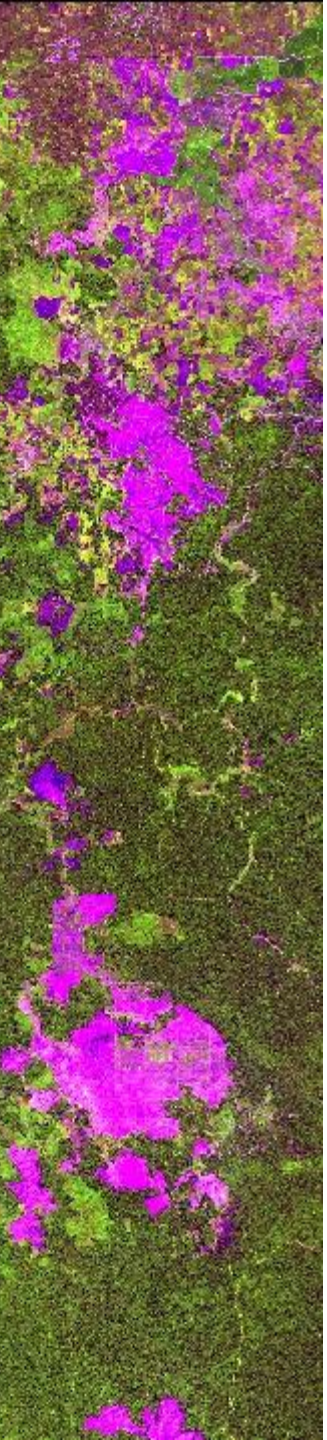

DAAD AWF Waldinventur • Fernerkundung

Bogor & Jakarta, Indonesia
16.–22. March 2014

DAAD Forest Asia Workshop

Transformation systems monitoring in forested tropical landscapes in Jambi Province, Sumatra

Sub-project of
Collaborative Research Center (CRC) 990: Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia)

Muh. Zuhdi and Dian Melati

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Background

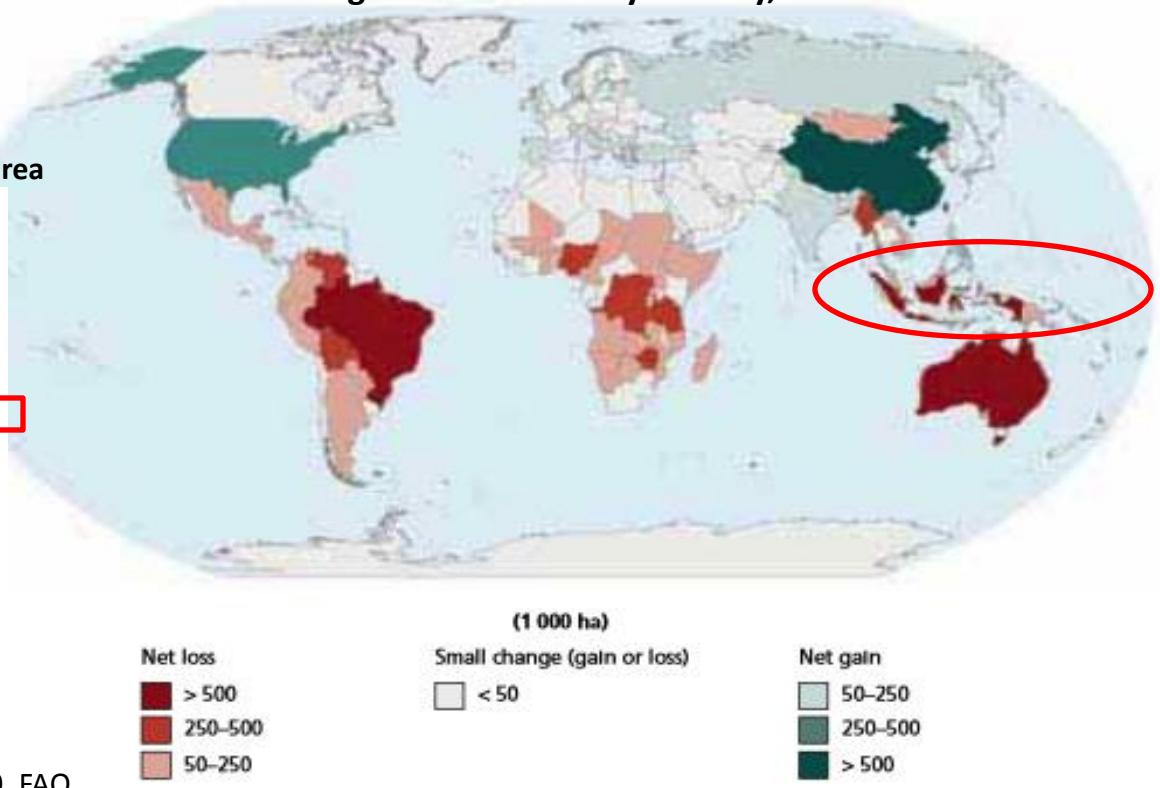
- **Deforestation** is still at high pace, which is mainly due to the **tropical forest conversion** into **agricultural land** (FAO, 2010)
- Between 1980 and 2000, **>55% of agricultural expansion** in the tropics was **intact forest**, **28%** in **disturbed forest** (Gibbs et al., 2010)

10 countries with largest annual net loss of forest area

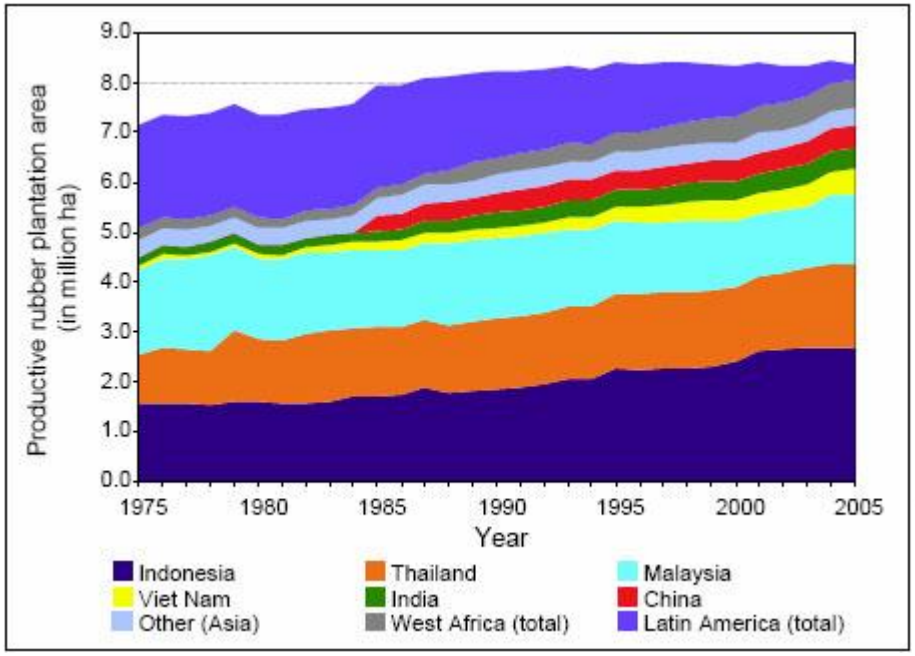
Country	Annual change 2000–2010	
	1 000 ha/yr	%
Brazil	-2 642	-0.49
Australia	-562	-0.37
Indonesia	-498	-0.51
Nigeria	-410	-3.67
United Republic of Tanzania	-403	-1.13
Zimbabwe	-327	-1.88
Democratic Republic of the Congo	-311	-0.20
Myanmar	-310	-0.93
Bolivia (Plurinational State of)	-290	-0.49
Venezuela (Bolivarian Republic of)	-288	-0.60
Total	-6 040	-0.53

Source: Global Forest Resources Assessment 2010, FAO

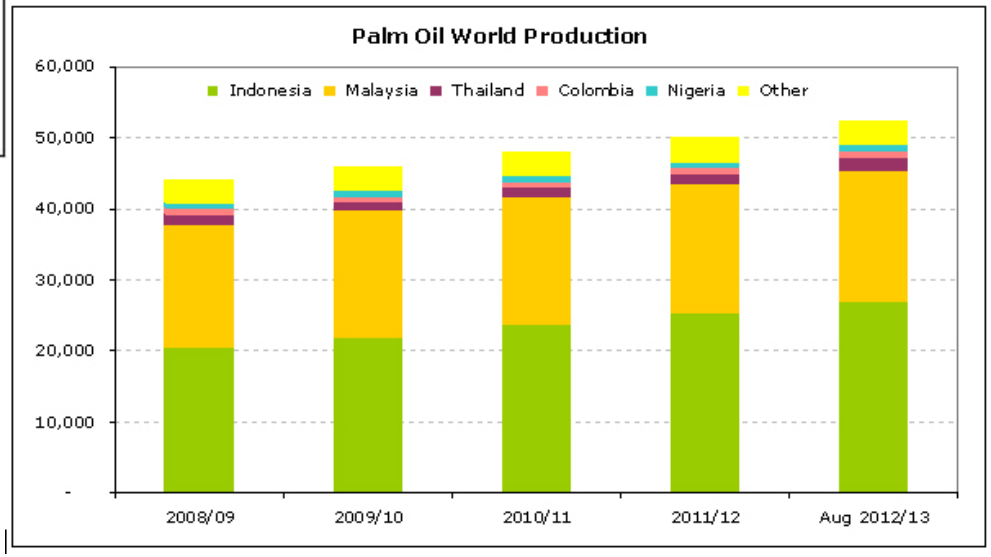
Annual change in forest area by country, 2005 - 2010



- **Primary driver of deforestation** in Indonesia as the result of **agriculture** is the expansion **of tree crops (e.g. rubber and oil palm)** (Miyamoto, 2006)

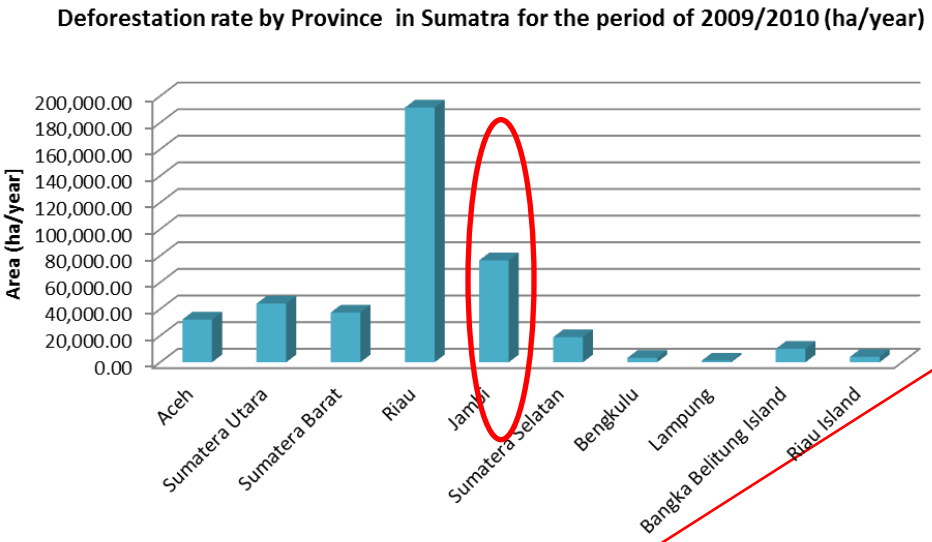


Source:
http://www.fao.org/docrep/011/i0627e/i0627e11.htm

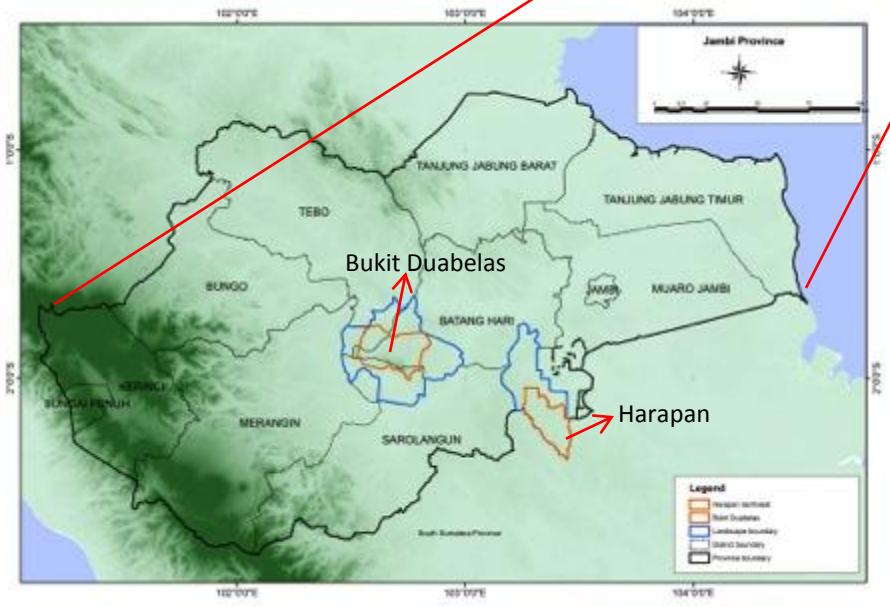


Source:
http://www.agricorner.com/top-ten-palm-oil-producers-2012/

Study area



Source: Forestry Ststistics of Indonesia 2011, MoF



The land has been **largely transformed** into **plantation**s for the cultivation of products such as **oil palm, rubber,** timber and some smallholder **agroforests** (e.g. rubber, fruit trees) (Beukema & Van Noordwijk, 2004)

Objectives

1. To investigate the land use land cover change between 1990 and 2011 in Jambi Province

2. To investigate the spatial pattern of the land use land cover between 1990 and 2011 in Jambi Province

3. To investigate the transformation systems within study area (i.e. secondary forest, jungle rubber, oil palm, and rubber plantation)

Historical LULC Map

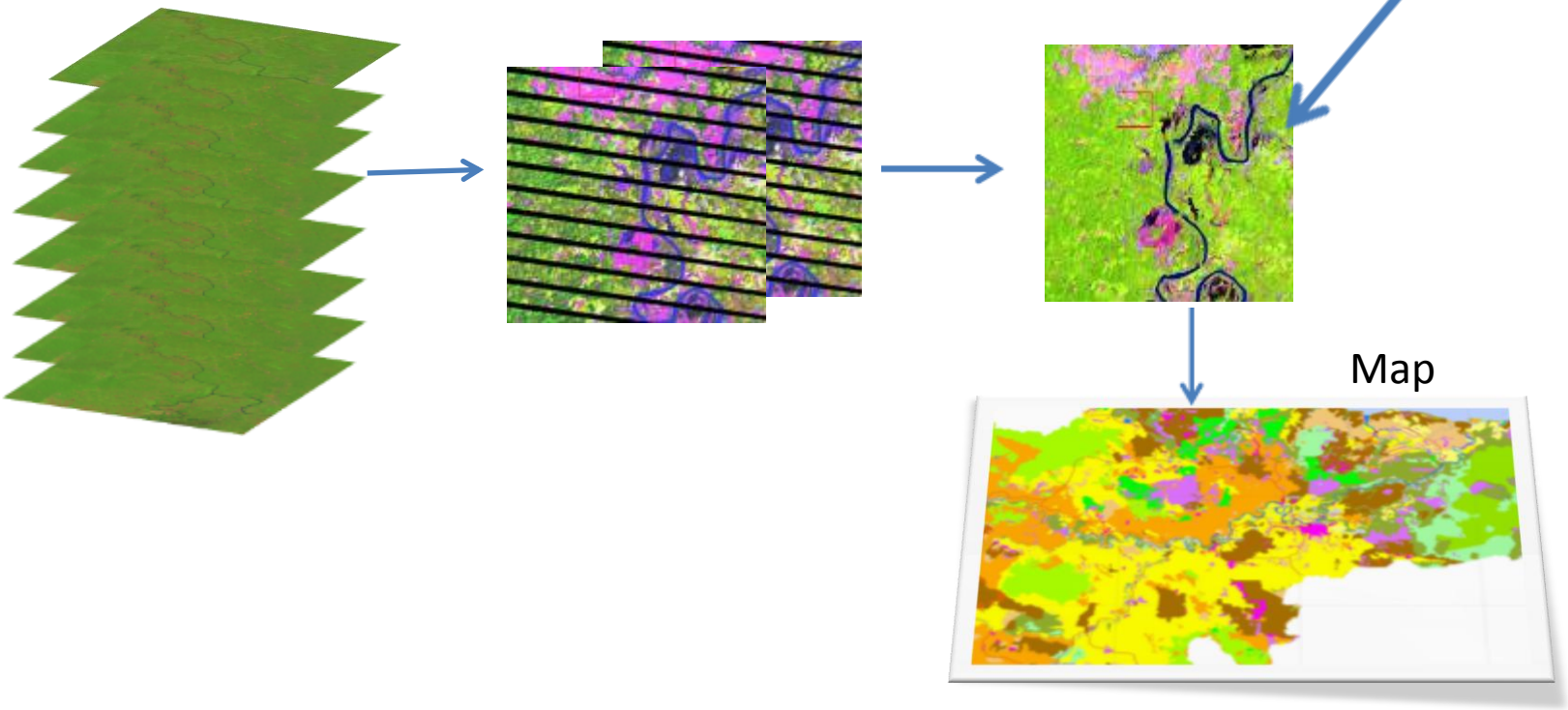
- Original data came from Ministry of Forestry (MoF) Indonesia
- Classes were derived based on MoF's LULC classification (23 classes)
- Improvement by Natural Resources Forest Management and Remote Sensing Laboratory, Fac. of Forestry, Bogor Agricultural University (IPB)

The work behind:

A series of Landsat mosaic (less than 2 years backward)

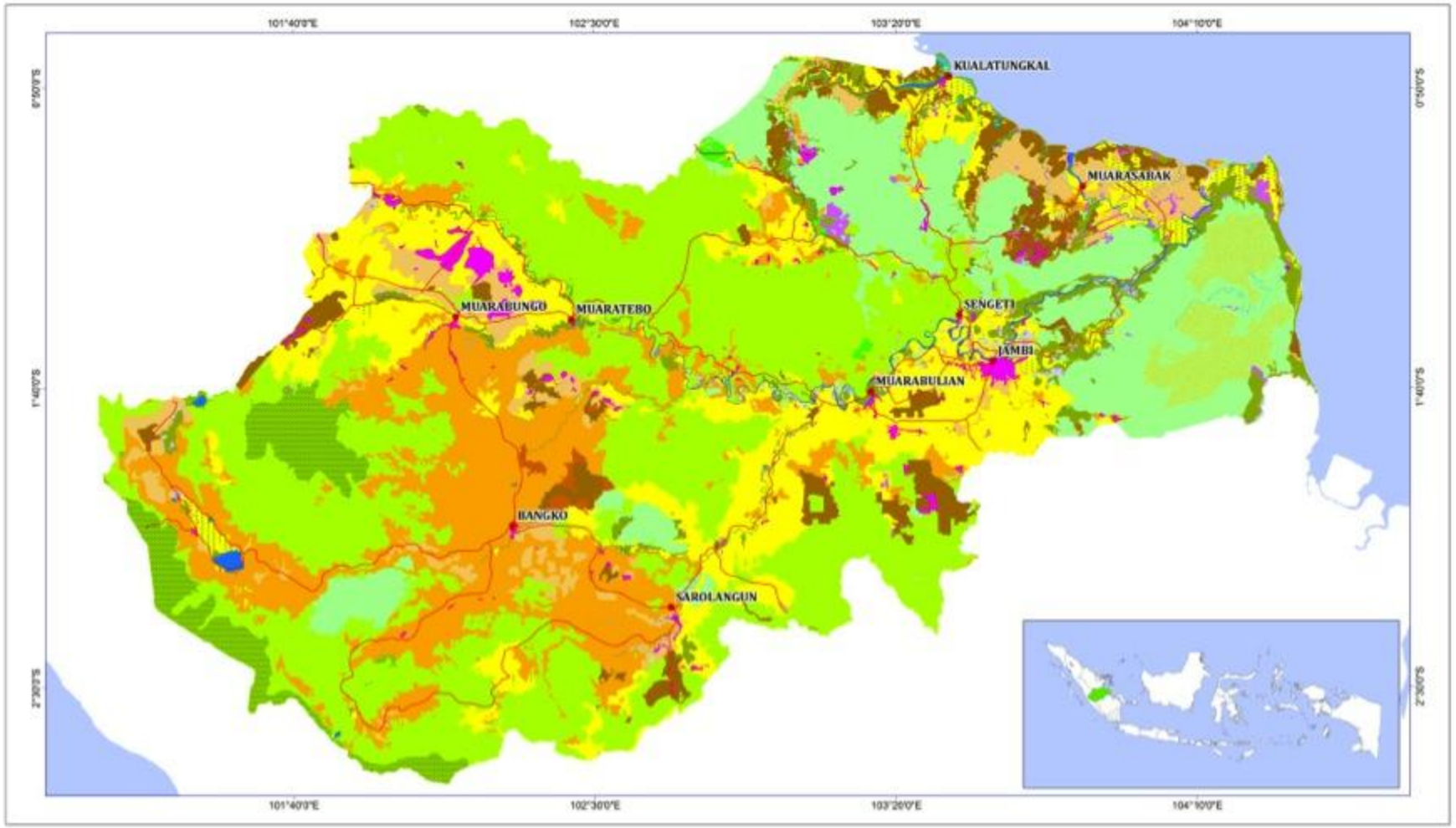
Pre-processing image (Landsat gap filling)

Visual Interpretation



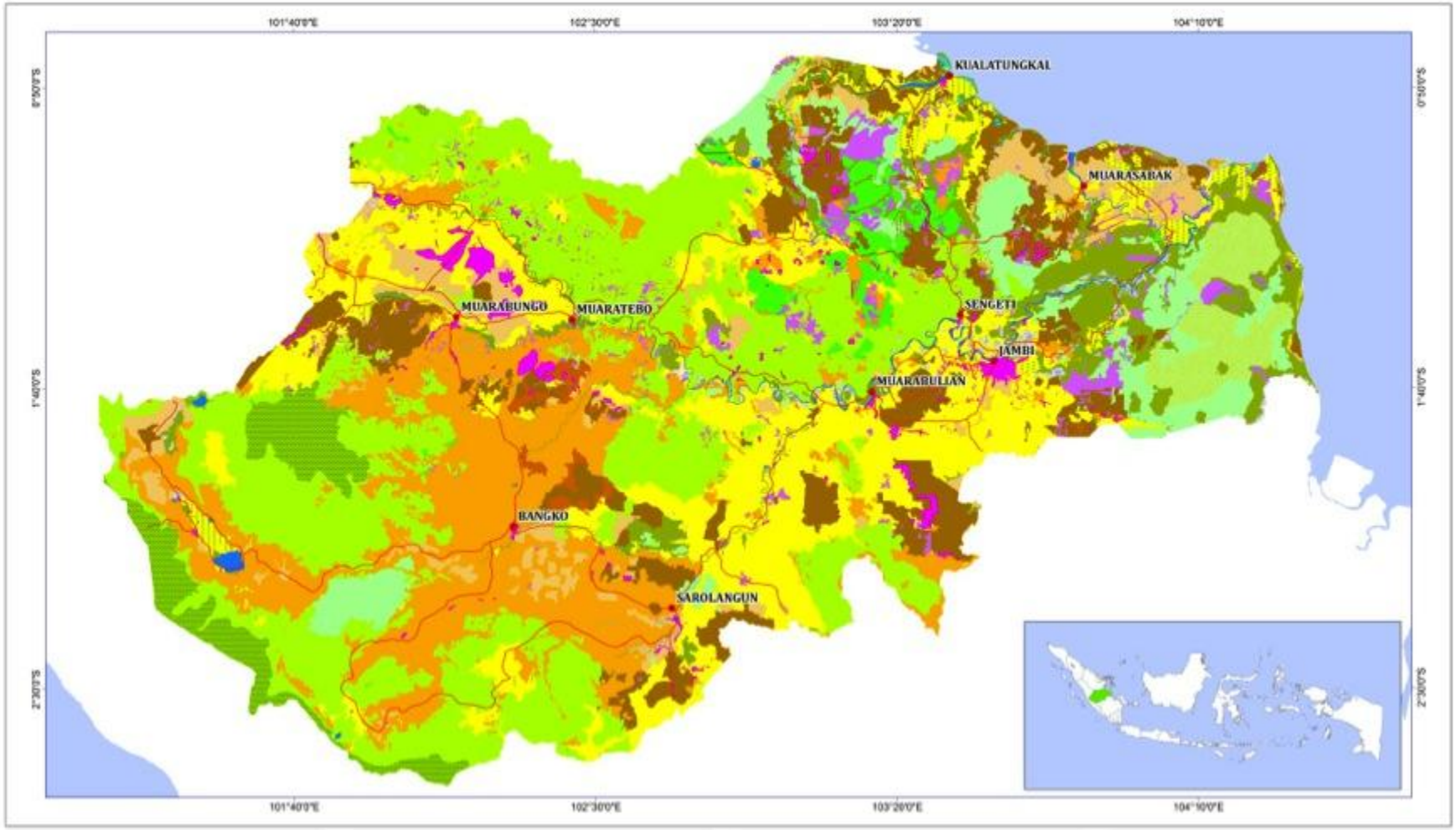
Historical LULC Map

1990



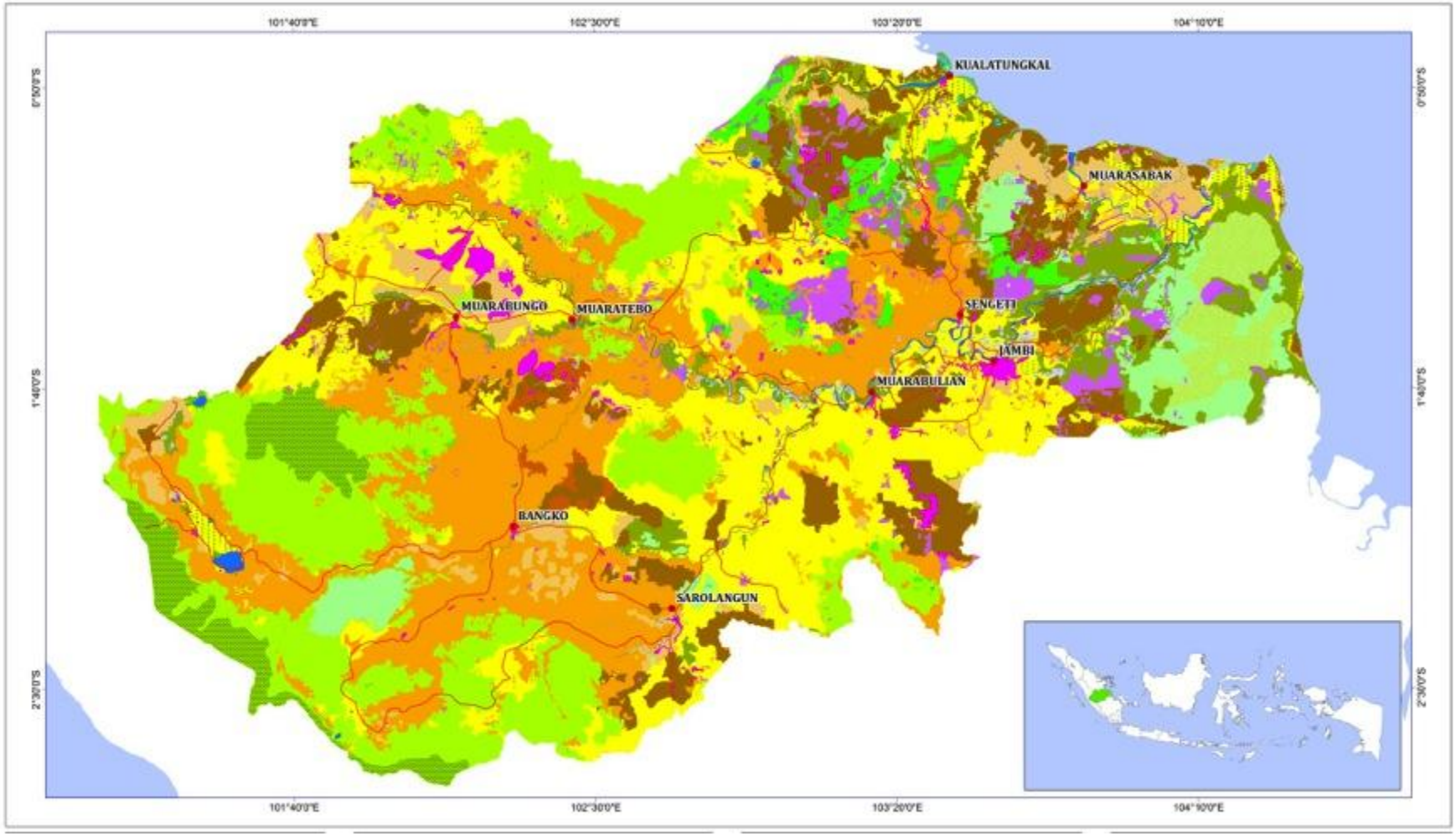
Historical LULC Map

2000



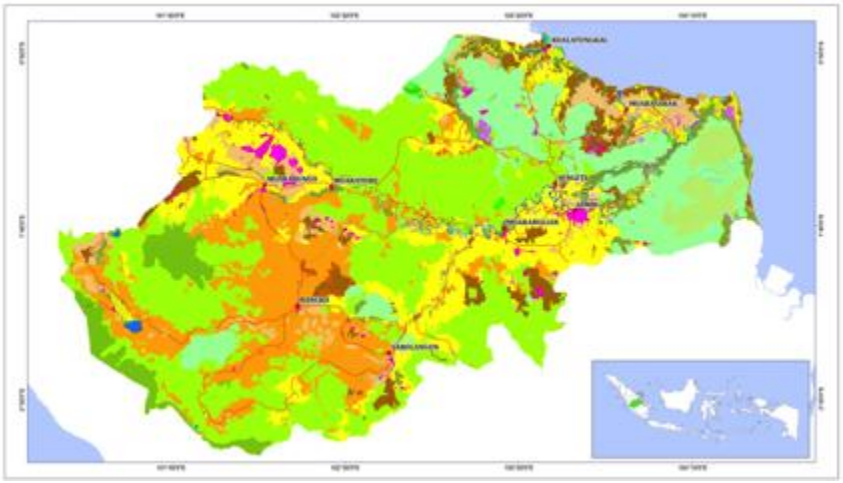
Historical LULC Map

2011

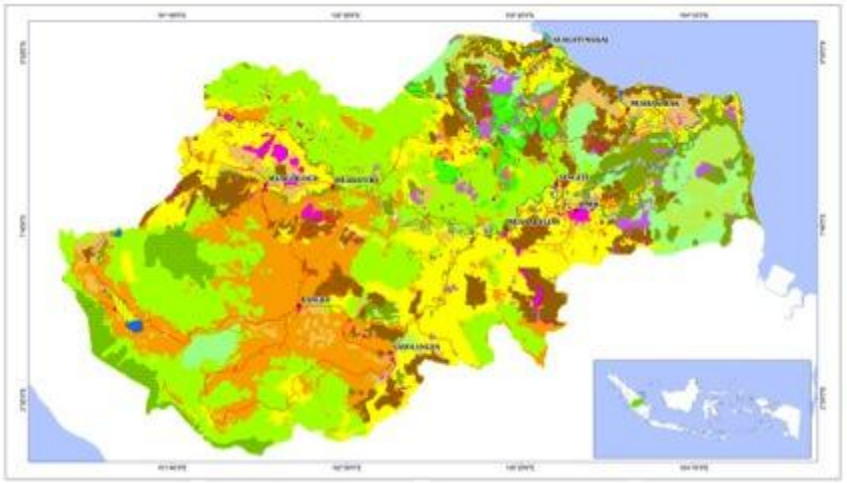


Land Cover 1990-2011

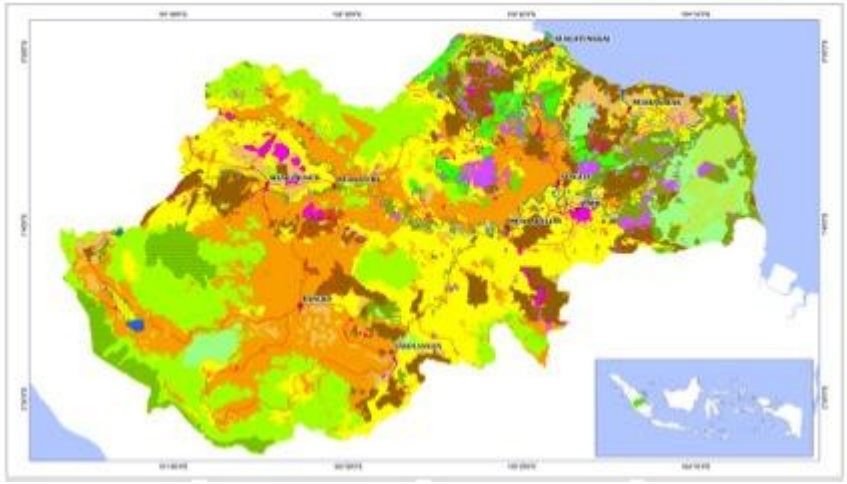
Land cover map 1990

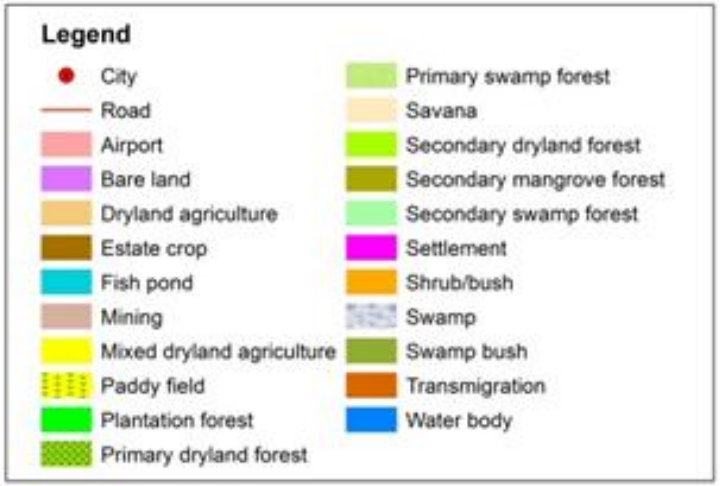


Land cover map 2000

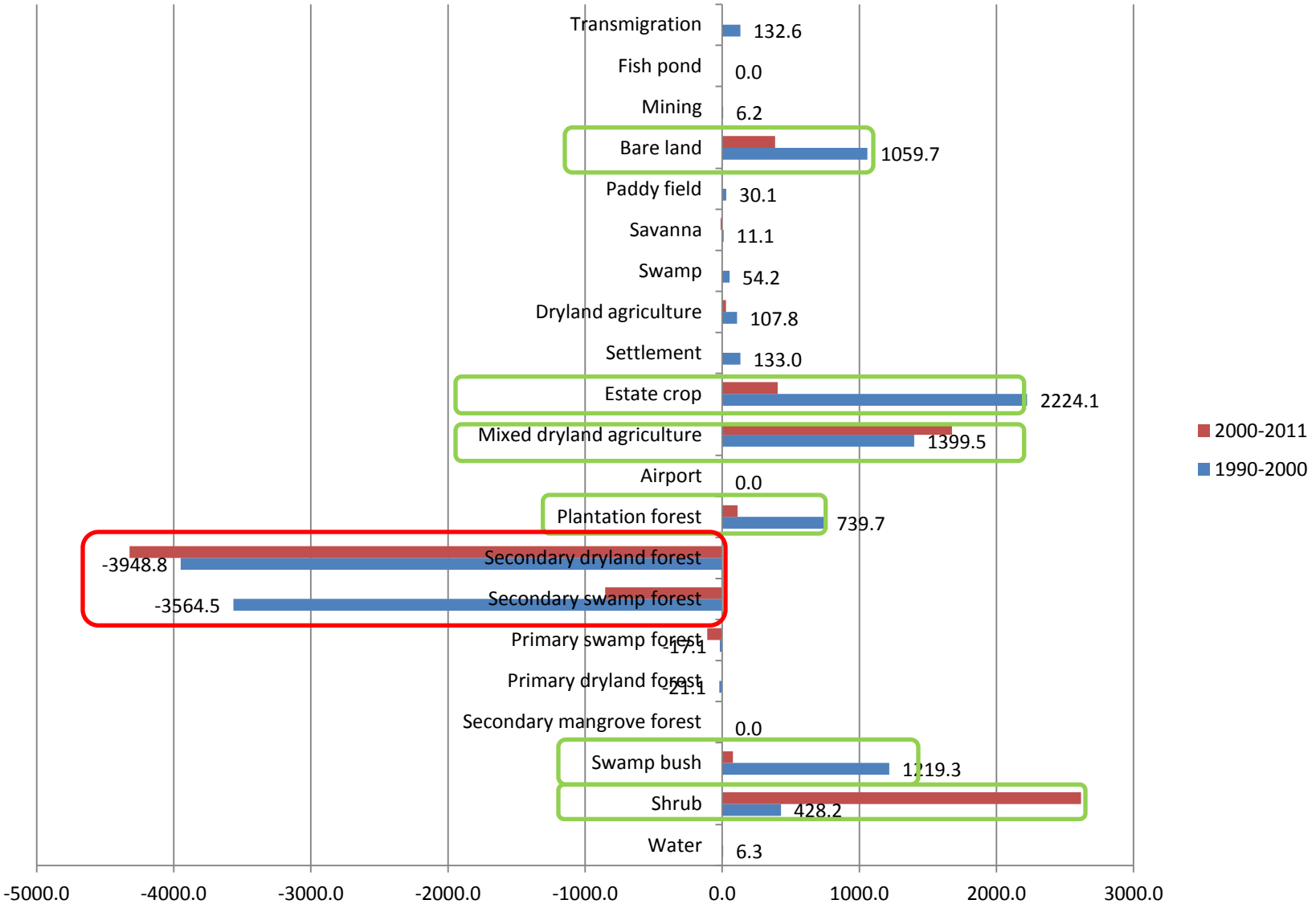


Land cover map 2011

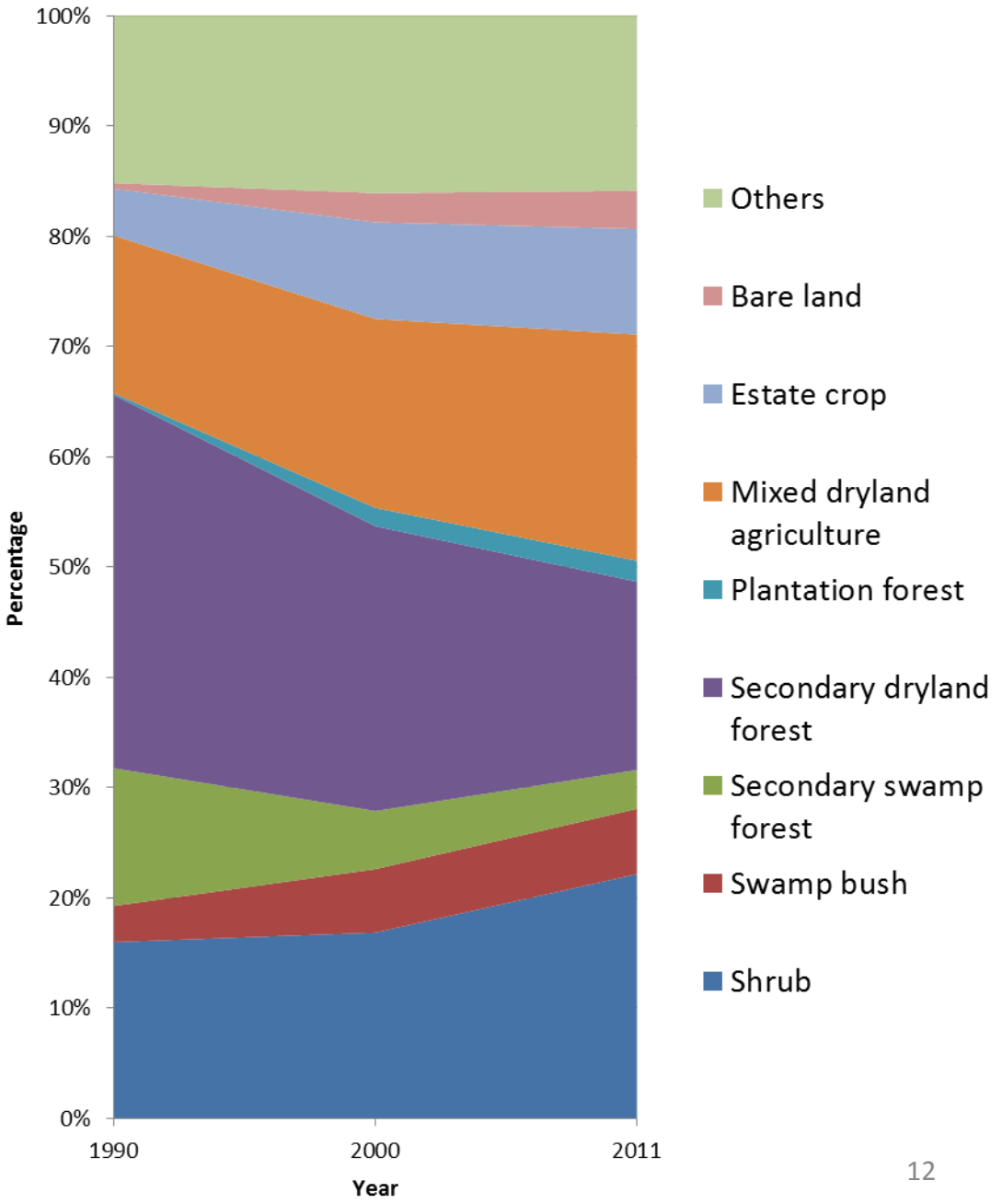




LULC Change in absolute number of area (sq km)



LULC Change
(Jambi Province)



Transformation matrix within LULC

Transformation matrix from 1990 to 2011 (%)

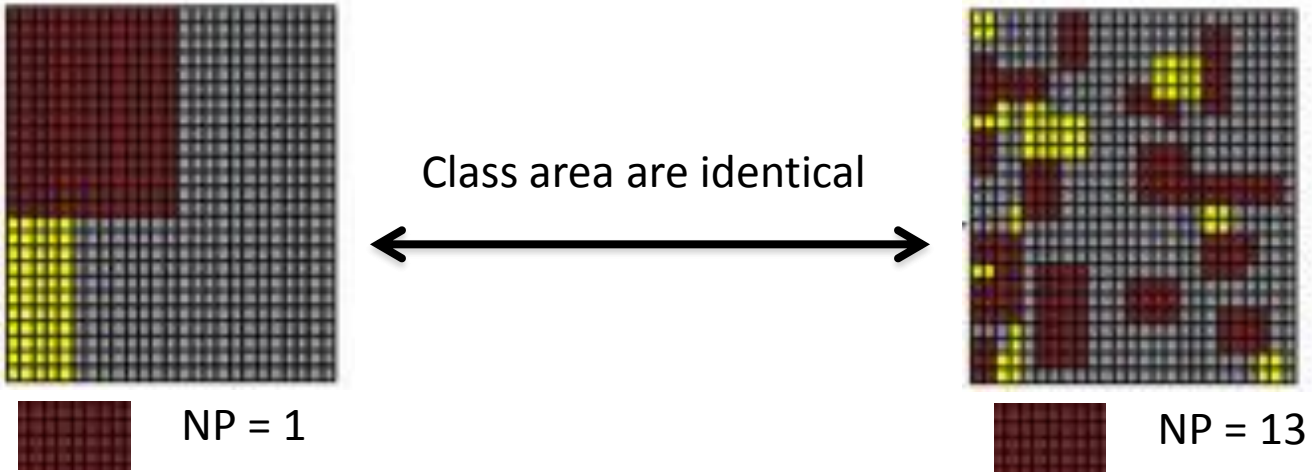
		LULC	2011								Total 1990	Loss
			1	2	3	4	5	6	7	8		
1990	1	Shrub	17.33	0.16	0.00	0.00	0.01	0.76	0.39	0.28	18.93	1.60
	2	Swamp bush	0.10	3.18	0.00	0.00	0.01	0.19	0.23	0.05	3.76	0.58
	3	Secondary swamp forest	0.85	3.71	3.92	0.01	1.45	0.29	2.74	1.67	14.65	10.73
	4	Secondary dryland forest	8.04	0.00	0.00	20.36	0.63	7.72	1.48	1.49	39.72	19.36
	5	Plantation forest	0.06	0.00	0.00	0.00	0.02	0.11	0.00	0.00	0.20	0.18
	6	Mixed dryland agriculture	0.02	0.00	0.00	0.00	0.00	15.40	1.50	0.14	17.06	1.66
	7	Estate crop	0.00	0.00	0.00	0.00	0.00	0.03	5.04	0.00	5.07	0.03
	8	Bare land	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.47	0.61	0.14
		Total 2011	26.40	7.06	3.93	20.37	2.26	24.51	11.38	4.10	100.00	
		Gain	9.07	3.88	0.01	0.01	2.24	9.11	6.34	3.63		

Spatial Pattern

- to understand the spatial structure (arrangement) of phenomena in space
- the fundamental way to monitor landscape change in patch-based of the pattern.
  Patch represents an area of a single land cover class
- quantification is performed using landscape metrics

Example:

Number of Patches (NP)



(Source: http://ec.europa.eu/agriculture/publi/landscape/ch1.htm)

Spatial Pattern

Aggregation Index (AI)

$$AI_i = \frac{e_{i\,i}}{\max\_e_{i\,i}}(100)$$

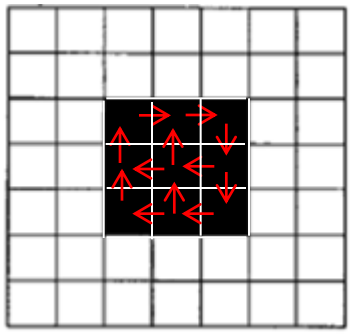
AI_i: Aggregation Index of class i

$e_{i,i}$: number of like adjacencies (joins) between pixels of patch type (class) i based on the single account method

$max\_e_{i,i}$: maximum number of like adjacencies (joins) between pixels of patch type (class) i based on the single-count method

$max\_e_{i,i} = 2n(n-1)$, where m=0, or
$max\_e_{i,i} = 2n(n-1)+2m-1$, where m≤n, or
$max\_e_{i,i} = 2n(n-1)+2m-2$, where m≥n
n is the side of of largest integer square smaller thab Ai (areaa of class i), $m=Ai-n^2$

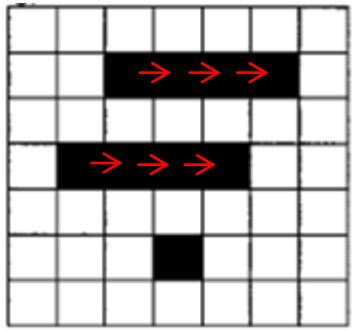
(Source: He et al., 2000)



$e_{i,i}$: 12
$max\_e_{i,i}$: 12

$AI_i = \frac{12}{12}(100)$

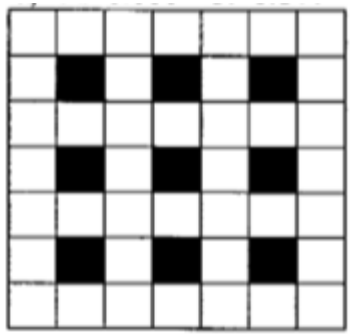
= 100%



$e_{i,i}$: 6
$max\_e_{i,i}$: 12

$AI_i = \frac{6}{12}(100)$

= 50%

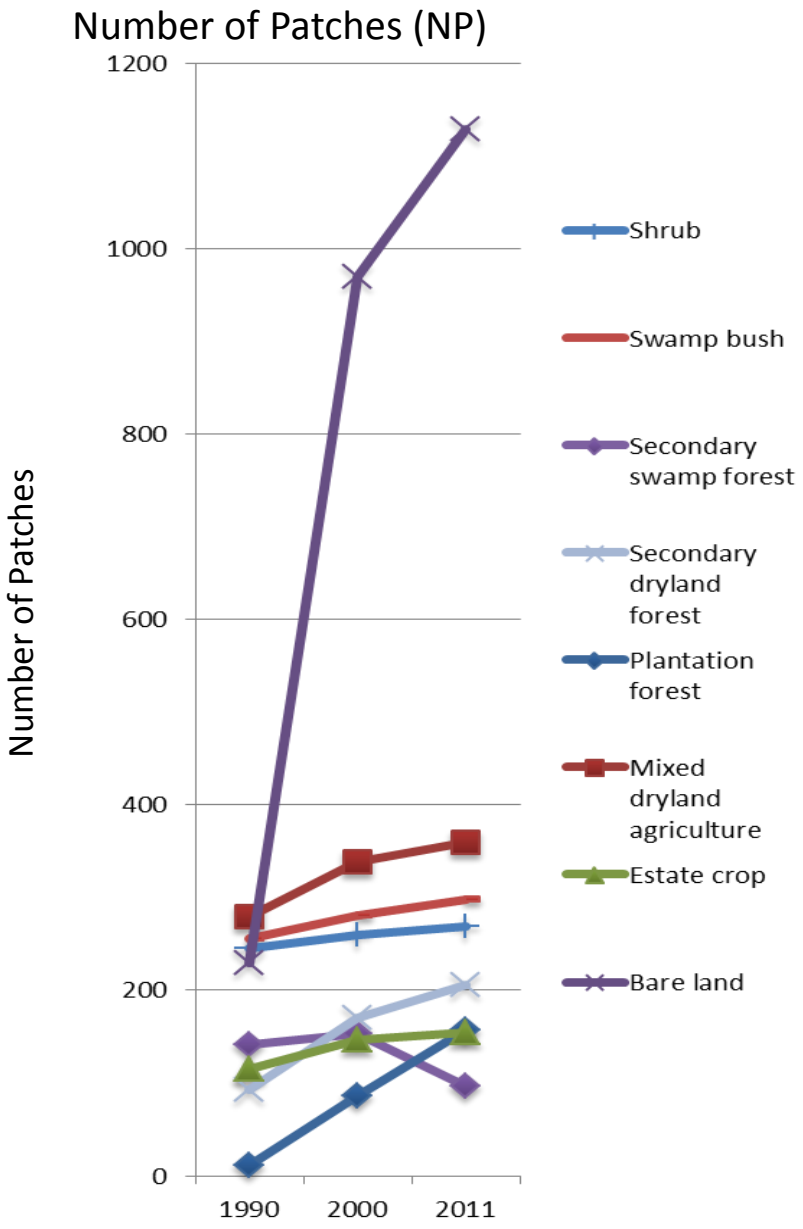


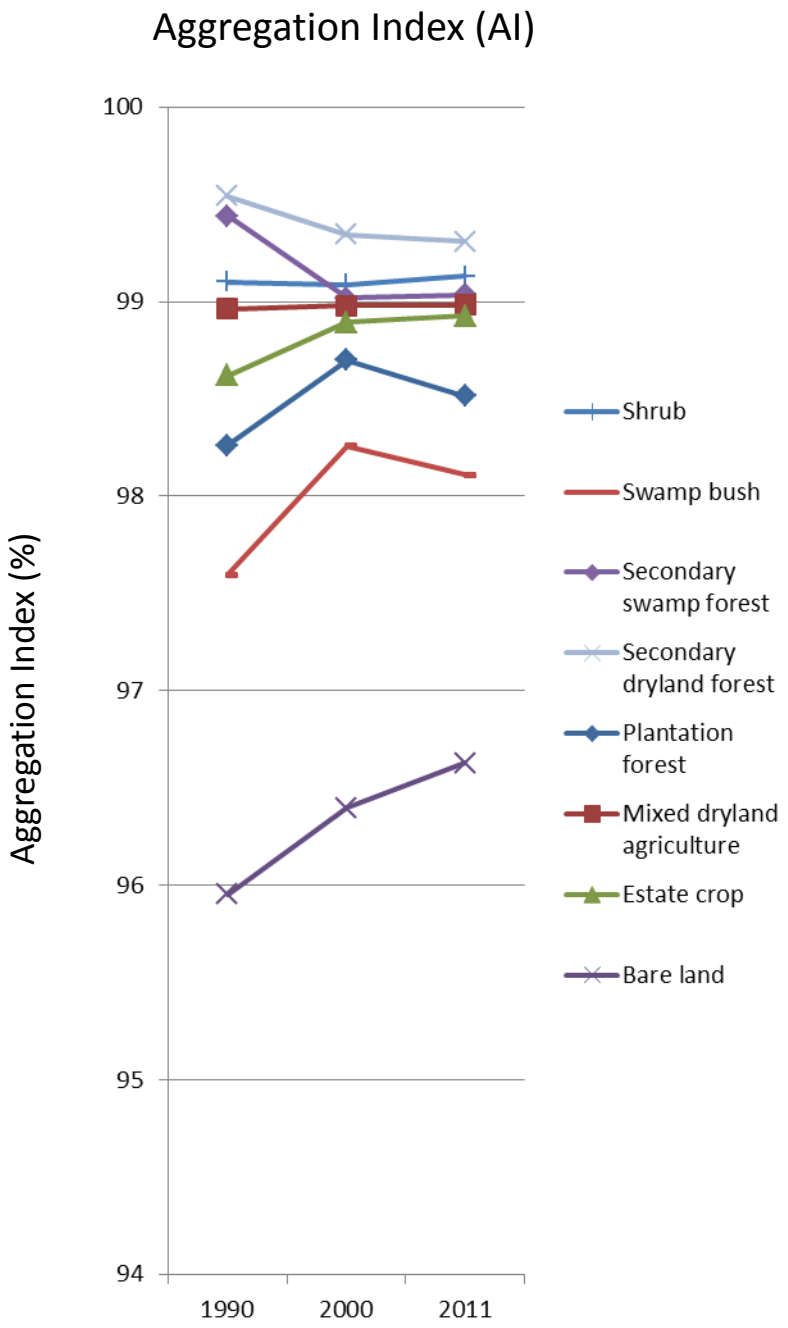
$e_{i,i}$: 0
$max\_e_{i,i}$: 12

$AI_i = \frac{0}{12}(100)$

= 0

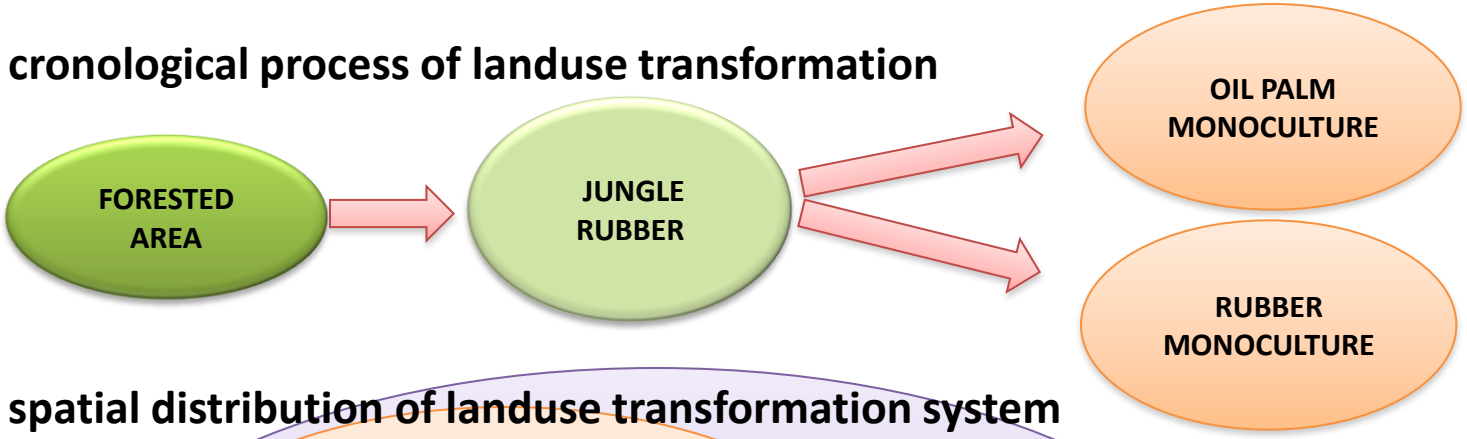
Landscape Metrics



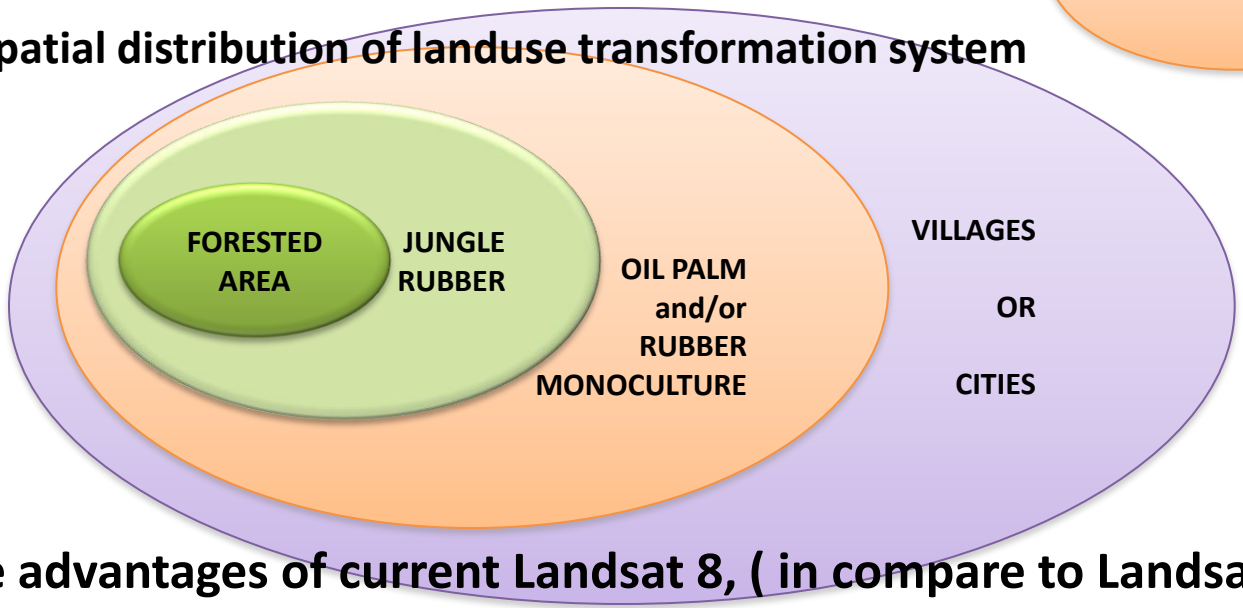


Transformation system pattern from Landsat 8 interpretation

The cronological process of landuse transformation



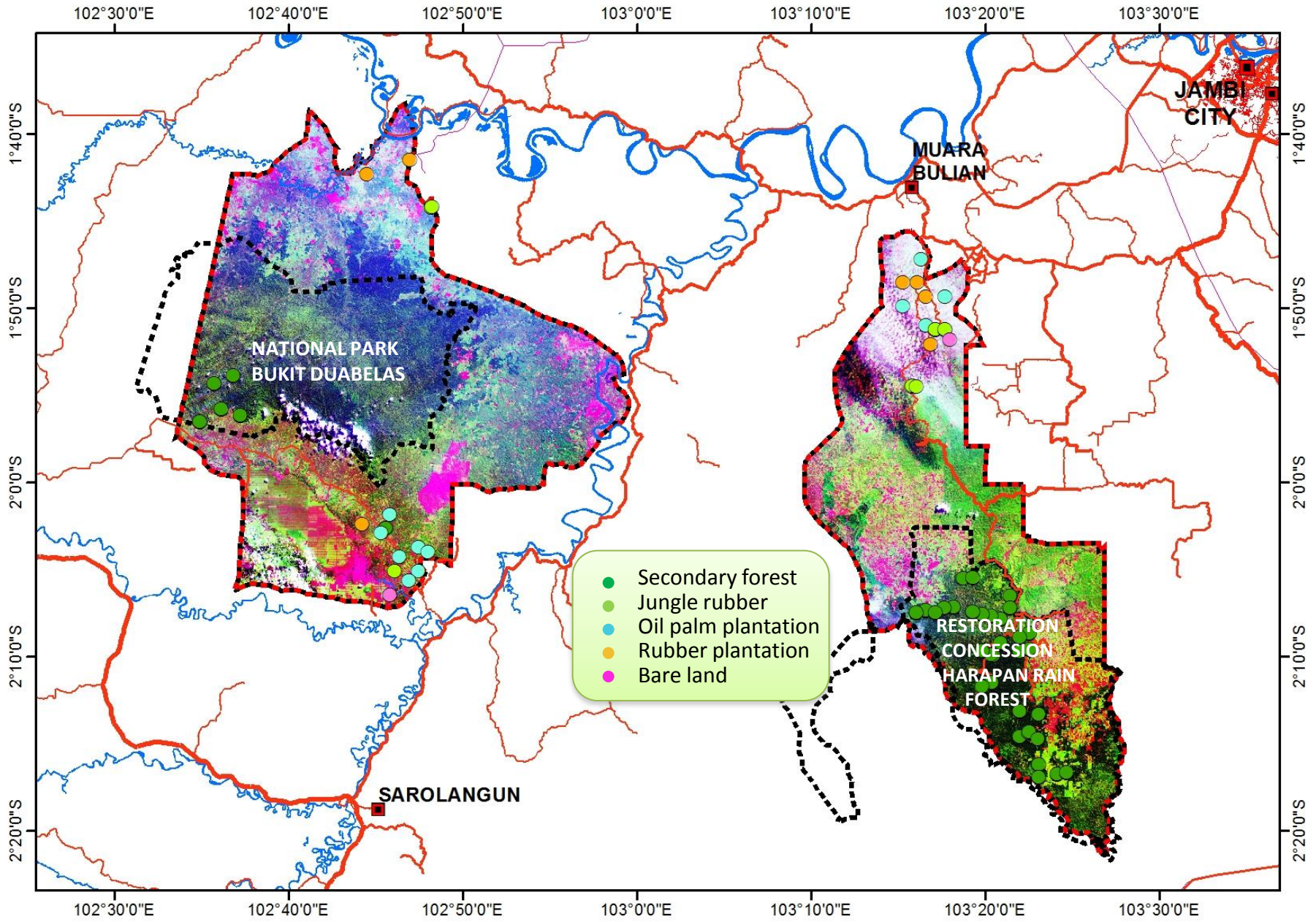
The spatial distribution of landuse transformation system



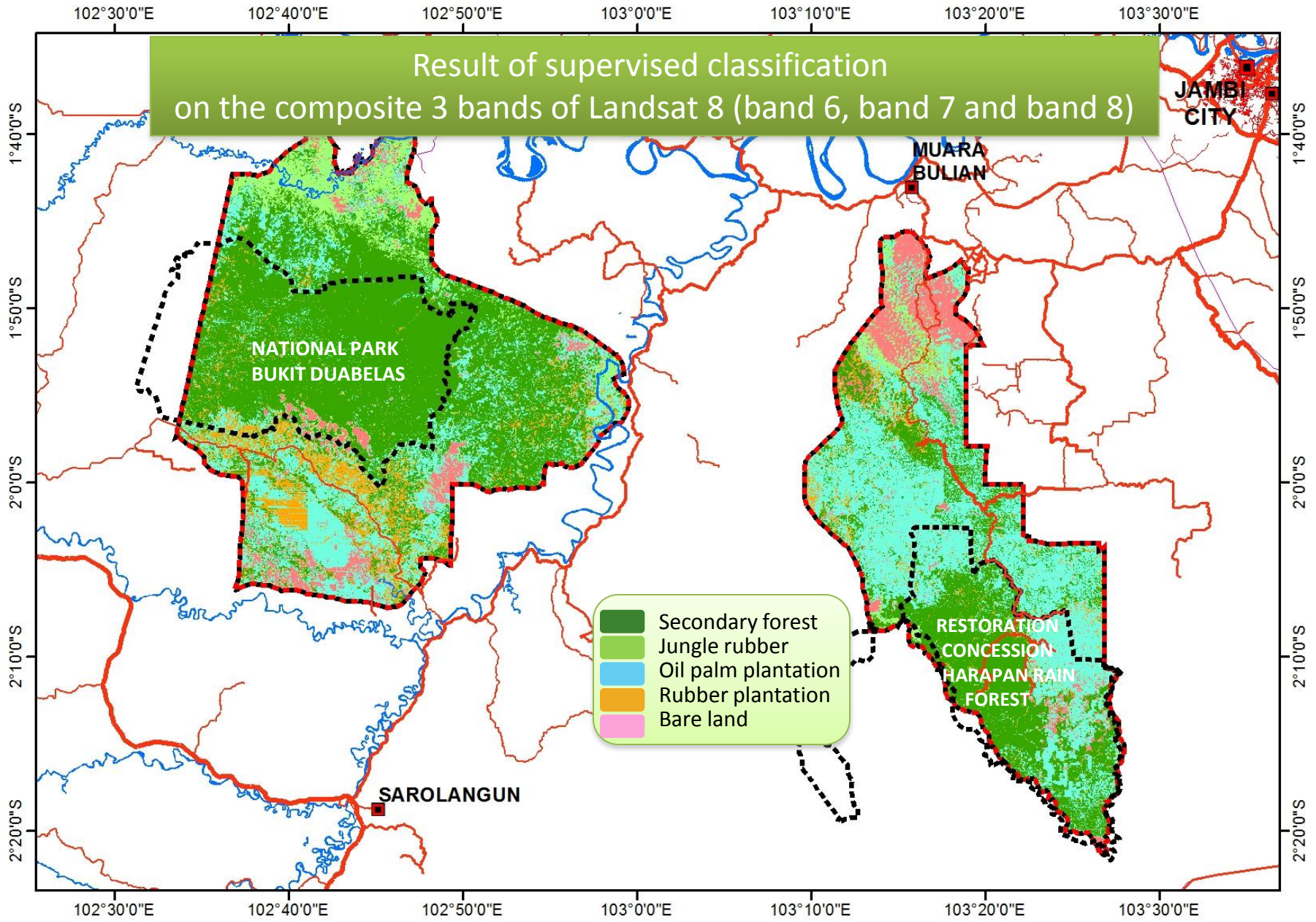
The advantages of current Landsat 8, (in compare to Landsat 7)

- Freely accessed but no stripping
- 12 bit of digital number, range from 0 to 4096
- Completed with additional panchromatic band with 15 m resolution
- Consists of 2 SWIR bands with cloud penetration capability

Transformation system pattern from Landsat 8 interpretation



Transformation system pattern from Landsat 8 interpretation



Conclusion and Discussion

1. Secondary dryland forest and secondary swamp forest have been decreased during 1990-2011, but the decline of secondary dryland forest was much higher during 2000-2011 than it was during 1990-2000.

2. The increase of bare land, estate crop, plantation forest and swamp bush was higher in 1990-2000 than in 2000-2011, while the increase of mixed dryland agriculture and shrub was higher in 2000-2011 than in 1990-2000.

3. Estate crop, plantation forest and secondary dryland forest were less fragmented and much aggregated.

4. The high number of patches of bare land and mixed dryland agriculture means that this land use land cover has been fragmented over time. It is also shown that bare land was much disaggregated.

THANK YOU