Bharathidasan University , Tiruchirappalli, Tamil Nadu

Programme: M.Tech Geoinformatics
Course: Resources Evaluation (Practical)

Change Detection Analysis

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- **Where and when has change taken place in the landscape?**
- **How much change, and what type of change has occurred?**
- **What are the cycles and trends in the change?**

TABLE 12–1 Common human-made and natural resource attributes or indicators that are often the focus of land-use planning and natural resource monitoring programs (expanded from Kennedy et al., 2009).

Man-made and/or Natural Resource Attributes or Indicators	Process of Interest or Threat
Change in the size or shape of areal patches (polygons) of related cover types	Urban expansion (sprawl); vegetation expansion; sea-level rise; consolidation, fragmentation; infilling; encroachment; erosion/dilution
Change in width or character of linear features	Densification of road, utility, or hydrologic network; impact of use of paths or roads; impact of flooding on riparian vegetation; dynamics of terrestrial and submerged near-shore aquatic vegetation
Slow changes in surface cover types or species composition	Succession, competition, eutrophication, consolidation, fragmentation, exotic species invasion
Abrupt changes in surface cover, water, and/or atmospheric condition	Catastrophic event (e.g., hurricane, flood, tornado, volcanic eruption, fire, wind, landslides), disturbance, human activity (e.g., land clearing; urban and/or environmental terrorism), land management practices (e.g., no-till farming; prescribed burning)
Slow changes in condition of a single cover type	Climate-related changes in vegetation species composition and/or productivity; sea surface temperature; slowly-spreading forest mortality caused by insect or diseases; changes in moisture regime
Changes in timing or the extent of diurnal and/or seasonal processes	Coastal zone dynamics, snow cover dynamics, natural vegetation and agriculture phenology

Remote Sensing System Change Detection Considerations

- Remote Sensor System Considerations,
- Environmental Characteristics
- Temporal Resolution
- Spatial Resolution
- Spectral Resolution
- Radiometric Resolution

Environmental / Developmental Considerations

- Atmospheric Conditions
- Cloud / Cloud Shadow
- Moisture
- Phonological

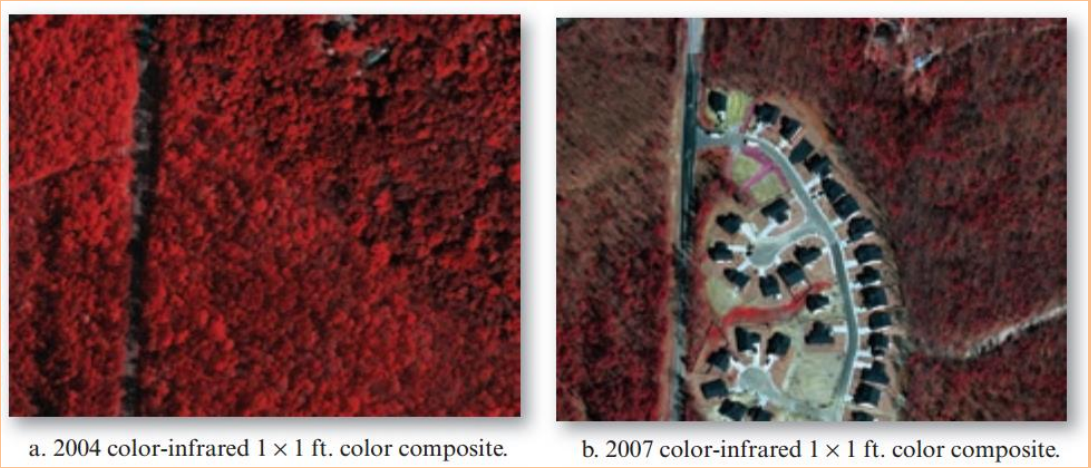
Techniques	*Specific Methods*
Algebra (Image Enhancement)	• Image differencing • Vegetation index differencing • Change vector analysis • Image regression • Ratioing
Transformation (Image Enhancement)	• Selective principal component analysis (SPCA) • PCA • Tasselled Cap (KT) • Gramm-Schmidt (multi-date KT) • Chi-square
Classification	• Direct multi-date unsupervised classification • Post-classification change differencing • Unsupervised change detection • Expectation maximization (EM)
Advanced Models	• Li-Strahler reflectance model • Spectral mixture model • Biophysical parameter method
GIS	• GIS + Remote Sensing • GIS
Visual analysis	
Image Enhancement + Post-Class Comparison	• Hybrid change detection

Change Detection Algorithm

Binary Change Detection Algorithms Provide
"Change/ N o-Change" Information

- **Band differencing and rationing**
- **Principal Components Analysis (PCA) composite image analysis**

Analog "On-Screen" Visualization Change Detection

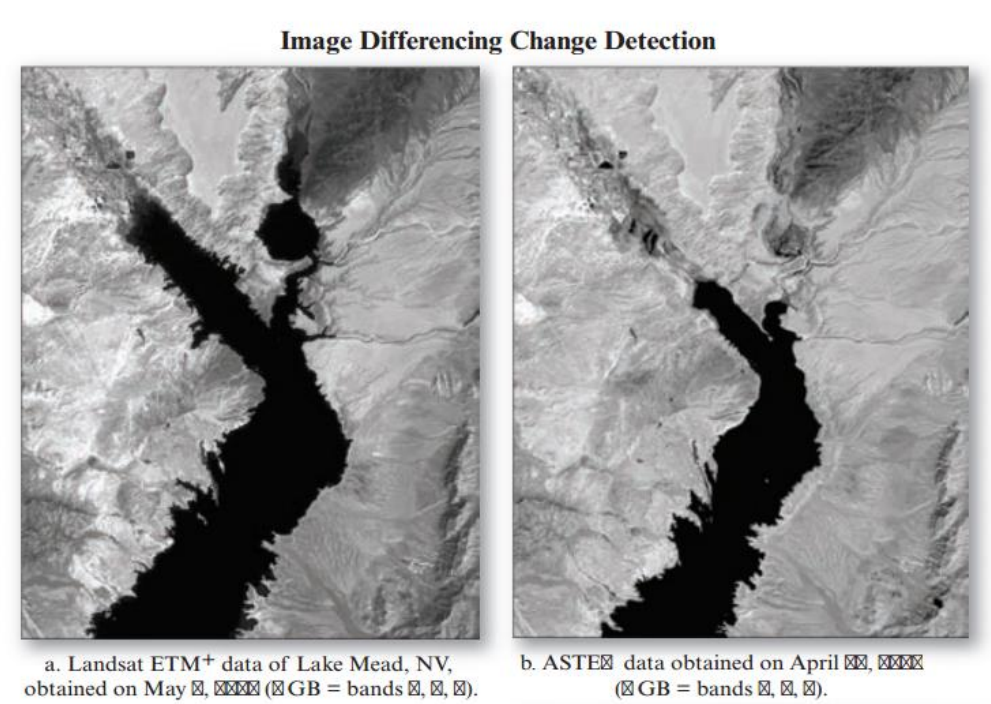


a. 2004 color-infrared 1 × 1 ft. color composite.

b. 2007 color-infrared 1 × 1 ft. color composite.

Binary Change Detection Using Image Algebra
Image Differencing Change Detection

$$\Delta BV_{i,j,k} = BV_{i,j,k}(1) - BV_{i,j,k}(2) + c$$



a. Landsat ETM+ data of Lake Mead, NV, obtained on May 8, 2000 (2 GB = bands 4, 2, 1).

b. ASTER data obtained on April 28, 2000 (2 GB = bands 4, 2, 1).

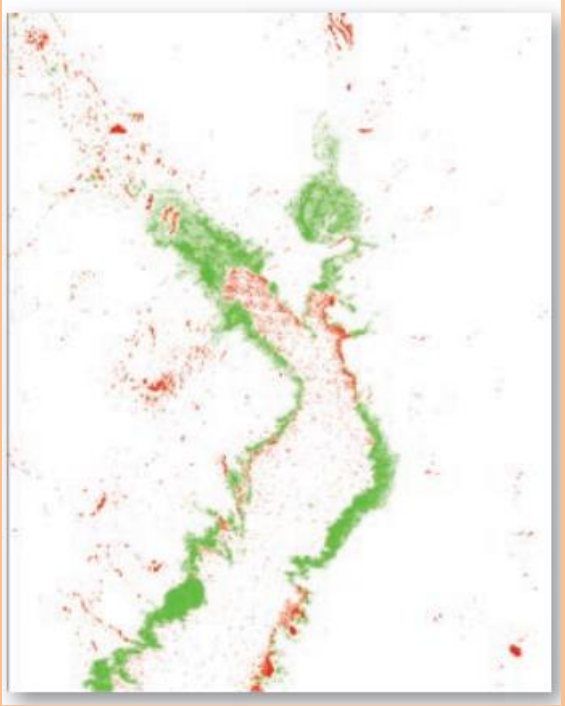


Image Differencing

8	10	8	11
240	11	10	22
205	210	205	54
220	98	88	46

Image Date 1

5	9	7	10
97	9	8	22
98	100	205	222
103	98	254	210

Image Date 2

3	1	1	1
143	2	2	0
107	110	0	-168
117	0	-166	-164

Difference Image = Image 1 - Image 2

Change Detection: Methods

- Image Ratioing
  - Date 1 / Date 2
  - No-change = 1
  - Values less than and greater than 1 are interpretable
  - Pick a threshold for change

Change Detection

Image Difference (TM99 – TM88)

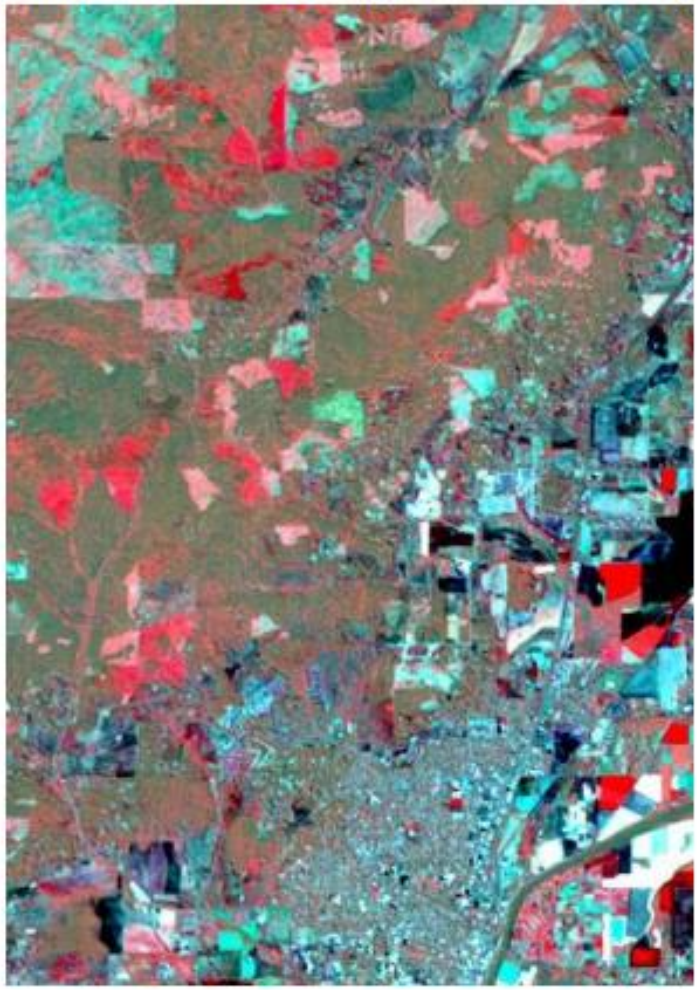
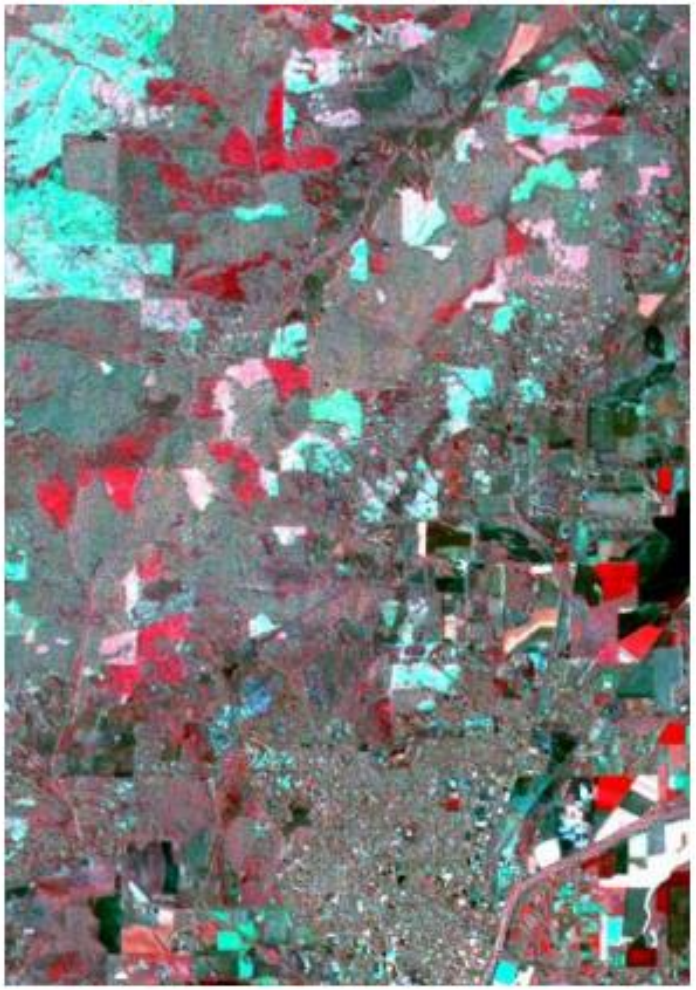


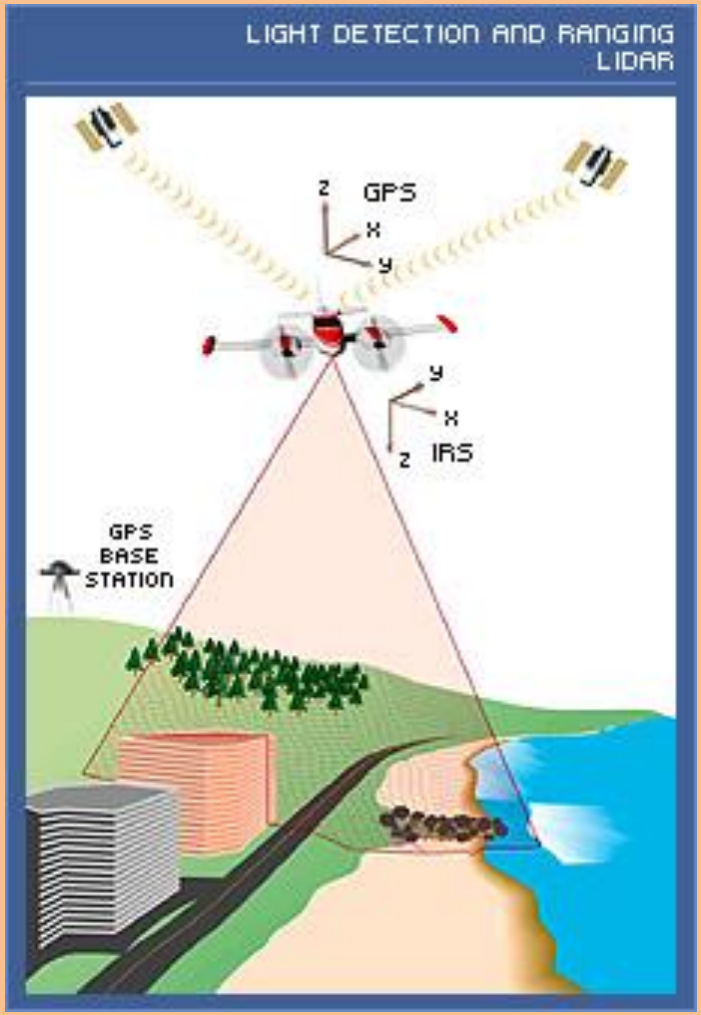
Image Ratio (TM99 / TM88)

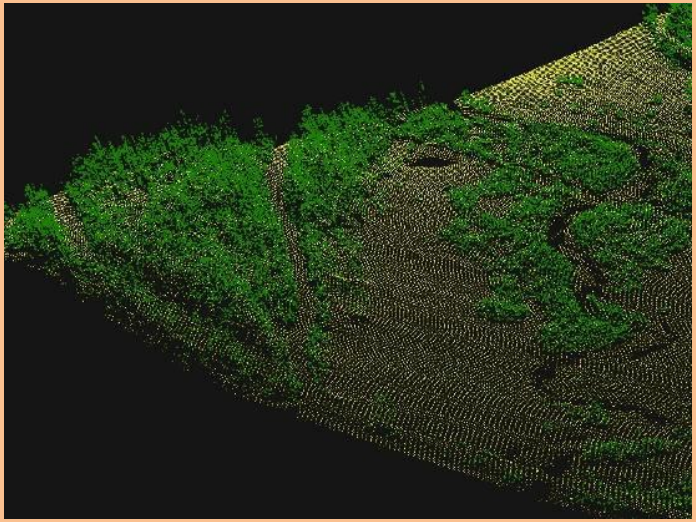


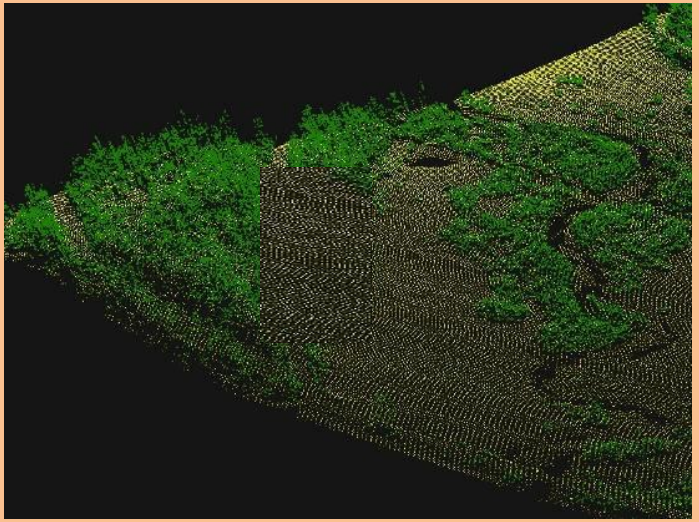
Thematic “From–To” Change Detection Algorithms

Photogrammetric Change Detection

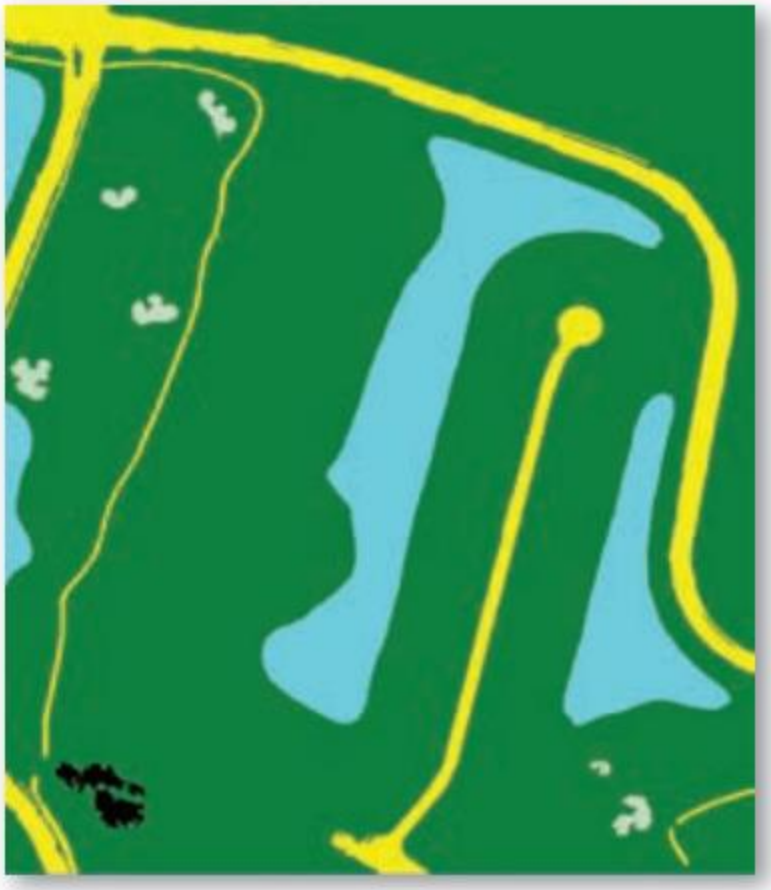
LiDARgrammetric Change Detection





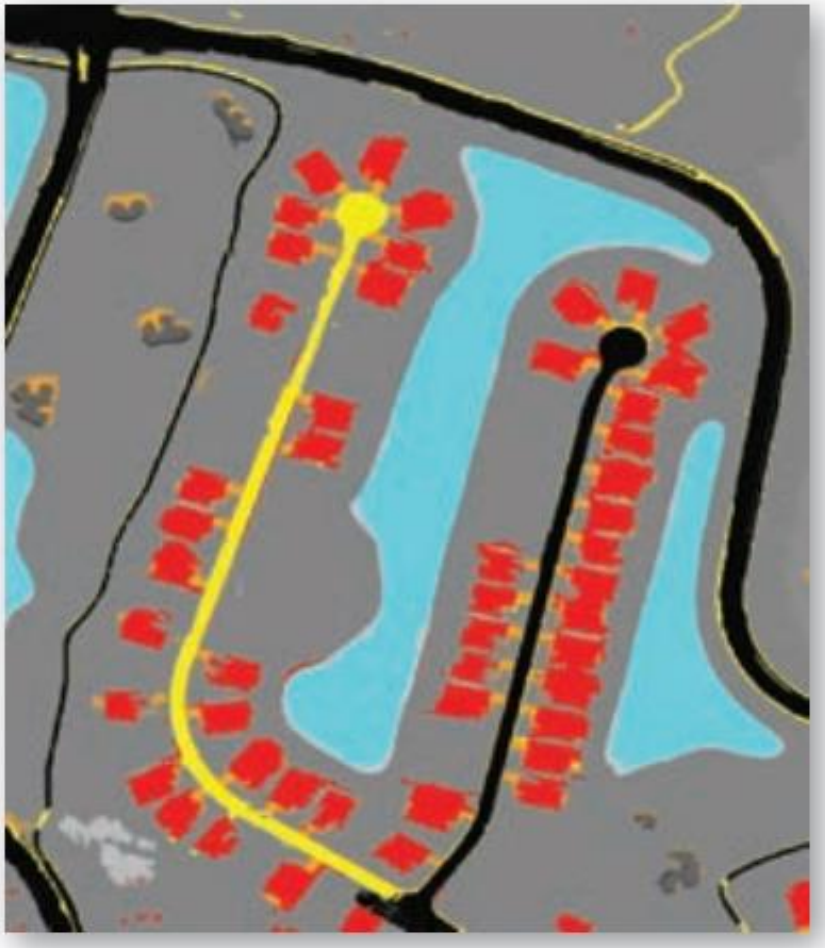


Post-classification Comparison Change Detection using Object-Based Image Analysis (OBIA)



a. 2007 Bluffton, SC, classi cation map.

b. 2011 Bluffton, SC, classi cation map.



Change Detection Matrix

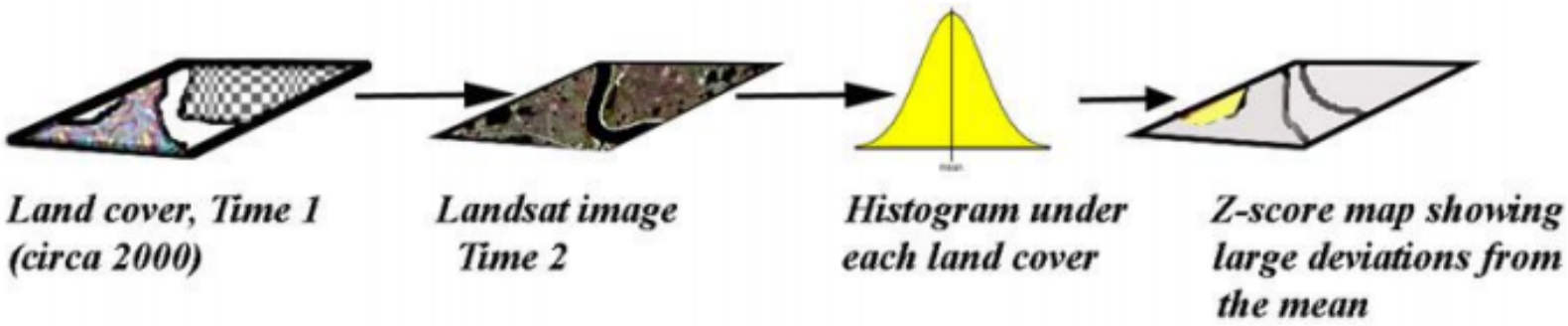
		Date 2					
		To:					
	Date 1	Class 1 - Building	Class 2 - Road	Class 3 - Driveway	Class 4 - Vegetation	Class 5 - Water	Class 6 - Shadow
From:	Class 1 - Building	1	2	3	4	5	6
	Class 2 - Road	7	8	9	10	11	12
	Class 3 - Driveway	13	14	15	16	17	18
	Class 4 - Vegetation	19	20	21	22	23	24
	Class 5 - Water	25	26	27	28	29	30
	Class 6 - Shadow	31	32	33	34	35	36

Legend

- 19 Vegetation to building
- 20 Vegetation to road
- 21 Vegetation to driveway

Cross-Correlation Analysis (CCA)

Cross-Correlation Analysis (CCA) uses a land cover map to delineate spectral cluster statistics between the baseline image year (Time 1) and each scene in the temporal sequence (Time 2). Calculating the Z-statistic deviations from the cluster mean identifies change pixels within each land cover cluster.



Land cover, Time 1 (circa 2000)

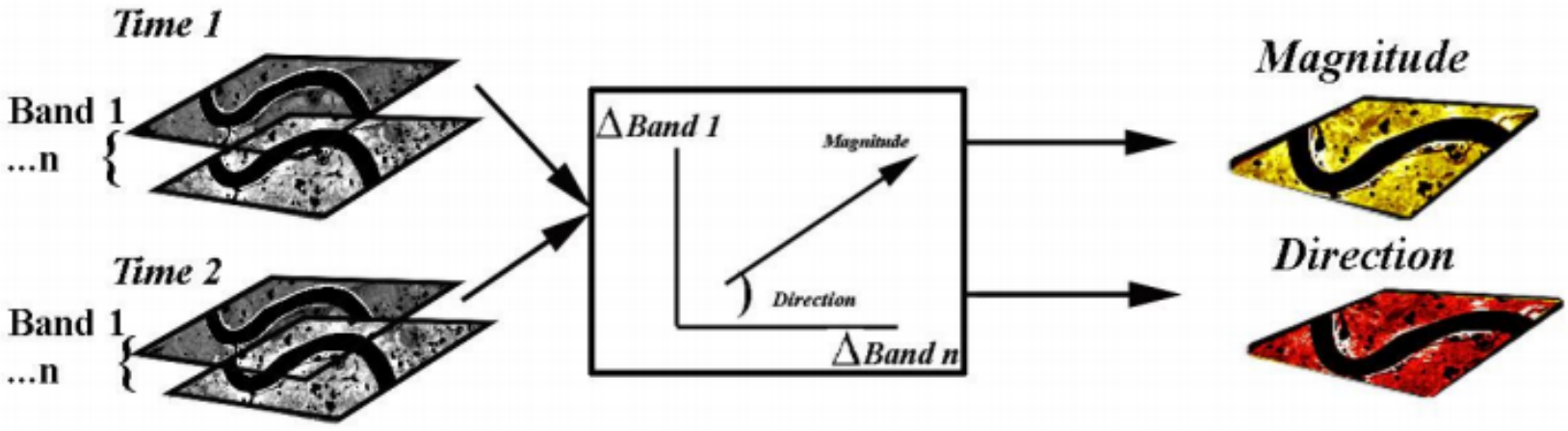
Landsat image Time 2

Histogram under each land cover

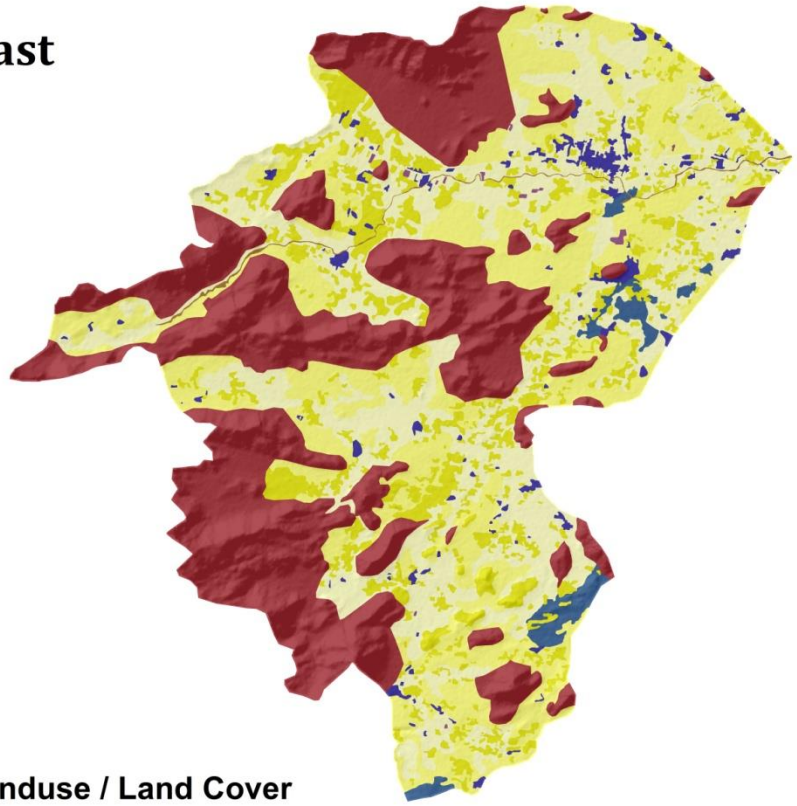
Z-score map showing large deviations from the mean

Change Vector Analysis (CVA)

Change Vector Analysis (CVA) uses two spectral channels to map both the: 1) magnitude of change and, 2) the direction of change between the two (spectral) input images for each date.



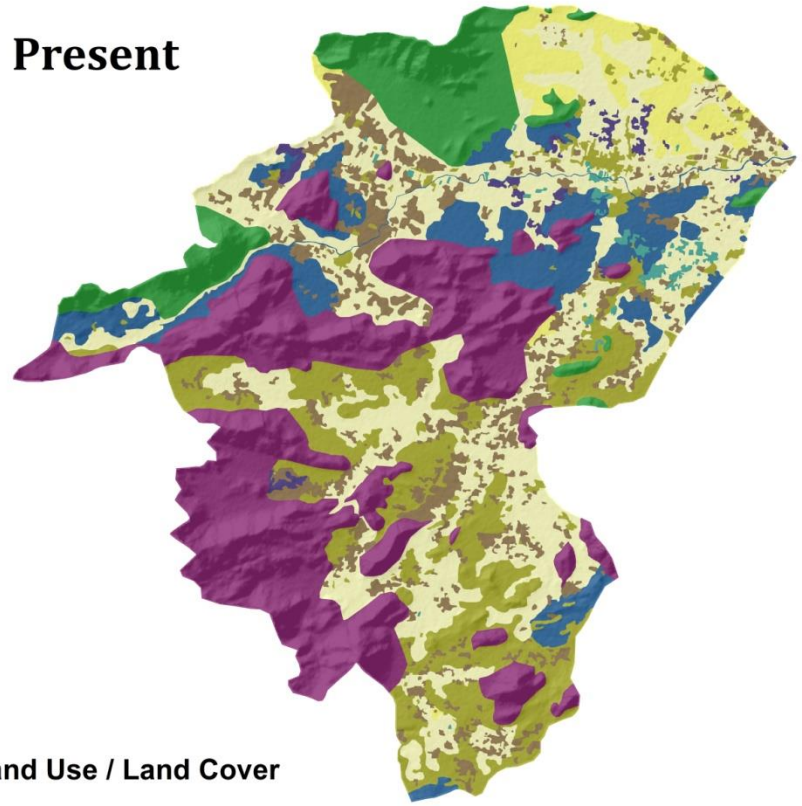
Past



Landuse / Land Cover

- Agriculture Land
- Fallow Land
- Forest
- Industry
- Plantation
- River
- Scrub Land
- Settlement

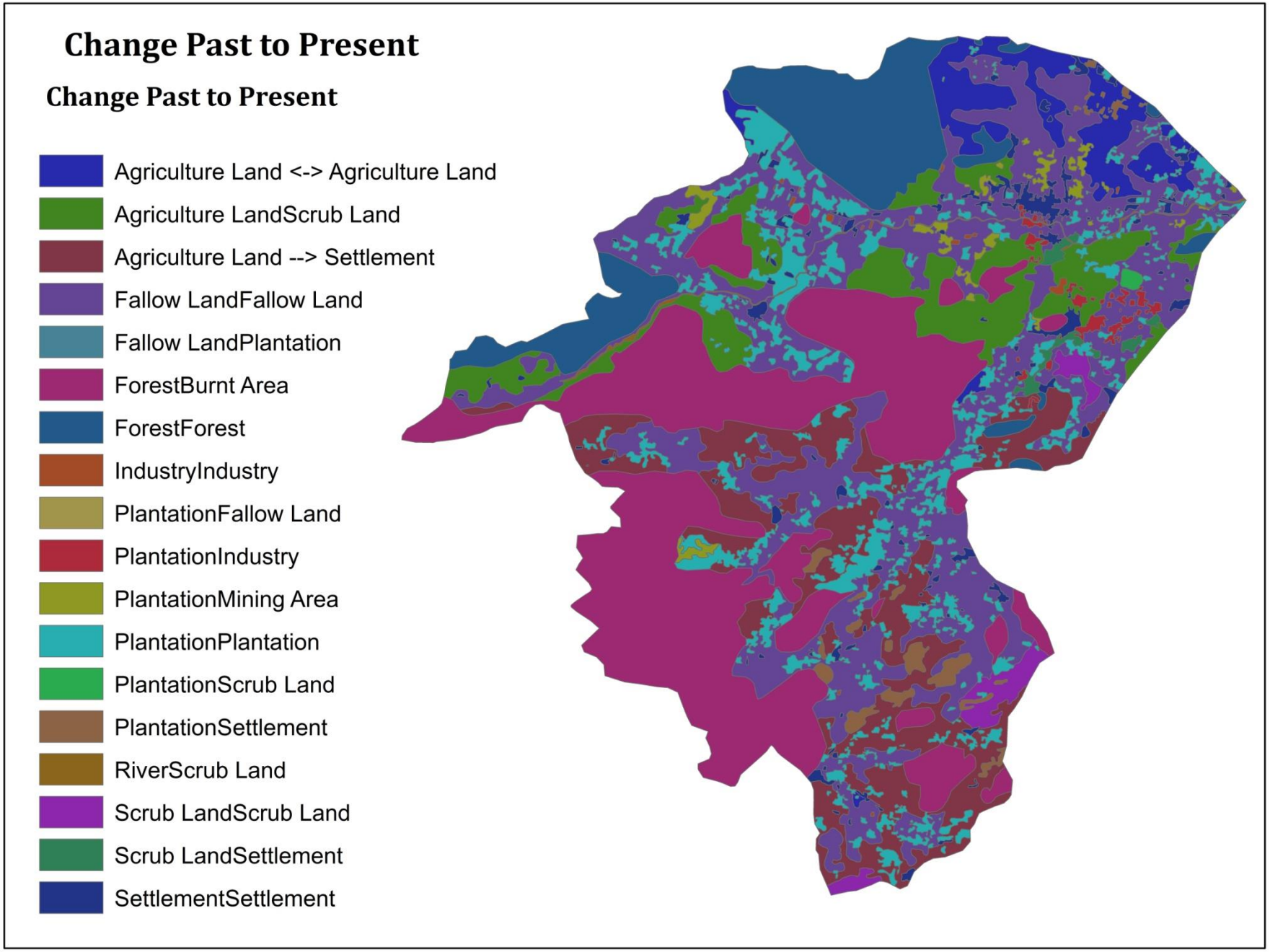
Present



Land Use / Land Cover

- Agriculture Land
- Burnt Area
- Fallow Land
- Forest
- Industry
- Mining Area
- Plantation
- Scrub Land
- Settlement

Change Past to Present



	Agriculture Land	Fellow Land	Forest	Industry	Plantation	River	Scrub Land	Settlemer	Burnt Area	Mining Area	Area (Sqkm)
Agriculture Land	11.93						20.78	31.78			64.5
Fellow Land		70.45									70.4
Forest			24.74						72.59		97.3
Industry				0.36							0.4
Plantation				1.50	26.11		0.28	3.04		2.60	33.5
River							0.78				0.8
Scrub Land							3.45	1.22			4.7
Settlement								5.32			5.3
Burnt Area											0.0
Mining Area											0.0
Area (Sqkm)	11.93	70.45	24.74	1.85	26.11	0.00	25.28	41.36	72.59	2.60	276.91

lulc	Lulc_Pr	change
Agriculture Land	Agriculture Land	11.93
Agriculture Land	Scrub Land	20.78
Agriculture Land	Settlement	31.78
Fallow Land	Fallow Land	70.45
Forest	Burnt Area	72.59
Forest	Forest	24.74
Industry	Industry	0.36
Plantation	Industry	1.50
Plantation	Mining Area	2.60
Plantation	Plantation	26.11
Plantation	Scrub Land	0.28
Plantation	Settlement	3.04
River	Scrub Land	0.78
Scrub Land	Scrub Land	3.45
Scrub Land	Settlement	1.22
Settlement	Settlement	5.32
		276.91

Past		Present	
Landuse	Area	Landuse	Area
Agriculture Land	64.49	Agriculture	11.93
Fellow Land	71.18	Fellow Lan	71.18
Forest	97.32	Forest	24.74
Industry	0.36	Industry	1.85
Plantation	34.26	Plantation	26.84
River	0.78		
Scrub Land	4.67	Scrub Lanc	25.28
Settlement	5.32	Settlement	41.36
		Burnt Area	72.59
		Mining Are	2.60

Thank You