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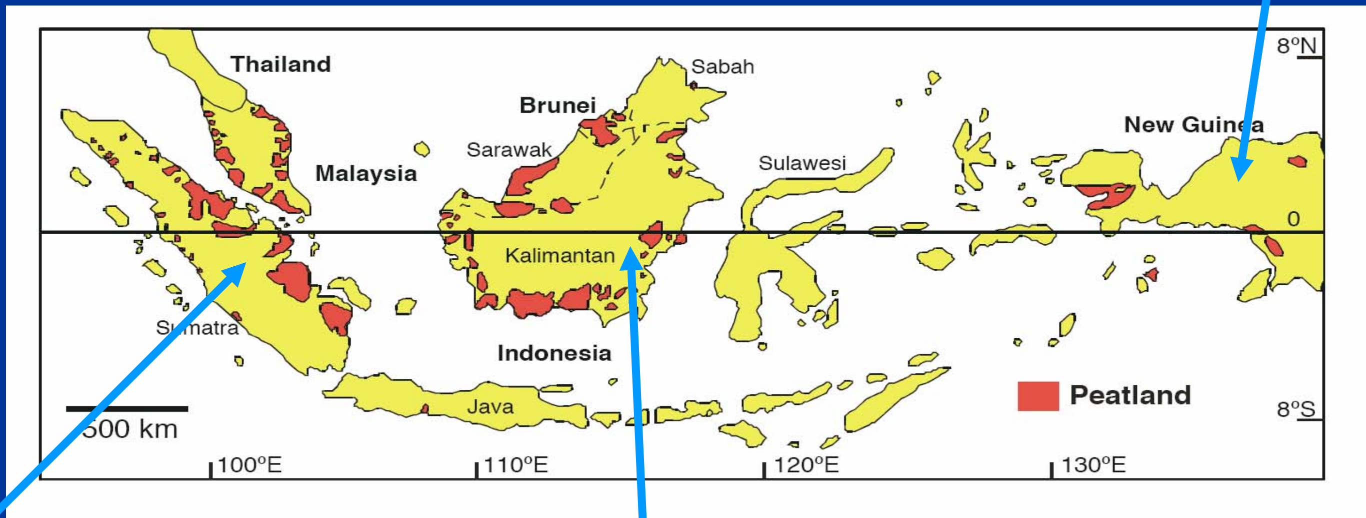
TROPICAL PEATLAND FIRES

Tropical peatlands: Location & extent

- Tropical peatlands ~12% global area
- Approx. 70% (~26 M ha) occurs in SE Asia, mainly in Indonesia
- Natural vegetation: peat swamp forest

West Papua 4 M ha



Sumatra 8 M ha **Kalimantan 7 M ha**

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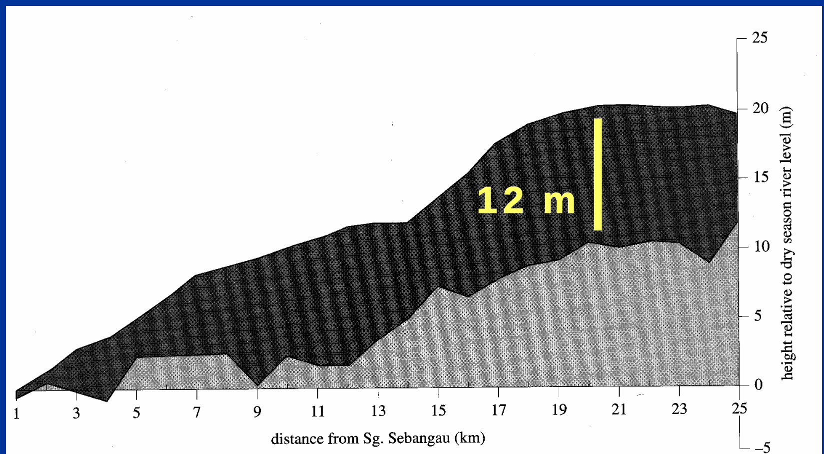
Tropical peat: Characteristics

- Tropical peat is formed from forest vegetation
- High wood content
- C content ~60%
- Peat thickness often exceeds 8 m (→ 20 m)
- Cover vast areas of coastal lowlands



25 km

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Tropical peatlands & the carbon cycle

- **C storage :**
  - Above-ground ~150 - 250 t C ha^{-1}
  - Below-ground ~250 - >10,000 t C ha^{-1}
- **Current C store in tropical peatlands: 40 – 70+? Gt C**
  - Between ~8-13% global peatland carbon pool (528 Gt C, Gorham 1991)
  - Up to 3% global soil carbon pool (2500 Gt C, Lal 2004)
- **Current _potential_ annual C sequestration: ~35 Mt yr^{-1}****
  - Equivalent to ~ 50% of that for all subarctic, boreal & temperate peatlands (66 Mt (Tg) yr^{-1}, Turunen et al. 2002)
  - BUT this is potential rather than actual carbon storage
  - Carbon sequestration function restricted by deforestation, drainage, agricultural conversion and fire.

** Assumes current carbon accumulation rate of 85 g C m^{-2} yr^{-1} (Page et al, 2004) and peatland extent of 42 M ha

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Tropical peatlands: from carbon sink to source

DRIVING FORCES

Logging (legal/illegal)
Deforestation
Drainage
Plantation and agricultural enterprises
Poor forest and land management
Fire !
<<ENSO>>

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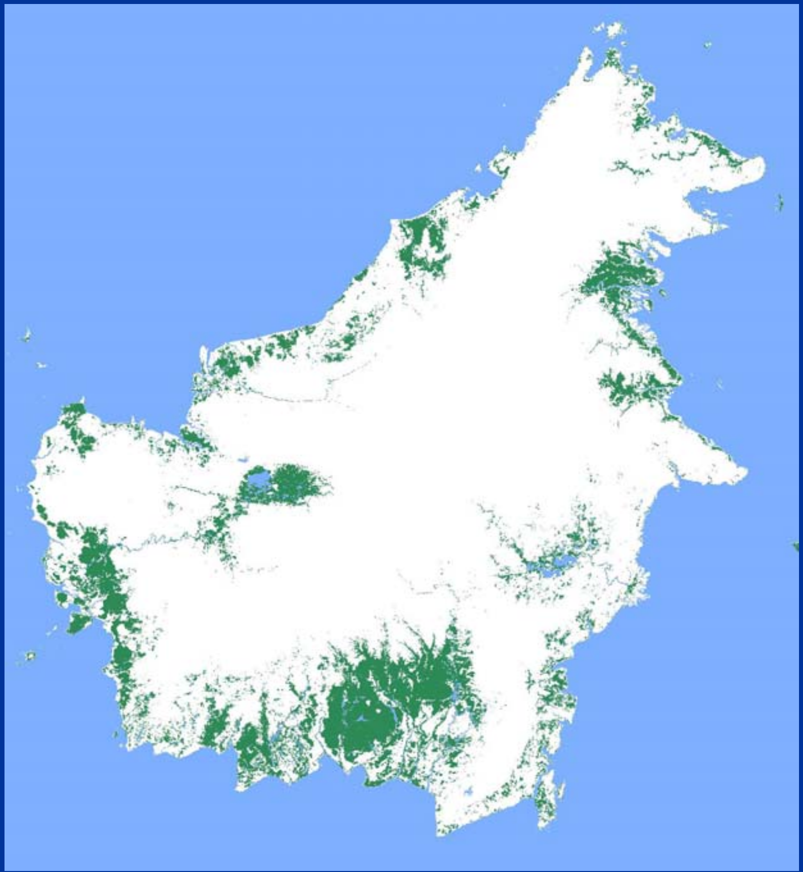
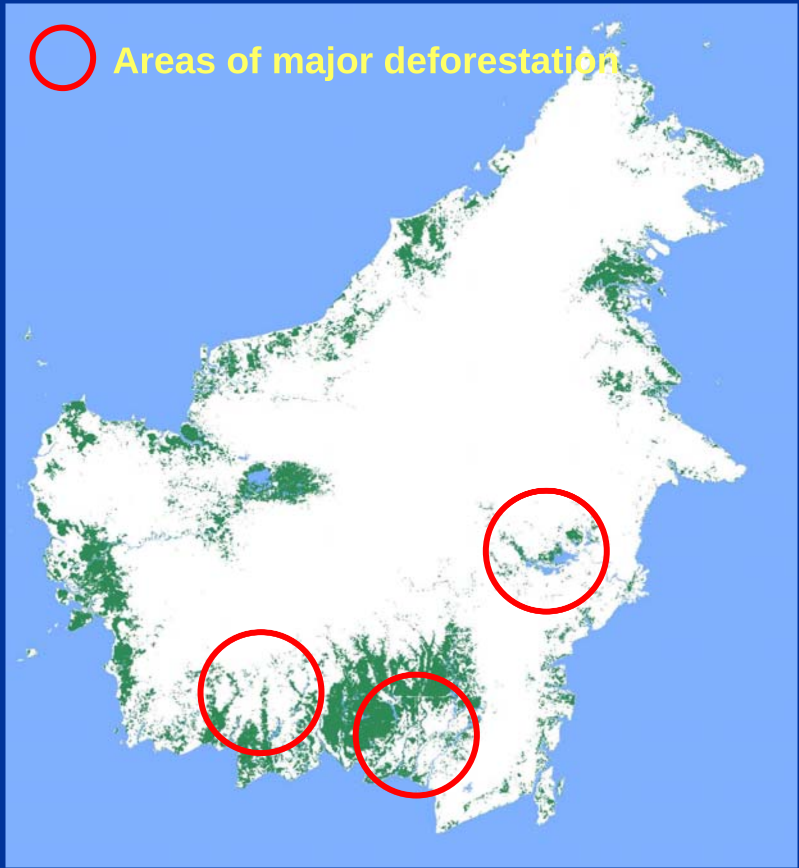
Driving forces :
Deforestation



2002



2005

Peat swamp forests: Deforestation rate 2.4% yr^{-1}

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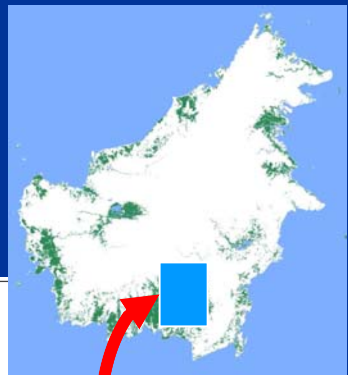
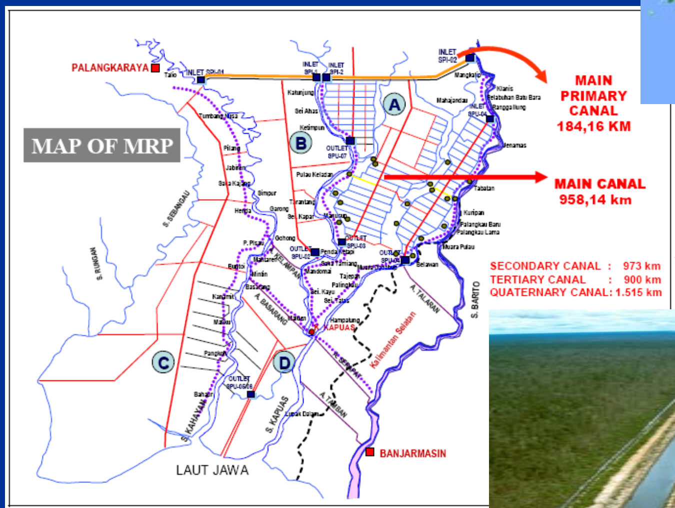
Driving forces : Land conversion & drainage

Large-scale agricultural and plantation projects

~ 7 million hectares of peatland : deforested and drained

Kalimantan Mega Rice Project





Riau pulp wood plantations

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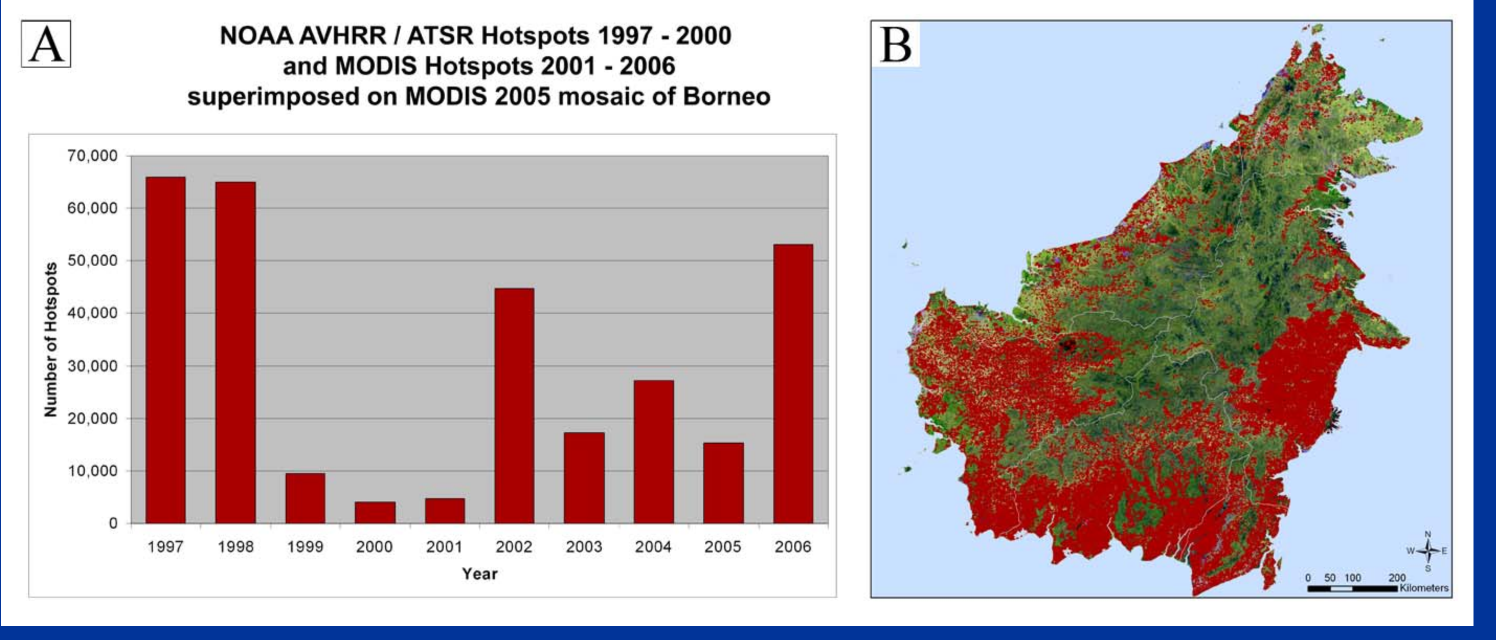
Driving forces : Fire

- Regular fires over last decade – **1997/98!**, **2002!**, 2003, 2004, 2005, **2006!** ….
- An annual event?



Annual fire hotspot data for Borneo 1997 to 2006
(Langner & Siegert, unpublished)

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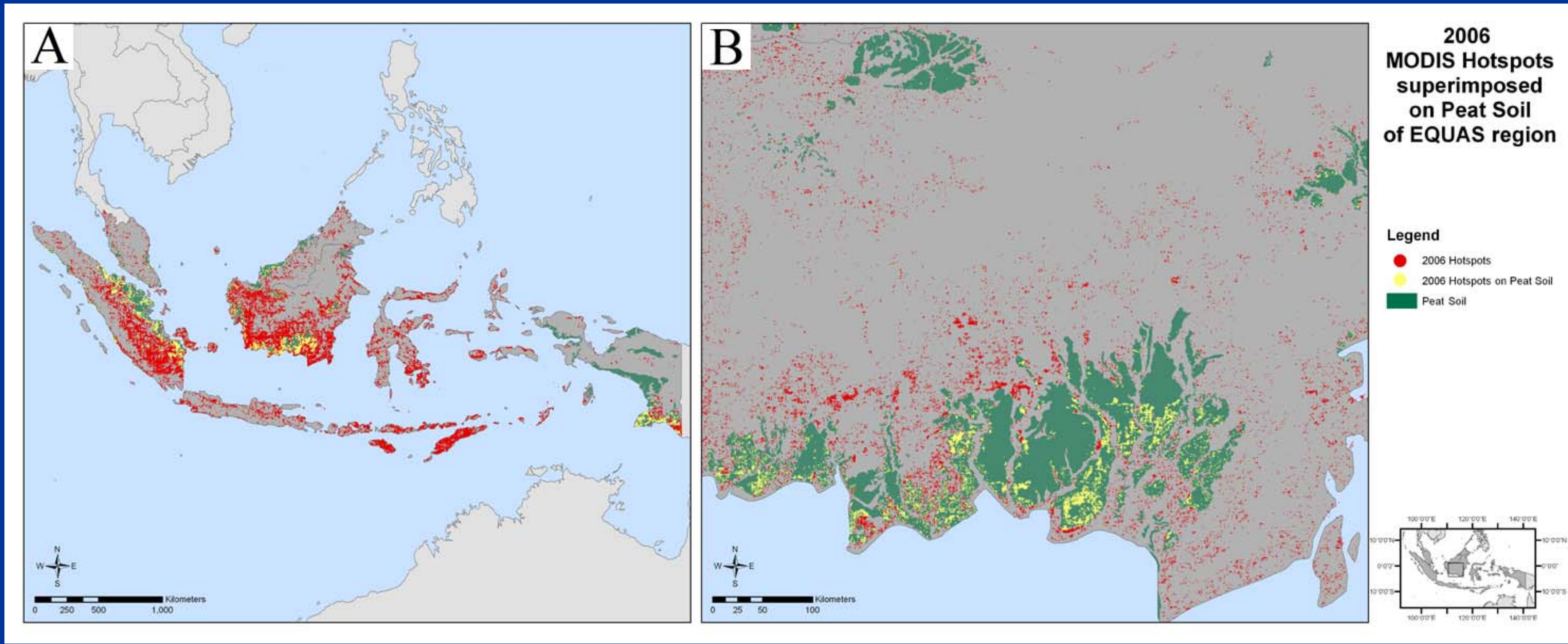
Driving forces : Fire



2006 fire hotspot data superimposed on distribution of peat
(Langner & Siegert, unpublished)

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Tropical peatlands and fire: Emissions

C emissions from Indonesian peatland fires during 1997/98:

- Range **0.81 – 2.57 Gt C** (Page et al. 2002)
  - Accounting for 55-95% of C emissions from all fires during that period in SE Asia (Schimel & Baker 2002; van der Werf et al. 2004, 2006).
- Equivalent to **18 to 57 years** of successful Kyoto implementation.

Drainage clearly increases risk of fire. In study area:

51% of drained peatland burnt compared with 19% of the undrained peatland.

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Tropical peatlands and fire

- Emissions caused by fires remain a large uncertainty in projections of C emissions from tropical peatlands.

- Problems of estimating emissions from hot-spots:
  - insufficient testing of relationship between hot spots and peat fire occurrence and severity; peat fires smoulder – are they detected?
  - problems of mapping hot spots onto peatland areas;
  - different fuel loads/emission factors for peat vs non-peat fires.

- Need detailed field assessments to confirm:
  - accuracy of burnt area estimates;
  - relationship between hot spots and fire occurrence / severity;
  - relationship between drainage depth, soil moisture and burn depth;
  - accurate values for 2^0 vegetation biomass combustion;
  - impact of post-fire conditions on fire risk / return period.

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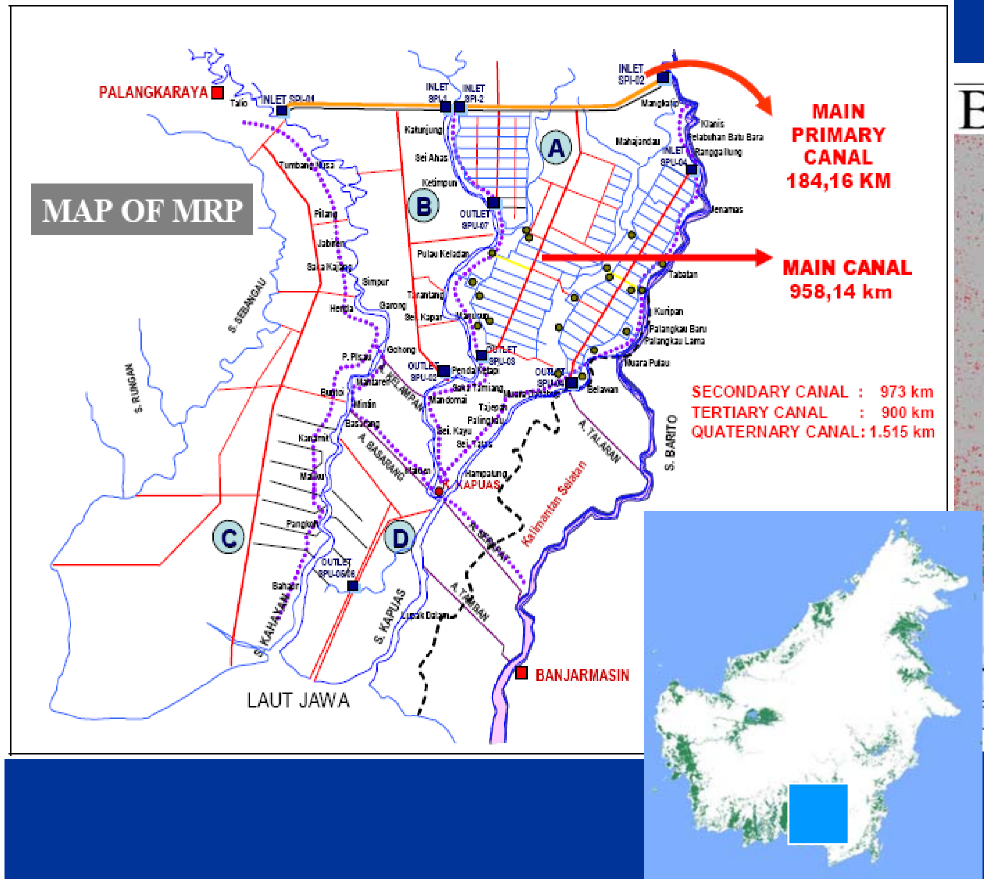
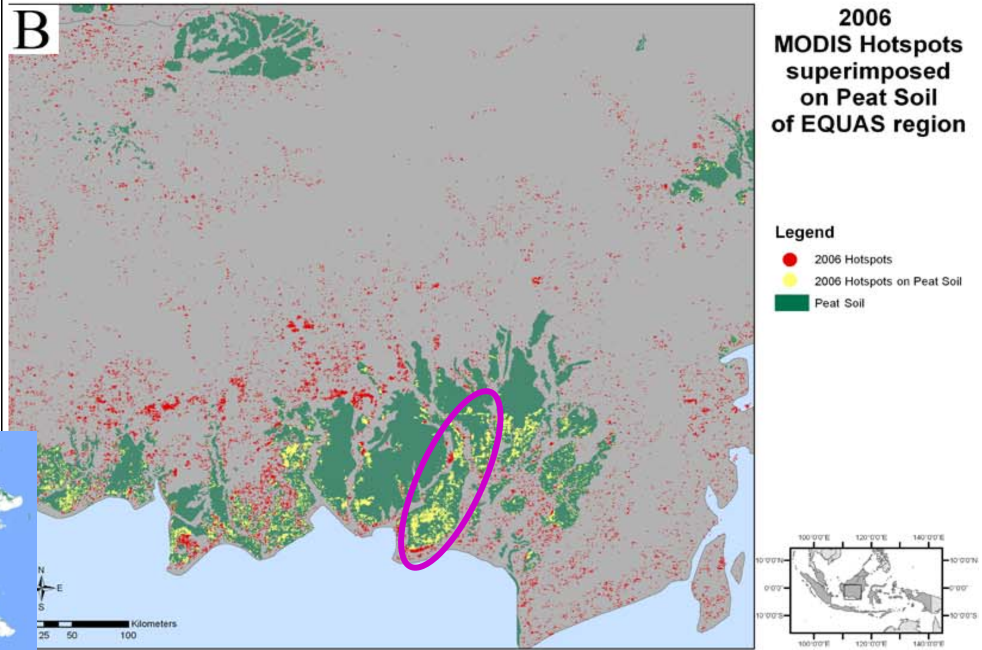
Tropical peatlands and fire: Study focus

Focus on Block C

450,000 ha

Former Mega Rice Project area
~1,000,000 ha
•Mainly peatland
•Carbon store c. 1-2 Gt
•1995-97 attempted agricultural conversion & extensive drainage





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LAND COVER CHANGE

1973-2003

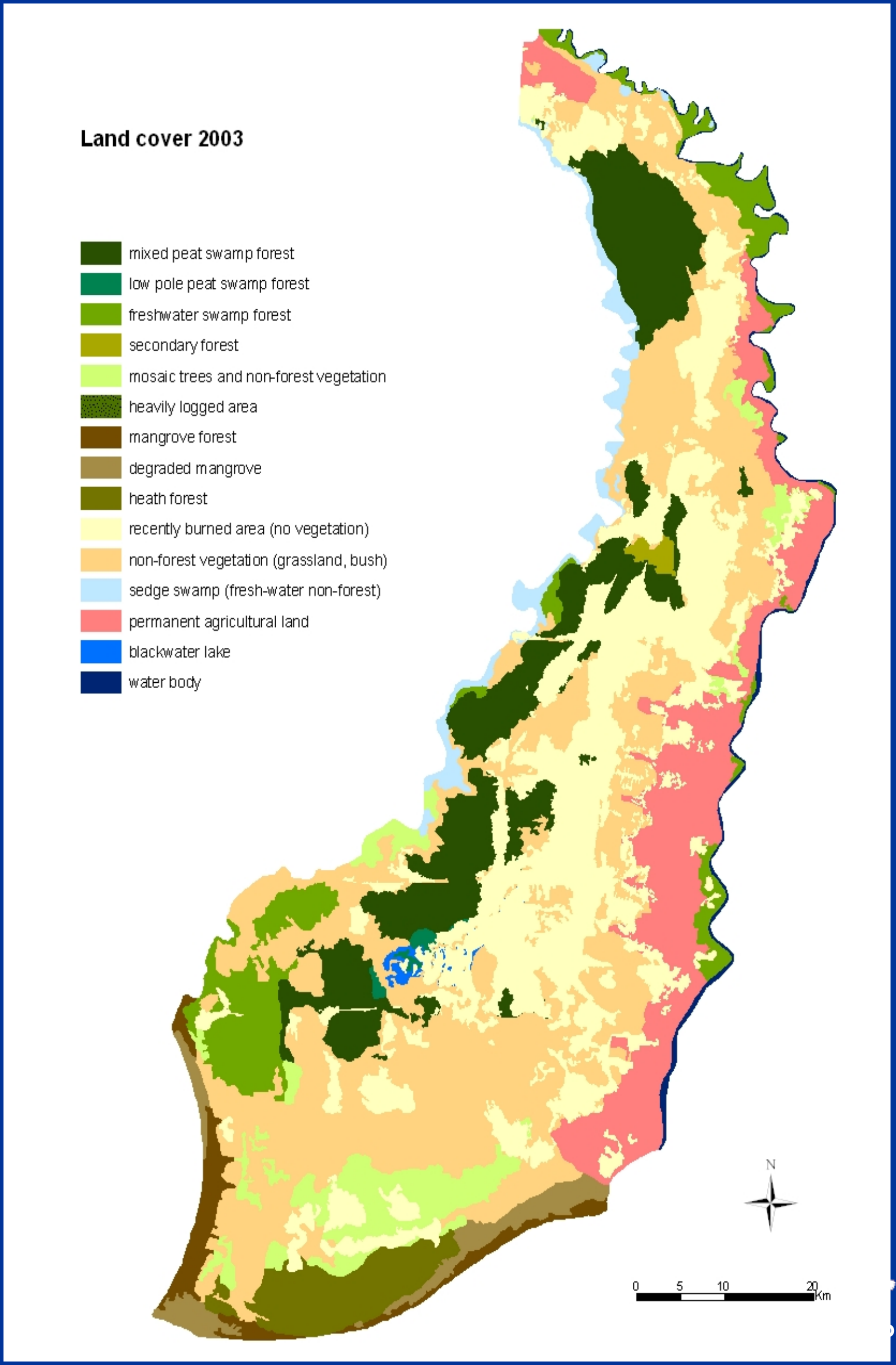
Landsat MSS

Landsat TM

Landsat ETM

Aster/TERRA

DMC (Disaster Monitoring Constellation)



PHY

Land cover change

FOREST TYPE	PRIMARY FOREST COVER (%) IN BLOCK C (450 000 ha)					
	1973	1991	1994	1997	2000	2003
Mixed peat swamp forest	56.5	48.6	41.1	40.0	16.0	12.8
Low pole peat swamp forest	3.1	3.1	3.1	3.1	0.7	0.3
Total peat swamp forest	**59.6**	**51.7**	**44.2**	**43.2**	**16.7**	**13.1**
Loss rate in relation to initial 1973		**13.3**	**25.8**	**27.6**	**72.0**	**78.1**
Heath forest	2.1	3.2	3.2	3.2	3.2	N/A
Freshwater swamp forest	8.7	8.4	7.9	7.8	6.0	N/A
Mangrove forest	2.1	2.1	2.1	2.1	2.1	N/A
Total forest cover	**72.5**	**65.6**	**57.6**	**57.3**	**27.9**	N/A

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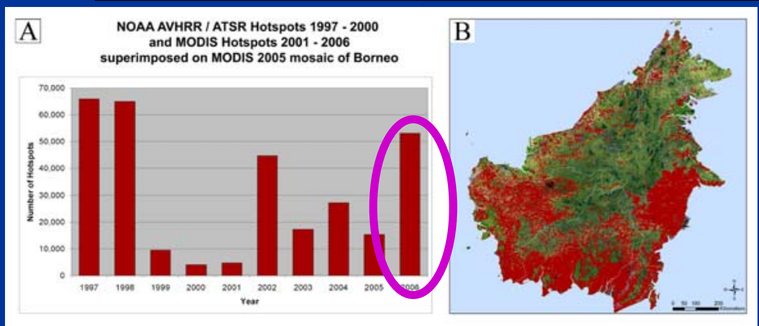
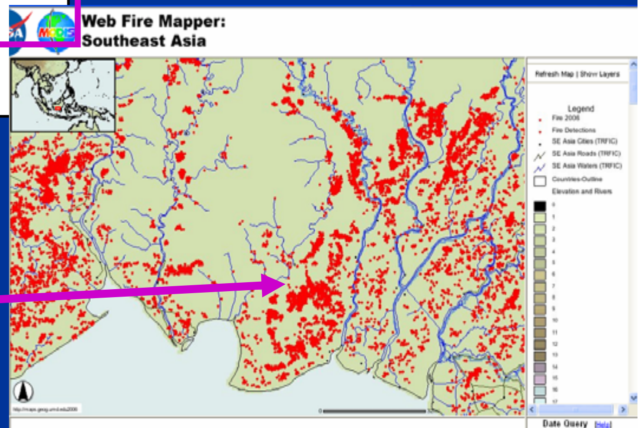
Fire history

Time period	El Niño events	Area of fire scars (ha)	% of block	TPSF	non-forest
before 1973	1972/73	31,109	6.9		
1974-1990	1982/83	35,605	7.9		
1991/92	1991/92	33,586	7.5		
1994-1996		4,629	1.0		
1997	1997/98	150,486	33.5	84.4	5.2
2002	2002/03	106,481	23.7	68.3	31.7
2003/04		64,180	14.3		
2005		55,768	12.4		
2006	2006	?	?		

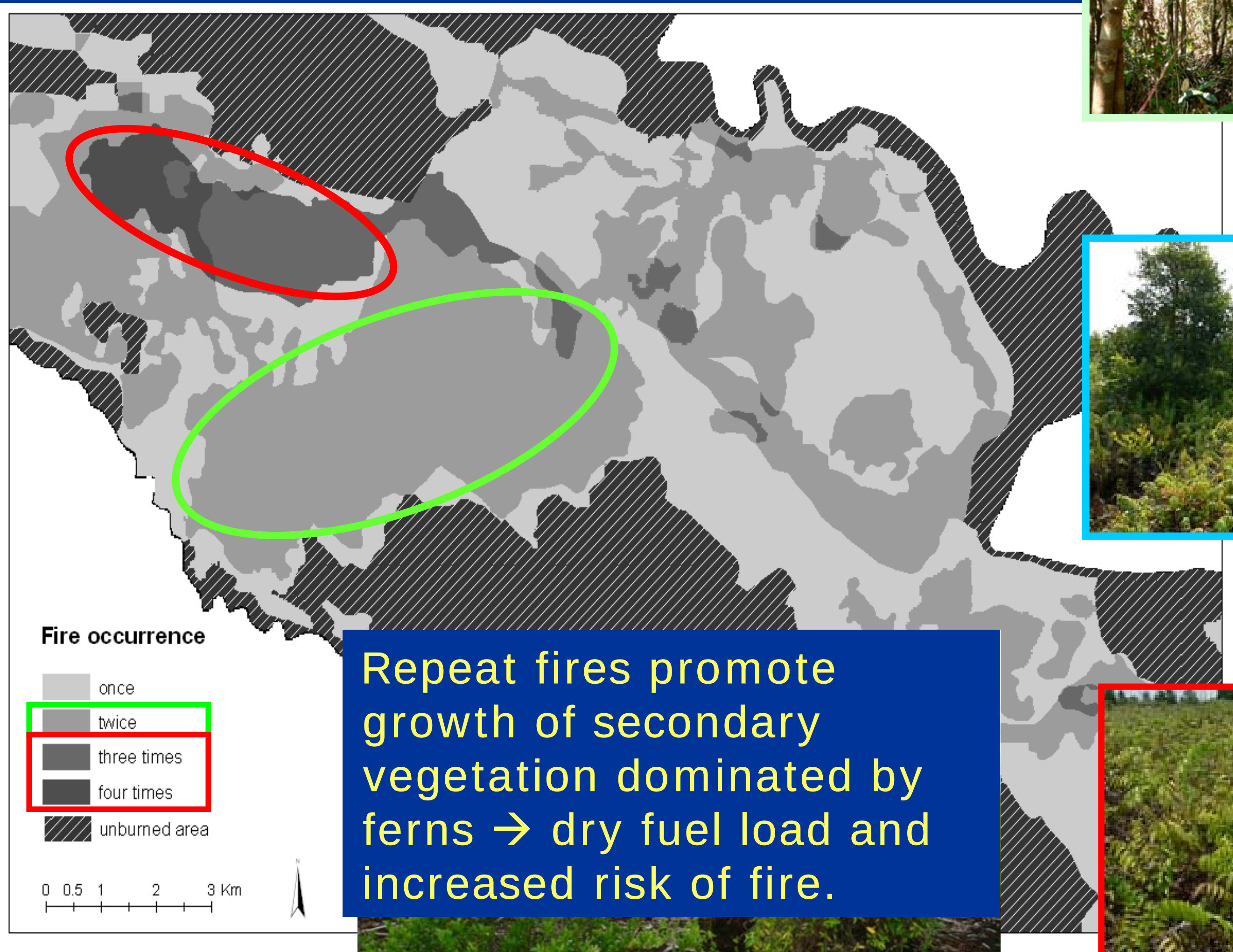


Dry season 2006



http://maps.geog.umd.edu/maps.asp

Fire frequency



Repeat fires promote growth of secondary vegetation dominated by ferns → dry fuel load and increased risk of fire.

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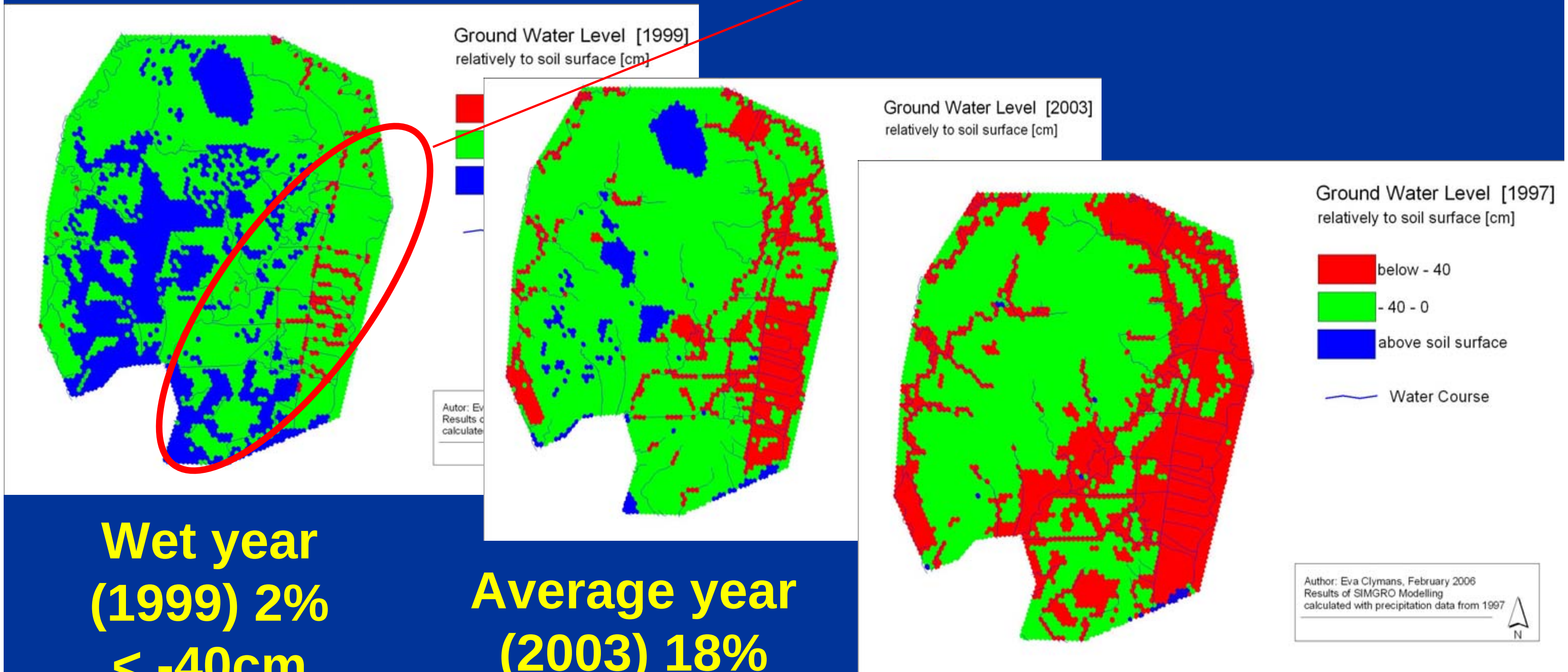
Hydrology and fire risk

Annual variation in ground water levels
(Wosten, Clymans, Page in press)

Block C



Wet year (1999) 2% < -40cm

Average year (2003) 18%

Dry year (1997) 40%

Groundwater level < **-40**cm ⇨ **high risk** of fire

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Estimating C losses from peatland fires:
Block C MRP : 1973-2005
(450,000 ha)

Drainage

Year	Area burnt peatland (ha)	C loss (Mt)**	Cumulative C loss (Mt)
before 1973	31,109	7.09	7.09
1974-1990	35,605	8.12	15.21
1991-96	38,215	8.71	23.92
1997	150,486	**34.31**	58.23
2002	106,481	**24.28**	82.51
2003-04	64,180	**14.63**	97.14
2005	55,768	**12.72**	**110**
2006	??	**20 ??**	**130 ??**

** based on combustion of 0.40 m peat, with bulk density 0.1 g cm^{-3} & C content 57% (excludes C lost in combustion of above-ground biomass)

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Conclusions

- Peatland fires will likely increase as more damaged, less fire-resistant vegetation covers the landscape & peatland drainage continues.
- Some fires are the unintended consequence of current land-use practices (….. although many are intended so can be controlled?).
- Peatland fires are currently main source of biomass combustion emissions in SE Asia.
- Peat fire emissions currently exceed those from slower peat decomposition.
- BUT this does not mean the problem can be solved by “fire fighting”.
- Peatland fires are ***promoted*** by deforestation and forest degradation linked to peatland drainage.
- They can only be stopped if these root causes are dealt with.
- **Stopping peat fires but not peatland drainage merely means it will take a longer time for the carbon to be released to the atmosphere !!**
- Longer term consequences for & of climate change ???

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Thank you !
CO_2
CO_2
CO_2


Thank you !

Tropical peatlands & the carbon cycle : from sink to source

Current (2005):

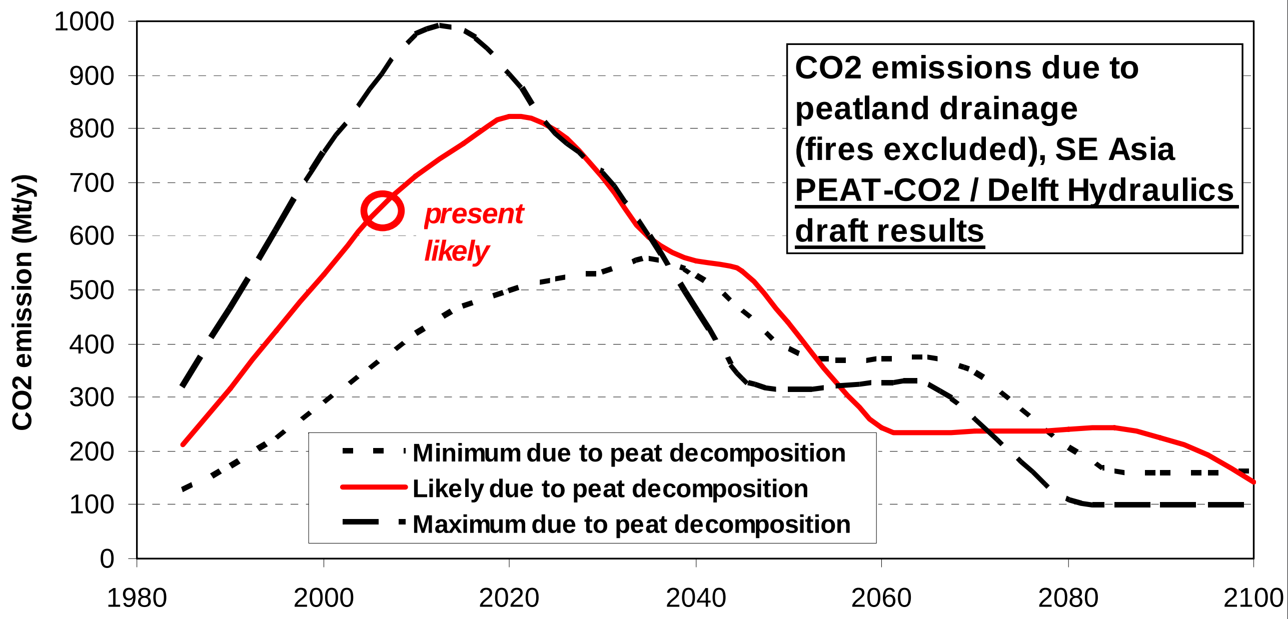
355-874 Mt CO_2 yr^{-1}

(100–240 Mt C yr^{-1})

Projected (2015-2035):

557-981 Mt CO_2 yr^{-1}

(150-270 Mt C yr^{-1})



Modelling C emissions from tropical peatland drainage – fire emissions NOT included

Current global emissions from fossil fuels ~ 25,000 Mt CO_2 yr^{-1}

(in comparison, tropical peat drainage emissions equivalent to 1.4-3.5% of fossil fuel emissions)

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Estimating C emissions from tropical peatland fires:
landscape-scale approach

- Block C peat fire emissions: 9.6 Mt C yr^{-1} (average annual emission 1997-2005)

- Block C peat drainage emissions (based on 0.25 t C ha^{-1} yr^{-1} emission per cm drainage depth (Hooijer et al. 2006; peatland area 337,632 ha)):
  - Drainage depth 0.50 m: 4.22 Mt C yr^{-1}
  - Drainage depth 1.00 m: 8.44 Mt C yr^{-1}

- Total emissions for Block C 1997-2005:
  - Fires: 86 Mt + Drainage: 38-76 Mt = 124-162 Mt C

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