Tropical peatlands of Southeast Asia: Functions, threats and the role of fire in climate change mitigation

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Tropical peat swamp forests are ecologically diverse

Tropical wetland forests

Structurally similar to other upland tropical wet forests. Hydric conditions drive ecosystem processes and functions, supporting unique biological communities physically and physiologically adapted to the anaerobic soil environment.

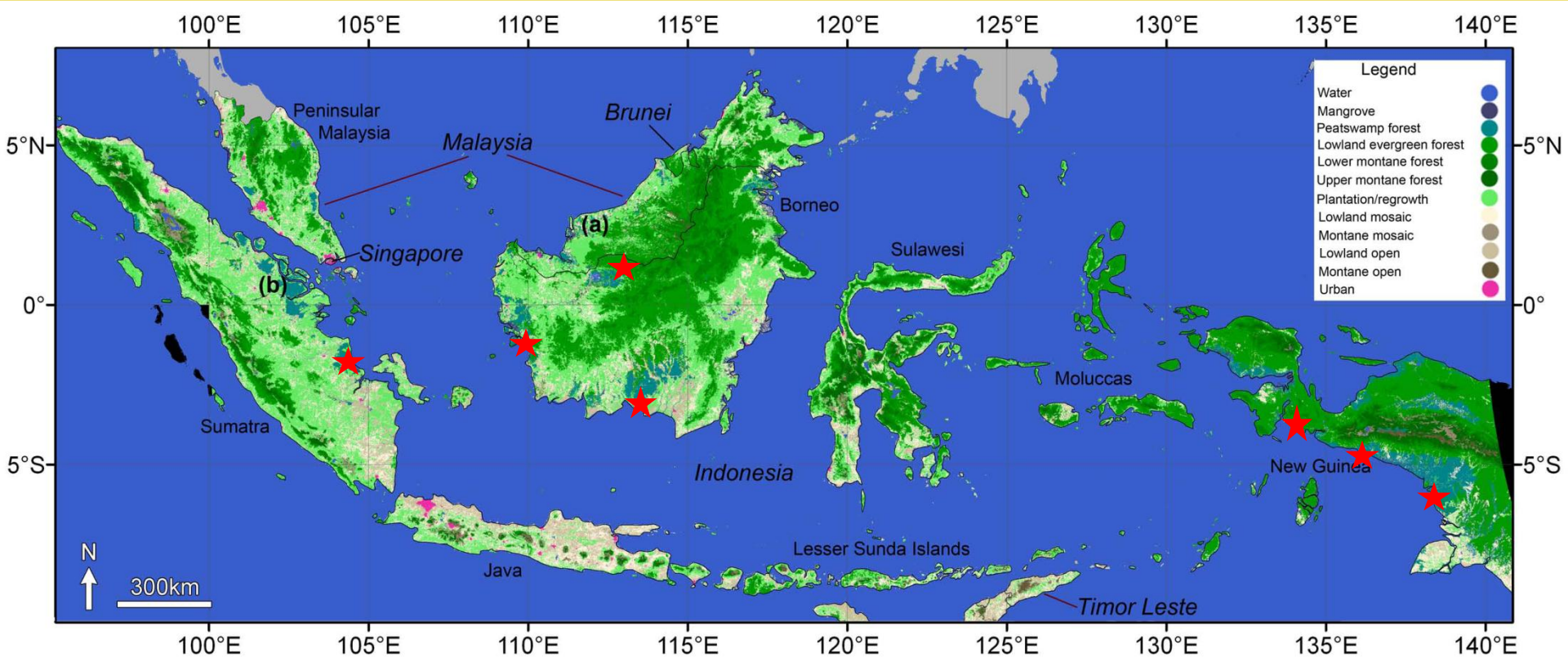
Southeast Asia:
The global center of tropical peatlands

About 44.1 Mha of tropical peatlands ~11% of the total peatland area; volume is ~18 -25% (Page et al. 2011).

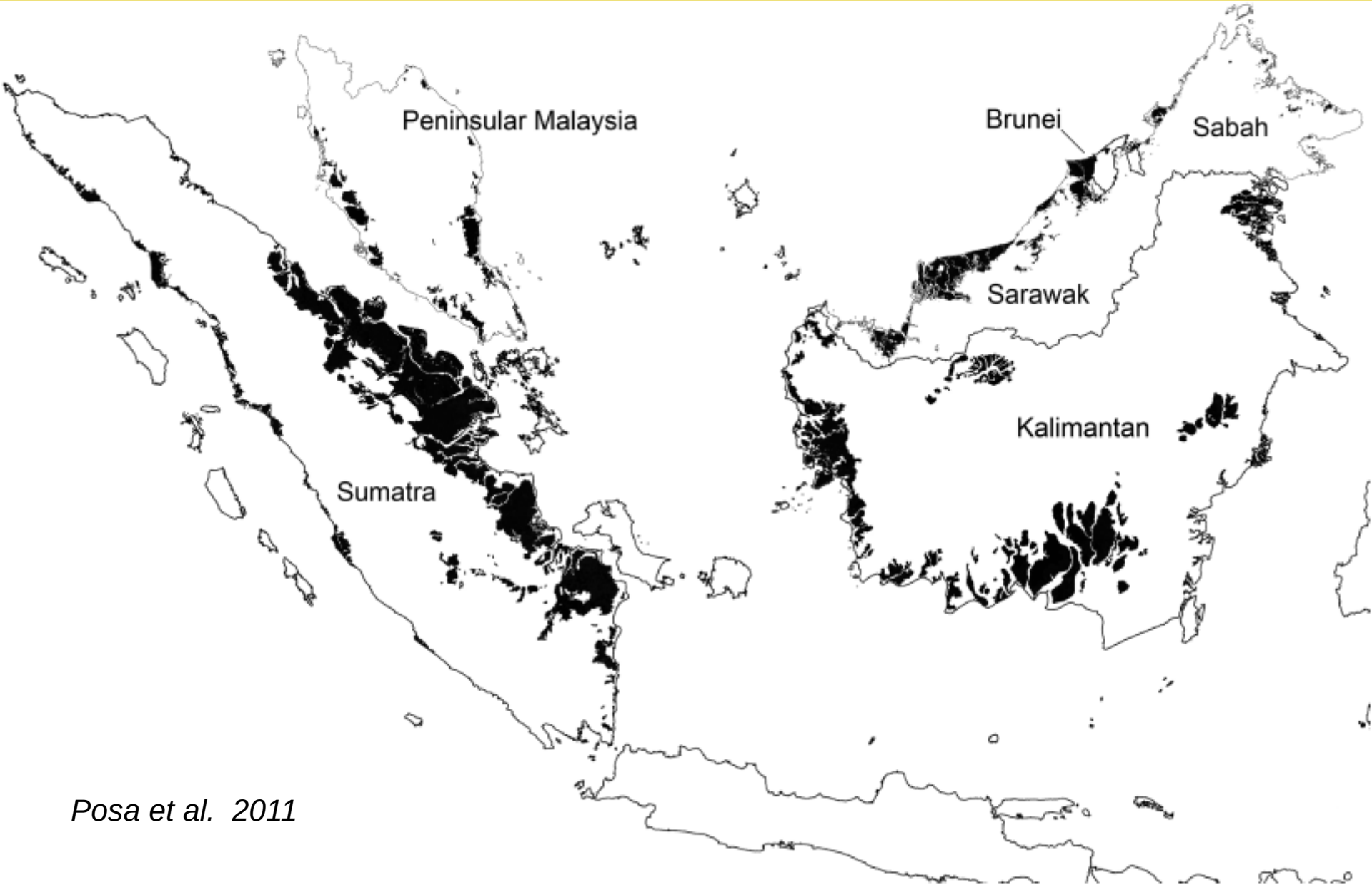
About 25 Mha (56%) of tropical peatlands occur in SE Asia. Indonesia contains around 47% (Page et al. 2011).

TRUE EXTENT?

Miettinen et al. 2011



Extensive peatlands occur in Sumatra, Borneo, and W. Papua (not shown)



Posa et al. 2011

Ecosystem Services

Environmental functions that support human well-being

- Supporting: Primary production, nutrient cycling, soil maintenance
- Provisioning: Food, water, fiber, timber, fuel, medicine, NTFP's
- Regulating: Climate, floods, sedimentation, drought, disease
- Cultural: Aesthetic, spiritual, recreational, educational, ecotourism
- Biological: Unique biodiversity, genetic and biochemical resources

Hydrological Regulation

Faiz Rahman

$ustenance

Timber

- Local construction
- Commercial extraction
- Fuel wood
- Charcoal

Biological Diversity

Many flagship species for conservation find refuge in wetland forests. Countless plants, fungi, fish and insects remain poorly known or undescribed.

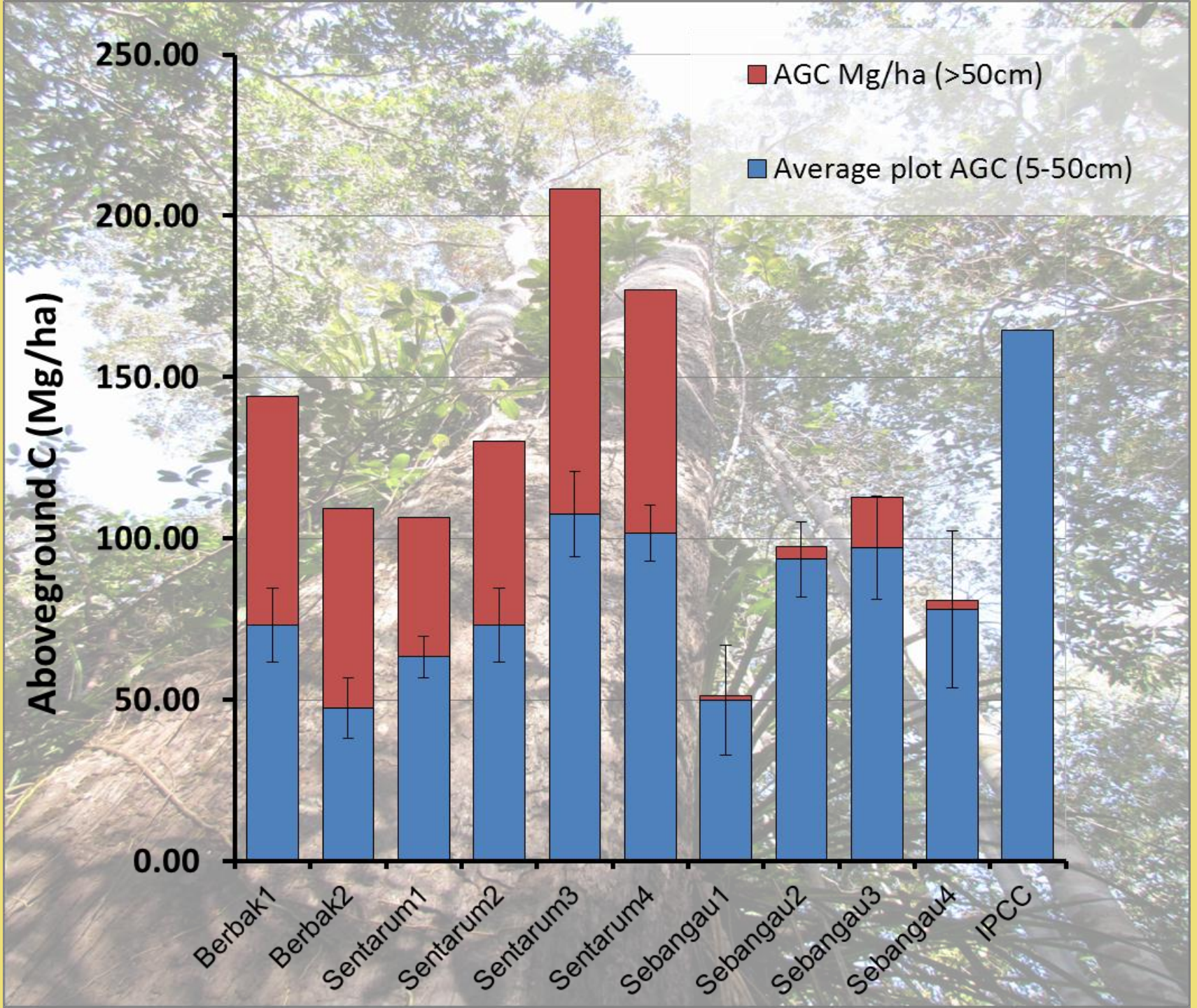
B. Kauffman

ZSL- Berbak

Orangutan Tropical Peatland Project: www.outrop.com

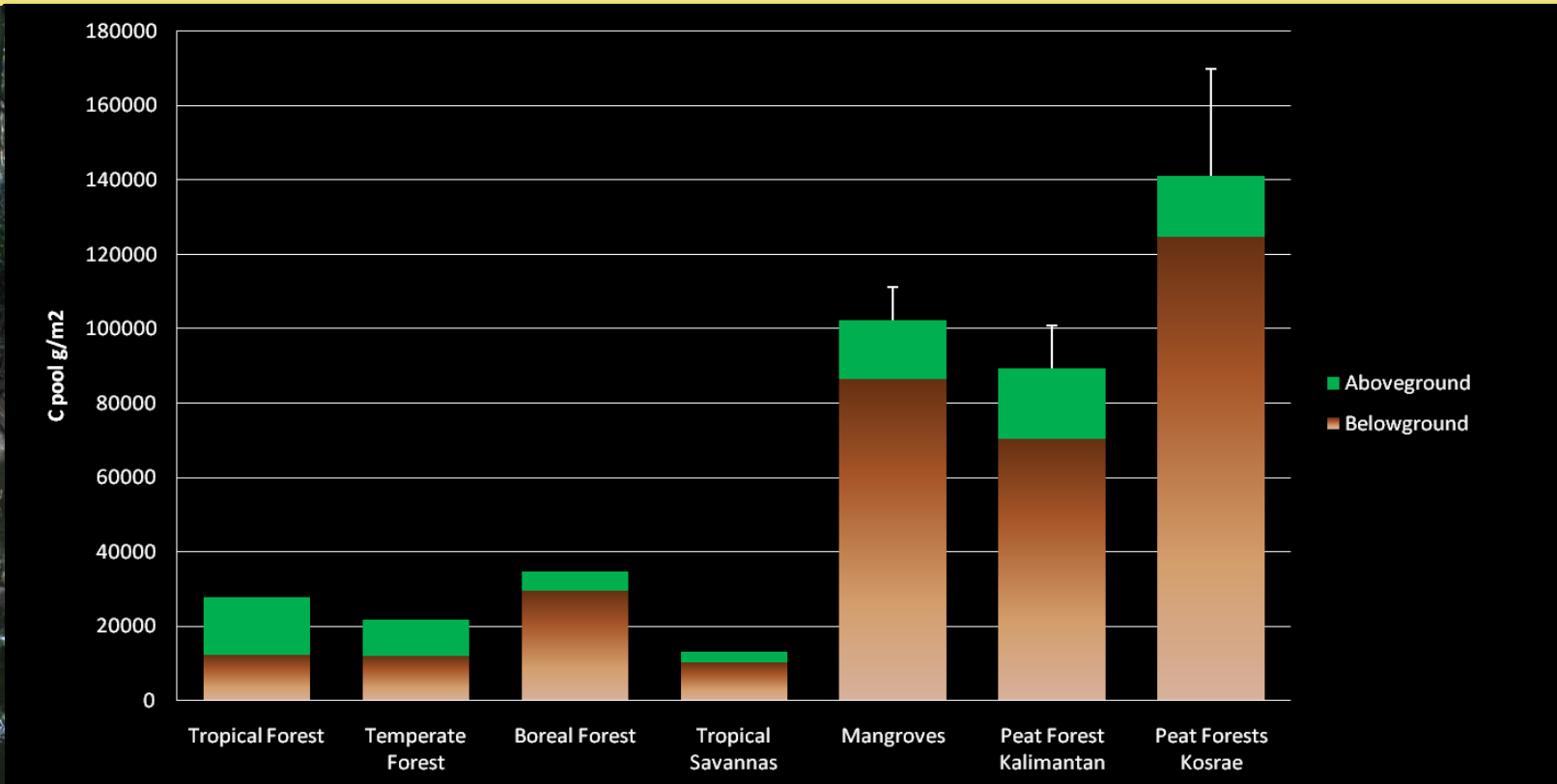
Carbon Storage

- Tropical wetlands store more C per ha than any other tropical forest type
- Tropical peatlands store about 88.6 Gt C, 15-19% of global peat C pool
- Estimates range from about 2000-3000 Mg C/ha, average 2009 MgC/ha globally (Page et al. 2011);
- 2,400 MgC/ha (this study, all forests). 100% organic layer: ~ 3001 MgC/ha
- Volume estimates are uncertain, and need to be refined with additional data


250.00
200.00
150.00
100.00
50.00
0.00
Aboveground C (Mg/ha)
AGC Mg/ha (>50cm)
Average plot AGC (5-50cm)
Berbak1
Berbak2
Sentarum1
Sentarum2
Sentarum3
Sentarum4
Sebangau1
Sebangau2
Sebangau3
Sebangau4
IPCC

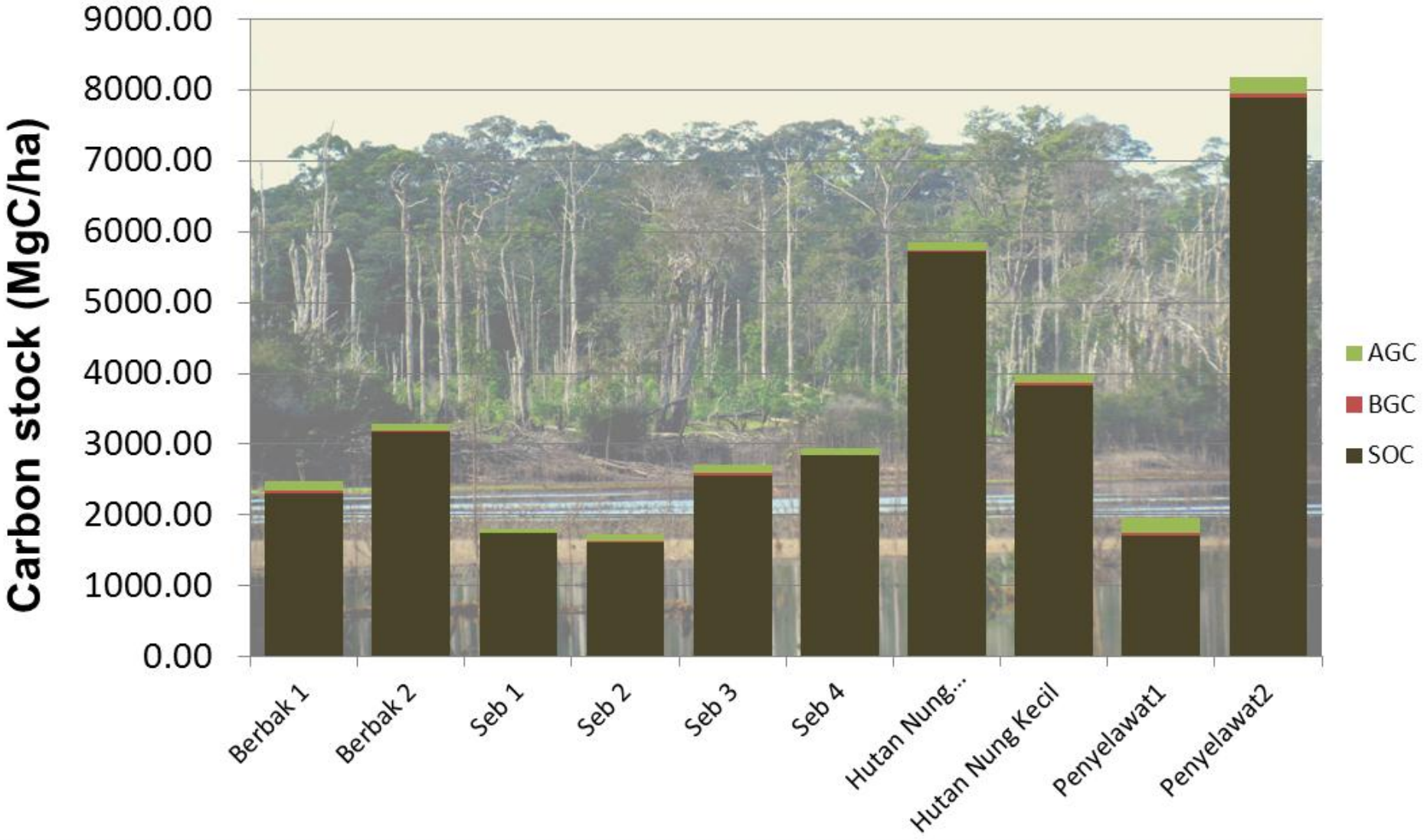
Tropical wetlands sequester and store more C/ha than other vegetation types in the upland forests

- Lack of oxygen slows decomposition, accumulating organic matter and Carbon
- Historical (millenia timescale) Carbon sinks vulnerable to disturbance and loss
- Often 90% of the ecosystem C is stored belowground
- Carbon storage up to 5-10 times that of upland tropical rainforests

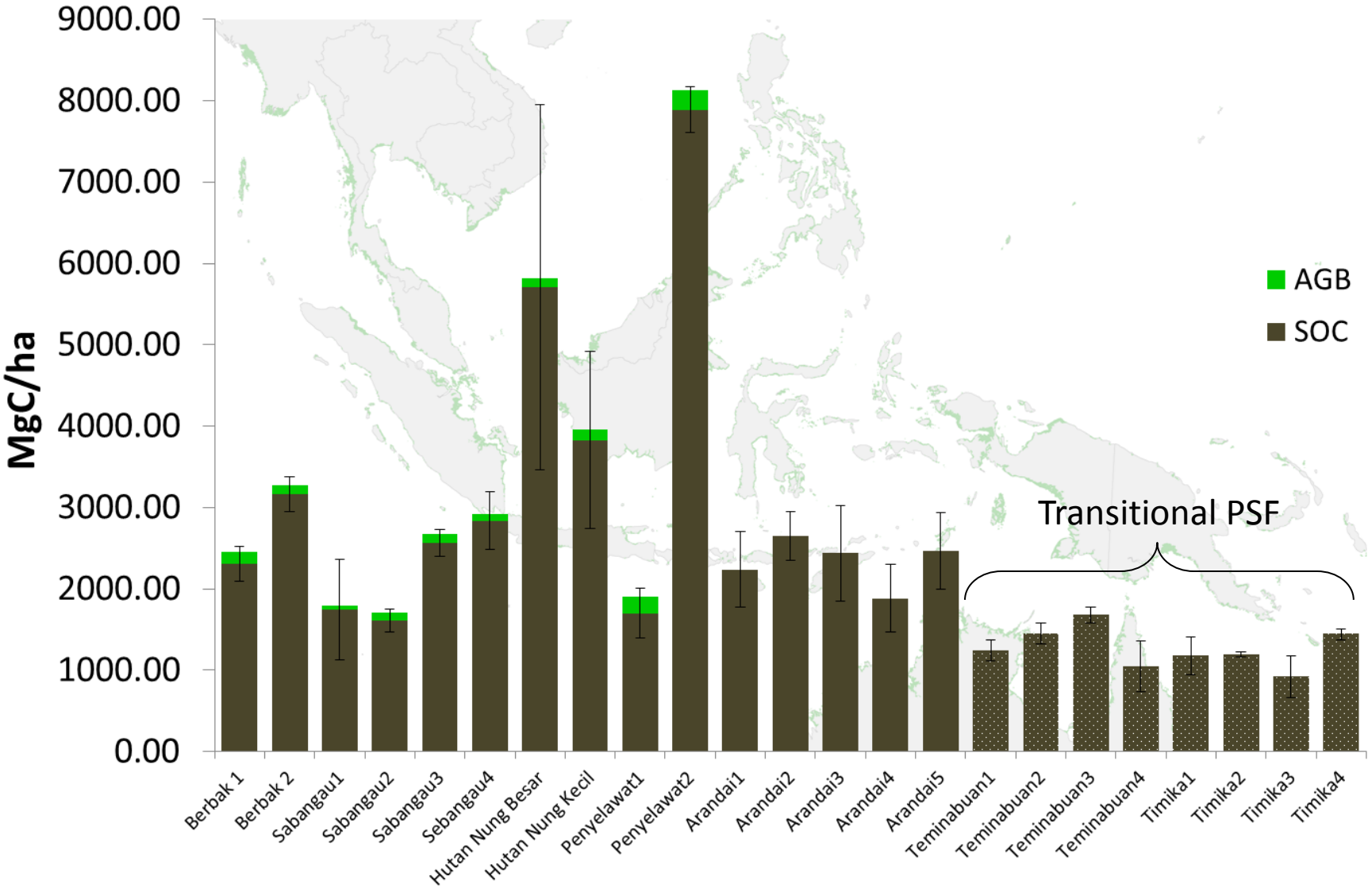


Data are from:IPCC, 2001: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change ; Donato et al. (2011); Kauffman (2011) .

Ecosystem C stocks in Peat Swamp Forest



Carbon stocks in Indonesian Peat Swamp Forests



Threats to Tropical Wetland Forests:

Fire, logging, land conversion, drainage, coastal development, climate change






Threatened Tropical Wetland Forests

Historical peatland area in SE Asia: 20 – 30 Mha

(Rieley et al. 1996)

Remaining PSF:

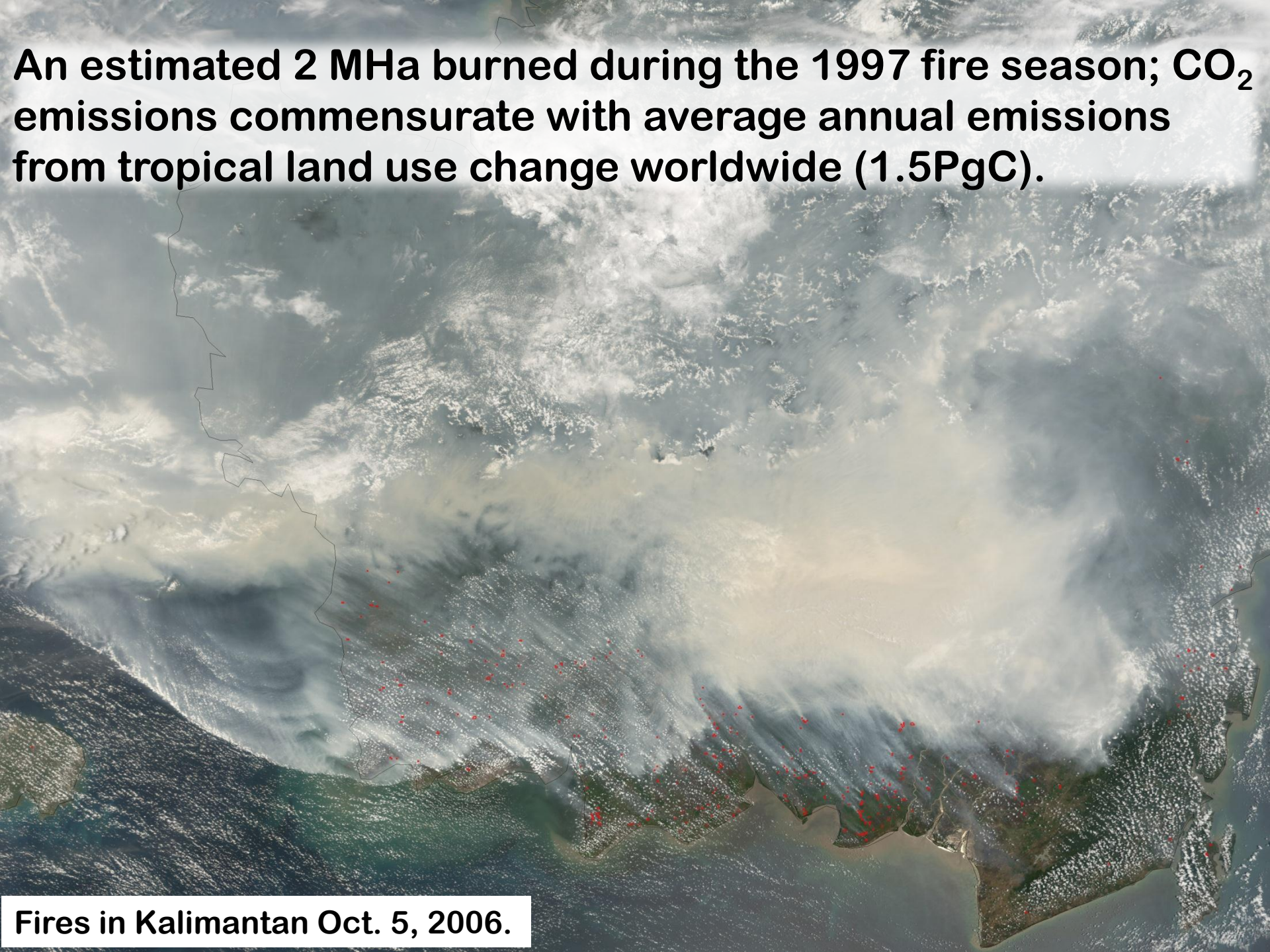
Malaysia 22%, Indonesia 49%, Region 36%, Protected 9%

(Posa et al. 2011, Miettinen et al. 2012)

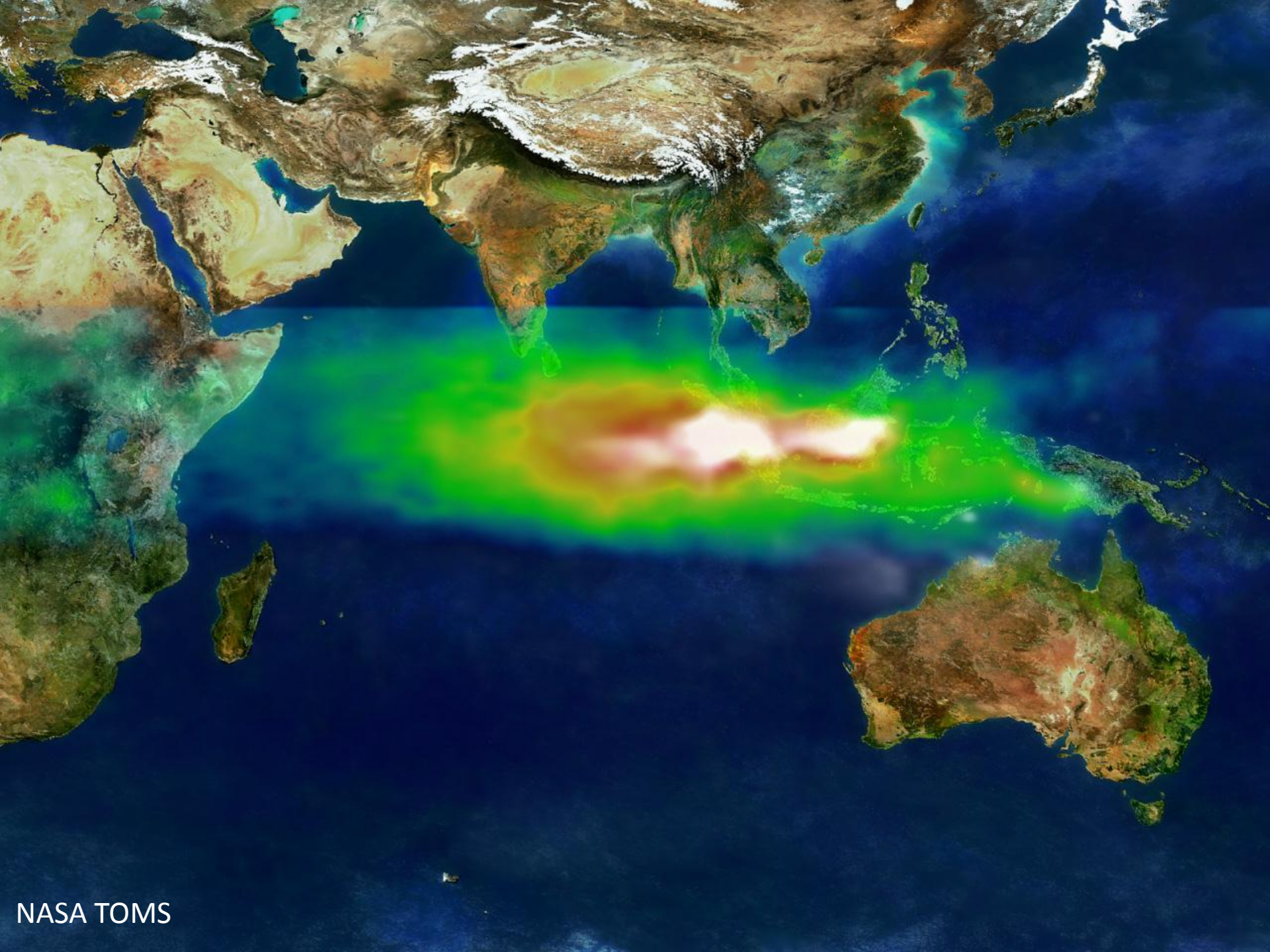
Average annual deforestation rate

Lowland dipterocarp:	**1.8% (Borneo)**
Peat swamp forest:	**3.4% (W. Indonesia)**
Mangrove forest:	**8.0% (Borneo)**

Of Indonesia's remaining PSF (49%), <10% is pristine.



Fires in Kalimantan Oct. 5, 2006.

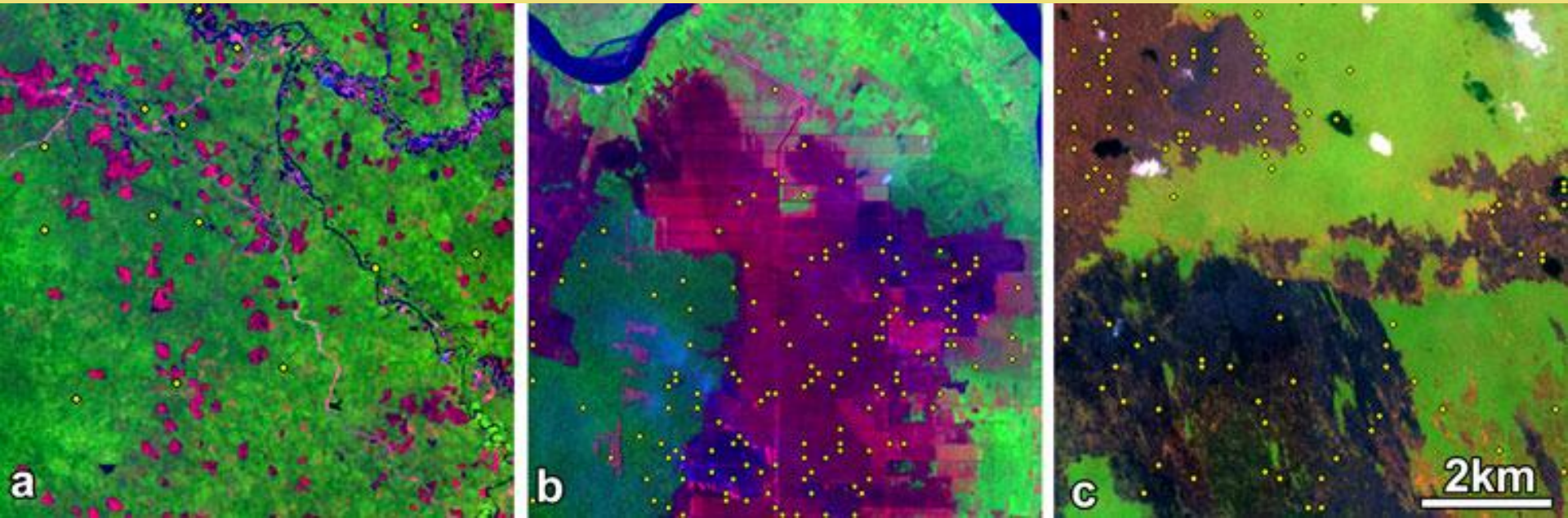

NASA TOMS

Miettinen & Liew 2009 , 2011

- SE Asian fires strongly connected to peatlands and land use: 41% of fires detected vs. 10% of land area.

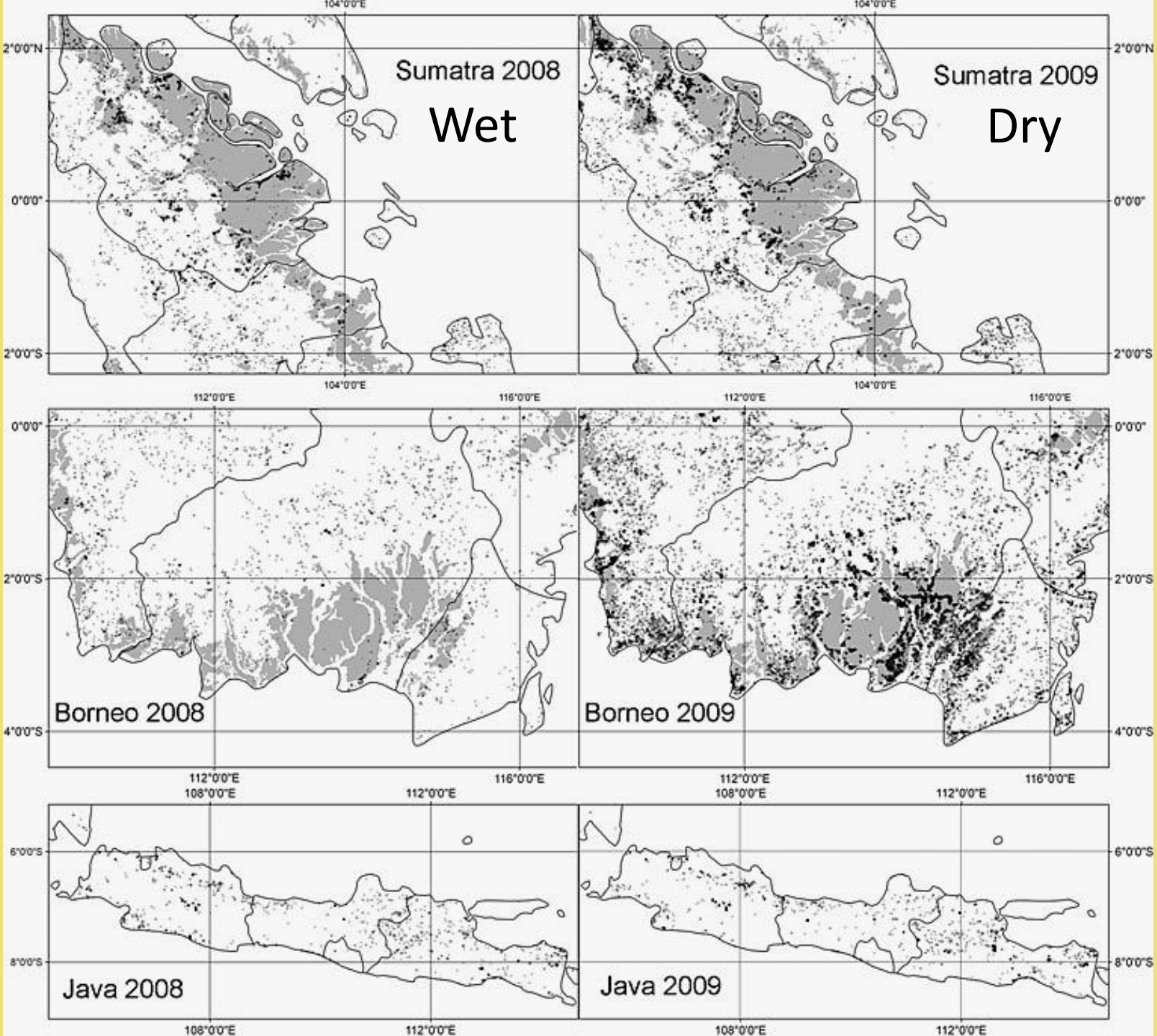
- Strong interactions among peatlands, land management, and ENSO.

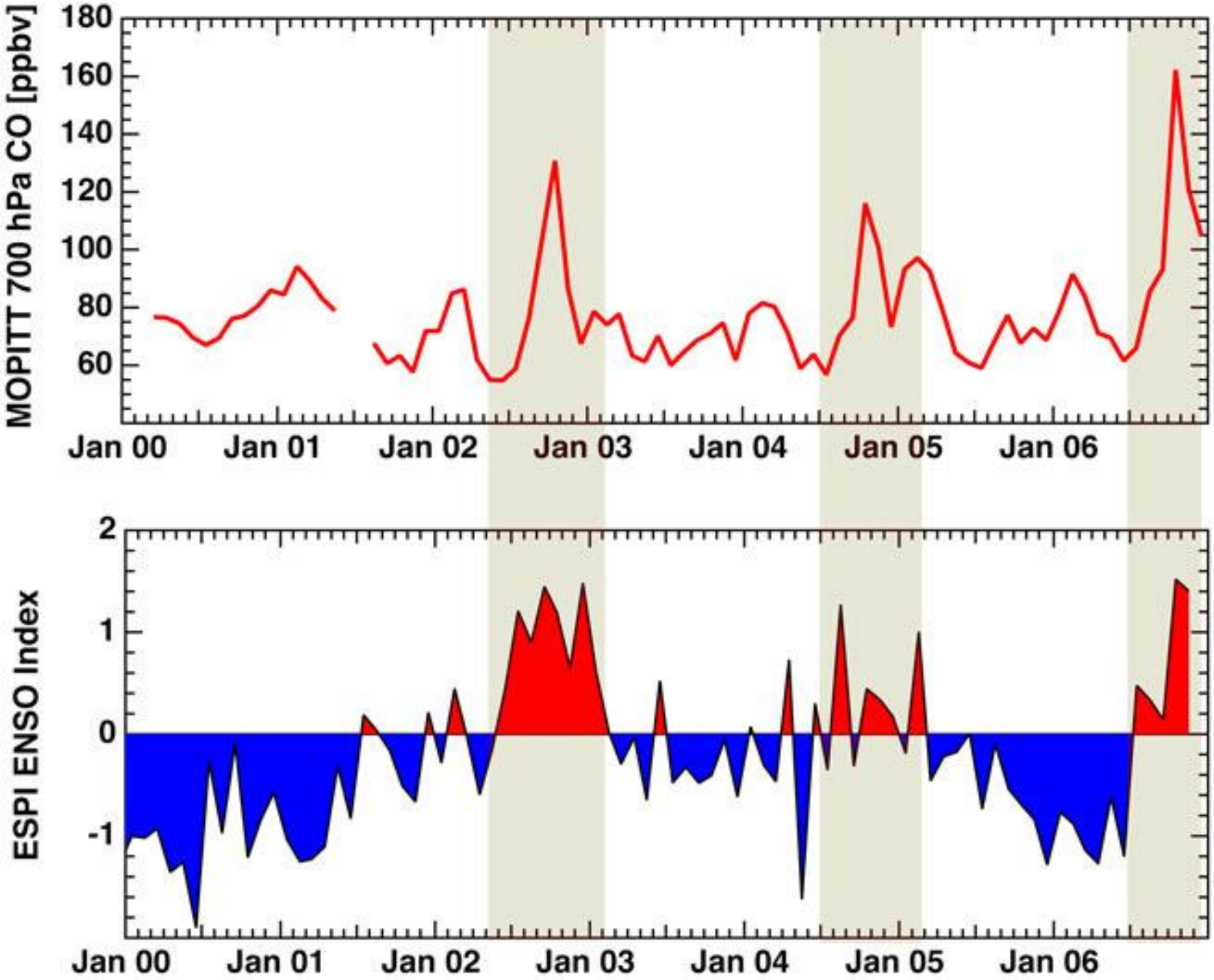
Smallholder Industrial Plantation Wildfire






Miettinen et al. 2011




MOPITT 700 hPa CO [ppbv]
180
160
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ESPI ENSO Index
2
1
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Peat fire effects on climate

Direct forcing

Pollution effects radiative balance
(organic and black carbon aerosols)

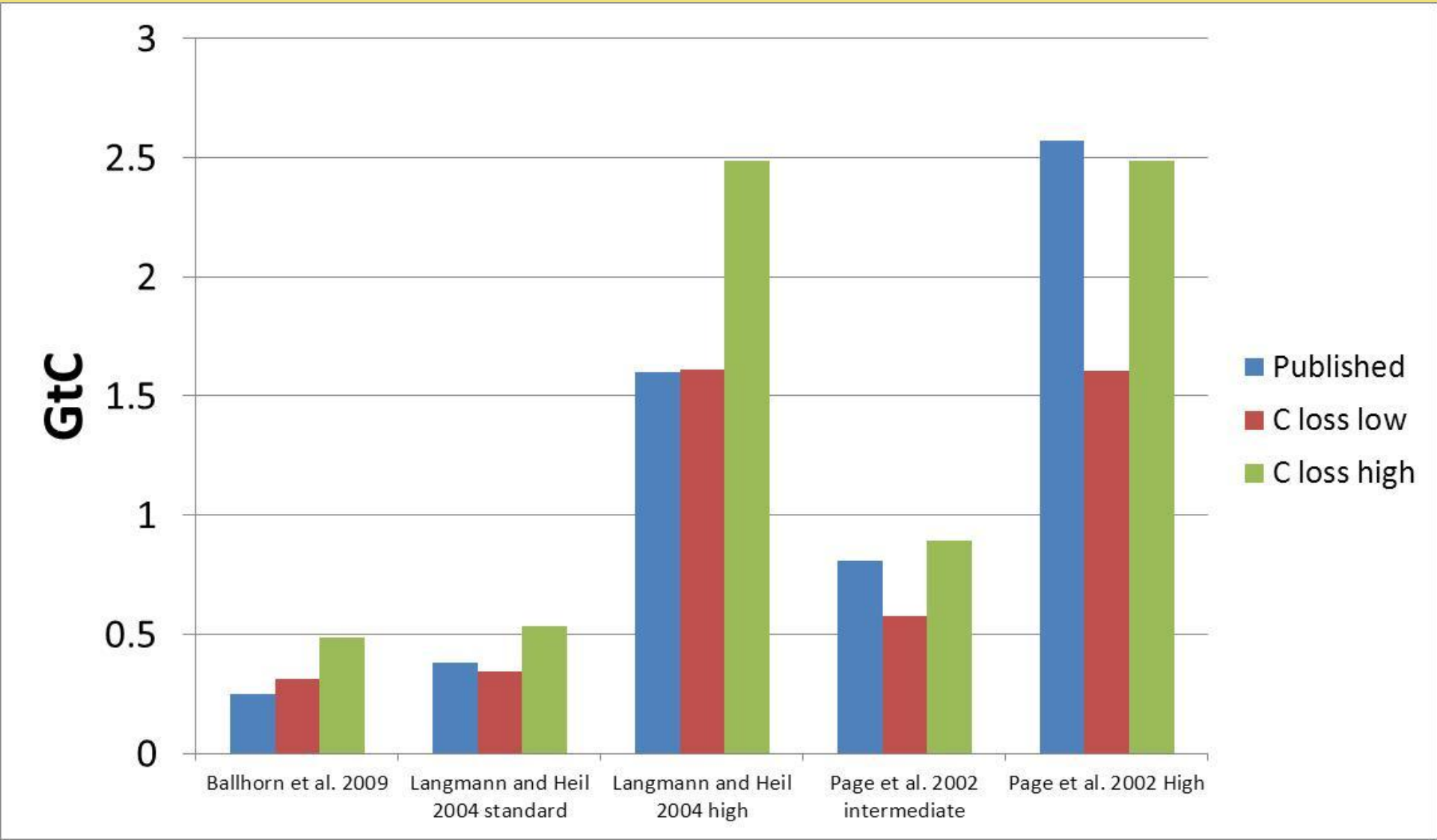
- Ocean: clouds, specific humidity (Duncan et al. 2003)
- Land: photosynthesis, primary productivity

Indirect forcing

CO_2, CH_4 and N_2O emissions contribute to greenhouse effect and global climate change

Peat fire carbon emissions

Area and depth uncertainties: Volume burned?



Peat fire carbon emissions

Gross atomspheric CO_2 increase (PPM)

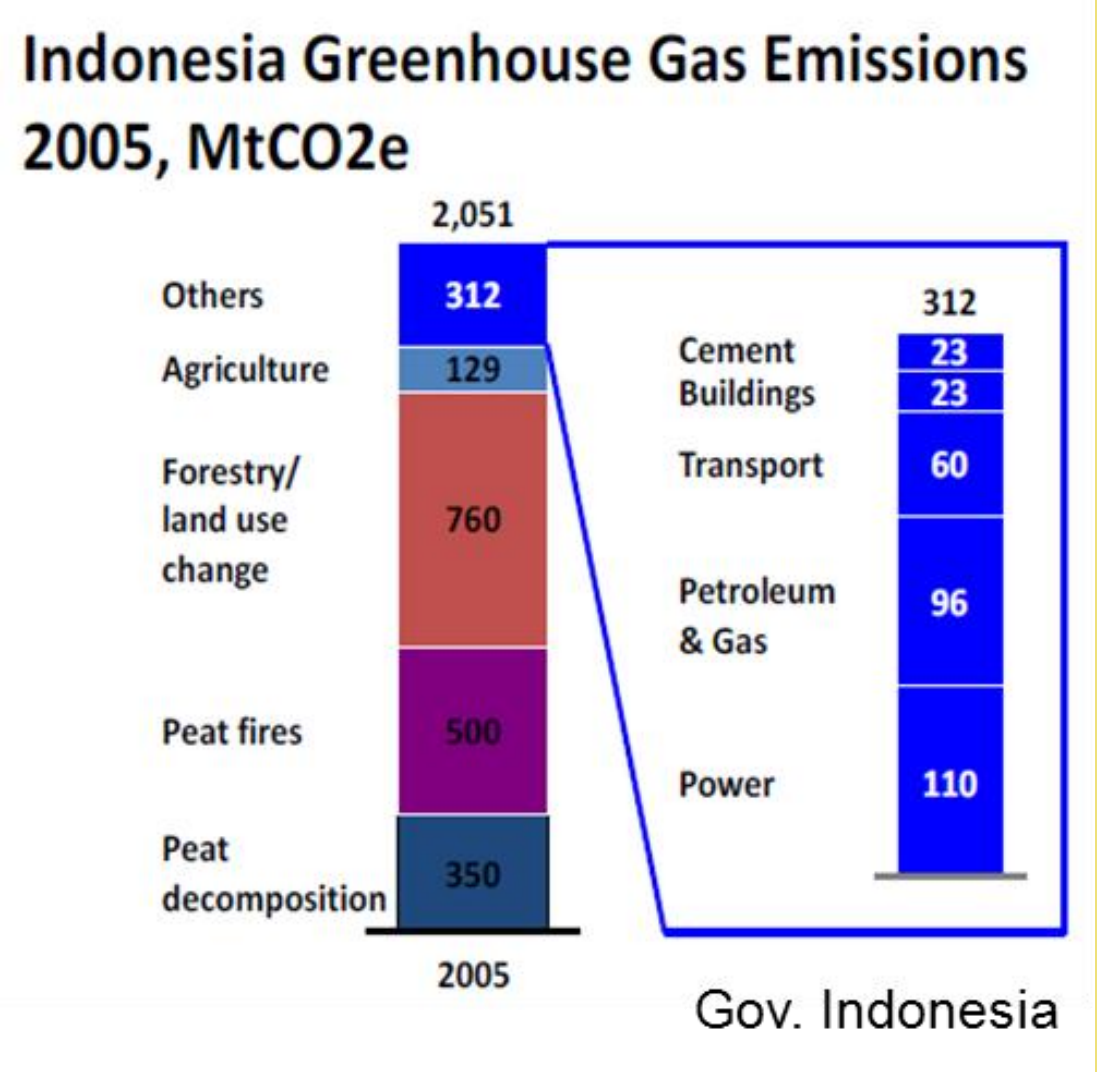
“Typical” El Niño year: 0.15-0.23 ppm

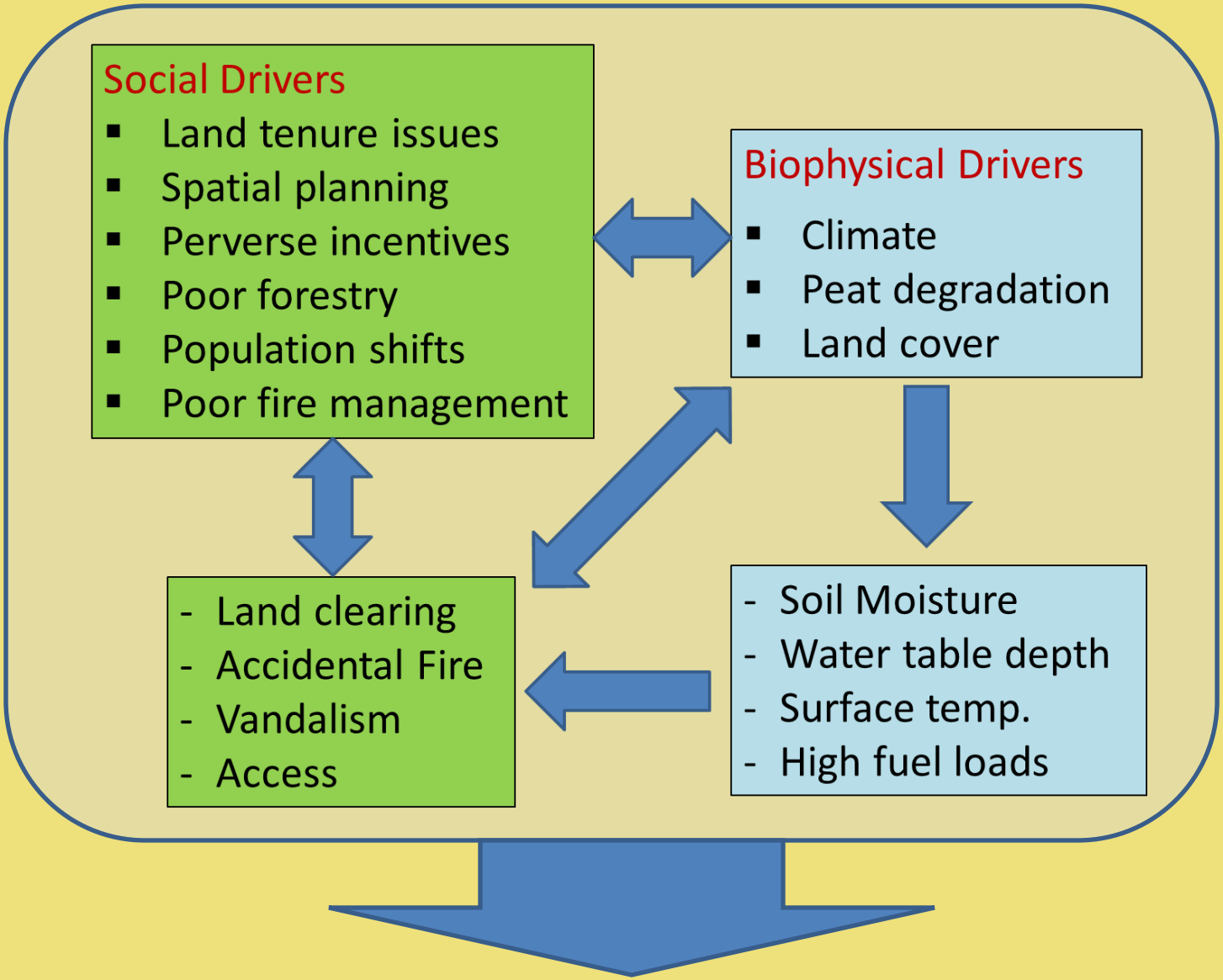
“Extreme” El Niño year: 0.16-1.17 ppm

Cumulative industrial plantations: 0.35-0.53 ppm
Cumulative oil palm plantations: 0.10-0.15 ppm

Indonesia's greenhouse gas emission profile

- 3rd largest emitter in the world
- 80% of national GHG emissions from LUC
- 40% emissions from peat soils





Peat Fire GHG Emissions

Adapted from: Fires in Indonesia: An assessment of the causes (CIFOR, ICRAF, USDA).

The Way Forward

- Address critical knowledge gaps
- Science based climate smart policy
- Improve institutional capacity
- Sync policy at multiple levels
- Enforce regulations
- Improved governance
- Incentivize sustainable peat mgt. (REDD+)?
- Improve fire management

Acknowledgements

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www.cifor.org/twincam