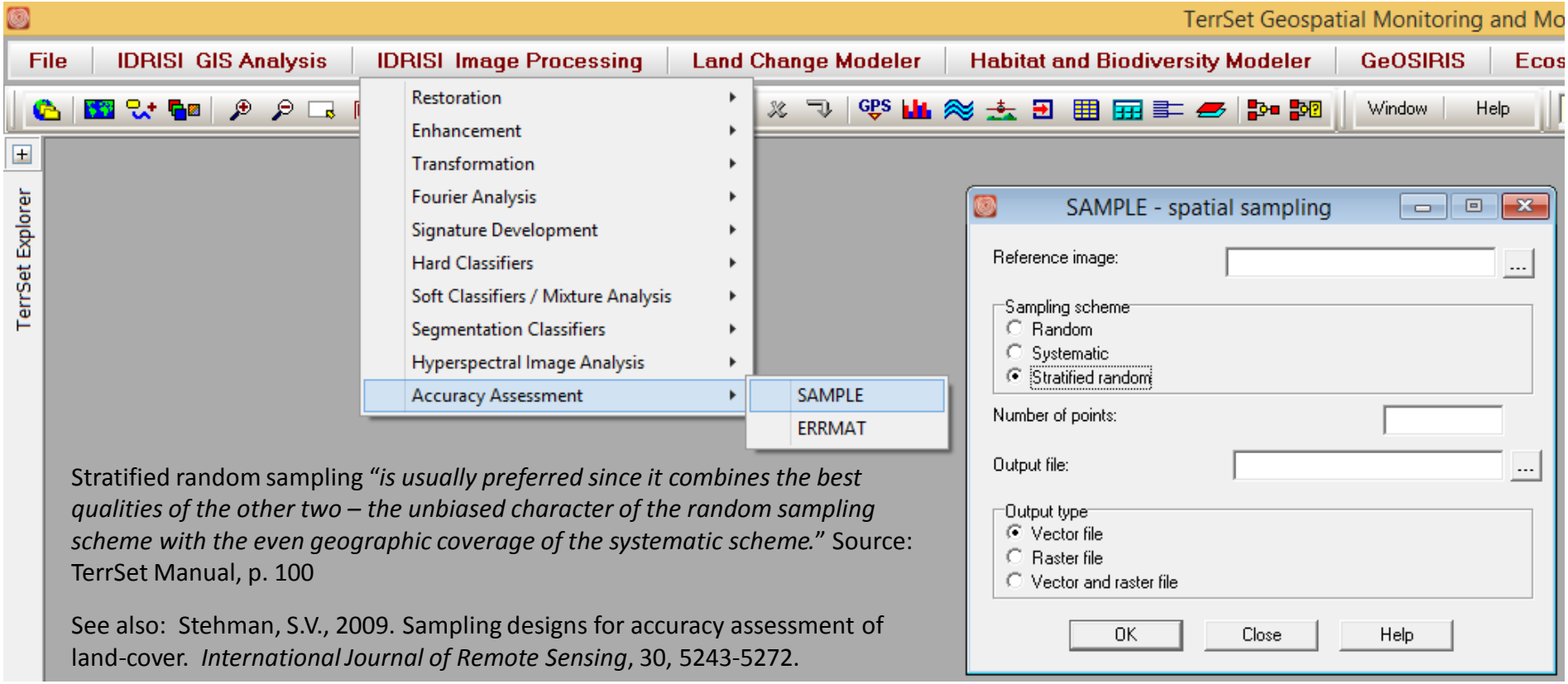
Overall Kappa: 0.8986

Print Contents | Save to File | Copy to Clipboard

2. Basic TerrSet modules

b. SAMPLE

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

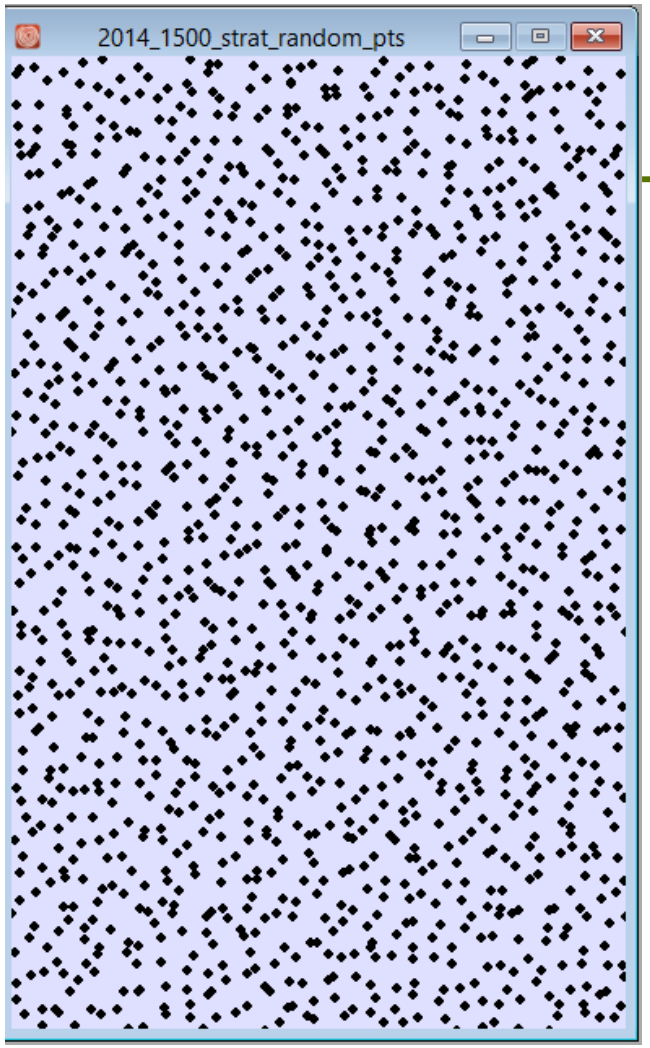


Stratified random sampling *"is usually preferred since it combines the best qualities of the other two – the unbiased character of the random sampling scheme with the even geographic coverage of the systematic scheme."* Source: TerrSet Manual, p. 100

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

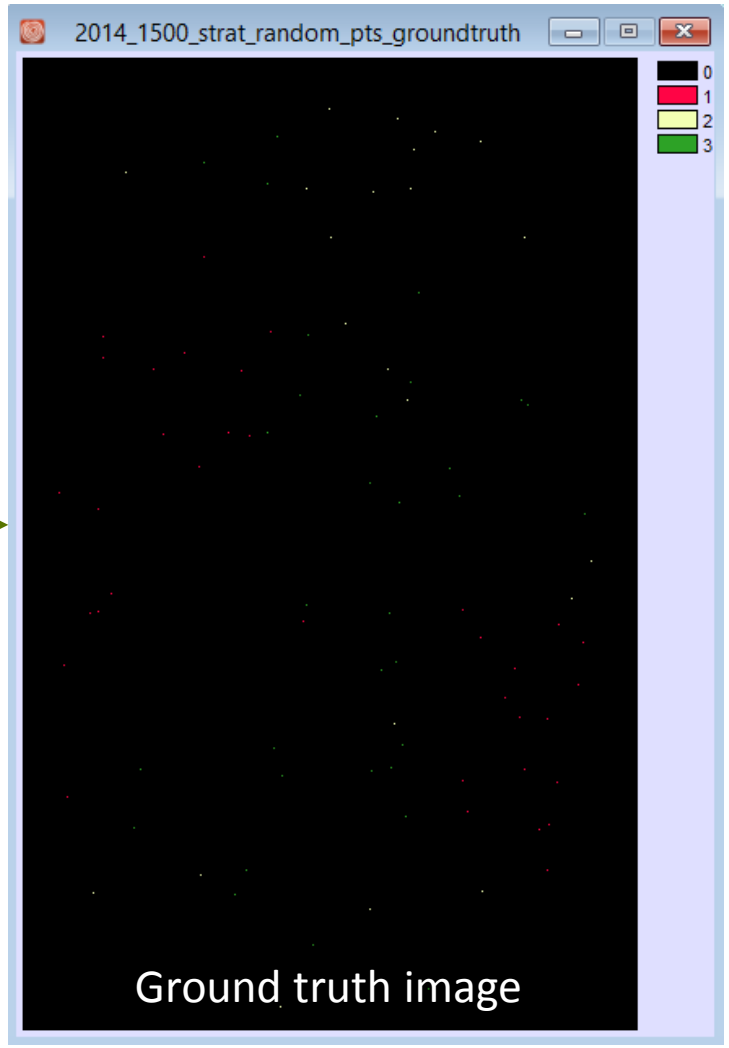
2. Basic TerrSet modules

b. SAMPLE



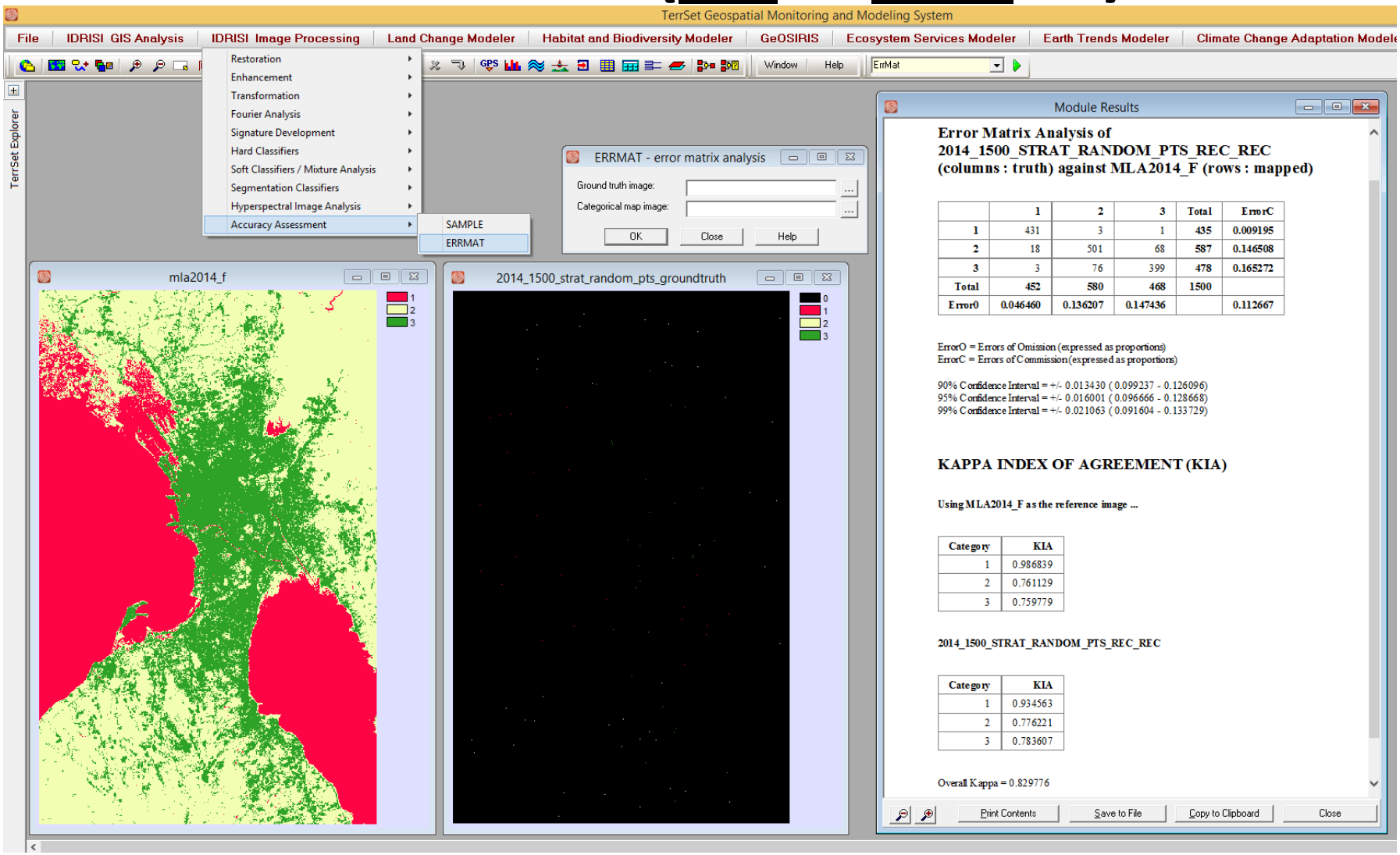
One way to prepare a ground truth image:

- 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)



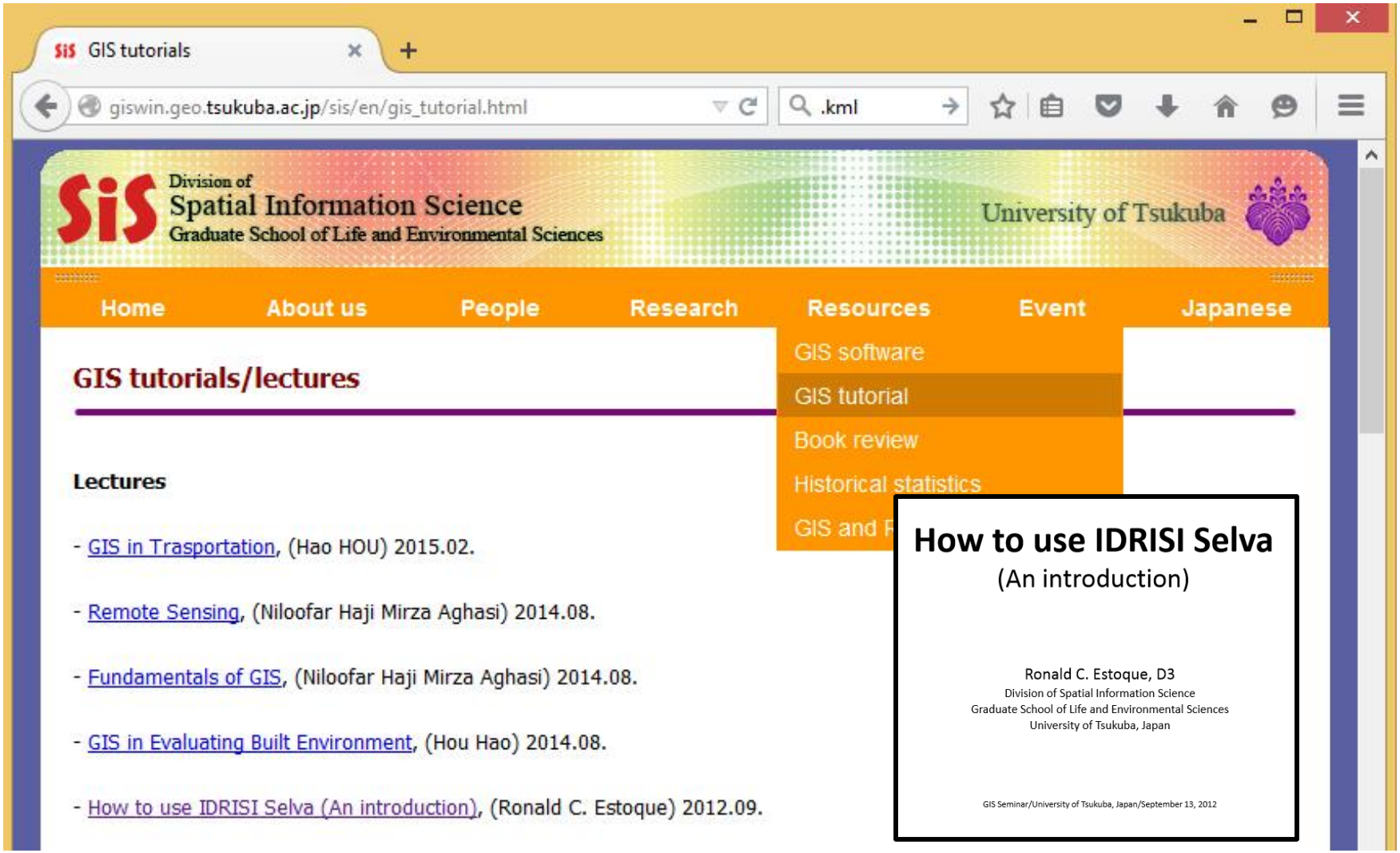
	1	2	3	Total	ErrorC
1	431	3	1	435	0.009195
2	18	501	68	587	0.146508
3	3	76	399	478	0.165272
Total	452	580	468	1500	
Error0	0.046460	0.136207	0.147436		0.112667

Category	KIA
1	0.986839
2	0.761129
3	0.759779

Category	KIA
1	0.934563
2	0.776221
3	0.783607

2. Basic TerrSet modules

See also:



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)

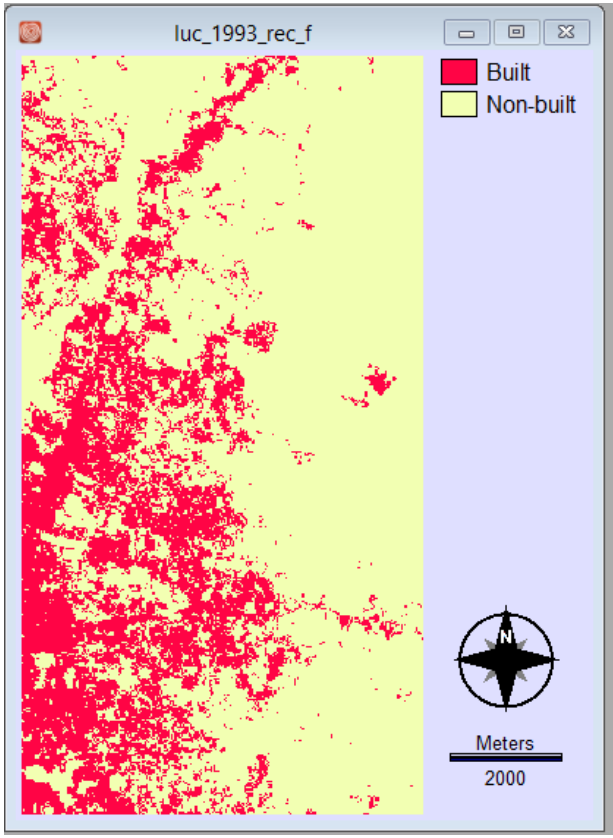
Urban land-change modeling in Manila

- 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

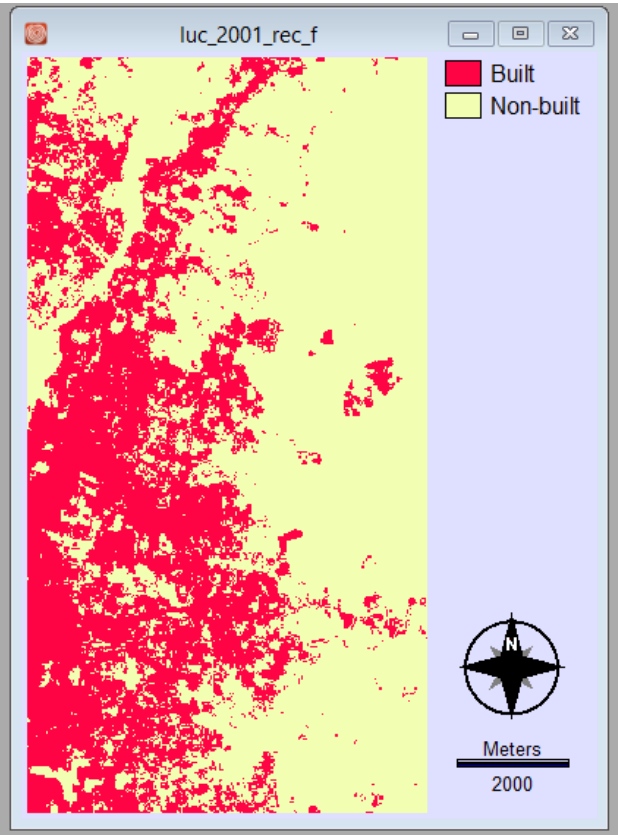
Data Source: Murayama Y, Kamusoko C, Yamashita A, Estoque RC (In preparation). ***Book Project***

Data: Land-use/cover (LUC) Maps

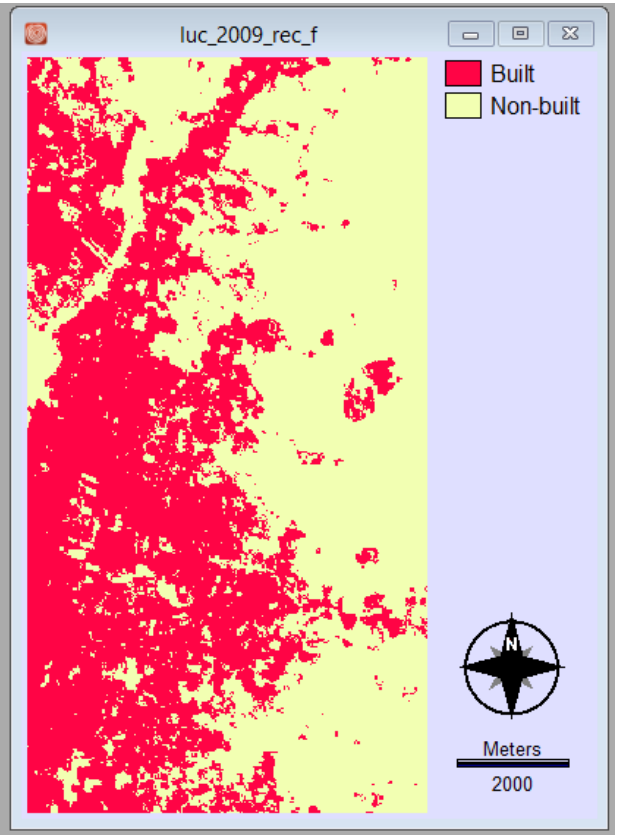
1993



2001

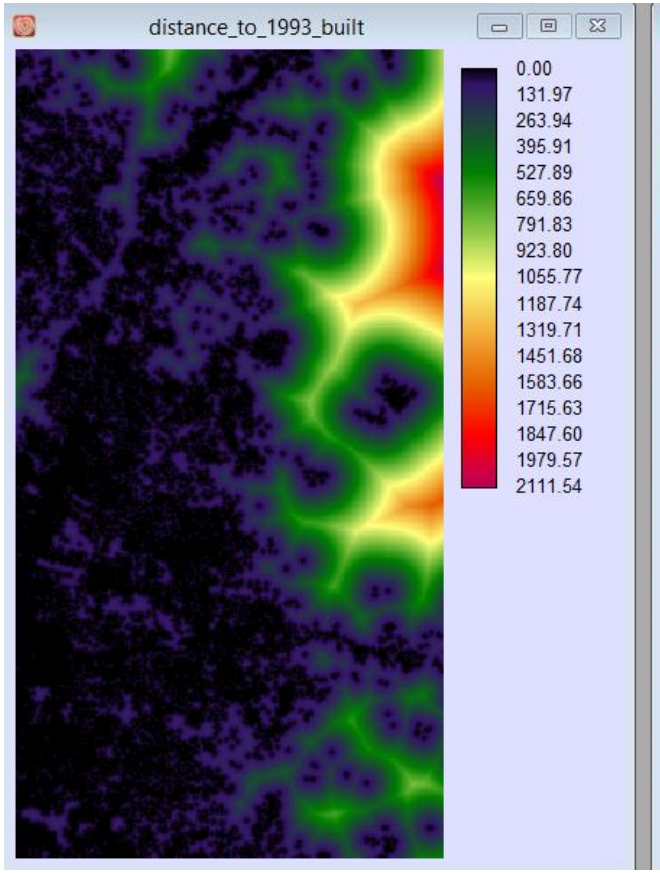


2009

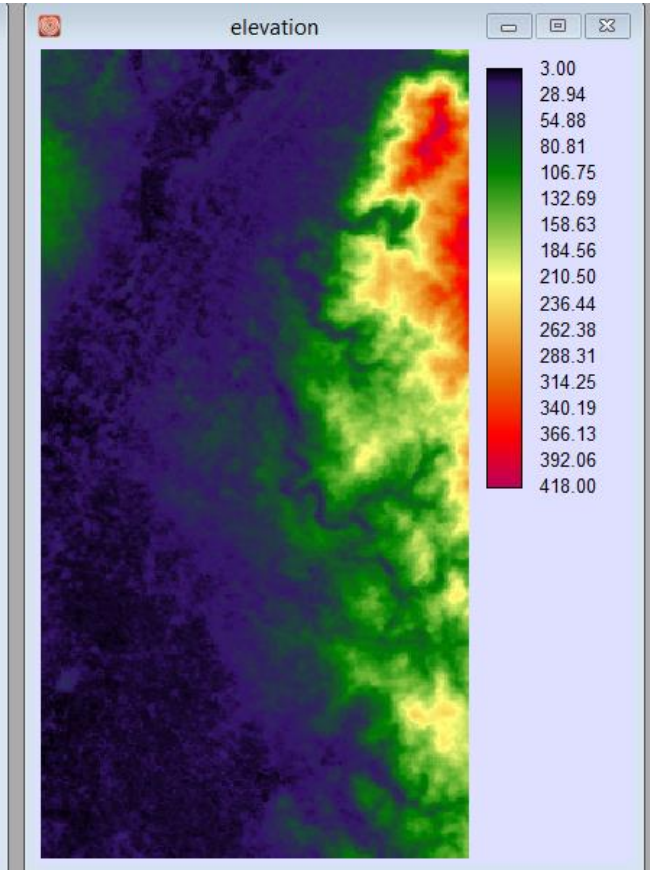


Data: Land change explanatory variables

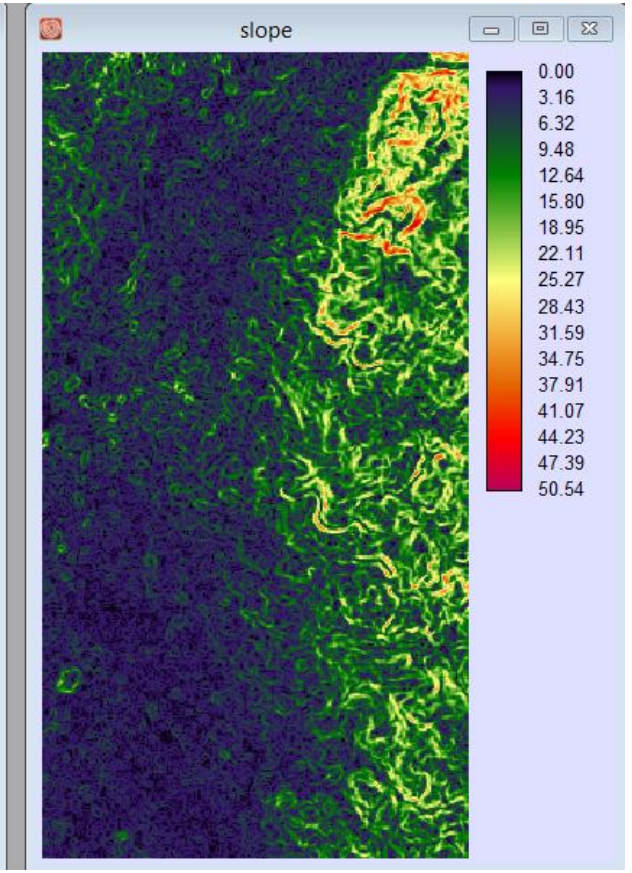
Distance to 1993 Built (m)



Elevation (m)

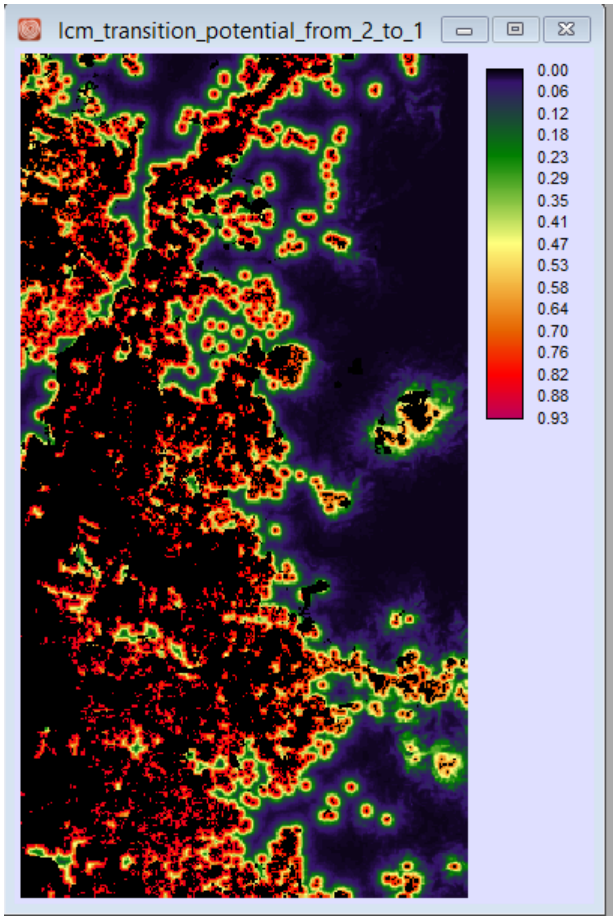


Slope (degree)

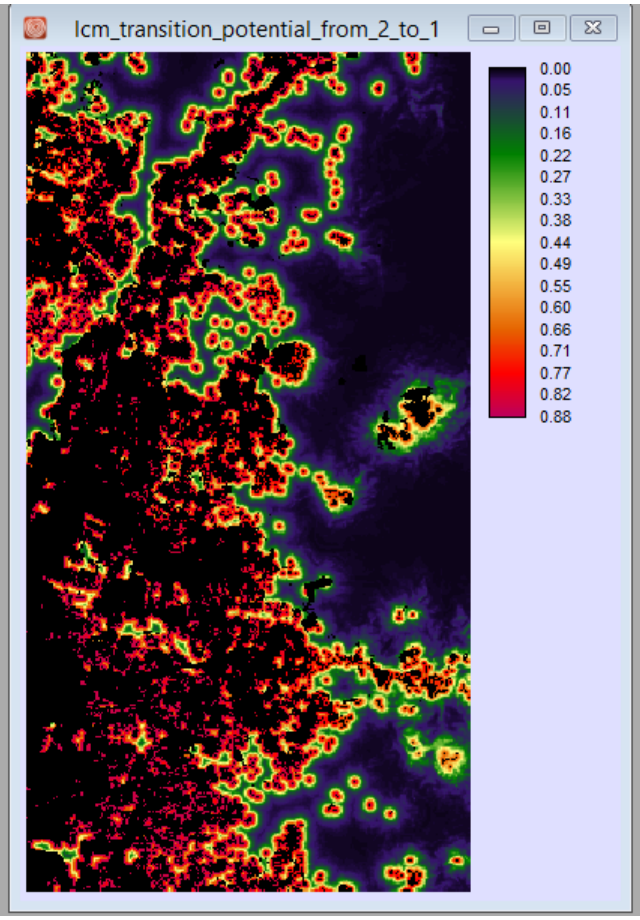


Transition potential maps

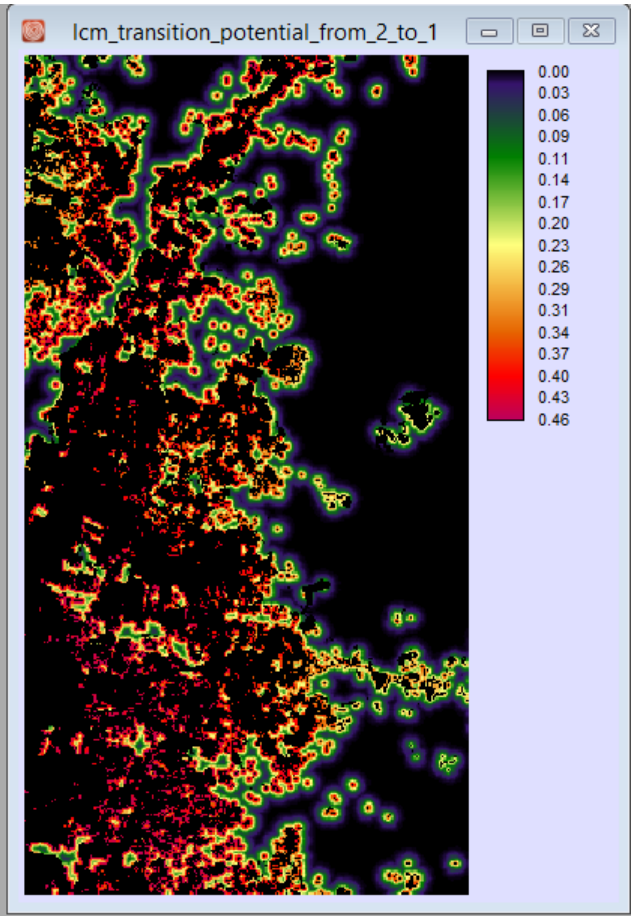
MLP Neural Network



SimWeight



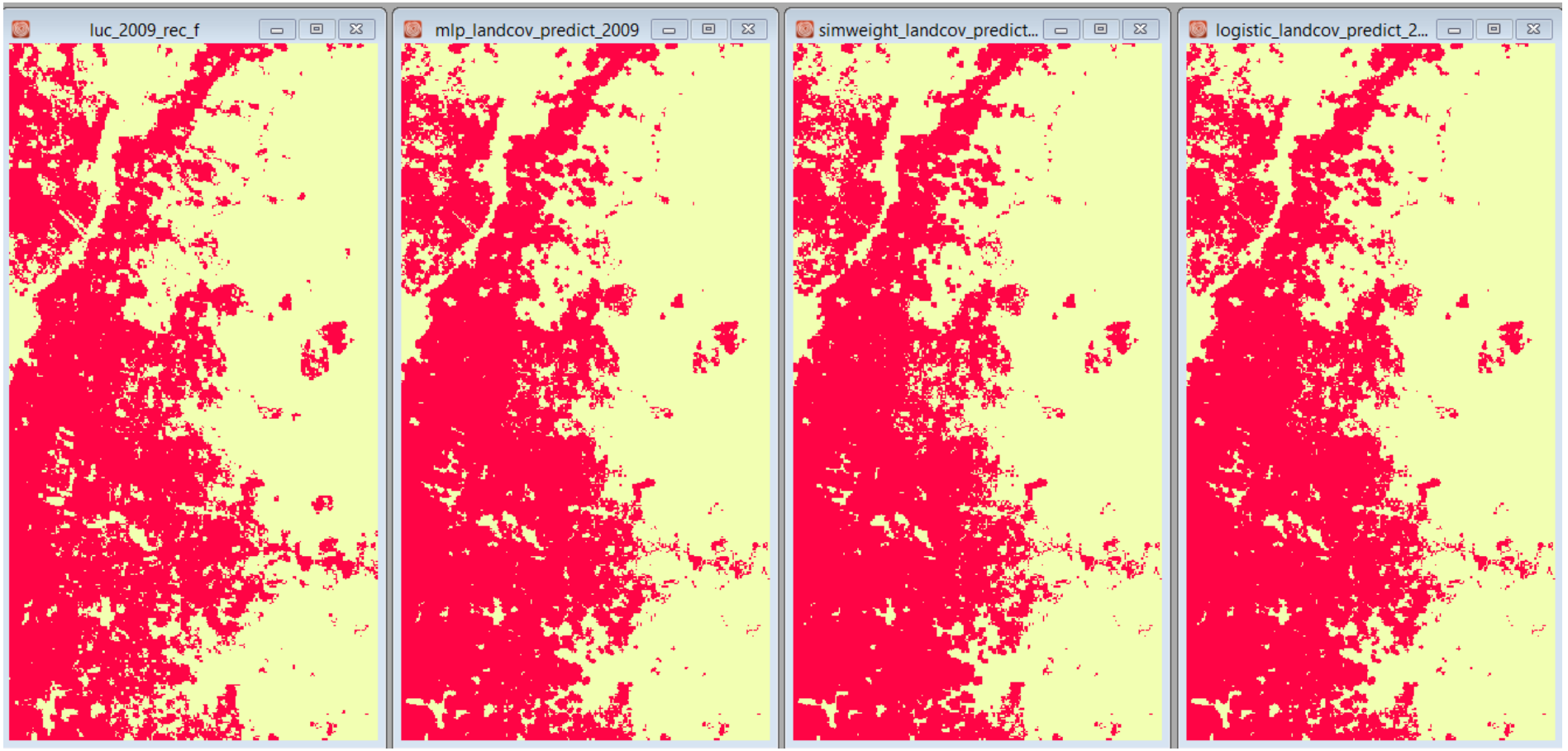
Logistic Regression



Results: Predicted 2009 LUC Maps

Predicted 2009 LUC Maps

LUC 2009 | MLP Neural Network | SimWeight | Logistic Regression

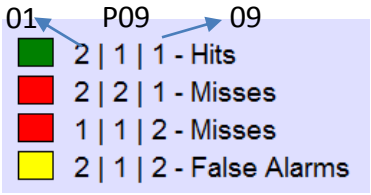


Built
Non-built

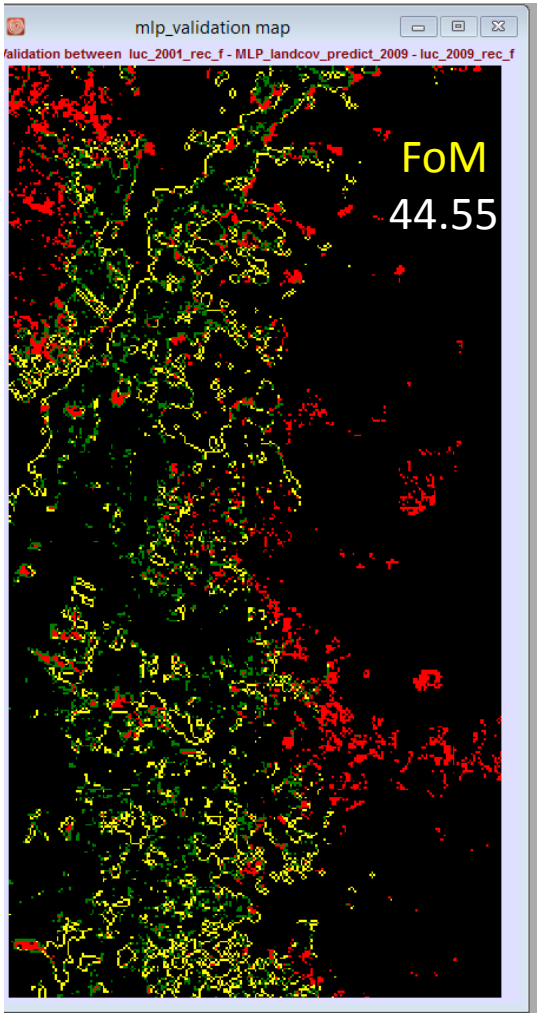
LUC 2009 Built = 46,680 pixels
Predicted 2009 Built = 47,263 pixels

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

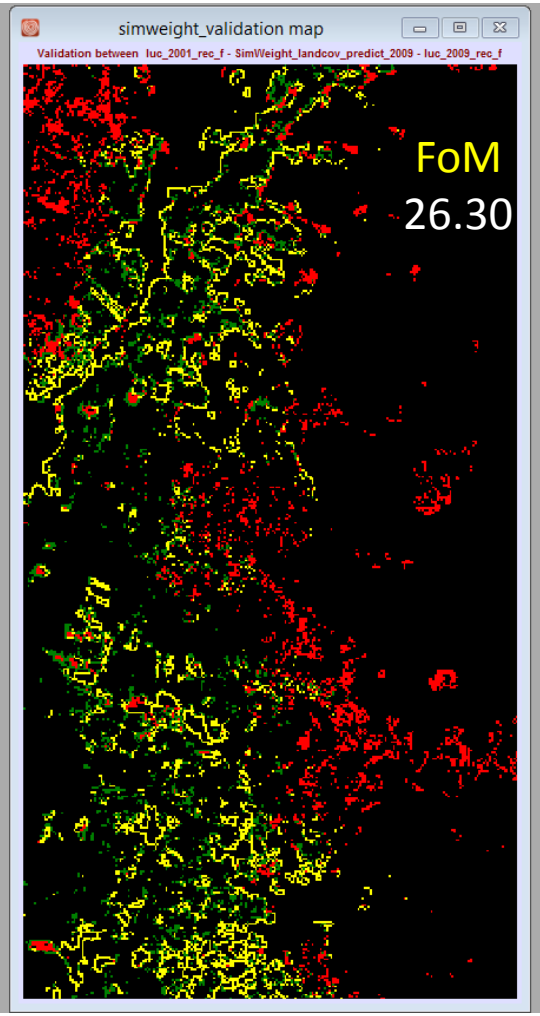
Validation Maps



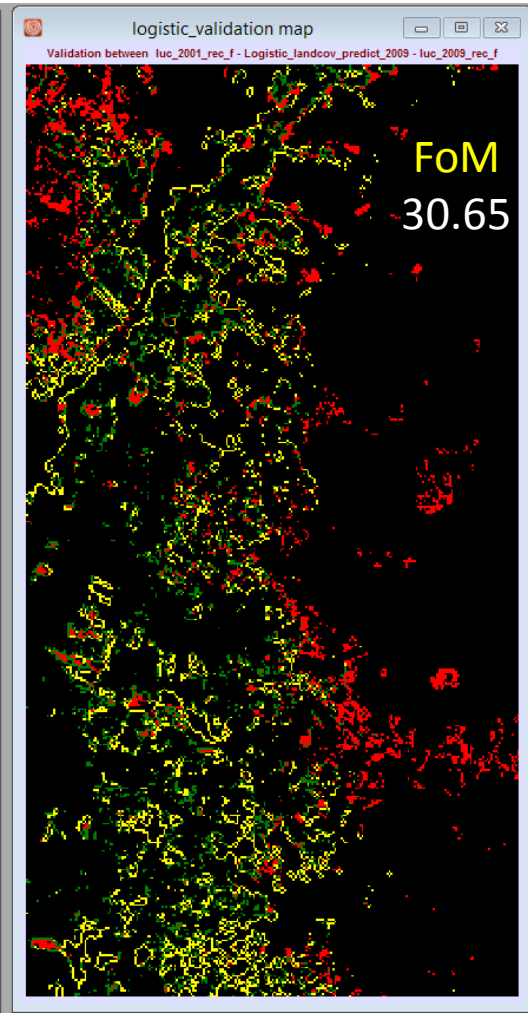
MLP Neural Network



SimWeight

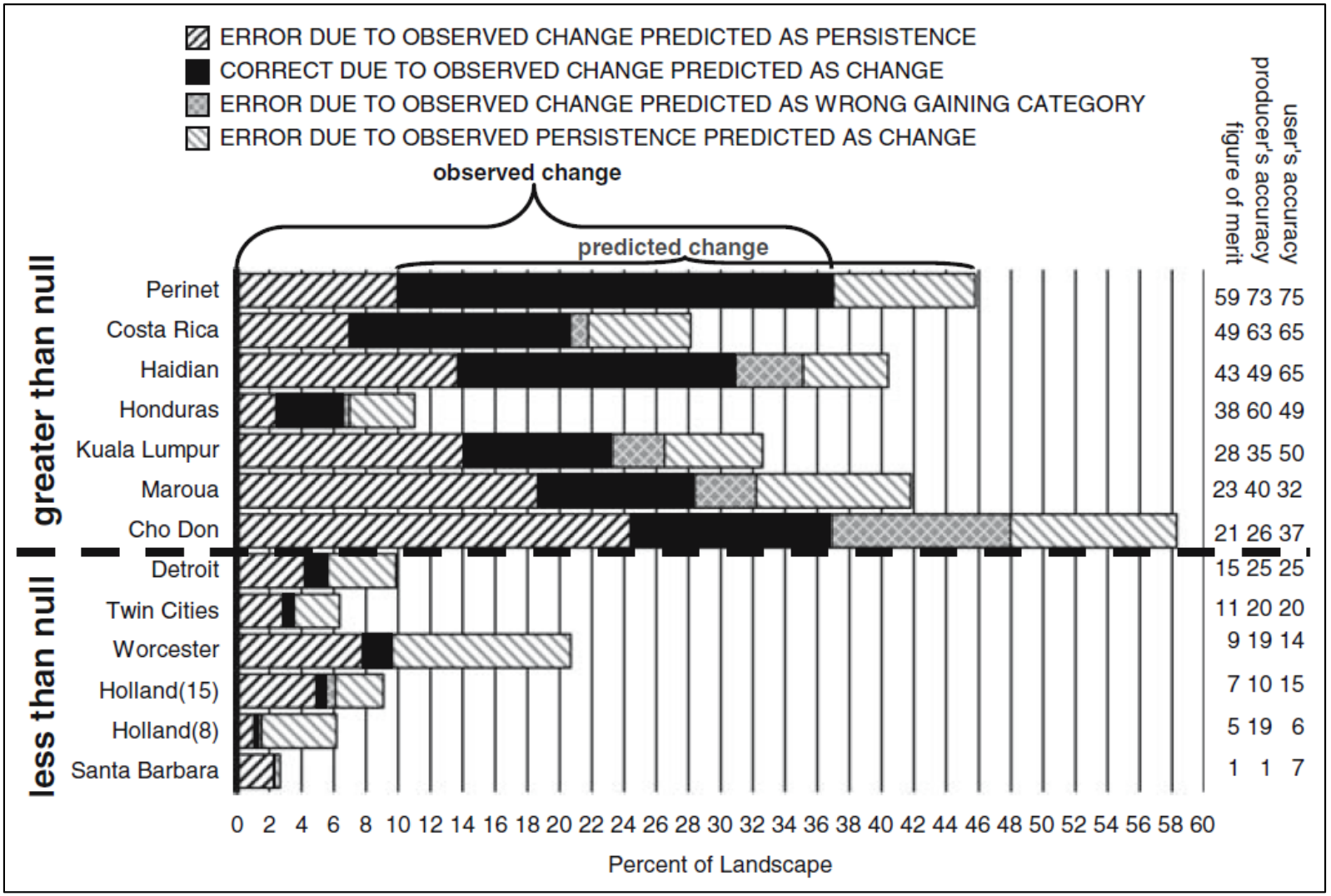


Logistic Regression



Pixel Count	MLP Neural Network	SimWeight	Logistic Regression
	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

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]

FoM = 8.36%

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

Urban growth modeling of Kathmandu metropolitan region, Nepal

Rajesh Bahadur Thapa *, Yuji Murayama [1]

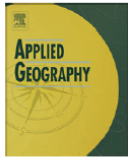
FoM = 19-26%

Applied Geography 35 (2012) 316–326

Contents lists available at SciVerse ScienceDirect

Applied Geography

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



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]

FoM = 42.80%

3. TerrSet Modelers

a. Land Change Modeler (LCM)

Sample Case Study (Multiple transitions)

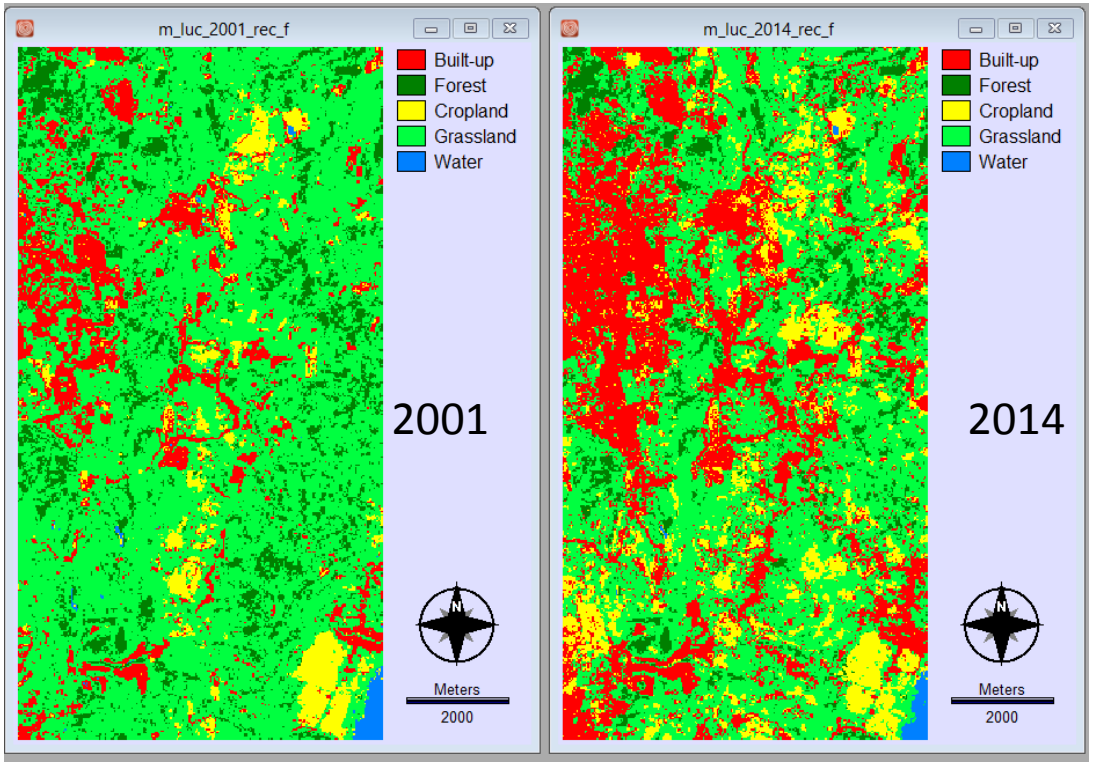
Land-use/cover (LUC) change modeling in Manila

- 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

LUC Data Source: Murayama Y, Estoque RC, Subasinghe H, Hou H, Gong H (2015) Land-use/land-cover changes in major Asian and African cities. ***Annual Report on the Multi Use Social and Economic Data Bank***, 92, 11-58.

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 :

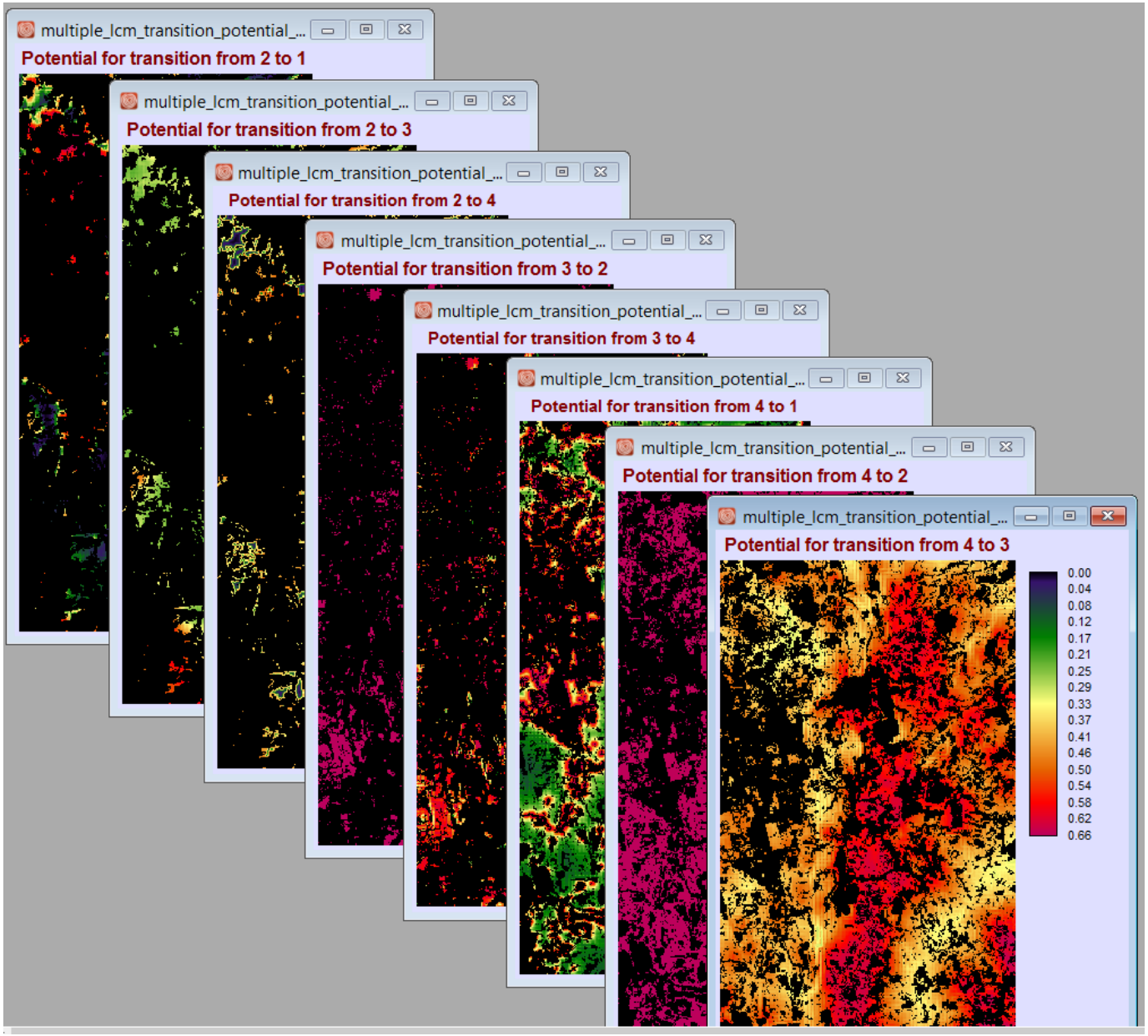
	Built-up	Forest	Cropland	Grassland	Water
Built-up	0.9999	0.0000	0.0001	0.0000	0.0000
Forest	0.0406	0.5643	0.1366	0.2585	0.0000
Cropland	0.0000	0.0062	0.6588	0.3350	0.0000
Grassland	0.2363	0.0006	0.0961	0.6670	0.0000
Water	0.0000	0.0000	0.1780	0.1243	0.6976

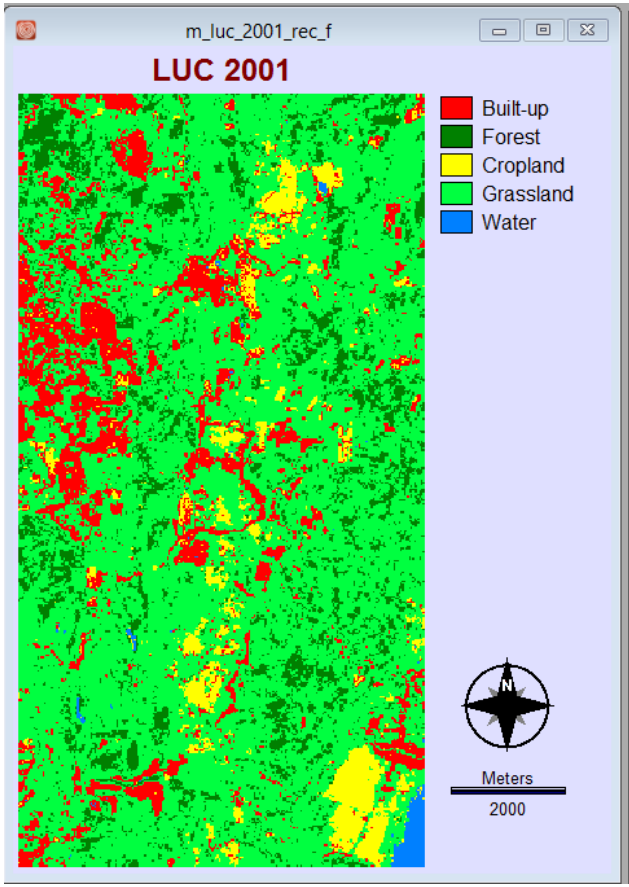
Save Close

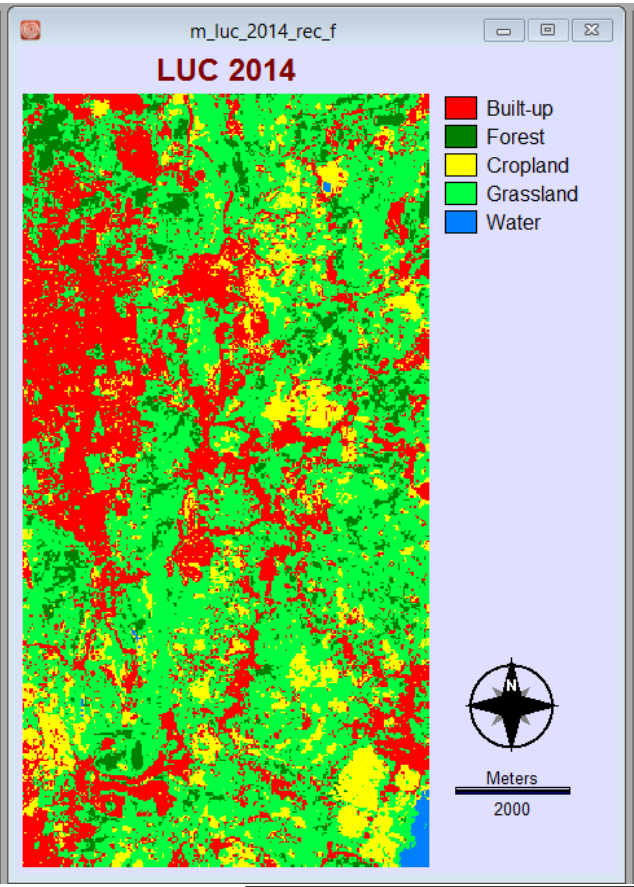
LCM – Multiple Transitions

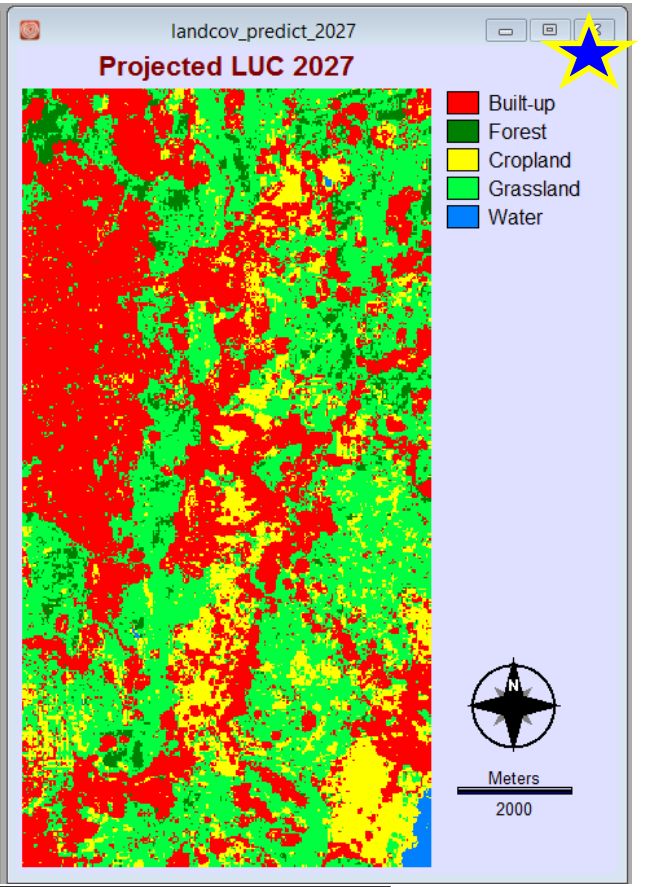
Transition Probability Maps

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



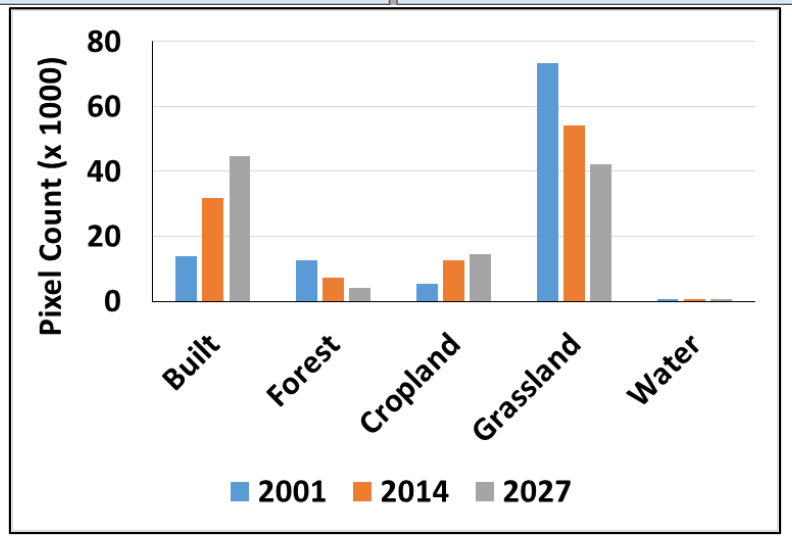






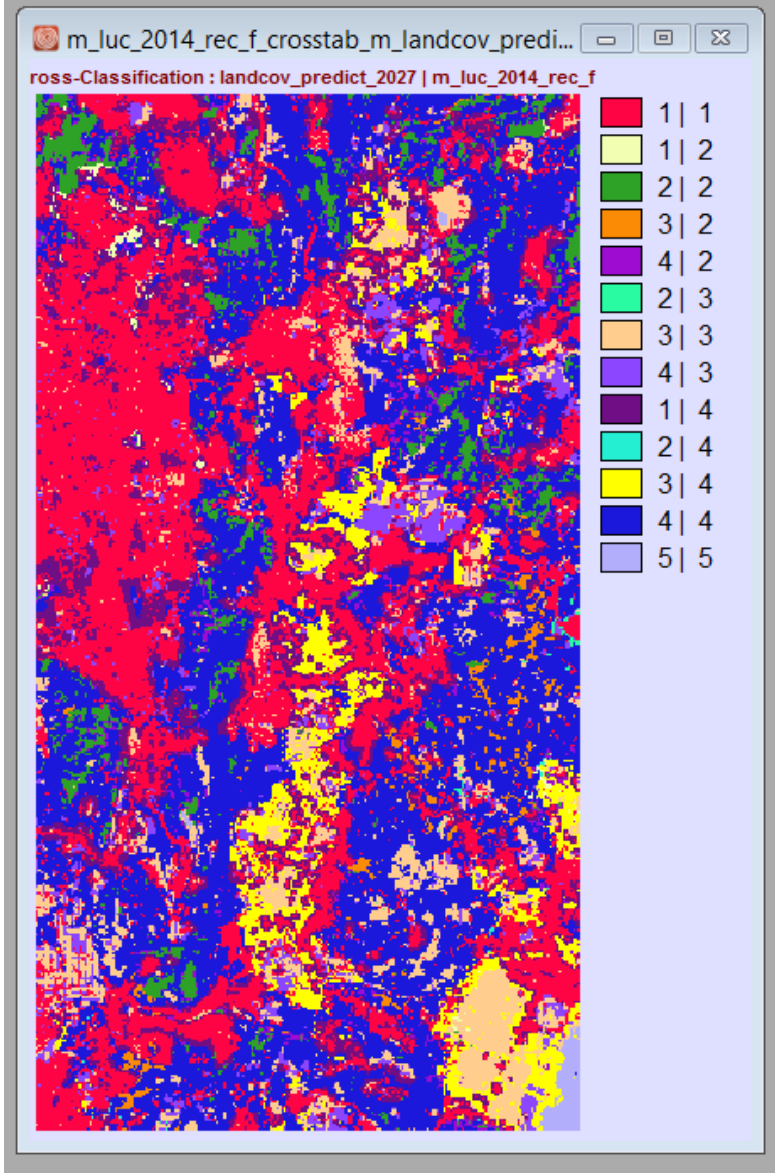
Results:

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

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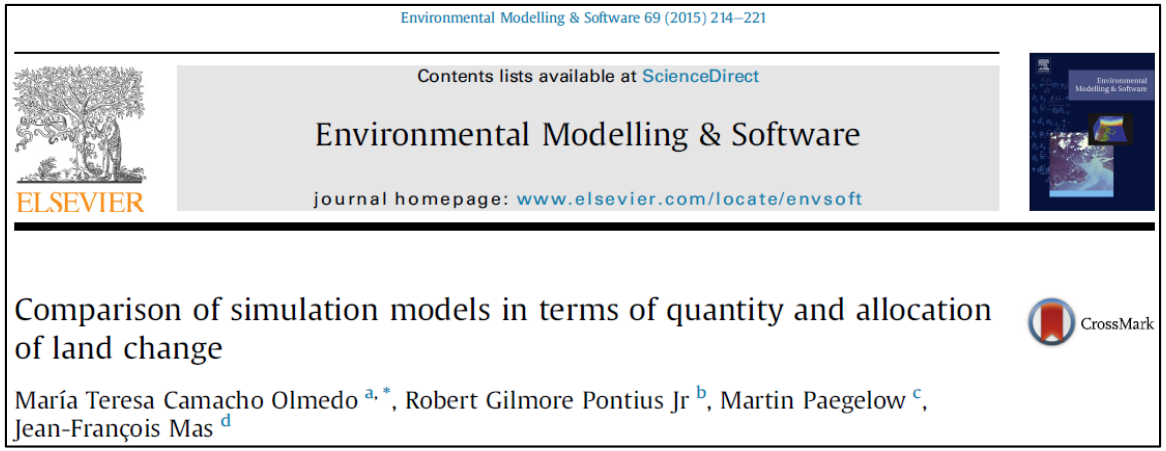
Some references for MLP NN, SimWeight and Logistic Regression Algorithms

2015



Environmental Modelling & Software 69 (2015) 214–221

Contents lists available at ScienceDirect

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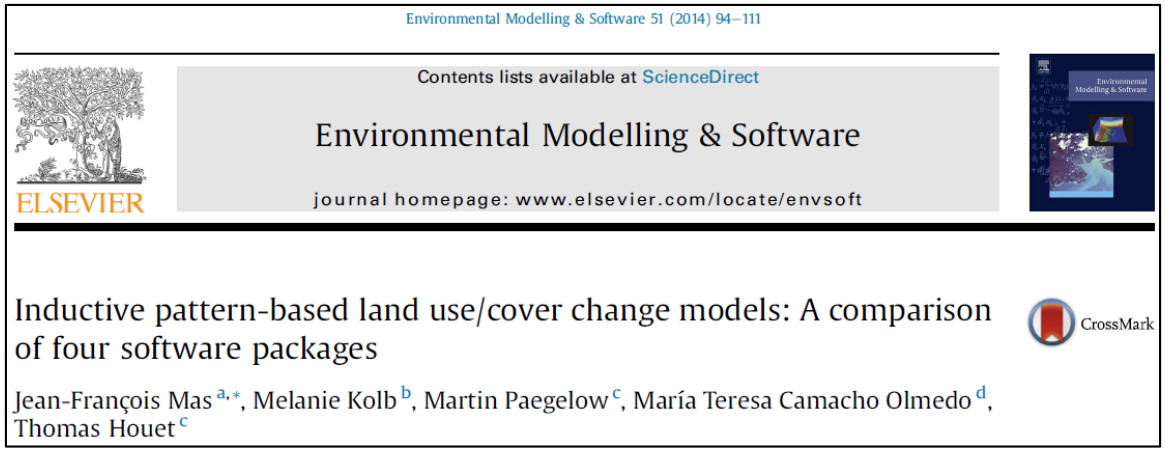
journal homepage: www.elsevier.com/locate/envsoft

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

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

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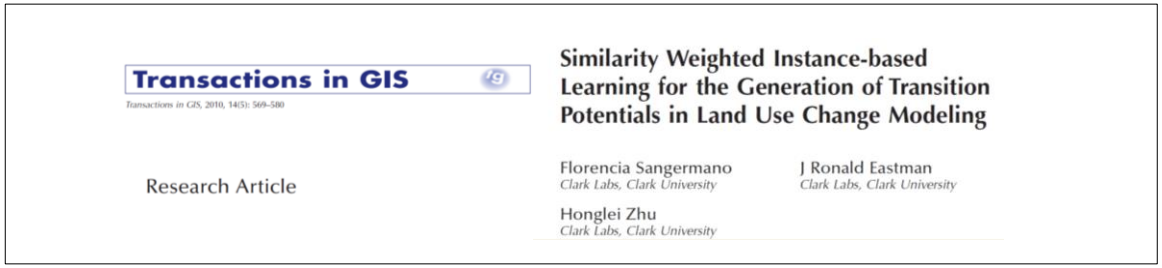
journal homepage: www.elsevier.com/locate/envsoft

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

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
   - c. ✓ ERRMAT

   } *Image Processing – Accuracy assessment*
4. TerrSet Modelers
   - a. Land change modeler
     - ✓ - Modeling one-way transition
     - ✓ - Modeling multiple transitions