Thailand's Experience with Remote Sensing and GIS Data

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WGIA 8

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Background of our experience in Remote Sensing and GIS Data (1)

Biomass open burning – Mekong River Basin Sub-Region and Thailand

- **Estimation of Pollutants Emissions from Biomass Burning in the Mekong River Basin Sub-Region (since end 2004)**
- **Rationale**
  - Policy and Decision-Making Support Information
  - Biomass = Bio-energy Resource
    - Emissions from biomass open burning = Baseline
  - Biomass burning = Area source
    - Overlooked and underestimated

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Legend

Biomass open burning – Mekong River Basin Sub-Region and Thailand

- **Objectives**
  - To develop a database of emission factors and emissions representative of the MRBSR
  - To develop an emission estimation based on repetitive and consistent measurements of biomass burning activity and emission factors using well-defined methodology
  - To set-up a capacity building for regional scientists on inventory of emissions from biomass open burning for AQ monitoring and modeling

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- **Starting point:** Estimation of air pollutant emissions from biomass open burning in the Mekong River Basin Sub-Region

Biomass Open Burning – Mekong River Basin Sub-Region and in Thailand

- **Scope**
  - Study sites: Thailand, Cambodia, Lao PDR, Vietnam, (Myanmar)
  - Pollutants of interest: PM_{10}, $PM_{2.5}$, EC/OC, GHG (CO_2, CH_4, N_2O), CO

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Legend

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Background of our experience in Remote Sensing and GIS Data (2)

- To better understand the ASEAN Transboundary Haze Pollution

Biomass burning – ASEAN countries

ASEAN Agreement on Transboundary Haze Pollution

- The first regional arrangement in the world that binds a group of contiguous states to tackle transboundary haze pollution resulting from land and forest fires.

- The Agreement aims to prevent and monitor transboundary haze pollution as a result of land and/or forest fires which should be mitigated, through concerted national efforts and intensified regional and international co-operation, on a sustained basis.

- It also serves to intensify the current regional and sub-regional arrangements through provisions on technical cooperation and procedures for joint emergency response.

Currently, eight countries (out of 10) composed of Brunei Darussalam, Cambodia, Lao PDR, Malaysia, Myanmar, Singapore, Thailand and Vietnam have signed the Agreement.

Haze in Malaysia during Indonesian forest fire in 1997

Haze in Chiang Mai in 2007

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Background of our experience in Remote Sensing and GIS Data (3)

- But also the biomass burning contribution to global emission

(GEIA, 2005)

Fossil fuel BC emissions (Tonnes/1°x1°)

Biomass burning BC emissions (Tonnes/1°x1°)

TABLE 2

Burning's contribution to global emissions

Comparison of global emissions from biomass burning with emissions from all sources, including biomass burning *(2)*.

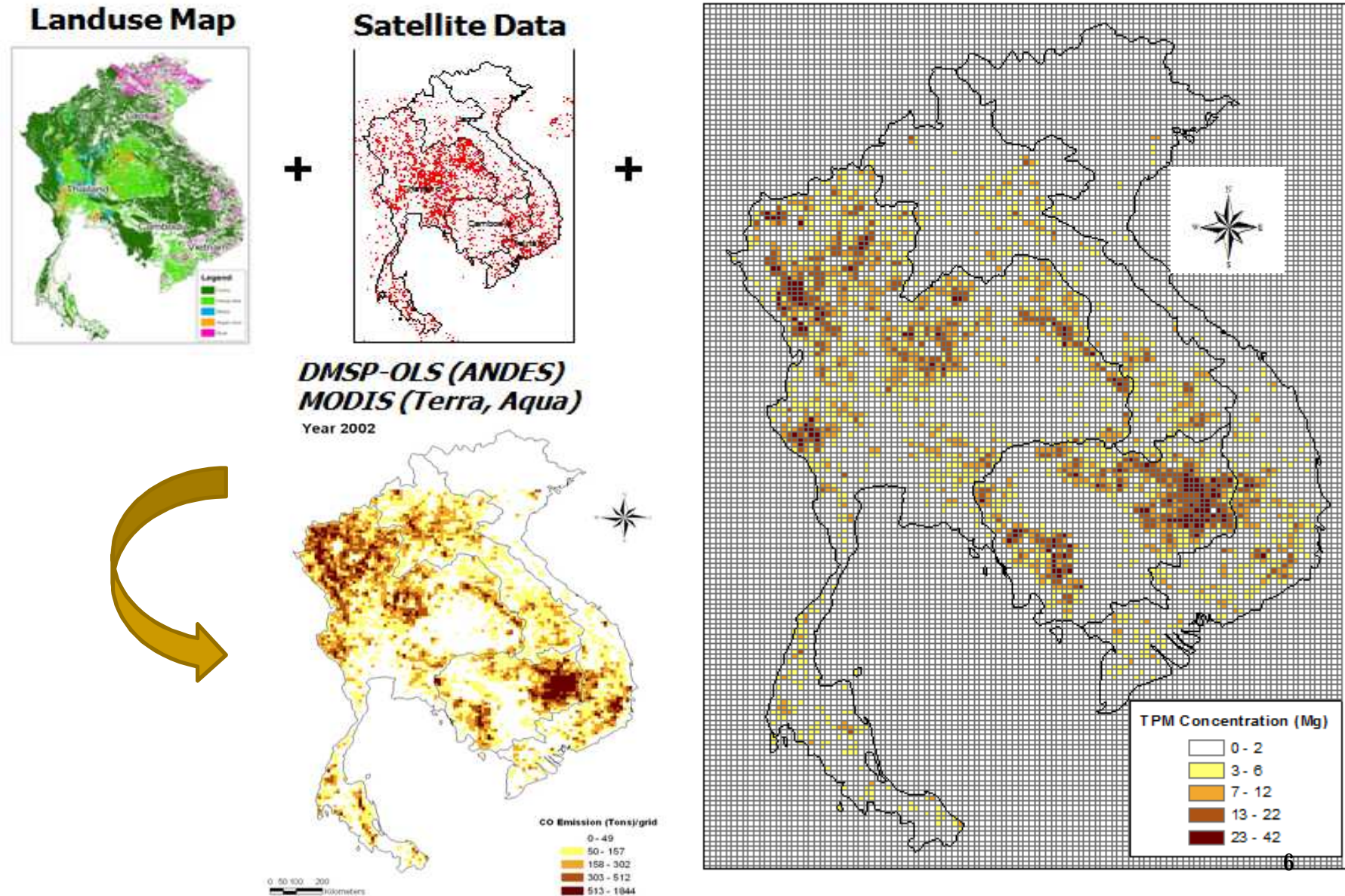| Species	Biomass burning (Tg element/ year)	All sources (Tg element/ year)	Biomass burning, %
Carbon dioxide (gross)	3500	8700	40
Carbon dioxide (net)	1800	7000	26
Carbon monoxide	350	1100	32
Methane	38	380	10
Nonmethane hydrocarbons[a]	24	100	24
Nitric oxide	8.5	40	21
Ammonia	5.3	44	12
Sulfur gases	2.8	150	2
Methyl chloride	0.51	2.3	22
Hydrogen	19	75	25
Tropospheric ozone	420	1100	38
Total particulate matter	104	1530	7
Particulate organic carbon	69	180	39
Elemental carbon (black soot)	19	<22	>86

[a]Excluding isoprene and terpenes.

(Levine et al., 1995)

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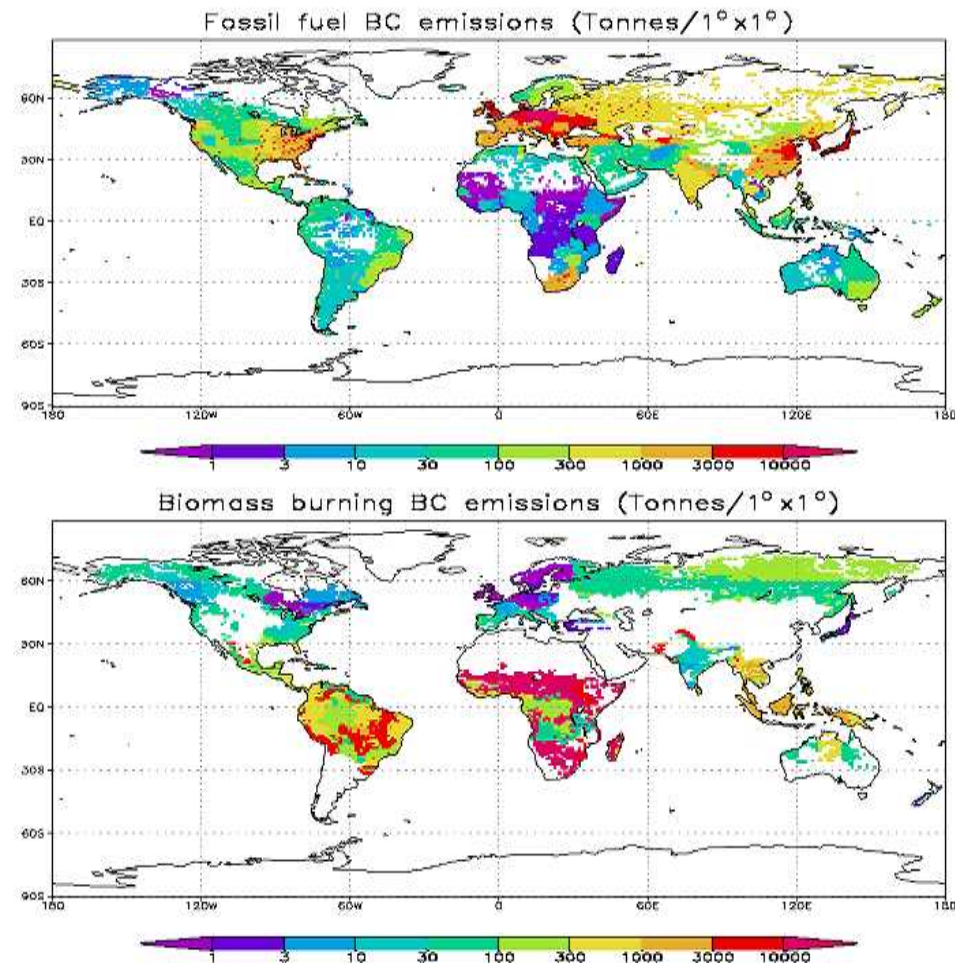
Background of our experience in Remote Sensing and GIS Data (4)

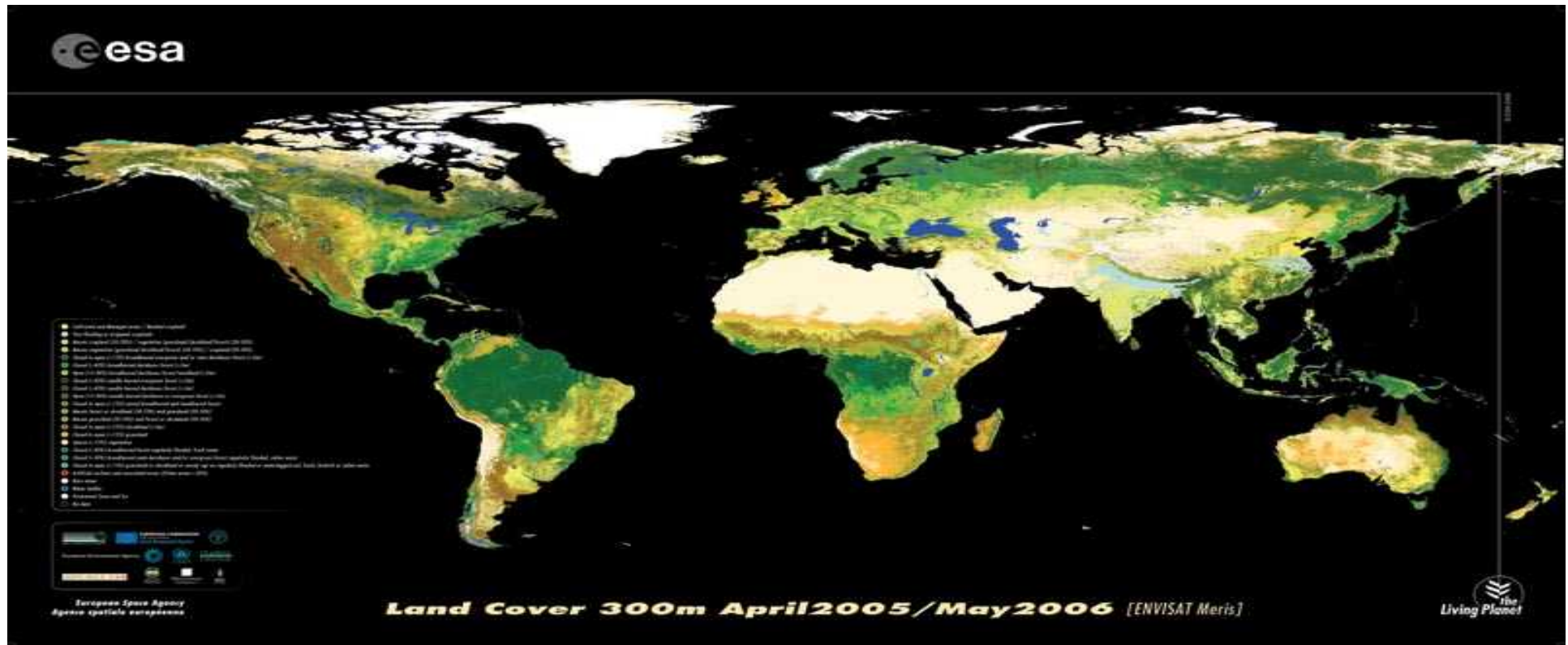■ And future change of biomass burning towards climate change

2000	2005	2030
2050	2100	
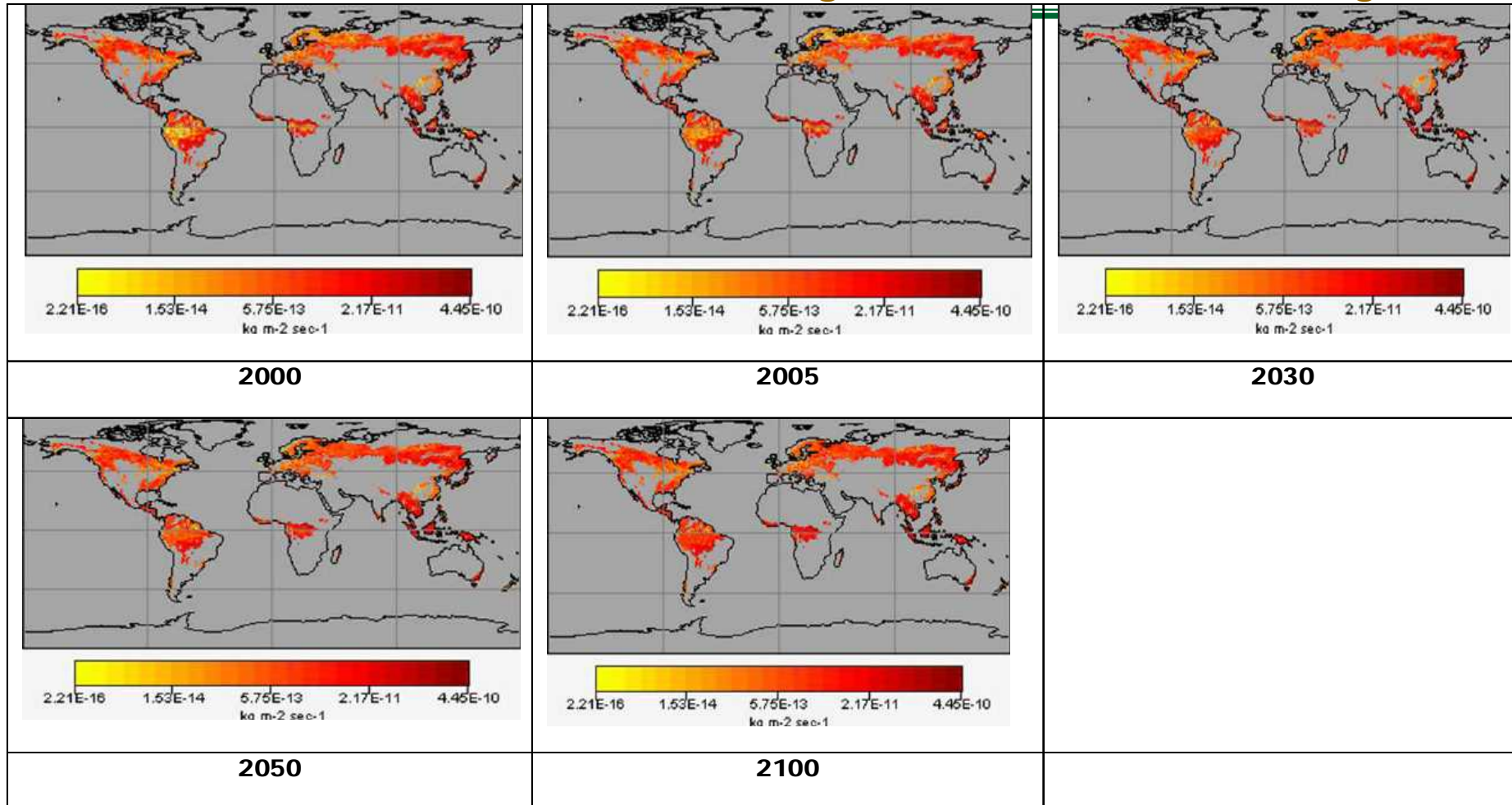
Evolution of spatial distribution of NOx (kg m^{-2} sec^{-1}) emissions from forest fires in 2000, 2005, 2030, 2050 and 2100 based on AIM (RCP 6.0) datasets(www.iiasa.ac.at/web-apps/tnt/RcpDb/)

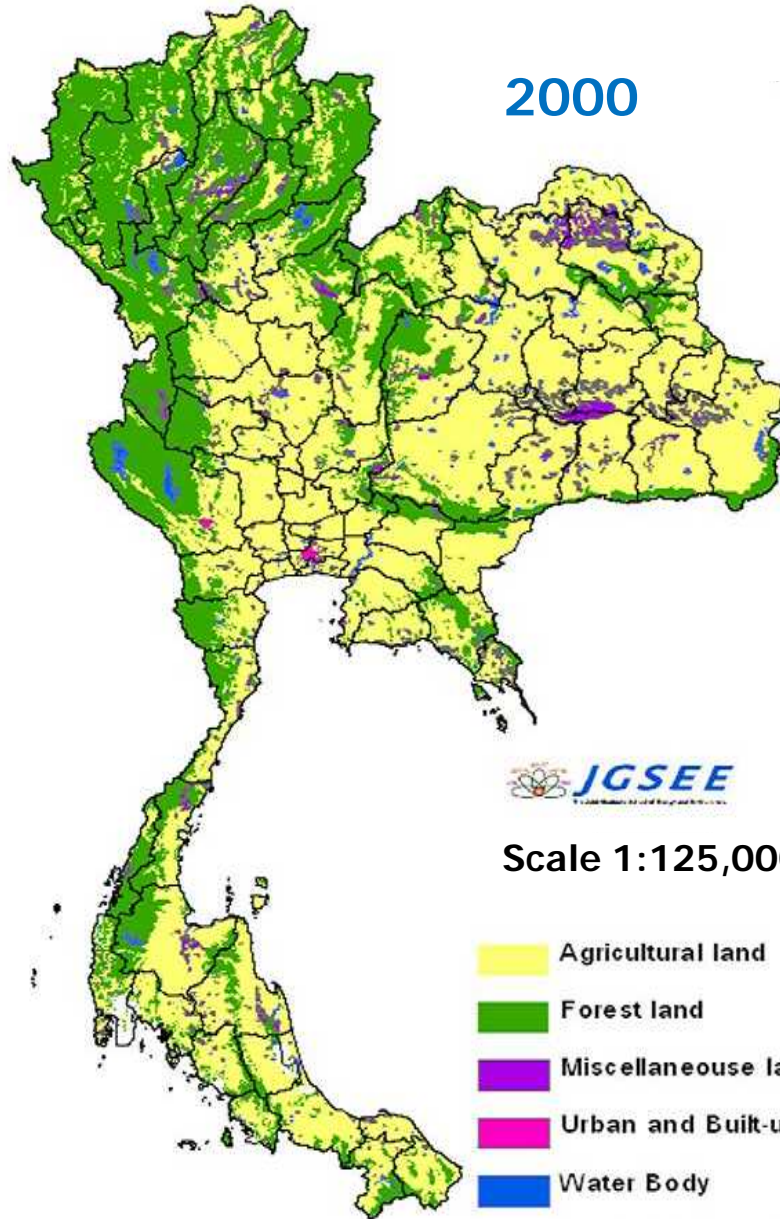# Estimation of CO and TPM emissions from biomass open burning in MRBSR

Landuse Map

Satellite Data

DMSP-OLS (ANDES)
MODIS (Terra, Aqua)

Year 2002

CO Emission (Tons)/grid
- 0 - 49
- 50 - 157
- 158 - 302
- 303 - 512
- 513 - 1844

0 50 100 200 Kilometers

TPM Concentration (Mg)
- 0 - 2
- 3 - 6
- 7 - 12
- 13 - 22
- 23 - 42

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Use of RS and GIS data for GHG inventory of LULUCF and in ALU

Land Cover 300m April 2005 / May 2006 [ENVISAT Meris]

Use of data of global land cover from European agencies, other sources of EOS (USGS, USDA, LANDSAT, …), national land use map, … in order to fill data gaps of LULUCF since data only exist for some periods of time
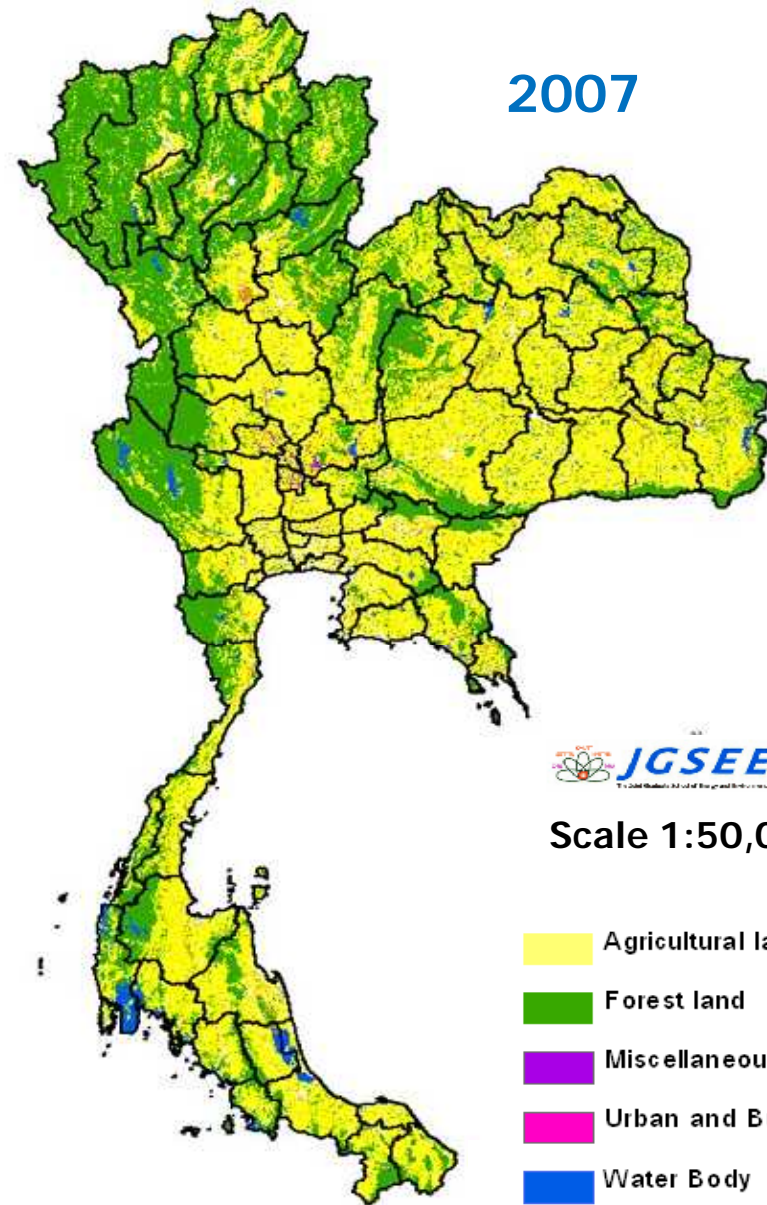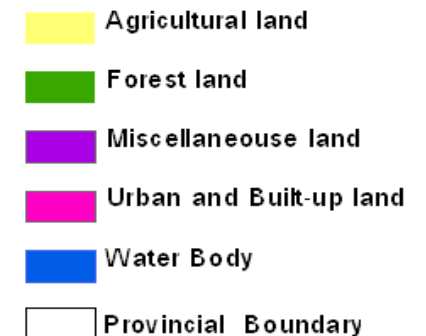
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National land-use maps

2000

Scale 1:125,000

2007

Scale 1:50,000

Legend:
- Agricultural land
- Forest land
- Miscelleouse land
- Urban and Built-up land
- Water Body
- Provincial Boundary

0 75 150 300 Kilometers

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Application to Ratchaburi (1)

Location

latitudes 13°32'15" N

longitudes 90°49'09" E

Climate

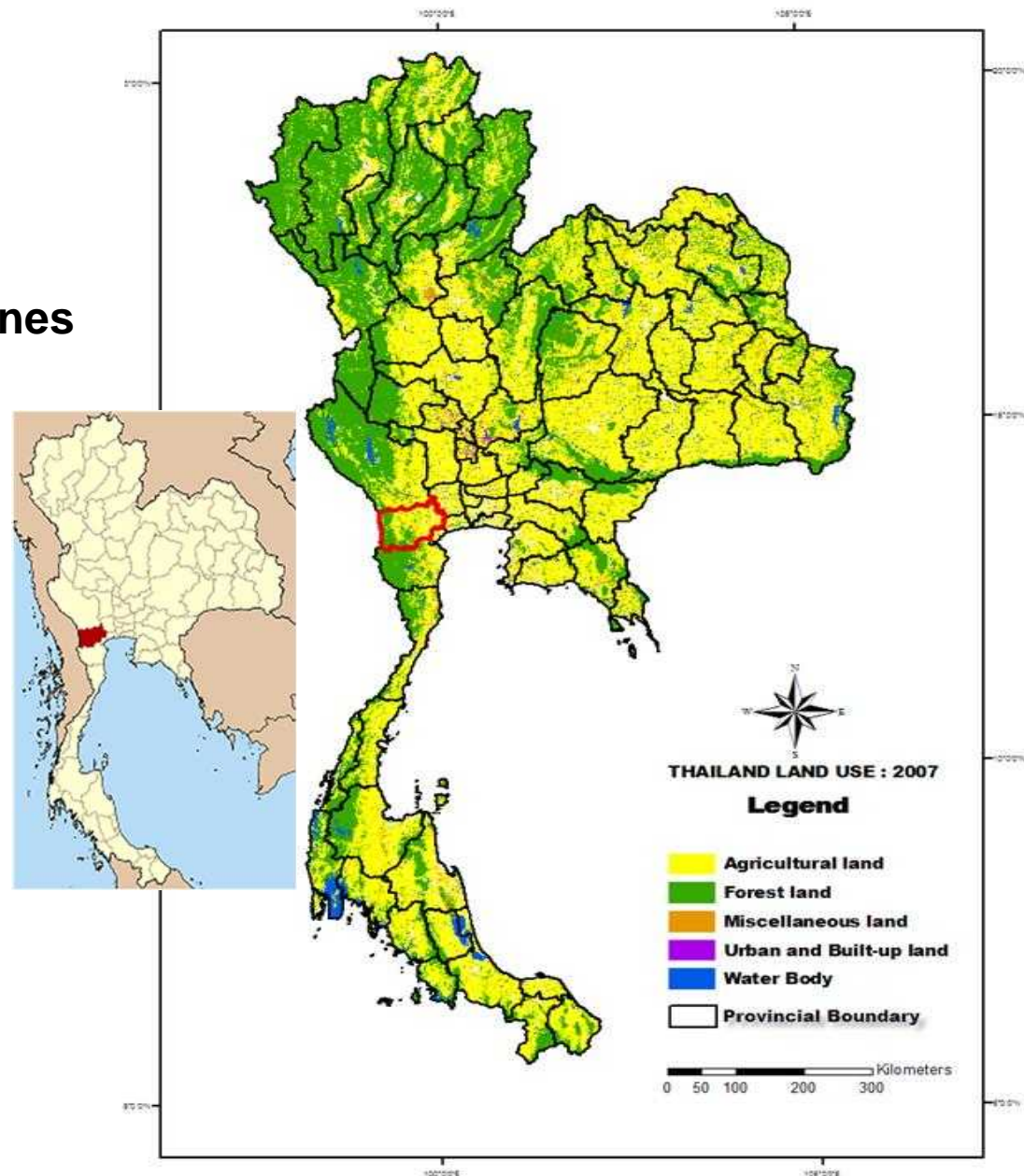SW monsoon with very dry zones

Mean Annual Temperature

21-38ºC

Average Annual Precipitation
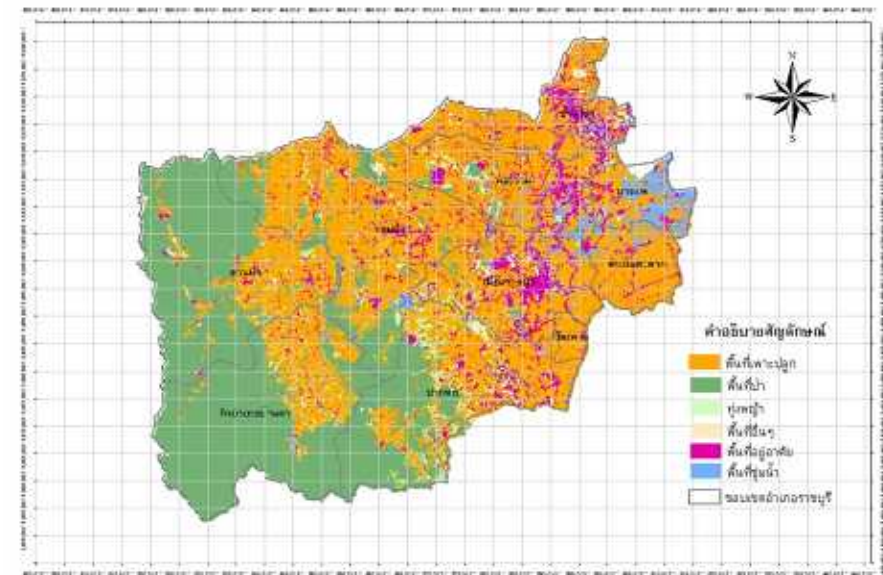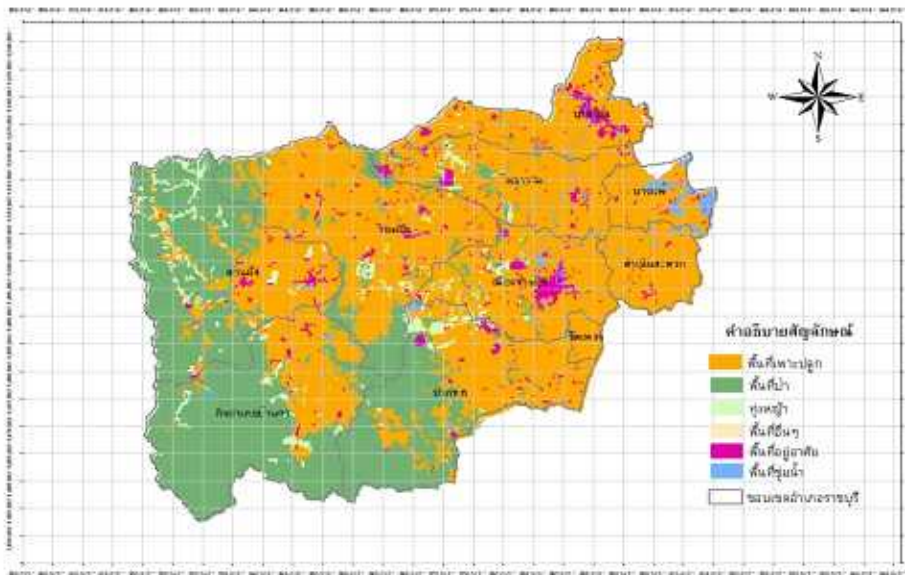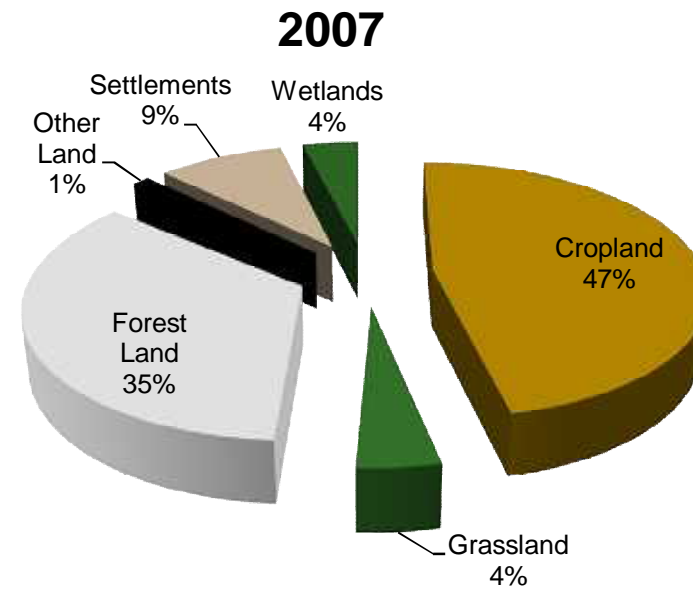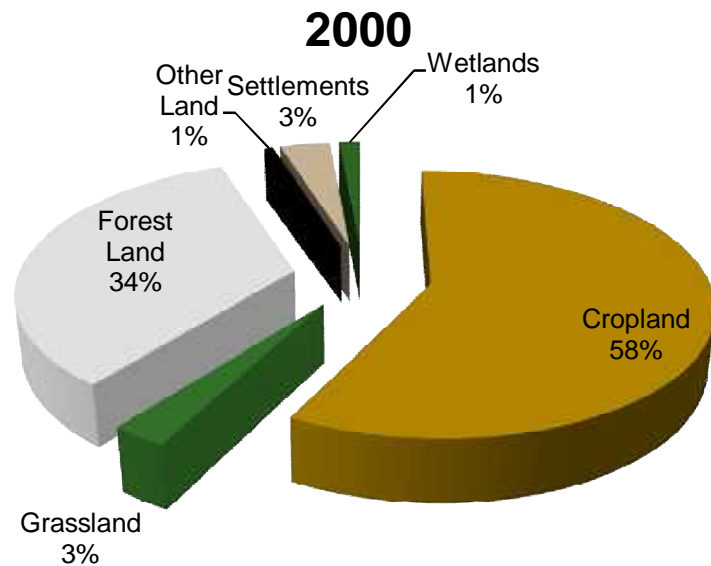
1,303 mm (131 days)

Population 2000 (2009)

791,217 (837,383) = 1,2% nat.

Total Land

5,196.5 km^2 (4 parts)

THAILAND LAND USE : 2007

Legend

- Agricultural land
- Forest land
- Miscellaneous land
- Urban and Built-up land
- Water Body
- Provincial Boundary

Kilometers
0 50 100   200   300

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Ratchaburi – Land-use repartition w/ GIS

2000

2007

Ratchaburi – GIS vs. RS (1)

2000

2007
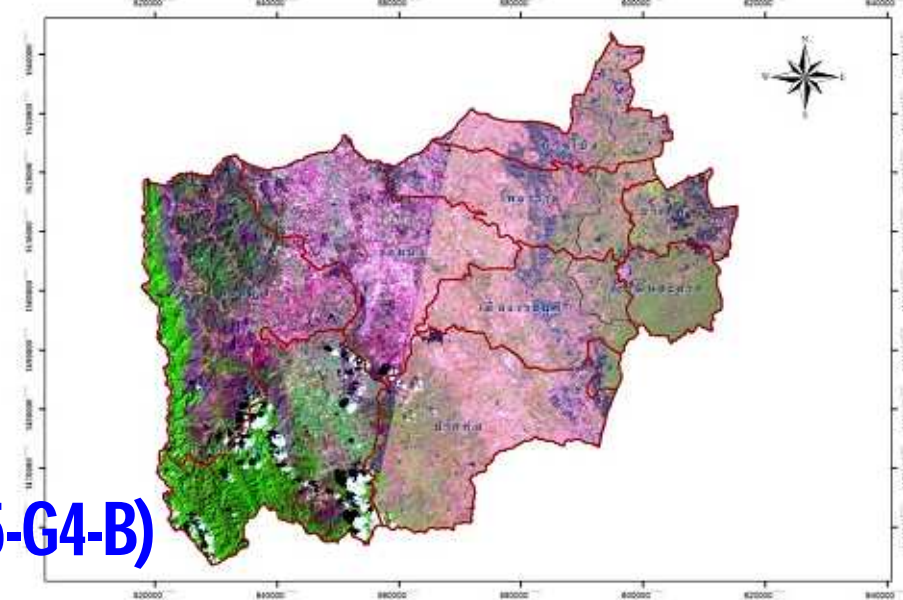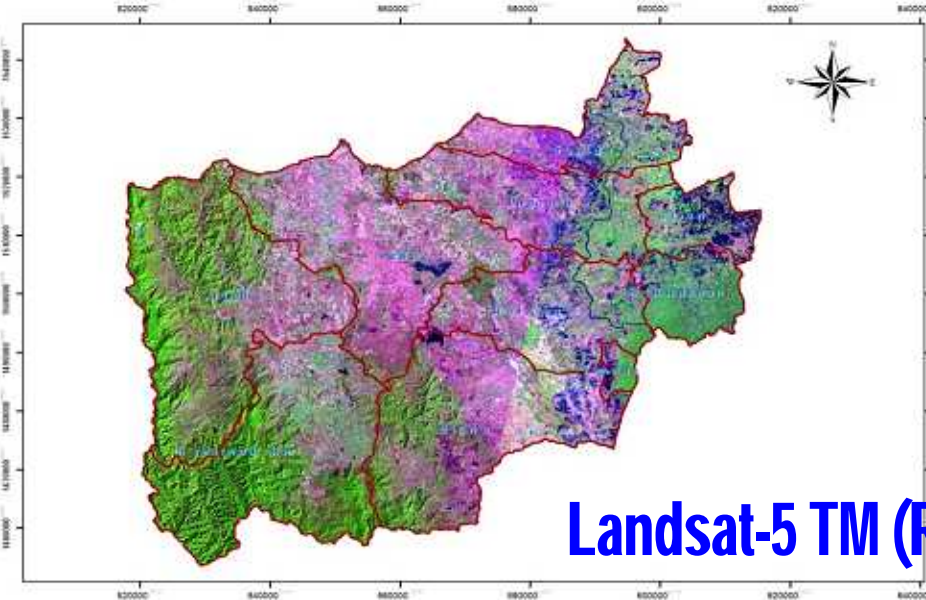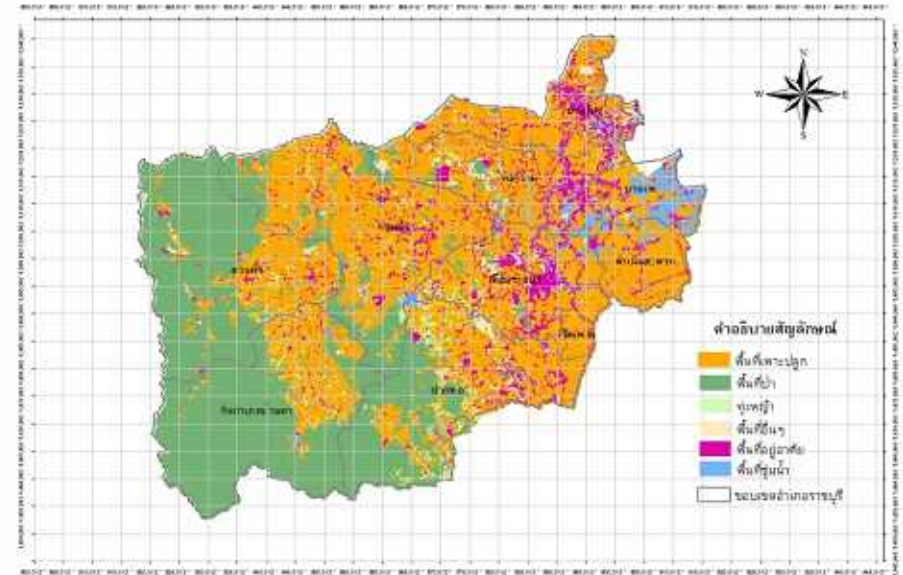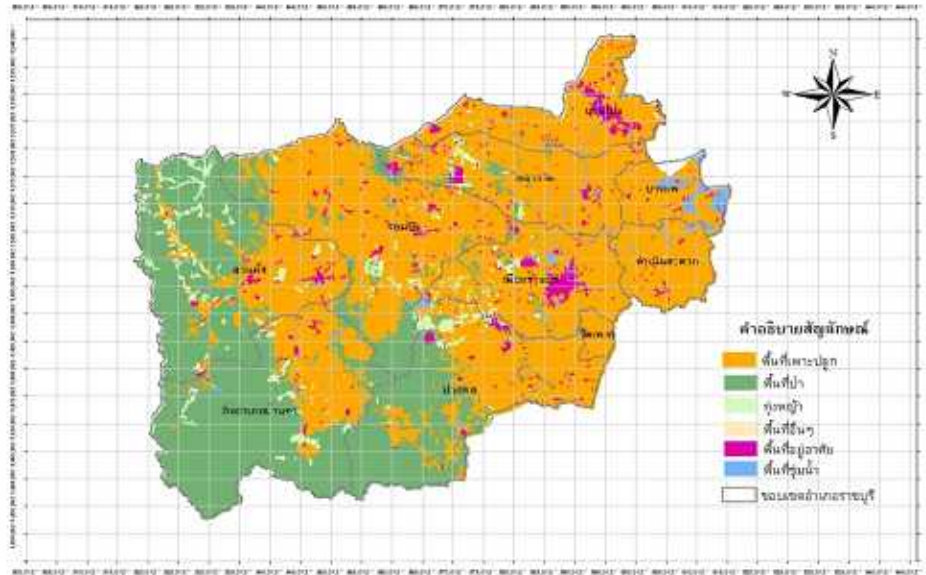
Landsat-5 TM (R5-G4-B)

Ratchaburi – GIS vs. RS (2)

	Land-use of Ratchaburi based on IPCC 2006 GL land classification category (ha)						
	Cropland	Grassland	Forest Land	Other Land	Settlements	Wetlands	Total
2007	241,368.92	21,522.52	182,027.90	6,358.74	45,923.75	20,322.54	517,524.34
%	46.64%	4.16%	35.17%	1.23%	8.87%	3.93%	100%
2007 revised with RS	249,153.74	26,712.40	156,078.48	8,953.67	52,411.11	24,214.95	517,524.34
%	48.14%	5.16%	30.16%	1.73%	10.13%	4.68%	100%

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Ratchaburi – LUC 2007 vs. 2000 (1)
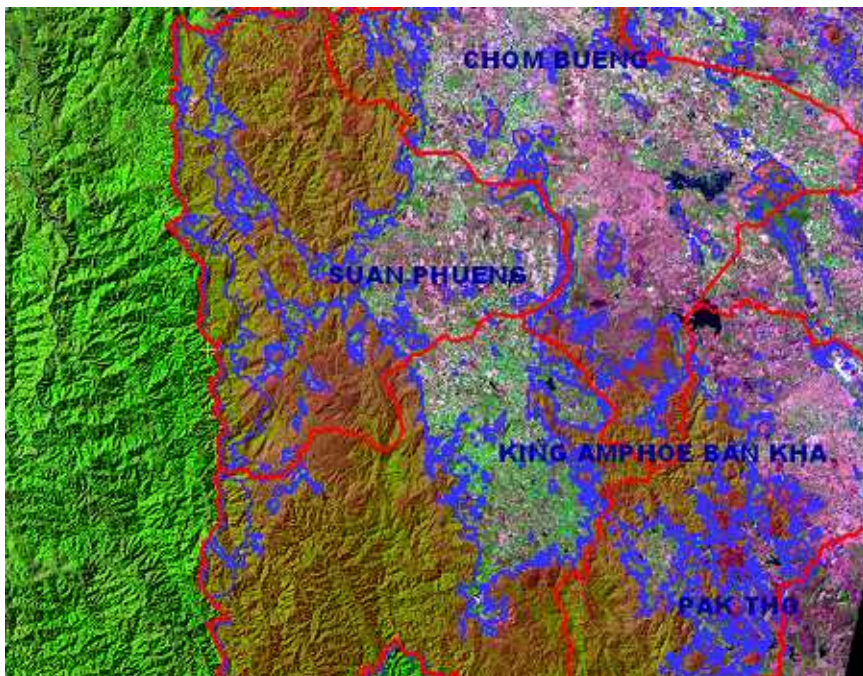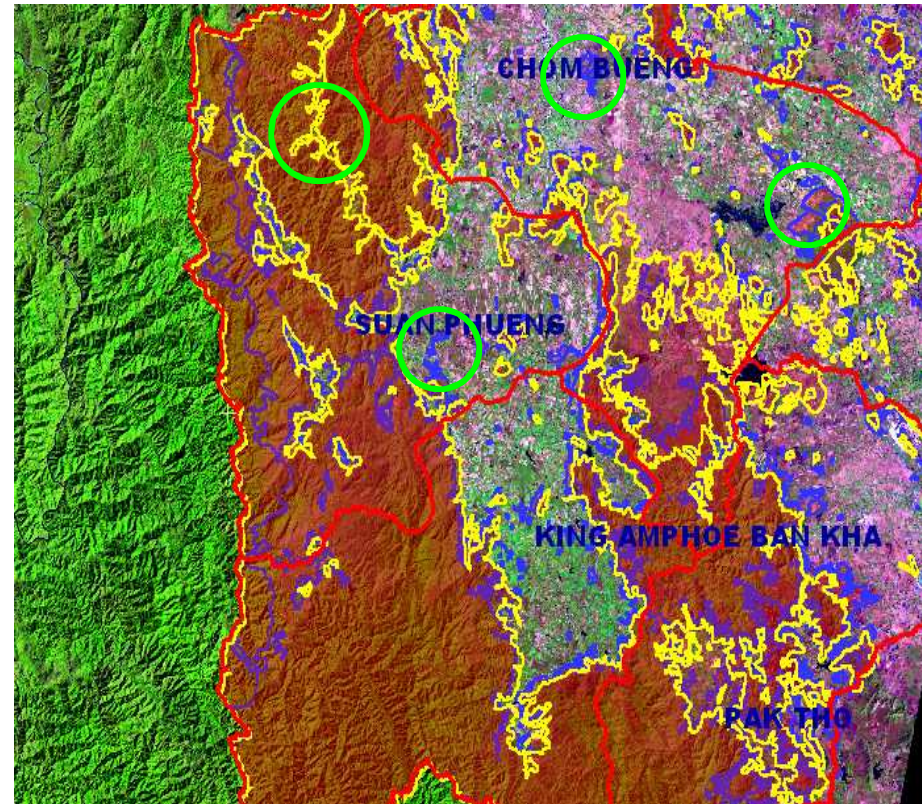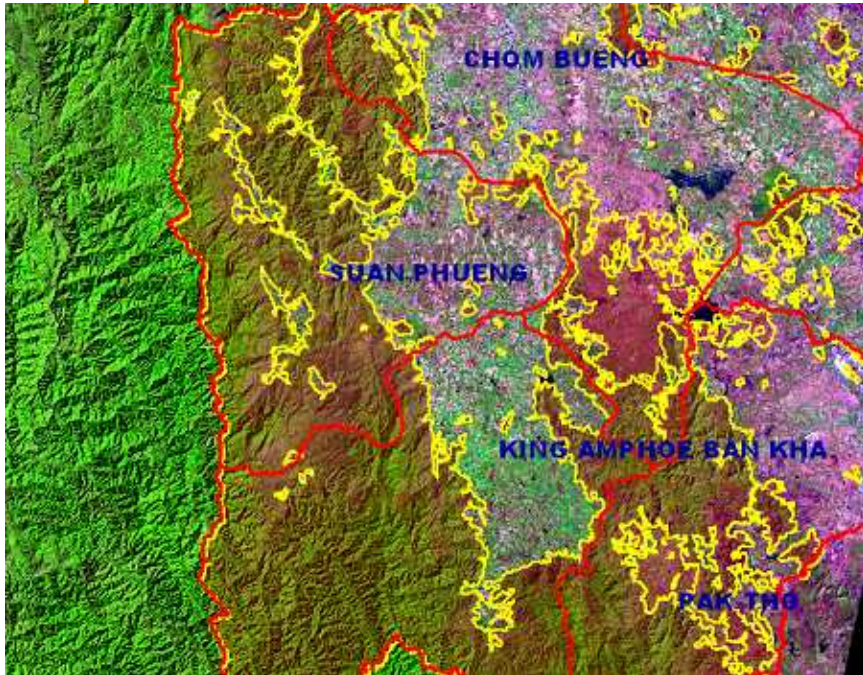
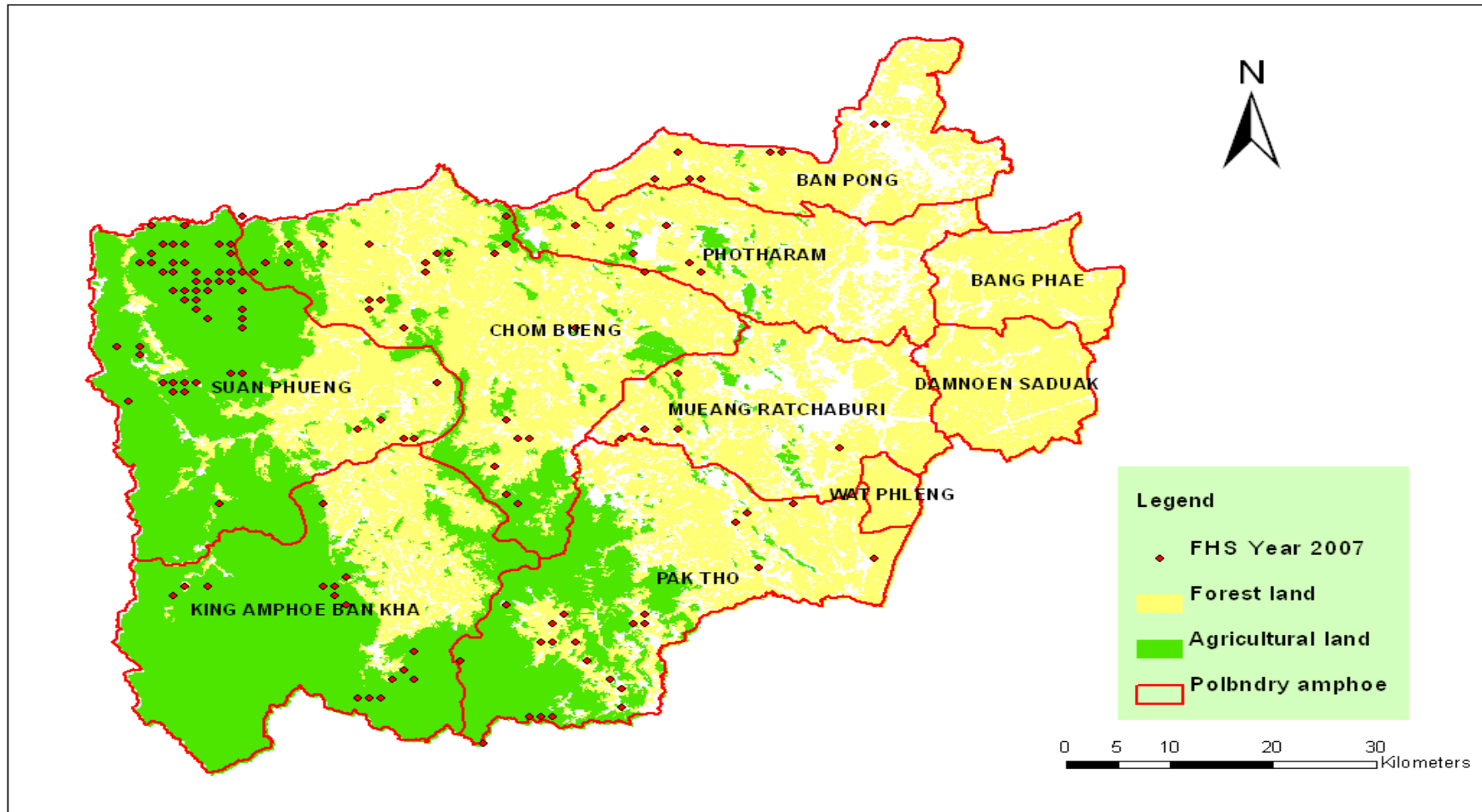**Layer of Forest Land: comparison of LU GIS maps between 2000 and 2007 then overlay with Lansat-5 images year in 2000**

Ratchaburi – LUC 2007 vs. 2000 (2)

2007 2000	Land-use of Ratchaburi based on IPCC 2006 GL land classification category (ha) - 2000 vs. 2007							%
	Cropland	**Grassland**	**Forest Land**	**Other Land**	**Settlements**	**Wetlands**	**Total in 2000**	
Cropland	214,170.13	16,754.93	10,296.34	4,099.72	37,347.82	16,120.03	**298,788.97**	**57.73%**
Grassland	5,460.24	1,783.67	5,242.48	630.56	977.76	317.61	**14,412.32**	**2.78%**
Forest Land	18,915.49	6,710.70	137,708.48	2,924.39	6,142.39	3,336.76	**175,738.21**	**33.96%**
Other Land	620.51	162.31	1,710.84	405.36	140.42	55.56	**3,095.00**	**0.60%**
Settlements	7,556.67	1,120.92	911.7	825.98	6,440.40	1,078.17	**17,933.84**	**3.47%**
Wetlands	2,430.70	179.87	208.64	67.66	1,362.32	3,306.82	**7,556.01**	**1.46%**
Total in 2007	**249,153.74**	**26,712.40**	**156,078.48**	**8,953.67**	**52,411.11**	**24,214.95**	**517,524.34**	**100%**
%	**48.14%**	**5.16%**	**30.16%**	**1.73%**	**10.13%**	**4.68%**	**100%**	**-**
% Change	**-9.59%**	**2.38%**	**-3.80%**	**1.13%**	**6.66%**	**3.22%**	**-**	

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Ratchaburi – State of biomass open burning in 2007

Ratchaburi – Annual change in C stock (1)

Land-Use Category		Annual change in carbon stocks							
		Removals				Emissions			
Initial Land Use 2000	Land Use during Reporting Year 2007	Living Biomass A (Mt CO_2)	Dead Organic Matter B	Soils C	CO_2 Emissions/ Removals D = (A+B+C) x (-1) (Mt CO_2)	Annual CH_4 emissions (t CH_4)	Annual N_2O emissions (t N_2O)	Annual NO_x emissions (t NO_x)	Annual CO emissions (t CO)
Forest Land	Forest Land	5.462	-	-	-5.462	8.41	0.25	1.98	128.73
Cropland	Forest Land	0.385	-	-	-0.385				
Grassland	Forest Land	0.216	-	-	-0.216				
wetland	Forest Land	0.009	-	-	-0.009				
Settlement land	Forest Land	0.034	-	-	-0.034				
Other land	Forest Land	0.07	-	-	-0.07				
Sub-Total for Forest Land		6.176			-6.176	8.41	0.25	1.98	128.73

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Ratchaburi – Annual change in C stock (2)

Land-Use Category		Annual change in carbon stocks							
		Removals				Emissions			
Initial Land Use 2000	Land Use during Reporting Year 2007	Living Biomass A (M t CO_2)	Dead Organic Matter B	Soils C	CO_2 Emissions/ Removals D = (A+B+C) x (-1) (M t CO_2)	Annual CH_4 emissions (t $CO_{2\,eq}$)	Annual N_2O emissions (t $CO_{2\,eq}$)	Annual NO_x emissions (t $CO_{2\,eq}$)	Annual CO emissions (t $CO_{2\,eq}$)
Sub-Total for Forest Land in (M t CO_2)		6.176			-6.176	176.61	77.5		

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On-going works and next steps …

- **For Biomass Burning**

    - Improve the assessment of area burnt using MODIS data by conducting specific ground survey and coupling w/ fire propagation model

    - Check time-series consistency using RS vs. forest fire control center records

- **For LULUCF**

    - Continue our work with Ratchaburi using RS data in ALU

    - Extend the work to other provinces, regions and finally the whole country

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Acknowledgements