Assessing GHG emissions from peatland: methodological challenges

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WORKSHOP ON OPTIONS FOR CARBON FINANCING TO SUPPORT PEATLAND MANAGEMENT
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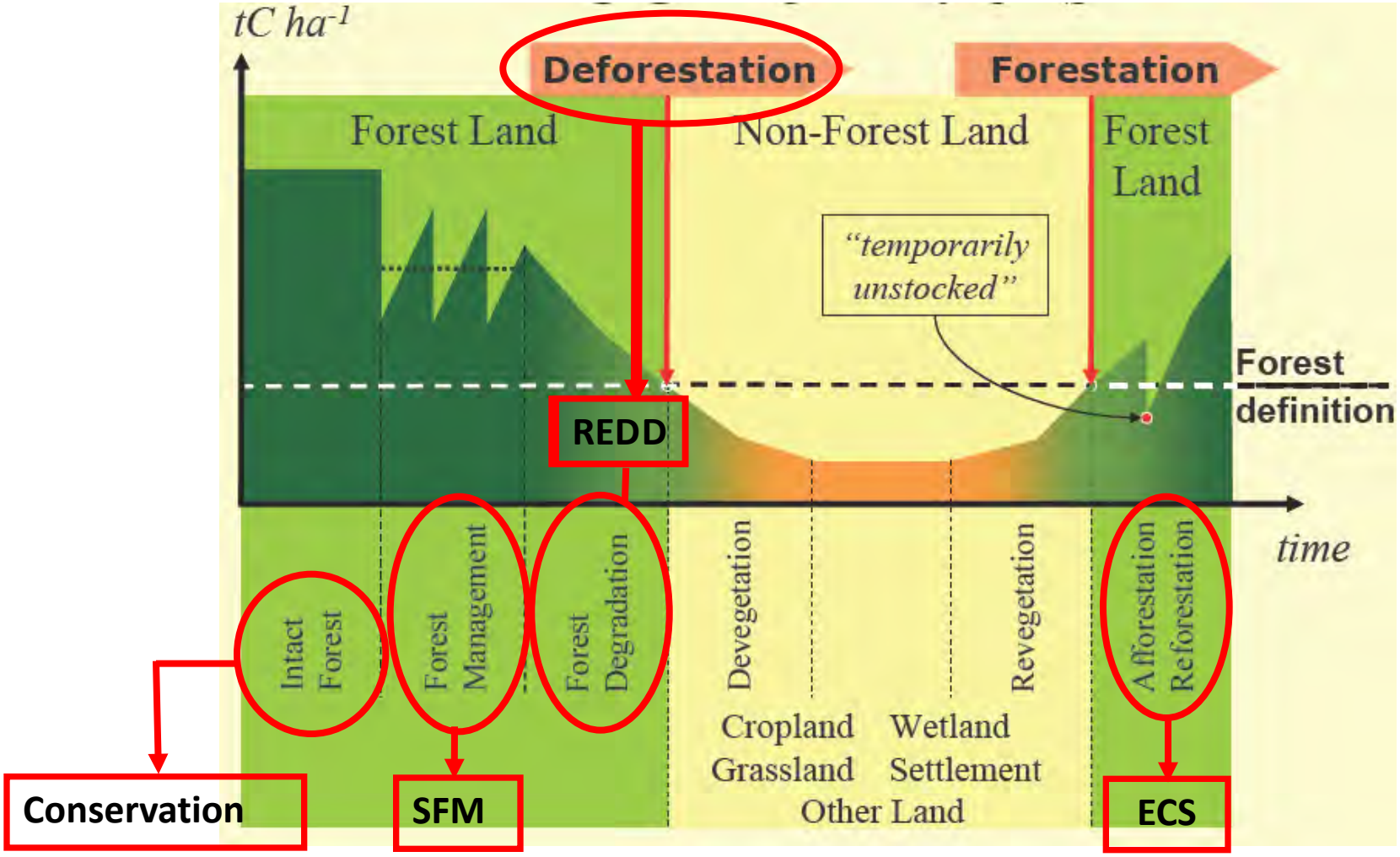
Outline

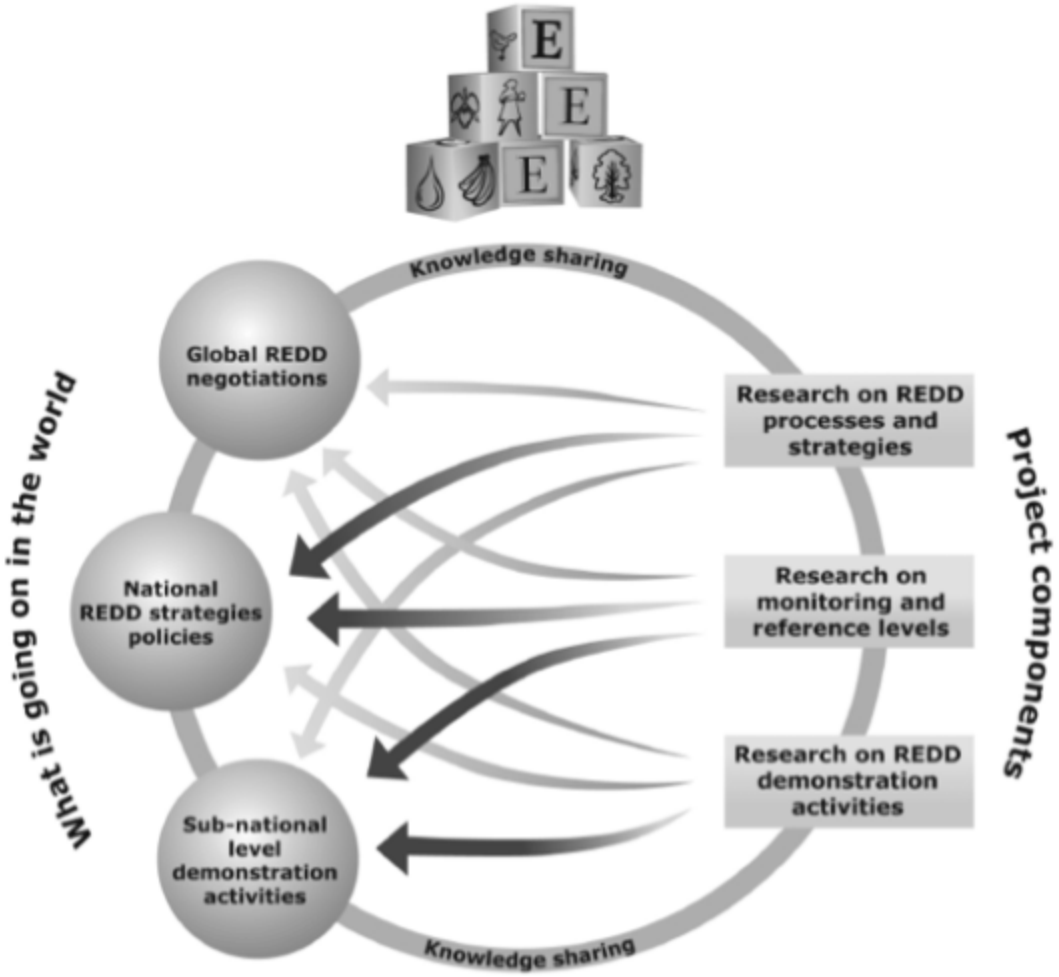
- Introduction
- IPCC methodologies
  - *Stock change approach*
  - *Flux change approach*
  - *Combination*
- Estimating C-pools → MRV
- REDD+ payment?
- Conclusions

RED, REDD, and REDD-plus



Source: Pedroni (2009)

Global Comparative Study on REDD (GCS-REDD)



- C1 – National REDD process and strategies
- C2 – REDD demonstration activities
- C3 – MRV and Reference Levels
- C4 – Knowledge sharing

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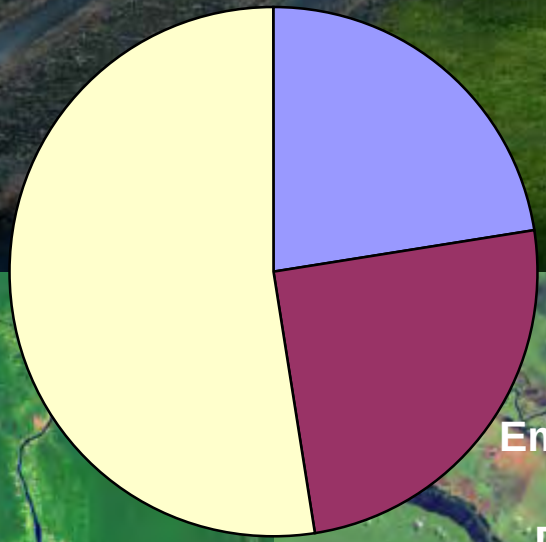
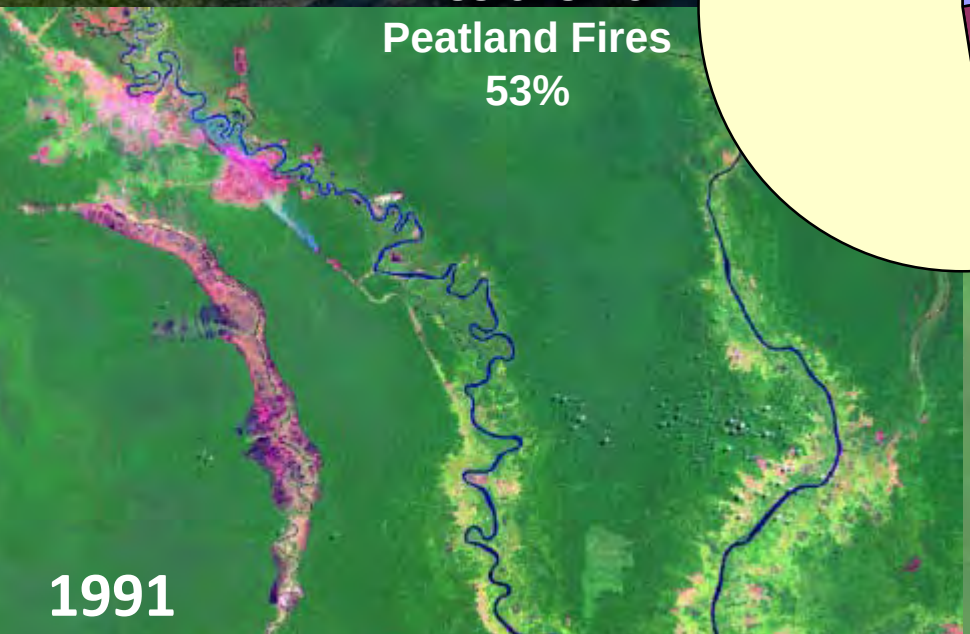
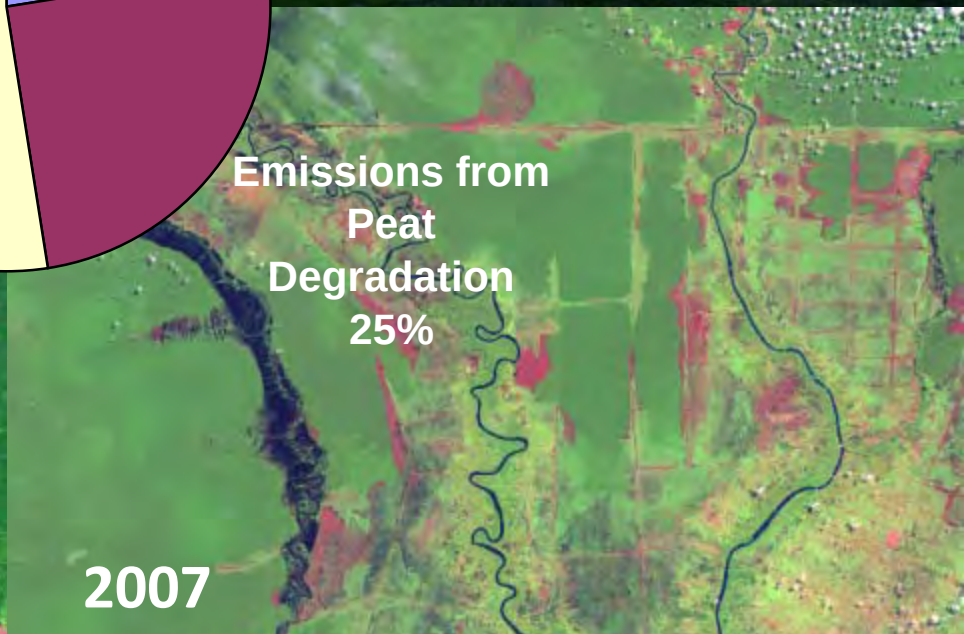
Annual emissions from peat loss (2,398 $MtCO_2$)

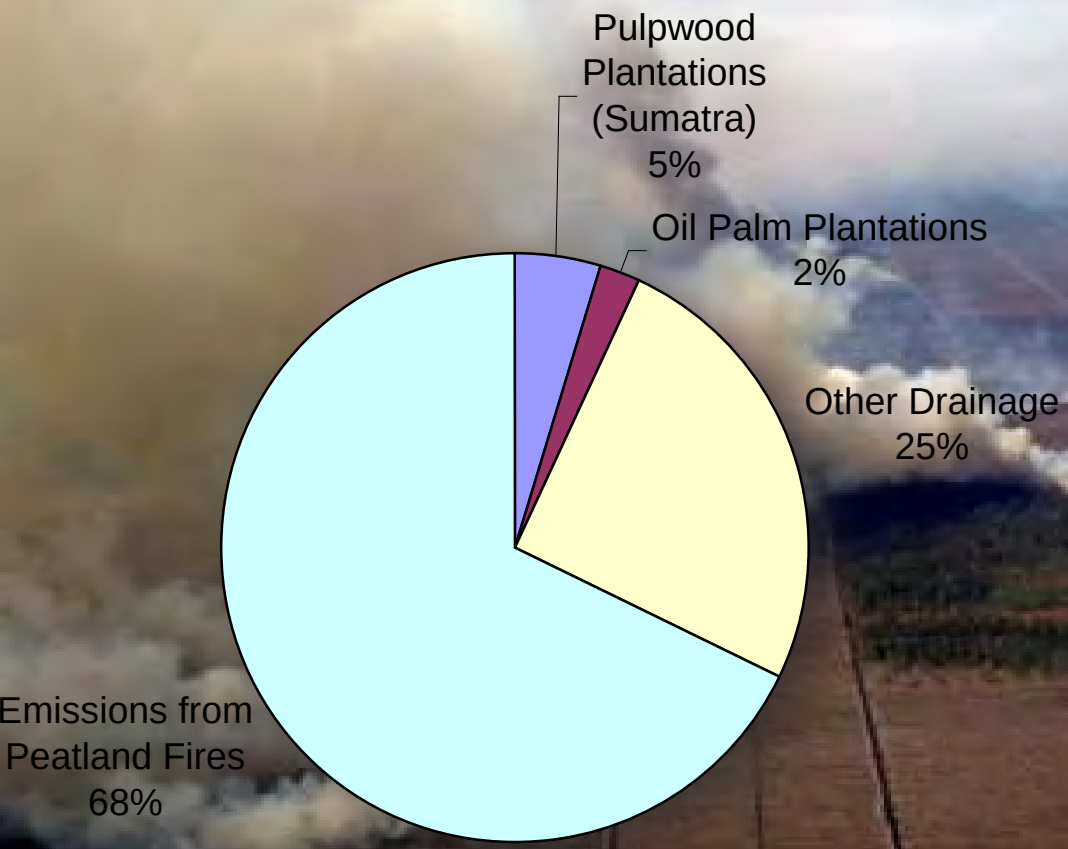


Source: PEAT–CO2 (2006)





Annual emissions from peat loss (1,860 $MtCO_2$)

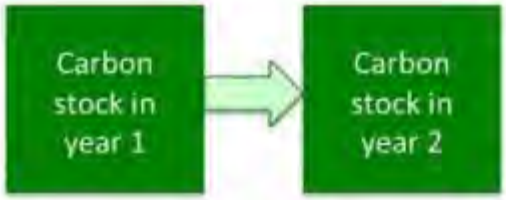


Source: IFCA (2007)

Photo: Faizal Parish

Methodological approaches

Stock-change approach



$$\Delta C = (C_{t2} - C_{t1}) / (t_2 - t_1)$$

Where:

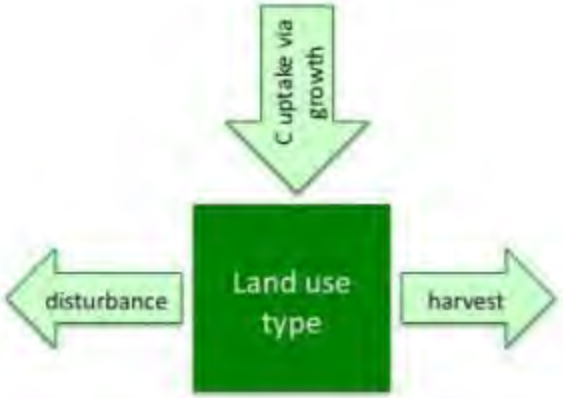
ΔC = annual carbon stock change in pool (t C/yr)

ΔC_{t1} = carbon stock in pool at time t_1 (t C)

ΔC_{t2} = carbon stock in pool at time t_2 (t C)

Source: IPCC (2006)

Flux-change approach



$$\Delta C = \Delta C_{gain} - \Delta C_{loss}$$

Where:

ΔC = annual carbon stock change in pool (t C/yr)

ΔC_{gain} = annual gain in carbon (t C/ yr)

ΔC_{loss} = annual loss in carbon (t C/ yr)

Methods
for estimating C loss from land conversion

Stock-change approach

Before

After

C_{FOREST}

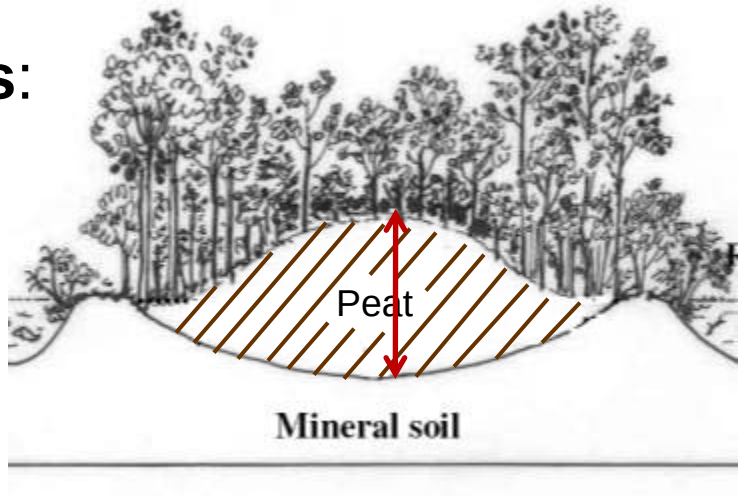
C_{OLU}

$$\Rightarrow \quad C_{loss} = C_{FOREST} - C_{OLU}$$

Measuring C-pools

Stock-change approach, **C Pools**:

- Aboveground biomass
- Belowground biomass
- Litter
- Dead wood
- Soil (**full depth** of peat deposit)



Difficulties & Limits: **Peat C stocks**

- Peat depth up to 20 m ⇒ compaction, limited number profiles
- Presence logs ⇒ bulk density
- High water table level ⇒ bulk density???

Methods
for estimating C loss from land conversion

Flux-change approach

Before

After

$\Delta C_{FOREST} = C_{IN} - C_{OUT}$

$\Delta C_{OLU} = C_{IN} - C_{OUT}$

$\Rightarrow$ **$C_{loss} = (\Delta C_{FOREST} - \Delta C_{OLU}) \times duration$**

Measuring C-flux

Flux change approach, **C fluxes**:

- Biomass growth (above- & below-ground, Net Primary Production)
- Losses from biomass harvest & burning
- Transfer **into** and **out of** peat stocks

Difficulties & Limits: **Biomass**

- Meteorological techniques:

  expensive & sophisticated

Methods
for estimating C loss from land conversion

Combination of both methods

Before

After

$C_{\text{Above-ground biomass FOREST}}$

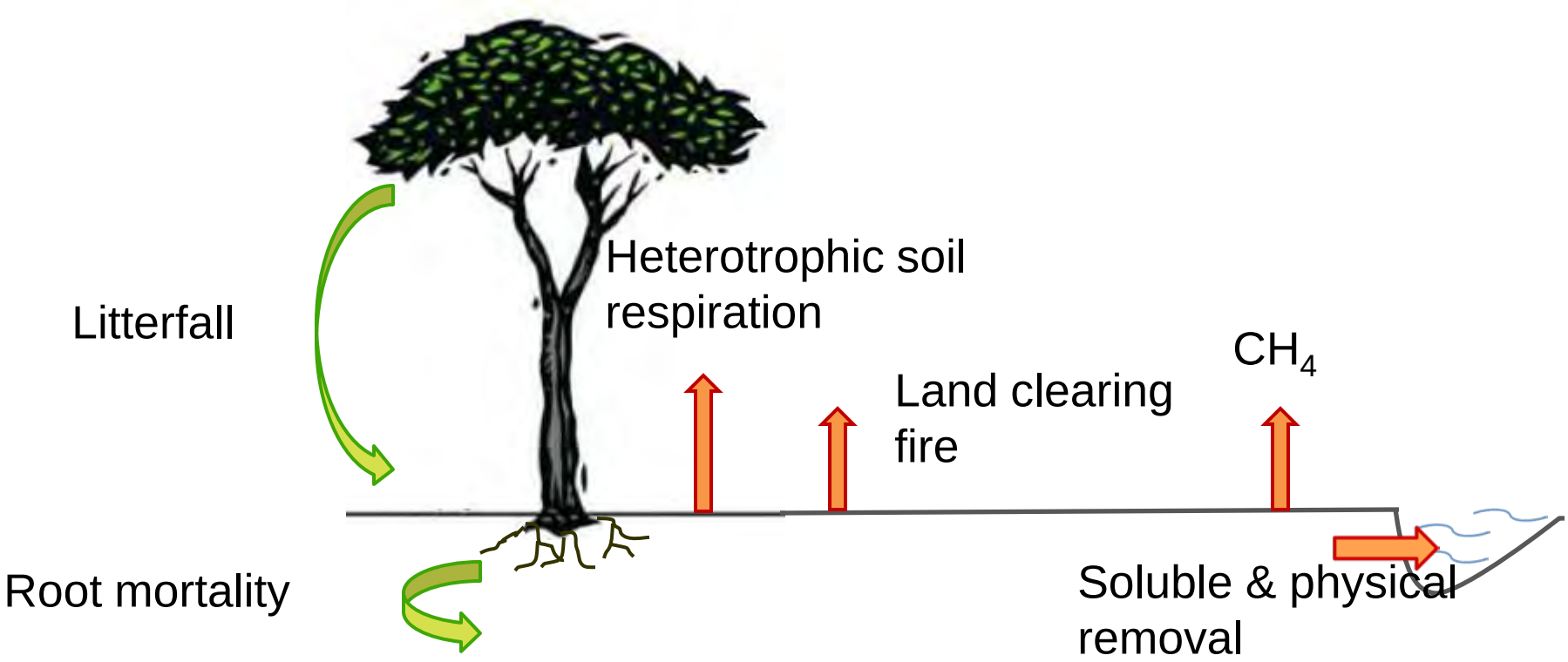
$C_{\text{Above-ground biomass LU}}$

$$\Delta C_{\text{peat FOREST}} = C_{\text{IN peat}} - C_{\text{OUT peat}}$$

$$\Delta C_{\text{peat OLU}} = C_{\text{IN peat}} - C_{\text{OUT peat}}$$

$$\Rightarrow \quad C_{\text{loss}} = (C_{\text{Abvgrd biomass FOREST}} - C_{\text{Abvgrd biomass LU}}) + (\Delta C_{\text{peat FOREST}} - \Delta C_{\text{peat OLU}}) \times \text{duration}$$

C fluxes into and out of the peat

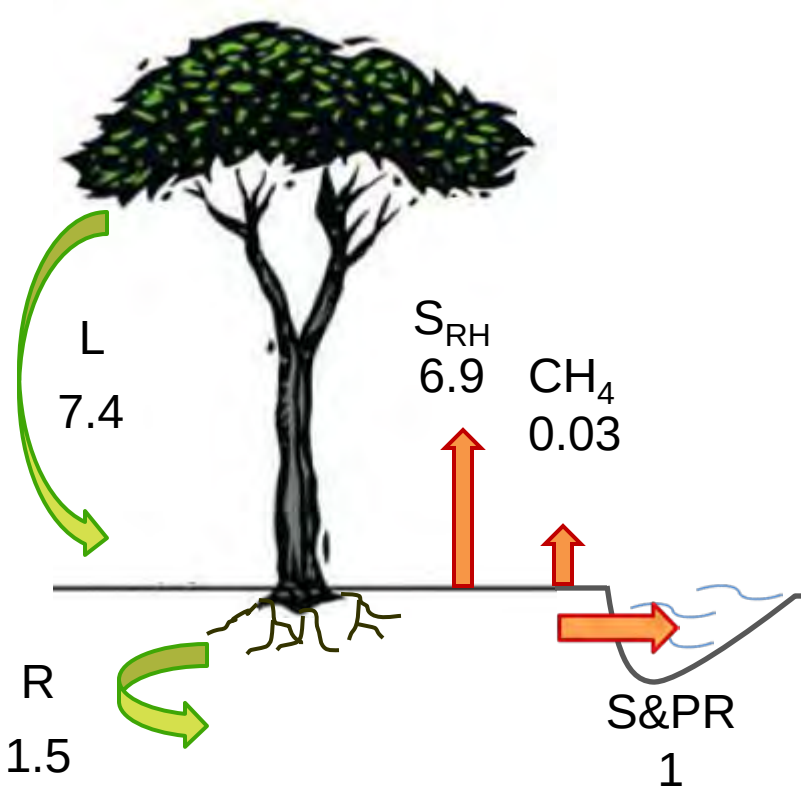


Total soil respiration = Heterotrophic soil respiration + root respiration

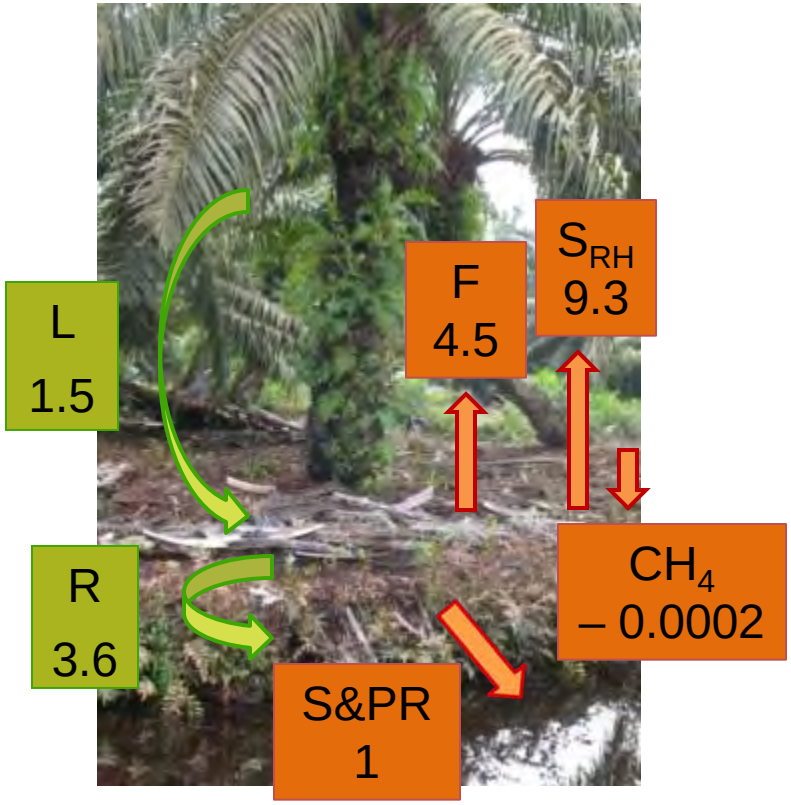
Heterotrophic soil respiration = peat oxidation = peat decomposition

Example

Before



After



$$\Delta C_{peat\ FOREST} = C_{IN\ peat} - C_{OUT\ peat}$$
$$= 8.9 - 7.9$$
$$= \mathbf{1.0\ Mg\ C\ ha^{-1}\ y^{-1}}$$

$$\Delta C_{peat\ OP} = C_{IN\ peat} - C_{OUT\ peat}$$
$$= 5.0 - 14.8$$
$$= \mathbf{-\ 9.8\ Mg\ C\ ha^{-1}\ y^{-1}}$$

Example

Before

After

$C_{\text{Above-ground biomass FOREST}}$

$\Delta C_{\text{peat FOREST}} = C_{\text{IN peat}} - C_{\text{OUT peat}}$

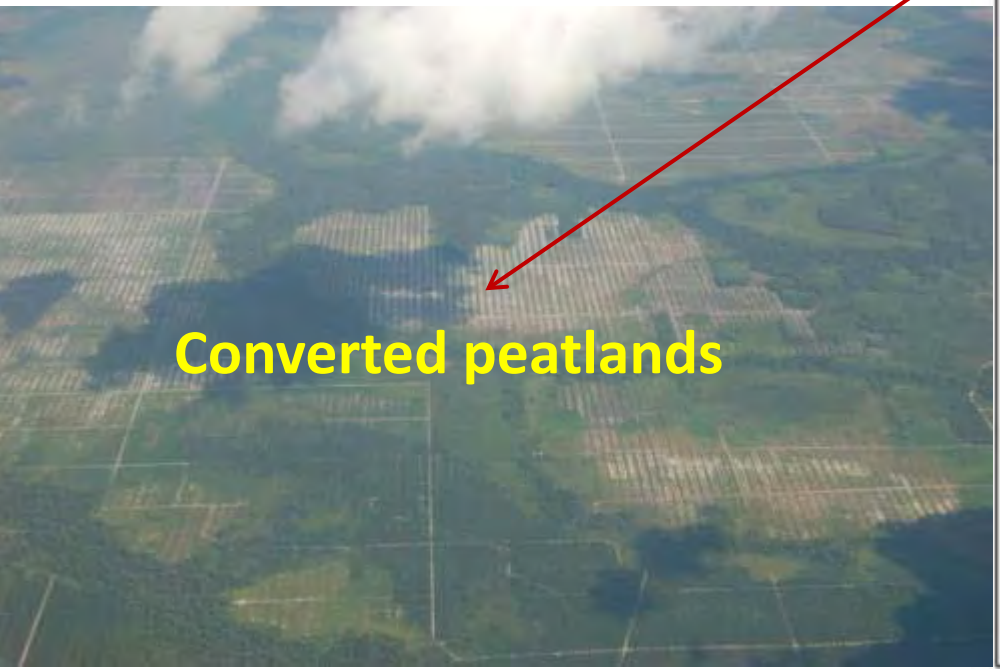
$C_{\text{Above-ground biomass LU}}$

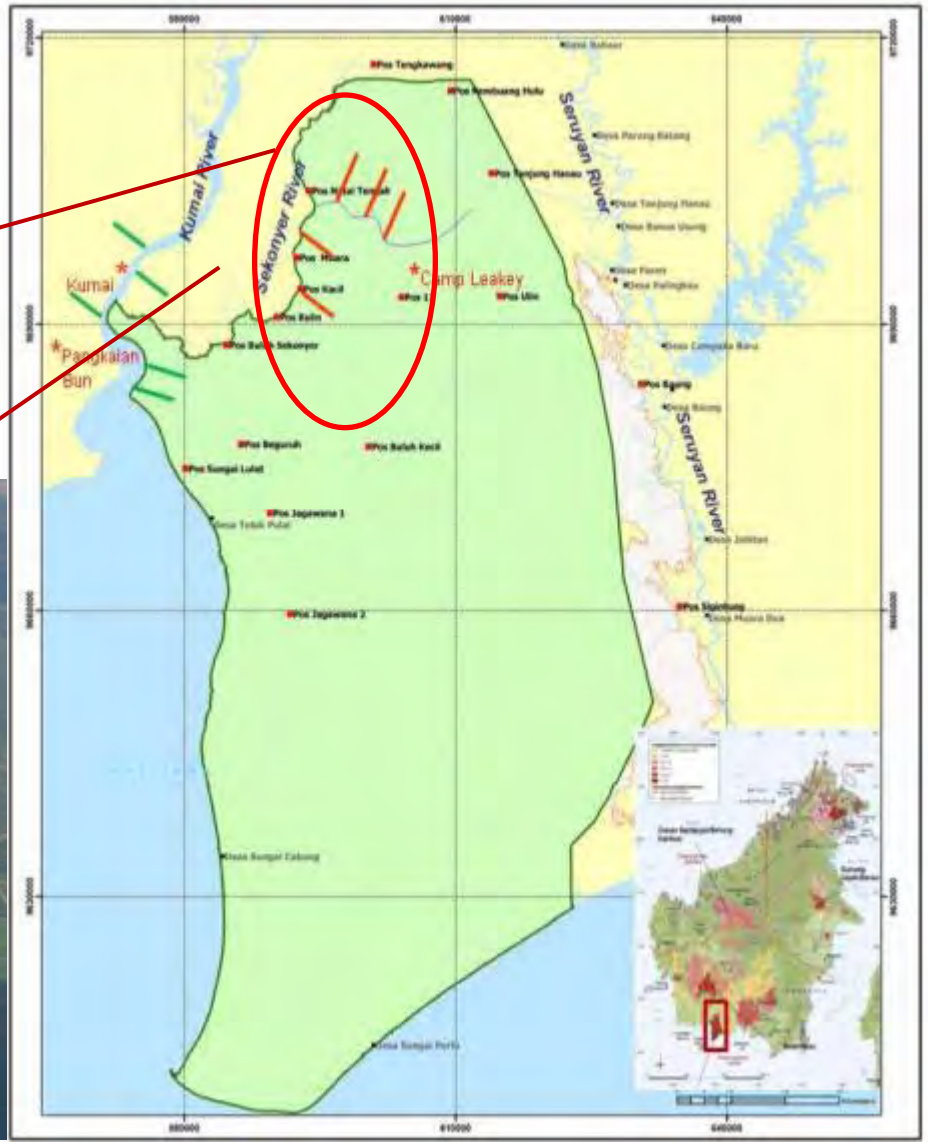
$\Delta C_{\text{peat LU}} = C_{\text{IN peat}} - C_{\text{OUT peat}}$

$\Rightarrow$ **C_{loss} = 428 Mg C ha^{-1} over 25 years**

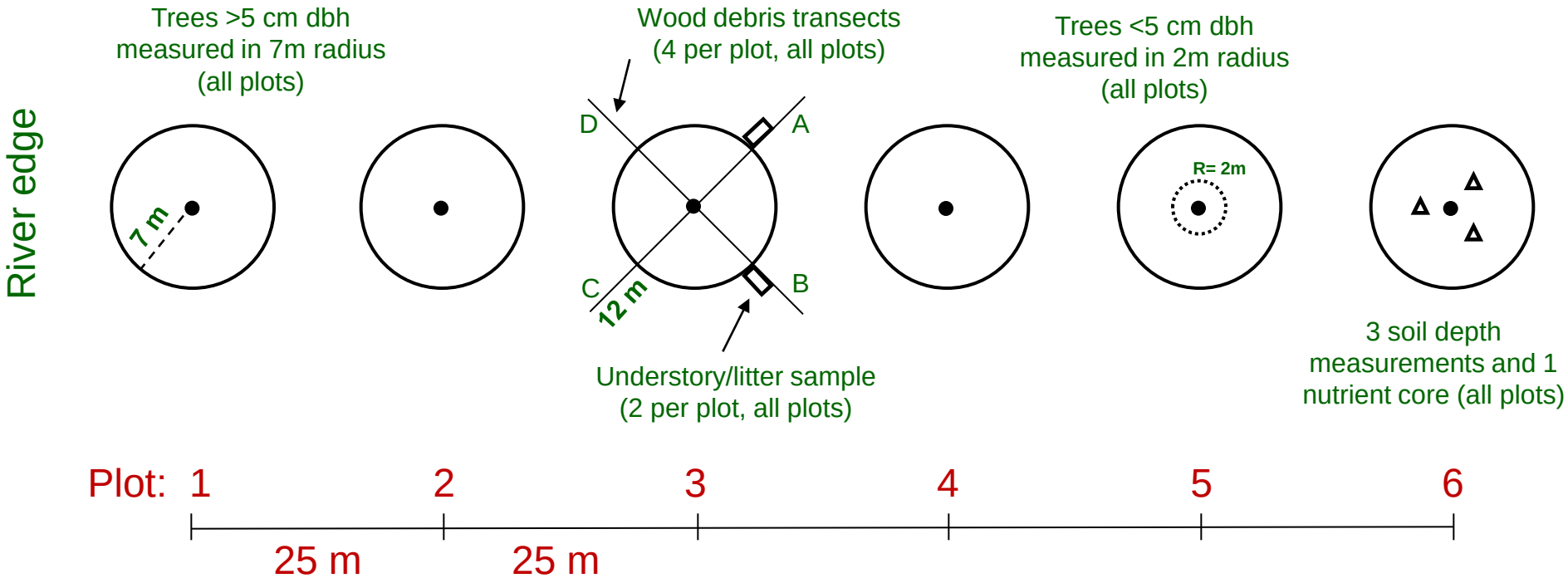
Estimating C-pools

Sampling transects

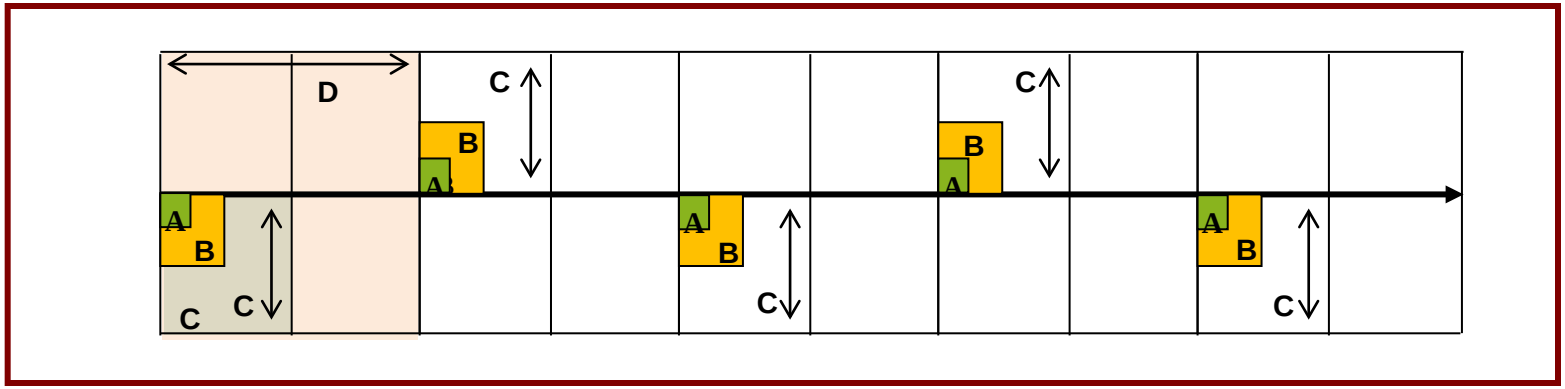




The transect

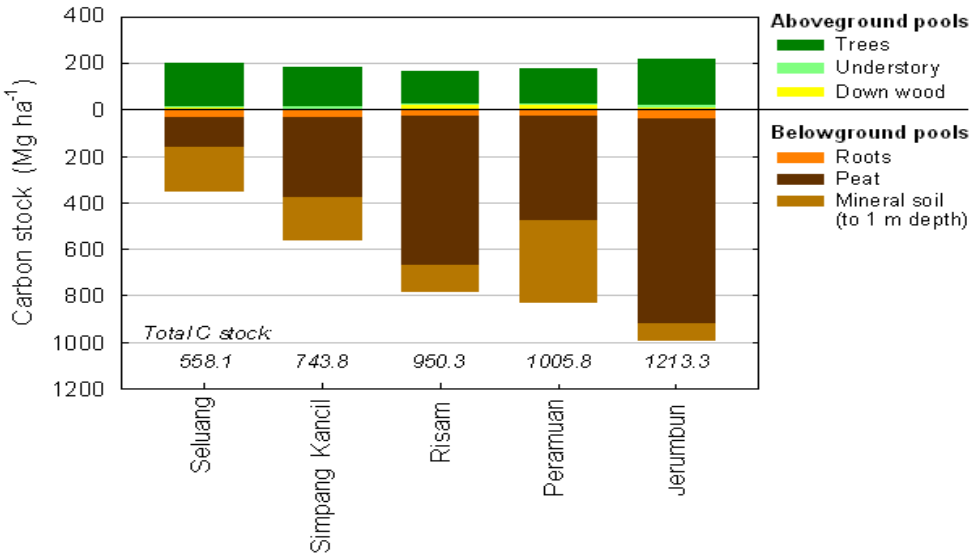


The transect



A: 2m X 2m for <u>seedlings</u> (h<1.5m), fern, shrubs and herbs
B: 5m X 5m for <u>saplings</u> (h ≥ 1.5m), palm tree, pandan, and non-woody liana
C: 10m X 10m for <u>poles</u> (d=10-20cm)
D: 20m X 20m for <u>trees</u> (d> 20cm), and woody liana

Above and belowground C-stocks



THINKING beyond the canopy

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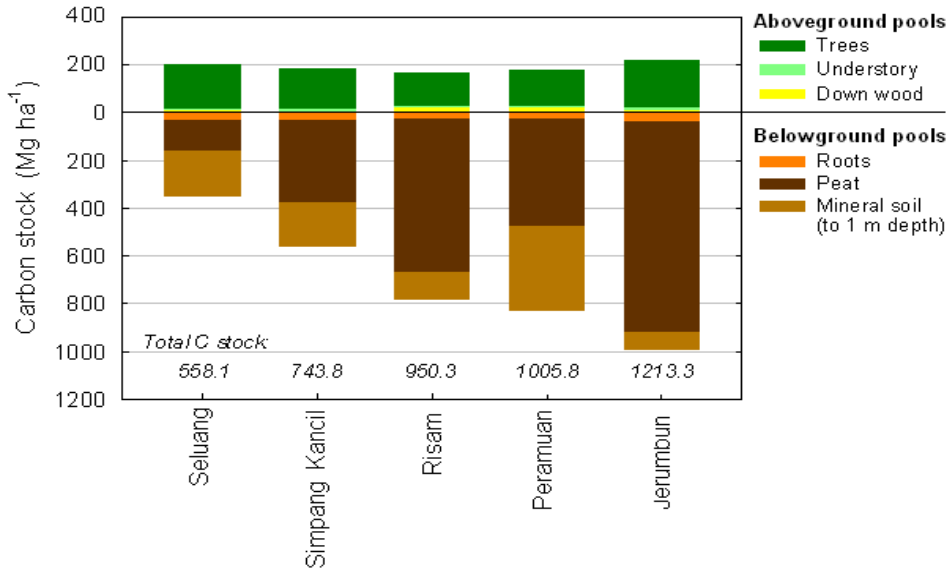
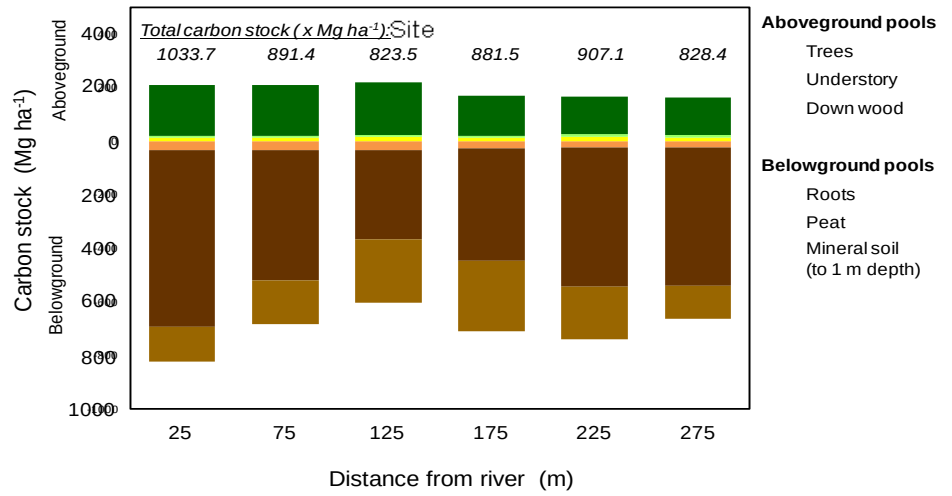
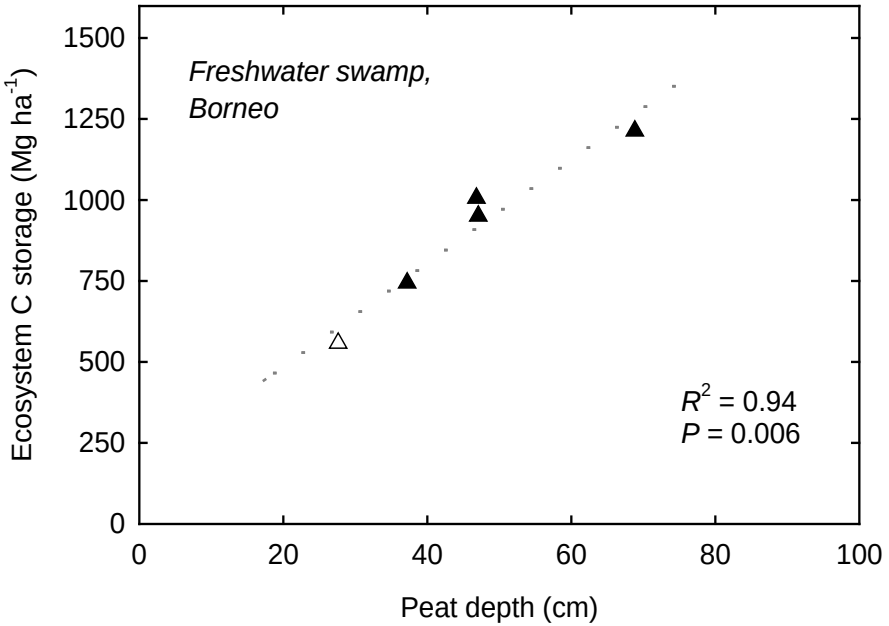
Peat depth matters







THINKING beyond the canopy

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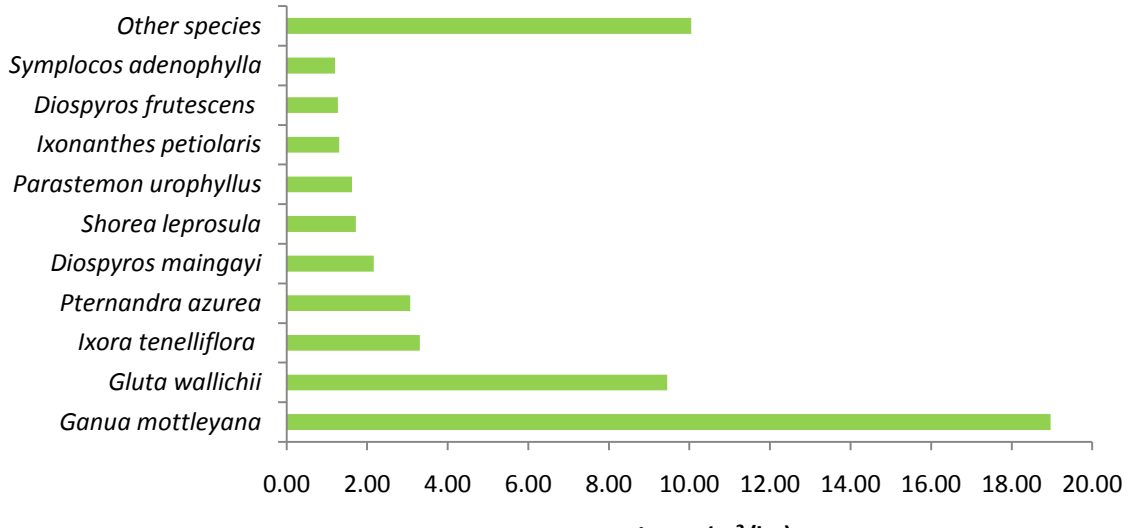
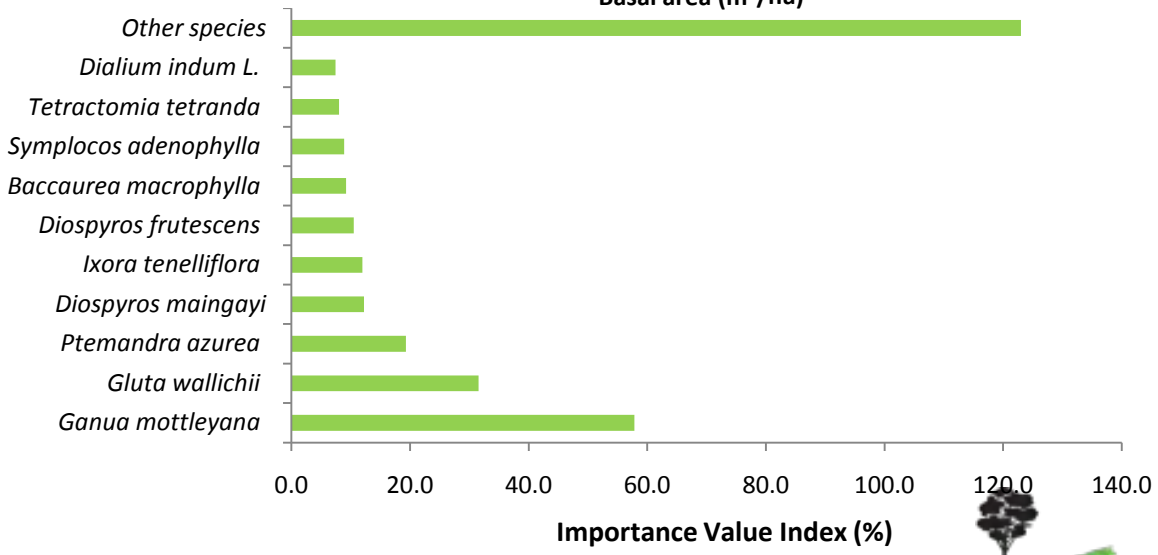
Basal area and IVI





THINKING beyond the canopy

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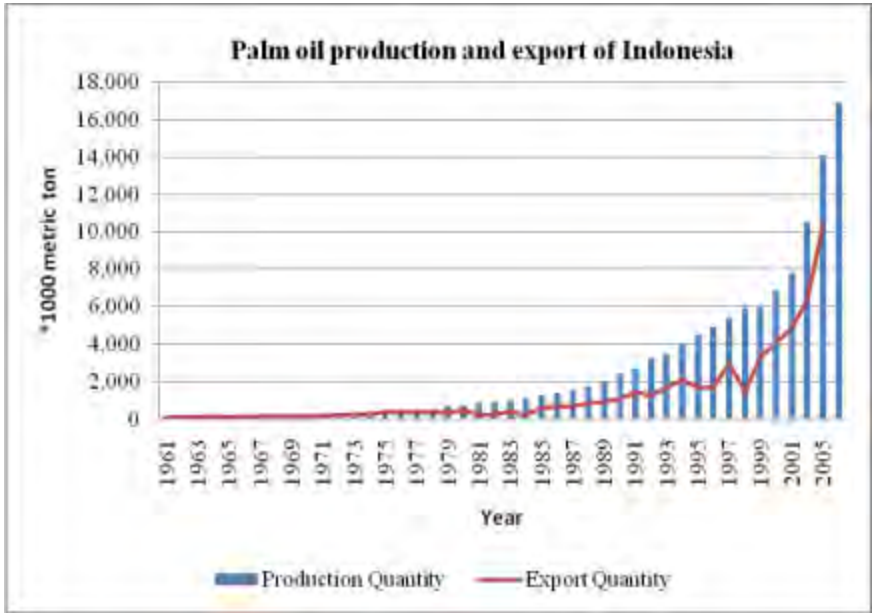
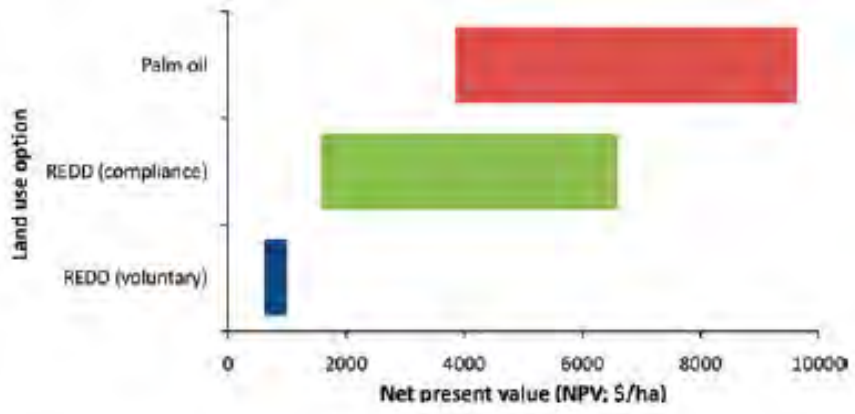
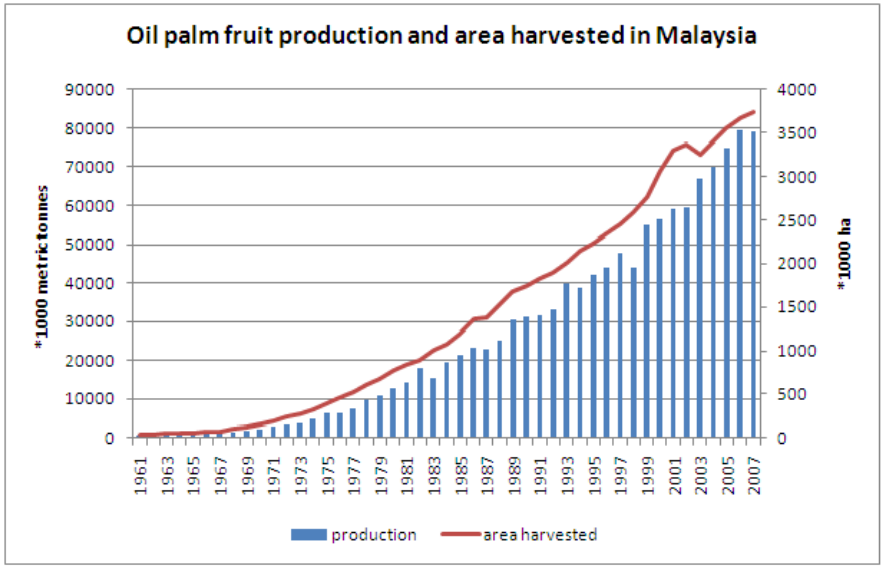
How can REDD+ compete with oil palm?

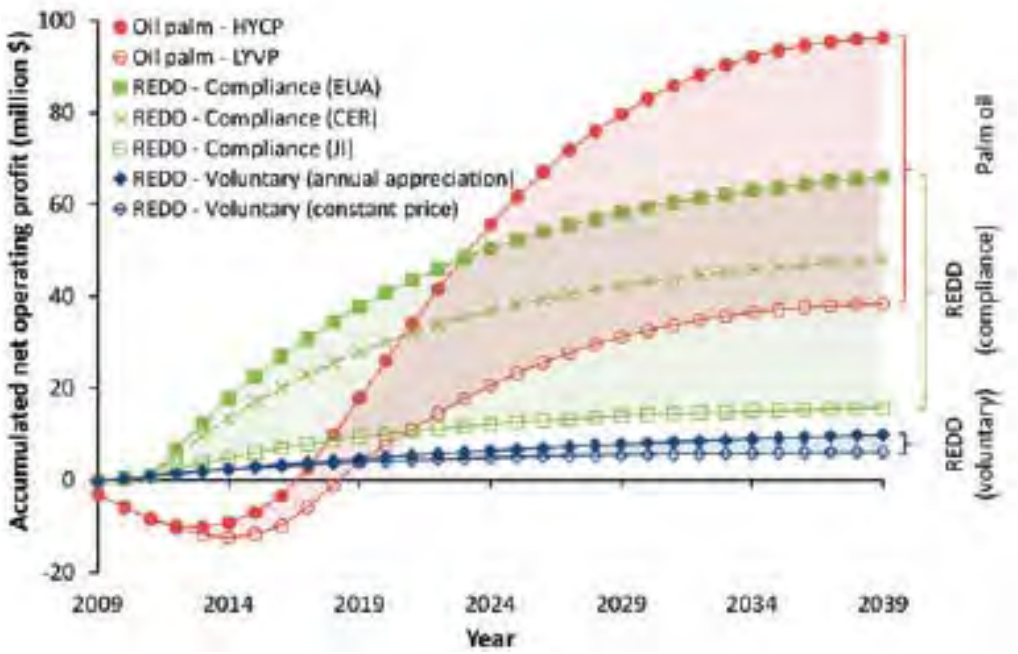


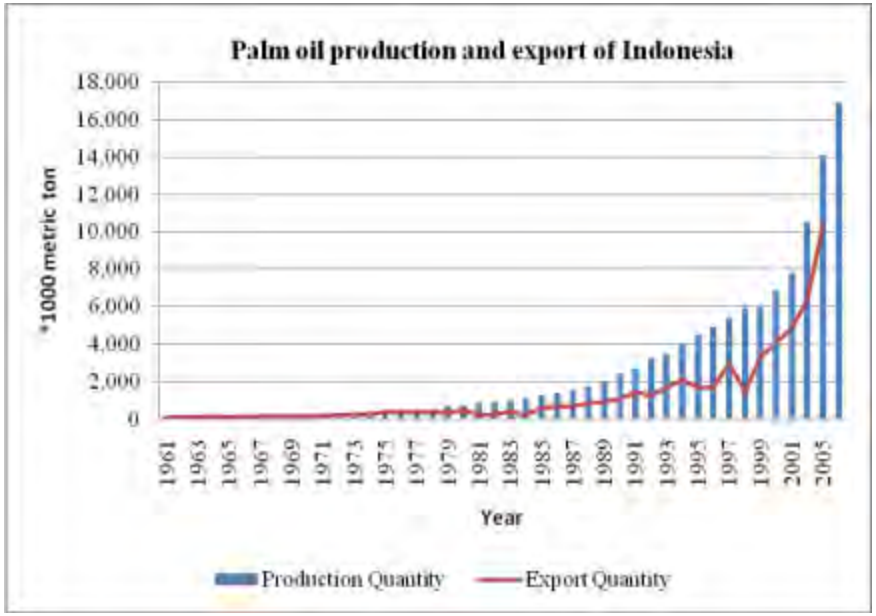
Source: Murdiyarso and Kanninen (2008)



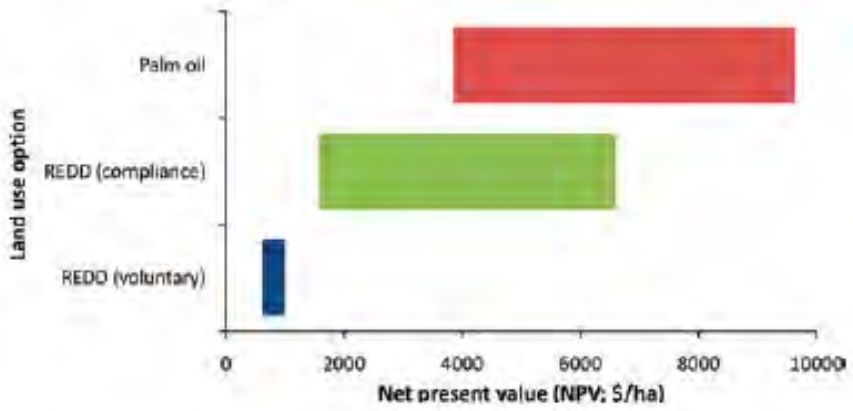
Source: Butler et al. (2009)







Source: Murdiyarso and Kanninen (2008)



Source: Butler et al. (2009)

Conclusions

- Important gaps knowledge of C cycle in tropical peatlands e.g. peat swamp forests and *Acacia* plantations
- Estimates show very high C-stocks and C-loss
- Peat swamp forest conversion into oil palm plantation: 63% total C loss from the peat
- Mean total C stock was 894.3 Mg C ha^{-1} (range: 558 to 1213) at mean peat depth of 45.5 ± 6.8 cm
- C-pools and their fates associated with land cover change and fire incidence are greatly needed in order to make sound policy decisions relating to carbon financing through REDD+ mechanism

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THINKING beyond the canopy

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