Thailand's Experience with Remote Sensing and GIS

Savitri Garivait, JGSEE-KMUTT, Thailand

WGIA 7

July 7-10, 2009 Mayfield Hotel Seoul, Korea



1

Background of our experience in Remote Sensing and GIS ... (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



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

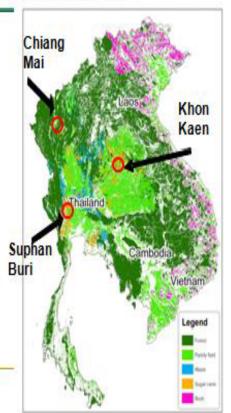


- Suphan Buri Chiang Chia
- Starting point: Estimation of air pollutant emissions from biomass open burning in the Mekong River Basin Sub-Region

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

- Scope
 - Study sites: Thailand, Cambodia, Lao PDR, Vietnam, (Myanmar)
 - Pollutants of interest: PM₁₀, PM_{2.5}, EC/OC, GHG (CO₂, CH₄, N₂O), CO

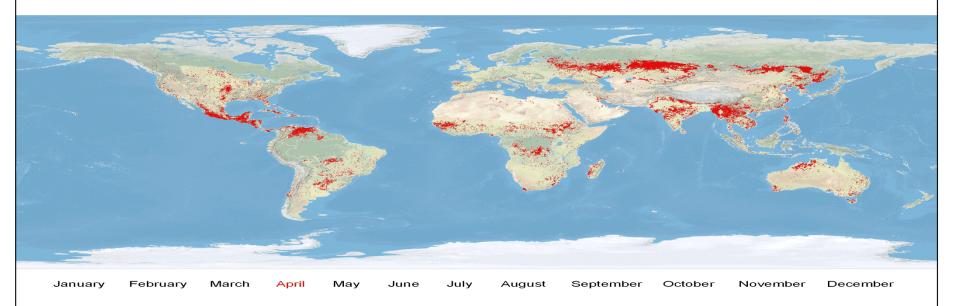




Background of our experience in Remote Sensing and GIS ... (2) But what is biomass open burning?



MODIS Rapid Response Active Fire Detections for 2008





Active fires, shown in red, are detected using MODIS data from the Terra Satellite. Source: MODIS Rapid Response http://rapidfire.sci.gsfc.nasa.gov/ Fire Information for Resource Management System (FIRMS) http://maps.geog.umd.edu

Background of our experience in Remote Sensing and $GIS \dots (3)$ Biomass burning contribution to

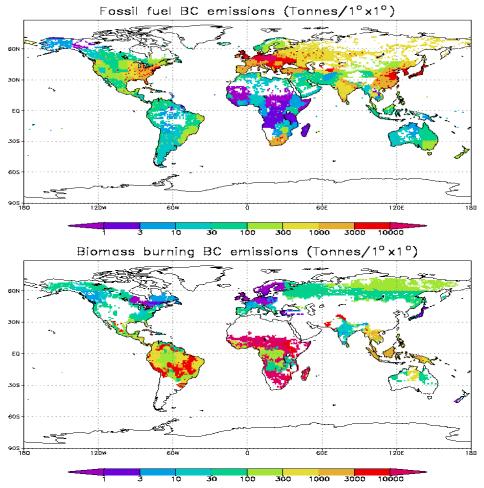
TABLE 2

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"	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	
*Excluding isoprene and te	rpenes.			

global emission (GEIA, 2005)



(Levine et al., 1995)

Background of our experience in Remote Sensing and **GIS** ... (4) Biomass burning and climate change

Impact of Biomass Open Burning: Haze Formation



Hare at 5km; up to 5km high Size of continental US Covering Indian Ocean, South Asia, Southeast Asia and China

Impact of Biomass Open Burning: Radiative Forcing



Impact of Biomass Open Burning: Rainfall Pattern Change - Climate Change

GEOPHYSICAL RESEARCH LETTERS, VOL. 26, NO. 29, PAGES 3105-3108, OCTOBER 15, 1999

TRMM¹ Observed First Direct Evidence of Smoke from Forest **Fires Inhibiting Rainfall**

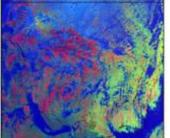
Daniel Rosenfeld Inst of Karth Sciences, The Hohere Estimating of Senaplem, Scient

Abstract. Although it has been known that anske from bio- 2. The TRMM Observations Alerted, Albrecht is to over allers ein aller om aller cally dud off. The tops of the annike-infected clouds must exabout -12°C, for the clouds to start procipitating. In contrast, affacent tropical clouds in the cleaner air precipitate most of their water believ ever freezing. There are indications that min suppression that to sir pollution prevails also in the co- h.Passive microware radiometer (TMI), which is sensitive to ta-minia.

clouds informed by heavy anska from farmer from any practicard the forcing level, i.e., grow to attendes solder that a Rainfall measuring rader (FK), which detects only precipitation-sized particles in clouds. The sub-satellite resolution is 4 km horizontally by 250 m vertically:

the circul dropiets as well as to precipitation particles. The sub-satellite horizontal resolution of the ES GPZ channels h4km





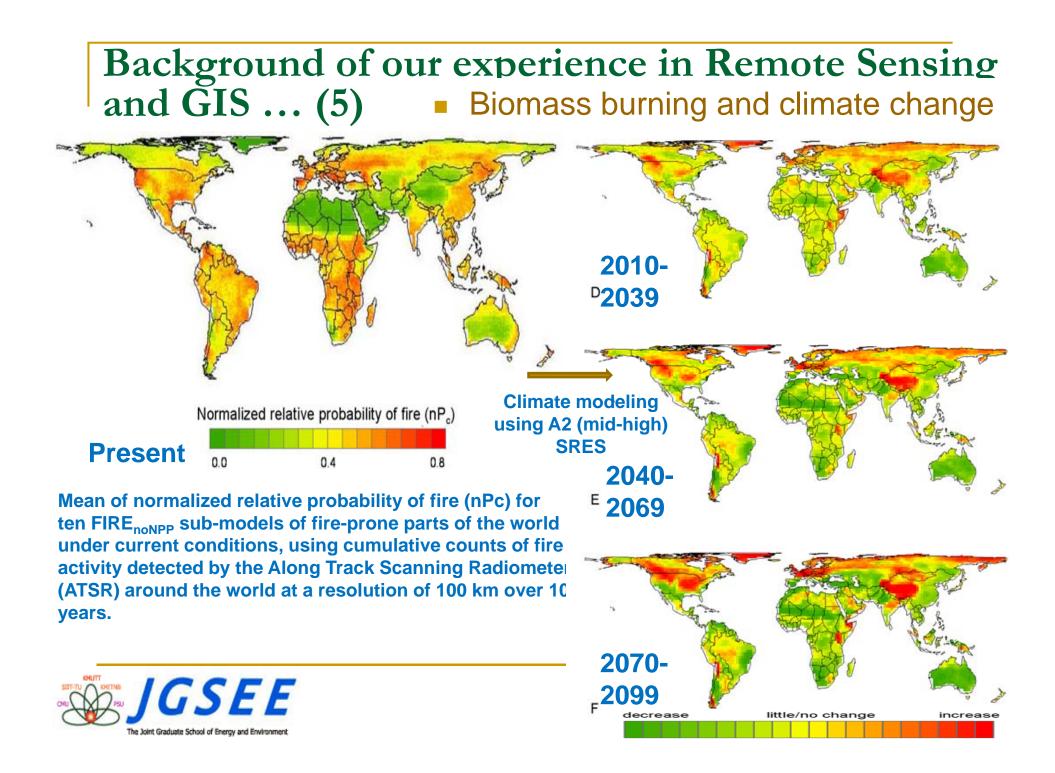
SUBMISSION TO THE COAG BUSHFIRE INQUIRY CONCERNING THE RECENT AUSTRALIAN BUSHFIRES

TRMM Program, 2004 12

	homor		hangui		Onosi	Owni	Agendani	2 could pain be aparter Cycloper Cycloperer Cycloperer Cycloperer Cycloperer Cycloperer Cycloperer
Spice .	linis?	Spiller.	last.	Bahal Bening	Main	Bowg	Inite	Foreitana -
MARINE AND	3/07	6.00	114-813	8.07	1	0.00	15	Totager Ny lanat
Trencant Annual	10	1117 G17	29+24 18+18	80	13	- 20 - 41	12 U	Seyname PAO
27	11.0	18-40	101101	104	_	44	1.4	Multiani
20	0114	10-41	10110	1010	-	11	11111	1 manual
100.00			-			-		Biotiss/64
N4,	the later	11.01	147.84	41.80	1.01	1.40	1.14	Colloped
16.7	10.000	8-21	9447	8.97	3.47	841	84.11	I TO ENGLISH
Sc	4.07	1218	1019	638	1.00	- 417	1819	Available
20. (19)	15+19	8.17 + 8.25	1.0	9.27 (10)		148	545	property
(19)	1021+1284	697	110-125	(LIAT	6.00	(int	4,821	Propanti
CMC	10711029	10.48	388+892	104-107	445	107	(04104)	Florensie Florensie
Chile	6001+5805	183-185	0852+5842	6.407	6.81	6.87	- 2005	Antoni
CIL	1881180	1.846	1008	0.001		0.010	0.817	2 Designments 2,3 Australia
14	1,301	6.3817	(2.001)	0.0017		(\$36)	问题打一	Protocore
PM ₁₂	34615	\$1+15	130 + 19	12+13	100	191	19	Department
5M	13132	43-365	178 2 64	94140	43	1127	0	Ocasumie -
20	12+13	44413	42-34	52+17	1.00	63	43	Page 1
00	14114	52x13	16-47	48+12		41	1.1	2 martials
30	14+13	3.40 + 0.21	1.0 + 1.0	1.9+4.7		12	1.01+1.023	h-method-
Linghang	0.31	642	6.71	121.0	1.00		621	3-skytha 3.4-beart
8	0.04+0.05	829+622	105-641	10.00		0.01	0.23-045	2,1-8444
0	434×18%	$(14 \times 10^{10})^{\prime\prime}$	-84×18"Y	\$54×18%	-	OAX MY	041.30%	Sandryde
CO11415.38	$L^2 = 10^{10} T$	0×10*9	Di+42+	$12\times 10^{10} \mathrm{Y}$		C+187	0+24	2,3 different

100	and the second			States and States		and the second		The Party of Concession, name				and the second second			
								Anin .	houses sed. Grantant	Testal Tanaf	Freedom and	Bernet Bernet	Channel Making	(Same	Agriculture Recolució
Impact of Biomass Open Burning: Acidity and O ₃ Formation Potential					CD, CD, CD, Tod averation	1623 a 98 82 a 28 23 a 818 34 a 148	1.880 x 90 20e x 30 6.8 × 2.0 8.7 × 5.0	1009 ± 120 1007 ± 221 4.7 ± 1.9 5.7 ± 4.8	(100 x 10) 78 x 10 8.1 x 13 7.3 x 8.7	440 76 10.7 28	2811 + 241 280 + 38 4.3 + 3.3 3.7 + 3.8	1910 + 117 92 + 54 2.9 1799			
					en Burning: dity and O ₃					111100 121-038 19-29 33-18 043 043 043 043 043 043 043 043	5.7 ± 4.6 9.27 ± 0.09 1.12 ± 0.05 0.04 ± 0.15 0.04 ± 0.16 0.04 ± 0.04 0.04 ± 0.04 ± 0.04 0.04 ± 0	1.1 - 0.00 1.2 + 0.4 1.2 + 0.4 1.2 + 0.4 1.2 + 0.4 1.2 + 0.4 1.3 + 0.4 1.3 + 0.4 1.1 + 0.0 1.1 + 0.0	2 849 8 9 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	1.7 5 1.8 9.47 - 9.37 9.44 + 9.37 9.57 + 6.48 10.967 10.9	
								2 conflict forderer 2 conflict forderer Leapener Cythogramme Bengener Cythogramme	0.000 x 0.004 0.000 x 0.000 0.011 x 0.000 0.020 x 0.01 0.020 x 0.00 0.000 0.000	0.000 0.000 0.007 0.007	6.017 0.026 - 0.026 0.070 0.070 0.070	0.04 0.08 0.25-0.40 0.40 0.40		6.011 6.01 6.020 6.020 15.007	and possible score and and and and and and and and and and
	Sector of	histor	hangel	Salai besht	Owni Man'	Oami Boar	Agendari Restari	3-factoria en factoria facilitation filippean Filippean Filippean	0.017 x 0.000 0.000 x 0.001 0.00 0.00 0.00 0.001 -0.000 0.001 -0.000	00001 00007 00007 00007 00002 00002 00002	0.07-0.11 000-0.00 0000/ ² 0.000 0.000 0.000	101020		HADP Road HADP HADP HADP	11111
Lotion .	385	6.35	109-111	ant		110	4.12	Restaux Tulugeo	0.37 × 0.17	6,71-6,81	10.49 × 50.00 10.40 × 50.04	1.000年期 1.1日日本市内	- 22	8.5-5.7 A.M. 0.6	8.14
-	47	4.2	10	10.01	-	100	412	No. or other states of the second states of the sec	0.047 ± 0.023 0.017 ± 0.003	8-04-12-00 9-011-1-0017	6,00 0.048	8.38 × 0.44 8.17 × 0.23		848-827	9.00
NEL.	4.1°	111	29 + 24 18 × 18	815 84-24	10	61	11	740	Rings Rings	40.0275* 40.0275* 12.05*	815 440054	\$1.46-8.5 \$1.825/ 11.57		6.65-6.22 19.825J 13.87 ⁴	#1400P #10250 1210P
_	2911.4	15-42	010	1010		144	44	Atlanta (44.0021 ⁴	and state of	1010	40.007°		shake *	south and
1.44	Contrast.		the later is the l	1010		-	21110	Romania .	1000	ALCONG.	BURNEY.	10.000 P		that?	6.012
_	0.0	1.44	147.65	41.80	10	11.80	5.54	flame!	0.00	1.80	10.000	01.000 P		ram P	11.4
	419	1211	1619	638	1.2	417	1817	Austaldeliguite	4.50+0.29	HATP	648-0.52	8.16+1.07	25	6.27	inert
	121-128	697	19	627 c100 (6367	ыr	1047	5.40° 5.801 307	property Property Breesel	8.60 6.00 9.002-0.024	10.00/ 10001	6.01-625 635 642	442-448 558-849 5484-8395		10.00 P	1000°
	10711102	10.43	325+122	634-637 61407	441	102	124+134	Florensis Autom	8/80 8/21-842	10.000 P	0.0047	20.4012*		0.00 ⁴	8.001
	1801080	1.848	1008	# #001	- 72	0.0107	0.817	3-hangerine 3-hengerine	8.25 10.57/ ²	10.417	0.17-0.74 0.25-1.5	8.05-4.98 VD.MEP	-	10.007	10.44C
	14115	\$1+15	132 + 12	12+13		10001	19	Protocourt	9/01-0.02 0/000	0.007	0.00	40.000°	2.1	10.00	8.007
	13132	43-315	178.244	94150	- 65	121	0	Octoberto .	0.015	0.00.0	10000	40.4047 8.402 (0.44)	- 60	(104)	4000°
	12+13	464.03	43-34	52(1)	100	6.5	43	Paran .	8.045	10.4617	0.45-0.43	645	- 20	10.41*	10.57
	14114	52x13 846+831	15-12	48+12 EB+0.T	÷.	8	13	2 control from 1 control from	10.004-0.005	0.11	8.47	49-100°		10.007	8.842
10.0	0.31	642	677	6.021			421	3-alcothase 3.4-Breethyl Boles	8.001	0.003	0.000	40-3000 P		an.ac77	8.000
	8.8+0.2	829+822	105-641	1510		140	423-645	2,1-doestkyl foran Sanak pelecitaise	9/802 6/814	19.331	8.00 (500) ⁴	0.002		10.007	0.007
15.35	(34×H ^P) C×H ^P 7	04×10%	04×18%	(D4.10%) D×30%	1	64:144	041.37	2,3 ubhuhndann	6042 6044	0.017	8-917	(6.62) ²		series,	1.000
-	12 1 10	11+187	11.197	E+197		10.07	0.1197	Bascologi Forfasi Mellel Somer	10.0014 (0.001/*	40013 40.37.# 49.423.#	(Andre	eae and	Mei	let, 2	001)





Background of our experience in Remote Sensing and GIS ... (6) Biomass burning in ASEAN

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

Methodology of estimating emissions from biomass open burning (1)

Equivalent methodology to of GL 2006

$$Q(x) = M \times EF(x)$$

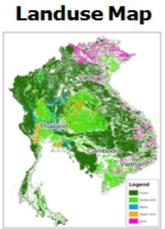
Emission Biomass Emission Quantity **Burned Factor of** of Species **(kg) Species** X (g) (g/kg) f (area burned, f (vegetation type, burning efficiency, burning conditions, biomass density, species, etc...) etc...) 0

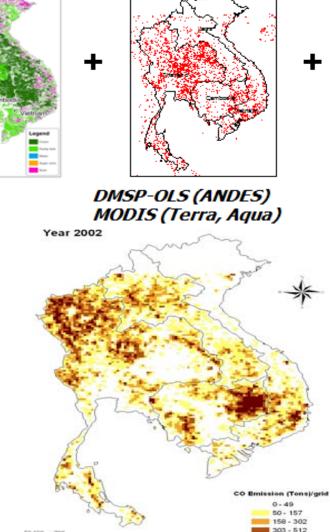
Methodology of estimating emissions from biomass open burning (2)

 $M = A \times B \times \alpha \times \beta$ Fraction **Biomass** Biomass **Burning** Area **Burned Burned Density** of Above Efficiency **(kg)** (m^2) (kg/m²) Ground **Biomass** Seiler and **Crutzen (1980)** 9

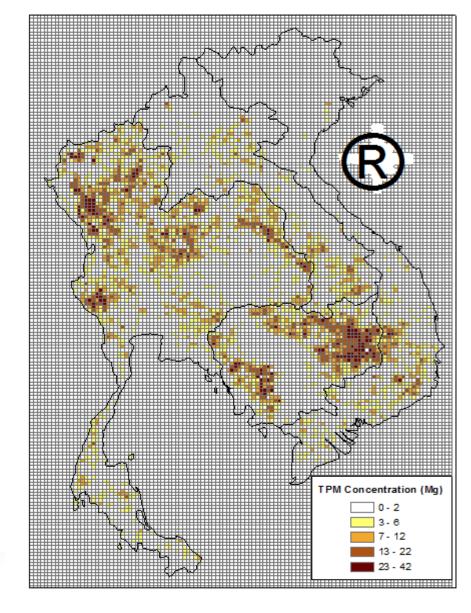
Estimation of CO and TPM emissions from biomass open burning in MRBSR

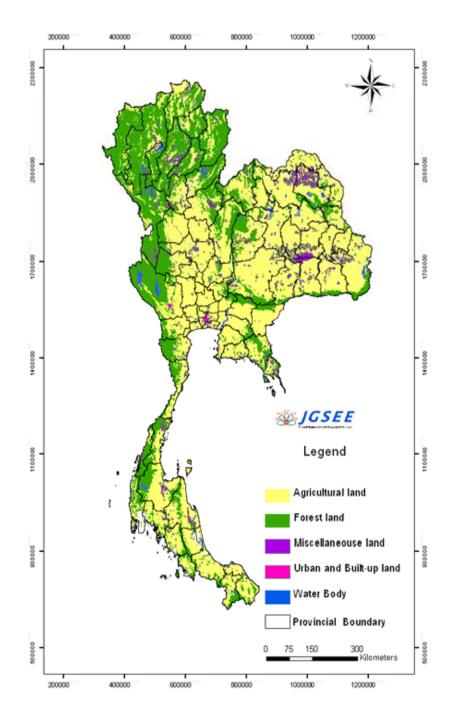
513 - 1844





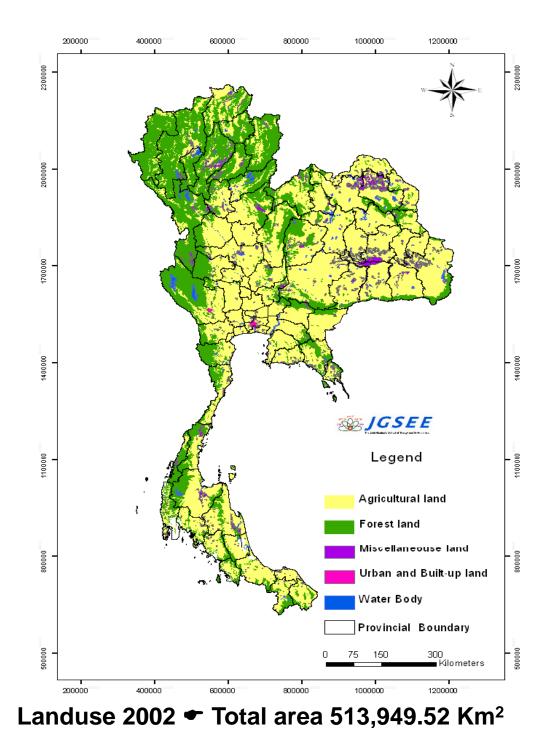
Satellite Data

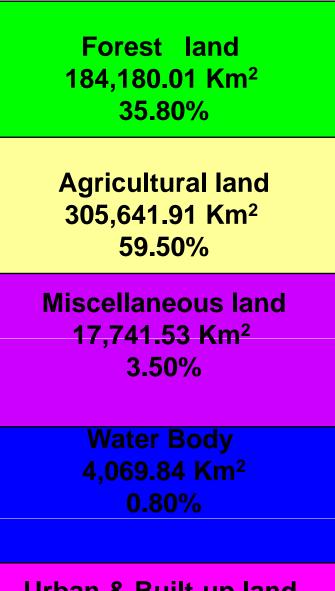




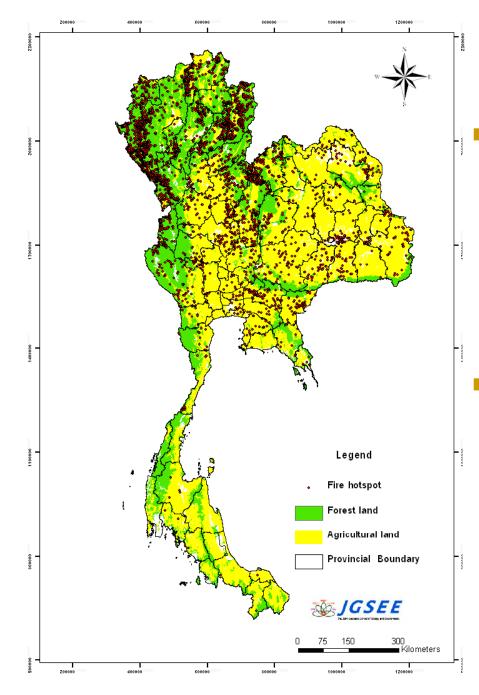
National landuse map

- Produced by Land
 Development Department, Ministry of Agriculture and Cooperative
- Scale = 1:50,000
- Primary data from LANDSAT-5 with resolution of 30 m x 30 m
- Updated in 2008-2009 with data from SPOT-4,5 and the scale become 1:25,000 and 1:4,000 may be available on request
- Data are set in the GIS (ArcGIS 9.2)





Urban & Built-up land 2,072.32 Km² 0.40%



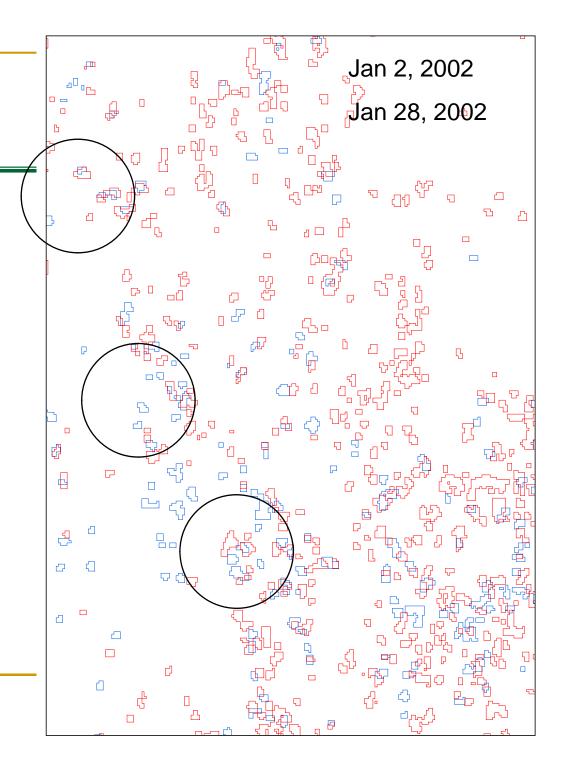
Fire Hot Spots (FHS) map

- Primary data with resolution of 1 km x 1 km from DMSP-OLS (ANDES) for 2000-2004 and MODIS (Terra and Aqua) from 2005 onward
 for spatial and temporal distribution
- For better accuracy of area burnt

 LANDSAT or SPOT, however the accuracy is limited by the period of pass over the same geographic position:
 - 16 days for LANDSAT
 - 26 days for SPOT

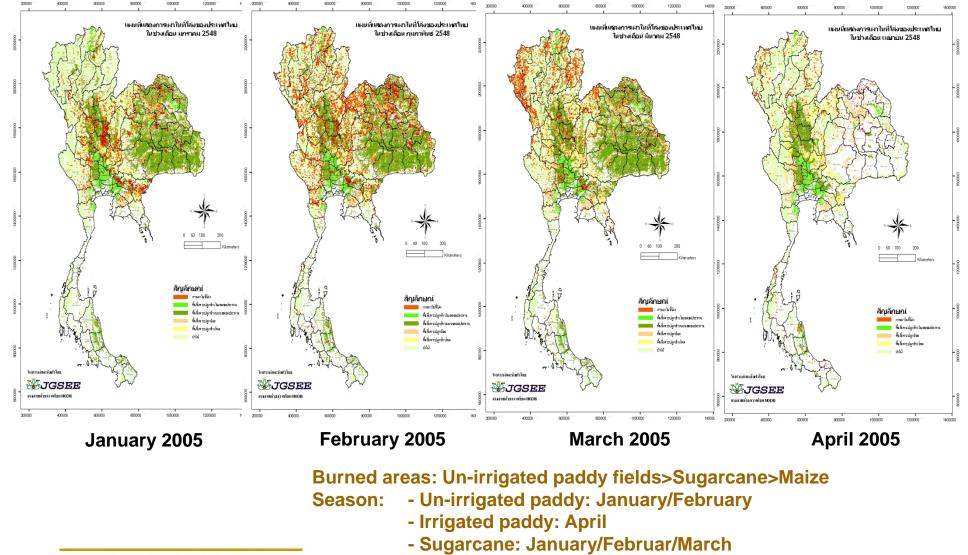
Examples of uncertainties – <u>Remote Sensing</u>

 Fires occurred in the same area on two different days





Examples of uncertainties – Remote Sensing: Agricultural open burning in Thailand in 2005

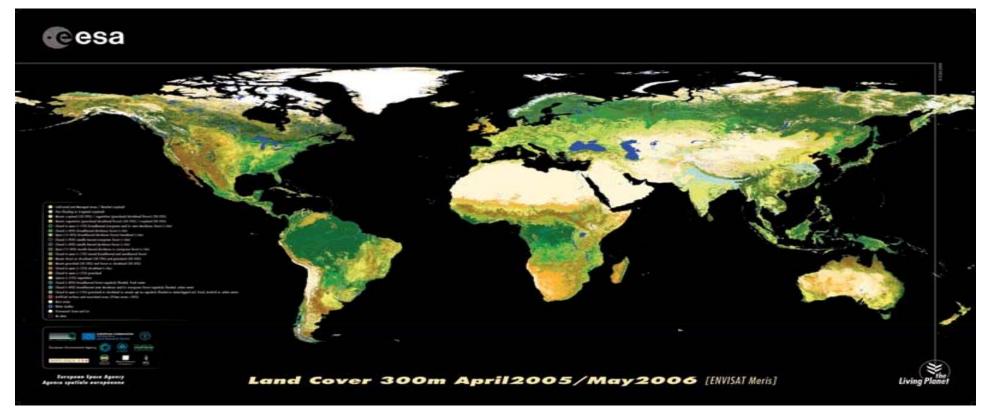


- Maize: January/February/March



MODIS data = HIGHLY UNDERESTIMATE

Current work: Use of RS data for GHG inventory of LULUCF and in ALU



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 LUCF since data only exist for 2000, 2004 and 2005



On-going works and ext steps ...

- Improve accuracy of area burnt using MODIS data by conducting specific ground survey
- Time series consistency check based on remote sensing data of global land cover.
- Time series consistency check based on national statistics
- Data gaps filling for LULUCF



