Land Use/Land Cover Change Mapping of Mandalay City

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Introduction

- Land use/Land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes.

- An accurate and up-to-date land cover change information is necessary to understand and assess the environmental consequences of such changes.

- The satellite remote sensing data helps in quantification of LU/LC patterns and determines their changes with time (Shamsudheen et al. 2005).

- In this study, Land use/land cover change mapping has been carried out for Mandalay City to detect the changes during 2001-2015.

Study Area
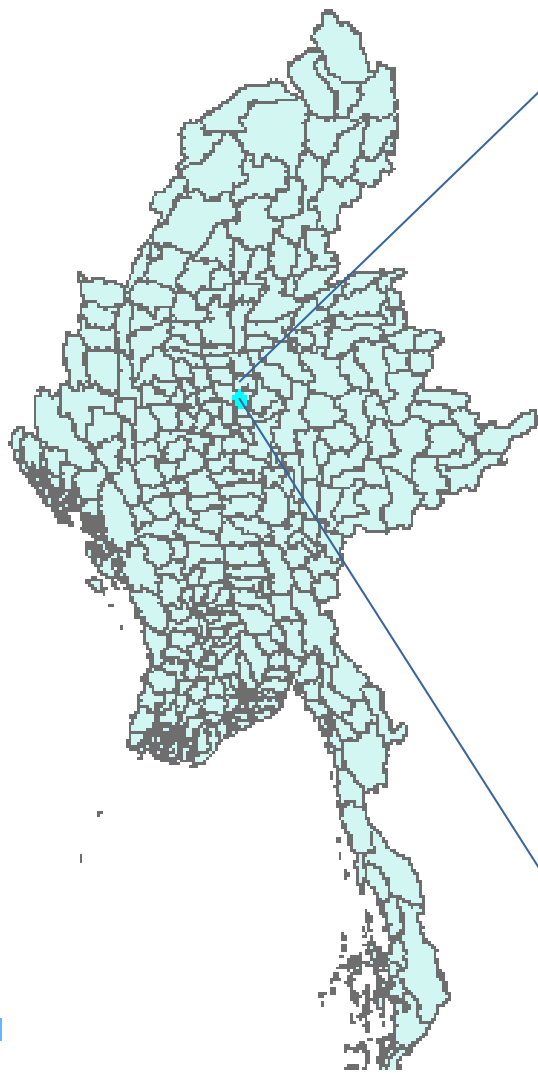
Mandalay Municipal Boundary Map
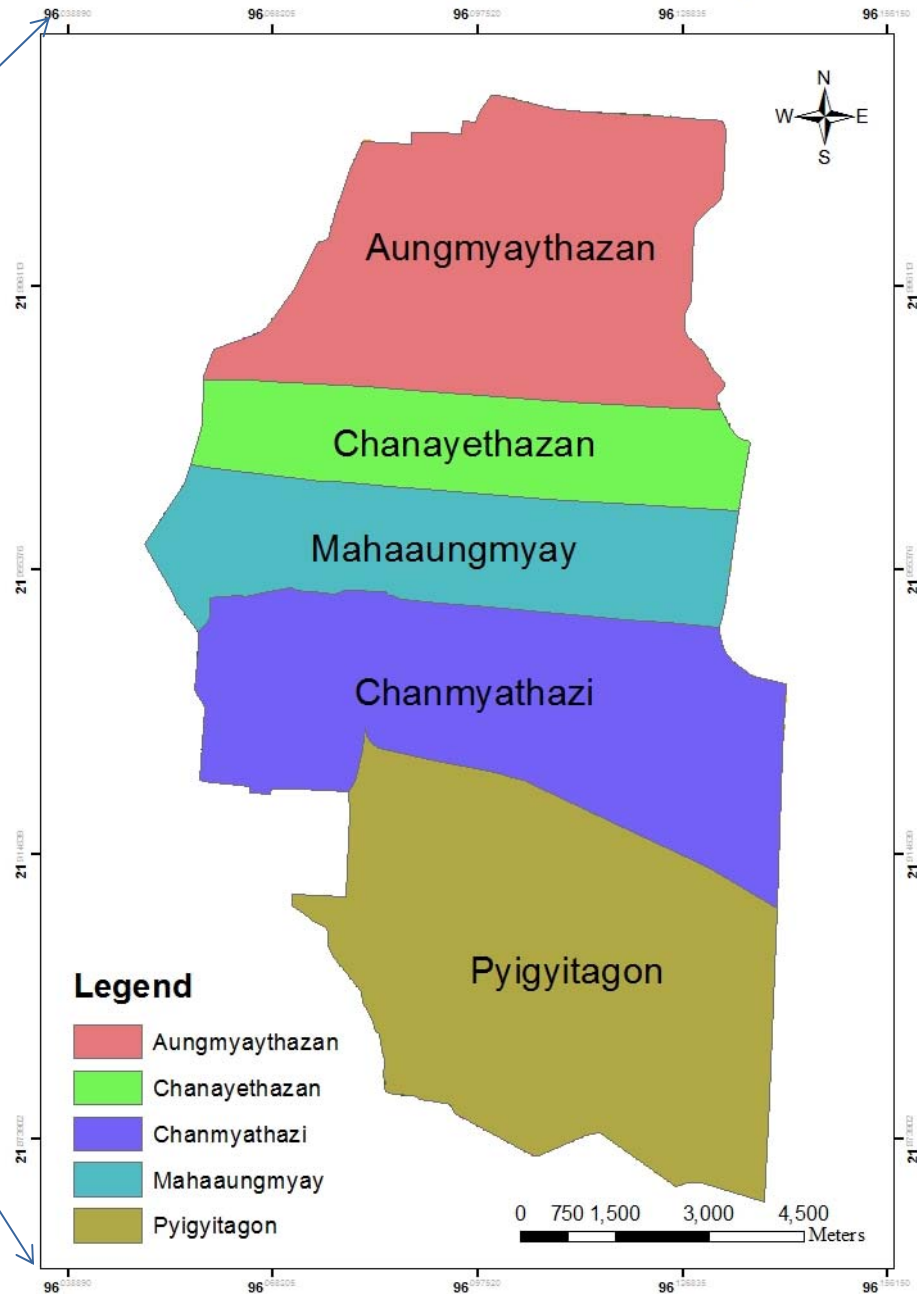
Study Area- Mandalay

- **Located between latitudes 21.87°N and 22.02°N, longitudes 96.05°E and 96.14°E (Central region of Myanmar)**
- **Population ~ 1.2 million (2014)**
- **Area ~ 113 km²(Municipal Area)**
- **Number of City Townships -5**

Aung Myay Thar San Townwship

Chan Aye Thar San Townwship

Mahar Aung Myay Townwship

Chan Mya Thar Si Townwship

Pyi Gyi Tan Khon Townwship

A Ma Ya Pu Ya Townwship

Source: Mandalay City Development Committee(MCDC)

Objectives

- **To analyze the dynamics of land use/land cover change using Landsat data for the years of 2001 and 2015**

- **To classify land use/land cover using (2001,2015) satellite images for Level I and (2004,2014) for Level II classification**

- **To compare different classification methods**

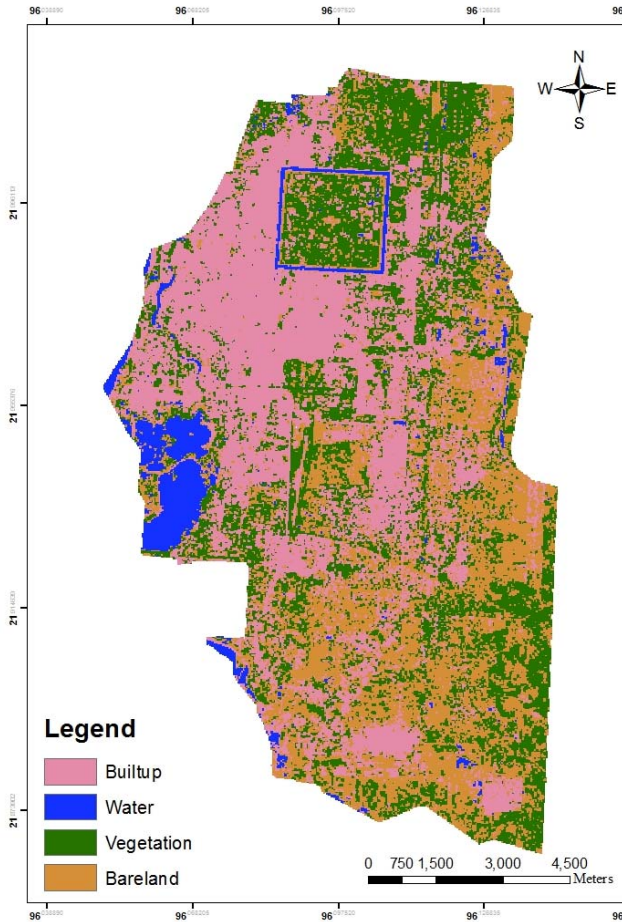# (i) Land Use/Land Cover Classification (Level I)

- Data used   -   Landsat TM image (2001)
  -    Landsat 8 image (2015)   Source :U.S. Geological Survey,
  -     Field Survey   Global Land Cover Facility(GLCF)
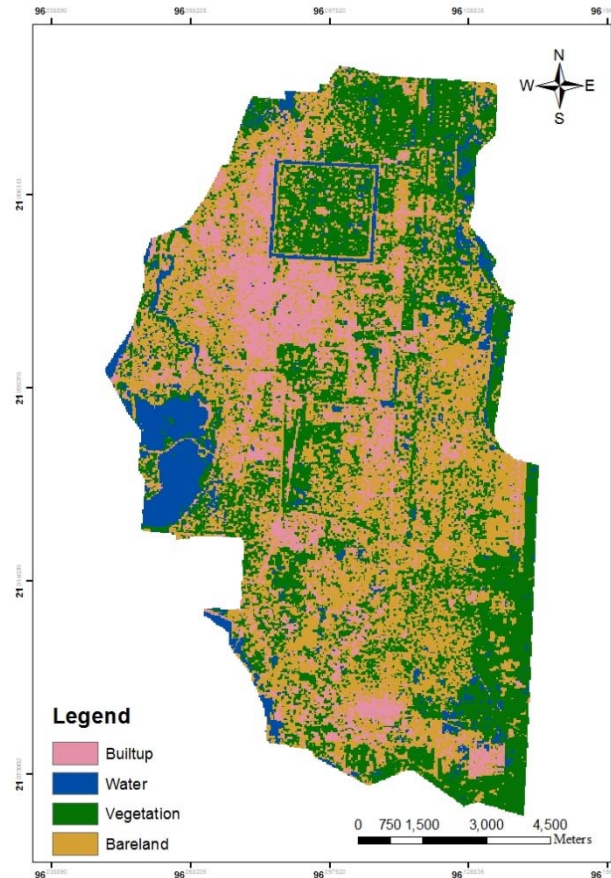- Software used   -   ArcGIS 10.1,QGIS
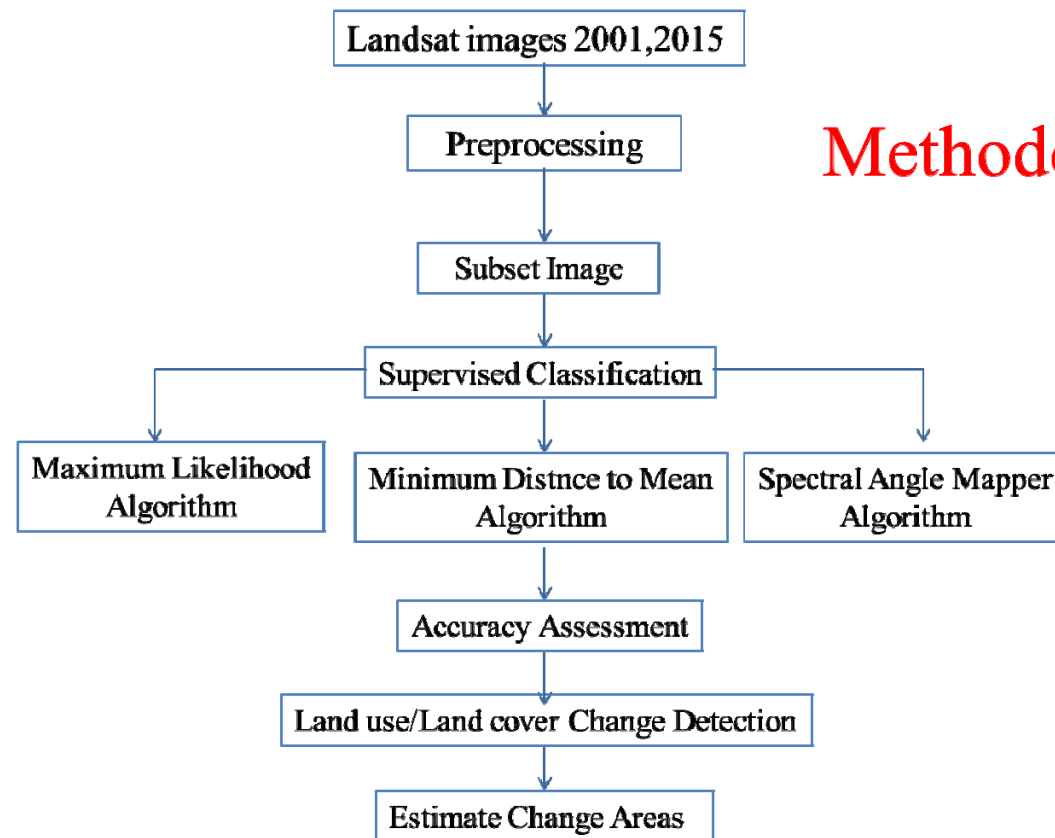
Methodology

Classified Maps of 2001

Maximum Likelihood Classified Map of 2001

Minimum Distance Classified Map of 2001

Spectral Angle Mapping Classified Map of 2001

Legend
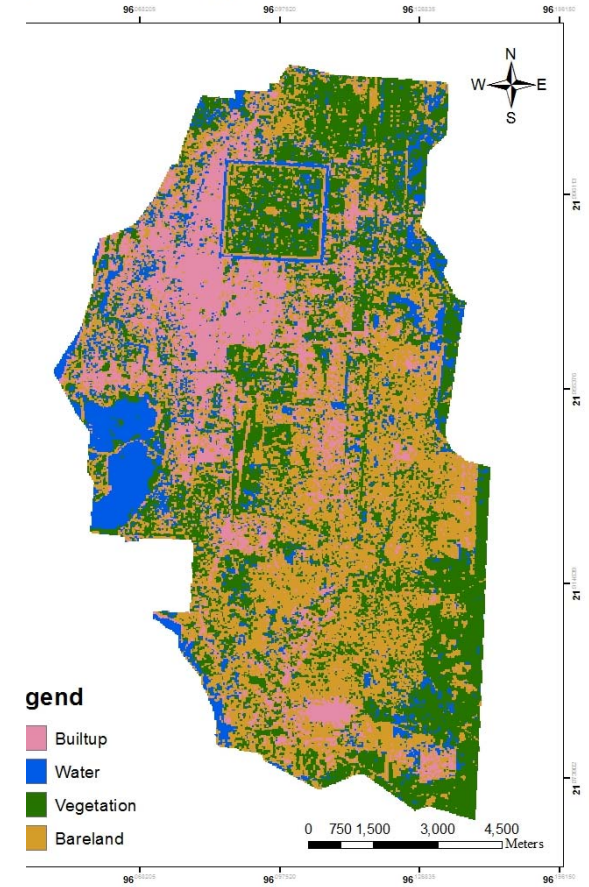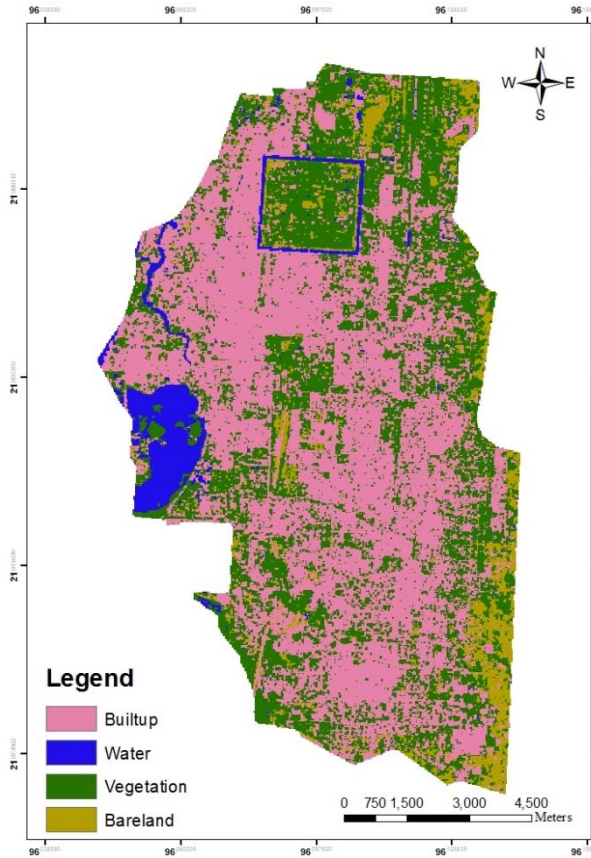- Builtup
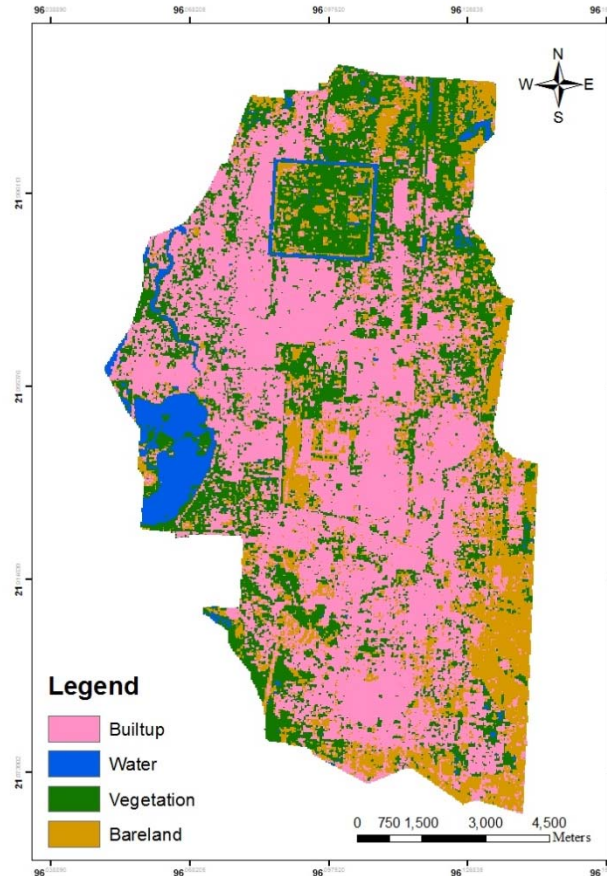- Water
- Vegetation
- Bareland

Classified Maps of 2015
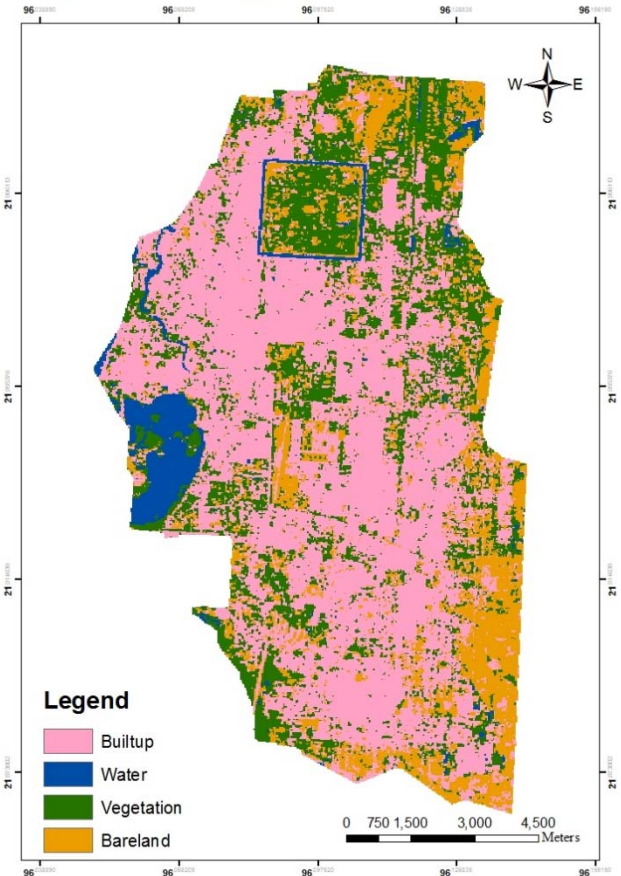

Maximum Likelihood Classified Map of 2015

Minimum Distance Classified Map of 2015

Spectral Angle Mapping Classified Map of 2015

Legend
- Builtup
- Water
- Vegetation
- Bareland

Comparison of Classification Methods

Algorithms	Maximum Likelihood Algorithm (km²)		Minimum Distance to Mean Algorithm (km²)		Spectral Angle Mapper Algorithm (km²)	
LU/LC Classes	2001	2015	2001	2015	2001	2015
Built up	41.87	69.41	17.16	56.68	17.90	61.22
Water	5.31	4.97	9.60	5.00	15.50	4.92
Vegetation	32.64	30.37	40.12	31.48	35.67	27.45
Bareland	33.30	8.36	46.24	19.97	44.04	19.53

Accuracy Assessment of Land use/Land cover Map

2001 Land use/Land cover map		
Methods	Kappa Value	Overall Classification Accuracy(%)
Maximum Likelihood	0.88	89.64
Minimum Distance	0.8	85.47
Spectral Angle Mapper	0.82	87.52

(2001)

2015 Land use/Land cover map		
Methods	Kappa Value	Overall Classification Accuracy(%)
Maximum Likelihood	0.89	89.53
Minimum Distance	0.86	85.71
Spectral Angle Mapper	0.86	87.78

(2015)

Land Use/Land Cover Change Map (2001-2015)

Land Use/Land Cover Change Map (2001-2015)

Legend

Color	Class	Color	Class
	1 to 1		3 to 1
	1 to 2		3 to 2
	1 to 3		3 to 3
	1 to 4		3 to 4
	2 to 1		4 to 1
	2 to 2		4 to 2
	2 to 3		4 to 3
	2 to 4		4 to 4

LU/LC Classes
1. Built up
2. Water
3. Vegetation
4. Bare Land

0 750 1,500   3,000   4,500
Meters
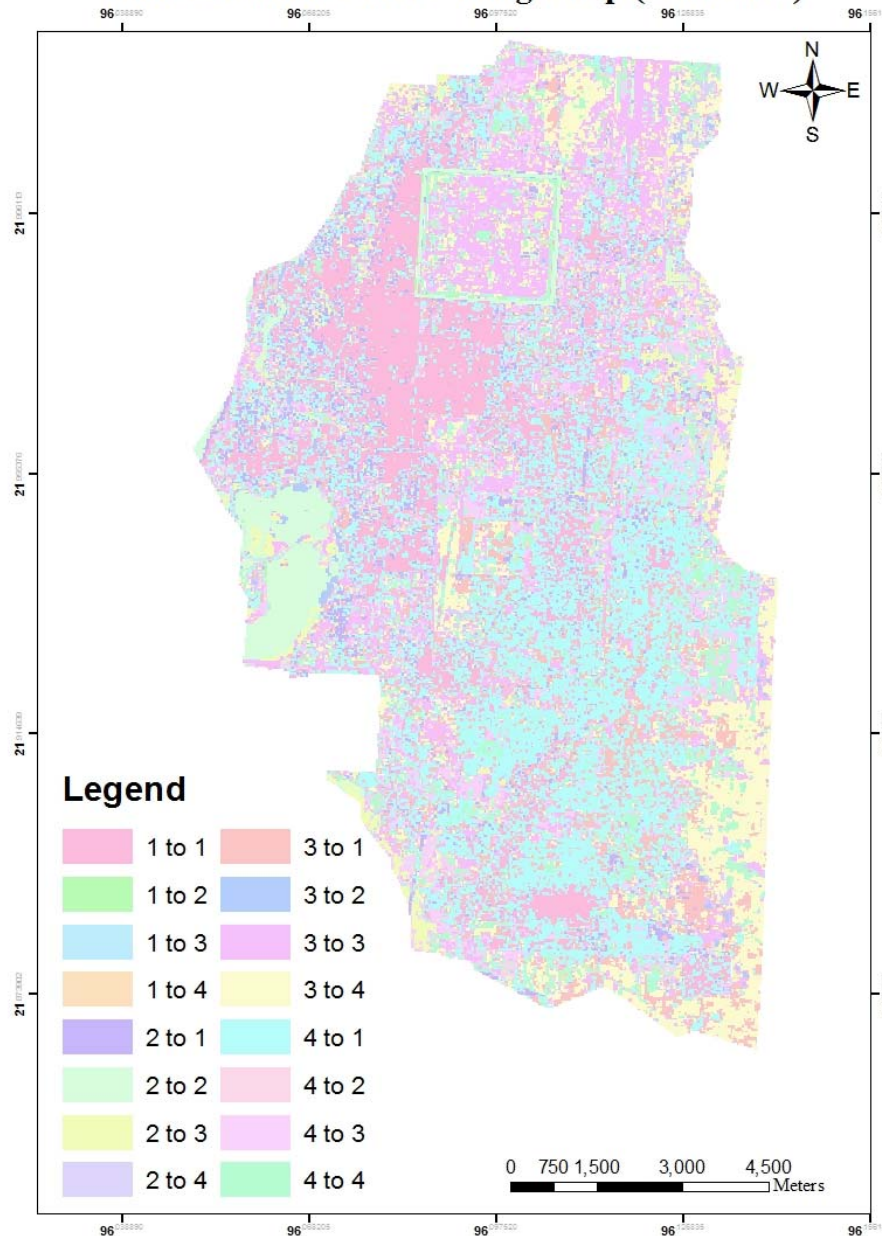
Change Detection Matrix(2001-2015)

From_To Change Matrix (Changes in Area(km^2))

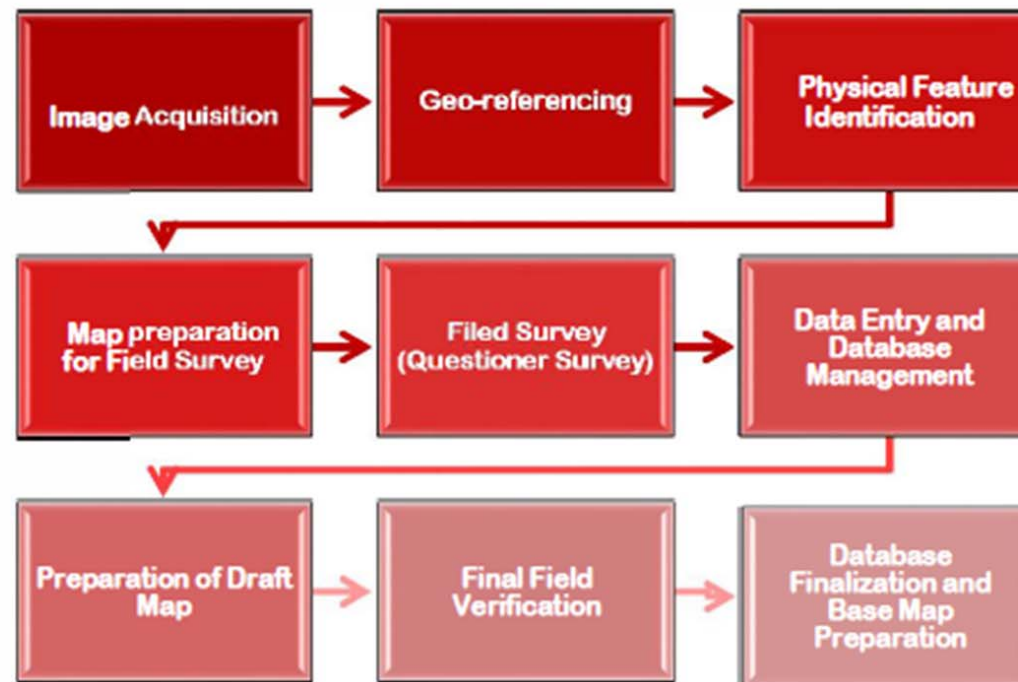| Sr	LU/LC Classes	1 Built up	2 Water	3 Vegetation	4 Bareland
1	Built up	16.78	0.17	0.53	0.42
2	Water	5.11	4.12	4.63	1.64
3	Vegetation	10.11	0.52	14.27	10.77
4	Bareland	29.2	0.11	8.03	6.7

Land use/land cover Classification (Level I)

- Level I classification was carried out by using three different methods such as Maximum Likelihood Algorithm, Minimum Distance to Mean Algorithm and Spectral Angle Mapper Algorithm in QGIS.

- The post classification change detection technique has been used to analyze the LU/LC change during 2001 and 2015.

- The accuracy of the classified maps was analyzed by estimating the Kappa value and overall accuracy.

- Based on the results of accuracy assessment, the LU/LC statistics obtained using Maximum Likelihood Classifier, which gave better accuracy with 0.88 and 0.89 Kappa values for 2001 and 2015, has been utilized for studying the change.

- According to classification results, only built up area is increased from 41.87 km^2 to 69.41 km^2 . Waterbody, vegetation and bare land area have been reduced respectively.

(ii) Land Use/Land Cover Classification (Level II)

- Data used – Satellite images of 2004 (QuickBird) and
  2014 (Worldview)
  _ Field Survey for Land use verification
- Software used - ArcGIS 10.1

Work Process

Survey form

ID	Health Centre		Religious			Hotel				Education					Government office			Industrial zone	Recreational Centre				Commercial			Open space	Mixed Used	Transportation			Description	Remark
	Public	Private	Pagoda	Monesty	Community hall	Five Stars	Four Stars	Three Stars	Others	Primary School	Middle School	High School	University	Institute	Admin	Fire Station	Militany		Cinema	Zoo	Park	Stadium	Market	Bank	Shop/Store	Football Ground		Airport	Bus Gate	Railway Station		

Map No   Date   Group No.

Data Collection

Level I	Level II	Level III
Urban or built-up	Residential	– Single unit, low-density (less than 2 DUPA)
		– Single unit, medium-density (2 to 6 DUPA)
		– Single unit, high-density (greater than 6 DUPA)
		– Mobile homes
		– Multiple dwelling, low-rise (2 stories or less)
		– Multiple dwelling, low-rise (3 stories or less)
		– Mixed residential
	Commercial & services	– Retail sales & Services
		– Wholesale sales & services (including trucking & warehousing)
		– Offices & professional services
		– Hotels & motels
		– Cultural & entertainment
		– Mixed commercial & services
	– Industrial	– Light industrial
		– Heavy industrial
		– Extractive
		– Industrial under construction
	– Transportation	– Airports, including runways, parking areas, hangars, & terminals
		– Rail roads, including yards & terminals
		– Bus & truck terminals
		– Major roads & high ways
		– Port facilities
		– Auto parking facilities (where not directly related to another land use)
	– Communications & Utilities	– Energy facilities (electrical & gas)
		– Water supply plants (including pumping stations)
		– Sewage- treatment facilities
		– Solid – waste disposal sites
	– Institutional	– Educational facilities, including Colleges, universities, high schools & elementary schools
		– Religious facilities, excluding schools
		– Medical & health care facilities
		– Correctional facilities
		– Military facilities
		– Governmental, administrative,& service facilities
		– Cemeteries
	– Recreational	– Golf courses
		– Parks & zoos
		– Marinal
		– Stadiums, fair grounds & race tracks
	– Mixed	
	– Open Land & Others	– Undeveloped land within urban areas
		– Land being development; intended use not known
Agriculture	– Crop Land & Pasture	– Row crops
		– Field crops
		– Pasture
	– Orchards, Groves, Vineyards, Nurseries & Ornamental Horticultural Areas	– Citrus orchards
		– Non citrus orchards
		– Nurseries
		– Ornamental horticultural Vineyards
	– Confined feeding Operations	– Cattle
		– Poultry
		– Hogs
	– Other Agriculture	– Inactive agricultural land
		– Other
Range Land	– Grassland	
	– Shrub & Brush land	– Sagebrush prairies
		– Costal scrub
		– Chaparral
		– Second-growth brush land
	– Mixed Range Land	
Forest Land	– Evergreen Forest	– Pine
		– Redwood
		– Other
	– Deciduous Forest	– Oak
		– Other hardwood
	– Mixed Forest	– Mixed Forest
	– Clear Cut Areas	
	– Burned Areas	
Water	– Streams & Canals	
	– Lakes & Ponds	
	– Reservoirs	
	– Bays & Estuaries	
	– Open Marine Water	
Wetlands	– Vegetated wetlands, forested Non forested	– Herbaceous vegetation
		– Fresh water marsh
		– Salt water marsh
	– Non Vegetated wetlands	– Tidal flats
		– Other non vegetated wetlands
Barren Land	– Dry lake Beds	
	– Beaches	
	– Sand &Gravel other than beaches	
	– Exposed Rock	
Tundra	– Bare Ground Tundra	
Perennial snow or ice	– Perennial snow fields	
	– Glaciers	

*DUPA=Dwelling units per acre.

Source: Modified from Anderson and others (1976);

Florida bureau of comprehensive planning 1976

Image Specification

- Satellite Image

- Geo-referencing and projection

- Physical feature Identification

Field Survey Activity

Training

Discussion

Site survey

Workflow for map development

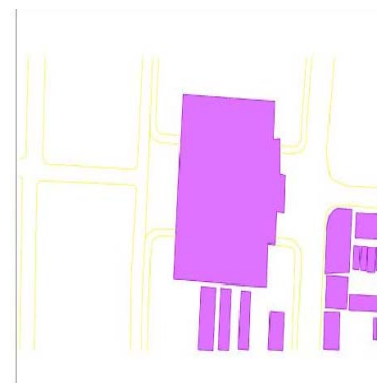(a) Image Collection and Dereferencing

(b) Digitization

(c) Digitization of the Feature Detail
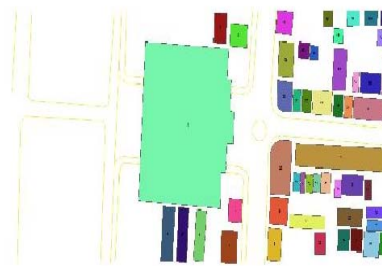
(f) Field Measurement (as requires)

(e)Interview with local people

(d) Digitized Map for Field Survey

(g) Attribute Information added in the Database

(h) Final Map with Feature Details

OBJECTID	NAME_ZONE	BD_ID	BD_ZONE_ID	BD_ID_1	Hold_no	BD_Name	Constr_Yr	St_Type	Occ_Class	Stories	Condition	Comment	area
1	A1	1	A1_1	A1_1	-	Shwe Man	> 50 Years	Brick-Nogging	Com		1 Average		140.100
2	A1	2	A1_2	A1_2		Thin	> 50 Years	Brick-Nogging	Com		2 Average		98.570
3	A1	3	A1_3	A1_3		Monastry	> 50 Years	Brick-Nogging	Rel		1 Average		87.580
4	A1	4	A1_4	A1_4			< 10 Years	Concrete	Res		6 Good		127.700
5	A1	5	A1_5	A1_5			> 50 Years	Wood	Res		2 Poor		119.100
6	A1	6	A1_6	A1_6	174	-	10-30 Years	Brick-Nogging	Com		3 Good		51.680
7	A1	7	A1_7	A1_7		Tea Shop	10-30 Years	Brick-Nogging	Com		2 Good		60.520
8	A1	8	A1_8	A1_8	004/57	Aye Chan Thar	10-30 Years	Concrete	Med		3 Average		67.740
9	A1	8	A1_9_B	A1_9_B			10-30 Years	Concrete	Com		2 Good		40.640
10	A1	30	A1_10	A1_10			> 50 Years	Wood	Res		2 Poor	Bamboo wall	101.200
11	A1	11	A1_11_B	A1_11_B			> 50 Years	Brick-Nogging	Res		2 Poor		157.100
12	A1	12	A1_11_B	A1_11_B		See You Again	10-30 Years	Brick-Nogging	Com		2 Average		122.800
13	A1	13	A1_13	A1_13			10-30 Years	Concrete	Com		2 Average		319.800
14	A1	14	A1_14	A1_14			10-30 Years	Concrete	Com		7 Average		122.200
15	A1	15	A1_15	A1_15			> 50 Years	Brick-Nogging	Com		2 Average		154.500
16	A1	16	A1_16	A1_16		Midea	> 50 Years	Brick-Nogging	Com		2 Average		129.500
17	A1	17	A1_17	A1_17			> 50 Years	Brick-Nogging	Res		1 Average		218.700
18	A1	18	A1_18_B	A1_18_B		Tea Shop	> 50 Years	Wood	Com		2 Poor		127.100
19	A1	19	A1_19	A1_19			10-30 Years	Brick-Nogging	Rel		1 Good		88.270
20	A1	20	A1_20	A1_20			10-30 Years	Brick-Nogging	Res		2 Average		503.500
21	A1	21	A1_21_B	A1_21_B	151		> 50 Years	Brick-Nogging	Res		2 Poor		210.100
22	A1	22	A1_22	A1_22	147		> 50 Years	Brick-Nogging	Res		2 Poor		94.740
23	A1	23	A1_23	A1_23			10-30 Years	Brick-Nogging	Com		3 Average		94.760
24	A1	24	A1_24	A1_24			10-30 Years	Brick-Nogging	Res		2 Average		152.000
25	A1	25	A1_25	A1_25	004/9		> 50 Years	Wood	Res		2 Poor		150.700
26	A1	26	A1_26	A1_26			10-30 Years	Concrete	Res		5 Good		176.400
27	A1	27	A1_27_B	A1_27_B			< 10 Years	Brick-Nogging	Res		2 Poor		24.460
28	A1	28	A1_28	A1_28			> 50 Years	Brick-Nogging	Res		1 Poor		73.940
29	A1	29	A1_29_B	A1_29_B			10-30 Years	Concrete	Res		6 Good		164.000
30	A1	30	A1_30	A1_30	188		10-30 Years	Brick-Nogging	Res		2 Average		82.740
31	A1	31	A1_31	A1_31		Hotel Royel	> 50 Years	Brick-Nogging	Com		2 Poor		58.850

Join Excel Database Into GIS

Shape File ➡ Joins and Relates ➡ Join
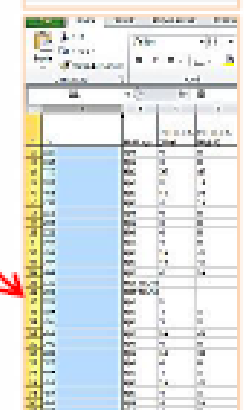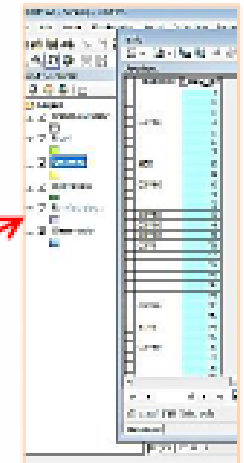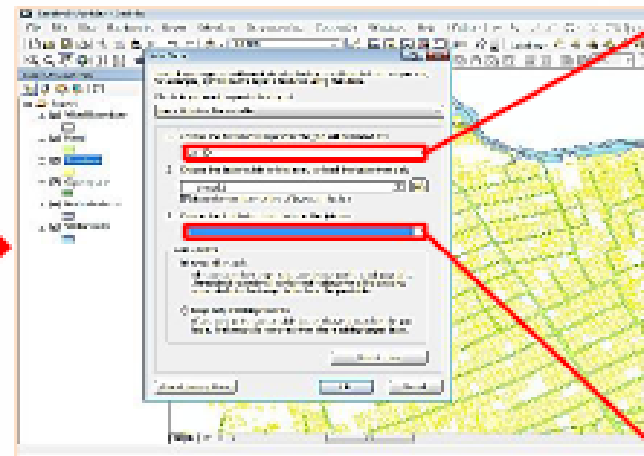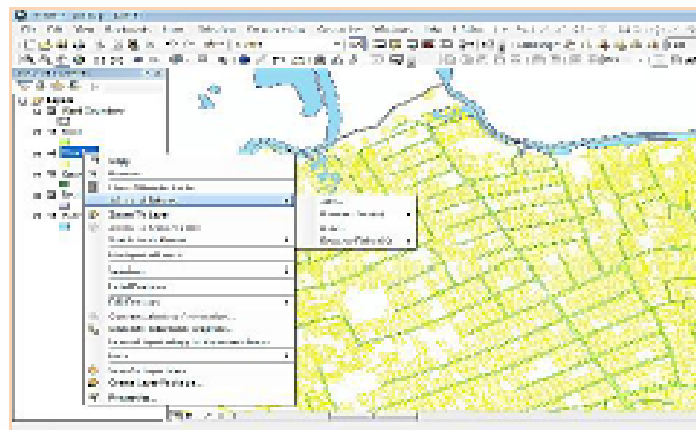
Land Use Maps (2004,2014)
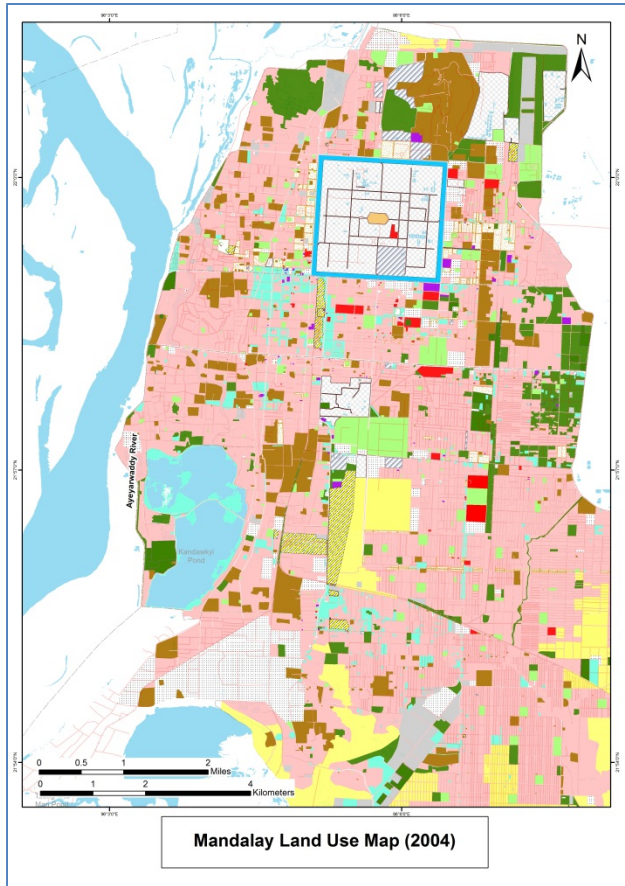
Mandalay Land Use Map (2004)
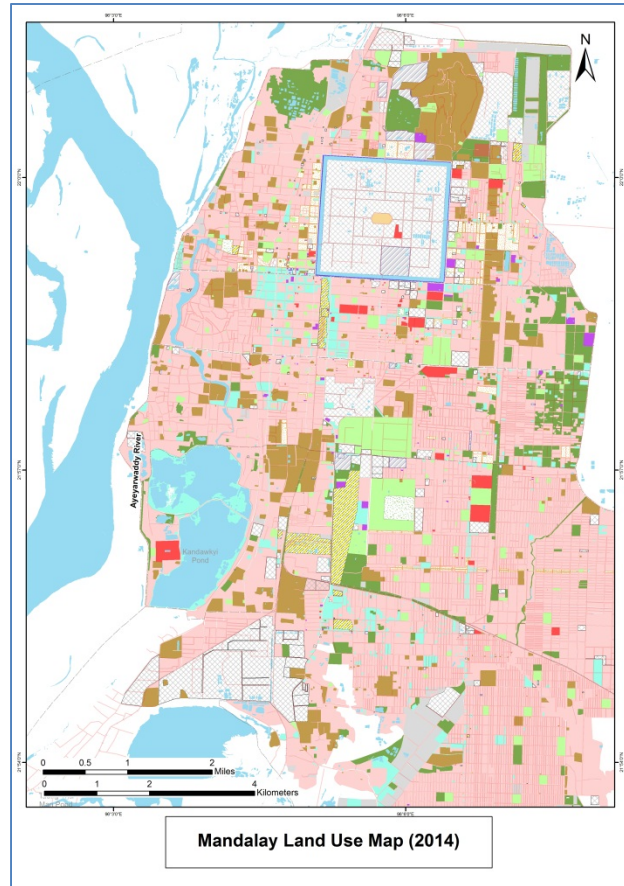
Mandalay Land Use Map (2014)

Legend

Commercial		Museum	
Education		Open space	
Government office		Recreational centre	
Health centre		Religous	
Heritage area		Residential	
Hotel		Stadium	
Industrial zone		Transporation	
Military		Waterbody	
Mixed			

Land Accounting

LUType	Percent (2004)	Percent (2014)
Agricultural land	9.64	4.17
Commercial	4.24	4.28
Education	3.18	3.91
Government office	5.85	5.79
Health centre	0.19	0.82
Heritage area	0.48	0.48
Hotel	0.06	0.28
Industrial zone	0.22	4.47
Military	4.03	5.61
Mixed	5.68	1.45
Museum	1.47	1.47
Open space	46.59	7.14
Recreational centre	7.15	0.98
Religous	0.93	8.22
Residential	8.23	50.55
Stadium	0.06	0.28
Transporation	0.06	1.25
Waterbody	1.27	0.68
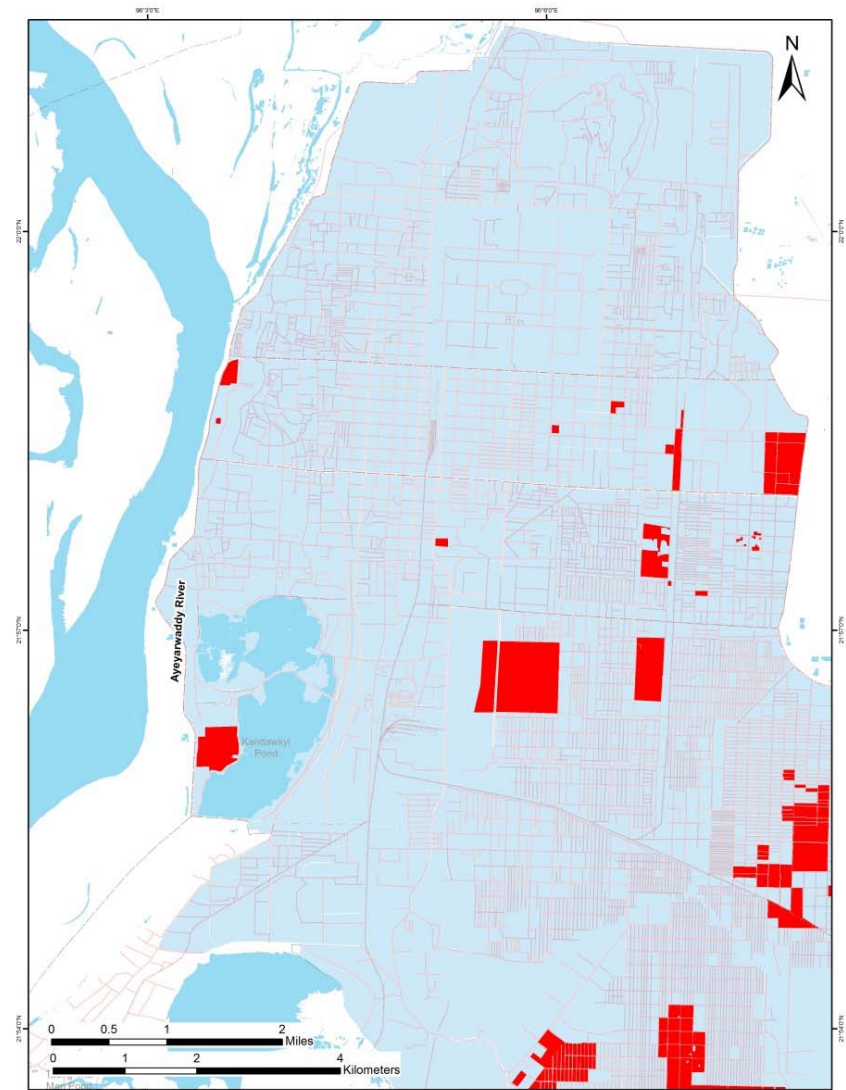
Mandalay Land Use Change Map

Land use/land cover Classification (Level II)

- Level II classification was carried out by manual digitizing based on field survey data.

- Waterbody was extracted from satellite image using NDVI, which was decreased from 1.27 to 0.68 percent during 2004-2014.

- Land use maps were checked and land accounting was calculated.

- According to land use change map, agriculture was decreased 5.5 percent in 2014 from 2004.Industrial zone was increased 0.22 to 4.47 percent during study period. Residential was increased from 8.23 to 50.55 percent.

Conclusion

- This study was carried out to detect changes of land use/land cover by level I and level II classification, respectively.

- Accuracy assessment was done to evaluate the performance of classification methods.

- Results indicated that maximum likelihood algorithm produced acceptable LU/LC classification with kappa coefficient of 0.89 for 2015 and 0.88 for 2001.

- Changes are mainly in built up areas which was significantly increased in 2015.

- This study demonstrates the ability of Remote Sensing and GIS in capturing spatio-temporal changes in LU/LC.

Thank You for Your Kind Attention!