## ASEAN Peatland Forests Project (APFP)

# Peatlands, fires and emissions


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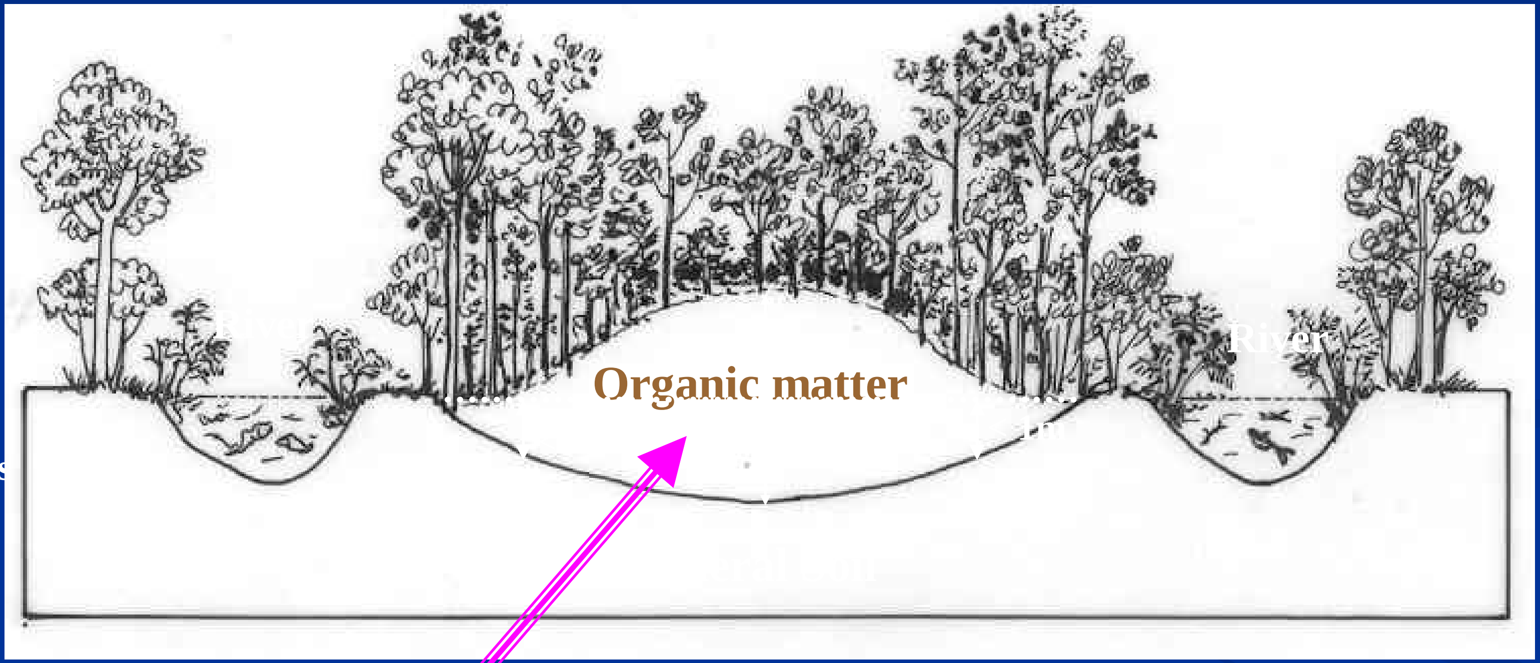
Regional Project
Executing Agency

# Peat Swamp Forest is the main wetland type in Se Asia

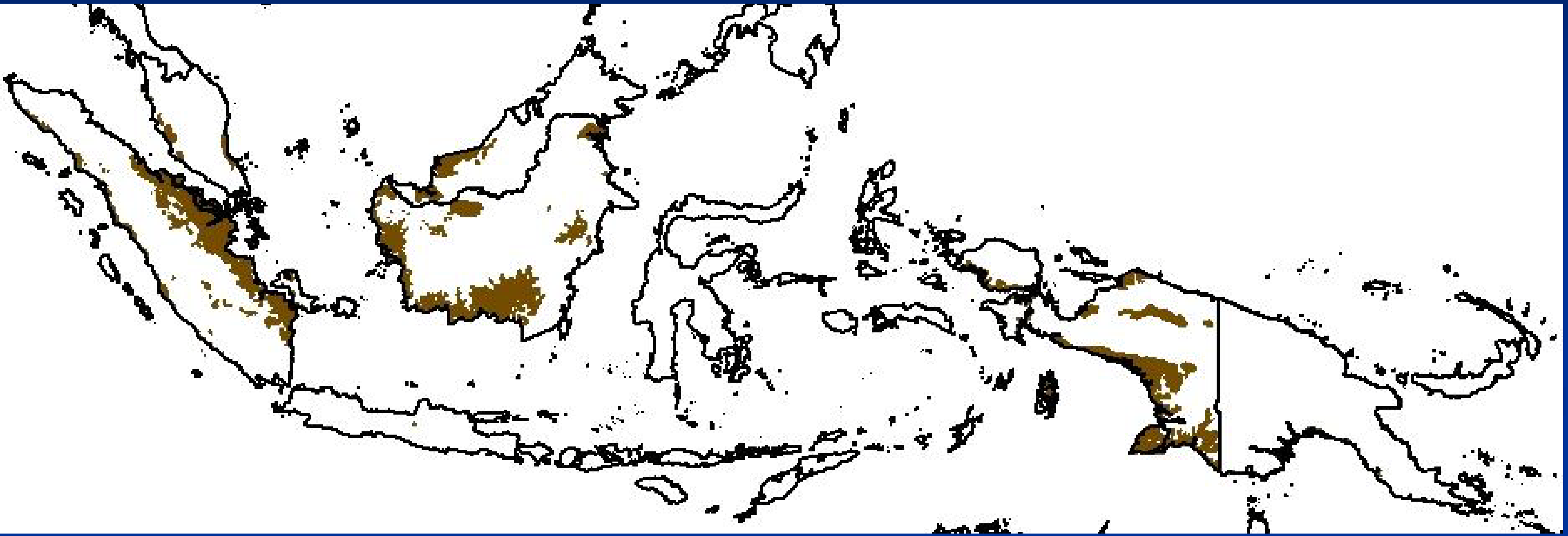
# Peat accumulates in thick layers over thousands of years




Peat layer up to 20 m thick

Source Nyoman Suriadiputra, Wetlands International Indonesia

# Peatlands cover 25 million ha in Se Asia



# Peatlands in 5 SE Asia countries impacted by fire



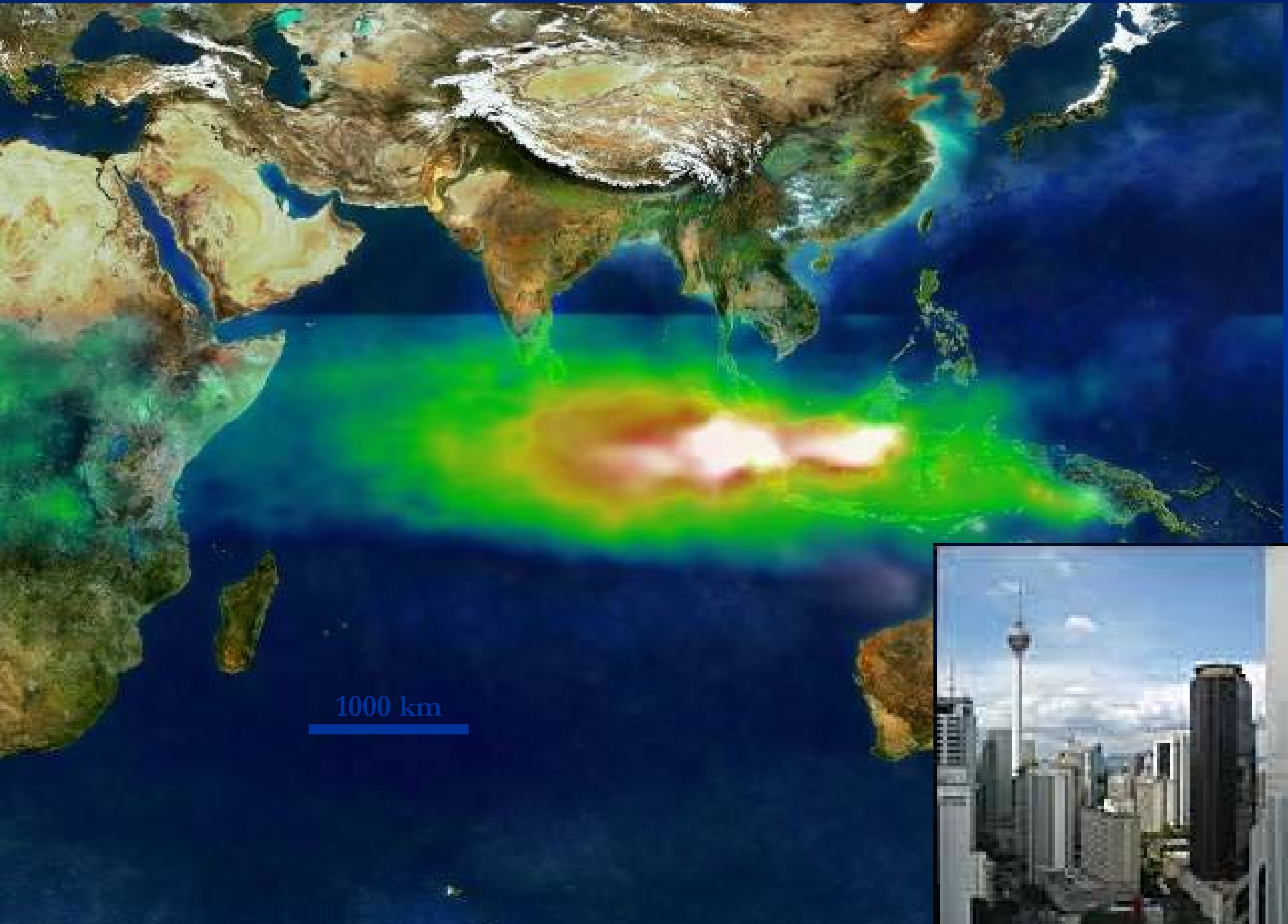

# Peatland fires lead to transboundary Smoke haze

**MODIS image June 2005 -**

**Red dots: fires**

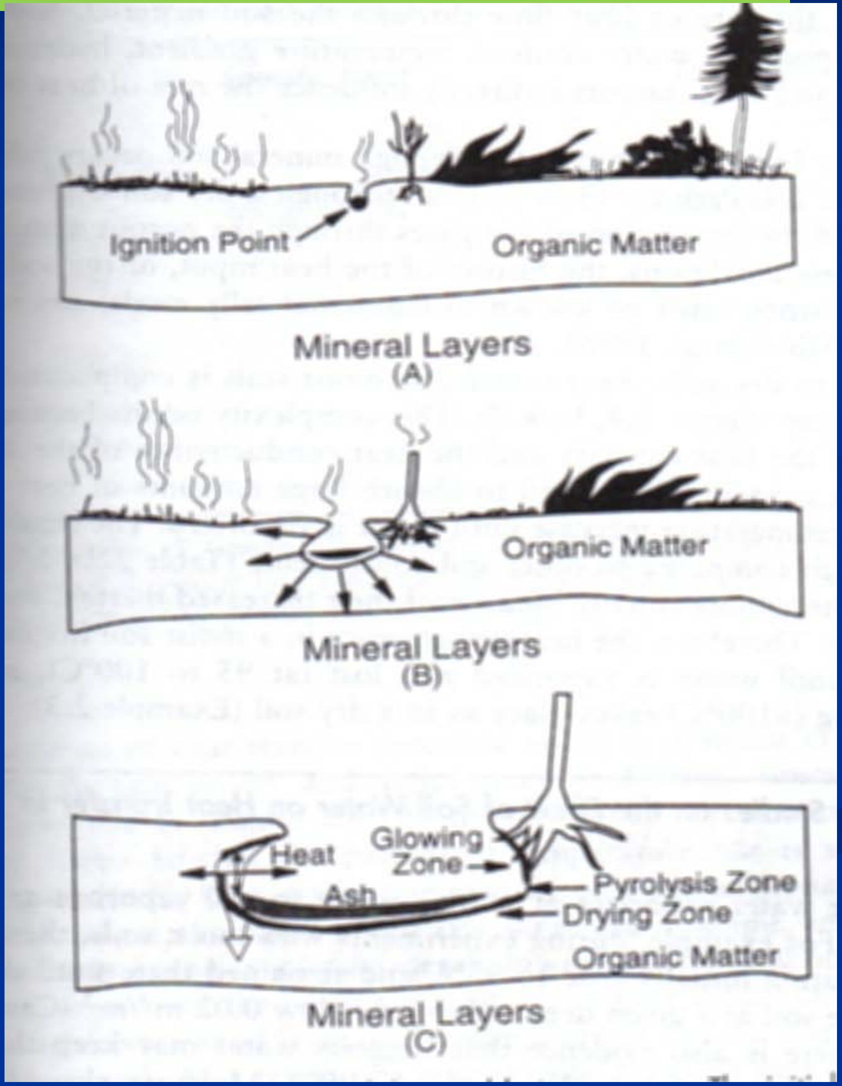
**Courtesy MODIS Rapid Response Team**

# Smoke Haze is the most serious regional environment problem in ASEAN




# Root Cause: Linkage between Drainage and Fires

# PEAT FIRE


Ignition Point
Organic Matter
Mineral Layers
(A)
Organic Matter
Mineral Layers
(B)
Heat
Glowing Zone
Ash
Pyrolysis Zone
Drying Zone
Organic Matter
Mineral Layers
(C)


Indonesia
High loss of peat layer due to fire…

# Estimation of Carbon emission from forest and land fires (A case study of CCROM IPB-WWF, 2009)

- Sample plots (systematic purposive random sampling)
  - Sebangau : Peatland 72 plots of 0.1 ha size in burned and unburned areas
  - Tesso Nilo : Non peatland 30 plots of 0.1 ha size in burned and unburned areas
- Parameter measured:
  - Fuel load (above and underground carbon stock)
  - Vegetation analyses
  - Water level
  - Moisture content
  - Fire severity

# Above ground biomass emission

## (Seiler and Crutzen, 1980)

- **M = A. B. a. b**

Where :

M : Burned biomass total in an ecosystem (ton/year);

A : Yearly burned area (hectare/year);

B : Biomass density (ton/ha);

a : above ground biomass fraction; and

b: burned above ground biomass fraction

# Under ground carbon emission

- M = A.B.E

Where :

M : Burned carbon in an ecosystem (ton/year);

A : Yearly burned area (hectare/year);

B : Biomass density (ton/ha);

E : Burning Efficiency

# TINGKAT KEPARAHAN KEBAKARAN (FIRE SEVERITY)

## *Peat fire classification*(Artsybashev 1984)

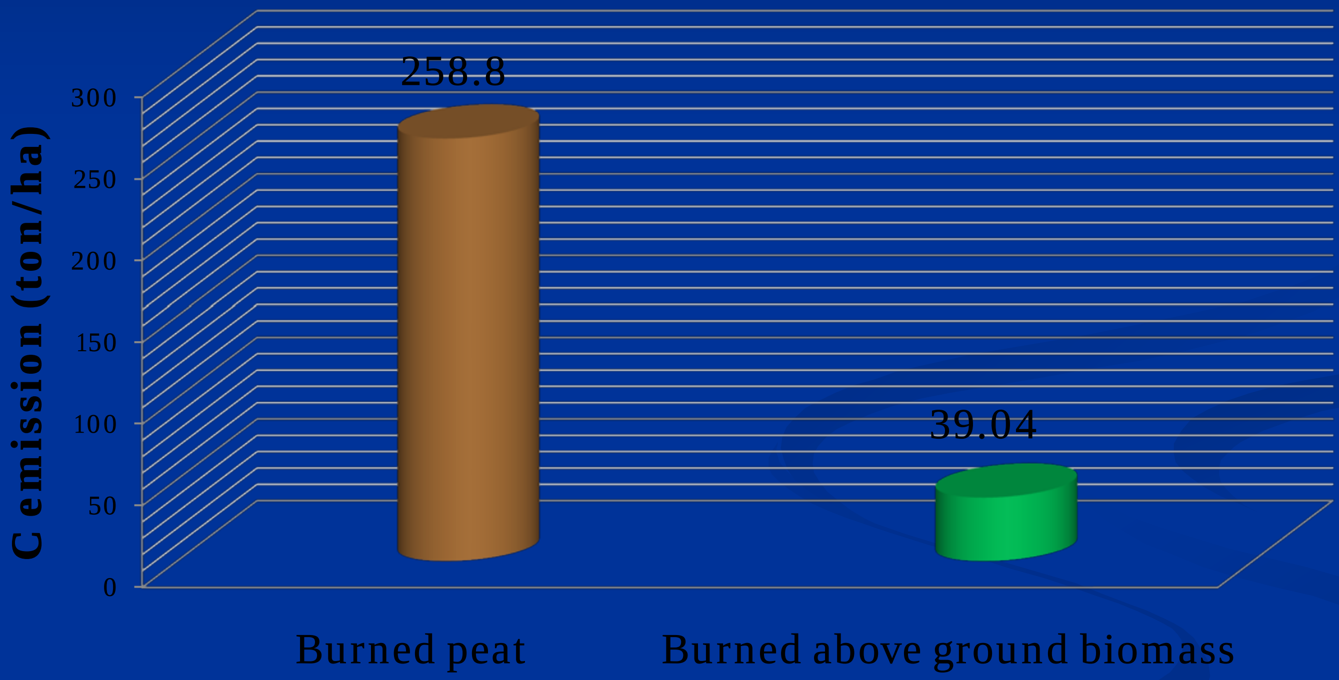
1) Low fire severity:  burned peat depth up to 25 cm

2) Moderate fire severity:   burned peat depth from 25 to 50 cm

3) High fire severity: burned peat depth more than 50 cm

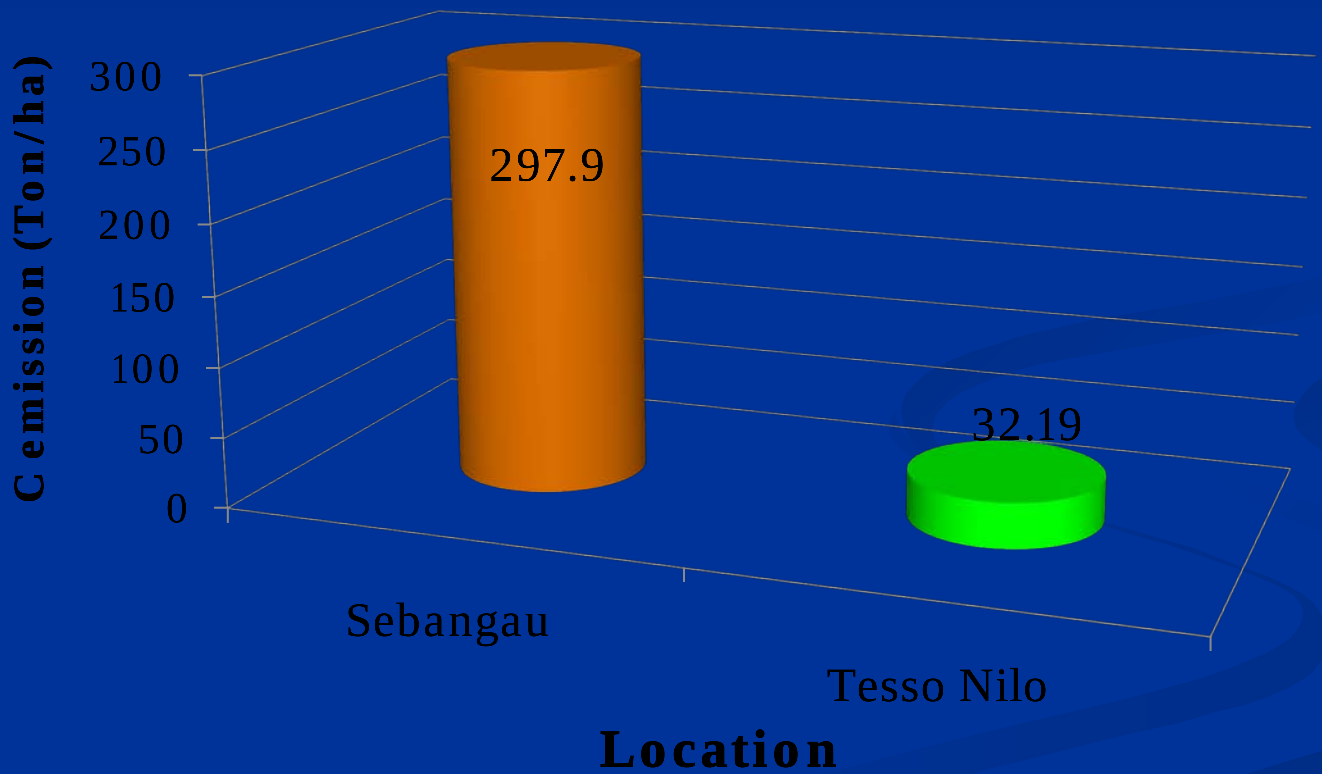



# Results




- Comparison C emission in burned peat and burned above ground biomass in Sebangau

# Results




Comparison of C emission in Sebangau and Tesso Nilo NPs

# Couwenberg et al 2010

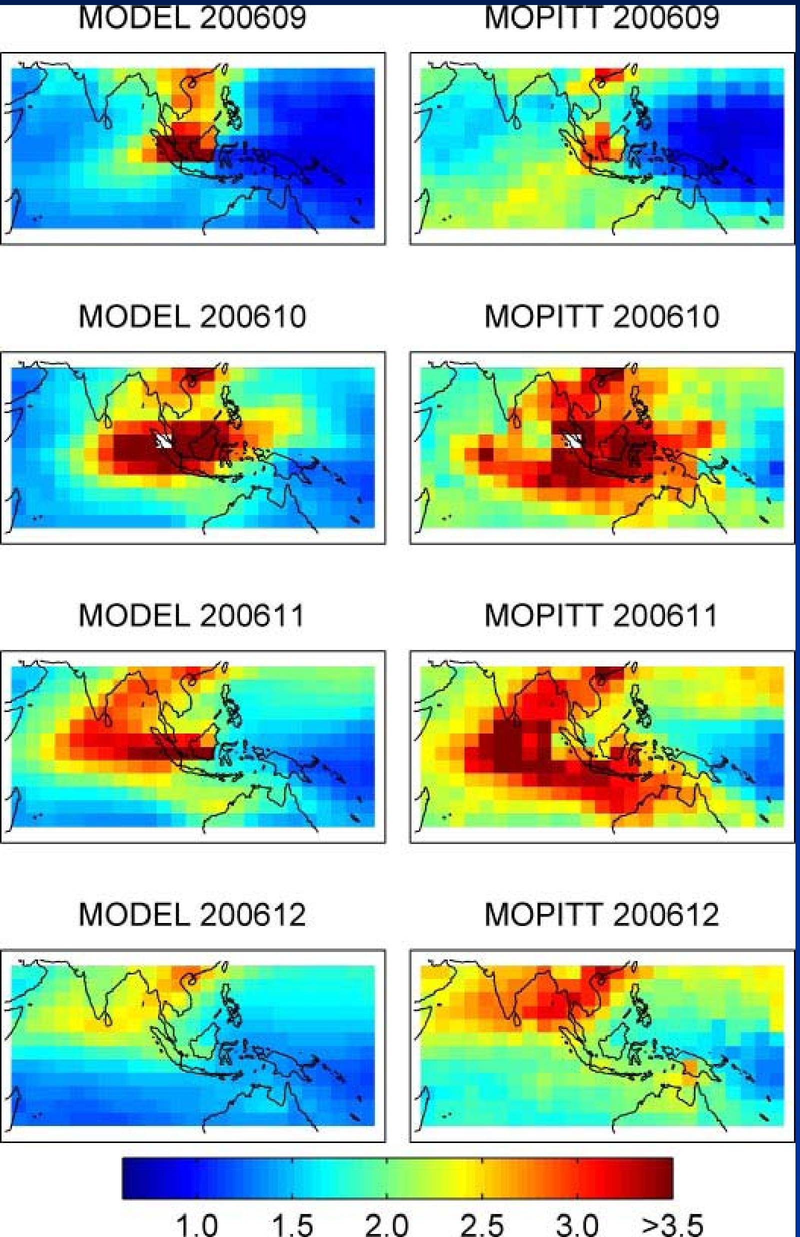


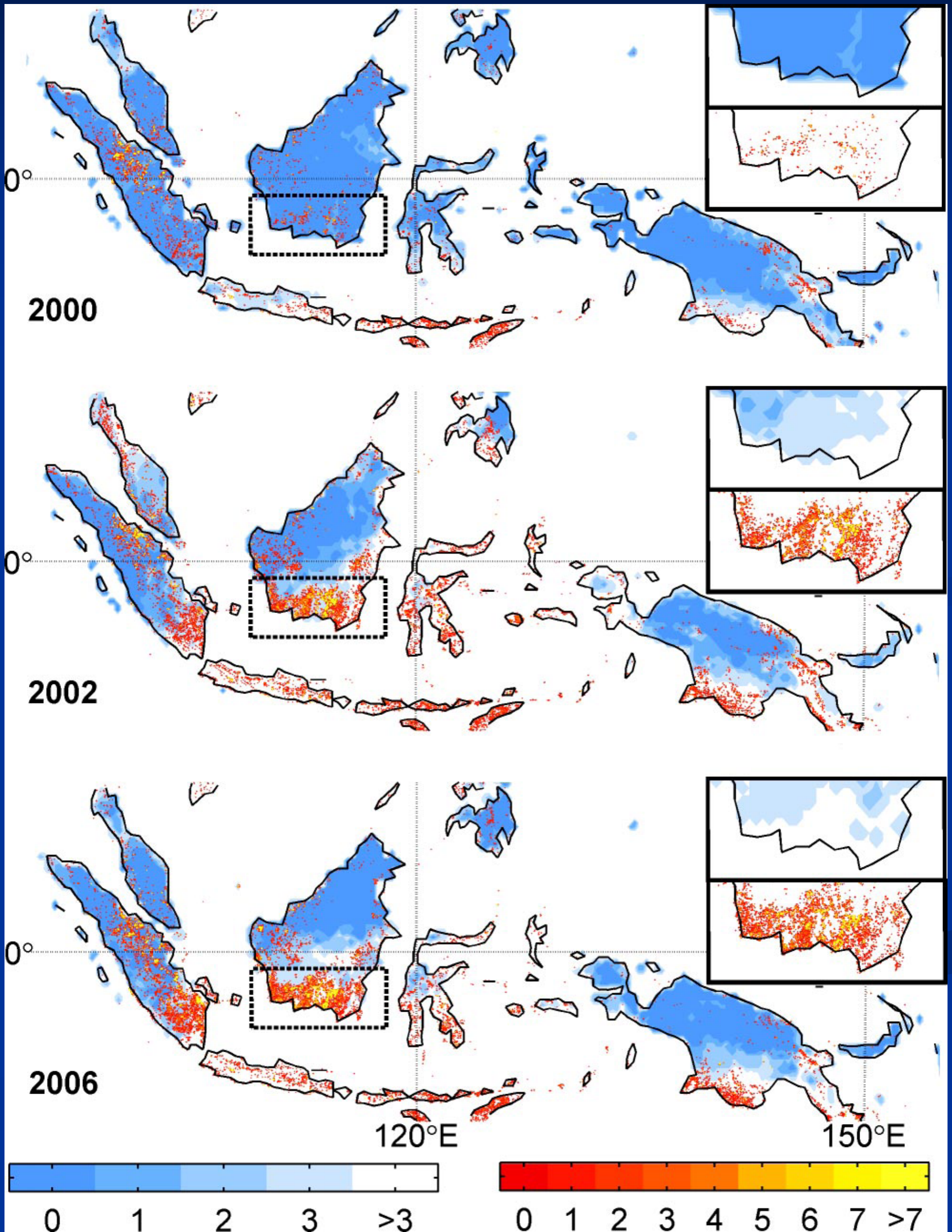
**Table 2** Carbon emissions from peat fires and related parameters

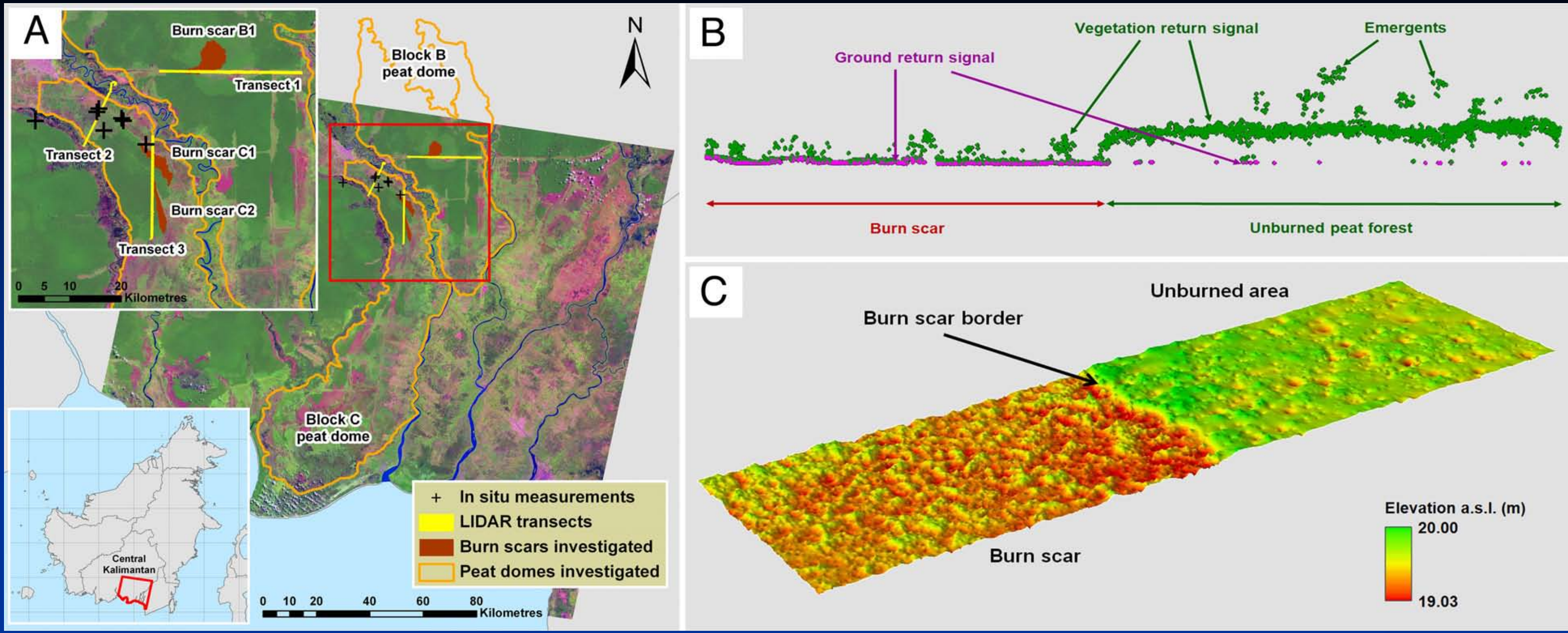
| Burnt peat depth (cm) | Year | Bulk density ($g\,cm^{-3}$) | Carbon content | Emission ($kg\,C\,m^{-2}$) | Fire type | Reference |
|---|---|---|---|---|---|---|
| 37 (25–60) | 1988, 1994 | | | | C | DID & LAWOO (1996) |
| 51 (20–150) | 1997 | 0.100* | 0.57* | 29.1 (11.4- 85.5) | W | Page *et al*. (2000, 2002) |
| 55 (25–85) | 1997 | 0.160 (0.100–0.220) | 0.54 (0.53–0.56) | 47.5 (13.3–104) | W | Limin *et al*. (2004) |
| 21 (3.5–44.5) | 2002 | 0.160 (0.100–0.220) | 0.54 (0.53–0.56) | 18.6 (6.3–37.1) | W | Limin *et al*. (2004) |
| 27 (15–30)† | 2002 | | | | W | Usup *et al*. (2004) |
| 12 (0–32) | 2001, 2002 | 0.155 (0.060–0.220) | 0.50 (0.46–0.54) | 9.0 (0–27.4) | E | Saharjo & Munoz (2005); Saharjo & Nurhayati (2005); Saharjo (2007) |
| Mean | | | | | | |
| 34 | | 0.144 | 0.54 | 26.1 | | |

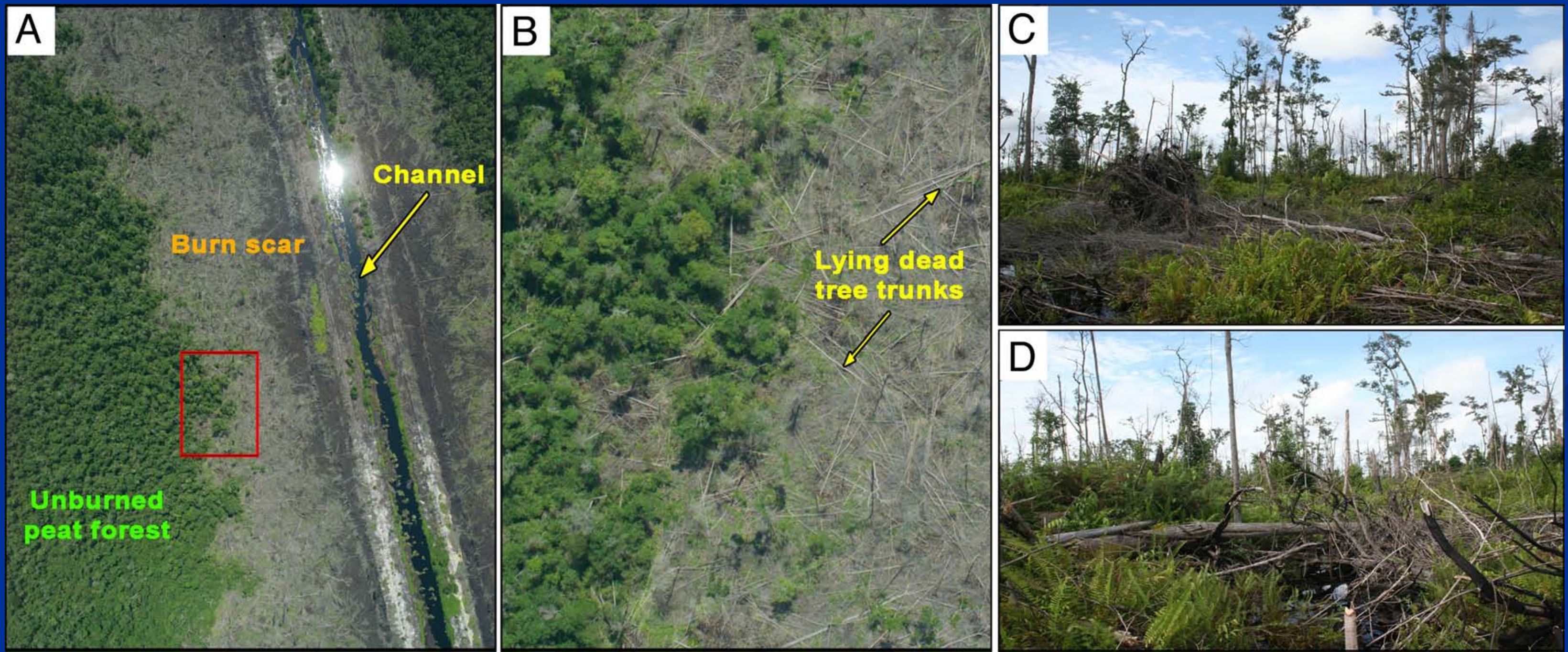
Data are mean values (range in parentheses).
*Data from Neuzil (1997).
†Own calculations based on weight loss data.
C, clearance fire; W, wildfire; E, experimental fire.

# Van der Werf et al 2008




A
Burn scar B1
Transect 1
Transect 2
Burn scar C1
Burn scar C2
Transect 3
0 5 10 20
Kilometres
Block B
peat dome
N
Block C
peat dome
Central
Kalimantan
+ In situ measurements
LIDAR transects
Burn scars investigated
Peat domes investigated
0 10 20 40 60 80
Kilometres
B
Ground return signal
Vegetation return signal
Emergents
Burn scar
Unburned peat forest
C
Unburned area
Burn scar border
Burn scar
Elevation a.s.l. (m)
20.00
19.03


A
Channel
Burn scar
Unburned
peat forest
B
Lying dead
tree trunks
C
D

# Ballhorn et al 2009

**Table 1. Different peat fire carbon emissions in Indonesia from the 2006 El Niño fire season**

| | Specific burn scars in the study area | | | | |
|---|---|---|---|---|---|
| | Block B peat dome | Block C peat dome | | | |
| | B1 | C1 | C2 | Study area | Indonesia |
| Peatland area | 283,800 ha* | 361,400 ha* | | 1,651,805 ha† | 21,892,399 ha† |
| Mean peat thickness | 4.90 ± 1.15 m* | 3.65 ± 0.92 m* | | 4.65 ± 1.05 m‡ | 4.5 ± 0.85 m* |
| Peat volume | 13.86 ± 3.26 $10^9 m^3$* | 13.17 ± 3.32 $10^9 m^3$* | | 76.81 ± 17.34 $10^9 m^3$§ | 985.16 ± 186.09 $10^9 m^3$§ |
| Carbon storage | 0.80 ± 0.19 Gt* | 0.76 ± 0.19 Gt* | | 4.45 ± 1.01 Gt¶ | 57.14 ± 10.79 Gt¶ |
| Fire damaged peatland | 2,632 ha‖ | 1,209 ha‖ | 864 ha‖ | 256,783 ha** | 1,331,367 ha†† |
| Percent peatland damaged | 0.9% | 0.3% | 0.2% | 15.5% | 6.1% |
| Peat volume loss | 8.69 ± 4.74 $10^6 m^3$‡‡ | 3.99 ± 2.18 $10^6 m^3$‡‡ | 2.85 ± 1.55 $10^6 m^3$‡‡ | 847.38 ± 462.21 $10^6 m^3$‡‡ | 4.39 ± 2.40 $10^9 m^3$‡‡ |
| Peat carbon loss | 0.50 ± 0.27 Mt¶ | 0.23 ± 0.13 Mt¶ | 0.17 ± 0.09 Mt¶ | 49.15 ± 26.81 Mt¶ | 0.25 ± 0.14 Gt¶ |

*See ref. 11.

†See refs. 18–20.

‡Average peat thickness of the three peat domes in Central Kalimantan (Block B, Block C, and Sebangau) modeled by Jaenicke et al. (11).

§Derived by multiplying peat land area and mean peat thickness.

¶Based on a peat bulk density of 0.1 g $cm^{-3}$ and a peat carbon content of 58% (0.58) (26).

‖Derived from visually digitizing the burn scars based on the Landsat ETM + 7 image (118–62, August 5, 2007, gap filled) (see *Materials and Methods*).

**Derived from the object oriented classification of the Landsat ETM + 7 image (118–62, 05 August 2007, gap filled) (see *Materials and Methods*).

††Derived from MODIS hotspot data of the year 2006 converted to fire affected areas minus a correction factor of 30% (see *Materials and Methods*).

‡‡Derived from a burned peat depth of 0.33 ± 0.18 m based on this LIDAR study.

# Comparison of assessments

- If we assume a total area of 1.9 million ha of peat soil burnt during the 1997 fires in south-east Asia (Heil et al., 2007), with each m2 emitting 26 kgC (Table 2), peat carbon emissions from the 1997 fires would have amounted to 494 Tg C.
- This value corresponds well with the 486 Tg peat carbon emissions (67% of total emissions of 726 Tg) of van der Werf et al. (2008), who used CO measurements from the MOPITT satellite to optimize bottom-up estimates based on burnt area.
- Above values are only slightly higher than the lower estimate of 380–460 Tg peat carbon of Page et al. (2002)
- For an average year 2000-2006 – 90Tg C for fire emissions
- Annual emissions from peat oxidation from drainage 130-170Tg C ( Hooijer 2010, Couwenberg 2010)

# Recommendations

- Review update and expand the emission factors on fires in chapter 2 of 2006 Guidelines
- Compile available methodologies and emission factors for use at different tiers for fires in peatlands
- Differentiate between emissions in drained and un-drained sites
- Review range of GHG produced from peatland fires

# Thank you