Thailand's Experience with Remote Sensing and GIS

Savitri Garivait, *JGSEE-KMUTT, Thailand*

WGIA 7

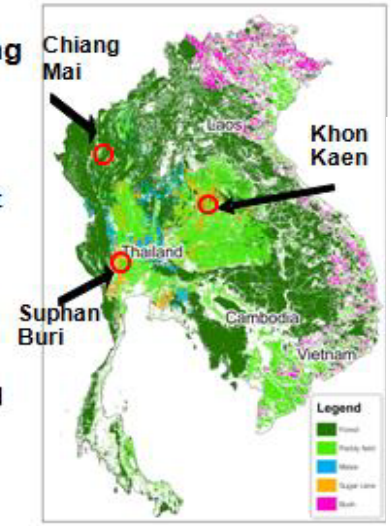
July 7-10, 2009
Mayfield Hotel
Seoul, Korea

JGSEE
The Joint Graduate School of Energy and Environment

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



JGSEE

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

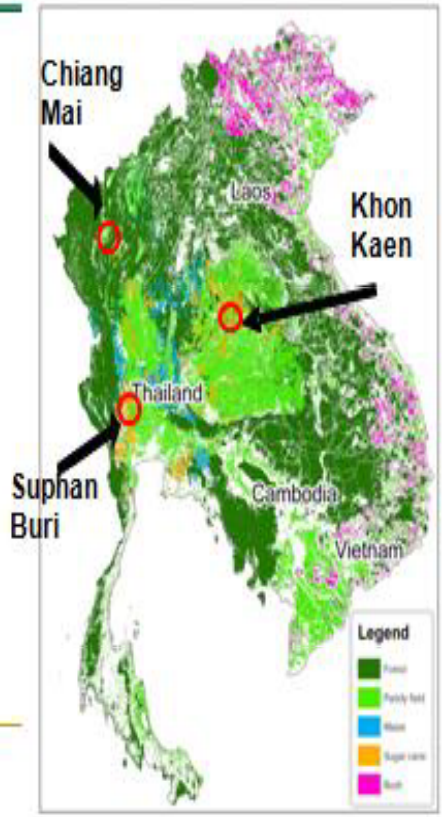
- **Objectives**
  - To develop a database of emission factors and emissions representative of the MRBSR
  - To develop an emission estimation based on repetitive and consistent measurements of biomass burning activity and emission factors using well-defined methodology
  - To set-up a capacity building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

JGSEE

- **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

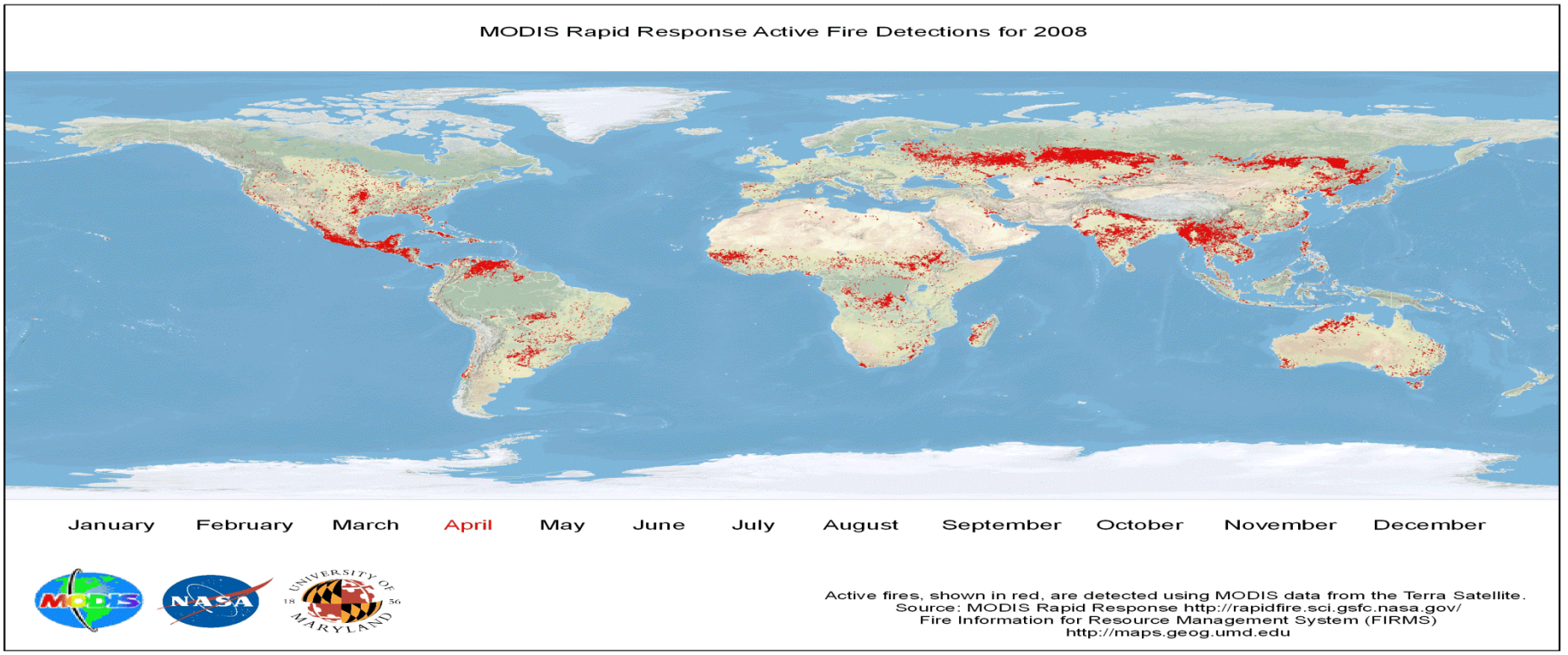
- **Scope**
  - Study sites: Thailand, Cambodia, Lao PDR, Vietnam, (Myanmar)
  - Pollutants of interest: PM_{10}, $PM_{2.5}$, EC/OC, GHG (CO_2, CH_4, N_2O), CO



JGSEE

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

- But what is biomass open burning?



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

- Biomass burning contribution to global emission

TABLE 2

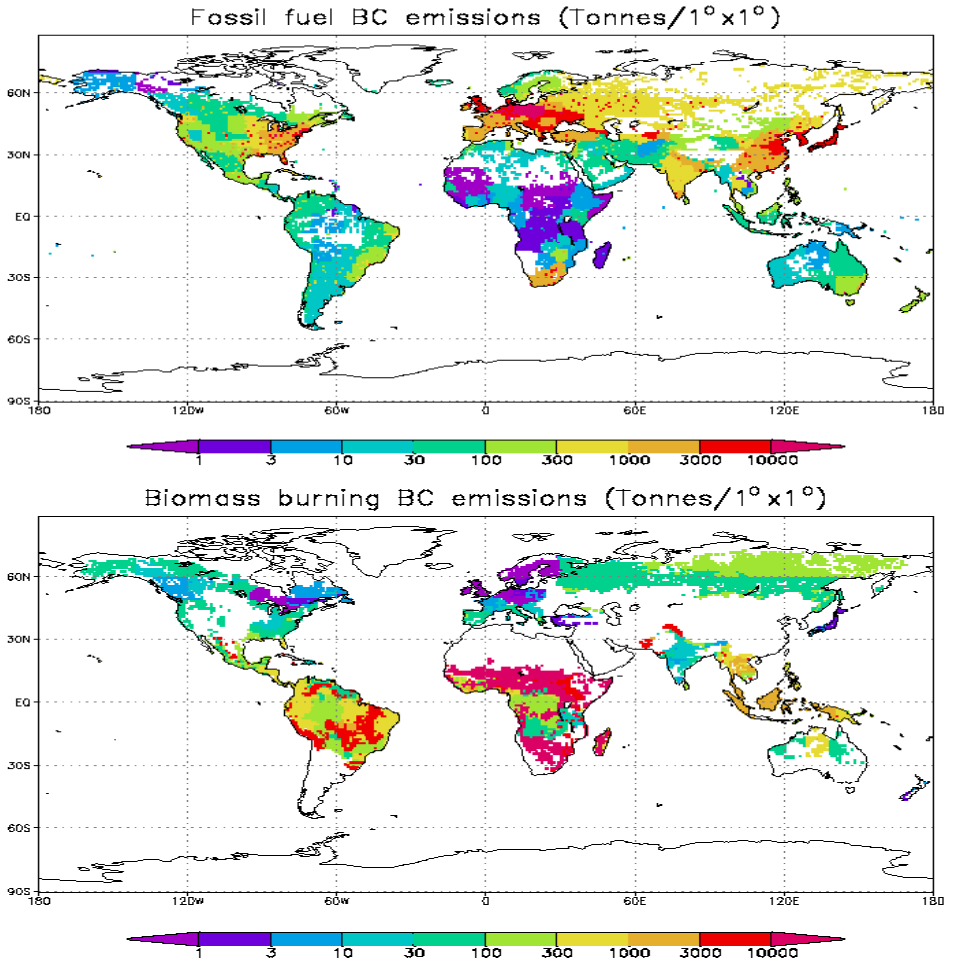
Burning's contribution to global emissions

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.

(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

Haze 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. 20, PAGES 3105-3108, OCTOBER 15, 1999

TRMM[1] Observed First Direct Evidence of Smoke from Forest Fires Inhibiting Rainfall

Daniel Rosenfeld

Inst. of Earth Sciences, The Hebrew University of Jerusalem, Israel

Abstract. Although it has been known that smoke from biomass burning suppresses warm rain processes, it was not known to what extent this occurs. The satellite observations of the Tropical-Rainfall-Measuring-Mission (TRMM), presented here, show that warm rain processes in convective tropical clouds inflicted by heavy smoke from forest fires are practically shut off. The tops of the smoke-inflicted clouds must exceed the freezing level, i.e., grow to altitudes colder than about -10°C, for the clouds to start precipitating. In contrast, adjacent tropical clouds in the cleaner air precipitate most of their water before ever freezing. There are indications that rain suppression due to air pollution prevails also in the extra-tropics.

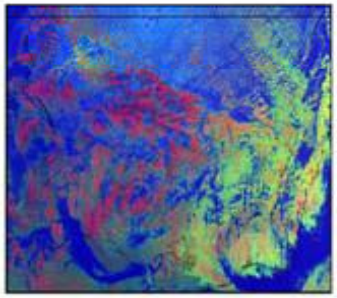
2. The TRMM Observations

Actual observations of both precipitation and cloud-drop s, over large areas, encompassing clouds in and out of smoke plumes, became possible just recently, with the launch of the Tropical Rainfall Measuring Mission (TRMM) satellite on 28 November 1997. The TRMM satellite instruments used here are:

a. Rainfall measuring radar (PR), which detects only precipitation-sized particles in clouds. The sub-satellite resolution is 4 km horizontally by 250 m vertically.

b. Passive microwave radiometer (TMI), which is sensitive to the cloud droplets as well as to precipitation particles. The sub-satellite horizontal resolution of the 85 GHZ channels is 4 km.

THE RECENT AUSTRALIAN BUSHFIRES RAINFALL AND ENVIRONMENT



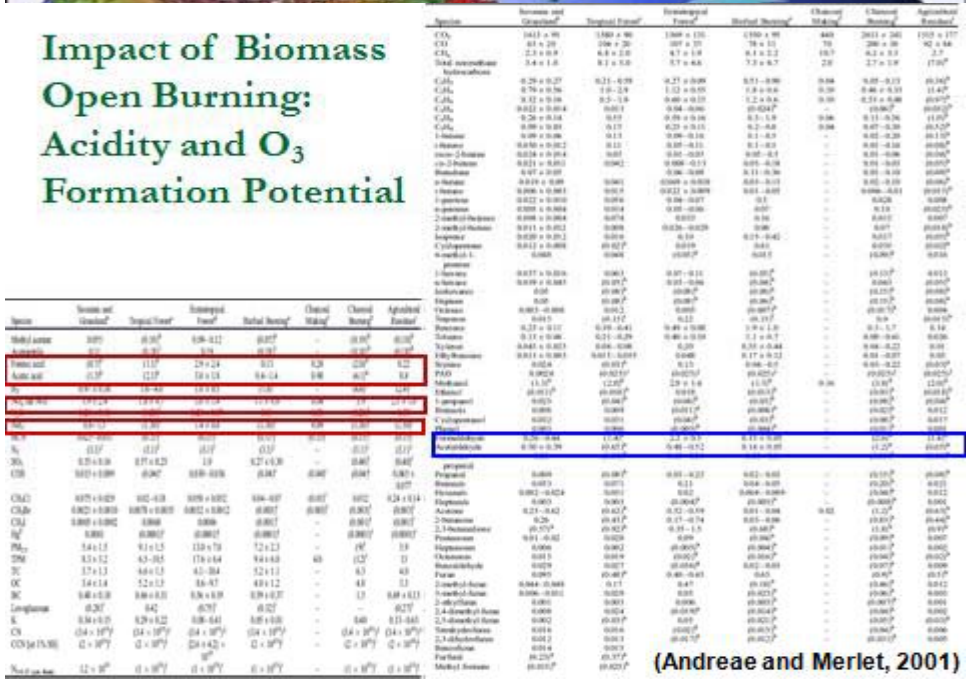
SUBMISSION TO THE COAG BUSHFIRE INQUIRY CONCERNING THE RECENT AUSTRALIAN BUSHFIRES

JGSEE

TRMM Program, 2004

10

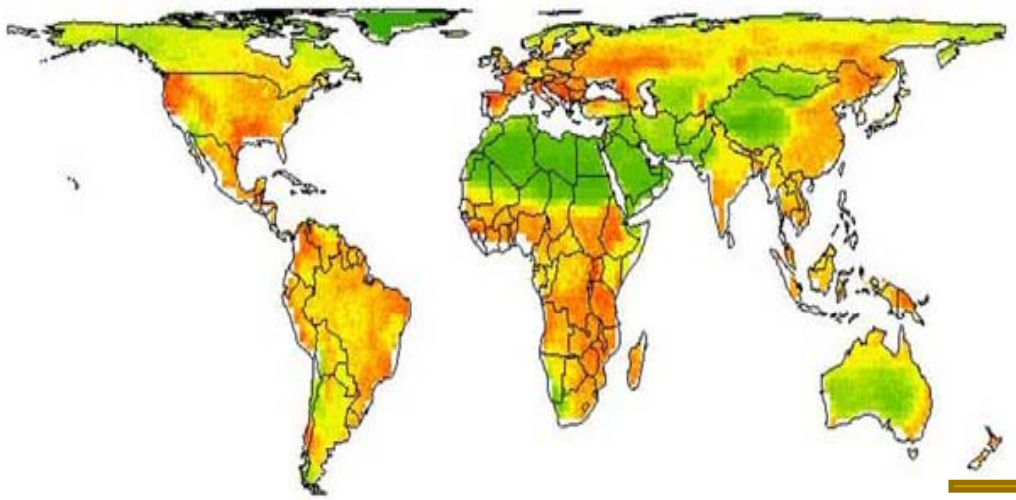
Impact of Biomass Open Burning: Acidity and O_3 Formation Potential



(Andreae and Merlet, 2001)

Background of our experience in Remote Sensing and GIS … (5)

- Biomass burning and climate change

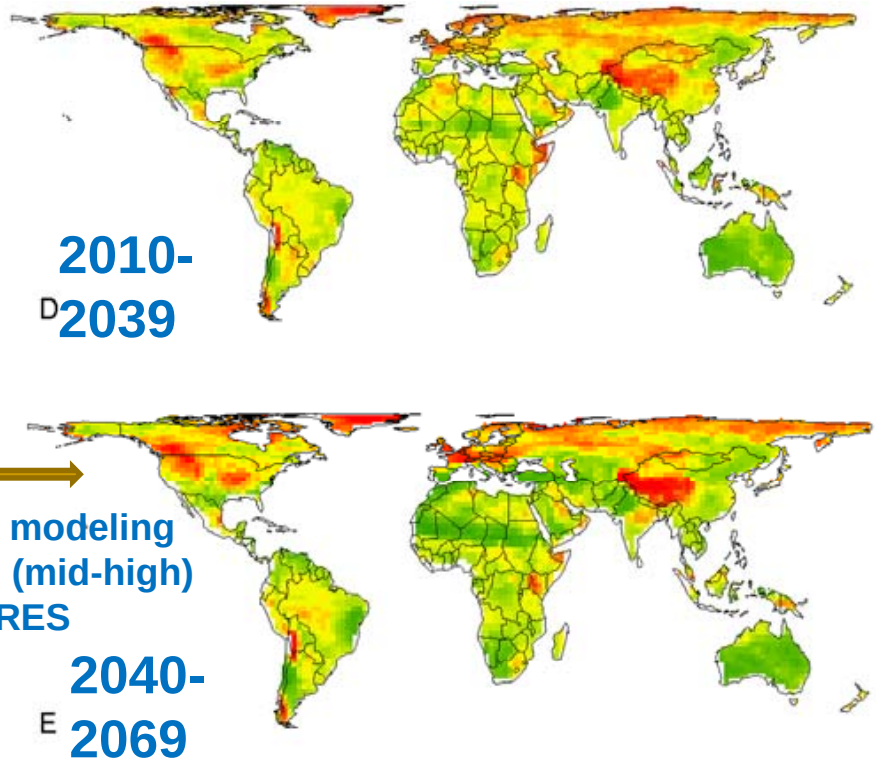


Normalized relative probability of fire (nP_c)

0.0 0.4 0.8

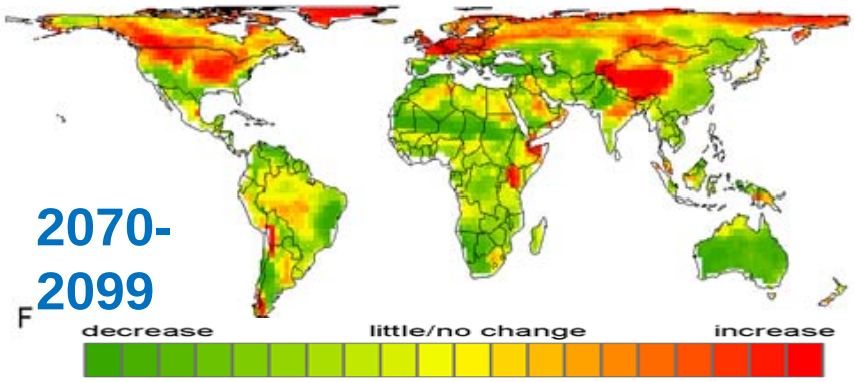
Present

Climate modeling using A2 (mid-high) SRES



2010-2039

2040-2069



2070-2099

decrease little/no change increase

Mean of normalized relative probability of fire (nPc) for ten $FIRE_{noNPP}$ sub-models of fire-prone parts of the world under current conditions, using cumulative counts of fire activity detected by the Along Track Scanning Radiometer (ATSR) around the world at a resolution of 100 km over 10 years.

JGSEE

The Joint Graduate School of Energy and Environment

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

JGSEE

Methodology of estimating emissions from biomass open burning (1)

Equivalent methodology to of GL 2006

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

Emission Quantity of Species X (g)

Biomass Burned (kg)

Emission Factor of Species X (g/kg)

f (area burned, burning efficiency, biomass density, etc…)

f (vegetation type, burning conditions, species, etc…)

JGSEE
The Joint Graduate School of Energy and Environment

Methodology of estimating emissions from biomass open burning (2)

$$M = A \times B \times \alpha \times \beta$$

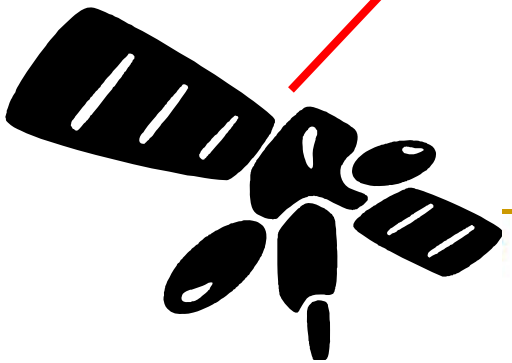
Biomass Burned (kg)

Area Burned (m^2)

Biomass Density (kg/m^2)

Fraction of Above Ground Biomass

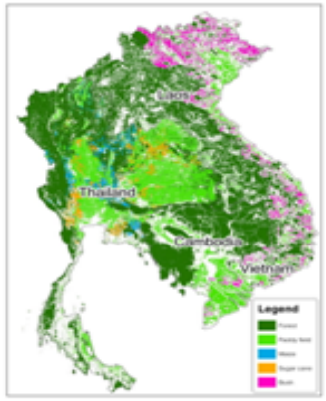
Burning Efficiency



Seiler and Crutzen (1980)

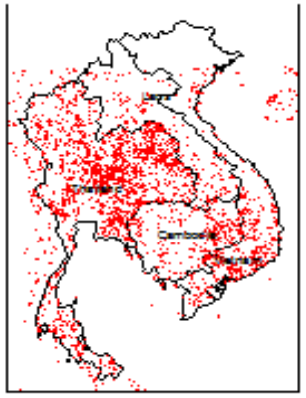
Estimation of CO and TPM emissions from biomass open burning in MRBSR

Landuse Map



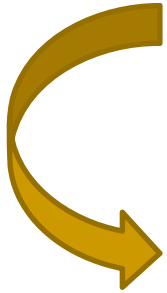
+

Satellite Data

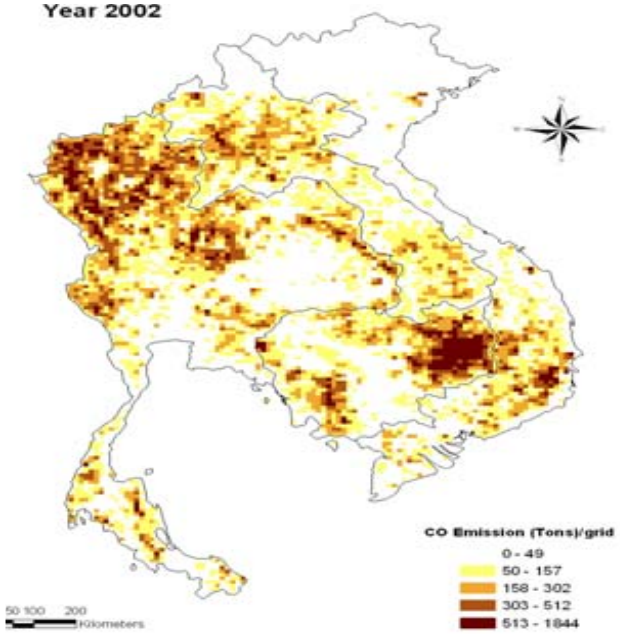


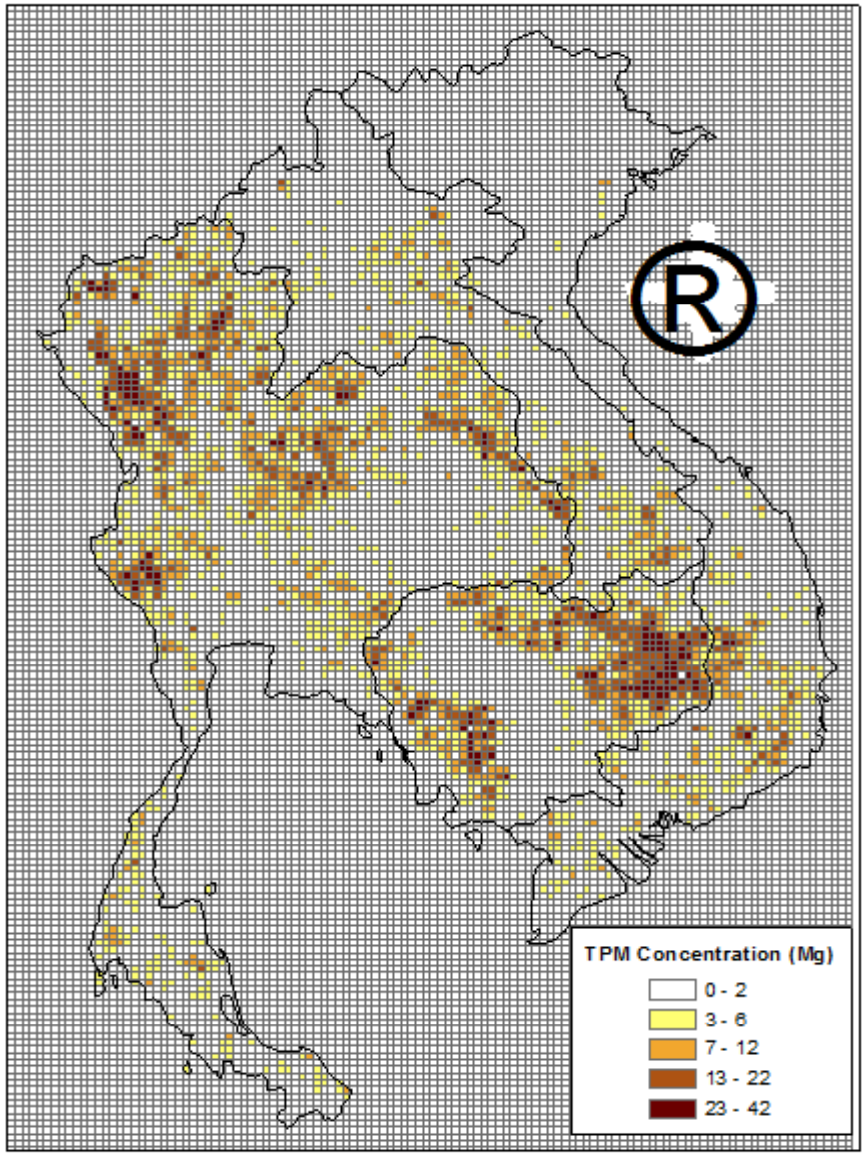
+

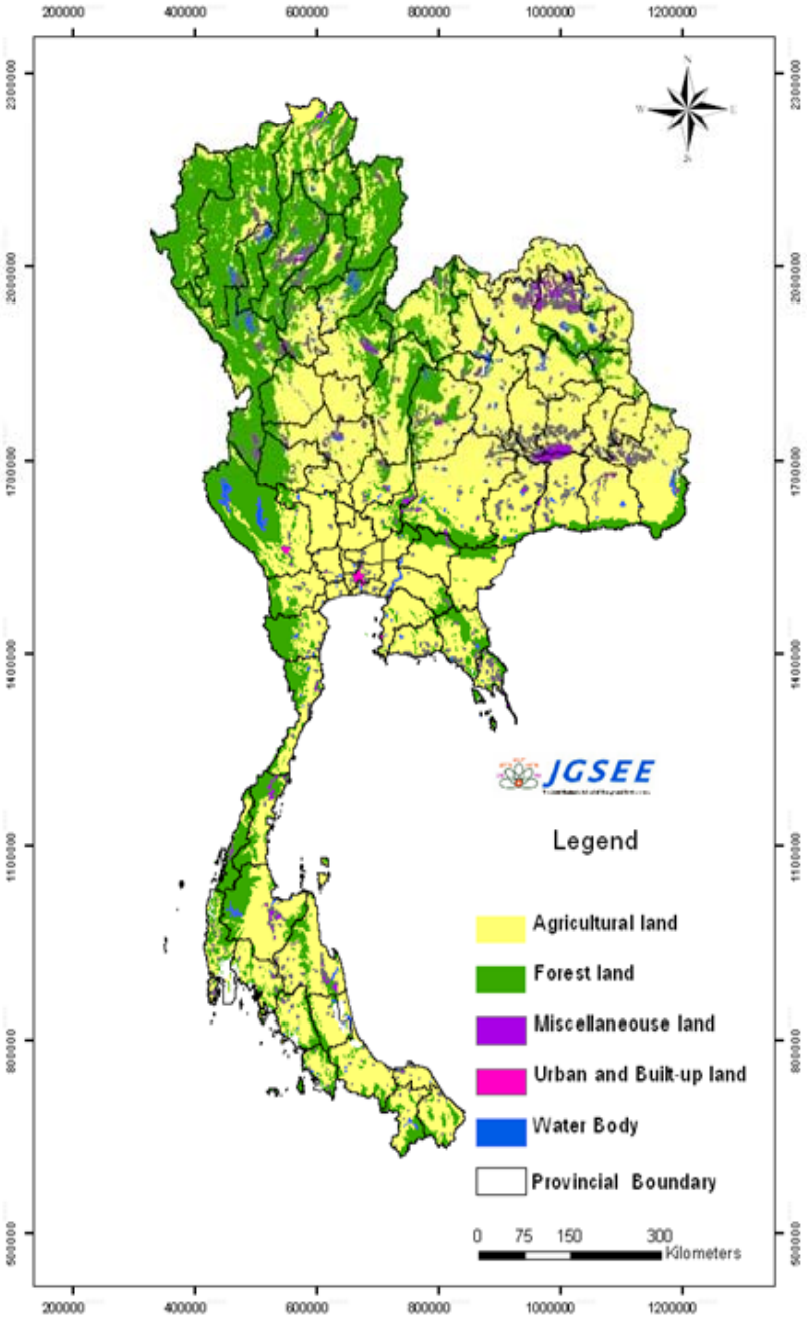
DMSP-OLS (ANDES)
MODIS (Terra, Aqua)



Year 2002

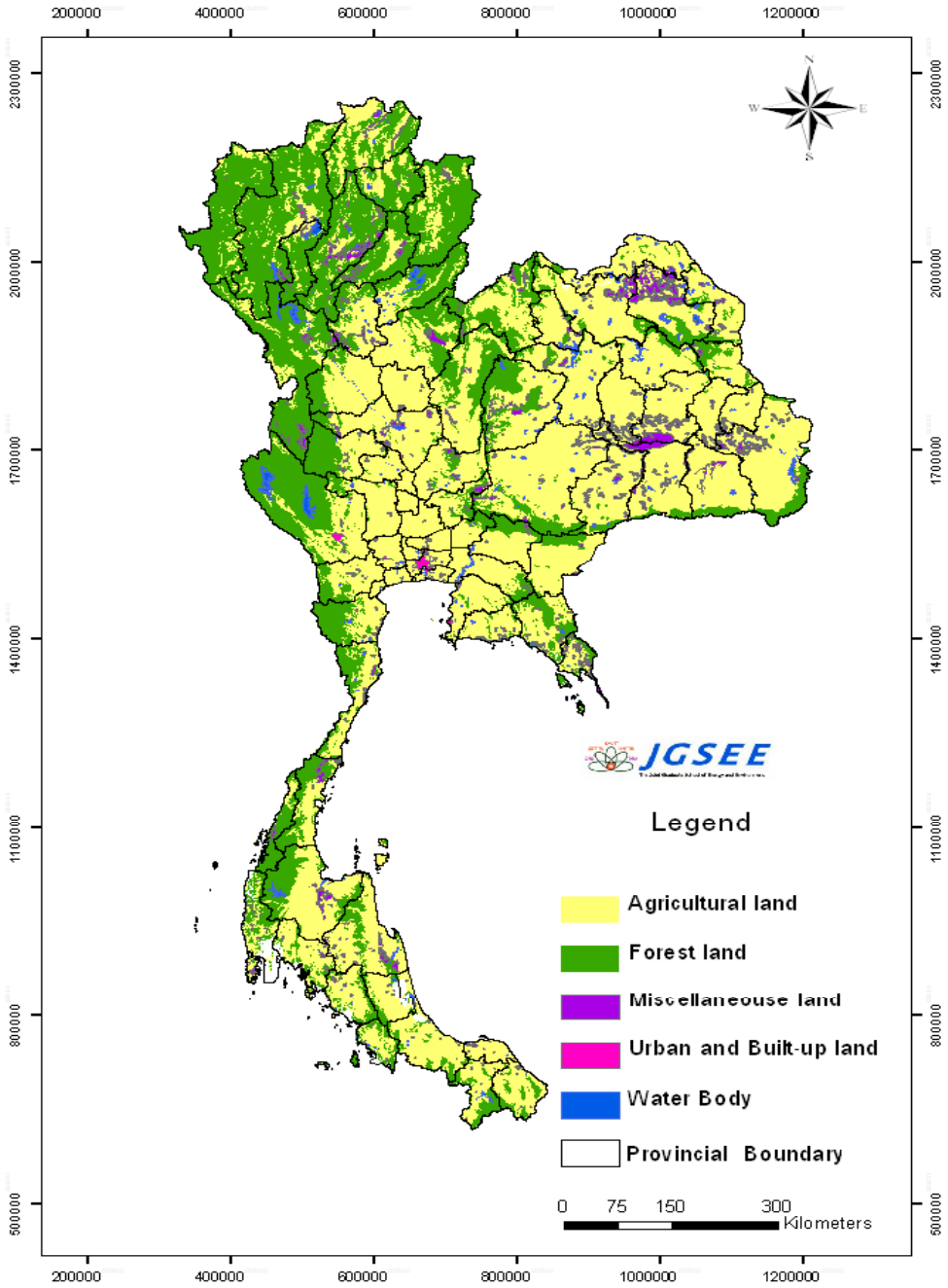






National landuse map

- 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)



Landuse 2002 ☛ Total area 513,949.52 Km²

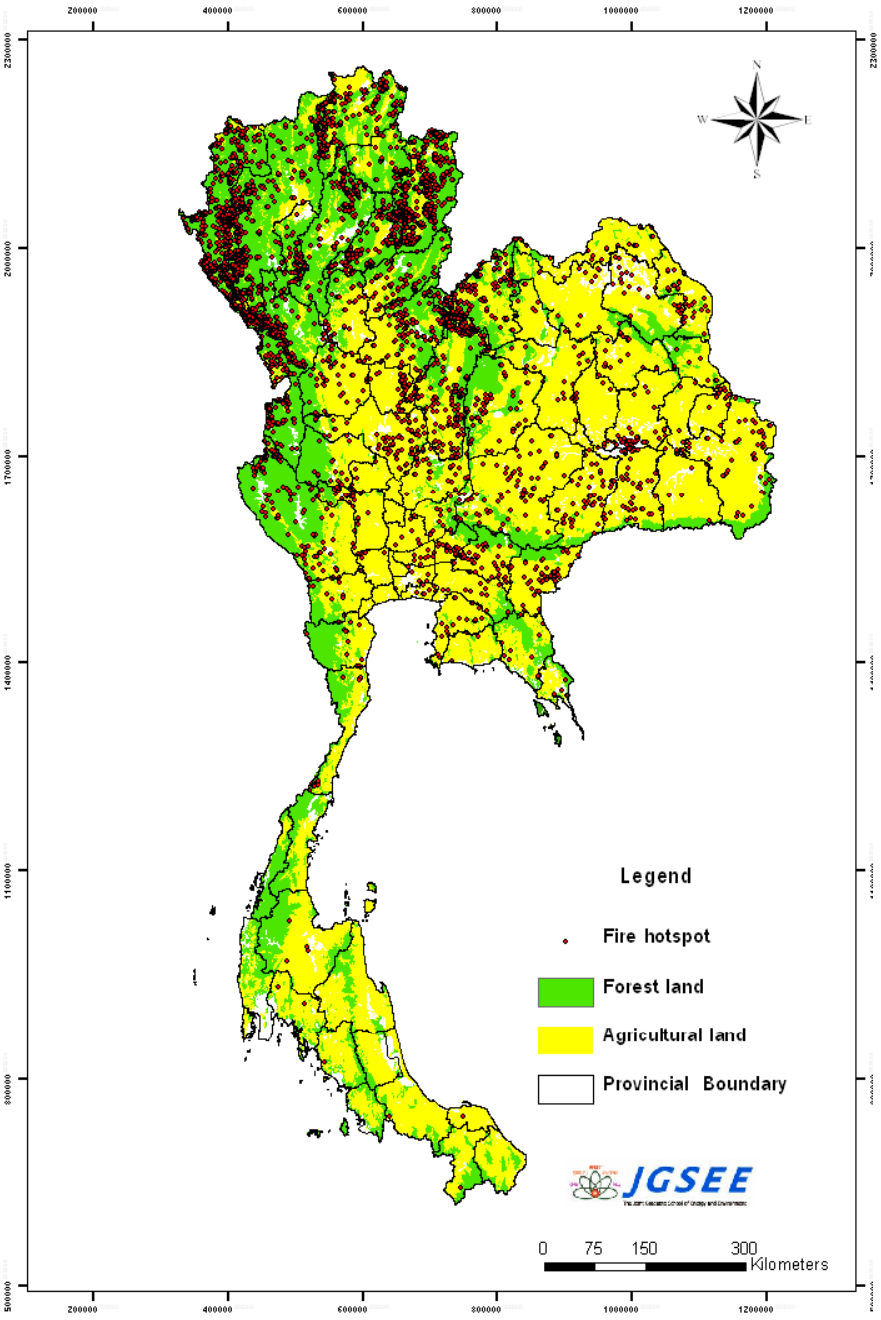
Forest land
184,180.01 Km²
35.80%

Agricultural land
305,641.91 Km²
59.50%

Miscellaneous land
17,741.53 Km²
3.50%

Water Body
4,069.84 Km²
0.80%

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

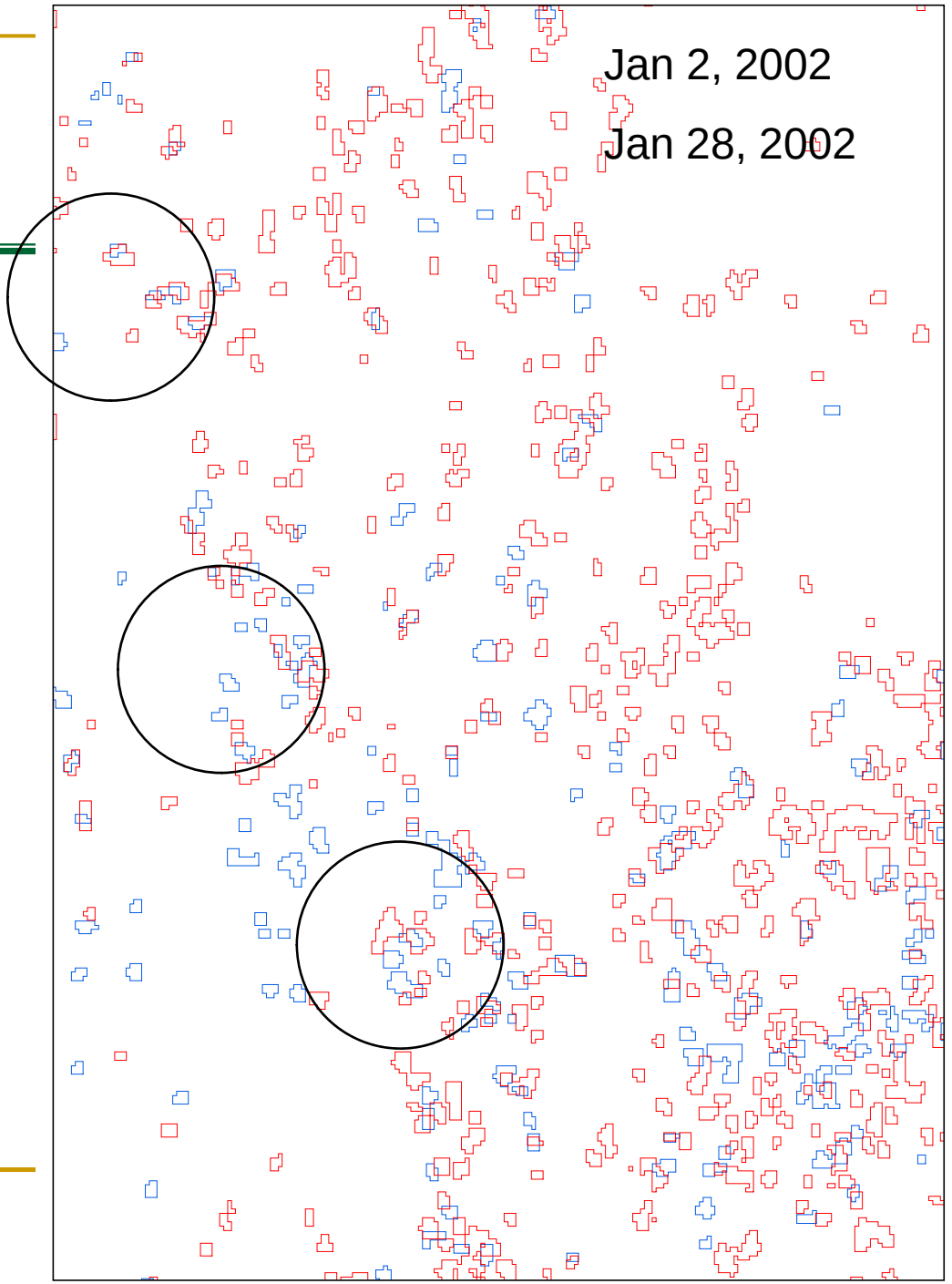


Fire Hot Spots (FHS) map

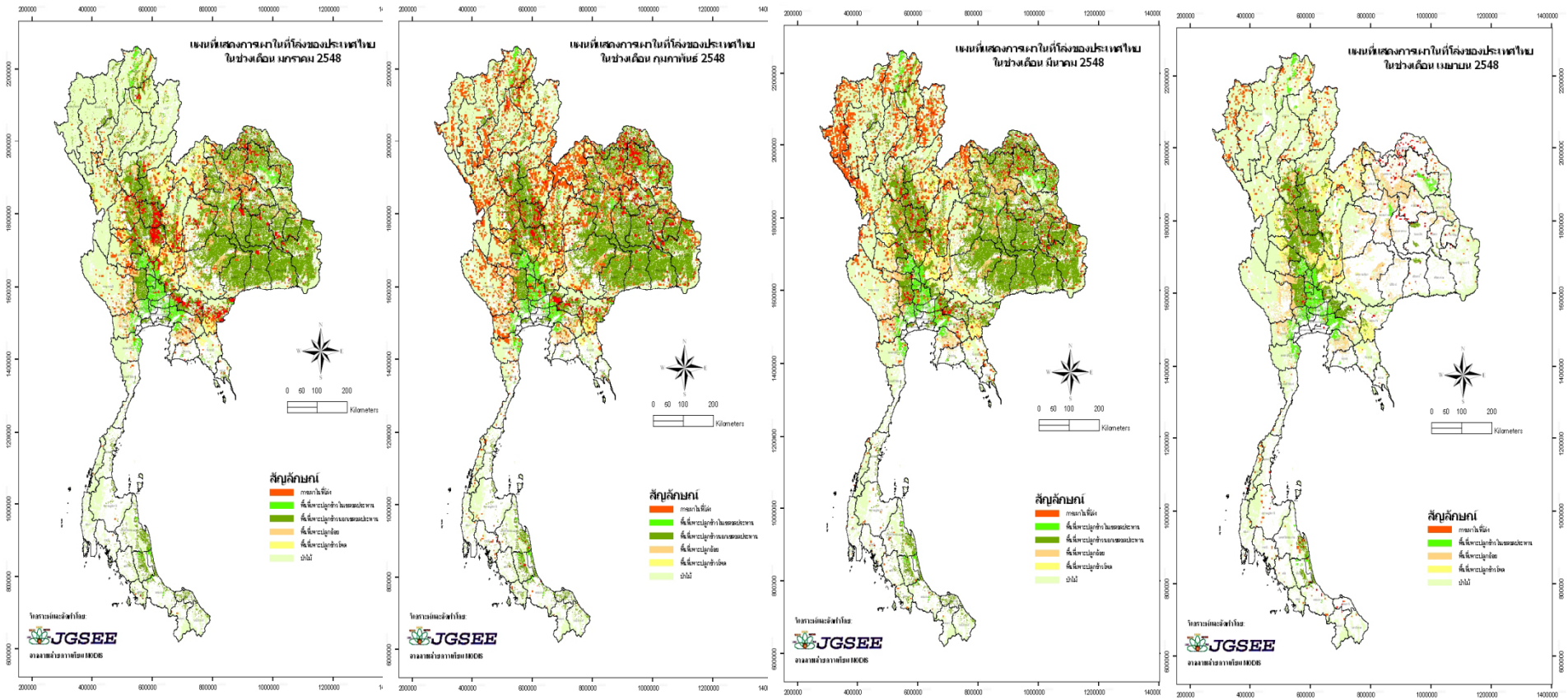
- Primary data with resolution of 1 km x 1 km from DMSP-OLS (ANDES) for 2000-2004 and MODIS (Terra and Aqua) from 2005 onward ☛ for spatial and temporal distribution
- For better accuracy of area burnt ☛ LANDSAT or SPOT, however the accuracy is limited by the period of pass over the same geographic position:
  - 16 days for LANDSAT
  - 26 days for SPOT

Examples of uncertainties – *Remote Sensing*

- **Fires occurred in the same area on two different days**



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



January 2005 **February 2005** **March 2005** **April 2005**

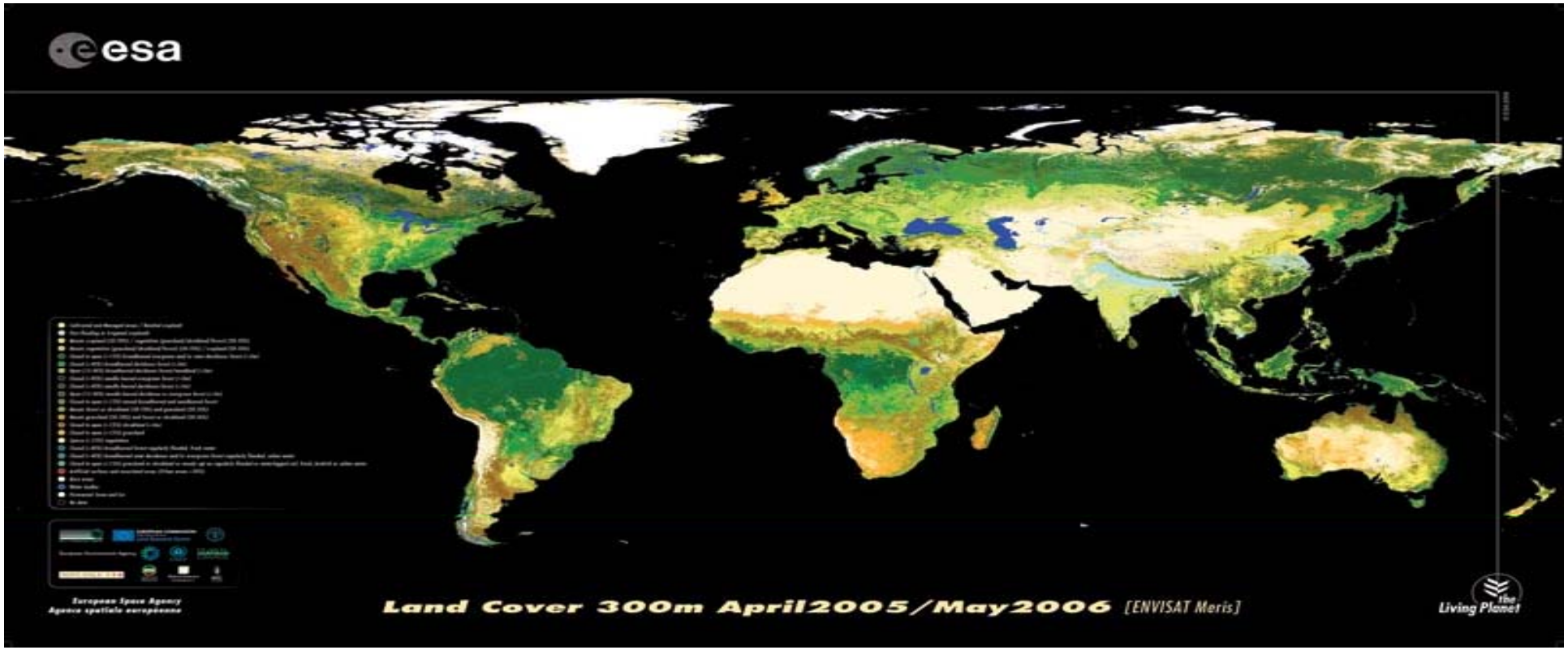
Burned areas: Un-irrigated paddy fields>Sugarcane>Maize

Season:
- **Un-irrigated paddy: January/February**
- **Irrigated paddy: April**
- **Sugarcane: January/Februar/March**
- **Maize: January/February/March**

MODIS data = HIGHLY UNDERESTIMATE

JGSEE
The Joint Graduate School of Energy and Environment

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

JGSEE
The Joint Graduate School of Energy and Environment

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

Acknowledgements

Southeast Asia START Regional Committee

IHDP • IGBP • WCRP

APN CAPaBLE

POLLUTION CONTROL DEPARTMENT

ขอบคุณค่ะ

Khob Khun Kha

สวัสดีค่ะ

Sawasdee Kha